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The State of Eritrea **Ministry of Health**

NATIONAL HEALTH-CARE WASTE MANAGEMENT PLAN

FINAL REPORT

Acronyms

AIDS	:	Acquired Immune Deficiency Syndrome
CHL	:	Central Health Laboratory
EC	:	Executive Committee
EPI	:	Expanded Programmes of Immunization
GNP	:	Growth National Product
GOE	:	Government of Eritrea
HAMSET	:	HIV/AIDS, Malaria, STDS & TB Control Project.
HCF	:	Health-Care Facility
HCW	:	Health-Care Waste
HCWM	:	Health-Care Waste Management
HCWMO	:	Health-Care Waste Management Officer
HDPE	:	High Density Polyethylene
HHIC	:	Hospital Hygiene and Infection Control
HIV	:	Human Immune Deficiency Virus
HMIS	:	Health Management Information System
HS	:	Health Services
ICC	:	Infection Control Committee
IDA	:	International Development Association
MAP	:	Multi-Country HIV/AIDS Programme
MOD	:	ministry of Defence
MOF	:	Ministry of Finance
MOH	:	Ministry of Health
MOLWE	:	Ministry of Land Water and Environment
NAP	:	National Action Plan
NBB	:	National Blood Bank
NGO	:	Non Governmental Organisation
NSCHCWM	:	National Steering Committee on Health-Care Waste Management
O&M	:	Operation and Maintenance
PC	:	Project Co-ordinator
PMU	:	Project Management Unit
TGIS	:	Task Group on Institutional Strengthening
TGMP	:	Task Group on HCW Monitoring Plan
TGPS	:	Task Group on Procedures Standardisation
TGRL	:	Task Group on Regulations and Laws
UNEP	:	United Nation Environmental Programme
UNICEF	:	United Nation Children's Fund
WHO	:	World Health Organization
ZHMT	:	Zonal Health Management Teams
ZHS	:	Zonal Health Services
ZMO	:	Zonal Medical Officer

Contents

Figures and Tables

Annexes

Executive Summary

The Eritrean Health Services remain below minimum international standards, resulting in significant risks to health-care workers and in-patients through the potential transmission of nosocomial infections within the Health-Care Facilities (HCFs). In this respect, the hygiene conditions linked to the handling and disposal practices of Health-Care Waste (HCW) are insufficient: the health and environmental risks linked with their mismanagement remain high, even if a real effort has been recently made to improve the management of some of the most hazardous categories of waste (i.e. sharps).

The institutional capacities of the Central, Zonal and sub-Zonal Health Services (HS) remain too limited to efficiently support the medical institutions (under-staffing, reduced financial resources, insufficient training). In addition, the lack of adequate guidelines for Health-Care Waste Management (HCWM) as well as the deficient legal and regulatory framework do not stimulate the Management Teams of the HCFs to set-up a safer HCWM system.

Standardised HCWM practices must be developed for the country and the differentiation of the HCW streams within the medical institutions of Eritrea must be progressively upgraded. Taking into consideration the Eritrean context and the difficulty to ensure a safe and sustainable transportation system within the country, the mission recommends to adopt a decentralised on-site approach for the disposal of HCW, except in Asmara where a centralised system can be considered. The HCFs must anyway be provided with appropriate equipment to implement safer procedures. The disposal technologies must be as simple and cost-effective as possible.

The following priority objectives should be pursued:

1. The Government of Eritrea (GOE) should establish a *National Steering Committee on Health-Care Waste Management* to ensure the coordination and supervision of the HCWM Plan at country level.

2. The mission strongly recommends that the different governmental services coordinate their activities in a better way and share information more systematically in order to monitor more efficiently the services provided in the Health Sector. A *National Action Plan* should be implemented over a five-year period to progressively upgrade the current HCWM practices and target objectives at all levels of the HS for an approximate initial cost of 7'800'000 Nakfa (520'000 USD). The annual costs associated with the establishment of new management and disposal procedures ranges between 3'450'000 and 3'750'000 Nakfa (230'000 and 250'000 USD).

3. The elaboration of the *legal framework* and the reinforcement of the existing *rules and regulatory documents* are essential to ensure that proper HCWM practices can be enforced. As a minimum:

- A *Law on the Management of Hazardous Waste* (that would consider not only HCW but also other categories of hazardous waste such as pesticides, certain industrial waste, etc…) should be issued by the GOE. Within this law, specific chapters or articles should be devoted to HCWM and contain the general and specific provisions to determine the authorities of enforcement, the obligations of HCW Producers and Operators, the authorised management, treatment and disposal procedures as well as the range of penalties to be applied;
- The GOE must formulate clear *National Guidelines* for the management of HCW. These guidelines would complete the Eritrean Hospital Standards Clinical Policies and Procedures. Ideally National Guidelines for Hospital Hygiene and Infection Control, in which the management of HCW should be specifically and comprehensively addressed, should also be edited. These guidelines would help the Zonal Health Management Teams (ZHMT) and the HCF Management Teams to implement adequate standards for the handling and the disposal of HCW.

4. The *standardisation of the current HCWM practices* with the application of rigorous on-going management and monitoring procedures, based on the Laws and National Guidelines mentioned above. The minimum recommendations comprise:

- The designation of a *Health-Care Waste Management Officer (HCWMO)* in large hospitals who should be given the responsibility to operate and monitor the management of the HCW on a daily basis;
- Standardised segregation procedures should be set-up in all Eritrean HCFs by implementing a *three bins system* that should be systematically associated with a *colour coding*, a *labelling system* as well as *minimizing procedures*;
- The development of specific *treatment/disposal methods* according to the type and the location of the HCF where the waste is generated. This includes:
  - In rural areas and low density urban areas: the use of *waste burning pits* in Health Stations and Health Centres, were all the waste may be burnt (including safety boxes) and the ashes safely buried; the direct burying of pathological waste such as placentas where there is no risk of contamination of the underground water, the burying in concrete lined placenta pits otherwise;
  - In urban settlements: in the absence of sanitary landfills – which would be the cheapest option – on-site incineration of medical waste in Mark 8a or eventually Mark 9 De Montfort incinerators for respectively Health Centres and Hospitals; the disposal of placentas and anatomical waste in concrete lined placenta pits; and the disposal of the non-risk HCW with the other municipal solid waste;
  - In Asmara: the incineration of the medical waste in a centralised double-chamber pyrolytic incinerator and the disposal of the non-risk HCW with the other municipal solid waste. The other alternatives would be either too complicated to implement (autoclaving and shredding, chemical disinfection) or too expensive (treatment using microwaves, for example). The mission recommends to carry out an inventory of the existing incinerators currently used in the medical institutions and assess the real need for the purchase of a new one versus the rehabilitation of an existing one.

5. The *reinforcement of the institutional capacities of the HS* at Central and Zoba levels through specific *technical training* and the *recruitment* of additional Environmental Health Officers to support the HCFs in implementing the new HCWM policy. The development of *on-going awareness and training programmes* as well as the *review of the curricula* of medical staff must be seen as an absolute priority.

6. The *elaboration of a rigorous Monitoring Plan* with the aim at providing the main stakeholders involved in the HAMSET project with relevant information for two different but complementary objectives namely: 1) the *progress* in the implementation of the HCWM plans within the HCFs of the country and evaluation of the impact of the National HCWM plan; 2) the *measurement* of the Operation and Maintenance[1] (O&M) performance of the Health Services (HS) to maintain a good standard of HCWM within the HCFs of the country. The Monitoring Plan would include as a minimum:

- The establishment of *Annual HCWM Plans* at medical institution and Zoba levels to progressively 1) lead the HCFs and the administrative authorities to consider HCWM as a routine issue and reinforce progressively their organisational capacities; 2) establish reliable national statistics helping, on the long run, in rationalising the HCWM practices throughout the country; 3) get relevant feedback information on the implementation of the HCWM plan;
- The set-up of adequate indicators of achievement, both *qualitative* and *quantitative*, in order to monitor and evaluate the outcome of the National HCWM plan.

[1] *Operation* refers to the procedures and activities involved in the actual delivery of services while *maintenance* refers to activities aimed at keeping existing capital assets in serviceable conditions.

7. For all the HCFs, *highly infectious waste* generated in medical laboratories and isolation wards should be chemically pre-treated in a solution of sodium hypochlorite in concentrated form; the mission recommends incinerating all the *Cytotoxic and Pharmaceutical Waste* generated throughout the country in the rotary kiln of the National Cement Factory located in Massawa.

Introduction

In January 2003, The Project Management Unit (PMU) of the Ministry of Health (MOH), in the framework of the implementation of the HAMSET[2] Project, mandated Emergence to complete a first survey[3] carried out in 1998 by the Ministry of Land, Water and Environment (MOLWE) and to support the Ministry of Health (MOH) to develop an integrated Health-Care Waste Management (HCWM) Plan for Eritrea. The tasks to be achieved by Emergence include[4]: 1) a three-weeks assessment, which took place in April 2003, 2) the redaction of a National HCWM Plan and 3) the facilitation of a National Workshop to be held by the MOH, during which the draft document should be reviewed and validated for further implementation. This overall consultancy ultimately aims at upgrading the HCWM system in the medical institutions of the country.

This report presents the findings of the three-weeks assessment[5] carried out in Eritrea:

- In the *first section*, are successively assessed: 1) the existing legal and regulatory frameworks for HCWM in Eritrea; 2) the current HCWM practices prevailing in the Health-Care Facilities (HCFs) of the country and the potential risks associated with those practices, and 3) the institutional and monitoring capacities of the national, regional and medical institutions involved in HCWM;
- The *second section* provides recommendations that should be applied by the Government of Eritrea (GOE) to improve the management of HCW within the Health-Care Facilities of the country. A special attention is paid to the organisational and coordination efforts that the GOE shall have to set-up so as to monitor efficiently the management of Health-Care Waste (HCW) in the country;
- Finally, the *third section* of this document contains a National HCWM plan that could be implemented by the MOH in the next five years. The costs linked to this plan have been rapidly estimated. It is divided into five objectives with the primary aim at rationalising and securing the HCWM practices in Eritrea. A step-by-step strategy to implement the plan is also proposed.

1. General Background

Eritrea remains one of the poorest countries in the World, with an estimated GNP per capita of about 200 USD in 1998[6]. Approximately 80 % of the 3.8 million inhabitants of the country live in rural areas and 30 % are semi-nomadic.

Since the independence in May 1992, the GOE has recognized the importance of health and given it a high priority by rehabilitating social infrastructures, expanding and drastically upgrading the primary health-care services[7]. Basic health population indicators have drastically improved. However, social indicators remains somewhat identical to the average for Sub-Saharan Africa: the infant mortality rate is 72 per 1'000 live births (average is 72), the child under 5 mortality rate is estimated at 135 per 1'000 (average is 93), the maternal mortality rate is 10 per 1'000 live births (average is 5 per 1'000), the average life expectancy is estimated at 51 years only (average is 50).

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2 HAMSET: HIV/AIDS, Malaria, STDS & TB Control Project.

3 Assessment of Solid / Liquid Waste Disposal at Health Facility in Eritrea. Impact on Environment. Department of Environment. Ministry of Land, Water and Environment, 1998.

4 See the Terms of Reference in Annexe 1.

5 The Agenda of the mission is provided in Annexe 2; the list of the interlocutors interviewed in Annexe 3.

6 Project Appraisal Document for HIV/AIDS, Malaria, STDs & TB (HAMSET) Control Project. The World Bank. November 2000.

7 For instance the EPI coverage has increase by 125 % and the overall access and use of health services has gone from 30 % up to 60 %.

Whilst the primary causes of morbidity and mortality for the children under 5 remain acute respiratory diseases, malaria and diarrhoea, among the adult population – above all in urban centres – the mortality and morbidity rates due to HIV/AIDS, tuberculosis and STD diseases is increasing. The first AIDS case in Eritrea was reported in Assab in 1988 and the cumulative number of reported AIDS cases rose to 15'023 at the end of the year 2002. Seventy percents of reported AIDS cases occurred among adults between 20 and 39. In order to control the outbreak of theses diseases, the GOE, supported by The World Bank developed a USD 40 million national HAMSET project.

The project should lead to an increase in the utilisation of quality, effective and efficient health services for HAMSET prevention, diagnosis and treatment. Consecutively to the development of medical activities, the production and the inappropriate handling of infected waste materials could lead to an increase in the environmental and health risks not only for the medical staff but also for municipal workers involved in waste handling as well as families and street children who scavenge on dump sites.

Consequently, the project must include a component focusing on the improvement of the existing HCWM procedures within the medical institutions. Appropriate treatment/disposal technologies must be found through the development of an integrated National HCWM plan, well budgeted with clear institutional arrangements for its execution.

2. Objectives

The mission intends to:

- Support the MOH in setting-up a *National HCWM Plan* to improve the current HCW management and disposal practices;
- Develop standardized and simple *HCWM procedures* in the HCFs of the country and provide appropriate *treatment and disposal technologies*, taking into consideration the financial and institutional capacities of local, regional and national institutions;
- Suggest an adequate *strategy* for the implementation of the plan at country level in the coming years.

3. Methodology

Preparing and implementing a HCWM plan requires developing four sequential steps that include:

- The *analysis of the situation* and the review of existing national policies. The relevance of the recommendations and objectives contained in the plan depend strongly on the attention that is paid to the initial assessment. This step is crucial;
- The *set-up of realistic recommendations* and objectives as well as the determination of the human, material and financial resources required. The objectives can be spread over time, according to the strategies that are adopted to develop the plan;
- The *development of the plan* and the set-up of a *strategy* for its implementation. The strategy has to take into consideration the necessity to strengthen the institutional and monitoring capacities of the different actors involved in the elaboration of the plan;
- The elaboration and the use of *monitoring and evaluation tools*, with adequate indicators of achievement.

The satisfactory execution of each of these steps is strongly dependent on the completion of the other ones; none can be omitted. The planning progression is nevertheless not linear and has to be periodically reconsidered for adjustments. Therefore, special attention has to be paid to *the capacity of the National Institutions to monitor, review and adjust the plan.*

To carry out the national sector assessment, the *rapid assessment tool* jointly developed by the World Health Organization (WHO), the United Nation Environmental Programme (UNEP)[8] and *Emergence* has been used. The assessment phase, carried out over a period of three-weeks, consisted in:

- Discussions with officials of the health and environmental sectors, representatives of Public Institutions or Bilateral and Multilateral Agencies, International and National NGOs working in the Eritrean health sector;
- Review of the existing documents obtained (with some difficulties) at the MOH and MOLWE in Asmara as well as existing policy documents already developed in other countries of the region;
- Visits paid in randomly selected hospitals in and outside Asmara, with systematic discussions initiated with the medical and administrative staff.

4. Definitions

No standardized official definitions for *Health-Care Waste* exists in Eritrea, with clear indication on what category of waste should be considered as hazardous or non-hazardous. This constitutes a major gap since the establishment of any sectorial policy at country level requires the recording of unambiguous and precise definitions in a legal document.

Definitions vary somewhat from one country to another and at international level, two major leading agencies in this sector, the WHO and UNEP under the Secretary of the Basel Convention, do not apply the same definitions and characterise HCW differently[9]. The definitions contained in this report take into consideration: 1) the necessity to provide a precise characterisation of the hazards associated with the type of HCW produced in Eritrean medical institutions and, 2) the financial and institutional capacities of these institutions to set-up an overall HCWM scheme as well as to develop an environmentally sound, affordable and safe treatment/disposal system.

In this report:

- *Health-Care Waste* (HCW) includes all the waste, hazardous or not, generated during medical activities. It embraces activities of diagnosis as well as preventive, curative and palliative treatments in the field of human and veterinary medicine. In other words, are considered as health-care waste all the waste produced by a medical institution (public or private), a medical research facility or a laboratory;
- *Non-risk Health-Care Waste* comprises all the waste that has not been infected. They are similar to normal household or municipal waste and can be managed by the municipal waste services. They represent the biggest part of the HCW generated by a medical institution (between 75 % and 90 %). It includes paper, cardboard, non-contaminated plastic or metal, cans or glass, left over food etc… The mission proposes to follow UNEP recommendations and include in this category of waste all items (such as gloves, gauze, dressings, swabs) that have been used for medical care but are visually not contaminated with blood or body fluids of the patient. Sanitary napkins from maternity wards even if contaminated with blood, can be included in this category of waste as they are usually. Of course, this is only applicable if the patient is not confined in an isolation ward;

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[8] This tool can be requested at the WHO headquarters in Geneva (email: hcwaste@who.int) or can be directly downloaded from the website www.health-carewaste.org at the bottom of the *on-line documents* section. In addition, Emergence, in cooperation with the WHO and UNEP is preparing a Guidance Manual for African countries to set-up HCWM Plans. This manual will be soon available o$n the same website.

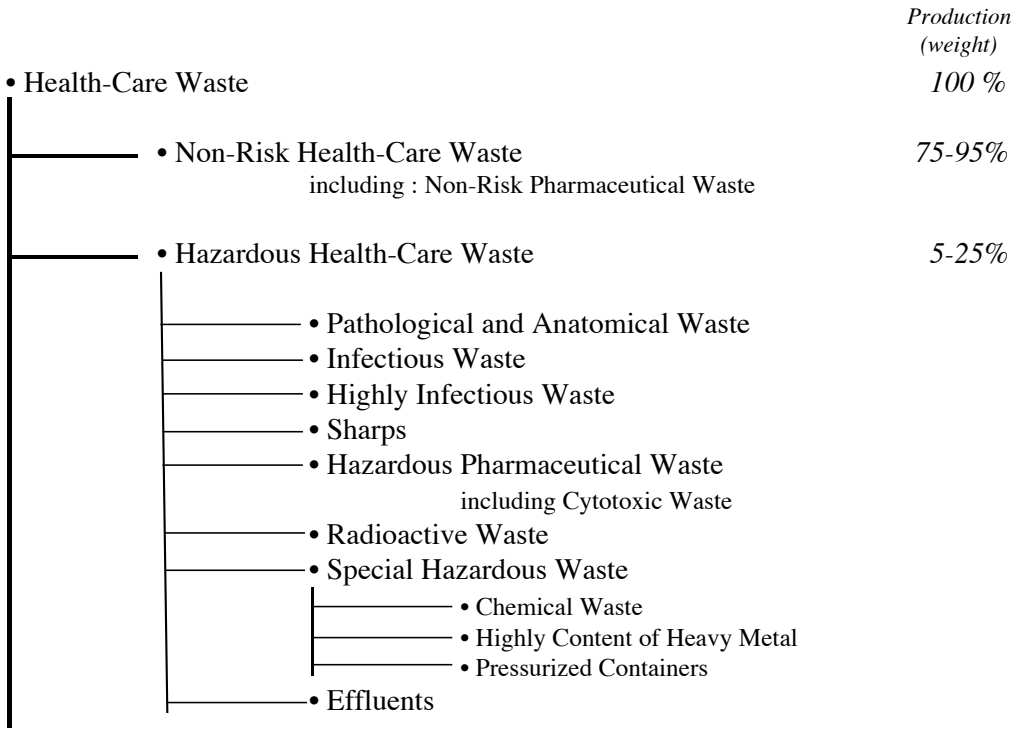
[9] For further details, refer to the following documents: Safe Management of Waste from Health-Care Activities Edited by Prüss, Giroult and Rushbrook, WHO 1999; Technical Guidelines on the Environmentally Sound Management of Biomedical and Health-Care Waste, Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, UNEP, 2002.

- *Pathological Waste* groups all organs (including placentas), tissues as well as blood and body fluids. Following the precautionary principle stipulated by WHO[10], this category of waste should be considered as infectious whether they may be infected or not. They should be disposed of consequently;
- *Anatomical waste* comprises recognizable body parts. It is primarily for ethical reasons that special requirements must be placed on the management of human body parts. They can be considered as a subcategory of Pathological Waste;
- *Infectious waste* comprises all biomedical and health-care waste known or clinically assessed by a medical practitioner to have the potential of transmitting infectious agents to humans or animals. Waste of this kind is typically generated in the following places: isolation wards of hospitals; dialysis wards or centres caring for patients infected with hepatitis viruses (yellow dialysis); pathology departments, operating theatres and laboratories. Infectiousness is one of the hazard characteristic listed in annex II of the Basel Convention and defined under class H6.2;
- *Highly infectious waste* includes all viable biological and pathological agents artificially cultivated in significant elevated numbers. Cultures and stocks, dishes and devices used to transfer, inoculate and mix cultures of infectious agents belong to this category of waste. They are generated mainly in hospital medical laboratories;
- *Sharps* are all objects and materials that pose a potential risk of injury and infection due to their puncture or cutting properties (e.g. syringes with needles, blades, broken glass…). For this reason, sharps are considered as one of the most hazardous category of waste generated during medical activities and must be managed with the utmost care;
- *Pharmaceutical Waste* embraces a multitude of active ingredients and types of preparations. The spectrum ranges from teas through heavy metal containing disinfectants to highly specific medicines. This category of waste comprises expired pharmaceuticals or pharmaceuticals that are unusable for other reasons (e.g. call-back campaign). Not all the pharmaceutical wastes are hazardous. They can thus be classified into two categories: Non-Hazardous Pharmaceutical Waste and Hazardous Pharmaceutical Waste;
- *Cytotoxic Pharmaceutical Waste* may be considered as a sub-group of Hazardous Pharmaceutical Waste, but this category of waste must be managed and disposed of specifically due to its' high degree of toxicity. The potential health risks for people who handle cytotoxic pharmaceuticals results above all from the mutagenic, carcinogenic and teratogenic properties of these substances, which can be split into six main groups: alkylated substances, antimetabolites, antibiotics, plant alkaloids, hormones and others. Cytotoxic waste are still generated in a limited number of medical institutions in Eritrea;
- *Radioactive Waste* includes liquids, gas and solids contaminated with radionuclides whose ionizing radiations have genotoxic effects. The ionizing radiations of interest in medicine include X- and γ-rays as well as α- and β- particles. An important difference between these types of radiations is that X-rays are emitted from X-ray tubes only when generating equipment is switched on whereas γ-rays, α- and β- particles emit radiations continuously. The type of radioactive material used in HCFs results in low level radioactive waste and concerns mainly therapeutic and imaging investigation activities where Cobalt ^{60}Co, Technetium ^{99m}Tc, iodine ^{131}I and iridium ^{192}Ir are most commonly used;
- *Special Hazardous Waste* includes gaseous, liquid and solid chemicals, waste with a high contents of heavy metals such as batteries, pressurized containers, out of order thermometers, blood-pressure gauges, photographic fixing and developing solutions in X-ray departments, halogenated or non-halogenated solvents… This category of waste is not exclusive to the

[10] The precautionary principle stipulates that the magnitude of a particular risk, when it is uncertain, should be assumed significant and measures to protect health and safety should be designed accordingly.

health-care sector. They can have toxic, corrosive, flammable, reactive, explosive, shock sensitive, cyto- or genotoxic properties;

- *Effluents*, and more particularly, effluents from isolation wards and medical analysis laboratories should be considered as hazardous liquid waste that should receive specific treatment before being discharged into the sewerage / drainage system, if such a system exists.



Note: pathological, infectious and certain highly infectious waste are commonly referred to as «**medical waste**» in Eritrea.

Figure 1 : Health-Care Waste Classification

PART ONE

Analysis of the situation

This part of the report presents the findings of the mission. Are successively analysed: 1) the organisation of the Eritrean Health Services (HS); 2) the legal and regulatory frameworks that is necessary to take into consideration for the implementation of the HCWM plan; 3) the HCW production in the medical institutions; 4) The HCWM practices and the risks associated with these practices; and finally 5) the institutional and monitoring capacities of the Eritrean HS. All the findings are synthesised in the last section.

Section 1. Organisation of the Health Sector

It is assumed that the reader has already a comprehensive knowledge of the Eritrean Health Sector organisation that will not be described in too many details[11]. Only the information essential to understand the context in which the future National HCWM plan will be established and implemented is synthesised in this section.

Clinical and Public Health Services are provided through three layers of services. Although the MOH encourages the participation of NGOs and the private sector in HS delivery, virtually, the Public Sector remains the only provider of HS in Eritrea. Private clinics and pharmacies exist only in larger cities and serve a limited proportion of the population, while religious organisations manage HCFs outside Asmara. At the end of the independence war in 1991, the organisation of the Public HS was seriously jeopardized: most of the HCFs that existed where destroyed and only a few medical institutions were still functioning[12]. With the necessary rehabilitation of the devastated HCFs and the harmonization of the HS, the MOH was facing immediate challenges and decided to enhance the primary Health-Care Services.

Currently a limited number of HCFs exist in the country (see table 1), with limited human resources and financial capacities. The six National Referral Hospitals of the tertiary level are all located in Asmara. The Primary HS (Health Stations and Health Centres) have a major role in the delivery of the HS to the Eritrean population.

Level of Health Services	Type of Health Facility	Nb. of Public HCFs
National (tertiary)		
	• National Referral Hospitals	6
	• Central Health Laboratory	1
	• National Blood Bank	1
Regional or Zoba (secondary)		
	• Zoba Referral Hospitals	6
	• First-Contact Hospitals	9
District or sub-Zoba (primary)		
	• Health Centres	50
Village		
	• Health Stations	139

Table 1: Structure of the HS and sources of HCW
[source: Assessment of Solid/Liquid Waste Disposal at HCF in Eritrea, 1998]

[11] For further details, refer to the Eritrean Health Profile, 2000. Ministry of Health, May 2001.

[12] Eritrea: Health Profile, 2000. Ministry of Health, May 2001.

1. Structure of the Health Services

While the second and the third levels of HCFs provide curative services, the first level of HCFs focus on preventive health-care. At the village and district (or sub-Zoba) level[13], the primary health-care network consists of *Health Posts* or *Stations* and *Health Centres* staffed with one or several nurses.

a) Primary or sub-Zoba Level Health Services

Health Stations

Located in remote villages, *Health Stations*, are the smallest curative units in the conventional health service structure and serve a population of approximately 10'000 inhabitants. They are the entry points into the general health services for the communities. A *Health Station* is administered by a Registered Nurse assisted by one or two Associate Nurse(s). In the Eritrean health structure, *Health Stations* provide primarily preventive care (immunization, antenatal care, communicable diseases care), health education and basic curative care.

Health Centres

Usually situated in small urban centres, *Health Centres* provide curative and preventive care and supervise Health Stations. They are expected to cater for approximately 50'000 inhabitants and are managed by two or three Registered Nurses. These facilities have a laboratory, in-patient and delivery facilities. They have between 20 and 30 beds. They provide polyclinic services, mother and child health, environmental sanitation, epidemic disease control and outreach services. *Health Centres* ensure both the supervision and serve as a referral centre for Health Stations.

b) Secondary or Zoba Level Health Services

All the hospitals of the secondary level visited by the mission are in poor shape. They would require significant civil engineering works to be rehabilitated. Some of them should even be abandoned and re-built. Aware of this situation, the GOE is completing the network of the regional hospitals by building four new hospitals in Barentu, Mendefera (with the support of the World Bank) Ghinda and Assab. However, the lack of skilled manpower has generated some delay in the construction of these hospitals that should be delivered to the MOH early next year, at the earliest.

First-Contact Hospitals or sub-Zoba Hospitals

Catering a population of 50'000 and more, *First-Contact Hospitals*, or *sub-Zoba Hospitals*[14] provide general medical and obstetric care, along with basic laboratory support services. A *First-Contact Hospital* has at least one physician and a pharmacist technical. These hospitals have facilities for minor surgical procedures and deliveries. They supervise Health Centres in their locality.

Zoba Referral Hospitals

The *Zoba Referral Hospital* is the secondary referral facility to the districts and serves a population of about 200'000. They are located in the six region (or Zoba) capitals. The services provided in a *Zoba Referral Hospital* are similar to the ones provided in the sub-Zoba Hospitals but include also various special medical services such as surgery, gynaecology/obstetrics, paediatrics or ophthalmology. The pharmacy and laboratory services are more developed than in a sub-Zoba Hospital.

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13 The country is divided into six regions (or Zobas) and 58 districts (or sub-Zobas).

14 They are also named *Community Health Hospitals.*

c) Tertiary or National Health Services

National Referral Hospitals

The Eritrean Health Sector is characterised by the absence of National Teaching Hospitals. The four *National Referral Hospitals* and the two specialized hospitals in *psychiatry* and *physiotherapy*[15] are all located in Asmara[16]. They provide the highest specialised health-care services. However, all of them remain drastically under staffed and under equipped. The level of services provided in these hospitals is quite low in comparison with other East African countries.

Public Health Institutions

The *National Blood Bank* has been renovated in January 2002 to increase the capacity of the Eritrean Health Authorities to systematically screen bloods samples and provide safe blood transfusion services. With an average of 4'000 blood bags are collected every year, the *National Blood Bank* covers more than 50 % of the national needs (the other 50 % are covered by the hospitals themselves). Between 1 and 4 % are screened positive to HIV, Hepatitis B and C or Syphilis and must be disposed of.

The *Central Health Laboratory (CHL)* is the highest laboratory institution in the country, which was renovated and refurbished in 1998. It acts as a national reference laboratory. Tests are conducted in clinical chemistry, histology and cytology, immunoserology, haematology and microbiology. As part of the HAMSET project, the CHL is establishing National Reference Laboratories on Tuberculosis, HIV and STD. The CHL is an important producer of highly infectious waste.

2. Organisation of the Public Health Administration

a) At Central Level

The MOH is responsible for the state health system in Eritrea. The basic functions of the MOH are quite standard and include: policy formulation, regulation, human resources development, evaluation and monitoring of the services provided. The MOH remains the principal provider of HS due to the low development of the community HS and the absence of a coherent private health sector. Consequently, although the GOE has adopted administrative decentralization as a national policy, the HS remain quite centralized. This is reflected in the structure of the MOH (see figure 2).

b) At Regional Level

At regional level, the *Zoba Health Services (ZHS)*, as part of the Department of Social Services of the Zoba, are *administratively* accountable to the Zoba Administration, which is directly under the supervision of the Ministry of Local Government but *technically* accountable to the MOH. The *Zonal Health Management Team (ZHMT)*, headed by the Zonal Medical Officer[17] (ZMO), is responsible for planning the HS and the implementation of health projects at Zoba level. The ZHMT works closely with the communities, in particular for the planning of the HS. They play a major role in the health education of the communities and the training of the village health agents.

