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Mainstreaming Environmental Management in the Health Care Sector

Implementation Experience in India & A Tool-kit for Managers

VOLUME I & II

Mainstreaming Environmental Management in the Health Care Sector

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THE WORLD BANK

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The findings, analysis and recommendations presented in this report are based on the direct involvement of the author in the implementation of World Bank-supported health sector projects in India, which includes reviews of institutional and policy frameworks in the sector, analysis of the environmental components, discussions with project authorities, facility officials and donor partners, and field visits to health-care facilities and centralized waste treatment facilities.

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Acronyms and Abbreviations

AD Syringe	Auto Disable Syringe
AIDS	Acquired Immuno Deficiency Syndrome
BMW	Bio-Medical Waste
CDC	Center for Disease Control
CHC	Community Health Center
CPCB	Central Pollution Control Board
CWTF	Centralized Waste Treatment Facility
DDT	Dichlorodiphenyltrichloroethane
DfID	Department for International Development
DGHS	Directorate General of Health Services
DMC	Designated Microscopic Center
DOH	Department of Health
DOTS	Directly Observed Treatment Short-Course
DPH	Directorate of Public Health
EA	Environment Assessment
EMP	Environment Management Plan
EPA	Environment Protection Act
ETP	Effluent Treatment Plant
GEF	Global Environment Facility
GoI	Government of India
GTZ	German Society for Technical Cooperation
HAI	Hospital-Acquired Infections
HBV	Hepatitis B Virus
HCF	Health-Care Facility
HCV	Hepatitis C Virus
HCW	Health-Care Waste
HCWM	Health-Care Waste Management
HIV	Human Immuno Deficiency Virus
IGNOU	Indira Gandhi National Open University
IPHS	Indian Public Health Standards
KMC	Kolkata Municipal Corporation
LUB	Local Urban Bodies
MDGs	Millennium Development Goals
MoEF	Ministry of Environment and Forests
MoH	Ministry of Health
MoHFW	Ministry of Health and Family Welfare
MPCB	Maharashtra Pollution Control Board
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
NACP	National AIDS Control Programme
NGO	Non-Government Organization
NABH	National Accreditation Board for Hospitals
NRHM	National Rural Health Mission
PATH	Program for Appropriate Technology in Health
PCC	Pollution Control Committee
PCDDs	Polychlorinated Dibenzodioxins
PHC	Primary Health Centre
PMU	Project Management Unit
POPs	Persistent Organic Pollutants
PPP	Public Private Partnership
PRI	Panchayati Raj Institutions
RCH	Reproductive Child Health
RKS	Rogi Kalyan Samities
RNTCP	Revised National Tuberculosis Control Programme
SBC	Secretariat of Basal Convention
SC	Sub-Center
SHSP	State Health Systems Project
SPCB	State Pollution Control Board
TB	Tuberculosis
TEQ	Toxic Equivalent
TNHSDP	Tamil Nadu Health Systems Development Project
TNPCB	Tamil Nadu Pollution Control Board
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
USEPA	United States Environment Protection Act
VBD	Vector-Borne Disease
VBDCP	Vector-Borne Disease Control Programme
VCT	Voluntary HIV Counseling and Testing
WB	World Bank
WHO	World Health Organization

VOLUME I

Mainstreaming Environmental Management in the Health Care Sector

Implementation Experience in India

Executive Summary

Environment management in the health-care sector comprises waste management, water and sanitation and associated practices related to infection control and occupational health and safety of health-care workers. Mitigation and management of these issues has an over-arching impact on health service delivery by reducing the risk of infection and providing a safe and hygienic health-care infrastructure.

Of the gamut of environment management issues, infection control practices and health-care waste constitute the highest potential risk of infection and environmental pollution. While it is a challenge to collect data on the direct correlation between disease burden and poor waste management and inadequate infection control practices, there is sufficient understanding and literature on the linkages and associated potential risks and hazards to the environment and human health. Over the past few years, there has been increasing recognition of the need for safe and hygienic health-care services. Accordingly the Government of India has taken substantive steps in establishing the legal, institutional and budgetary context for the improvement of infection control and health-care waste management.