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15 Saint Mary 's Psychiatric Hospital and the Physiotherapy Centre.

16 They include Halibet Hospital for medical and surgical adult cases, Mekane Hiwot Paediatric Hospital, Berhan Aini Ophthalmic Hospital and Mekane Hiwot Obstetric and Gynaecology Hospital.

17 Also named *Zonal Health Director*.

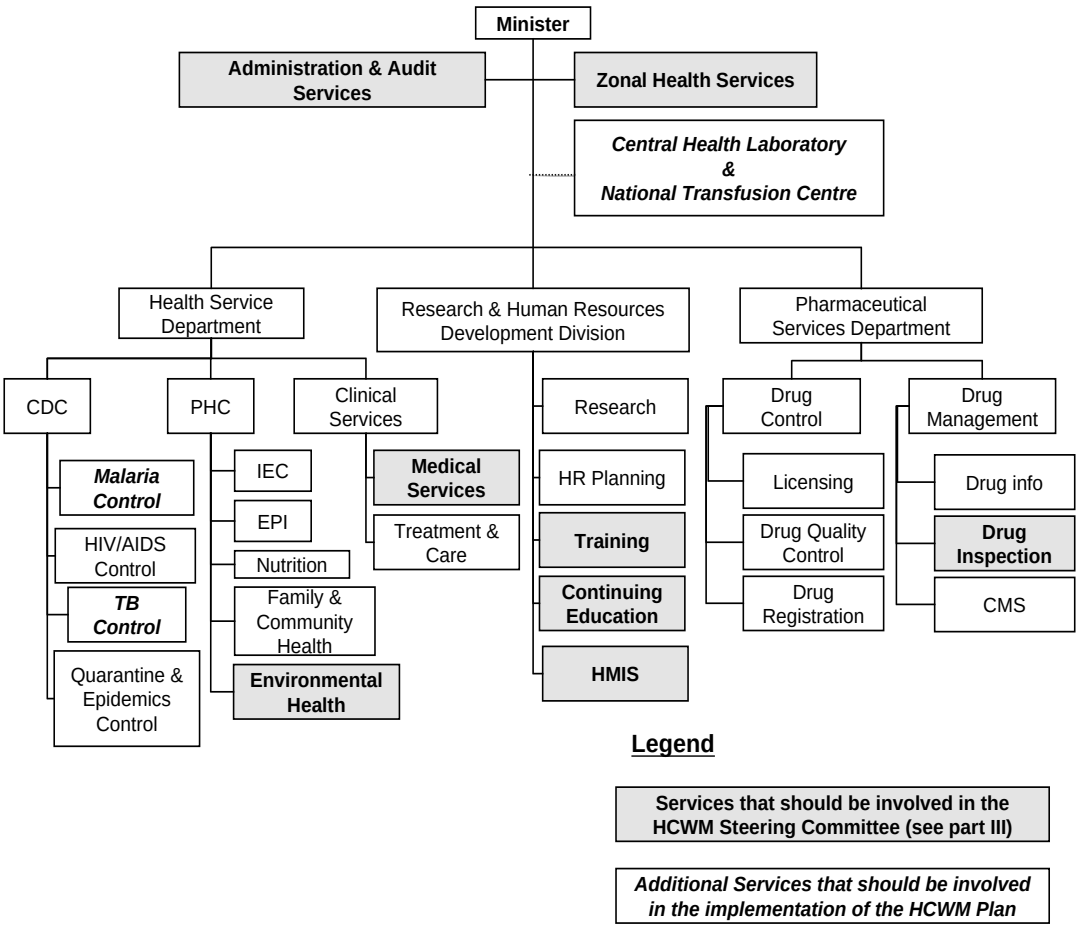

Figure 2 : Inventory of the *Central* Health Services involved in the implementation of the HCWM Plan

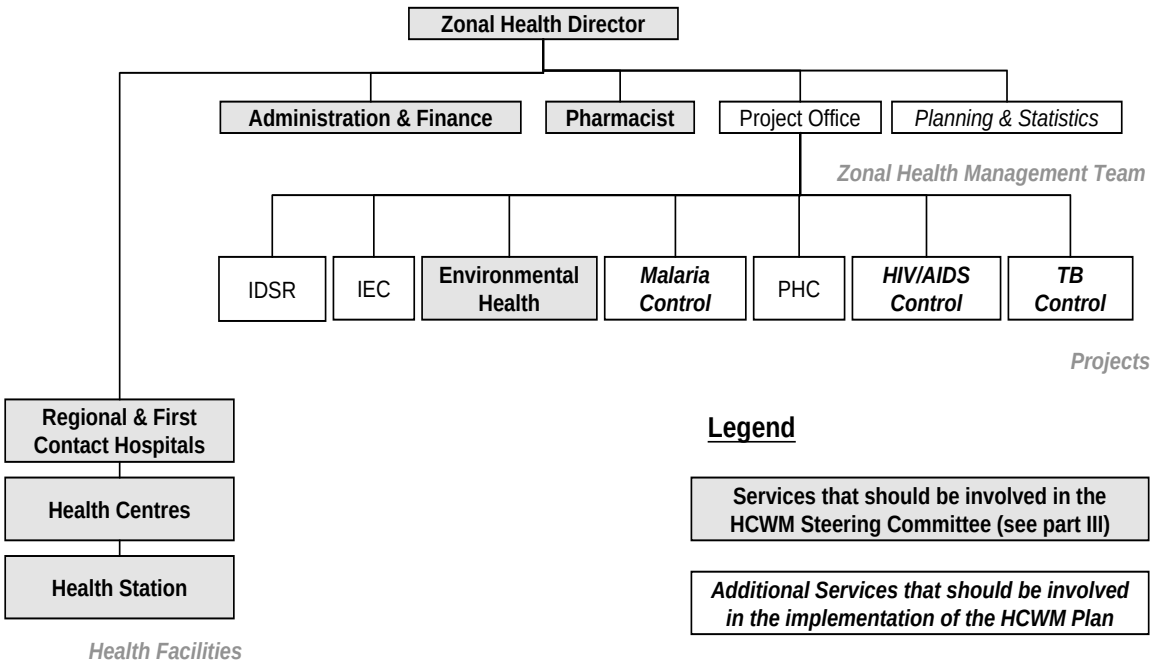

Figure 3 : Inventory of the *Zonal* Health Services involved in the implementation of the HCWM Plan

Section 2. Legal and Regulatory Frameworks

This section reviews rapidly the current legal provisions for HCWM in Eritrea as well as the current rules that are applied within the medical institutions. The findings are mainly based on the discussions that the mission held with the different governmental partners. The legal documents were somewhat difficult to get due to their dispersion through the different Health and Environmental Services and the lack of a clear centralised information system.

It is important to remind that the legal provisions constitute the backbone for improving the management of HCW in any country since it enables to:

- Establish a National Policy that is compatible with the technical, institutional and financial capacities of the HFCs of the country;
- Determine official standard procedures and guidelines for HCWM, to which any Health Worker can refer to;
- Define clearly the duties and responsibilities of each actor involved in the management of HCW;
- Set-up legal control of the HCWM systems within the HCFs.

1. Review of the Existing Environmental and Health Legislation

The few different legal documents that have been made available to the mission by the MOH and the Ministry of Water Land and Environment (MOWLE) have been analysed. The environmental legislation was still in a draft format and therefore subject to further modifications.

At international level, Eritrea has not yet ratified the *Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal* (1992)[18]. It is also not yet party to the *Stockholm Convention on the Persistent Organic Pollutants* (2002)[19]. However, in order to improve the environmental management within the country, the GOE prepared in 1995 a National Environmental Management Plan that provides some useful guidelines and has also adopted the *National Environmental Assessment Procedures and Guidelines*, to be used in all projects, regardless of the sources of funding.

At national level, there will be a need to harmonize both the Environmental and Health Legislations to cover in a comprehensive manner HCWM issues (see part II, section 1).

At regional level, linked to the new decentralised scheme, Municipal and sub-Zoba Authorities are responsible for the collection and transportation of the solid waste generated in their area of jurisdiction. However, there is no Act or provision that has been developed to regulate the management of the solid wastes by the Municipal and sub-Zoba Authorities. Except in Asmara, the refuse collection capacity of the Collection Services in the municipalities is clearly insufficient to cope with the waste generated in the urban centres: Local Authorities remain drastically under equipped.

2. Appraisal of the Hospital Regulations

The proper management of HCW depends to a large extent on good administration and organisation but also requires that adequate instructions be consigned in a formal document (e.g. a HCWM plan) and that the medical and paramedical staff be fully aware of their duties and responsibilities.

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[18] Infectiousness is one of the hazard characteristics listed in annex III to the Basel Convention and defined under class H 6.2.

[19] Persistent Organic Pollutants (POPs) such as dioxins or furans are produced during incineration of waste. At international level there is a strong debate at present between environmentalists and public health specialists on the pertinence to operate low-cost incinerators and releasing the fumes without prior treatment.

a) Rules in Hospitals

Although there is no Public Health Act in Eritrea to regulate and consolidate the promotion, the prevention and the maintenance of public health, the MOH prepared in 2002 standards[20] providing guidelines to improve the quality of care in Eritrean HCFs. The different procedures to be applied in the HCFs of the country have been broached into a comprehensive and functional document that have been recently distributed to the different medical institutions and forced them to re-assess their internal practices.

In particular, the *Eritrean Hospital Standards, Clinical Policies and Procedures* underlines the importance of prevention and control of nosocomial infection. It includes provisions and standards for the safe "handling and the disposal of medical waste" to "minimise the spread of infections and reduce the risk of accidental injury to staff, clients, visitors and the local community"[21]. HCWM is therefore seen as an essential aspect for the prevention and the control of hospital acquired infections, which is a very positive point.

However, this document remains incomplete:

- The definition of "Medical Waste" is imprecise. They are segregated in three categories (blood products and body fluids, organic waste and sharps) and are not specifically characterised;
- No colour coding system is suggested and no segregation practice recommended;
- Some treatments that are suggested, like burning in drum incinerators, are not recommended anymore by major institutions like the WHO or UNEP;
- There are no guidelines for planning and monitoring the management of HCW within the HCFs, etc…

Finally, in all the medical institutions visited, HCWM is organised according to specific schemes but there are no explicit rules consigned in a single document providing adequate instructions regarding the management of the HCW within the establishments. Nobody is formally nominated to supervise the whole HCWM system or co-ordinate the efforts between all actors within the hospitals. This engenders an obvious lack of efficiency and harmonisation in the HCWM procedures.

b) Duties and Responsibilities of the Medical Staff

Well-defined duties and responsibilities are essential to operate an integrated HCWM system. The responsibility of the different components of the HCWM system is shared between:

- The Director and the Administrator, who are directly in charge of the overall implementation of a safe HCWM system inside the hospital;
- The Medical Doctors and Nurses who should directly ensure an immediate segregation of the HCW, under the supervision of the Head Nurses of the different medical units and the Matron or the Patron of the hospital;
- The ancillary staff (Ward Attendants or Nurse Assistants) in charge of the packaging, waste collection and on-site disposal under the direct supervision of the nurses.

Although the mission requested it several times, it was not possible to get precise, written *job descriptions* for each category of medical staff working in order to review the different duties and responsibilities assigned to each of them. A few documents were made available to the mission such as the *Standard Nursing Procedures for Associate Nurses (2002)*[22] that gathers provisions for infection

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[20] Eritrean Hospital Standards. Clinical policies and procedures, part one. MOH, June 2002.

[21] Pages 50 to 52.

[22] The mission did not have access to the Standard Nursing Procedures for Registered Nurses.

control and includes some element pertaining to the proper disposal of waste[23]. However, the provisions contained in these procedures cannot be considered as specific guidelines regarding the duties and responsibilities of these categories of health workers since they remain incomplete and too general.

As far as the mission was able to get all the legal information available, there is an incomplete Professional Code of Ethics for Nurses in Eritrea that could govern proper conduct in the profession and in which the responsibilities and the accountabilities of the nurses should be defined. The edition of such a document would be of a great interest to frame the different medical professions and ensure that the Nurses and Midwives may be personally legally liable and able to make the employer liable for her/his faults or incompetence. In other words, such a Code would help in precisely defining the duties and the responsibilities of each category of medical staff with a specific mention to the management and the disposal of HCW. Such definitions of duties and responsibilities would be of a great interest to start defining and implementing a monitoring plan for HCWM.

3. Conclusion

There are currently significant gaps in the legislation for an efficient and well-monitored HCWM system in the Eritrean HCFs. There are no legal indications on authorised HCWM practices (segregation, colour coding system, packaging, on-site transportation, contingency plans, etc.). There is no specification regarding HCW treatment and disposal technologies that might be considered acceptable in the Eritrean context.

The legal provisions fail to enforce the medical institutions, the ZHMT and the Municipal Authorities to reduce the risks associated with the management of HCW through the establishment of HCWM plans at the HCF, Municipal or Zoba levels. This prevents also the medical institutions from setting-up integrated HCWM plans since they do not have the possibility to refer themselves to a precise legal framework that should at least provide definitions and characteristics of HCW. In other words, at country, Zoba or municipal levels, *the minimum requirements are not established to ensure homogeneous, efficient and safe HCWM practices*. Consequently, neither the Directors of HCFs nor the Zoba or the Municipal Health Services are urged to develop proper HCWM plans.

Section 3. Characterisation of the HCW Production

In order to develop an efficient HCWM plan, select the appropriate treatment and disposal technologies, produce reliable cost estimations and decide on a centralised or a decentralised system, the MOH must be able to evaluate the current and the future levels of waste production per hospital category and region with a maximum accuracy. For each HCF, the level of waste production of course depends on its size and its level of activity. These two parameters can be estimated knowing the number of beds, the average daily occupancy rate and number of out-patients treated in the HCF (see estimation methodology hereunder).

Unfortunately, while the total number of HCFs is ventilated per category and regions in the Eritrean Health Management Information System (HMIS), the statistics provided by the HMIS on the number of HCFs, beds, out-patients and the occupancy rate for each category of HCF differ significantly from other sources[24] or from the direct observation in the field by the mission. In addition, the military hospitals, which are probably important producers of HCW, are not included in the HMIS and no information regarding these facilities is available at the MOH level. Another problem is linked to the

[23] Page 167.

[24] Information contained in the Eritrea: Health Profile, 2000. Ministry of Health, May 2001 or in the Assessment of Solid/Liquid Waste Disposal at Health Facilities in Eritrea, report prepared by the MOLWE in 1998.

absence of standardised definitions for the different categories of HCFs[25], which leads to results that can differ significantly from one survey to another. Therefore, providing reliable estimations on the level of HCW production in Eritrea remains a difficult task as long as there is not reliable, comprehensive and homogeneous system to collect and share the basic relevant health information.

1. Type of HCW Generated

Among all the categories of HCW produced in the medical institutions, the large hospitals (Referral, Zoba and First-Contact), in which almost all the ranges of medical activities are practised, produce the following categories of HCW:

- *Non-risk HCW* or *domestic waste* made of all wastes that are not contaminated with infectious or pathogen agents (food residues, paper, cardboard and plastic wrapping);
- *Medical HCW* that contains *pathological waste, infectious waste* as well as items that have been used for medical care but are not necessarily contaminated [26]. This category of waste includes also *highly infectious waste* that is discarded without prior treatment;
- *Anatomical waste* and *placenta* that are managed separately from the medical waste[27];
- *Sharps*, mainly, but not exclusively, auto-disable or disposal (single-.use) syringes with needles that are collected in general in separate cardboard boxes;
- *Pharmaceutical waste* that consists in outdated drugs. They are specifically managed and disposed of with a strict control from the MOH. No distinction is done between the *hazardous* and the *non-hazardous pharmaceutical waste*;
- *Specific hazardous HCW* (radioactive waste, chemicals) that are produced in very small quantities and in a very limited number of specialised medical institutions;
- *Effluents*[28] of HCFs are directly discharged into the sewerage (Asmara, CHL, NBB) and consequently into the environment. In general, wastewater from the hospitals is treated through separate septic tanks.

The production of HCW in the Health Centres and Health Stations remains limited to *non-risk HCW*, *medical waste, placentas* and *sharps*, generally in small quantities. This is due to their specific level of services (no major surgery, deliveries, preventive health-care activities).

2. Estimation of the Quantities Generated

a) Estimation Methodology

The production of hazardous HCW was calculated in each medical institution by estimating the number of containers (bags, rubbish bins) used for medical waste collection during a defined period of time. The discussions with the medical and paramedical staff (nurses, nursing-assistants and technical services) enabled to adjust the total volume of waste collected by using a filling rate for each category of container. Finally, a volumetric mass ratio was applied (0,30 kg/l) according to the type of waste thrown into the container in order to estimate the total weight of medical waste generated. The figure

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[25] For instance, the HCF in Tio (Southern Red Sea Region) is considered as a "Mini-Hospital", included in the First-Contact Hospital category in the HMIS while the interlocutors qualified this HCF as a Health Centre.

[26] See definitions provided in the introduction of this document.

[27] This terminology will be used in the continuation of this report to define the pathological waste, infectious waste and other items that are considered as contaminated and hazardous by the Eritrean interlocutors.

[28] It has not been possible to address this point in a comprehensive way during the mission.. The review of the current system for discharge of effluents from hospitals should be addressed in a second phase after having first successfully implemented a solid waste management system.

obtained is then divided by the total number of beds and the occupancy rate to estimate the quantity of medical waste generated per occupied bed per day in each hospital category (kg/occupied bed/day).

b) Results

At Health-Care Facility Level

Annexe 4 presents the detailed calculations of the quantities of HCW produced in large health-care facilities, as well as an example of how the information was collected. Since the level of care and services provided in one type of facility is quite similar to those provided in a facility at a lower level (cf. section 6), no differentiation has been made between National Referral and Regional Hospitals to estimate the daily production of medical waste in these establishments. An average of *0.28 kg/occupied bed/day* of medical waste is being generated in the Eritrean Health Institutions [29]. In Health Centres, the total production per day and patient is certainly lower.

At National Level

Following the indication provided by the HMIS, around 3'700 beds are distributed in the different medical institutions of the country. Based on an average production of 0,28 kg/occupied bed/day[30], the overall production of medical waste can be estimated between *2 and 3 tons per day*. Around 12 % of the daily production of HCW is concentrated in Asmara (approximately 400 to 450 kg/day)[31]. Asmara should be considered in priority for the application of the HCWM plan. Of course, with the development of the HS, the production of HCW should increase in the future and the disposal equipments sized accordingly.

Production of Sharps

In 2002, Pharmecor supplied about 5 millions disposable syringes and needles to the public and private HCFs[32] for curative care only. Assuming than the average weight of a syringe plus needle is 10 g, this means that approximately 150 to 200 kg of syringes and needles are used and must be disposed of every day in the Eritrean HCFs. These figures do not include the syringes used during the EPI programme. In comparison with the total amount of HCW to be disposed of, the quantities of sharps produced are significant (approximately 7 %)[33].

Section 4. Characterisation of the HCWM Practices

The HCW that are generated within a HCF should always follow an appropriate and well-identified stream from their point of generation until their final disposal. This stream is composed of several steps that include: generation, segregation collection and on-site transportation, on-site storage, off-site transportation (if needed) and finally on or off-site treatment and disposal (see figure 4). However, one of the key points of the safe management of HCW is *the minimization of the HCW generated*. Therefore, ensuring an *efficient* and *reliable segregation* remains the most important step.

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29 For detailed estimations, see Annexe 4. This result is in accordance with the studies carried out in similar countries by the Commission of the European Union in 1994 and the International Health-Care Network in 1995.

30 With a margin error to take into consideration the production of HCW in the four to six military hospitals dispersed in the country.

31 These figures might be underestimated due to the fact that the mission did not always get sufficient detailed information.

32 Detailed information provided to the mission by Pharmecor.

33 This means for instance that an incinerator of an average capacity of 80 kg per hour would be able to treat all the needles and syringes used in Eritrea each day in 3 to 4 hours.

All these steps require a rigorous organisation that should be translated into HCWM plans *at health-care facility level*.

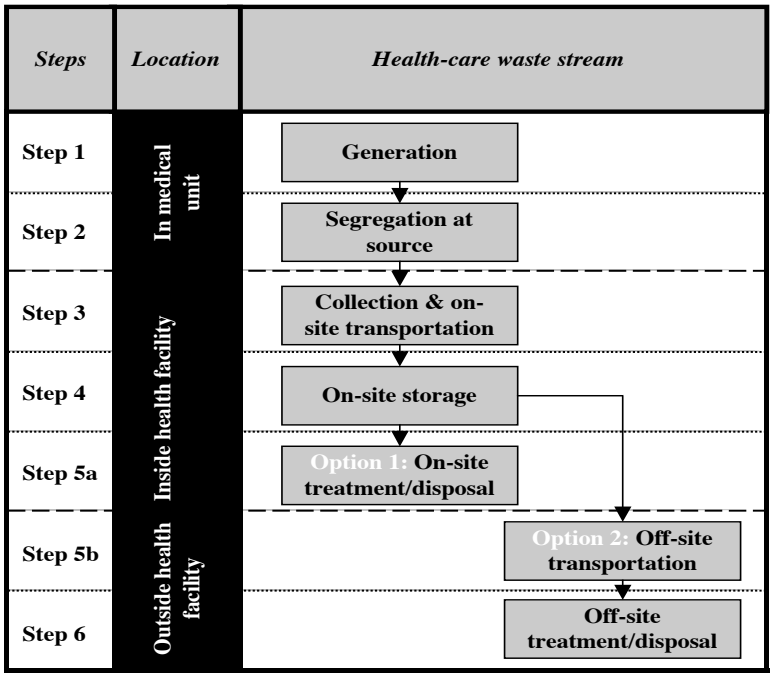

Figure 4: Synopsis of the HCW stream

In addition, management of HCW should always be considered as an integral part of hospital hygiene and infection control. Infectious HCW contributes to nosocomial infections, putting the health of medical staff and patients at risk. Proper HCWM practices should therefore be strictly followed as part of a comprehensive and systematic approach to hospital hygiene and infection control. A set of protective measures should also be developed in relation with the handling and the treatment/disposal of HCW.

Implementing adequate procedures to minimise the overall risks associated with HCWM should remain one of the priority objectives of the MOH. Waste management and treatment options should first protect the health-care workers and the patients and minimise impacts on the environment. A special emphasis has therefore been put by the mission on the level of risk associated with the management of HCW in the Eritrean HCFs.

The HCWM practices do not differ significantly in the *National Referral, Zoba Referral and First Contact Hospitals*. Therefore, for practical reasons, these categories of HCFs are regrouped into the generic named of *Hospital,* in the following section.

1. Segregation, Packaging and Labelling

Segregation is one of the most important steps to successfully manage HCW. Given the fact that only about 10-25 % of the HCW is hazardous, treatment and disposal costs could be greatly reduced if proper segregation were performed. Segregating hazardous from non-hazardous waste reduces also significantly the risks of infecting workers handling HCW. Actually, the part of the HCW that is hazardous and requires special treatment could be reduced to some 2-5 % if the hazardous part were immediately separated from the other waste.

The segregation consists in separating the different waste streams based on the hazardous properties of the waste, the type of treatment and disposal methods that are applied. A recommended way of identifying HCW categories is by sorting the waste into colour-coded, well-packed and labelled containers. Segregation must always be applied *at source*.

a) In Hospitals

In the Hospitals visited, there is an attempt to segregate the HCW generated at the source (i.e. in the wards themselves). In particular, *sharps* are systematically discarded in separate containers, which is a very positive aspect. However, in the absence of clear definitions and protocols, segregation is not carried out according to international standards and the medical staff is not fully aware of what type of waste should be considered as infectious or hazardous. Another problem identified is that due to inadequate management practices or simply because of the absence of adequate treatment/disposal facilities, segregation fails to be maintained all along the waste stream.

The wastes produced within hospitals are generally segregated as follows:

- *Non-risk HCW*, similar to domestic waste, is collected in usually plastic or metallic rubbish bins of different sizes (50, 80 litres…) and colours. These bins are not lined with PE bags;
- *Medical waste* is collected together into a variety of containers like plastic bins that may be covered with a lid or not. These containers, located at strategic points inside the wards, are not lined with adequate leak proof bags. They are often mixed at the storage points and disposed of with the domestic waste. *Anatomical waste* and *placentas* are generally collected and disposed of separately;
- *Sharps* are collected in separate cardboard boxes recycled after being used. These boxes are not always hermetically sealed. Specific UNICEF / WHO safety boxes, specially designed for safe collection and open-air burning, have been introduced by the Expanded Programme of Immunization (EPI) and are sometimes used when the Hospitals have extra stocks. However, sharps have been found with medical waste indicating failure in some of the segregation practices. The MOH has developed a new policy for disposable syringes and needles that is in accordance with WHO and UNICEF international recommendations: syringes and needles must be discarded of immediately following use without being recapped, bent or broken before disposal[34]. Needles shouldn't be recapped or removed from the syringe and the whole combination must be inserted into the safety box directly after use. However, the mission observed some two-hands recapping practices in a few HCFs where the new guidelines are not applied yet[35];
- *Hazardous* and *non-hazardous pharmaceutical wastes* follow a totally separate waste stream from the other categories of waste (see hereunder);
- In general, *highly infectious waste* produced in hospital medical laboratories is set aside and pre-treated before being disposed of with the medical waste. The pre-treatment consists in putting the items to be discarded in a solution of sodium hypochlorite over night. However, some hazardous items, such as the TB sputum cups are *not* systematically disinfected before being discarded. Only at the Central Health Laboratory and the National Blood Bank in Asmara, are rigorous protocols applied for the management of highly infectious waste such as: 1) the autoclaving of the microbiology products, the blood samples and all body fluids before disposal, 2) the use of leak proof containers, 3) the chemical disinfection of the sinks after use. However, a rapid look inside the skip container located at the CHL showed that ensuring a proper segregation remains a difficult task to be achieved in Eritrea.

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[34] See the Eritrean Hospital Standards Clinical Polices and Procedures, part one. MOH, June 2002.

[35] According to the EPI unit of the MOH, more than 40 % of the nurses would continue to recap the needles of the syringes.

b) In Health Centres and Health Stations

The HCW segregation practices in Health Centres and Health Stations do not significantly differ from the ones observed in the Hospitals: sharps are also systematically discarded in separate "safety" boxes[36], placentas are disposed of separately as well as pharmaceutical waste. The other categories of waste are not segregated.

2. Collection, On-Site Transportation and Storage

In order to avoid an accumulation of waste, it must be collected on a regular basis and transported to a central storage area within the HCF before being treated or removed. The collection must follow specific routes through the HCF to reduce the passage of loaded carts through wards and other clean areas. The carts should be 1) easy to load and unload, 2) have no sharp edges that could damage waste bags or containers and 3) be easy to clean.

Great care should be taken when handling HCW. The most important risks are linked with the injuries that sharps can produce. When handling HCW, sanitary staff and cleaners should always wear protective clothing including, as a minimum, overalls or industrial aprons, boots and heavy duty gloves.

In hospitals, HCW is temporarily stored before being treated / disposed of on-site or transported off-site. Non-risk HCW should always be stored in a separate location from the infectious / hazardous HCW in order to avoid cross-contamination.

a) Collection and On-Site Transportation

The organisation of the collection and on-site transportation depends on the type of HCF and the human resources available. One to two collections per day are normally scheduled (one in the morning and one in the afternoon), depending on the size of the HCF and, in general, cleaners are in charge of this duty. The following problems have been noticed in almost all the facilities surveyed:

- Collection of waste is not done on a regular basis nor along well defined routes within the HCFs;
- In a few places, the nursing-assistants transport and drop off the waste directly to the storage or disposal points. This practice should be avoided to minimize the risk of spreading infections once back in the wards;
- Medical waste, including syringes and needles, often drops from the overfilled bins / sharp boxes and can be found scattered on the ground inside the hospital compounds. Actually, the trailers used to collect the bins are not well equipped to prevent spillages;
- Sanitary labourers or nursing-assistants are often not properly protected during waste handling. Personal protective equipment such as heavy duty-gloves, aprons or overalls and boots are not systematically available.

b) Storage in the Hospitals

In large health-care facilities [37], medical waste and sharps are sometimes stored in specific locations. When there is no on-site disposal facility and when no special collection services are organised, medical and domestic wastes are stored in the same location, although segregation has been previously

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[36] In several Health Centres, the mission noticed that some of them were open, which could indicate that they are periodically emptied to be reused.

[37] Storage facilities are not useful in Health Centres and Health Stations where the amounts of HCW generated remain limited. However, the HCW may not be disposed of on a regular basis and very often, they remain for days in the pits or drums before being burnt.

ensured. In municipalities where off-site disposal is ensured by the Local Authorities (Asmara, Mendefera), the skip containers are removed only when they are full or when the hospital administration requests it be done. Therefore, although a maximum storage time should not exceed 24 hours, the storage may last up to weeks before the waste is disposed of, which leads to leakages from the skip container and sometimes strong putrefaction odours.

In addition, the waste is not protected from the effects of the weather (sun, rain…) and scavenging by animals (dogs, cats, birds, flies). In none of the HCFs, did the mission observe that the access to the storage area is restricted. This situation associated with inadequate behaviours (no regular hand-washing practices, free access to wards…) results in insufficient standards of hygiene.

3. Treatment and Disposal

Hazardous / infectious HCW can be treated *on-site* (i.e. in the HCF itself) or *off-site* (i.e. in an other HCF or in a dedicated treatment plant). On-site treatment is often the only possible option in rural HCFs but on-site treatment can be also carried out for HCW generated in urban HCFs.

On-site treatment systems are particularly appropriate in areas where hospitals are situated far from each other and the road system is poor. Above all, in urban areas, on-site treatment remains the only possibility to be considered when the municipal waste collection services cannot ensure a regular and reliable transportation system of the waste. The advantages of providing each health-care establishment with an on-site treatment facility includes convenience and minimization of risks to public health and the environment by confinement of hazardous / infectious HCW to the health-care premises. However, extra technical staff may be required to operate and maintain the systems and it may be difficult for the relevant authorities to monitor the performance of many small facilities. This may result in poor compliance with operating standards, depending on the type of systems, and increased environmental pollution.