The World Bank has had 20 years of experience in supporting the Government of India in the health-care sector, and almost a decade in promoting environmental management, specifically infection control and waste management, in this sector. Implementation experience from interventions at national and state levels through the World Bank, Development Partners and Government Health projects and disease-control programs has generated valuable lessons on how to improve operational practices, upgrade institutional capacity and establish effective systems.

Implementing systematic waste management systems in the health sector faces a range of challenges, from harmonizing internal practices to increasing the use of external services for utilities and waste disposal. An essential element is to support awareness and attitudinal changes among healthcare professionals and workers with regard to the mitigation measures on infection control and waste management. Coordinated approaches are needed to ensure effective implementation of cross-cutting activities at the decentralized level of health services delivery, and to work across sectors, with municipalities and environmental agencies.

An increasing number of health-care facilities are implementing best environmental management practices by fully integrating environmental guidelines with overall facility management. In other facilities, critical activities such as sharps management and

waste segregation are being put in place, although institutional coordination mechanisms are yet to be strengthened.

This report emphasizes the importance of moving beyond a single focus on infection control and waste management, to mainstream key environmental management issues, using an integrated approach which cuts across all health and disease-specific programs and other relevant sectors. It includes examples of emerging good practices and implementation constraints and shortcomings and provides guidance to project managers on systematic approaches for achieving holistic and effective environment management systems within the health-care sector.

1 Introduction

1.1 Background

Provision of good quality health care for its one billion citizens is a major concern for India, for which the Government has dedicated signifi cant resources at both national and state levels. There are many specific problems which are being tackled through a variety of targeted programs, such as the national programs for HIV, TB and malaria prevention and control. However, there is a need to upgrade the level and quality of services and facilities. Implementing basic environmental management systems is part of the overall efforts for the development of this sector.

Environment management is usually seen as an external issue for the health sector, although the sector is consistently facing a range of signifi cant environmental challenges ranging from waste management, water supply and water quality, to sanitation and sewage, and associated infection control. All of these affect the health and safety of people, patients, health-care- and non-health-care-workers. Mitigation and management of these issues can have an overall impact on health service delivery by reducing the risk of infection and providing a safe and hygienic health-care infrastructure.

Of the gamut of environment management issues related to the health-care sector, poor management

Photo 1.1: *Risks to environment and health from poorly managed health-care waste*

Photo credit: Megha Rathi

of health-care wastes presents a potential high risk of infection and environmental pollution. This issue is challenging – not only because it involves behavior-change interventions but also due to the complex structure of its implementation – which require coordination of stakeholders across sectors, upgrading of technology and the need to address resource allocation.

The health sector in India provides useful lessons for environment management as the sector covers a wide range of services from elite facilities in urban centers to primary health care services spread across disparate rural areas. In the last few decades, India has made significant progress in regulating and institutionalizing infection control and waste management issues in its health-care systems, while aiming to improve its national health care delivery system. With the emergence of India as an international hub of medical tourism, it is critical that the health-care sector undertakes continuing efforts to provide a clean, safe and hygienic environment. This task requires moving beyond implementing basic health-care waste management to mainstreaming core environmental management issues into planning, policies, programs and budgetary allocations.

The World Bank and other development partners have been working with national and state partners in India on health projects over the past twenty years. For almost a decade the World Bank has been promoting environmental management in the sector, with a particular emphasis on infection control and waste management. Recognizing the systemic issues and implementation challenges, the World Bank has promoted environmental management through a phased approach. The aim has been to introduce the essential elements early, and to establish a base for ongoing improvement as part of general health care upgrading. The most relevant issue is related to the control and disposal of infectious health-care waste. Improvement in bio-medical waste disposal translates into direct health benefits, while also creating a basic institutional and physical infrastructure, and strengthening a core public health function – a public good with large externalities. (Section I of Volume II).

Agencies and facilities with existing basic infrastructures can proceed to instituting higher standards of environmental management, which requires a strong institutional mechanism and an integrated approach for enhancing coordination among multiple departments and stakeholders. This can eventually lead to accreditation of the health-care facilities under the relevant regulations.

Useful lessons have been learned from this phased approach, primarily from the state- specific health reform projects which have provided the platform for engaging in a dialogue within a structured institutional set-up, over a period of time. This document seeks to bring together these experiences in India in a comprehensive manner.

A key finding is that a disjointed approach, focusing only on discrete activities of procurement, capacity-building and contractual arrangements, is not sustainable. This document builds its analysis and recommendations for a conceptual approach which includes Policy, Institutions, Planning, Budget, Capacity-Building and Monitoring. It is hoped that such an integrated and cohesive approach will help create a common understanding of how the different elements inter-connect and facilitate a more strategic, phased, focused and sustained implementation. Such an approach will provide the direction whereby the essential costs of improved environmental management are internalized by the health-care system at multiple levels.

The pace and quality of progress depends on the context and on the availability of resources. However, good progress has been made in many different health systems, due to leadership, strong commitment and strategic vision, despite limited resources. The lessons learned and relevant recommendations, which are summarized here, provide direction for future efforts.

1.2 Objectives

This document is organized into two parts, and is intended to review lessons learned in India (Volume I) and to use those lessons and other experiences globally, to serve as a guidance tool-kit for task managers and

program officers in the health-care sector (Volume II). The aim of the first part (Volume I), is to demonstrate practical and feasible responses to the challenges faced while implementing and improving environmental management. It is hoped that the experience summarized here will enhance understanding of the importance of core environmental management and thus support the planning, budgeting and monitoring of environment management activities in the context of an inter-sectoral, integrated and coordinated operational approach.

1.3 Structure of the document

Volume I of this report titled "Mainstreaming Environmental Management in the Health-Care Sector – Implementing Experience in India" provides a detailed analysis of the challenges and practical lessons learnt in implementing the basic standards of infection control and health care waste management in the health care sector of the second most populous country in the world. It provides recommendations for improving the existing systems and also for mainstreaming and scaling-up the larger set of environmental management issues, including water, sanitation and solid waste management, through an integrated and inter-sectoral approach. The recommendations are separated into short and medium-term operational actions, and longer-term strategic policy changes.

Volume II of the report – "Tool-kit for Managers" provides references and synopses of national and international guidelines on key technical issues, operational and cost parameters. It sets out relevant national laws and regulations and also the associated World Bank Safeguard Operational Policies, along with sample monitoring and supervision templates and guidance on technology and construction management.

2

Environmental Management in the Health-Care Sector

- *Good environment management is an integral component of improved health-care services.*
- *Management of sharps and/or infectious health-care waste is the initial first step.*
- *A holistic and coordinated approach needs to be taken to ensure effective implementation and impact.*

2.1 Introduction

The principles and benefi ts of sound environmental management of health service delivery are well understood, but in India, implementation poses many challenges because of the need for coordinated and integrated actions across a range of actors, both within and outside the sector. Over the course of preparation and implementation of more than a dozen health sector projects supported by the World Bank and other partners, at the national and state levels, many lessons have been learned about what approaches are effective and what practical results can be achieved, in the context of the current systems. This report draws on that experience, and the findings are based on implementation experiences gathered from reviews of institutional and policy frameworks in the sector. This includes health-care waste management plans, discussions with project authorities and health-care facility officials, as well as field visits to project sites and Common Waste Treatment Facilities in cities and districts at state levels.