The HCW generated in a HCF can also be treated *off-site*, when centralized facilities and reliable waste collection services exist, mainly in urban areas. Greater cost-effectiveness may be achieved for larger units, through economies of scale, unless the running costs for waste collection and transportation remain too expensive. Although off-site treatment increases dependency of the HCF on an external actor and requires a fine-tuned transportation system, it provides the following advantages:

- Hospitals will not have to devote time and personnel to manage their own installations;
- Efficient operation can be more easily ensured in one centralized facility than in several plants where skilled workers may not be readily available;
- Future modifications or expansions (relating to flue-gas cleaning systems of incinerators, for example) are likely to be less expensive;
- Where partial or complete privatization of facilities is seen as a desirable option, this can be achieved more easily on a regional basis than for numerous small units;
- Air pollution may be more easily kept to a minimum at a centralized plant, if specific flue-gas cleaning and procedures and incineration temperatures are respected.

Incineration and burning are the only disposal technologies known in the Eritrean medical institutions. The GOE must be aware that alternative technologies exist to treat hazardous / infectious HCW and reach a level of hazard / infectiousness that is considered acceptable, enabling the disposal of such categories of waste with the general solid waste. Detailed information on the advantages and disadvantages of each treatment / disposal technology are provided in Annexe 5.

a) In Hospitals

None of the hospitals visited by the mission has the necessary equipment to correctly incinerate or treat the Hazardous HCW generated. Therefore, all the categories of Hazardous HCW are burnt,

except placentas and anatomical waste that are too difficult to burn and are therefore buried or disposed of in placenta pits. Actually, the current disposal of HCW in the absence of adequate financial means, technical knowledge and specific budget lines is problematic and will certainly remain so in the coming years.

The following specific practices have been observed:

- Medical and pharmaceutical wastes as well as sharps are burnt in drums or directly in pits with kerosene or any other flammable material to initiate the combustion. The burning is carried out on a periodic basis (from daily to weekly depending on the resources of the HCF). Temperatures of barely 300-400°C are reached under these circumstances, which remains largely insufficient to properly deal with these wastes;
- Medical wastes can be collected by the municipal services and disposed of together in dumpsites (Mendefera). In this kind of situation, even if the Hospital Authorities ensure a separate on-site burning of sharps, the segregation initially performed fails to be maintained all along the waste stream;
- Anatomical and pathological wastes generated in Operation Theatres are disposed of separately. They are buried inside the hospital compound. Placentas are also buried or in some hospitals, dropped inside a placenta-pit with a concrete lining. In some regions (Gash Barka, Southern and Northern Red Sea regions), placentas are often given back to the family who then buries them.

In some hospitals, the MOH tried to build single-chamber incinerators[38] with an air inflow based on natural ventilation. However, these kind of incinerators are not able to sustain combustion of waste in a reliable manner and do not demonstrate any significant improvement compared to open burning. Finally, the lack of specific and affordable transportation services in municipalities as well as the low monitoring capacities of the Municipal, Zoba and Health Authorities reduces drastically the waste treatment and disposal options, which could be envisaged.

b) In Health Centres and Health Stations

There is no significant difference in the way that *medical waste* and *sharps* are disposed of. In the absence of adequate infrastructures and equipment, they are dropped into a pit, without segregation, and periodically burnt open-air. *Placentas* are directly buried. In order to improve the current disposal practices, the MOH intends to equip all the HCFs of the primary level with low-cost incinerators. However, the mission believes that it will be probably hard to implement such a policy due to the limited institutional capacities of these medical institutions: sustainable maintenance and adequate operation of such system cannot be guaranteed in the Eritrean HCFs in a near future. Furthermore, the implementation of such a solution would remain too costly.

c) Specific cases

The Municipality of Asmara

The Municipality of Asmara should be considered separately for the following reasons:

- The number of HCFs in this municipality is important and the amount of HCW produced in such a densely populated area is significant in comparison with the quantities produced throughout the country;
- With the development of medical services, the utilisation of on-site low-cost incinerators cannot be seen as a sustainable long-term solution. On the other hand the use of on-site pyrolytic double-chamber incinerators would be too expensive;

[38] The design of these incinerators is based on a technical book written by Médecins Sans Frontières (Public Health Engineering in Emergency Situation, first edition, 1994). However, the model provided in this book is obsolete and not recommended anymore by the international organisations.

- Although the introduction of alternative technologies such as autoclaving or hydroclaving®[39] could be seen as valuable on-site treatment technologies, the success of their implementation is uncertain and these technologies cannot be recommended in Eritrea where water scarcity problems are serious;
- The implementation of a centralised solution (off-site treatment), although interesting poses another set of problems relating amongst others to the verification and the cost of the transport of HCW. Currently the Municipal Services do not have the capacity to perform such controls. So far, the private sector is not sufficiently developed to ensure an efficient cross-subsidy of the HCW transportation and disposal. Furthermore, hospitals in Asmara will have difficulties to pay for such a service;
- There is no proper sanitary landfill where the medical waste could be safely buried.

The HCW disposal in the Municipality of Asmara is currently ensured by the Cleaning Sanitation Unit of the Zoba of Maakel. Asmara is the only municipality where a solid waste collection service is ensured. The Unit provides empty skip containers to the hospitals when requested and ensures a periodic, but not always regular, evacuation of the full skip containers towards a landfill located at the outskirts of the city. All categories of hazardous HCW are disposed of in a specific location within the landfill and burnt before being mixed with the other categories of waste.

Although important efforts are made by the Cleaning Sanitation Unit to control the pollution generated by the landfill, the current management practices cannot guaranty a safe and environmentally friendly disposal of the HCW: no regular hydro-geological survey, spontaneous fires of the waste, waste reused to produce "compost" without a proper segregation and control of the toxicity, etc…

The Disposal of Pharmaceutical Waste

Drugs are state property. They are distributed to the HCFs of the country through a network of regional stores and pharmacies (in general located in the regional hospitals, see figure 5) and cannot be destroyed without the specific authorisation of the Central Authorities. Expired drugs are therefore destroyed according to strict procedures, extremely well monitored and directly supervised by the inspectors of the Pharmacy Division of the MOH, the local Authorities and Police. Any HCF has to fill-in *a Certificate of Destruction* that repertories the items to be disposed of, their quantity the batch number, the manufacturer and mentions the expired date. It is therefore possible to track this category of waste in a strict way.

Once the inspectors have certified that the drugs have effectively expired, the hospital pharmacist can destroy the expired drugs (open-air burning) in front of three witnesses. Pharmaceutical waste is burnt open-air twice a year in the different regions of the country. Even if the quantities that are destroyed remain marginal, this practice should be avoided since the temperature reached during this process remain too low (400°C maximum). Potentially toxic fumes are produced and chemical residues will leak into the soil and/or the groundwater.

Sharps

The safety boxes used to collect sharps are systematically burnt. The MOH must be aware that alternative sharp disposal technologies generating less pollution are currently discussed at international level[40]. Annexe 6 provides more information on these technologies. However, in order to avoid confusion of health workers, the mission does not recommend changing the new policy that the MOH is currently implementing in the Eritrean HCFs.

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[39] The mission strongly recommends not introducing any other alternative technologies in Eritrea such as microwave or chemical disinfections: the operation costs of such technologies remain extremely high while the maintenance requires very skilled personnel.

[40] East and Southern Africa Workshop on Health-care Waste Management, Tanzania, June 2003.

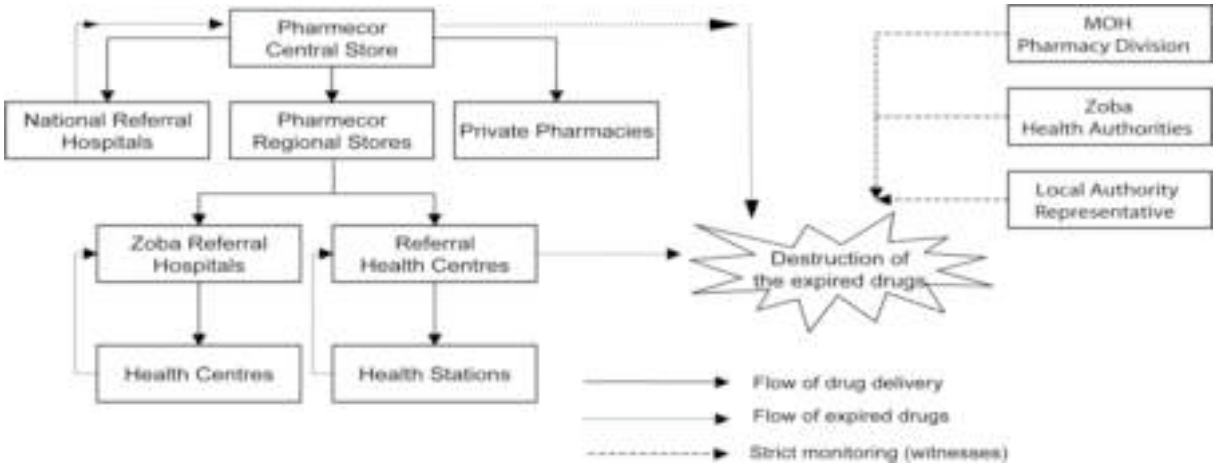

Figure 5 : Drug Delivery and Disposal Flows

4. Risks Associated with the Current Practices

There is no standardized segregation procedure applied in the Eritrean medical institutions – in this regard, the *Eritrean Hospital Standards, Clinical Policies and Procedures prepared by the MOH in June 2002* are still incomplete: the definitions remains too imprecise, the labelling system is deficient and there is no systematic colour coding system. The health-workers, who are uncertain about the definitions of medical wastes, use therefore identical and unmarked bins. Potential mistakes in segregation can easily occur and the risk of a person coming accidentally into contact with hazardous waste is important. The WHO precautionary principle should be more rigorously respected.

The nurses or the nursing-assistants fail to apply the aseptic measures when they handle and transport the bins within the wards or outside. The waste containers are not lined with adequate bags or even not regularly disinfected. The lids are manipulated with no specific precaution. In addition, many medical institutions are not sufficiently supplied with water and thus cannot ensure regular cleaning, facilitating the proliferation of pest vectors such as cockroaches. The absence of a regular pest vector control programme within the hospitals, an insufficient of water supply and the lack of fundamental hygienic measures obviously result in an increase of the risks of transmitting nosocomial infections.

The risk of spillage of medical waste and sharps during the transportation due to the use of inappropriate containers and the loss of syringes and needles from overfilled cardboard boxes, the failure in restricting access to the storage points, the lack of protection from scavenging animals or the disposal of HCW in dump sites without prior treatment increase the risks that HCW may be dispersed in the HCF compound and enter in contact with the general public.

The current burning practices at low temperatures (300 to 400°C) release important quantities of air pollutants (PCI, heavy metals, etc…) that constitute an environmental health threat. The option consisting in disposing of medical waste with the domestic waste in dumpsites and the absence of control procedures increase the risk for scavengers to be contaminated.

Section 5. Appraisal of the Institutional Capacities of the HS

Most of the interlocutors met by the mission intend to develop a purely technical approach of the HCWM issue. In other words, the MOH officials, the Zonal Health Management Teams or the Hospital Management Committees, in their discussions with the members of the mission, systematically emphasised the delivery of incinerators or the construction of placenta pits as *the* solution to solve the current difficulties in the management of HCW. Are rarely mentioned the numerous aspects that should be taken into consideration for the implementation of a sustainable HCWM programme, such as the low operation and maintenance capacities of the Eritrean institutions, their weak financial and human resources or their poor administrative management capabilities, etc… If a more comprehensive approach of HCWM is not developed in Eritrea, the implementation of the National HCWM Plan may fail. In this section, are thus reviewed the current institutional and planning capacities of Health Services in order to establish adequate strategy and monitoring plans.

1. Management and Planning Capacities

a) At Central Level

The MOH plays a major role in the day-to-day management of the Public Health Services. It is in charge of the policy formulation through appropriate legislation and regulations; the development of guidelines and standards to facilitate the implementation of the National Health Policy; the monitoring and evaluation of the Health Services to improve their quality; the training, the deployment and transfers of all cadres of health workers. Unfortunately, the MOH's capacity remains limited and over-stretched, due to the shortage of staff with relevant skills and experience as well as the workloads from fragmented tasks.

In addition, sharing statistical data (which are not always complete)[41] and information across sectors but also across the different services in the same Ministries (MOH, MOLWE) remains a challenge in Eritrea. The project approach and the implementation of vertical programmes (HAMSET, IECD, etc…) lead also to fragmented planning and implementation arrangements with many parallel systems co-existing with a serious lack of horizontal co-ordination. As a result, there is clearly a risk for the MOH to loose the global vision of the health situation in the country.

b) At Zoba Level

In order to improve the Health Services, the GOE initiated in 1996 a decentralisation process which aims at empowering the health activities at Zoba (regional) level. Nowadays, the planning of health activities is decentralised and based on a participative process (in general a one-week workshop during which problems are identified and actions prioritised) involving the regional HS, the health workers, the elders of the communities, the actors of the civil society and traditional birth and health attendants. In *Eritrea, the ZHMTs are therefore the key components for health planning, health monitoring and health operation and maintenance*[42]. Unfortunately, their limited human[43], logistic and financial resources jeopardize their capacity to implement or supervise the health programmes that are planned annually. Their institutional capacities remain severely restricted.

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41 Some interlocutors complained that the data collected by the HMIS remains too confidential and cannot be used to target, evaluate and improve their action in the field.

42 Recently, in 2003, a more decentralised planning process has been tested to produce yearly plans of actions for health at sub-Zoba (district) level and strengthen the role of the sub-Zoba Administrators.

43 Skilled staff is scarce particularly in the rural areas.

c) At Health-Care Facility Level

As for the MOH, the hospital management is highly fragmented. Many committees have been created: *Executive Committees*[44], *Health Management Committees*[45], *Infection Control Committees*[46], *Purchasing Committees, Therapeutic Committees, Disciplinary Committees, Quality Insurance Committees, etc…* Nevertheless, the multiplication of the committees within the hospitals is not an indicator of a high-quality management and several sections of the referral system are not functioning as intended, largely because of consistent under-funding, weak management support systems and poor communications (roads and telecommunications).

HCFs frequently lack essential medical equipment and suffer from deteriorating infrastructures. In addition, with only 150 Medical Doctors and 400 Registered Nurses working in the country, the HCFs remain under-staffed with skilled personnel, limiting drastically the organisation and institutional capacities in these facilities. This situation will not improve rapidly since the hospital administrations face drastic budget restrictions in comparison with the medical needs. In this context, the safe management of the HCW is not (and cannot be) seen as a priority by the executive and managerial teams.

2. Financial Resources

The country can afford to spend between 30 and 75 Nakfa (2 and 5 USD) per capita on health, largely concentrated on curative health[47]. Even if the population pays registration and accommodation fees when they are admitted in a HCF[48], as well as 50 % of the medical treatment, the GOE does not have the means yet to implement an efficient cost recovery system.

Although the health expenses have drastically increased over the last 10 years[49], the HCFs face drastic shortages of funds and weak management. These shortages have also led to deteriorating infrastructures, inducing the GOE, with the support of the World Bank, to build-up new HCFs. Less than 1 % of the annual budget of the hospitals is dedicated to sanitation and cleanliness. This represents only 0,75 Nakfa (approximately 0,05 USD) per occupied bed and per day.

The HCWM plan will have to balance optimal but costly and unaffordable solutions with realistic but not always fully satisfactory technical options for the disposal of HCW. In order to cope with this constraint, a clear difference between short term and long term solutions will have to be provided in the plan.

3. Monitoring and Control Capacities

Theoretically, monitoring is one of the main tasks to be carried out by the ZHMTs. Based on a supervision checklist, evaluations are undertaken once or twice a year only. Regular monitoring of

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44 This committee is composed of the Hospital Medical Director, the Administrator and the Matron and has weekly meetings.

45 Made of the different Heads of Department, the Head Nurses, the Medical Doctors, the X-Ray Technicians. This committee has monthly meetings.

46 Medical Director, Matron, Administrator and Department Heads belong to this committee.

47 For instance, in 2002, the health budget of the Gash Barka region – including salaries, running costs and drugs – was approximately 20'000'000 Nakfa for a population of 560'000 inhabitants.

48 5, 7, and 16 Nakfa to be registered respectively in a Health Station, a Health Centre, a First-Contact Hospital and a Regional Hospital; 2 Nakfa per day and per bed for accommodation. With a certification provided by the Local Administration, the poorest people have the possibility to get access to the HS, being dispensed with paying these fees.

49 For instance the value of drugs and medical supplies distributed in the public health facilities has been multiplied by 25 between 1994 and 2000. Source: the Eritrea Health Profile.

health activities in remote areas is virtually non-existent due to the lack of communication and logistical facilities.

There is a lack of local and national expertise in Eritrea regarding the management of HCW. Scientific knowledge and analytical capacities on HCWM remain both limited at central, zonal or HCF levels. The Health Authorities have difficulties to provide adequate backstopping for the medical institutions under their jurisdiction. In practice, there is a lack of monitoring of the management of HCW due to: 1) scarce knowledge on HCWM in the country; 2) limited financial resources; 3) incomplete legal and regulatory provisions and 4) the understaffed Health Authorities [50].

The finite resources of the Government strongly limit its possibilities to set-up a monitoring system to control HCW streams inside and outside the public and private HCFs of the country. The monitoring of new HCWM practices and the control of new procedures in the medical institutions will thus be problematic to set-up.

4. Operation and Maintenance

There is no maintenance or technical teams in the hospitals. The maintenance of the most important equipment such as autoclaves is centralised in Asmara. Preventive maintenance is virtually non-existent in the Eritrean Hospitals since "the equipment is controlled when it is repaired". The GOE should be aware that the quasi-total absence of adequate operation and maintenance capacities within the different Eritrean HCFs is one of the major factors that will condition the technological options to be used for the disposal of HCW. Table 2 provides a good indication of the level of O&M in the Eritrean HCFs.

Level of performance	Management process structure	Feedback	Forecast horizon	Integration
Very high	Systems	Always	Large	Total
High	Procedures	Often	Considerable	Far-going
Medium	Rules	Regularly	Reasonable	Reasonable
Low	Rules of thumb	Sometimes	Short	A little
Very Low	No rules	Never	None	None

Table 2: The HCWM Operation and Maintenance Level of performance

[50] For instance, the *Health Officer* (HO) plays a central role in the monitoring and control of the application of environmental health standards at HCF, district, regional and central level but his/her professional responsibilities include: 1) the control of communicable diseases, 2) health education, 3) sanitary inspections, 4) food quality control, 5) enactment, revision and enforcement of the relevant laws, 6) control of waste collection, transport and disposal, improvement of housing conditions, 9) improvement of school health, 10) improvement of occupational health, 11) vector and vermin control, 12) continuing education, 13) immunisation, 14) port health control. The multiplicity of the tasks to be performed by the HOs is such that it is obviously impossible to ensure that a proper monitoring is applied in all these fields of activities.

5. Training and Awareness of Staff

a) Initial training

As already mentioned, there is no Faculty of Medicine in Eritrea; Medical Doctors are trained abroad. In order to cope with the immediate need of Medical Doctors, the GOE has developed an original system to train Health Professionals. The students who have completed successfully the Growth Point Average at the high school can be trained at the College of Nursing and Health Technology that includes three Schools[51] or directly at the University to get a Bachelor of Nursing in a management or clinical field speciality. An average of 100 nurses and 45 post-graduate nurses are trained every year, which remains insufficient to meet the staffing needs of the health sector.

Health workers are sensitised to the handling of HCW during their initial training and the potential harmful consequences linked to the mismanagement of HCW (risk of injuries and nosocomial infections)[52]. But in the absence of clear and homogenized definitions on HCW, as well as National Guidelines for HCWM, teachers are left to themselves in preparing the content of their lectures without specific guidelines. The content of the initial curricula should therefore be reviewed in the near future to harmonise it with the future National Guidelines.

b) In-service training

To improve the quality of the HS in Eritrea, ongoing training is required. Workshops are organised at Zoba (for HIV/AIDS for instance) and HCF levels. Recently, the MOH has developed a plan[53] to ensure on-going training of the medical staff. A steering committee has been created to evaluate the needs of hospitals, harmonize their requests and implement a national strategy for in-service training. So far, in-service trainings have been organised to update the knowledge of the different categories of health workers in the handling and the disposal of sharps according to the new policy established by the MOH.

c) Awareness

The level of awareness is a key element to change and improvement. To compare the needs identified by the mission with those expressed by the administrative and medical staff of the hospitals, a number of qualitative questions were systematically asked during the field visits [54]. This information is essential in helping to select the most appropriate strategy for the implementation of a new policy.

Table 3 illustrates both the differences in appreciation of a situation, which can prevail within a HCF depending on the actor's function/knowledge and how the situation is assessed by the mission. Actually, the discussions with the executive staff (matrons, medical doctors, administrators) reveal that most of them are quite aware that the current practices are unsafe and the minimum standards are not reached. It should be thus relatively easy to raise the level of awareness in the "executive community" to implement the HCWM plan. However, the situation is slightly different and the awareness less obvious for staff directly involved in the management of HCW (nurses, nursing assistants…)

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[51] The School of Nursing to become a registered nurse after 3 years of study or a nurse assistant after 18 months; the School of Advanced Nursing to get an additional training in specific fields such as midwifery or anaesthesia; the School of Medical Technology to specialise in radiology, public health, laboratory technician, pharmacy…

[52] See the Nursing Diploma Programme Curriculum of the Ministry of Health, December 1998; the Diploma Program Curriculum of the Public Health Technicians, Ministry of Health, June 2001.

[53] Although the mission requested this plan, it was not possible to get a copy.

[54] Analysis of the needs identified by the mission vs. the demands expressed by the interlocutors.

What is your appraisal of the current situation regarding the management of HCW within your institution?					
	Very bad	Bad	Fair	Good	Very Good
HALIBET REFERRAL HOSPITAL					
• *administrator*			*x*		
• *matron*		*x*			
• *ward head nurse*				*x*	
• *surgery ward head nurse*				*x*	
• *chief laboratory*	*x*				
• *mission*		*X*			
MENDEFERA ZOBA HOSPITAL					
• *direction*		*x*			
• *chief nursing*			*x*		
• *mission*	*X*				
BARENTU ZOBA HOSPITAL					
• *administrator*			*x*		
• *matron*		*x*			
• *mate ward head nurse*				*x*	
• *surgery ward head nurse*				*x*	
• *mission*		*X*			

Table 3: Opinions on the HCWM system in selected HCFs

Section 6. Synthesis of the Findings

In the absence of treatment or disposal facilities within the hospitals, medical waste is systematically burnt open-air or collected separately to be burnt outside the hospital compound. There is an urgent need to provide the hospitals with adequate equipment and to implement proper managerial procedures (colour coding system, collection procedures, etc…).

If the quantities remain relatively low, better segregation practices could help to reduce drastically the amount of medical waste to be burnt and significantly reduce the pollution generated during the burning process. However, in the absence of clear definitions and *National Guidelines*, it is difficult to improve current segregation practices. There is consequently an urgent need to develop an integrated and homogenous HCWM Plan and complete the *Eritrean Hospital Standards, Clinical Policies and Procedures*. A specific *Law* and *Internal Rules* for hospitals will have to be established so as to clarify roles, duties and responsibilities of all the actors involved in the HCWM process.

Although the medical and paramedical staffs have a relatively good perception of the degree of hazard associated with HCW, the current practices in the hospitals visited by the mission result in significant public health risks. The hygiene conditions linked to HCW handling and disposal cannot guarantee a satisfactory control on the transmission of nosocomial infections throughout the HCFs. Although direct and indirect costs of this situation are difficult to establish, they remain certainly significantly high.

The backstopping and monitoring capacities of the Central and Zonal Authorities to support the medical institutions remain limited. Furthermore the legal framework is not sufficiently developed. The implementation of an efficient monitoring framework and the involvement of the executives remain key issues to improve the situation within the hospitals. Moreover, the administrations of the medical facilities have difficulties to estimate the costs related to the management of HCW. The

structure of their accounting system does not enable them to differentiate the expenses associated with the management of the HCW from the ones linked to other activities. Consequently it is extremely difficult for the medical institutions to estimate the financial costs for the development of an integrated HCWM plan.

Some suggestions to improve the management of HCW within the medical institutions of Eritrea are proposed and their economical implications roughly analysed in the following part of this report. A strategy to upgrade the current HCWM practices is also developed taking into consideration that the improvement of the prevailing situation requires a long-term involvement from the MOH to monitor and implement adequate managerial procedures. A potential "*National Action Plan*" with measures that could be carried out by the MOH within the next five years to implement the recommendations is contained in the third part of this report.

Colour Plates

Photo 1: wheeled-bin overfilled with non-segregated waste (Assab Hospital)

Photo 2: non-segregated waste stored in open-air (Barentu Hospital)

Photo 3: stored salvaged and WHO/UNICEF sharp boxes before off-site transportation and open-air burning (Keren Hospital)

Photo 4: compost and scavenging animal at Asmara landfill where HCW is burnt and disposed of

Photo 5: A well-labelled waste container at the Central Health Laboratory (Asmara) but…

Photo 6: …in the end, hazardous and domestic waste are put together in the municipal skip container before being disposed of in the landfill

Photo 7: Scavengers at Barentu dumpsite where…

Photo 8: …syringes and needles may be found

Photo 9: A drum incinerator at Debarwa Health-Centre

Photo 10: A new MSF-design "incinerator" at Mendefera Hospital

Photo 11: A new placenta pit at Mendefera Hospital

Photo 12: The rotary kiln at the Eritrean Cement Factory in Massawa

PART TWO

Recommendations

The differentiation of the HCW streams within the medical institutions of Eritrea must be progressively improved taking into consideration the current situation prevailing in the country. The clear identification of the priority areas of improvement and the enunciation of adequate recommendations constitute the basis for the definition of the National HCWM Plan.

The mission recommends targeting in priority the following objectives:

- Consolidating the legal and regulatory frameworks;
- Standardising HCWM practices;
- Strengthening the institutional capacities of the HS;
- Establishing an efficient monitoring plan.

Section 1. Consolidating the Legal and Regulatory Frameworks

The establishment of a precise, strong and comprehensive legislation related to the management of HCW is a crucial point. A legal and regulatory framework must be created in Eritrea for the management of HCW. A number of legal documents should be edited by the MOH to reinforce the duties and responsibilities of key staff / institutions and underline the key steps essential to achieve these objectives.

1. National Legislation and Regulations

The Government of Eritrea (GOE) should edit a *law* that would aim at providing the minimal administrative requirements that should be respected for the management, the treatment and the disposal of HCW. Legal procedures contained in this law should aim at obliging the medical and non-medical staff in being responsible at their own level and securing the HCW disposal process.

Considering that the legal framework in Eritrea is not yet complete and that the vision and the tasks at central level are quite fragmented, the mission recommends that the GOE adopt a global approach by issuing a *Law on the Management of Hazardous Waste* that would apply not only to HCW but also other categories of hazardous waste such as pesticides, industrial waste and other categories of hazardous waste as they are listed in annex III of the Basel Convention. Within this law, specific chapters or articles should be devoted to HCWM and contain the general and specific provisions to determine the authorities of enforcement, the obligations of HCW Producers and Operators, the authorised management, treatment and disposal procedures as well as the range of penalties to be applied. More details are provided in table 4 hereafter.

In addition, the GOE must formulate clear *National Guidelines for the management of HCW*. These guidelines would complete the *Eritrean Hospital Standards Clinical Policies and Procedures*. Systematically associated with and referring to the Law, they should be practical and directly applicable and include the minimum obligatory procedures for the safe management of HCW.

Ideally *National Guidelines for Hospital Hygiene and Infection Control*, in which the management of HCW should be specifically and comprehensively addressed, should also be edited. These guidelines would help the Zonal Health Management Teams (ZHMT) and the HCF Management Teams to implement adequate standards for the handling and the disposal of HCW. Table 5 provides further details regarding the contents and the structure of these guidelines.

General Provisions of the Law

The rationale and the purpose of the Law should be explained in the General Provisions of the Law as well as basic but important definitions allowing to specify the appliance area of the Law.

- The main object is to regulate the generation, handling, segregation, collection, transportation, treatment and final disposal of all the HCW generated by health activities of preventive, curative and palliative treatments; activities of research as well as industrial production in relation with biomedical products;
- The objectives are that every producer and operator of HCW comply with the management, treatment and disposal procedures stipulated in the Law and abide by the registration and tracking provisions contained in the Law;
- As a minimum a glossary with the following information should be provided in the Law: definitions and a classification of HCW, generation, handling, segregation, collection, transportation, treatment and final disposal, HCW producers and operators.

Authorities of Enforcement

The Law should: 1) specify which institution is responsible for the enforcement and the coordination of the policy on HCWM; 2) explain what should be the different competencies of the Central, Regional and District / Municipal Authorities regarding HCWM; 3) describe the enforcement power of each of these authorities.

Provisions Related to HCW Producers and Operators

Should be listed in the Law:

- The type of institution that should be considered as a producer in the framework of the Law; the type of institutions / societies that should be considered as operators; The obligations that each HCW producer and operator should comply with to be allowed to operate: registration procedures to enforcement authorities, list of environmental mitigation measures taken;
- The compulsory measures that should be taken by the HCW producers and HCW operators to reduce health risks for the staff and reduce the environmental impact of HCWM;
- The training courses on the risks and the safety measures that should be taken during the handling, transportation and treatment of HCW; medical check-up to be carried out in case of an accident; compulsory immunisation vaccines that staff being in contact with HCW should receive; equipment that the staff dealing with HCW should have; the security instructions and guidance manual that should be available for the staff in any establishment generating HCW.