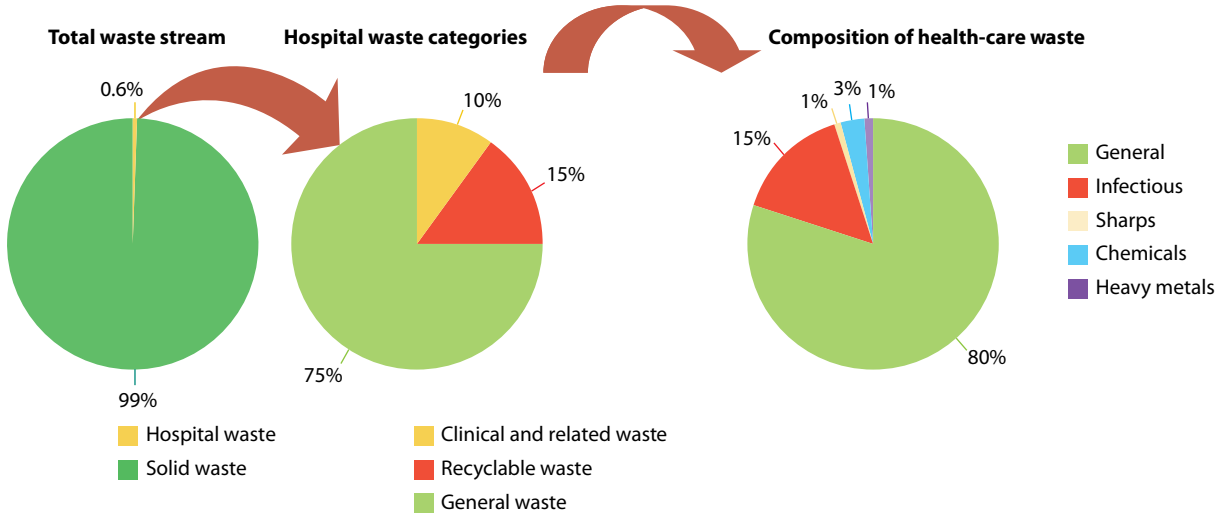
2.2 Towards a holistic approach

Environmental management is a core public health function – a public good with large externalities. Good health and a clean environment reduce the disease burden and increase the economic productivity of individuals, and thereby have the potential for improving economic growth.

Basic good environmental management for the health-care sector includes efficient infection control measures, adequate water supply and sanitation, occupational health and safety of staff, and proper disposal of infectious wastes and wastewater. Measures for waste minimization, increased energy efficiency, improved infrastructural design, optimal utilization and recycling of resources, switching to zero-mercury equipment and promoting green procurement initiatives comprise the pinnacle of environment management.

Sound environmental management in the health-care sector is important, not simply for reduction of its environmental footprint in the sector, but also for its direct impact on outcomes by reducing the risk of infection and preventing potential diseases through the provision of a clean, hygienic and safe environment for both health-workers and patients. Such preventive measures pose serious challenges in implementation as these require an integrated and coordinated multi-sectoral approach among multi-stakeholders (in the public and private sectors).

Figure 2.1: Composition of waste streams



Although there are many areas of interface between environment and health in health-care activities, professionals from both the fields agree that the convergence point for the environment-health nexus is, first and foremost, good infection control practices and related health-care waste management. Failure to effectively address these issues poses a high risk of diseases and secondary (nosocomial[1]) infections, and causes environmental damage and pollution. Recognizing this, the health projects supported by the World Bank have focused primarily on this basic issue and the associated institutional coordination required for improved implementation.

2.3 The context: The need for environmental management in health-care

Infection control and health care waste[2]

All waste produced in a health-care establishment is defined as health-care waste[3], but in practice, up to 75-90 percent of health-care waste is general waste with no relative higher risk than general municipal solid waste, and thus can be regarded as non-infectious. The concern relates to a small segment which includes infectious waste (comprising sharp waste, contaminated dressings etc., anatomical and body parts), chemical or pharmaceutical waste, and small amounts of radioactive, cytotoxic or mercury-based waste. Such waste (between 10-25 percent by weight) represents an elevated risk as a source of potential infection, injury or other health impact. A very small fraction (generally less than one percent of the total) may pose a serious chemical, radiological or physical hazard.

Infectious waste, if badly managed, has the potential to endanger the health of patients, health-care workers, waste-handlers, waste-pickers and the general population. It has been linked to transmission of diseases such as Hepatitis B and C, tuberculosis and water-borne diseases. Many human pathogens can be found in health-care waste items, (e.g., Staphylococcus sp., HIV, Hepatitis B and Hepatitis C in blood, Salmonella, Shigella sp. in faeces and vomit, and Streptococcus in mucus) though the transmission routes are still uncertain.

Well-documented infection pathways are through physical contact with infectious waste and puncture injuries from sharps. Sharps waste poses the highest risk

1 Infections which are a result of treatment in a health-care service unit but secondary to the patient's original condition; they appear 48 hours or more after hospital admission or within 30 days after discharge.
2 Ref: Safe management of wastes from health-care activities, edited by A. Pruss, E. Giroult and P. Rushbrook, WHO, 1999; Appendix I of Tool-kit provides detailed categorization of health-care waste.
3 Also referred to as medical waste; bio-medical waste or hospital waste.

Photo 2.1: Indiscriminate disposal of sharps waste

Photo credit: Megha Rathi

among the whole range of infectious health-care waste. Studies have shown that Hepatitis B Virus (HBV) can remain infectious for a week when dried at room temperature, and the probability that a single needle stick will result in sero-conversion[4] is approximately 30 percent.[5] For other waste items, in addition to direct contact, the potential pathways are presumed to be airborne (e.g. spores or aerosols) or vector-borne (e.g. flies) transmission.[6]

The World Health Organization (WHO) estimates that the global burden of disease each year due to unsafe injection practices is 1.3 million early deaths, a loss of 26 million years of life, and an annual burden of US$ 535 million[7] in direct medical costs. It is also estimated that unsafe injections annually cause[8]:

- 21 million Hepatitis B Virus (HBV) infections (32 percent of all new infections);
- 2 million Hepatitis C Virus (HCV) infections (40 percent of all new infections); and
- 0.26 million HIV infections (5 percent of all new infections).

Photo 2.2: Unsafe occupational practices for handling insecticides

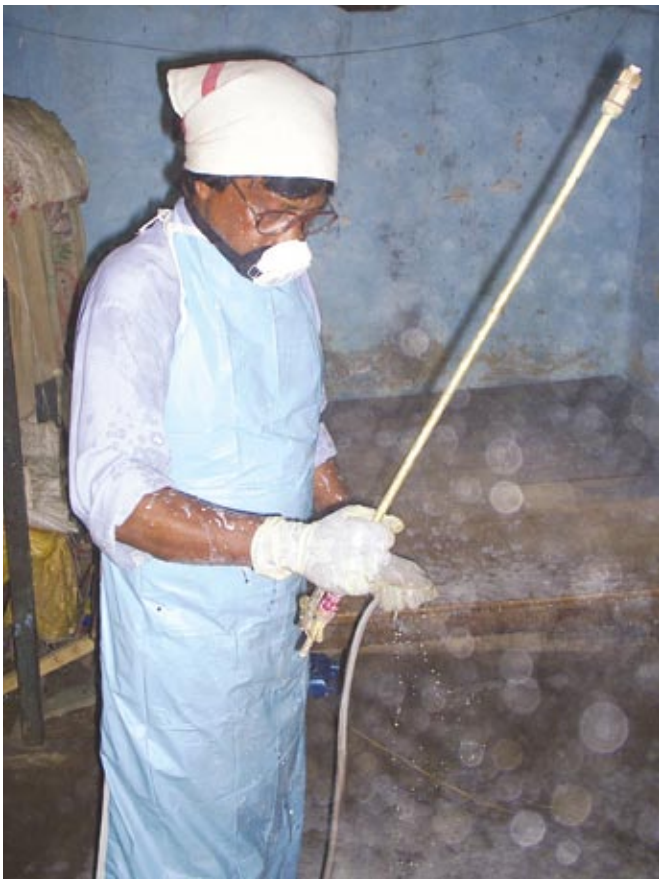


Photo credit: World Bank Mission team

Waste generated from specific programs, such as vector control programs/projects, is also classified as health-care waste. Though the use of insecticides, including DDT, in public health is far less than it is in agriculture, improper usage can result in increased contamination of soil and water if precautionary guidelines are not followed. Proper handling of insecticides involves storage, transportation, handling, (mixing and spraying) and disposal of empty containers and unused insecticides. Any of these activities, if not managed properly, can contaminate the environment and result in potential health impacts.