Provisions Related to Management, Treatment and Disposal Procedures

The mission recommends to include the following provisions:

- List all the management procedures that the producers should comply with: segregation, handling, on-site transportation, storage, off-site transportation, on/off-site treatment and final disposal;
- Describe the standard treatment and disposal norms that should be respected by HCW producers and operators to get an operating certificate issued by the Ministries to allow them to run their activities;
- Give the duration of validity of the certificate and provide specific provisions in case of an accident; Describe and inventory compulsory labelling and tracking measures and provide standardised labelling and registration forms in the annexe of the Law.

Penalties

The major mismanagements that would lead the enforcement authority to withdraw the certificate and to apply penalties should be inventoried.

Table 4: Fundamental provisions to be included in the Law

section 1. definitions

1. health-care waste
2. non-risk health-care waste
3. pathological waste
4. anatomical waste
5. infectious waste
6. highly infectious waste
7. sharps
8. pharmaceutical waste
9. cytotoxic waste
10. radioactive waste
11. special hazardous waste
12. effluents

section 2. public health risks associated with HCW

1. occupational risks
2. risks to the population
3. indirect risks via the environment
4. managing health-care wastes to minimise the overall risks

section 3. health-care waste management procedures

1. classification of health-care waste
   a) segregation
   b) colour coding system
   c) consideration on HCW minimisation and recycling
      recycling of non-contaminated plastic items
      recycling of glassware inside the diagnostic laboratories
      reuse of specific equipment

2. general HCWM procedures
   a) waste collection and on-site transportation
   b) waste storage
   c) off-site transportation
   d) waste treatment and disposal
   e) accidents and spillage

3. specific procedures associated with HCW categories
   a) class 1: non-risk health-care waste
   b) class 2: clinical waste
   c) class 3: sharps
   d) class 4: anatomical waste and placentas
   e) class 5: hazardous pharmaceutical waste and cytotoxic waste
   f) class 6: highly infectious waste
   g) class 7: radioactive waste
   h) others
      large quantities of chemical waste
      waste with high contents of heavy metals
      effluents

section 4. guidelines for the implementation of HCWM plans in HCFs

1. assign duties and responsibilities
   a) duties and responsibilities of the medical officer in charge of the hospital
   b) duties and responsibilities of the health-care waste management team
   c) duties and responsibilities of the health-care waste management officer
   d) duties and responsibilities of the head of administration
   e) duties and responsibilities of the heads of departments
   f) duties and responsibilities of the patron / matron of the hospital
   g) duties and responsibilities of the head of operation and maintenance
   h) duties and responsibilities of the pharmacist in charge

2. allocate resources and provide equipment for health-care waste handling
   a) estimation of needs
   b) selection of the technology for HCW treatment/disposal
   c) allocation of resources and provision of equipment

3. organise the HCW streams
   a) outline the procedures and practices
   b) ensure training of staff members
   c) prepare the HCWM plan document
   d) set-up a monitoring system and reporting procedure
   e) focus on specific locations

4. considerations on the involvement of the private sector

section 5. guidelines for Zoba and sub-Zoba HS

1. setting-up annual regional and district health-care waste management plans
2. backstopping of health-care facilities
3. inspection

Table 5: Example of the content of National Guidelines

2. Rules in Medical Institutions

a) Code of Hygiene

The Management of HCW must be considered as an integral part of hygiene and infection control in HCFs. The legal framework must therefore be reinforced with the application of strict internal rules that should be regularly monitored. Currently, the MOH makes an effort to improve hospital hygiene by creating committees within the hospitals and providing standards for clinical policies and procedures. It could be worthwhile that hygiene and control of nosocomial infections be consigned in a comprehensive *Code of Hygiene* providing:

- Ongoing monitoring and managerial activities to be carried out in hospitals to reinforce hygiene and infection control;
- Rules setting duties and responsibilities of the medical and para-medical staff regarding the hygiene and infection control measures that should be applied in hospitals and during their medical practices;
- Recommended practices to maintain a high level of hygiene, particularly with regards to HCWM.

b) Assignment of Responsibilities

Personal responsibility is a key issue to ensure that the medical and paramedical staff actively participates in the general HCWM effort. Each health-worker should be notified, *in writing,* of his/her duties and responsibilities concerning the management of HCW. Nurses and Nursing-Assistant job descriptions should also be reviewed so as to reinforce the duties and responsibilities of this category of staff in the daily management of HCW.

Section 2. Standardising HCWM Practices

The recommendations that are presented hereafter should be implemented in all the medical institutions of the country. The financial constraints that the medical institutions face are taken into consideration to propose pragmatic and affordable HCWM plans and disposal technologies. A step-by-step strategy will need to be implemented to progressively improve the HCWM practices. The figure 6 summaries the recommendations provided in this section.

1. Minimising the Quantity of HCW Generated in Medical Institutions

The MOH should encourage the reduction of hazardous HCW generated in HCFs by coordinating, in co-operation with MSD, the establishment and the implementation of an adequate *minimisation policy* aiming at:

- Improving the purchasing practises to reduce the source of potentially hazardous HCW [55];
- Rationalising the stock management (use of the oldest batch of a product first, regular checking of expiry dates…);
- Enforcing a rigorous and careful segregation of the HCW, at source (see below).

[55] For instance, the replacement of mercury based thermometers with simple gallium (indium + stain) based thermometers would advantageously replace the mercury ones, avoiding that a heavy, toxic and volatile metal be disposed of when thermometers are broken or out of order.

2. Segregation, Packaging and Labelling

The recommendations provided in this chapter are valid for all Eritrean HCFs. They follow the guidelines provided by the World Health Organization.

a) Segregation

The segregation of HCW is of the utmost importance for three different reasons: 1) proper segregation is the basis for safe manipulation and appropriate disposal of medical waste; 2) the treatment and disposal procedures can be optimized for each category of waste; 3) it is one of the most efficient ways to reduce the costs linked to the treatment and the disposal of HCW.

The mission recommends *to set-up standardised segregation procedures* in all the HCFs of Eritrea [56] by implementing a *three-bin system* that should be s*ystematically associated with a colour coding and labelling procedure*. The following categories of HCW should be considered (see table 6):

- *Non-Risk HCW* or domestic waste;
- *Medical Waste* that includes all the pathological and infectious wastes as described in the introduction of this report as well as some particular waste generated in isolation wards;
- *Sharps* that include all items that can cause cuts or puncture wounds. They should always be collected in rigid safety boxes. In particular, all disposable syringes and needles should be discarded immediately after being used without recapping the needle or removing it from the syringe: the whole combination should be inserted into the safety box.

In addition to this three bins system, in the different services where they are generated:

- *Anatomical Waste*, generated in Operation Theatres and Placentas should be collected separately to be specifically disposed of;
- *Highly Infectious Wastes* generated in Medical Laboratories have to be pre-treated before being disposed of with medical waste (see annexe 7);
- *Pharmaceutical Waste*[57] should be specifically packed to be sent back to Pharmecor and disposed of in Massawa (cf. chapter 4).

b) Packaging

Packaging is a problem in Eritrea. In order to set-up a good monitoring system, the MOH should *standardise the different waste bins* in all HCFs of the country (size and colour). However, the mission suggests to take into consideration the reality of the country by implementing different solutions for packaging:

- Outside Asmara, *where on-site treatment is planned*, plastic bins can be used if they are regularly disinfected. To enable the monitoring process, the use of other sizes should never be allowed by the MOH !
- For the hospitals located in Asmara, *where off-site treatment is planned*, bins for medical waste should be replaced with bag-holders using 60 to 80 litres[58] yellow PE bags (200-300µm gauge). Black plastic bins should be used for non-risk HCW.
- Safety boxes, similar to the one used for EPI programmes should be used for sharps. However, in remote areas, the use of recycled cardboard boxes in Health-Stations can be admitted as long as they are adequately conditioned and labelled.

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[56] It is actually essential to implement homogenous procedures throughout the country to reduce the risks of mistakes by the medical staff.

[57] Whatever the sub-category may be: non-hazardous, hazardous, cytotoxic.

[58] The bags of other sizes, either fill-in too rapidly (too small) or are carried with difficulties by the nursing-assistant (too big).

c) Colour Coding

A standardised *colour coding system* aims at ensuring an immediate and non-equivocal identification of the hazards associated with the type of HCW that is handled or treated. In that respect, the colour coding system should remain *simple* and be *applied uniformly throughout the country.* The internationally recognised colours that should be applied in the medical institutions of Eritrea should be:

- *Black:* for all bins, bags containers filled with non-risk HCW;
- *Yellow:* for all bags, sharp boxes and containers filled with hazardous HCW.

Medical Waste	Sharps	Non-risk waste
Gloves, gowns, masks gauze, dressings, swabs, spatulas that are visually contaminated with blood or body fluids Urine, blood bags, sump tubes, Suction canisters, disposable bowls and containers used for medical purposes, Haemodialysis tubing, Intravenous (IV) lines, bags Foley catheters Pre-treated highly infectious waste from medical laboratories, isolation wards Are considered as potentially infectious waste but are managed separately for technical reasons: Human tissue placentas, body parts	Needles, Needle and Syringe assemblies, Lancets, scalpels, blades, Scissors Broken glass, ampoules Intravenous catheter Glass slides, cover slips	Gloves, gowns, masks, gauze, dressings, swabs, spatulas that are contaminated neither with blood nor body fluids Sanitary napkins, Incontinence pads (except in isolation wards) Packages, boxes, Wrappings Newspapers, Magazines Disposable plates, cups, food utensils, left over food and packaging, canisters Tissues, paper towels, intravenous bottles, packs...

Table 6 : Practical segregation examples

d) Labelling

In the major HCFs located in cities, when off-site treatment is planned, the mission would recommend to set-up an adequate tracking system of medical waste and sharps. The labelling should be written at least in two of the official languages of Eritrea and mention:

- The *type of waste* in the container with the formulation « Danger ! Medical waste »;
- The name of the hospital;
- The date of collection.

3. Collection, On-Site Transportation and Storage

The recommendations provided in this chapter are mainly valid for Hospitals where the quantities of HCW generated remain significant.

a) Collection and On-site Transportation

The mission would recommend to:

- Store temporarily filled up yellow bins or waste bags and black bins in separate locations so as to avoid mistakes, away from patient areas, preferably close to the nurse room;
- In major hospitals located in Asmara, two-wheeled 240 litre bins or four-wheeled 700 litre bins (with a lid) should be used, for temporary storage of medical wastes and sharps inside the HCFs and off-site transportation. Once again, to enable the monitoring process, the use of other sizes should not be allowed by the MOH !

- Precise the schedule for the collection of waste and containers from each Medical Department in order to ensure the regular removal of waste from each location and to avoid misunderstandings between medical and non-medical staff;
- Remove the waste from the different units within the HCF at least once a day;
- Set-up separate schedules and separate collection times for black bins and yellow bags/bins;
- Ensure that the cleaners and waste collectors wear protective clothes when they handle waste, at least, heavy-duty gloves, industrial boots and an overall.

b) Central Storage

The mission would recommend improving the central storage points in hospitals for the two types of waste. They should be geographically separate within the hospital ground in order to: 1) avoid contamination of non-risk HCW waste from medical waste; 2) facilitate the collection of both wastes that will go to different treatment/disposal facilities. Above all, the wastes should be stored in such a way that they are protected from the effects of the weather and from the scavenging of animals and insects. *All waste should be disposed of within a maximum of 48 hours*.

c) Off-Site Transportation (for Asmara only)

In Asmara, where all the medical facilities are located close to each other, the construction of a central disposal facilities can be envisaged for medical waste. It is thus necessary to consider off-site transportation. The following recommendation can be made:

- Delivery forms specifying the number of 240 or 700 litres wheeled bins conveyed for each trip should be prepared by the MOH to ensure an adequate monitoring of off-site transportation. The hospital, the conveyor and the waste regulator should have the duty to fill-in and sign the form, plus keep a copy when loading (respectively unloading) the medical waste. The Municipality of Asmara or the Authorities of Zoba Maakel should always receive a copy on a weekly or monthly basis;
- The vehicles used for the transport of yellow bags should not be used for any other purpose. They should be free of sharp edges, easy to load and unload by hand, easy to clean/disinfect, and fully enclosed to prevent any spillage in the hospital premises or on the road during transportation. They should carry a consignment note from the point of collection to the central treatment facility. They should be cleaned and disinfected on a daily basis.
- The transportation could be organised by a private conveyor jointly mandated by the Municipality of Asmara, the Zonal Authorities and the MOH.

4. Treatment and Disposal

Environmental-friendly, safe and affordable options may not be available for every situation in Eritrea. The health risks from environmental exposure should always be weighed against the risk of accidental infection due to an inadequate disposal system.

To date, landfilling – without prior pre-treatment of the waste – and incineration have been the treatment technologies chosen in Eritrea,. Other technologies internationally recognised and accepted for treating hazardous HCW exist (cf. annexe 5). Currently, at international level, two major concepts for the treatment/disposal of HCW are applied:

- Expensive modern *incineration*, with a strong control of the air-stack emissions. This solution is mainly used in most of the European and some Asian countries such as England, France, Germany, Switzerland, Hong-Kong, Singapore… In general medical waste are incinerated with other categories of hazardous or non-hazardous waste. This option is interesting when land is expensive and a priority is put on reducing the volume of residues (i.e. ashes) to be disposed of;

- *Disinfection* through the use of autoclaves or microwave technologies followed by controlled landfilling of the waste. This solution is used in countries where land is easily found for dumpsites (USA, Canada) or where modern incineration cannot be afforded (Mexico, Argentina). The implementation of this solution remains anyway quite expensive.

With the recent Stockholm Convention on Persistent Organic Pollutants (POPs), ratified by most of the international community, pressure for the use of alternative technologies to incineration when strict air emission control cannot be ensured is increasing. However, in low-income countries, because of the lack of funding on the one hand and the lack of adequate monitoring capacities on the other hand, finding affordable, environmentally sound and sustainable technologies that remain sufficiently simple to be durably operated is often impossible. For these countries, burning *in low-cost incinerators* or burying HCW in *sanitary landfills*, using adequate techniques remain the most affordable and acceptable options, also not fully satisfactory. In the Eritrean context, the mission does not recommend to bury the HCW in *sanitary landfills*, for the following reasons:

- There are no sanitary landfills operated in the country, but dumpsites, whose management should be improved prior to any further operations[59];
- Municipal waste collection services[60] are not in a position to carry out the work in appropriate conditions;
- The institutional capacities and the financial resources of the municipalities being scarce, they are – and will not in the near future – be able to face simultaneously the increase in domestic waste produced by an ever growing urban population and ensure at the same time a safe and regular collection and disposal of contaminated HCW[61]. Improving the domestic waste disposal is and will remain the first priority for all municipal technical services.

Currently the WHO is supporting the construction of low-cost, high-temperature incinerators that have been specifically developed and designed for the treatment of HCW in low-income countries by the De Montfort University . Mark 8a and 9 models[62] of the De Montfort incinerator have been already installed in various countries throughout the World. *If properly operated*, a De Montfort incinerator has the following advantages:

- It reaches temperatures of 800°C or more [63];
- The operating costs of the De Montfort incinerator remain extremely low (less than 5 USD/ton) as well as the capital cost (about 500 USD for a Mark 8a and 750 USD for a Mark 9);
- Operation and maintenance are simple.

Products of Incomplete Combustion (PCI) are obviously generated during the whole process. Nevertheless in areas that are not densely populated, incineration enables to reduce the immediate hazards linked to medical waste and sharps. With respect to the financial resources available in the hospitals, this type of incinerator, if upgraded (for instance *Mark V* incinerators can be used), can

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59 With the noticeable exception of Asmara dumpsite, which is on the whole quite well managed thanks to the commitment of the Municipal Cleaning and Sanitation Unit. Unfortunately, this site is located next to the City – 6 km away from the Centre. In addition, the surface area of this dumpsite (approx. 4 ha) remains too limited to receive the 185 tonnes of municipal waste thrown away daily and assign a specific location to dispose of the hazardous HCW.

60 For instance, the Municipality of Berentu – more than 40'000 inhabitants – currently owns two trucks, out of which one was under repair in Asmara, and has only five skip containers for the whole town.

61 For instance, in Asmara, only four agents – for 125'000 inhabitants – operate the dumpsite. No hydro-geological study is carried out to control the effluents and no environmental impact assessments seem to have been made by the MOLWE.

62 The *Mark 9* is designed for hospitals up to 1'000 beds, and burns at about 4 times the rate of the *Mark 8a*. (50 kg/h approx.). It can support the weight of a relatively high chimney for use where a high chimney is a legal requirement or where the proximity of other buildings makes a high chimney necessary to disperse smoke and fumes.

63 Results of a campaign of measures carried out at De Montfort University. Personal communication of Professor D. J. Picken. Further information can be found here: http://www.mw-incinerator.info/en/501_lab_measures.html

constitute an acceptable intermediate solution to dispose of *medical waste*s and *sharps*. The residual ashes must be buried.

In any case, Operation and Maintenance of these incinerators must be well planned to ensure their sustainability. They have a life span of up to 5 years if well maintained and operated on a regular basis. In that respect, the MOH should propose adequate financial, management and institutional mechanisms.

a) Disposal of the Health-Care Waste Generated in Health-Centres and Health Stations

If the MOH wants to rapidly improve the situation, the mission recommends adopting a pragmatic approach for these categories of medical institutions that are often under-staffed and under-equipped. The MOH should first concentrate its effort on the minimisation, the safe segregation of the HCW as well as the respect of safe management procedure as mentioned above. A safe treatment/disposal system remains problematic in these categories of HCFs. However, considering the small quantities of HCW that are usually generated in these facilities, the following solutions are suggested.

In Rural Areas

The mission recommends burning medical waste, sharp safety boxes and domestic waste all together, on a *daily* basis, in *burning pits*, that might be lined with concrete walls, only when there is an obvious risk of contamination of a shallow underground water table (like in Tio). Placentas and other pathological waste that do not burn well should be deeply buried (1 metre minimum). The use of concrete lined placenta pits can be envisaged in places where there is a risk of contaminating the underground water table (for construction instructions, see annexe 9).

In Urban Areas

The same approach is recommended as in rural areas. In Health-Centres and Health Stations located in urban areas, the first improvement would consist in ensuring the on-site burning of sharps and the safe burying of the ash; the safe burying of placentas and pathological waste (in concrete lined pits, if necessary). However, the MOH could equip the Health-Centres located in the most populated areas with Mark 8a De Montfort incinerators in a second step.

b) Disposal of the Health-Care Waste Generated in Hospitals

In Asmara

A decentralised solution, using low-cost De Montfort incinerators cannot be considered as an acceptable medium-term solution for Asmara where all the major hospitals are concentrated in the same area and where off-site transportation should not be problematic. With the construction of the new paediatric hospitals, it is possible to use a *central pyrolytic incineration system* [64] with limited pollution emission if adequate technical specifications are respected. The incineration capacity should be calculated taking into consideration the projected population growth in Asmara as well as the increase of Health-Services provided.

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[64] Pyrolytic incineration, also called controlled air incineration or double-chamber incineration is the most reliable and commonly used treatment process for HCW. Pyrolytic incinerator comprises a pyrolytic chamber and a post-combustion chamber. In the pyrolytic chamber, the waste in thermally decomposed through an oxygen-deficient, medium-temperature combustion process (800-900°C), producing solid ashes and gases. The pyrolytic chamber includes a fuel burner, used to start the process. The waste is loaded in suitable waste bags or containers. The gases produced in the first chamber are then burned at high temperatures (1'200°C) in the post-combustion chamber, using an excess of air to minimize smoke and odours. Ashes produced normally contain less than 1% of un-burnt material, which can be disposed of in a landfill.

The mission recommends that the MOH *progressively* target a treatment capacity of 1 tonne per day and install *two* discontinuous, manual loading and ash removal, static pyrolytic incinerators[65] with a capacity of 80 kg/hour each[66].

A reasonable strategy for the MOH would be to install, *in a first step, one* incinerator at the Paediatric Hospital and organise the transportation of medical waste towards this hospitals (in the first years, the capacity of this incinerator will remain sufficient), *before installing a second one* in an other HCF of Asmara and re-scheduling the organisation of the transportation services. This prudent approach would enable the MOH to test and adjust the operation and maintenance procedures. In a *third step*, the treatment of stack emissions might be foreseen by the GOE.

Pyrolytic incinerators require well-trained technicians to operate and maintain them. Correct operation is essential not only to maximise treatment efficiency and minimise the environmental impact of emissions but also reduce maintenance cost and extend the life expectancy of the equipment. International bidding procedures should be respected. The mission strongly recommends that the MOH either negotiates with the manufacturer proper training of staff regarding operation and maintenance procedures or chooses a public-private partnership for this service.

In the other municipalities

Zoba Hospitals should be progressively equipped with De Montfort incinerators to treat *sharps* and *medical waste*, depending on the size and the location of the hospitals inside the municipality [67]. In sub-Zoba Hospitals, Mark 8a De Montfort should be sufficient, while in Zoba Hopsitals (including in the new hospitals under construction in Mendefera, Barentu and Gindha), Mark 9 De Montfort incinerators should be installed (more details on the De Montfort incinerators are provided in annexe 8). The mission believes that this is the most realistic short-term solution and represents a significant improvement comparatively to the present situation for the following reasons:

- This double chamber incinerator, designed at the De Montfort University (England) has been tested and reaches temperatures above 900°C if it is properly built and operated [68];
- The operating costs of the De Montfort incinerator remain extremely low (less than 5 USD/tonne) as well as the capital cost (about 500 and 750 USD for respectively a Mark 8a and a Mark 9);
- Operation and maintenance is relatively simple but the MOH must be aware that without a proper national maintenance strategy and a proper training of the operating staff, this incinerator will breakdown as any other system;
- The medical institutions cannot afford alternative solutions and/or are difficult to apply;
- A lot of these incinerators have already been built and tested in East African countries; the expertise is currently available in the sub-region.

Placentas and *anatomical wastes* cannot be treated in this kind of incinerator since they would drastically reduce the efficiency of the combustion. Therefore, the mission would recommend equipping the Hospitals with specific concrete placenta pits for the safe burying of this category of waste (see annexe 9).

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65 The MOH must actually be aware that regular maintenance is needed for this kind of incinerator. The installation of two incinerators enables to set-up contingency plans when one incinerator is under maintenance or has to be repaired. In addition, small size incinerators are usually easier to operate.

66 2 x 80 kg/hour represents a capacity of 800 kg/day if the incinerators are used 5 hours a day on average.

67 The *Mark 8a* has a capacity of 12 kg/ hour and can be used in sub-Zoba Hospitals. The *Mark 9* is designed for hospitals up to 1'000 beds, and burns at about 4 times the rate of a *Mark 8a*. (50 kg/h approx.).

68 In case of doubt, we strongly recommend that the designer of these incinerators (D.J. Picken) be contacted to obtain all necessary technical information.

c) Disposal of Highly Infectious and Hazardous Pharmaceutical Waste

Highly Infectious Waste

Waste from the Medical Analysis Laboratories such as sputum cups, media and culture plates, etc. are considered as being highly infectious and should be autoclaved before being disposed of with medical waste. However, such a solution is difficult to be applied in Eritrea. The mission therefore recommends to ensure a chemical pre-treatment in a solution of sodium hypochlorite in concentrated form (see annexe 7).

Pharmaceutical Waste

High temperature incineration is the best way to dispose of pharmaceutical waste. The waste should be disposed of with their cardboard packaging to ensure optimal combustion conditions. Low-temperature incineration/burning, as is currently practiced in Eritrea, provides only limited treatment for this type of waste and is therefore not recommended. Cement factory rotary kilns are particularly well suited for the treatment of pharmaceutical waste since the temperatures reached often exceed 1'200-1'400°C, thus ensuring both complete combustion and near to zero toxic exhaust gases.

The mission visited the Eritrean Cement Factory in Massawa. With a capacity of 60'000 tons a year of Portland cement and a rotary kiln of 85 m long, 2,8 m diameter, reaching up to 1'500°C, the relatively small quantities of pharmaceutical waste generated in the country could be easily treated in this facility in 2-4 batches per year. Using the trucks which currently supply the regional stores with drugs to bring back to the central store in Asmara the expired pharmaceuticals, organising the transport from there to the cement factory in Massawa should pose any problems. This solution should be progressively implemented, starting for example with the pharmaceutical waste generated in the Red Sea Regions.

Section 3. Strengthening the institutional capacities of the HS

If privatising the HCWM services might be seen as a solution to cope with the recurrent weaknesses of the Eritrean HS, the mission believes that the reinforcement of the institutional capacities of the HS will continue to be a major issue requiring priority attention. Experience shows that the option of involving the private sector in the day-to-day management, by granting concessions for the collection and/or the treatment of HCW is strictly correlated with the institutional, negotiation, monitoring and control capacities of the Public Authorities. The development of a harmonious private waste management service can be envisaged only when:

- The capacities of the Central and Local Health Authorities to control the quality and audit the practices of the Private Sector are ensured;
- The Health Authorities is in a position to prepare adequate technical specifications and bidding documents for international and transparent requests for Proposals.

Currently, the capacities of the Health Authorities remain limited at all levels of the Eritrean HS, by their financial status, technical knowledge and management practices. The GOE will need to make an important effort to improve these aspects, which will also contribute to the set-up of a sustainable HCWM system.

1. Improving the Accountancy and Financial Resources

The implementation of a cost recovery mechanism will be difficult with regards to the current priorities in the Health Sector. However, without specific financial resources, it is impossible to get sustainable improvements in the management of HCW. Since *HCWM is an integral part of health-care*, it needs to be budgeted for and each HCF should be aware of the costs that are linked with the safe management and disposal of the waste it generates.

An adequate accountancy system, with a *specific budget line* dedicated to the management of the HCW within the medical institutions should be set-up. This measure would force the actors involved at all levels to take into consideration and estimate the expenses linked to the management of HCW.

2. Launching Capacity Building

Drastically improving the technical and management capacities of the Health Officers of the MOH, the Zoba and sub-Zoba HS as well as the HCFs is an absolute necessity to set-up sustainable HCWM Plans in Eritrea. A *National Training and Awareness Programme* must be prepared as soon as possible and launched rapidly once appropriate means (budgetary and human resources) are made available.

a) Training Requirements

A policy for the management of HCW cannot be effective unless it is applied carefully, consistently, and universally. Training is a critical issue and its overall aim is to develop awareness of the health, safety and environmental issues relating to HCWM. The following subjects may be considered for training and awareness raising activities:

- Proper procedures and precautions for segregation, handling, storage and disposal of hazardous HCW (including briefing on the De Montfort incinerators);
- Proper emergency procedures during a hazardous HCW spill or exposure;
- Health hazards associated with the mishandling of hazardous HCW;
- Organizational process for reporting hazardous materials and waste spills or exposures.

b) Target Groups

The following target groups should receive training:

- At *central level*, the mission recommends that the GOE get a strong external support to formulate a comprehensive training programme and train a group of selected trainers;
- At *regional and municipal levels*, ZHMTs must be strengthened through the training and the recruitment of additional Health Officers with specific technical knowledge;
- At *HCF level*, Directors, health-care workers and waste collectors should receive in-service practical training sessions aiming at helping them manage HCW in the most effective way on a daily basis.

c) Potential Strategy for the Implementation of the Training and Awareness Programmes

A *training package* could be developed by the MOH. It should be well illustrated with drawings, diagrams and/or overhead transparencies. All procedures should be carefully represented in diagrams and photographs. The following priorities have been identified:

- Specific *in-service training programmes* on HCWM should be organized for hospital staff including administration services, nurses, medical doctors and technical services, Zonal Health Management Teams, Central Services of the MOH and MOLWE;
- *Academic programmes* in the College of Nursing and Health Technology should be reviewed to ensure that adequate training on HCWM is provided. Compulsory modules specifically dedicated to HCWM could be set-up. They should focus on: 1) the health risks associated with HCW; 2) the adequate management systems that should be applied in all the HCFs of the country, and 3) duties and responsibilities of health-care workers;
- An *initial briefing* should be systematically organised for new health-care workers recruited.

3. Operation and Maintenance Capacities

The capacities of the HS should be reinforced by recruiting additional staff and setting-up *zonal operation and maintenance teams* capable of backstopping the HCFs in their HCWM procedures.

For the construction and maintenance of the De Montfort incinerators as well as the initial training of the operator, it is strongly recommended that the GOE sign contracts with a limited number of well trained and certified local construction companies. The local manufacturing of standardized cardboard safety boxes for sharps should also be encouraged. In this respect, public-private joint ventures are solutions that could be envisaged.

Section 4. Establishing an efficient HCW Monitoring Plan

Regular reporting and field visits as well as a good information system to store and analyse the data are the basis of an efficient Monitoring Plan. The monitoring plan should aim at providing the main stakeholders (MOH and Zoba Health Authorities as well as HCFs staff) involved in the HCWM issue relevant information for two different but complementary objectives:

- Progress in the implementation of the HCWM plans within the HCFs and evaluation of the impact of the National HCWM Plan;
- Measure the Operation and Maintenance[69] (O&M) performance of the health services to maintain a good standard of HCWM within the HCFs.

[69] *Operation* refers to the procedures and activities involved in the actual delivery of services while *maintenance* refers to activities aimed at keeping existing capital assets in serviceable conditions.

The Monitoring Plan must provide the necessary *tools* to measure if these objectives have been reached. They include:

- The set-up of adequate indicators of achievement or performance. The mission recommends that the MOH couple *qualitative* with *quantitative* indicators in order to monitor and evaluate the outcome of the HCWM plan. This aspect is further discussed in the third part of this report;
- An *simple, regular reporting system* to keep all the stakeholders constantly informed with sufficiently accurate and relevant information that can be easily verified, enabling decision-makers to change the implementation strategy if necessary based on the practices encountered in the HCFs;
- The set-up of regular control and backstopping activities carried out by the Central and Zonal Health Authorities, addressed to the HCFs.

1. Setting-up HCWM Plans at HCF Level

The establishment of a HCWM plan should progressively lead the medical institutions and the administrative authorities to consider HCWM as a routine issue to cope with and reinforce progressively their organisational capacities. The MOH should oblige the major hospitals to formally nominate a Health-Care Waste Management Officer (HCWMO) who should, in co-operation with the Infection Control Committees, co-ordinate and supervise the whole HCWM system. He/she should have sufficient authority to ensure that all hospital staff complies with the HCWM plans. In each medical institution, roles, responsibilities and duties of the medical and non-medical staff regarding HCWM should be well defined in standardised in personal job descriptions. Annexe 10 provides all the necessary recommendations for the establishment of these plans at HCF level.

2. Setting-up a reliable information system

The mission recommends to consolidate the on-going management and administration procedures by setting-up an efficient information system related to HCWM at all levels of the HS:

- *Annual Reports* written by the HCFs for the Zoba Health Services should be completed following the indications contained in Annexe 10;
- ZHMTs should gather and synthesise all the reports of the hospitals under their jurisdiction and set-up their own *Regional HCWM plan* that should contain at least: 1) an inventory on existing treatment and disposal facilities in each HCF; 2) a compilation of the needs for each HCF and recommendations as mentioned in steps 2 and 3 of Annexe 10; 3) an estimation of the budget to be allocated for the management of HCWM in the coming year; 4) a strategy to improve the management of HCW in the region; 5) a provisional agenda for the monitoring of the disposal facilities located in the HCFs. Year after year, the annual plan of action edited by the ZHMTs should translate into specific actions and a clear strategy;
- At central level, the MOH should complete the HMIS to have a better knowledge of the status of the HCWM practices in the medical institutions and regions. They will be able to modify the *National HCWM Policy and Strategy* if required [70].

[70] For instance the knowledge of the occupancy rate in hospitals and the daily recording of the volumes of waste produced would enable to estimate more accurately the production of HCW and establish easily cross-checking procedures in order to evaluate the equipment needs of each HCF for the management of HCW.

3. Setting-up adequate Control and Backstopping Procedures

Based on the HCWM plans and on the information system, the MOH should encourage Zonal HS and HCFs to introduce a protocol for the monitoring and the auditing of the HCWM plans. This should lead the Zonal Health Authorities and the Directors of the HCFs to follow-up regularly the HCWM practices in their medical institution.

a) At Central Level and Zonal Levels: Enforcing Safe Practices

The Central and Zonal Health Authorities should:

- Gather and analyse the information contained in the HCWM plans and set-up a strategy to gradually upgrade the HCWM procedures;
- Carry out regular inspections to verify at least that segregation procedures are respected and safety measures applied;
- Backstop the different HCFs by providing a feedback on the problems observed and giving appropriate training and advice to correct/improve the current practices.

b) At HCF level

The following parameters should be monitored by the HCWMO (see annexe 10):

- Waste generated each month, by waste category (in each department); treatment and disposal methods;
- Direct costs of supplies and materials used for collection, transport, storage, treatment and disposal as well as decontamination and cleaning;
- Costs of operation and maintenance of on-site treatment facilities;
- Incidents resulting in injury, "near misses", or failures in the handling, separation, storage, transport or disposal system, which should also be reported to the Infection Control Committee.

Section 5. Conclusion

Improving durably the HCWM practices in Eritrea through the implementation of all the recommendations formulated in the second part of this report remains a difficult exercise.

The numerous aspects that must be taken into consideration to improve the management of HCW in the Eritrean medical institutions must be articulated into a coherent *National HCWM Plan*, with the development of a precise *strategy* for its implementation. This is the object of the third part.

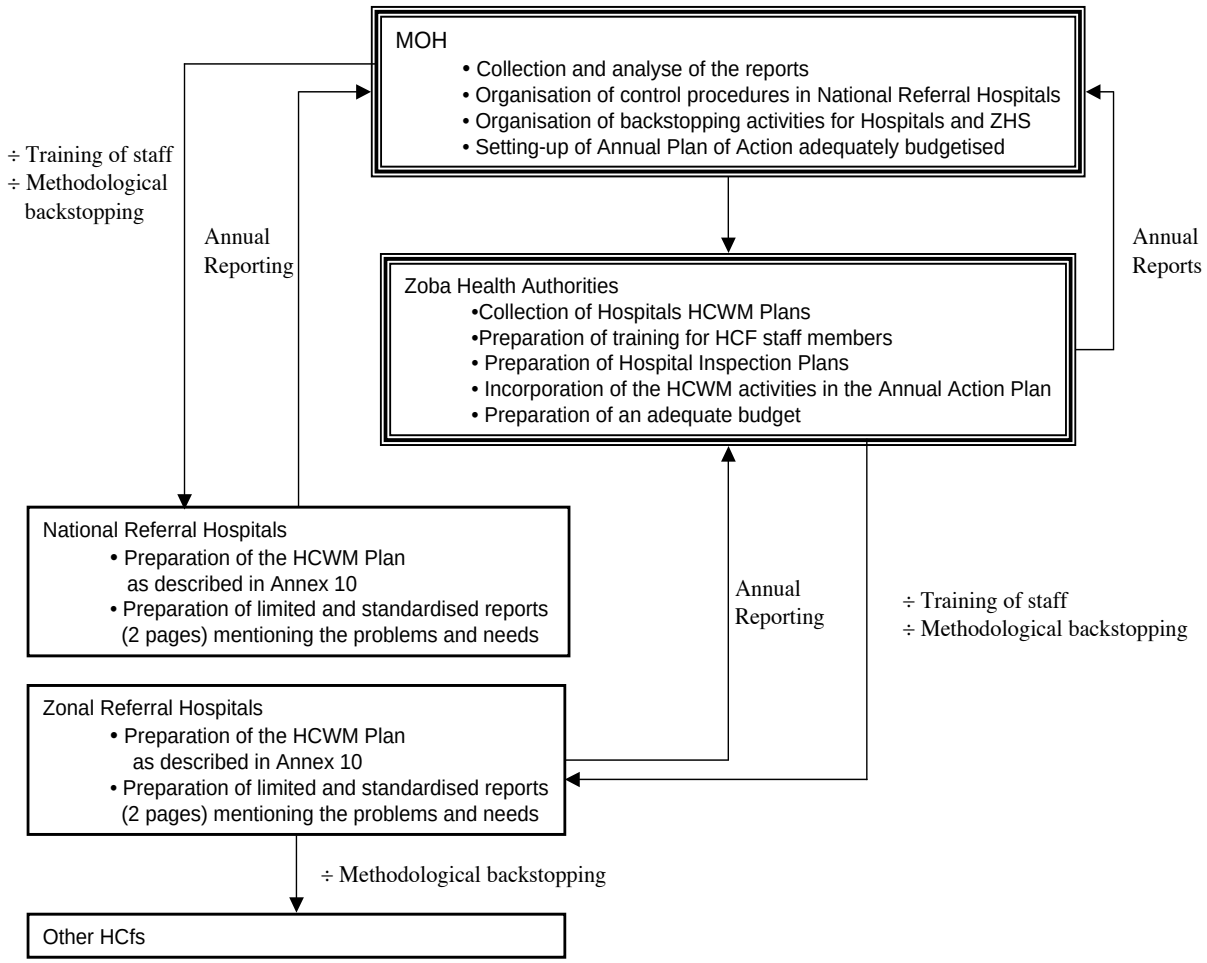

Figure 7: Streams of information for an efficient HCWM Monitoring Plan

PART THREE

National Action Plan

The GOE must develop a *step-by-step strategy* to improve the management of HCW in the HCFs of the country and reduce significantly the occupational risks associated with the current practices. The strategy should show clearly the medium and the long-term objectives to be achieved and reflect the integrated effort that is necessary to set-up safe and environmentally sound HCWM practices. Whenever possible, it should underline the institutional and individual responsibilities as well as define the monitoring and administrative procedures.

Section 1. National Strategy for the Implementation of the Plan

As already mentioned in the first part of this report, the lack of exchange of information and the poor coordination between the different HS and between the MOH and the other Ministries was certainly one of the major problems encountered by the mission in Eritrea. Information sharing, multidisciplinary work and efficient coordination are important challenging issue for the MOH.

It is of the utmost importance that the MOH implement new HCWM procedures *in close co-operation with all the stakeholders of the country* i.e. with the MOLWE, Zoba and sub Zoba Health Authorities, the HCFs themselves and the Medical Doctors and Nurses Community. The MOH should induce the Authorities of the HCFs and the ZHMTs to develop their own HCWM plans. *New standards should be applied first in the National and Regional Referral Hospitals*. A three-steps approach is proposed:

- Step 1: organise a National Workshop to validate the National HCWM Plan and the strategy that is proposed;
- Step 2: establish the institutional framework to initiate the HCWM plan: recruit a Project Coordinator and form a National Steering Committee for HCWM;
- Step 3: launch the National Action Plan.

1. First Step: Organise a National Workshop

The national workshop should focus on amending and validating the *National HCWM Plan*. The implementation of the HCWM plan will require a regular commitment and monitoring. Thus *participative decisions* should be taken during the workshop to ensure a good cooperation between all the stakeholders for the future implementation of the plan. The following institutions should participate to the workshop:

- National and local institutions: MOH [71], MOLWE, MOF, MOD[72], Pharmecor, College of Nursing and Health Technology, University of Asmara, Representative Organisations of Nurses and Medical Doctors, Representatives of the ZHMTs of all the regions;
- Civil Societies: representatives of NGOs and private manufacturers[73];
- Representatives of International Agencies working in Eritrea such as the WHO, UNICEF and UNEP;

Although a lot of committees exist in Eritrea, the mission strongly recommends setting up a *National Steering Committee for HCWM*. The members of this Committee should be designated during the workshop and its tasks clearly established.

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[71] And most particularly the following services: Environmental Health Unit, EPI, Medical Services, Training, Continuing Education, HMIS, Drug Inspection, Zonal Health Services

[72] In order to include the Military Hospitals in the National HCWM plan.

[73] For instance National Companies building incinerators or international NGO working in cooperation with the MOH within the hospitals.

2. Second Step: Set-up the Institutional Framework to Implement the Plan

The *National Steering Committee for HCWM* (NSCHCWM) should supervise and monitor the overall implementation of the HCWM plan [74]. The members of the Steering Committee should meet on a regular basis (every three months minimum). They should be divided into specific *Task Groups* aiming at implementing specific portions of the NHCWM plan. The mission strongly recommends that the MOH seek external support that would aim at backstopping the NSCHCWM in its initial organisation.

The tasks of the *National Steering Committee* should be the following:

- Nominate a project coordinator and compose the Task Groups;
- Establish the criteria for the monitoring of the HCWM plan during its implementation;
- Designate the administrative authorities in charge of the implementation of the HCWM plan at Zoba and sub-Zoba levels;
- Select HCFs and Zoba where the National HCWM plan could be tested in a first step;
- Set-up intermediary and final evaluations of the implementation of the HCWM plan.

A *Project Coordinator* (PC) should be assigned a full time position during the overall duration of the implementation of the plan (approx. five years). He/she should have excellent organising, managing and communication skills. In the specific Eritrean context, the mission believes that the PC should receive periodic external support.

Four multidisciplinary *Task Groups*[75] should be set-up to deal with the numerous aspects linked to the implementation of the HCWM plan and achieve, in their respective field of competence, the four objectives contained in the National HCWM plan, namely:

- Objective 1: develop the legal and regulatory frameworks for HCWM;
- Objective 2: standardise HCWM practices and equip the medical institutions accordingly;
- Objective 3: improve the institutional and management capacities of the HCFs as well as Zonal and Central Health Authorities;
- Objective 4: set-up a proper HCW Monitoring Plan at HCF, Zonal and Central levels.

The mission recommends to clearly identify at all levels supervision and coordination bodies:

- *At National level*, the *NSCHCWM* is in charge of the monitoring and the supervision of the National HCWM Plan. The *PC* is in charge of its implementation and supervises the activities of the Task Groups;
- *At Zoba level*, the *ZHMTs* are responsible to supervise and monitor the HCWM practices within the Zoba. They nominate an *Environmental Health Officer* who is responsible for the smooth implementation of the HCWM Plans at zonal level. He reports to the PC and the ZHMT;
- *At hospital level*, the *Executive Team* is administratively responsible for the implementation of a HCWM Plan within the institution. The Executive Team nominates the *HCWMO*, who has the entire responsibility with the *Infection Control Committee* to set-up Hospital HCWM Plans (see annexe 10 for further details).

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[74] The institutional scheme proposed by the mission to implement the National HCWM Plan is shown in figure 8.

[75] A *Task Group on Legislation and Regulation* composed of Lawyers, Environmental and Public Health Specialists from the MOH, MOLWE, and the Ministry of Industry. A *Task Group on Standardisation Procedures* composed of representatives of the MOH, MOLWE, Ministry of Works, MOF, Representatives of ZHMTs and HCFs. A *Task Group on Institutional Strengthening* and a *Task Group on HCWM Monitoring*, both composed of representatives of the MOH and ZHS.

3. Third Step: Launch the National Action Plan

The implementation of the four objectives contained in the National HCWM Plan requires the development of specific actions. They are included in the *National Action Plan* (NAP) presented hereafter. The Plan should be periodically monitored and reviewed. As mentioned previously, a typical timeframe for a NAP is around five years. The NAP is structured as follows:

- For each *objective*, a table summarises the actions that must be taken to achieve this objective. The actions are classified by order of priority;
- For each *action*, the institution responsible for its implementation and its coordination are designated. Indicators of achievement that should help in the regular monitoring of the Plan are listed. The initial and the annual costs in relation with this action are presented.

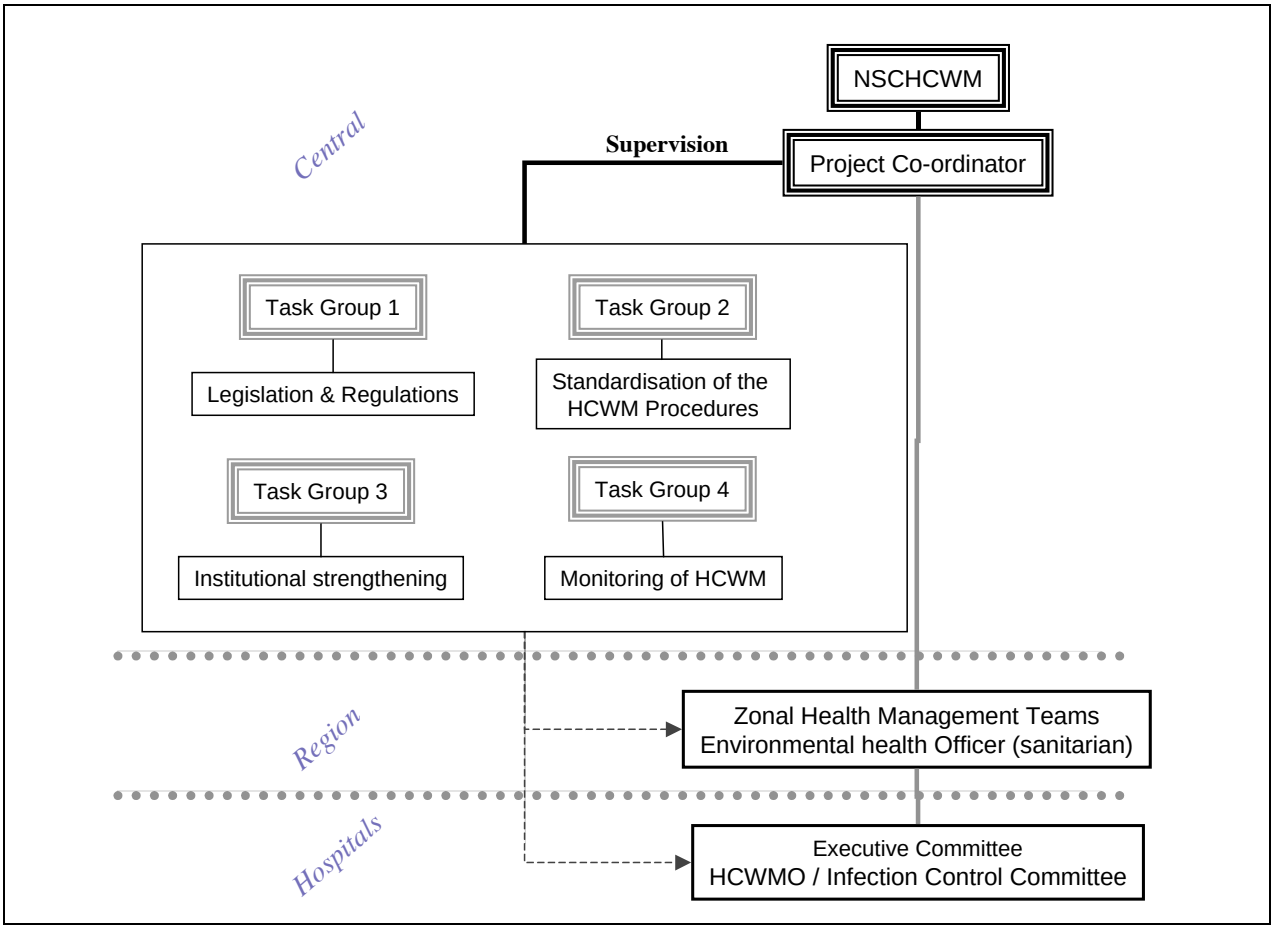

Figure 8: Institutional Framework for the implementation of the HCWM Plan

Section 2. The National Action Plan

This section presents the National Action Plan in five tables. The first table summarises the recommendations already formulated in the first section while the four other tables present objective by objective the actions to be launched to implement a national HCWM Plan in Eritrea.

1. Define a General Framework for the Implementation of the National Action Plan

Actions			Co-ordination	Supervision	Indicators of achievement	Cost (USD)	
						Initial	Annual
Short-term	1.1	Organisation of a national workshop to modify and validate the proposed NAP and set-up specific Task Groups	MOH	Director of the HS Unit	Minutes of the Workshop	2'500	0
	1.2	Establish a National Steering Committee on Health-Care Waste Management	MOH	Director of the HS Unit	A list of the members is established, the objectives are stipulated and regular meetings are scheduled	0	2'400
	1.3	Designation of a project coordinator (PC) for the implementation of the NAP	NSCHCWM	Director of the HS Unit	Job description with clear listing of tasks	0	6'000
	1.4	Establishment of the criteria for the evaluation of the NAP during its implementation	PC	NSCHCWM	Indicators of evaluation available	0	0
	1.5	Designation of the administrative authorities in charge of the implementation of the NAP at Regional level, selection of the Regions to test the NAP	NSCHCWM/PC	Zonal Health Services	Directive of the MOH	0	0
	1.6	Set-up and schedule of the: 1) objectives 2) *intermediary* and 3) *final* evaluations of the implementation of the NAP	PC	NSCHCWM	Progress and final reports	0	0
Recommendation The setting-up of clear initial objectives and well-scheduled intermediary evaluations is the backbone for an efficient monitoring of the implementation of the plan. The MOH should pay careful attention to this point.							

2. Develop the Legal and Regulatory Framework

	Actions			Co-ordination	Supervision	Indicators of achievement	Cost (USD)	
							Initial	Annual
	Short-term	2.1	Prepare National Guidelines for HCWM	TGLR & PC	NSCHCWM	Guidelines are available at all health service levels	35'000	0
		2.2	Establish a Code of Hygiene for Hospitals	Department of Health services	PC/Director of the HS	Code of Hygiene is available at all health service levels	15'000	0
	Long-term	2.3	Prepare a Law on Hazardous Waste Management	MOLWE	GOE	Law available and registered in the Eritrean Gazette	35'000	0
		2.4	Review the Health Workers Job Description and Code of Ethics	MOH	MOH	Code of Ethics available and taught in the nursing schools	0	0
		2.5	Ratify the Basel and Stockholm Conventions on hazardous waste and POPs	GOE	GOE	The convention is ratified	0	0

Recommendations

- *National Guidelines* should be urgently written and distributed to the HCFs by the MOH. Ideally, a *Catalogue of the Equipments* available in Eritrea for the safe management of HCW (see table on the standardisation of the HCWM procedures) should be annexed to these guidelines as well as the HCWM registration forms and certificate (see table on HCW Monitoring Plan).
- The regulatory documents should clearly define roles, responsibilities, duties and penalties in relation with the (mis)management of HCW (cf. part 2 of this report).
- The criteria for enforcement and inciting measures to ensure that the medical staff complies with the management procedures defined in the Law and described in the "National Guidelines" as well as the review of the Health Worker job description and their Code of Ethic should be set up together with the representatives of the Medical Doctor and Nurse Associations.
- The GOE will need to get external support to prepare the National Guidelines, establish the Code of Hygiene and prepare a Law on Hazardous Waste.

3. Standardise the HCWM Practices

Actions			Co-ordination	Supervision	Indicators of achievement	Cost (USD)	
						Initial	Annual
Chronological (per priority) Order	3.1	Define acceptable procedures of HCWM and requirements for HCW disposal technologies	TGSP & PC	NSCHCHM	Amended Nat. Guidelines & list of accepted technologies	0	0
	3.2	Elaborate a National Catalogue of Equipment for segregation, packaging, collection and disposal of the HCW in the Medical Institutions materials	TGSP & PC	NSCHCHM	Catalogue available at all levels	5'000	0
	3.3	Designate: 1) HCWMO in Referral, National and Zoba Hospitals; 2) Officers in charge in Health Centres and Health Stations; 3) EHO in charge in Zoba and Central HS	HCF Directors, ZHMTs, MOH	MOH	Job descriptions are available	0	10'800
	3.4	Establish the HCWM plans in the medical institutions, include these plans in the Annual Action Plan of each HCF	HCWMO, ICCs, Ecs	NSCHCWM	Annual HCWM Plans available	0	3'000
	3.5	Inventory existing incinerators, write Technical Specifications and Bids for the installation/rehabilitation of centralised treatment plants in Asmara, impulse the creation of Mutual Benefit Groups between the HCFs of Asmara and organise off-site collection services (including for pharmaceutical wastes)	TGSP & PC	MOH, MOF	Tenders available, Plan of Action available	0	0
	3.6	Impulse the construction of placenta pits, Mark 8a and 9 De Montfort incinerators in the Large / Medium HCFs outside Asmara in coordination of the Zoba Authorities and Private contractors. Install a central pyrolytic incinerator in Asmara	TGSP & PC	MOH	De Montfort incinerators in HCFs, central incinerator in Asmara	183'600	154'237
	3.7	Equip all hospitals HCFs with segregation, packaging, collection material (including protective clothes), transportation (if necessary) and disposal equipments	TGSP & PC	MOH	Hospitals equipped	154'000	52'500
	3.8	Equip all small HCFs with pits	TGSP & PC	MOH	Small HCFs equipped	0	0

Recommendations

- An Action Plan for the equipment of the HCFs should be set-up. The mission strongly recommends to test the NAP in one or two regions before generalizing it in the whole country.
- The Catalogue of Equipment should specify the technical characteristics of all the material (including protective clothes) that is accepted for segregating, handling, packaging, collecting and transporting HCW inside and outside Medical Institutions. Ideally, the equipment should be listed.
- HCWM plans at facility levels must include detailed estimation of the costs associated with the implementation of the HCWM plans in the HCFs. They should provide the necessary indications to estimate the quantities of HCW generated in the HCFs, report incidents, inventory the available equipment and materials and assess the on-going needs for HCMW.

4. Strengthen the Institutional Capacities of the Stakeholders

Actions			Co-ordination	Supervision	Indicators of achievement	Cost (USD)	
						Initial	Annual
Chronological Order	4.1	Define a specific budget line dedicated to HCWM, at HS levels	TGIS & PC	MOH/MOF	The line exists and is used	0	0
	4.2	Recruit additional staff at the Environmental Health Unit of the MOH	MOH	MOF	New staff member with job description and terms of references	0	0
	4.3	Set-up a Group of Trainers and elaborate a specific and detailed training package (train the trainers)	WGT & PC	NSCHCWM	Training packages available and sessions organised	0	
	4.4	Set-up an awareness campaign for the medical and paramedical staff in health-care facilities	WGT & PC	NSCHCWM	Awareness material available	25'000	0
	4.5	Review the Academic programmes in the College of Nursing and Health Technology, University of Asmara	WGT & PC	NSCHCWM	Academic curricula available	5'000	0
	4.6	Provide Technical Training for the Central and Zonal Environmental Health Officers (Train "trainers of trainers") and set-up in-service training programmes for medical, paramedical and technical staff	WGT & PC	NSCHCWM	Sessions registered with specific target groups	40'000	0
	4.7	Provide specific technical training on HCW disposal technologies for the Zonal Engineers and private contractors for the construction of De Montfort incinerators	WGT & PC	NSCHCWM	Groups of technicians capable of building a De Montfort incinerator	15'000	0

Recommendations

- A budget lines specifically dedicated to HCWM would help the different institutions and ZHMTs to estimate accurately the costs associated with the management of HCW and would facilitate the specific budget allocations.
- The mission recommends that the groups of trainers organise the on-going sessions directly in the hospitals. Several steps implemented every sixth weeks for instance. The sessions should be organised in a participative way and could be based on some elements already developed by the WHO and the WB through the PHAST programmes.
- Expertise already exists in other East African countries for the construction of De Montfort incinerators (for instance in Tanzania, Kenya…). The MOH could learn from the experiences made in these countries and take advantage of the expertise they have developed.

5. Develop a HCWM Monitoring Plan

Actions			Co-ordination	Supervision	Indicators of achievement	Cost (USD)	
						Initial	Annual
Short-term	5.1	Complete the HMIS	TGMP & PC	NSCHCWM	HIMS completed	0	
	5.2	Write the standardised delivery forms to be used for the control of the transportation of HCW in Asmara	TGMP & PC	NSCHCWM	Forms exist and are used	1000	200
	5.3	Standardise annual reports (mentioned in figure 7)	TGMP & PC	NSCHCWM	Standardised reports exist and are written	0	0
	5.4	Set-up HCWM Plans at HCF level (already mentioned, see action 3.4) and complete the Annual Zoba and National Action Plans (inspections and backstopping)	TGMP & PC	NSCHCWM	All documents available in any HCFs or ZHS. Annual progress reports produced by the MOH	10'000	5'000
	5.5	Establish an operation and maintenance strategy for each category of HCF	TGMP & PC	NSCHCWM	Strategy elaborated	0	9'000

Recommendations

- The information contained in the standardisation of the Annual Report includes volumes of waste disposed of, type and shape of the disposal equipment and infrastructure, volume of waste disposed of, etc… (cf. annexe 10).
- Monitor and review progress; provide ongoing support and assistance to ensure objectives are being met; revise approaches as needed.
- On-going controls carried out in the field by the MOH and the PHS should be reinforced to ensure an adequate implementation of the HCWM plans. They should be accompanied with activities of advice and follow-up.
- As already mentioned, the monitoring of the implementation of the HCWM plan is completely included in the NAP itself, with the indicators of achievement and the recommendations to carry out quarterly progress evaluation of the implementation of this plan.

6. Timeframe

Experience shows that timeframes are rarely respected. The mission proposes to develop a five-year action plan and suggests the MOH establish an adequate timeframe according to its institutional and financial possibilities. A regular monitoring of the implementation of the HCWM plan should be set-up (every quarter) and the strategy reviewed accordingly if necessary. The Project Coordinator will play a major role in this matter.

Section 3. Cost Estimations

Disposal of HCW remains costly. The direct management costs should however always be weighted against the indirect costs associated with mismanagement practices. The overall initial and annual costs for the implementation of the plan and the standardisation of the HCWM practices are presented in table 7 and are based on the calculations provided in Annexe 11. The initial costs cover the implementation period of five years of the plan.

It has been assumed that:

- The National Action Plan is implemented over a period of five years;
- Only one pyrolytic incinerator of a capacity of 80 kg/hour is installed in Asmara, in a first step. With the population growth and the development of the HS, a second similar incinerator should be installed. Although the initial cost of installing two incinerators is higher, the mission recommends to apply this prudent strategy. Furthermore, installing two small incinerators enables to diminish transport costs of HCW and provides a effective alternative solution in case one of the installations breaks down or is out of use for maintenance repairs.
- In priority, the MOH should install Mark 9 De Montfort incinerators in all the hospitals outside Asmara. The construction of Mark 8a incinerators in the Health Centres is not seen as a first priority by the mission and only some of them will be equipped during the implementation of the HCWM Plan.

The total implementation costs of the plan ranges between 500’000 USD and 530’000 USD while the annual costs associated with the new HCWM procedures would range between 230’000 and 250’000 USD.

		Actions	Initial Cost		Annual Cost		Remarks
			NAKFA	USD	NAKFA	USD	
Define a General Framework for the Implementation of the NAP	1.1	Organisation of a national workshop to modify and validate the proposed NAP and set-up specific Task Groups	37'500	2'500	0	0	
	1.2	Establish a National Steering Committee on Health-Care Waste Management	0	0	36'000	2'400	Regular meetings of the NSCHCWM (average of 12 persons / 3 months)
	1.3	Designation of a project co-ordinator (PC) for the implementation of the NAP	0	0	90'000	6'000	Average salary of 500 USD / month for the project co-ordinator
	1.4	Establishment of the criteria for the evaluation of the NAP during its implementation	0	0	0	0	
	1.5	Designation of the administrative authorities in charge of the implementation of the NAP at Regional level, selection of the Regions to test the NAP	0	0	0	0	
	1.6	Set-up and schedule of: 1) objectives 2) *intermediary* and 3) *final* evaluations of the implementation of the NAP	0	0	0	0	One evaluation per quarter
		TOTAL	37'500	2'500	126'000	8'400	
Develop the Legal and Regulatory Framework	2.1	Prepare National Guidelines for HCWM	525'000	35'000	0	0	International Consultancy to backstop the MOH
	2.2	Establish a Code of Hygiene for Hospitals	225'000	15'000	0	0	Regional Consultancy to backstop the MOH
	2.3	Prepare a Law on Hazardous Waste Management	525'000	35'000	0	0	International Consultancy to backstop the MOH
	2.4	Review the Health Workers Job Description and Code of Ethics	0	0	0	0	
	2.5	Ratify the Basel and Stockholm Conventions on hazardous waste and POPs	0	0	0	0	
		TOTAL	1'275'000	85'000	0	0	
Standardise the HCWM Practices	3.1	Define acceptable procedures of HCWM and requirements for HCW disposal technologies	0	0	0	0	
	3.2	Elaborate a National Catalogue of Equipment for segregation, packaging, collection and disposal of the HCW in the Medical Institutions materials	75'000	5'000	0	0	
	3.3	Designate: 1) HCWMO in Referral, National and Zoba Hospitals; 2) Officers in charge in Health Centres and Health Station; 3) EHO in charge in Zoba and Central HS	0	0	162'000	10'800	1 additional officer in recruited in each of the six regions
	3.4	Establish the HCWM plans in the medical institutions, include these plans in the Annual Action Plan of each HCF	0	0	45'000	3'000	
	3.5	Write Technical Specifications and Bids for the installation of centralised treatment plants in Asmara, impulse the creation of Mutual Benefit Groups between the HCFs of Asmara and organise off-site collection services (including for pharmaceutical wastes)	0	0	0	0	The international companies should pay to get the bids, which should reimburses the expense linked with the formulaion of the bidding documents
	3.6	Impulse the construction of placenta pits, Mark III and II De Montfort incinerators in the Large / Medium HCFs outside Asmara in coordination of the Zoba Authorities and Private contractors. Install a central pyrolytic incinsrator in Asmara.	2'754'000	183'600	2'313'550	154'237	see detailed calculations in Annexe 11
	3.7	Equip all hospitals HCFs with segregation, packaging, collection material (including protective clothes), transportation (if necessary) and disposal equipments.	2'310'000	154'000	787'500	52'500	see detailed calculations in Annexe 11
	3.8	Equip all small HCFs with pits	0	0	0	0	it is assumed that simple burning pits are built with local communities
		TOTAL	5'139'000	342'600	3'308'050	220'537	

		TOTAL	5'139'000	342'600	3'308'050	220'537	
Strengthen the Institutional Capacities of the Stakeholders	4.1	Dedicate a specific Budget line dedicated for the HCWM, at HS levels	0	0	0	0	
	4.2	Recruit additional staff member at the Environmental Health Unit of the MOH	0	0	0	0	
	4.3	Set-up a Group of Trainers and elaborate a specific and detailed training package (train the trainers)	0	0	0	0	
	4.4	Set-up an awareness campaign for the medical and paramedical staff in health-care facilities	375'000	25'000	0	0	
	4.5	Review the Academic programmes in the College of Nursing and Health Technology, University of Asmara.	75'000	5'000	0	0	
	4.6	Provide Technical Training for the Central and Zonal Environmental Health Officers (Train "trainers of trainers") and Set-up in-service training programmes in for medical, paramedical and technical staff	600'000	40'000	0	0	international backstopping of the MOH necessary
	4.7	Provide specific technical training on HCW disposal technologies for the Zonal Engineers and private contractors for the contruction of De Montforts	225'000	15'000	0	0	Regional backstopping (WHO, Tanzanian officials, others) of the MOH necessary
		TOTAL	1'275'000	85'000	0	0	
Develop a Monitoring Plan	5.1	Complete the HMIS	0	0	0	0	
	5.2	Write the standardised delivery forms to be used for the control of the transportation of the HCW in Asmara	15'000	1'000	0	0	
	5.3	Standardise annual reports (mentioned in figure 7)	0	0	0	0	
	5.4	Set-up HCWM Plans at HCF level (already mentioned, action 3.4) and complete the Annual Zoba and National Action Plans (inspections and backstopping)	0	0	0	0	
	5.5	Establish and operation and maintenance strategy for each category of HCF.	0	0	180'000	12'000	2'000 USD per region is annually budgetised for the O&M of the disposal facilities
		TOTAL	15'000	1'000	180'000	12'000	

GRAND TOTAL	Nakfa	USD	Nakfa	USD
	7'741'500	516'100	3'614'050	240'937

Table 7 : Estimation of the capital and annual cost of the National HCWM Plan

Conclusion

The current HCWM practices observed in Eritrea are not fully safe and have harmful environmental effects mainly due to the lack of adequate disposal technologies, the low financial resources, the limited institutional capacities and the lack of expertise of the Health Sector. Although they are difficult to estimate, the direct and indirect costs associated with this situation are certainly significant.

The development of appropriate financial means and a strong institutional commitment will be key issues for the successful and long-term implementation of the National Health-Care Waste Management Plan. Considering its relatively high costs, the Government of Eritrea may therefore develop a partial strategy aiming at improving the health-care waste management practices in the Referral Hospitals of the country as a first step.

However, experience shows that the implementation of a HCWM system has little chances to remain sustainable as long as a holistic approach is not developed. Actually, the sustainable implementation of safe procedures to manage health-care waste requires a lasting commitment starting at the government level and prolonged all the way down to the hospital staff. The implementation of the four objectives targeted by the National Health-Care Waste Management Plan should contribute to durably improve the situation if they are progressively implemented, i.e.:

- The *legislative and regulatory* provisions will need to be completed so as to define both which practices and technical solutions are admissible or not as well as who is competent/responsible for what;
- The *standardisation of the health-care waste management practices*, though the establishment of clear protocols, the equipment of the health-care facilities as well as managerial measures are fundamental to secure the whole health-care waste stream. The procedures will have to be in accordance with the prescriptions contained in the national legislation and in the internal hospital rules. The equipment will provide to the administration and medical staff the necessary tools to apply the standardised procedures in their establishments and medical services;
- The *reinforcement of the institutional capacities* of the main stakeholders participating in the HCWM process through the development of in-service training programmes and adequate curricula, the formation of Operation and Maintenance teams as well as the set-up of an extended awareness and education programme will remain essential issues;
- Finally, the elaboration of a sustainable *monitoring plan*, including inspection and backstopping measures should help the Central and Zonal Health services in reinforcing the implementation of safe HCWM practices proposed in this report.

Annexes

Annexe 1: Terms of Reference

CONSULTANCY TO PREPARE A HEALTH-CARE WASTE MANANGEMENT PLAN FOR ERITREA

Background

Health related activities produce a considerable amount of waste on daily basis as a result of preventive and curative service delivery. The composition of waste produced is in the form of sharps (needles, syringes), non- sharps, blood and other body fluids being infected and non-infected, chemicals, pharmaceuticals and medical devises. Health workers, waste handlers, users of health facilities and the community are all exposed to health-care related waste and ill health as a result of poor management. A good health-care waste management plan could result in healthier communities thereby reducing the cost of health-care, as well as creating opportunities for recycling. A few important principles of sound management of health-care related waste include:

1. Definition of a policy framework;
2. Assignment of legal responsibility for safe management of waste disposal to the waste producers;
3. Allocation of adequate financial resources and cost recovery mechanisms;
4. High level of awareness on proper waste disposal among all health workers in all cadres, as well as on part of patients/families/communities, particularly in case of infectious diseases, such as HIV/AIDS, other transmitted diseases and tuberculosis.

Project Description

This Health-care waste management plan designed for the Health Project and the HIV/AIDS, Malaria, other Sexually Transmitted diseases and Tuberculosis project. The Health Project has the following four components: (i) construction and equipment of two zonal hospitals in Mendefera and Berentu; (ii) strengthening rural health services in all zones, including provision of equipment to health centers and health stations; (iii) capacity building at national and zonal levels and enhancing the sustainability of the health program; and (iv) project implementation and monitoring.

HAMSET Project includes five components as follows: (i) collect and analyze information on HAMSET to facilitate evidence-based decision-making and rapid response; (ii) Multi-sectoral control of HAMSET transmission; (iii) strengthen HAMSET diagnostic, health-care and counselling services; (iv) community-managed Response program; and (v) project management and evaluation.

A preliminary assessment of current health-care waste management (HCWM) and disposal systems was recently carried out in Eritrea, as part of the supervision mission of HAMSET, the Health and Integrated Early Childhood Development. Field visits and discussions held between the mission team and relevant line ministries, including Ministry of Health; Ministry of Land, Water and Environment; Ministry of Education and Municipal officials reveal that, in general, the current state of waste management system is inadequate. Health-care waste and contaminated health-care waste handling, storage and disposal, in particular, raises serious environmental and social concerns. Hence the need for a thorough assessment of HCWM and disposal, with a particular focus on injection safety and management of wastes from HIV/AIDS, other sexually transmitted diseases and tuberculosis. This assessment shall lead to a national Health-care Waste Management Plan (HCWMP) to be developed as part of the consultant report.

Main Objective

The main objective of this consultancy is to identify the most appropriate management and disposal system for health-care waste in Eritrea – appropriate being defined as environmentally sound, technically feasible, economically viable, and socially acceptable - and to prepare a policy framework

and five-year action plan (including both physical investments and training activities) to put in place and implement this system.

Scope of the study

The study would cover the following: (i) assessment of existing policies and practices; (ii) assessment of technology, siting, and financing options; (iii) assessment of level of awareness on safe health-care waste handling, storage and disposal among health workers and other parties involved (i.e., municipalities councils); (iv) assessment of existing training programs. Study outputs would include:

- A legal/policy framework for regulating and enforcing health-care waste standards;
- Waste disposal technology investment plan;
- A training needs and awareness program for health workers, municipal workers and the general public;
- Public consultations would be a key feature of the study methodology.

Task 1 – Assessment of Existing Policies and Waste Management Practices

a) Assess the policy, legal and administrative framework as well as the regulatory framework on health-care waste management and treatment in the country. This includes air emission standards, which are currently required by law for the next ten years.

b) Identify permit requirements including environmental building and the other procedures that health-care waste management facilities would need to address and the time demands to obtain these permits. In this respect, identify the environmental impact requirements and public participation requirements.

c) Identify all health-care facilities in the country and include basic information for each facility, such as number of beds, bed occupancy rates, specialists divided into categories: University hospitals (if any), regional hospitals, general hospitals, municipal hospitals, and other health-care establishments, including military, if applicable.

d) Assess the health-care waste generation at randomly selected facilities. The details should include the minimum weight of total generated wastes at each health-care facility per week. Composition of the waste should be determined through segregation at the waste end point and the results should be extrapolated to cover the entire country.

e) Review and analyze existing health-care waste storage, collection and disposal systems at the randomly selected facilities, with due regard for level of separation, frequency of collection and environmental – through soil, surface and ground water and air resources – and health impacts for existing treatment.

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

Task 2 – Determination of Technology and Sitting

a) Determination of Technology

For the types and quantities of health-care waste generated in the study, assess the different types of technology and facility sizes available for treatment and destruction. The assessment shall compare alternatives on the basis of capital cost, operation cost, ease of operation, local availability of spare parts, local availability of operational skills, demonstrated reliability, durability and environmental impact. The technologies to be considered include: safe land filling, incineration, sterilization (autoclave and microwave) and chemical disinfections. On the basis of this assessment, recommend a process flow for economic and environmentally sound treatment and final disposal of health-care waste.

b) Determination of Disposal Sites Analysis of the site

Analyze the above information to determine whether there is sufficient appropriate material on site for daily and final cover, whether the site soil, hydrological and geo-hydrological conditions would ensure adequate protection of any ground and surface water used for drinking and/or irrigation. If the sites prove to be unsuitable, inform the client stating the reasons.

c) Financing

Assess alternative approaches for financing the treatment and disposal activities. Assess public-private partnerships and cost recovery at the regional, municipal level based on the polluter pays principal, where each health facility pays according to the volume of waste generated. Assess private sector participation as service provider.

d) Public consultation

Public consultation with beneficiary groups, institutions, NGOs and Community Based Organizations and other interested parties must be held as part of the final assessment for sitting of the treatment facility(ies).

Task 3 – Training and Public Awareness

a) At the randomly selected facilities surveyed as part of **Task 1**, assess awareness of health workers of safety risks, correct procedures for collecting, handling and disposing of health-care wastes.

b) Review existing training and public awareness programs on health-care waste management at hospitals and other health-care establishments and prepare a training needs assessment.

c) Working in conjunction with relevant government institutions and municipal councils prepare a costed training program targeting the general public, health-care workers, municipal workers, dump site managers, incinerator operators (if that is the choice of technology), nurses, scavengers/pickers, families and street children.

d) The design of the material required for the awareness/capacity building programs should be discussed with the relevant authorities and the general public to ensure that their concerns that are deemed appropriate are incorporated in the design of the program, sitting layouts, mitigation measures and community communication programs.

Task 4 – Public Consultation on draft Policy, Plan, and Training Programs

The training and awareness building program and the waste management program shall be appropriately costed and the plan of action shall be presented in a national workshop.

Following the stakeholder consultations, the consultant(s) shall revise the draft reports in accordance with the comments of the Government, the World Bank, relevant institutions in the donor community and other interested parties and submit the final report incorporating all changes and modifications as required.

The consultant is expected to provide 6-8 well bound reports with pictures and maps where necessary to the government and the Bank.

Study Supervision and Time Schedule

The work of the consultant or consultant team would be supervised by the relevant government institution(s) responsible for the project. The Agency will coordinate with all other governmental agencies, ministries and other donors working in the sector. The Consultant (s) shall begin work immediately following contract effectiveness date. It is anticipated that the Consultant (s) would complete the outputs of the work over a maximum duration of 8 weeks with four weeks in the field for data collection and collation and two weeks of report writing and finalization of the document after the review has been carried out by ASPEN and the Proponent. The consultant should propose a clear

schedule with critical milestones, and makes all possible efforts to complete the work at the appointed time.

Consultant Qualifications and Experience

The consultant (s) should have the technical competence in scientific, health, environmental and engineering fields in particular sanitary engineering. He/She may also have competence in the private sector participation field and skills in training and institutional strengthening. The Consultant is expected to provide 6-8 well-bound reports with pictures and maps where necessary to the Government and the Bank.

Suggested Report Outline

The draft report should focus on the significant environmental and human health issues in a format similar to the following:

- ✓ Executive summary
- ✓ Policy, legal and administrative framework
- ✓ Baseline data
- ✓ Assessment of health-care waste
- ✓ Health-care waste training needs assessment
- ✓ Determination of technology
- ✓ Determination of disposal sites
- ✓ Management and training for institutions and agencies
- ✓ Implementation Plan (Responsibilities + Budget)
- ✓ Monitoring plan (Responsibilities + Budget)
- ✓ Appendices
  - list of people consulted
  - References
  - Record of Inter- agency / forum / consultation meetings

Annexe 2: Agenda of the mission

Agenda • mission April 2003				**Health-Care Waste Management • Eritrea**
N°	**Date**	**Place**	**Purpose / topics discussed**	**Interlocutors**
1	30 March 2003		Geneva - Asmara	
2	31 March 2003	Asmara		
	10:00 - 11:00	PMU Office	General Briefing of the mission	Dr Eyob Teckle, Dr Kesete
	11:00 - 12:00	MOH	General Briefing of the mission (cont.)	Dr Zemui, Dr Kesete, Mr Goutom
	13:00 - 16:00	Ambo Saira Hotel	Review of documentation provided by during the morning meetings	
	16:00 - 17:00	The World Bank	General infomative meeting	Mrs Bradley
	17:00 - 23:00	Ambo Saira Hotel	Preparation of a working plan	
3	01 April 2003	Asmara		
	08:00 - 12:00	MOH	Several Rounds of meetings (EPI, Administration, Drug Info, Medical Services, etc...)	See Interlocutors worksheet
	14:00 - 16:00	Central Blood Bank	Vist of the Blood Bank, review of the HCWM system in the Blood Bank	Dr Teflemariam
	17:00 - 18:30	UNICEF	Collection of information on EPI programme	Mr Toft
	18:30 - 22:30	Ambo Saira Hotel	Review of the Documents provided by the MOH	
4	02 April 2003	Asmara		
	08:00 - 10:00	MOH	Information on training of health workers	Mrs Mehreteab, Head
	10:00 - 12:00	MOH	Statistical Data on the Health Management Information System	Mr Gebresselassie
	14:00 -16:00	MLWE	Information on the Environmental Legislation	Mr Eyassu, DG
	16:00 - 18:00	ERCS	Briefing on the Activity of the Red Cross with communities	Mr Ghebresus, DSG
	18:00 - 18:30	IFRC	Briefing on the Activity of the IFRC	Mr Dewez, HOD
5	03 April 2003	Asmara		
	08:00 - 10:30	Zoba Maakel	Visit of the disposal landfill	Mr Durganas
	10:30 - 11:30	WHO	Collect of information on WHO policy on EPI and HCWM management	Mr Tseggai
	14:30 - 15:30	PMU Office	Several issues	Dr Teckle
	15:30 - 17:00	CHL	Visit of the Laboratory	Mr Seyoum, FB
	15:30 - 17:00	Asmara Maternity Hospital	Visit of the Hospital	MH
	17:00 - 23:00	Ambo Saira Hotel	Review of documentation	

Agenda • mission April 2003				**Health-Care Waste Management • Eritrea**
N°	**Date**	**Place**	**Purpose / topics discussed**	**Interlocutors**
6	04 April 2003	Asmara		
	08:00 - 09:30	MOE	Support given to the EMP mission	Mr Berhe
	09:30 - 12:30	Halibet Hos.	Assessment of the Hospital	Mr, Mrs,
	14:00 - 15:30	MOH	Planning of the Field Trips	Mr Goitum
	15:30 - 17:00	PMU Office	Review of the TOR, support Given to the EMP Mission	Dr Tecle, Mr Goitum, Mr Assefaw, Mr
7	05 April 2003	Massawa	Review of Documentation and Reporting	
8	06 April 2003	Massawa	Review of Documentation and Reporting	
9	07 April 2003	Asmara		
	08:00 - 09:00	WHO	Collect of information	-
	09:00 - 10:00	PMU Office	Collect of information on prices and arrangement of the visit of the Cement Factory	Mr Eprhem
	10:00 - 12:00	MOH	Visit of the training services, CHL, Pharmecor and Medical Store Division. Request for addtional information	Several interlocutors
	12:00 - 14:00	Ambo Saira Hotel	Meeting with WB Official of the Procurement Department to get precisions on the IECD Project	Mr Sarno
	14:00 - 15:30	HEWO	Visit of the hospital	Mr Travaglino
	15:30 - 16:15	MOE	Collect of information	Mr Assefaw
	16:15 - 17:30	WHO	Collect of information	-
	17:00 - 23:00	Ambo Saira Hotel	Review of the documentation provided by the FAO and the WHO	
10	08 April 2003			
	08:30 - 09:00		Trip to Sheketi	
	09:00 - 10:30	Sheketi	Visit of the Health Station	Mr Goitum, Mr Sereme
	10:30 - 12:30	Debarwa	Visit of Debarwa Health Centre	Mr Goitum, Mr Tesfamicael
	14:00 - 17:00	Mendefera	Visit of the Zobal Hospital	Mr Goitum, Mr Berme
	17:00 - 18:30		Trip back to Asmara	
	20:30 - 22:00	Asmara	Review of Documentation	
11	09 April 2003			
	07:30 - 12:30		Trip to Berentu (Gash Barka Zoba)	
	13:30 - 15:30	Barentu	Visit of the Zoba Hospital	Mr Goitum, Dr Dawud, Mr Asfaha
	17:00 - 18:00	Barentu	Visit of the new hospital (in construction)	-
	19:30 - 21:30	Barentu	Meeting with Oxfam Representatives	Mrs Fay, Mr Mesorley, Mr Kalai
12	10 April 2003			
	07:30 - 09:30	Barentu	Visit of the Gash Barka Zonal Health Administration	Mr Goitum, Dr Berhane, Mr Sale
	10:30 - 12:30	Barentu	Visit of the Municipality and the dump site	Mr Goitum, Mr Youcef
	14:00 - 15:30	Mongolo	Visit of the Catholic Health Centre	Mr Woldu
	17:00 - 18:00	Akurdet	Visit of the Health Centre	Mrs Asefaha
	18:00 - 19:00		Trip to Keren	

Agenda • mission April 2003				**Health-Care Waste Management • Eritrea**
N°	**Date**	**Place**	**Purpose / topics discussed**	**Interlocutors**
13	11 April 2003			
	07:30 - 09:00	Keren	Visit of the Anseba Zonal Health Administration	Mr Goitum, Dr Ahmid Mr Bebrekidan
	09:00 - 12:00		Visit of the Zoba Hospital	Mr Goitum, Dr Banteyrga,
		Keren		Mr Abdelmicael
	14:00 - 15:00	Eden	Visit of the Health Centre	Mr Goitum, Mr Haile
	15:00 - 17:00		Trip to Asmara	
	17:00 - 20:00	Asmara	Reporting	
14	12 April 2003			
	08:00 - 10:30		Trip to Massawa	
	10:30 - 12:30	Massawa	Visit of the Eritrea Cement Factory	Mr Goitum, Mr Kidane
	14:00 - 19:00	Massawa	Reporting	
15	13 April 2003			
	05:30 - 14:00		Trip to Tio	
	14:00 - 15:30	Tio	Visit of the Community Hospital	Mr Teayes, Mr Goitum
	15:30 - 21:00		Trip to Assab	
16	14 April 2003			
	09:00 - 10:00	Assab	Visit of the Southern Red Sea Zonal Health Administration	Mr Goitum, Dr Ghirmai, Mr Iseas
	10:00 - 13:00	Assab	Visit of the Zoba Hospital	Mr Goitum, Dr Abraham
	14:00 - 20:00	Assab	Reporting	
	20:00 - 21:30	Assab	Collect of information from the Cuban Medical Team	Dr Noel, Dr Oel
17	15 April 2003			
	06:00 - 16:00		Trip to Massawa	
18	16 April 2003			
	07:30 - 08:30	Massawa	Visit of the Northern Red Sea Zonal Health Administration	Mr Goitum, Dr Esmael, Mr Mana
	08:30 - 11:30	Massawa	Visit of the Zoba Hospital	Mr Goitum, Mr Mesfin
	14:00 - 16:00	Gindae	Visit of the Community Hospital	Mr Goitum, Dr Alazar
	16:00 - 17:30		Trip to Asmara	
	20:00 - 21:30	Asmara	Reporting	
19	17 April 2003			
	08:00 - 09:00	Asmara	Collect of information at the MOH	Mr Goitum
	09:00 - 10:30	Asmara	Administrative issues	
	10:30 - 11:30	Asmara	Review of the curriculae at the MOE	Mr Tecle
	11:30 - 12:30	Asmara	Collect of information at the MOE	Mr Tecle
	14:00 - 16:00	Asmara	UNICEF - EPI and Family Community Health	Mr Saidfilli
	16:00 - 18:00	Asmara	Reporting	
20	18 April 2003			
	08:00 - 09:00	Asmara	Collect of information at the MOH	Mr Goitum
	09:00 - 11:00	Asmara	MOE - PPU - Collect of information	Mr Below
	11:00 - 12:00	Asmara	MOH - temptative of debriefing	
	11:00 - 12:00	Asmara	MOH - temptative of debriefing	Mr Goitum
	12:00 - 14:00	Asmara	Business lunch	Mr Khorassandjian
	16:00 - 17:30	Asmara	Debriefing MOH	Mr Goitum, Mr Assefaw, Dr Zemui
21	19 April 2003		Asmara - Geneva	

Annexe 3: Contact List

Contacts							HCWM & EM Plans • Eritrea
n°	Coordinates			Institution / Address	Function / Responsability	E-mail	Tel & Fax
	Title	Last Name	First Name				
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2	Mr	Holden	David	Advanced global Engineering / 06074 Perugia, Italy	General Manager	agengineering@europe.com	T: ++39 0755171703 F: ++39 0755173361
3	Mr	Sitte	Mohamed	Ahmed Hilal Elementary School / Assab	Director	none	-
4	Mrs	Assefaha	Yoanna	Akurdet Health Centre	Nurse	none	-
5	Mr	Montaigne	Pierre	Ambassade de France / PO Box 209 Asmara	Conseiller de Coopération	afdirp@gemel.com.er	T: ++291 1 12 10 36 F: ++291 1 12 19 98
6	Dr	Ahmid	Mohamed	Anseba Health Office	Regional Director of Health	none	T: 40 12 04
7	Mr	Kebrekidan	Berhane	Anseba Health Office	Environmental Health Coordinator	none	T: 40 12 04
8	Mr	Haile	Mrebrahtu	Anseba Regional Branch of Education	Head	none	-
9	Mr	Khorassandjian	Philip	Architectural Consultancy	Assiociate	phil@pkac.co.uk	T:++44 114 285 4007
10	Mr	Hiden	Kiflem	Argodet Secondary School	Director	none	-
11	Mr	Asfaha	Jacob	Berentu Zoba Hospital	Administrator	none	T: 73 10 18
12	Dr	Dawud	Mohamed	Berentu Zoba Hospital	Medical Director	none	T: 73 10 18
13	Dr	Tesfemarima	Tifle	Central Blood Bank	Director	none	T: ++291 1 20 03 57 F: ++291 1 20 27 80
14	Dr	Artigas	Alberto	Central Health Laboratory / PO Box 1686, Asmara	Pathologist	alberto1949cu@yahoo.com	T: ++291 1 11 43 54 F: ++291 1 12 15 85
15	Dr	Melles	Seyoum	Central Health Laboratory / PO Box 1686, Asmara	Director	melles@gemel.com.er	T: ++291 1 11 43 54 F: ++291 1 12 15 85
16	Dr	Naik	Durgadas	Central Health Laboratory / PO Box 1686, Asmara	Microbiologist	none	T: ++291 1 11 43 54 F: ++291 1 12 15 85
17	Mr	Nesfinhaile	Gojtum	Debarwa / Bhar Nejash Elementary School	Director	none	none
18	Mr	Araia	Abraham	Debarwa Administration	Officer in charge of the Sub-Zoba Education Services	none	none
19	Mr	Tesfamichael	Ghirmay	Debarwa Health Centre	Head, Nurse - midwife	none	none
20	Mr	Fikuru	Pamenlos	Debub / Hamset Office	Project Officer	none	none
21	Mrs	Ghabrut	Milinet	Debub / Hamset Office	Project Accountant	none	none
22	Mr	Ahmed	Issa	ECD - Southern Red Sea Zoba	Communication Co-ordinator	none	-
23	Mr	Kidane	Abraham	ECD - Southern Red Sea Zoba	Finance Co-ordinator	none	-
24	Mr	Haile	Al Azar	Eden Health Centre	Director	none	T: 40 21 04
25	Mr	Soulemar	Amet	Eden Kindergarden	Director	none	-
26	Mr	Kindane	Woldai	Eritrea Cement Factory / Massawa	General Manager	none	T: ++291 1 12 70 63 F: ++291 1 12 70 63
27	Mr	Gebresus	Tsehaie	Eritrean Red Cross Soceity	Deputy Secretary General	rcse@eol.com.er	
28	Mr	Tecleab	Ephraim	Food and Agriculture Organization, UN Compound	Assistant Representative	none	T: ++291 1 15 05 51 T: ++291 1 15 17 53
29	Mr	Bokhuretsion	Andemicael	Gash Barka Education Office	Head, Regional Education	none	-
30	Mr	Ghirmai	Kelit	Gash Barka Education Office	Supervisor of Primary Schools	none	-

Contacts HCWM & EM Plans • Eritrea

n°	Coordinates			Institution / Address	Function / Responsability	E-mail	Tel & Fax
	Title	Last Name	First Name				
31	Dr	Berhane	Aria	Gash Barka Health Office	Regional Director of Health	none	T: 73 12 10 / 55
32	Mr	Sale	Ibrahim	Gash Barka Health Office	Administrator	none	T: 73 12 10 / 55
33	Mr	Ahmed	Ali	Ghantelay Elementary School	Director	none	-
34	Mr	Tesfamariam	Asafaha	Gindae Middle & Secundary School	Director	none	-
35	Dr	Alazar	Sahle	Gindae Sub-zoba Hospital	Medical Director	none	-
36	Mrs	Alem	Freweiny	Halibet National Referral Hospital, Asmara	Head Nurse	none	
37	Mrs	GebreSelasie	Nebiat	Halibet National Referral Hospital, Asmara	Matron	none	
38	Mr	Teckle	Amanuel	Halibet National Referral Hospital, Asmara	Head, Hospital Laboratory	none	
39	Mr	Tesfazghi	Gebremichael	Halibet National Referral Hospital, Asmara	Administrator	none	
40	Mr	Kebati	Tadesse	HAMSET - Gash Barka Region	Project Officer	none	-
41	Mr	Amdemichael	Werede	HAMSET - Southern Red Sea Region	Project Officer	none	-
42	Mr	Giorgizri	Vittorio	Hansenian's Eritrean Welfare Organization / PO Box 974, Asmara	Director	giorgizriv@tiscali.it	T:++39 06 20 57 971
43	Prof	Travaglino	Carlo	Hansenian's Eritrean Welfare Organization / PO Box 974, Asmara	Programme Coordinator	hewoasm@gemel.com.er	T: ++291 1 12 44 05 F: ++ 291 1 12 42 79
44	Mr	Tsegai	Isaak	Hansenian's Eritrean Welfare Organization / PO Box 974, Asmara	Administrator	hewoasm@gemel.com.er	T: ++291 1 12 44 05 F: ++ 291 1 12 42 79
45	Mr	Bereketeab	Daniel	IECD - Gash Barka Region	Project Co-ordinator	none	-
46	Mr	Ezabulla	Ejikael	IECD - Gash Barka Region	IEC unit	none	-
47	Mr	Mekonen	-	Integrated Early Childhood Development	Project Manager	none	
48	Mr	Capuzzo	Nicola	International Committee of the Red Cross / PO 1109 Asmara	Water and sanitation Engineer	asmara.asm@icrc.org	T: ++291 1 18 11 64 F: ++291 1 18 11 52
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50	Mr	Dewez	Frank	International Federation of the RC and RC Societies	Head of Delegation	ifrc@eol.com.er	T: ++291 1 15 05 50 F: ++291 1 15 18 59
51	Mrs	Haviland	Anne	International Medical Corps / PO Box 7340 Asmara	Medical co-ordinator	imctes@eol.com.er	T: ++291 1 15 16 26 F: ++291 1 15 16 28
52	Dr	Banteyrga	Leul	Keren Zoba Hospital	Patron	none	T: 40 10 92
53	Mr	Teckesete	Kahasag	Massawa Referral Hospital	Administrator	none	-
54	Mrs	Haile	Freweiny	Mendefera Zoba Hospital	Matron	none	T: 61 11 82
55	Mr	Temesghen	Berme	Mendefera Zoba Hospital	Administrator	none	T: 61 11 82
56	Mr	Berhame	Fessehaie	Mendefera/ Adi Ugri Elementary School	Director	none	T: 61 12 68
57	Mr	Dainom	Kiflemariam	Ministry of Education /PO Box 1056, Asmara	Adult Education Unit, Head	dainon.kiflemariam@moe.gov.er	T: ++291 1 11 97 33
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59	Mr	Gebremedhin	Below	Ministry of Education /PO Box 1056, Asmara	Head, Physical Planning Unit	none	T: ++291 1 12 06 86
60	Mrs	Habtemicael	Asmeret	Ministry of Education /PO Box 1056, Asmara	Department of General Education, Supervision Unit	none	T: ++291 1 20 28 00
61	Mr	Merhazion	Isaias	Ministry of Education /PO Box 1056, Asmara	Head, EMIS	isaias.merhazion@erimoe.gov.er	T: ++291 1 12 37 35 F: ++291 1 12 19 13
62	Mr	Russom	Abraham	Ministry of Education /PO Box 1056, Asmara	Head, Curricula Development	none	T: ++291 1 12 37 35 F: ++291 1 12 19 13
63	Mr	Teckle	Debesai	Ministry of Education /PO Box 1056, Asmara	Staff, Curricula Development	none	T: ++291 1 11 99 77 T: ++291 1 11 72 68
64	Mr	Zablon	Meles	Ministry of Education /PO Box 1056, Asmara	Deputy Head, Physical Planning Unit	none	T: ++291 1 12 06 86
65	Mr	Ambaye	Andom	Ministry of Health /PO Box 212, Asmara	Head, Drug Info Unit	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99

Contacts HCWM & EM Plans • Eritrea

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	Title	Last Name	First Name				
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67	Mr	Apaya	Rezene	Ministry of Health /PO Box 212, Asmara	Logistic Officer, EPI Unit	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
68	Dr	Debron	Berhane	Ministry of Health /PO Box 212, Asmara	Head, Medical Services	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
69	Dr	Gebrehiwet	Michael	Ministry of Health /PO Box 212, Asmara	Clinical Services	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
70	Mrs	Gebresselasie	Azenegash	Ministry of Health /PO Box 212, Asmara	Head, IEC	aghebre@gemel.com.er	T: ++291 1 20 03 57 F: ++291 1 20 27 80
71	Mrs	Gebresselasie	Shashu	Ministry of Health /PO Box 212, Asmara	Head, HMIS	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
72	Mr	Glyesus	Tewolde	Ministry of Health /PO Box 212, Asmara	Administration Unit	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
73	Mr	Goutom	Fituni	Ministry of Health /PO Box 212, Asmara	Health Officer, Health Environment Unit	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
74	Dr	Haite	Berhana	Ministry of Health /PO Box 212, Asmara	PHC, Family & Community Health	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
75	Dr	Kesete	Araia	Ministry of Health /PO Box 212, Asmara	Head, Health Environment Unit	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
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77	Mrs	Mehreteab	Terhas	Ministry of Health /PO Box 212, Asmara	Head, Training	terhasm@yahoo.com	T: ++291 1 20 03 57 F: ++291 1 20 27 80
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80	Mr	Eyassu	Mebrahtu	Ministry of Land Water and Environment	Director General of the Environment Sector	none	T: ++ 291 1 12 58 87
81	Mr	Gebreamlak	Ephrem	Ministry of Land Water and Environment	Environmental Pollution Expert	none	T: ++ 291 1 12 58 87
82	Mr	Mirgna	Beyene	Ministry of Land Water and Environment	Head, Env. Information and Assessment	none	T: ++ 291 1 12 58 87
83	Dr	Srikanth	-	Ministry of Land Water and Environment	Environmental Health Expert	none	T: ++ 291 1 12 58 87
84	Mr	Woldu	Johanes	Mogolo Catholic Health Centre	Public Health Nurse	none	-
85	Mr	Omeridris	Mohamed	Mogolo Elementary & Middle School	Director	none	-
86	Mr	Fesshaie	Youcef	Municipality of Berentu	Waste Collection Services	none	T: 73 11 18
87	Mr	TecleWedi	Mesfin	Northern Red Sea Education Office / Maaswa	Administrator	none	-
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91	Mrs	Battas	Sophie	Oxfam	Humanitarian Co-ordinator	sbattas@oxfam.org.uk	T: ++291 1 18 49 91
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97	Mr	Zeremariam	Yemane	Pharmecor / PO BOX 200, Asmara	Sales & Distribution Manager	none	T: ++291 1 11 73 03 F: ++291 1 12 28 99
98	Mr	Dirar	Ephrem	Project Management Unit / Ministry of Health / PO Box 4899, Asmara	Civil Engineer	ephd123@yahoo.com	T: ++291 1 12 29 78 F: ++291 1 12 43 57
99	Dr	Teckle	Eyob	Project Management Unit / Ministry of Health / PO Box 4899, Asmara	Director	teckle@cent.coom.er	T: ++291 1 12 29 78 F: ++291 1 12 43 57
100	Mr	Gebremicael	Alemseghed	Salam Elementary School	Director	none	-

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n°	Coordinates			Institution / Address	Function / Responsability	E-mail	Tel & Fax
	Title	Last Name	First Name				
101	Mr	Ghebrelu	Semere	Shiketi Health Station	Head	none	none
102	Mr	Habtemariam	Goitum	Southern Red Sea Education Office / Assab	Administrator	none	-
103	Dr	Ghirmai	Yosief	Southern Red Sea Health Office / Assab	Regional Director of Health	none	-
104	Mr	Iseas	Araia	Southern Red Sea Health Office / Assab	Administrator	none	-
105	Mr	Teckle	Gamai	Southern Red Sea Health Office / Assab	Regional Pharmacist	none	-
106	Mrs	Bradley	Marilou	The World Bank / 15 Tsegai Adig Street, Zone 03, SubZone 01, Asmara	Operations Officer	mbradley@worldbank.org	T: ++291 1 12 43 02/03 F: ++291 1 12 43 09
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108	Mr	Tesfaldet	Teayes	Tio Community Hospital	Head Nurse	none	-
109	Mr	Hussein	Ali	Tio Elementary School	Director	none	-
110	Mr	W/Gebriel	Berhane	Tio Middle School	Director	none	-
111	Mr	Debessai	Haile	UNICEF / PO Box 2004, Asmara	Project Officer, Health - EPI	dhaile@unicef.org	T: ++291 1 15 11 99 F: ++291 1 15 13 50
112	Mr	Toft	Erik	UNICEF / PO Box 2004, Asmara	Assistant Programme Officer wat/san	etoft@unicef.org	T: ++291 1 15 11 99 F: ++291 1 15 13 50
113	Mr	Toumzghi	Sengal	Vision Eritrea / PO box 5571 Asmara Eritrea	Project Co-ordinator	sengal@gemel.com.er	T: ++ 291 1 20 13 97 F: ++ 291 1 12 79 11
114	Mr	Seyvom	Berhane	Wegaheta Elementary School / Assab	Director	none	-
115	Mr	Tewolde	-	Wegaheta Elementary School / Assab	Assistant Director	none	-
116	Mrs	Bitonde	Jennifer	WFP / Asmara	Project Officer	-	T: ++291 1 18 47 35
117	Dr	Andemichael	Ghirmay	WHO/ PO BOX 5561, Asmara	Family Health Programs Adviser	michaelg@afro.who.int	T: ++291 1 15 10 06 F: ++ 291 1 15 13 22
118	Mr	Tseggai	Beiene	WHO/ PO BOX 5561, Asmara	Health Information and Promotion Officer	tseggaib@afro.who.int	T: ++291 1 15 10 06 F: ++ 291 1 15 13 22
119	Mr	Tesfai	Amanuel	Zoba of Maakel / PO Box 5478, Asmara	Head, Cleaning and sanitation unit	none	T: ++291 1 11 64 51 F: ++ 291 1 12 31 83
120	Dr	Abraham	Yohanness	Zoba Referral Hospital / Assab	Medical Director	none	-
121	Mr	Berhae	Hayelom	Zoba Referral Hospital / Assab	Administrator	none	-

Annexe 4: Results of the Survey

HCF	Category	Nb of beds	Occupancy rate	Occupied bed	General Medical waste & sharps			
					litre / day	ratio	kg /day	kg/oc.bed/ day
Halibet RH	National Referral	450	74%	333	450	0,26	117	0,35
Mendefera RH	Regional Hospital	100	95%	95	110	0,26	29	0,30
Barentu RH	Regional Hospital	60	100%	60	60	0,26	16	0,26
Keren Hospital	Regional Hospital	188	80%	150	150	0,26	39	0,26
Assab RH	Regional Hospital	79	110%	87	100	0,26	26	0,30
Massawa RH	Regional Hospital	120	80%	96	110	0,26	29	0,30
Gindha FCH	First-Contact Hospital	33	90%	30	30	0,26	8	0,26
Debarwa HC	Health Centre	36	100%	36	40	0,26	10	0,29
Mongolo Catholic HC	Health Centre	25	70%	18	20	0,26	5	0,30
Akurdet HC	Health Centre	24	85%	20	20	0,26	5	0,25
Enden HC	Health Centre	30	30%	9	10	0,26	3	0,29
Tio HC	Health Centre	28	65%	18	15	0,26	4	0,21
Average		97,75	82%	79,34				0,28

Annexe 5: HCW Disposal Technologies

The choice of a technology for HCW treatment and disposal should always be driven with the objective of minimizing negative impacts on health and the environment. Several technologies exist to treat or dispose of HCW. They include: 1) Incineration in rotary kilns or double chamber incinerators; 2) Burning in single chamber incinerators; 3) Wet thermal treatment (autoclaving); 4) Chemical disinfection; 5) Microwave irradiation; 6) Sanitary landfill, including inertization and encapsulation.

Not all these technologies can be used for the treatment or the disposal of all categories of HCW. The suitable treatment and disposal technologies according to the different categories of HCW are presented in the table below.

Waste category	Rotary kiln	Two chambers pyrolytic incineration	Single chamber incineration	Wet thermal treatment (autoclave)	Chemical disinfection	Microwave irradiation	Sanitary landfill
non-risk HCW	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Human anatomical waste	YES	YES	YES	NO	NO	NO	NO
Waste sharps	YES	YES	YES	YES	YES	YES	YES for small quantities with encapsulation
Hazardous Pharmaceutical waste	YES	Small amount only	NO	NO	NO	NO	NO
Cytotoxic pharmaceutical waste	YES	NO YES for modern ones	NO	NO	NO	NO	NO YES for small quantities with inertization
Infectious waste	YES	YES	YES	YES	YES	YES	YES
Highly infectious waste	YES	YES	YES	YES	YES	YES	NO YES only after pre-treatment
Other hazardous waste	YES	NO	NO	NO	NO	NO	NO YES if specially designed
Radioactive health-care waste	NO	NO	NO	NO	NO	NO	YES Specially designed

Incineration is not the same as burning. **Incineration** is one of the only technologies that can treat all types of health-care waste properly and has the advantage of reducing significantly the volume and weight of the waste treated. Incinerators nevertheless require skilled operators, extensive flue gas emission control systems and, frequently, imported spare parts. Incineration generates ash residues and air emissions can contain pollutants such as dioxins and heavy metals.

Burning in small-capacity single chamber "incinerators" is a technique often used in HCFs in low income countries. These installations may nevertheless constitute a serious air pollution hazard to the surrounding area due to the relatively low operation temperatures and the lack of emission control systems. If biomedical and health-care waste are treated with single chamber "incinerators", waste fractions such as cytotoxic drugs, chemicals, halogenated materials or waste with a high content of heavy metals (batteries, broken mercury thermometers, etc.) *should not be treated* with this type of system (see table above).

Incineration / Burning	Advantages	Drawbacks
Pyrolytic or double chamber incinerators (incineration at 800–900°C) Rotary kiln (incineration at 1200°C and higher)	Elimination of health risks due to the complete destruction of the waste The waste is non-recognizable Fully destroys micro-organisms and sharps Reduces significantly volume and weight of the waste Destroys all types of organic waste (liquids, pharmaceuticals, and other solids) Important quantities of waste can be treated (except for batch incinerators)	High investment costs Requires skilled staff 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 control systems For batch incinerators: limited capacity Emits toxic flue gases (including dioxins and furans) Generates residues that need safe land-filling
Single chamber "incinerators" (burning at low temperatures 300-400°C)	• Good disinfection efficiency • Reduces significantly volume and weight of the waste • No need for highly trained operators	• Significant emission of atmospheric pollutants • Need for periodic removal of slag and soot • Inefficiency in destroying thermally resistant chemicals and drugs • No destruction of sharps

Autoclaving is the exposure of waste to saturated steam under pressure in an enclosed container. Preparation of material for autoclaving requires segregation to remove unsuitable material and shredding to reduce the size of the individual pieces for greater treatment efficiency. Small autoclaves are common for sterilization of medical equipment but a waste management autoclaves can be a relatively complex and expensive systems 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 land-filled with municipal waste. There is also a wastewater stream that needs to be disposed of with appropriate care and control. Furthermore, large autoclaves may require a boiler with stack emissions that will be subject to control.

Steam Disinfection / Autoclave	Advantages	Drawbacks
	Relatively simple to operate (a known technology at health-care facilities) • Environmentally sound technology	Relatively expensive to install and operate Requires boiler with stack emissions controls Relatively high maintenance costs Cannot be used to treat some special wastes • Generates contaminated wastewater that needs special treatment

Microwave irradiation is based on the use of a high energy electromagnetic field that heats up rapidly the liquids contained in the waste causing the destruction of the infectious components. The HCW passes through a preparative process that may include segregation to remove undesirable material before it is shredded and then eventually humidified prior to being treated in the irradiation chamber. At the end, the waste goes through a compactor before being disposed of.

Similar to the autoclaving technique, the output from a microwave facility is considered non-hazardous and can be land-filled together with municipal waste. Since the technology does not involve the application of steam, there is a minimal generation of wastewater that 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 can require the combustion of fuel for the generation of steam.

Microwave irradiation	Advantages	Drawbacks
	The shredding and compacting process reduces the volume of the waste • Once treated, waste can be land-filled with other municipal waste • No air pollution	Highly sophisticated and complex Important investment and running costs Only solids can be treated and only once shredded Cannot be used to treat some special wastes such as pharmaceuticals, and cytotoxic waste Highly skilled operators required No reduction of the weight of the waste treated

Chemical disinfection, used routinely in HCFs to kill micro-organisms on medical equipment has been 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. Thermal sterilization should nevertheless be given preference over chemical disinfection for reasons of efficiency and environmental considerations.

Chemical treatment	Advantages	Drawbacks
	When applied, the shredding process reduces the volume of the waste	Can't be used to treat some special wastes such as pharmaceuticals, and cytotoxic waste Highly skilled operators required; Chemicals used are themselves also hazardous and require special precautions/equipment when used; Final disposal must be same as for untreated special HCW; Generates hazardous waste water that needs treatment

Land disposal of untreated HCW is not recommended and should only be used as a last resort option. When this solution has to be used, it is important the HCW be disposed of in a *sanitary landfill* and rapidly covered: one technique consists in excavating a trench in mature municipal waste at the base of the working face and immediately covering it with a two-metre thick layer of fresh municipal waste.

Alternatively, a specially constructed *burial pit* can be used. Ideally it should be lined with a material of low permeability such as clay to prevent pollution of shallow groundwater and have a fence around it to prevent scavengers accessing the waste. HCW should be covered immediately with a layer of soil after each load. For added health protection and odour suppression, it is suggested that lime be spread over each waste load. Once the pit is filled, it should be sealed off.

Technique	Advantages	Drawbacks
Safe land filling Trench method (HCW is buried in a trench excavated in other waste)	Simple and inexpensive to operate No specific construction costs required Operates within readily available landfill system Waste pickers are unable to access the health-care waste	Special health-care waste is not treated and remains hazardous High demand for coordination between collector and landfill operator; Reduces awareness amongst health-care workers of the need to segregate waste categories Potentially long/costly transportation to landfill
Safe land filling Separate disposal cells (HCW is deposited in specifically designed cells)	Simple and relatively inexpensive to manage if operated in connection with existing landfill for other waste	Special health-care waste is not treated and remains hazardous Requires a safe landfill with fencing Requires control of scavenging and animals • Needs conscientious operation according to manual
Encapsulation (Filling containers with waste adding an immobilising material and sealing the container)	• Simple, low-cost and safe • May be used for sharps • Efficient way of reducing the risk of scavengers gaining access to the waste	• Not recommended for non-sharp waste • Must be considered as an temporary solution
Inertization (Mixing waste with cement before disposal in order to minimise the risk of leakage of toxic substances contained in the waste)	• Simple, low-cost and safe • May be used for pharmaceutical waste	• Not applicable to infectious HCW

Annexe 6: Fundamentals on the Management of Sharps

Sharps represent one of the most problematic and hazardous types of waste generated within HCFs. Syringes and needles are of particular concern because they constitute an important part of the sharps and are very often contaminated with blood. The occupational risks are linked to:

- The great quantities that are manipulated daily by health-workers and generated throughout the world for both curative and preventive activities;
- The cuts and punctures they may cause followed by a potential infection of the wounds. The main diseases of concern are those which may be transmitted by subcutaneous introduction of the pathogens such as viral blood infections;
- The scavenging and re-use practices that occur in some countries, exposing the populations (and most particularly children) to risks of cross contamination.

All biomedical and health-care waste with sharps or pointed parts have a high potential to injure and inoculate potentially dangerous pathogens. *They must therefore be categorized as infectious waste* and have to be manipulated, discarded, transported and disposed of with maximum precautions by health workers.

Due to the lack of reporting at HCF level, needle-stick injuries occurring worldwide are globally underestimated. However a recent study carried out by the WHO shows that, depending on the country, a nurse can get a needle-stick injury more that twice a year. Therefore, handling and disposing of safely needles and syringes, and more generally sharps, must be seen as an absolute priority by the Health Services of any country. The safe management of sharps requires that one:

- Define a strict policy at national level with clear handling and disposal protocols to be respected in all HCFs;
- Provide each HCF with adequate equipment for sharps discarding and disposal;
- Ensure that all HCF staff are aware of the protocols and are properly trained (in-service training and review of the initial curricula are often necessary);
- Establish a system to report accidents that occur and monitor the application of the policy.

It is internationally recognized that the safe management procedures of sharps should comprise the following practices:

- A health-worker performing an injection or the staff member transporting health-care waste should always wear appropriate gloves (a study carried out at the Geneva University Hospital – Switzerland – showed actually that more than 50 % of the blood remaining in an infected needle is stopped by the gloves when a needle-stick injury occurs);
- All disposable syringes and needles should be discarded immediately following use. The needle should never be recapped since most of the accidents occur when the nurses attempt to recap the needles;
- Under no circumstances are syringes or needles (or the full containers) to be disposed of with normal garbage or dumped randomly without prior treatment;
- Sharps should be placed in specific cardboard, plastic, high-density polyethylene or metallic containers resistant to punctures and leak-proof, designed so that items can be dropped in using one hand, and no item can be removed. The container should be: 1) labelled with the international biohazard symbol; 2) be of a yellow colour (the international colour coding system for infectious waste strongly recommended by the UN Agencies), and 3) marked «Danger ! contaminated sharps, do not open»;

- The containers should never be overfilled but systematically disposed of once they are three-quarters full. They should not be emptied for re-use, except when specifically designed for this option (see "the MSF practice" and needle cutters described hereafter).

There are two ways of disposing of needles and syringes in a safe way. The first solution consists in discarding the whole combination needle plus syringe in a puncture and leak-proof recipient which, once filled will then be treated/disposed of with other infectious waste or emptied in a sharp pit. The second option consists in separating the needle from the syringe on the spot using a specific device.

Option 1: disposing to complete combination

The basic idea is to discard the whole combination "syringe plus needle" into a safety box immediately after use. The box is then treated with other infectious waste. This option is recommended by the WHO and UNICEF and applied in all industrialised countries. This practice enables to reduce the risk of needle-stick injuries for the medical staff but generates important volumes of sharp waste that must be incinerated since alternative technologies such as autoclaving and shredding or microwave processing are difficult to apply in low income countries.

In order to oxidise completely the needle, it is necessary to incinerate it at temperatures greater than 1'400°C. Modern pyrolytic incinerators or rotary kilns, which are expensive to install and operate, must therefore be used. Alternatively, air-excess incinerators or improved double-chamber auto-combustion incinerators such as the De Montfort incinerator can be used. These kinds of incinerators are able to burn the syringes and disinfect the needles at temperatures of 800-900°C. However the ash that is produced during the process still contains the needles and must therefore be carefully buried.

Open-air burning of cardboard safety boxes in pits can be seen as an alternative in remote places when there is no other possibility.

The UNICEF & WHO safety box: a cheap option	HDPE boxes: a much more expensive option
	

Option 2: disposing needle and syringe separately

In this option, the needle is separated from the syringe. The main interest of this option is that it enables to reduce drastically (more than 90 percent) the volume of infectious sharps waste that requires special handling. Infectious needles are isolated in a puncture-proof recipient prior to burning, incineration, or burial. The syringe must nevertheless be disposed of in a safe manner (sharp box).

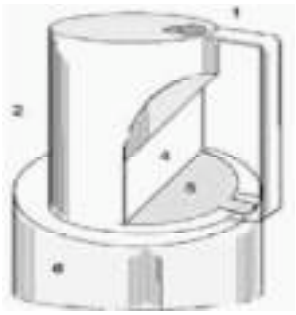
The needle can be separated from the syringe in three ways: removed, cut or destroyed.

a) The MSF needle remover and the PATH "popper"

In this first option one inserts the needle into a slot of a container specially designed to separate it from the syringe using one hand only. The needle drops in the container, which can be made of polyethylene (closed tube or empty drug-boxes, cans, etc…). Once full, the container is safely emptied

into a sharp pit, using a system that prevents the user from being in contact with the needles it contains or the container is thrown in the pit with it's content.

The pit, once full, is encapsulated (i.e. an immobilising material such mortar, clay or bitumen is poured into the pit before it is sealed off) and a new one must be built. This option requires great care from the health-workers when separating the needle from the syringe.

MSF sharp box	PATH needle removal can ("Popper")
	

b) Needle cutters

These devises are installed at the point of use in order to cut the needle from the syringe immediately after use. The needle is inserted into the device, and cut off mechanically by blades. The needle drops into a container, which once full, can either be put in a sharp pit or incinerated. Also already commercialized these types of devices are still being tested. They are relatively inexpensive, robust, easy to use and transport, safe and appropriate in remote areas lacking electricity supply. However they could be difficult to use in mass vaccination campaigns.

A needle remover / cutter

c) Needle destroyers

In these relatively expensive devices, the needle is destroyed at the point of use with the use of an electrical current. The user inserts the needle into a hole or slot in the device, which positions the needle between two electrodes in the device's interior. By contacting both electrodes simultaneously, the needle causes an electric current to run through it which heats the needle to temperatures reaching 1'500°C to 3'000°C. The result is a partial or total oxidation of the needle. Various tests have concluded that these devices are not really suitable in developing countries.

A needle destroyer

The table below provides a comparison of the advantages and the drawbacks of the different options.

Options	Advantages	Drawbacks
1	• It is possible to dispose of AD syringes • The handling of the needle and syringe is reduced at a maximum enabling to diminish the risks of needle-stick injury • The volume reduction, once incinerated, is drastic (more than 90 %)	• POPs may be produced depending on the incineration system used • If the incineration is not performed at sufficiently high temperatures, the needles remain and ash must be safely buried • Incinerators require regular maintenance to be kept in optimal working conditions • Except for open-air burning the capital and operational costs remain relatively high
2a	• Once it has been constructed the pit is simple to use and does not require any maintenance • There are no operational costs. The capital costs remain limited • There are no emissions of air pollutants since the needle isn't burned/incinerated • The volume reduction is similar to the one obtained with incineration	• The needle has to be separated from the syringe which may increase the risks of needle-stick injury for the health-workers • It is not possible to dismantle AD syringes, which are used more and more frequently in low-income countries • A new pit has to be periodically built depending on its filling rate • The pit may be filled with other material than sharps and become rapidly full, increasing the construction costs • Requires space within the HCF compound to dig the successive sharp pits
2b	• Idem as 2a • These devices are robust (they can cut between 200'000 and 400'000 needles before the blades need to be changed) • All types of syringes and needle sizes can be dealt with	• Difficult to use in EPI activities
2c	• Provides a satisfactory solution to get ride of the needle at the point of use • Avoids the transport of sharps • Does not require an on-going supply of sharp boxes or containers • May be an alternative technology in urban areas for some specialised HCFs where a lot of sharps are manipulated (Mother and child centres, blood banks, STD clinics)	• Requires electricity to run • Require a good maintenance of the device that can "clog " easily if the small amounts of ashes produced are not regularly removed • Expensive solution that will be difficultly to include in a HCWM policy in low-income countries

Annexe 7: HCWM Procedures in Medical Laboratories

The management of HCW in medical laboratories remains a sensitive issue since *highly infectious waste* are often generated there. International standard procedures of highly infectious waste management should therefore be respected. They are summarized in the table below. Consequently, each laboratory should be equipped with the adequate material and rigorous protocols set-up to ensure a pre-treatment of the highly infectious waste before it joins the other medical waste for final treatment/disposal.

Highly infectious waste from medical laboratories, such as media or culture plates, should be collected in leak proof yellow bags or containers suitable for autoclaving and properly sealed. Ideally, each laboratory should have an autoclave room dedicated for the specific pre-treatment of this category of waste only. No office waste or other miscellaneous waste should be placed in this room, which shouldn't be either used for waste storage. Once disinfected, medical laboratory waste should be collected and treated with the other infectious HCW.

If a distinct autoclave is not available at the medical laboratory to ensure a thermal treatment, highly infectious waste should be disinfected in a solution of sodium hypochlorite in concentrated form and left overnight. It should then be discarded in a specific yellow bag, properly sealed before joining the hazardous HCW.

Step	Action
Segregation	Highly infectious waste should be: • kept in the medical area until it is pre-treated; • segregated from other general and medical waste; • placed immediately into leak-proof bags or containers.
Pre-treatment	Highly infectious waste should be immediately pre-treated (i.e. autoclaved or chemically treated) before joining the other medical waste.
Packaging	Yellow bags should be labelled with the biohazard symbol and clearly marked with the words "highly infectious waste" with a comment on whether it has been pre-treated or not.
Labelling	Yellow bags should be labelled with the name of the institution and department, type of waste, date, name and signature of person sealing the bag/container.
Storage, transport and treatment	Disinfected highly infectious waste packaged in yellow bags is no longer regarded as highly infectious and can therefore leave the medical area with other yellow-bagged waste, stored, transported and disposed of.

Procedures for the management of highly infectious waste

During the handling of HCW in medical laboratories, a number of precautions should be taken to avoid cross-contamination, such as:

- The re-useable laboratory items should never be mixed with disposable ones;
- The contaminated items must be autoclaved or alternatively chemically disinfected and should never be discarded with general waste;
- Single-use/disposable laboratory items must be autoclaved and never discarded with general waste;
- All sharps (including broken glass) must be autoclaved and never discarded with general waste. They must be disposed of in approved yellow sharps containers.

Annexe 8: Design of De Montfort Incinerators

All the incinerators listed are variations on the same basic design, which is the **Mark 1** incinerator now used in many parts of the world. It burns up to 12 kg/h of waste. It has now been superseded by the Mark 8a, which is more robust and reliable and cheaper to build.

- The **Mark 2** is the mark 1 with a larger secondary combustion chamber to increase the retention time and improve the flue gas emission quality. It has been used for experimental purposes only.
- The **Mark 3** is designed for hospitals up to 1'000 beds, and burns at about 4 times the rate of the Marks 1 & 2. (50 kg/h approx.) It has now been superseded by the Mark 9, which is more robust and much easier to build.
- The **Mark 5** incinerator is thermodynamically the same as the Mark 3, but modified to carry the weight of a much higher chimney for use where a high chimney is a legal requirement or where the proximity of other buildings makes a high chimney necessary to disperse smoke and fumes. This design is being modified at present.
- The **Mark 7** is a version of the Mark 1 specifically designed for use in emergency situations where it is essential to erect and bring into use quickly. It will nevertheless attain very similar combustion temperatures as the others. It is intended that a stock of components for this will be available shortly.
- The **Mark 8** and **8a** are similar to the Mark 7, but the body is brick-built. It has been designed for use in those areas where manufacturing facilities are very limited, and cost must be kept to a minimum but its performance is similar to the rest of the range. The Mark 8a is recommended for most applications. Where the amount of waste is too large for a Mark 8a, consider building two side by side.
- The **Mark 9** is similar to the Mark 3, but again simplified for manufacture and to eliminate operational faults which occurred in the Mark 3.

Mark 8a incinerator (12 kg/hour)

Mark 9 incinerator (50 kg/hour)

1. Construction guidelines

Some basic indications regarding the construction of the De Montfort incinerators are provided hereafter. Detailed information/plans can be found at: http://www.mw-incinerator.info.

Despite the fact that they have been designed to be as simple and affordable to build, the De Montfort incinerators must be built in an appropriate location with care and using the right materials.

Choosing an appropriate location

The incinerator should be built at a convenient distance away from buildings so that any smoke or flue gas does not enter buildings. 150 metres is the suggested minimum, unless the buildings are very high in which case the distance may need to be increased. The incinerator should be built on a solid concrete foundation appropriate to the local ground conditions. It should be convenient for the waste disposal officer to carry the waste containers to the site, and facilities to store the waste securely before burning should be provided. An ash pit to finally dispose of ashes should be provided nearby.

Choosing a qualified builder

It is best to choose a contractor who is competent in simple bricklaying and also in fabricating mild steel sections so that one person can be responsible for the construction of the whole incinerator. The contractor should understand the importance of the correct choice of refractory materials and ideally should be able to source all the materials.

Selecting the right materials

The incinerator will be operated at temperatures which can occasionally exceed 1000°C. Thus it is important that refractory bricks and mortar are used throughout. The mild steel specified is either in the form of sheet steel or rolled steel angle, or rolled steel "U" section (channel). It is often not possible to obtain this U section steel, but it can be substituted by two lengths of rolled steel angle welded to form the correct shape. exact cross-sectional dimensions are not critical. The thickness of the mild steel plate is important to avoid premature failure due to corrosion.

The chimney should be made from steel pipe 3mm thick if it can be obtained, and its diameter can vary between 100mm and 150mm to ease procurement. If no such pipe can be obtained it should be fabricated from the thickest plate that can be rolled with the tools available. The thinner the chimney gauge, the more frequently the chimney will need replacing due to corrosion.

2. Materials

Each model has it's own specifications. Common issues are presented below.

The ***bricks*** in the combustion area and in the secondary combustion chamber/flue will get very hot during operation. Common building bricks will disintegrate if used in these areas.

The ***mortar*** is composed of high alumina refractory cement and refractory granulates.

Mild steel is subject to corrosion, especially in those areas subject to high temperatures and combustion gases. Therefore, although some variation in the specified materials is possible, it is recommended that steel plate thickness is not reduced merely to simplify construction.

Rolled steel angle components may be made from the nearest available size to that specified. There is a lot of tolerance here provided that the chosen size is not significantly weaker than that specified.

U section (channel) is likely to prove the most difficult to obtain in the size specified. It can be made by welding together two lengths of rolled steel angle to form a U section of approximately the specified dimensions.

Door hinges and fasteners may be made in any manner available to the constructor and agreed by the user.

3. Tools

The brickwork requires no tools other than those normally used in building: ***shovel***, ***trowel***, ***plumbline*** and ***square***.

Standard mild steel sections have to be cut, either at 90° or 45°, using either a powered or hand operated ***saw***.

Mild steel plates can be cut to shape using an ***angle-cutter grinder*** or by hand using a ***hammer*** and ***chisel***.

The chimney is best made from mild steel tube, but if this cannot be obtained mild steel plate must be rolled in sections and the sections welded together to form the chimney. This process is best carried out using a ***rolling machine***, but in extreme necessity it can be done manually by rolling the plate sections over a ***wooden former***.

4. Construction: standard problematic areas

Dimensions

The size of refractory bricks can differ widely between one country and another. For this reason, only approximate dimensions are given, and the instructions are written in terms of the number of bricks in each layer, to avoid unnecessary cutting of bricks. The small variations in the size of the completed incinerator will have no effect on its performance. It follows that the steelwork also must be made to the measured dimensions of the brickwork so that the steel and brick components fit together.

Sealing issues and air flow

The fuel and load should burn only after they reach the level of the air holes. Thereafter the flames should be drawn down to the grate and through the transfer hole to the secondary combustion chamber and up the chimney. This means that the loading door must be completely airtight except when it is opened to add more fuel.

It is also important that the firebricks of the primary combustion chamber are sealed with fireclay or fire cement to the top plate to prevent the burning gases or flames being drawn up the primary combustion chamber and directly into the chimney. If for any reason the sand seals should distort during operation, incorrect burning will occur and the maximum incineration temperature will not be attained. Should this happen, the joint between the sand seals and the brickwork should be again sealed with fireclay.

The air holes have been calculated to allow in the correct amount of air for efficient combustion at high temperature. Some tolerance is allowable so that air pipes can be made from materials available locally, but it is not good practice to leave the ash door open during operation, and it is incorrect to leave a gap beneath the ash door. Air should enter the combustion chamber only through the air holes.

The chimney

The chimney should be at least 4 metres high, and can be extended if it is thought necessary to take the gases above any nearby buildings. Its diameter can be between 100mm and 150mm, but the spigot on which it rests must be adjusted so that the chimney is a loose fit.

There are a number of ways of maintaining the chimney in a vertical position. If a roof is built over the incinerator area, it may be possible to attach the chimney to a roof truss. Otherwise four steel cables can be attached to the chimney at a point about two-thirds up the chimney and the other ends of the cables anchored to the ground at least two metres from the chimney. If the chimney weight is above average, either because it is made of heavy gauge steel or because it is much longer than 4 metres, the plate supporting the chimney spigot must be doubled in thickness.

5. Operation

The De Montfort incinerators are of a high thermal capacity design, and thus need to be heated up before infectious wastes are added. It follows that they should be operated for long periods (minimum 2 hours) to avoid using unnecessary amounts of fuel.

To operate the incinerator, here are the main steps to follow:

- Light the incinerator with paper and wood or dry non-toxic waste at the bottom of the primary chamber. The loading door may be kept open for this operation. Add more wood or waste with a small quantity of diesel oil/kerosene (if available) till the flame is burning well. Add more dry waste and close the loading door. Light smoke should be observed coming out of the chimney top. Add more fuel at regular intervals till the flame can be seen burning fiercely through the primary air holes. After about half an hour (longer if the incinerator is very cold or wet) the chamber should be hot enough to start loading.
- Make sure that the chamber is at least 2/3 full of dry matter before adding waste. Before infectious waste is added, flames should be observed through the rear air hole in the secondary chamber. To hurry this process, more diesel/kerosene can be added in the liquid fuel version.
- Thereafter keep feeding waste in at regular intervals, of between 5 and 10 minutes, keeping the primary chamber as full as possible.
- If the flame appears to be burning less fiercely, poke out any blockage in the transfer flue between the two chambers. This can be done using a length of steel pushed in through the air holes at the front.
- Very wet loads should be separated with drier material, and in extreme case supplemented by an extra increment of diesel/kerosene.
- If the incinerator is being loaded with entirely plastic materials, such as syringes in sharps boxes, it is advisable to let one box burn almost completely before adding the next. The time can be gauged by noting when the smoke level decreases.
- When the loading door is opened combustible gases may come into contact with air and burn suddenly and fiercely. This is harmless providing the operator is wearing a face mask / eye protection and is not peering directly into the chamber.

When the loading door is closed suddenly more burning gases may come through the air holes. Thus the operator should load from the side. Furthermore, to minimize the risk of injuries, the use of heavy duty gloves as well as an apron are indispensable.

6. Maintenance

As with any type of equipment, there is a need to perform some regular maintenance to ensure both that the system will continue to work properly and to prolong the life span of the incinerator.

Before each operation.

- Check that ashes have been completely cleared from the grate and floor of incinerator.
- Check that loading door closes properly onto the sand seal in an air-tight manner. Loosen sand if necessary.

Annual inspection and rectifications

Component	Check	Rectify if necessary
Chimney	Vertical fixings	Reset or renew
	Corrosion	Repair any holes or weak points. Replace chimney or section thereof if necessary
Chimney support plate	Corrosion	Replace if necessary
Top sand seals	Cement seal to brickwork. Adequate sand level	Re-seal with refractory cement. Top up sand
Ash door	Corrosion, hinges, catch, blockage in door-frame	Repair and clean as necessary
Brickwork	Missing cement	Replace with refractory cement
	Evidence of thermal damage to bricks	Line inner surface of bricks with 10 mm refractory cement

7. Important information to be kept in mind…

What the De Montfort medical waste incinerator does…

It reduces all waste added to ash and flue gases. This includes dressings, wet or dry, plastics, organic matter, etc. Used hypodermics can be added, but needles may not all be reduced though they will be sterilised and denatured. Care should be taken when removing ashes in this case. Small glass sharps will normally be part melted and rendered safe.

When properly operated, the flue gases emitted will have been held at a high temperature (800°C) for at least one second and should be almost harmless.

...and what it will not do…

It will not render all flue gases smoke free, and will not meet clean air requirements in all situations with all loads. If this is your requirement, you will need to buy a much more expensive incinerator and have it professionally installed and operated.

It will not operate automatically without attention. When burning waste, particularly infectious waste, an operator must be in constant attendance.

It is not suitable for short sharp burns with no warm up period. For this sort of operation you need a low thermal capacity incinerator, probably made of stainless steel, and gas heated.

It is not suitable for operation in a closed room. Smoke will be emitted whenever the loading door is opened. A roof may be fitted to protect the operator from rain, but only minimum walls.

8. Disclaimer

Since the safe and successful use of the incinerator, which operates at very high temperatures, is entirely dependent on the building, operation and maintenance thereof, the University and the organizations supplying the drawings and instructions can bear no responsibility for any mishaps to personnel or inadequate technical performance of the incinerator.

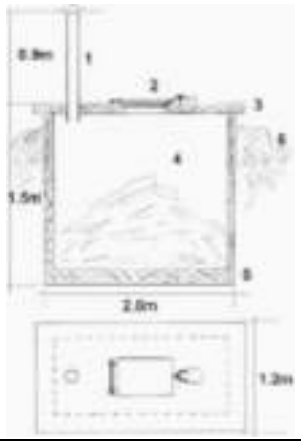
Annexe 9: Design of Placenta Pits

Placenta pits (see photo hereafter) are cheap, practical and safe facilities to dispose placentas, anatomical and some pathological waste that cannot be incinerated in a De Montfort incinerator because they would drastically reduce its performances. It offers a good security for the disposal of organic waste, is relatively easy to build and does not require any specific maintenance.

This kind of facility is not recommended when the areas are subject to heavy rains or inundations or when the water table is near the surface, unless a water proof concrete lining is built.

An example of a safe placenta pit

The model described hereafter is a 3.5 m3 (1.2 x 2 x 1.5 m) that is recommended by the international medical organisation: Médecins Sans Frontières (MSF) to be used in Health Centres. It can last for three to five years in health centres taking in charge 10 to 15 deliveries a week



1. Ventilation tube
2. Lid (50 x 50 cm) in stainless steel that can be closed and locked
3. Concrete slab
4. Pit (preferable completely lined with concrete rings or at least with clay)
5. Concrete slab on bottom
6. Perimeter channel (rain water protection)

MSF Placenta pit

More information can be requested to MSF – Belgium, 39, Rue de la Tourelle, 1040 Brussels, tel +32-2-280.18.81 • fax +32-2-280.01.73.

To size a placenta pit, having a 5 years life span, the following methodology can be used:

- Calculate the average number of placentas generated in the medical institution per week: **P**;
- Calculate the volume of placentas generated per week (m3), using a ratio of 1,5 litre/placenta: (**P** x 0,0015);
- Calculate the volume of placentas generated in a period of five years: (**P** x 0,002 x 52 x 5);
- Calculate a volume reduction corresponding to the decomposition of the placentas: (2/3) x (**P** x 0,002 x 52 x 5);
- And use a safety margin of 10 %: 1,1 x ((2/3) x (**P** x 0,002 x 52 x 5))

Based on these indications, for instance a hospital having 25 deliveries per week (3 to 4 deliveries per day), a 9 m3 placenta pit should last between 3 to 5 years. However, these indications are not and cannot be rigorous. The life expectancy of a pit depends very much on the way it is built and used. For instance, it can be reduced if the ashes generated by the De Montfort incinerators are also disposed of inside the pit (which can help reduce the odours).

The way placenta pits are operated is also important. In particular, they should *always* be kept closed and clean to avoid the proliferation of flies and a mosquito net should be installed on top of the ventilation tube.

Annexe 10: Guidelines to set-up HCWM Plan at Hospital level

(Adapted from WHO International Standards)

At HCF level, the development of a HCWM plan can be divided into six majors steps as described hereafter:

- Designate a coordinator;
- Conduct an HCWM survey and invite suggestions;
- Recommend HCWM improvements and prepare a set of arrangements for their implementation;
- Draft the HCWM plan;
- Approve the HCWM plan and start implementation;
- Review the HCWM plan.

Step 1: Designate a coordinator

The preparation of a HCWM plan must begin with commitments from the Director of the HCF and senior directors who should designate a Health-Care Waste Management Officer (HCWMO) with overall responsibility for the development and the monitoring of the HCWM plan as well as the day-to-day operation of the HCWM system. Because (too) many committees already exist in the Eritrean HCFs, the mission does not recommend to create a HCWM committee at Hospital level but to assign already existing *Infection Control Committees* with the approval and periodic review of the HCWM plan.

Step 2. Conduct a HCWM Survey

A survey should be conducted on the current HCWM situation *within* the hospital in order to identify the necessary improvements. In close cooperation with head nurses from the medical departments, the HCWMO should be responsible in coordinating the survey and analysing the results as well as reviewing and assessing the existing waste management situation. In the same way the mission carried out this analysis at national level, every HCWMO should do it in his/her HCF:

- Compile general information: types of waste generated in the health-care establishment, number of beds, occupancy rates, number of medical departments, etc;
- Conduct a waste generation survey: waste composition, waste quantity, sources of generation and number of beds in use. The survey results should be presented in the form of average daily quantities of waste generated (in kg) in each HCW category from each department;
- Conduct a critical review of existing waste management practices, (i.e. segregation, storage, collection, transport, treatment and disposal);
- Quantify the number of trolleys, containers and other equipment used in waste handling, collection and transportation;
- Identify the costs related to waste management;
- Assess existing safety (e.g. protective clothing) and security measures (e.g. in case of spills and chemicals accidents);
- Evaluate the contingency measures applied in case of a breakdown of HCW treatment units or during close down for planned maintenance (e.g. safe procedures for handling laboratory wastes in case of breakdown of the autoclave);

- Raise awareness amongst health-workers;
- Prepare drawings or sketches of the HCF showing, storage areas for hazardous and other types of waste, on-site treatment facilities (for the hospitals outside Asmara.), waste collection trolleys routes through the HCF (e.g. routes for transportation of general and hazardous waste outside medical department), areas for washing and disinfecting waste collection trolleys, etc;
- Prepare drawings of each medical department, floor or building showing: location of individual HCW collection points (at least for medical waste, sharps and domestic waste), location of temporary storage areas/containers, routes for internal transport of waste in medical departments (at least for hazardous waste), location of equipment for disinfection;
- Prepare drawings and specifications of: PE waste bags (thickness, width and length), containers (for medical waste and sharps, etc.), trolleys and wheeled containers for internal collection and, transport, protective clothing to be used in the handling of each category of waste (e.g. gloves, masks, plastic aprons, overalls, boots…).

Step 3. Set-up an Action Plan

Making recommendations

Based on the results obtained from Steps 1 and 2, the *Infection Control Committee* and the HCWMO should prepare recommendations on how to improve HCWM in the HCF. These recommendations should include staff responsibilities and roles, training needs, staff and equipment resources.

The following are basic actions for achieving the goals of the WHO minimal programme to improve the management of HCW:

- Assessment of waste production (waste generation and composition);
- Assessment of the local handling, treatment and disposal options;
- Segregation of HCW into hazardous and general (or municipal) waste;
- Establishment of internal rules for waste handling (e.g. storage, colour coding or signs, bag/container filling, closing and labelling);
- Ensuring workers' training and safety at work (e.g. training on the safe use of chemicals for waste disinfection);
- Assignment of responsibilities within the health-care establishment;
- Choice of suitable or better treatment and disposal options.

Setting priorities for HCWM improvements

Medical departments should first focus on the safe practices/procedures for HCW segregation, internal collection and storage. *These measures have the greatest impact in reducing poor hygiene practices*. Improvements with respect to waste segregation, internal storage and collection in medical departments should consist, at least, of the following:

a) Segregation

- Separation of health-care waste into three categories (general waste, hazardous health-care waste and sharps);
- Colour coding of bags/containers to differentiate between waste categories;
- Use of posters and checklists to help segregate the waste;
- Use of labels for closed yellow-bagged waste;
- Use of holders to contain highly infectious waste bags/containers;

- Existence of safety measures (protective clothing etc.) and emergency response (in case of needle-stick injuries, etc.);
- Awareness-raising and hands-on training.

b) Internal Storage

- Separate temporary storage areas and containers for hazardous and general wastes;
- Temporary storage areas/containers located away from patient areas;
- Fixed collection schedule for temporary stored bagged waste;
- Periodic cleaning and disinfection of temporary storage areas and containers.

c) Internal transport

- Fixed collection schedule for each waste category (three-bin system) dedicated trolleys and wheeled containers (leak proof with cover) for collection and transport of hazardous waste;
- Colour coding system or (if not feasible) coloured signs for trolleys and wheeled containers to differentiate between trolleys for general and hazardous waste;
- Periodic disinfection and cleaning of trolleys and wheeled containers;
- Existence of safety measures (e.g. protective clothing) and emergency response (e.g. in case of spills, occupational injuries);
- Awareness-raising and hands-on training.

Costs associated with HCWM improvements

The cost of HCWM improvements depends upon the nature of the improvements; e.g. the total cost of introducing segregation of waste includes the cost of purchasing plastic bags and containers, of trolleys and wheeled containers and their maintenance, and of separate transportation. Waste minimization, segregation and recycling can greatly assist in the cost reductions increasingly required by HCFs, by reducing disposal costs.

As a general guideline, the final cost of HCWM improvements may consist of the following:

- Capital investment cost (e.g. purchase of trolleys and wheeled containers);
- Operating costs: labour, consumables (e.g. purchase of plastic bags);
- Cost of maintaining equipment or improving buildings (e.g. creation in medical departments of separate temporary storage areas for yellow and black-bagged waste);
- Costs of contracted HCWM services (e.g. collection of segregated waste by contractual services);
- Treatment and disposal costs (by private or public sector);
- Miscellaneous.

Implementing the proposed HCWM improvements

Arrangements for the implementation of HCWM improvements should be stated in the HCWM plan. A work plan or protocol comprising practical approaches/steps for safe implementation of waste management improvements in each medical department should be *developed by the HCWMO / Infection Control Committee* in close cooperation with the head nurses of medical departments.

It may be preferable to test the proposed HCWM improvements first in one or two departments. This approach also provides practical training for staff. Subsequently, the improvements can be extended to

other parts of the HCF. The work plan for implementation of HCWM improvements in each medical department may include the following:

- Methods and timetable for implementing HCWM improvements and definition of responsibilities and roles;
- Checklists to assist nurses during the implementation process;
- Training and awareness-raising activities to introduce procedures for implementation of planned activities. The following subjects may be considered for training and awareness-raising activities: 1) proper procedures and precautions for segregation, handling, storage and disposal of hazardous HCW, 2) proper emergency procedures during a hazardous HCW spill or exposure, 3) health hazards associated with mishandling hazardous HCW, 4) organizational process for reporting hazardous materials and waste spills or exposures;
- Detailed information on safety practices and emergency response in case of incidents or accidents associated with HCWM (e.g. occupational injuries, spillage of hazardous waste, exposure to cytotoxics) and in case of disease outbreaks (e.g. cholera);
- Health surveillance and control (e.g. immunization against HBV and tetanus) and provision of information on rapid access to post exposure prophylaxis;
- Measures to control and monitor the implementation of waste management improvements. By reviewing performance data every few months modifications can be made to the waste management system;
- Contingency measures, including instructions on storage or evacuation of HCW in case of breakdown of treatment units or during close down for planned maintenance.

Step 4. Draft the HCWM plan

Based on the results of the situation assessment phase and its recommendations, the HCWMO should then draft the HCWM plan. If necessary, he/she should ask for advice, information and support from the MOH.

The content of the draft of the HCWM plan can be as simple or as complex as desired by the management of the health-care institution.

However, all HCWM plans should address the following three aspects:

1. Clear and open examination of the current HCWM situation (Step 2).

2. Analysis of what resources are available for improving HCWM and the possible options for improvements (Step 3).

3. Preparation of a detailed set of arrangements to implement the proposed waste management improvements including:

- arrangements for training staff;
- acquiring new waste storage;
- handling;
- treatment and disposal equipment;
- a timetable for implementation (Step 3).

An HCWM plan should show its linkage with other hospital management plans, if they exist (e.g. safety management plan, security management plan, emergency preparedness plan, equipment investment plan). Weakness in the linkages with these management plans and lack of cooperation and coordination with related executive officers may affect the effectiveness of the HCWM improvements/plan.

Step 5. Approve the HCWM plan and start implementation

The draft of the HCWM plan should be discussed by the Executive Committee and submitted for approval by the institution's management. Once approved, the implementation of the HCWM plan should be of the responsibility of the Director of the HCF. The HCWMO or the Infection Control Committee, in charge of monitoring the operation of the HCWM system, may also be delegated by the Director the responsibility for the HCWM plan implementation.

Step 6. Review the HCWM plan

Operation of the HCWM system in HCFs cannot be efficient nor optimized in the long run unless there is a *periodic review of the HCWM plan.* With respect to the process of review it is recommended that a periodic review (e.g. every 2 years) of the HCWM plan be carried out by the Infection Control Committee.

The infection Control Committee meets periodically (e.g. monthly) to monitor the implementation of the HCWM plan and determine whether the approved HCWM improvements need review or adjustment.

The Director of the HCF should also invite the Zoba Authorities or the MOH representatives to periodic meetings to discuss and review the existing HCWM practices.

Annexe 11: Equipment Costs

Asmara (Central incineration)

Hypothesis for the costs estimations
- A total of 50 km per day is cover for waste collection per city
- The HCFs in Asmara generate 1 tonne of medical waste per day
- Two pyrolytic incinerators of a capacity of 100 Kg/hour are used

		Unit price		Needs	Total price	
		USD	NAKFA		USD	NAKFA
Initial Costs	• Segregation & packaging					
	80 l 200 micro PE yellow bags	0,30	5	55'000	16'500	16'170'000
	5 l WHO/UNICEF sharp boxes	0,60	9	35'000	21'000	20'580'000
	80 l yellow plastic bins	30	450	108	3'240	3'175'200
	80 l black plastic bins	30	450	216	6'480	6'350'400
	adhesive tape	0,50	8	0	0	0
	tape tender	10	150	0	0	0
	• Collection and storage					
	yellow 240 l wheeled-container	125	1'875	36	4'500	4'410'000
	• Protective equipment					
	Gloves	10	150	56	560	548'800
	Aprons	20	300	56	1'120	1'097'600
	Boots	25	375	28	700	686'000
	Sub-total I				54'100	53'018'000
	• Transportation					
	4 m3 enclosed vans	18'000	270'000	2	36'000	35'280'000
	• Treatment					
	2 incinerators capacity of 80 kg / hour	85'000	1'275'000	1	85'000	83'300'000
	installation	8'500	127'500	1	8'500	8'330'000
	Sub-total II				129'500	186'670'400
	TOTAL				183'600	2'754'000
Annual Costs	• Segregation & packaging					
	80 l 200 micro PE yellow bags	0,30	5	55'000	16'500	16'170'000
	5 l WHO/UNICEF sharp boxes	0,60	9	35'000	21'000	20'580'000
	80 l yellow plastic bins	30	450	10	300	294'000
	80 l black plastic bins	30	450	24	720	705'600
	adhesive tape	0,50	8	2'000	1'000	980'000
	tape tender	10	150	70	700	686'000
	• Collection and storage					
	yellow 240 l wheeled-container	125	1'875	6	750	735'000
	• Protective equipment					
	Gloves	10	150	30	300	294'000
	Aprons	20	300	30	600	588'000
	Boots	25	375	18	450	441'000
	Sub-total I				42'320	41'473'600
	• Transportation					
	4 m3 enclosed vans (depreciation costs 10 yeas)	2'500	37'500	2	5'000	4'900'000
	driver and collector salaries	3'000	45'000	12	36'000	35'280'000
	transport (oil + fuel unit price / km)	0,45	7	27'000	12'150	11'907'000
	• Treatment					
	Incinerator (depreciation cost 15 years)	5'667	85'000	1	5'667	5'553'333
	incineration only (nominal cost: 150 USD / ton)	150	2'250	354	53'100	52'038'000
	Sub-total II				111'917	109'678'333
	TOTAL				154'237	2'313'550

Health-Centres Regional and other Hospitals locatedoutside Asmara

Hypothesis for the costs estimations
- On-site treatment using a low-cost incinerator
- Around 3 tonnes of medical waste is daily generated
- DeMontfort incinerators and placenta pits are used

		Unit price		Needs	Total price	
		USD	NAKFA		USD	NAKFA
Initial Costs	• Segregation & packaging					
	60 l black yellow bins	20	300	350	7'000	105'000
	60 l black plastic bins	20	300	350	7'000	105'000
	5 l WHO/UNICEF sharp boxes	0,70	11	75'000	52'500	787'500
	• Protective equipment					
	Gloves	10	150	200	2'000	30'000
	Aprons	20	300	200	4'000	60'000
	Boots	25	375	200	5'000	75'000
	Sub-total I				77'500	1'162'500
	• Treatment					
	Construction of Mark III De-Montfort Incinerators	2'500	37'500	15	37'500	562'500
	Construction of Mark II De Montfort Incinerators	1'500	22'500	50	75'000	1'125'000
	Placenta pits	600	9'000	65	39'000	585'000
	Sub-total II				76'500	3'600'000
	TOTAL				154'000	150'920'000
Annual Costs	• Segregation & packaging					
	60 l black yellow bins	45	675	35	1'575	23'625
	60 l black plastic bins	45	675	35	1'575	23'625
	5 l WHO/UNICEF sharp boxes	0,60	9	75'000	45'000	675'000
	• Protective equipment					
	Gloves	10	150	20	200	3'000
	Aprons	20	300	20	400	6'000
	Boots	25	375	20	500	7'500
	Sub-total I				49'250	738'750
	• Treatment					
	Depreciation MARK III (4 years)	625	9'375	15	9'375	140'625
	Depreciation MARK II (4 years)	375	5'625	50	18'750	281'250
	Depreciation Placenta Pit (10 years)	60	900	65	3'900	58'500
	Running (nominal cost: 50 USD / tonne)	50	750	65	3'250	48'750
	Sub-total II				12'625	1'284'375
	TOTAL				52'500	51'450'000

TOTAL

Initial Costs	337'600 / 330'848'000
Annual Costs	206'737 / 202'601'933

Annexe 12: Glossary of Terms commonly used in HCWM

term	definition
air pollution	the presence of a material or substance in the air which may be harmful to either the natural or human environment, which includes any material present in sufficient concentrations for a sufficient time, and a number of circumstances, to interfere significantly with the comfort, health or welfare of persons or with the full use and enjoyment of property
air quality standards	the level of pollutants that cannot by law be exceeded during a specified time in a defined area
anatomic waste	consisting of recognizable body parts
biomedical and health-care waste	solid or liquid waste arising form health-care (medical) activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorized by virtue of his professional qualifications
capacity	the quantity of solid waste that can be processed in a given time under certain specified conditions, usually expressed in terms of mass per 24 hours
chemical waste	consisting of/or containing chemical substances
collection	the act of removing accumulated containerized solid waste from the generating source. Private collection of solid and liquid waste by individuals or companies from residential, commercial, health facility or industrial premises. The arrangements for the service are made directly between the owner or occupier of the premises and the collector
container	vessel in which waste is placed for handling, transportation, storage and/or eventual disposal. The waste container is a component of the waste package
cytotoxic waste	drugs possessing a specific destructive action on certain cells
decontamination	the process of reducing or eliminating the presence of harmful substances such as infectious agents so as to reduce the likelihood of disease transmission from those substances
disinfectant	chemical agent that is able to reduce the viability of micro-organisms
disposal	intentional burial, deposit, discharge, dumping, placing or release of any waste material into or on any air, land or water

term	definition
exposure	the amount of radiation or pollutant present in a particular environment (i.e. human, natural) which represents a potential health threat to the living organisms in that environment
fly ash	the finely divided particles of ash entrained in the flue gases arising from combustion. The particles of ash may contain incompletely burned material. The particles are frequently glassy spheres but may also be crystalline or even fibrous in structure
handling	the functions associated with the movement of waste materials
health-care wastes with high content of heavy metals	consists of materials and equipment which include heavy metals and derivatives in their structure
incineration	the controlled burning of solid, liquid or gaseous combustible wastes to produce gases and residues containing little or no combustible material
irradiation	exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray or ultraviolet) for medical purposes, the destruction of bacteria in milk or other foodstuffs or initiation of polymerization of monomers or vulcanization of rubber
infectious health-care waste	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 wastes from infection isolation wards
minimization (of waste)	the application of activities such as waste reduction, reuse and recycling to minimize the amount of waste that requires disposal.
monitoring	periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things
off-site facility	a clinical and related waste treatment, storage or disposal facility that is located away from the generating site
on-site facility	a clinical and related waste treatment, storage or disposal facility that is located on the generating site
open dump	characterized by the uncontrolled and scattered deposit of wastes
pharmaceutical waste	consisting of/or containing pharmaceuticals
pressurized containers	consists of containers (full or empty) with pressurized liquid, gas or powdered materials
pyrolysis	the decomposition of organic material by heat in the absence of or with limited supply of oxygen

term	definition
radioactive waste	material contaminated with a radioisotope which arises from the medical or research use of radionuclides. It may be in a solid, liquid or gaseous form
recycling	a term embracing the recovery and reuse of scrap or waste material for manufacturing or other purposes
residual waste	those materials (solid or liquid) which still require disposal after the completion of a treatment or resource recovery activity (e.g. slag and liquid effluents following a pyrolysis operation and the discards from front-end separation systems
risk	probability that a hazard will cause harm and the severity of that harm
sanitary landfill	characterized by the controlled and organized deposit of wastes which is then covered regularly (daily) by the staff present on site. Appropriate engineering preparations of the site and a favourable geological setting (providing an isolation of wastes from the environment) are required
sanitation	the control of all the factors in the physical environment that exercise or can exercise a deleterious effect on human physical development, health and survival
segregation	the systematic separation of waste into designated categories
sharps	sharps are a subcategory of infectious health-care waste and include objects that are sharp and can cause injuries
sterilization	a process used to reach a state of free of viable micro-organisms. Note that in a sterilization process, the nature of microbiological death or reduction is described by an experimental function. Therefore, the number of micro-organisms that survive a sterilization process can be expressed in terms of probability. While the probability may be reduced to a very low number, it can never be reduced to zero
storage	the placement of waste in a suitable location or facility where isolation, environmental and health protection and human control (e.g. monitoring for radioactivity, limitation of access) are provided. This is done with the intention that the waste will be subsequently retrieved for treatment and conditioning and/or disposal (or clearance of radioactive waste)
treatment	any method, technique or process for altering the biological, chemical or physical characteristics or waste to reduce the hazards it presents and facilitate, or reduce the costs of, disposal. The basic treatment objective include volume reduction, disinfection, neutralization or other change of composition to reduce hazards, including removal or radionuclides from radioactive waste
waste management	all the activities - administrative and operational - involved in the handling, treatment, conditioning, storage, transportation and disposal of waste

Annexe 13: Documents reviewed during the mission

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