4 Sero-conversion: development of specific antibodies in the blood serum as a result of infection or immunization; often used in reference to blood testing for anti-HIV antibodies. For HIV and Hepatitis C Virus (HCV), the probability that a single needle stick will result in sero-conversion is 0.3-0.5 percent and 2-5 percent, respectively.
5 Health-Care Waste Management Guidance Note. The World Bank, May 2000.
6 Better HCWM: Zghondi and Rushbrook, WHO and World Bank.
7 The cost of unsafe injections by M.A. Miller & E. Pisani: *Bulletin* of the World Health Organization, Vol. 77, No. 10.
8 WHO Global Burden of Disease study 2000 (Hauri A. et al, Int J STD and AIDS 2004; 15: 7-16.

Improper occupational practices and unsafe handling of infectious waste pose a high risk to health care workers, environmental-service staff, waste-haulers, and the general public. The incidence of HCV tends to be relatively higher among health-care workers, due to increased risk of exposure to infected patients, accidental needle-pricks, contact of cut skin surface with blood/ blood products, and infected medical waste.[9] Table 2.1 highlights the occupational risk associated with improper infection control and waste management practices.

Table 2.1: Waste category and the associated potential hazards[10]

Waste category	Waste types causing the hazard	Pathway of hazard	Potential risks and their health effects[11]
Infectious and pathological	Human and animal tissues, body fluids, laboratory cultures, waste from isolation wards, tissues (swabs), materials or equipment that have been in contact with infected patients.	Direct or indirect contact through a carrier.	Exposure to pathogens can result in contraction of HIV/ AIDS, Hepatitis B, Hepatitis C and other blood-borne diseases.
Hazardous chemicals	Disinfectants, laboratory chemicals and reagents, film developer and solvents. Mercury: found in thermometers, blood pressure gauges and dilators.	Contact through proximity to waste. Contact through release into water bodies and atmosphere.	Burns and severe skin reactions, poisoning, allergies and asthma. Mercury causes damage to nervous system and to kidney and urinary system, especially in fetuses and newborns.
Radioactive waste	Radioactive isotopes, unused liquids from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper. Urine and excreta from patients treated or tested with unsealed radio nucleotides and chemotherapic drugs.	Direct or indirect contact through proximity to waste.	Cancer, other diseases and possible genetic damage.
Sharps	Needles, vials, infusion sets, scalpels, knives, blades and broken glass.	Direct contact	HIV, HBV and physical injury.
Pressurized containers	Containers of pressurized gases.	Result of being in close vicinity when the container explodes.	Injuries due to burns and cuts.
Liquid waste	Liquid waste from laboratories, operation theatres etc. like blood and body fluids, chemicals and heavy metals.	Direct or indirect contact with polluted water or release into the atmosphere.	Contamination of ground water and surface water with disease-causing pathogens and antibiotic resistant pathogenic strains.
Ash and gaseous emissions	By products of burning/incineration like dioxin and furans, heavy metals.	Direct or indirect contact with polluted water or release into the atmosphere.	Cancers, endocrine disruption and reproductive disorders.
Insecticide (and DDT) waste	Vector control activities such as indoor residual spraying, impregnation of bed-nets, etc.	Direct contact with skin, contact or consumption of polluted water or food.	Long-term exposure can result in chronic illnesses, including cancer, reproductive and neurological effects.

9 Jindal, N., Jindal, M., Jilani, N. & Kar, P. (2006) Sero-prevalence of Hepatitis C Virus (HCV) in health-care workers of a tertiary care centre in New Delhi. Indian Journal of Medical Research, 123, 179-180.

10 Table adapted from reports from World Bank, IGNOU and Appleton, and Ali (2000) Health-Care or Health Risks.

11 The extent of exposure and of the associated risk is determined by proximity to waste, occupational safety measures and level of awareness among other factors.

End-disposal of health-care waste

Although bio-medical waste accounts for only a relatively small proportion of health-care waste, the scale of the problem is significant, especially when it gets mixed up with large volumes of non-infectious and municipal solid waste and is disposed without adequate segregation, disinfection or treatment.

Concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) are probably the waste items that represent the most acute potential hazards, if not disposed properly. Inadequate disposal of drug waste, expired or unused pharmaceuticals, heavy metals such as mercury, phenols and disinfectants, and polluted wastewater is detrimental to environmental safety and public health. Chemical residues discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving water bodies. Inadequate treatment and/or deliberate disposal of infectious waste could have direct impacts on workers, including scavengers and rag-pickers, from risks associated with potentially infectious bio-medical waste at disposal facilities (such as landfills or incinerators).

Incineration (burning at high temperature) is often seen as a fast and easy way of waste disposal as it reduces the volume significantly. However uncontrolled burning of health-care waste in open and poorly designed incinerators can produce emissions such as dioxins and furans, which are potentially hazardous and carcinogenic, and which have regional and global impacts. According to the US Environment Protection Agency, medical waste incinerators are one of the largest sources of mercury pollution in the environment and the amount of mercury emitted by such incinerators represents more than 60 times the emission level from pathological waste incinerators.[12] Studies show that there is up to 50 times more mercury in hospital waste than in general municipal waste and an average-sized hospital can release around 3 kg of elemental mercury into the environment in a year.[13]

Photo 2.3: *Poor disposal and re-use of health-care waste*

Photo credit: Megha Rathi and Toxics Link

12 Estimating Exposure to Dioxin-Like Compounds, USEPA, 1994.
13 Mercury-Based Medical Devices in India, Toxics Link, 2009 (http//www.Toxicslink.org).

Photo 2.4: Hazardous emissions from suboptimal incineration practices

Photo credit: Megha Rathi

Associated utility services

International and local good practices highlights the importance of basic utility services such as water supply, sanitation and solid waste management for protecting patients and staff from potential risks. Inadequacies and poor management of these services could have adverse impacts, such as outbreaks of water-borne diseases including viral hepatitis, typhoid, cholera, diarrhea etc. Furthermore, poor practices with regard to non-infectious general waste, such as inadequate storage, poor collection and disposal can attract stray animals and waste-pickers thereby becoming breeding grounds for vector-borne, water-based and fecal-oral infections.[14] Furthermore, dumping of solid wastes around the environs of a health-care facility may cause blockages of access roads, water and sewage drains, resulting in an unhygienic environment for provision of health services.

Water supply (quality, quantity and access), sanitation and solid waste management are problematic areas impacting millions of poor people in their daily lives in most developing countries. This is further worsened in significant proportion of populations, especially for people with existing health problems and/or weakened immune systems, creating an increased burden on already fragile health systems (including health facilities). The WHO estimates that 5 to 30 percent of patients globally develop avoidable nosocomial infections during their stay in health-care facilities due to the unhygienic environment[15] caused by the lack of proper sanitation. According to the Center for Disease Control and Prevention (CDC), health-care-associated infections (HAI) are estimated to be 1 of the top 10 causes of death in the United States.[16] A significant percentage of these infections may be avoided by better infection control practices and improved water, sanitation and hygiene conditions in the health-care facilities.

Box 2.1: The consequences of unhygienic hospital conditions

At least 23 babies in a hospital in Kerala died as a result of a fatal nosocomial infection, which was suspected to be the caused by over-crowded and unhygienic conditions in the gynecology wards and the neonatal intensive care units. Authorities indicated that this situation had resulted from the acute shortage of sanitation staff in the hospital.[17]

14 Occupational and Environmental Health Issues of Solid Waste Management: Sandra Cointreau, The World Bank, July 2006.
15 WHO fact file on sanitation, 10 facts on sanitation, March 20, 2008 (http//www.who.int).
16 World Alliance for Patient Safety, Global Patient Safety Challenge 2005-2006, Clear Care is safe care, World Health Organization, 2005.
17 Compiled from articles on Health/Epidemics- 2007 (January to December 2007) by K. Samu, Indian Social Institute; Deccan Herald, March 2, 2007 and National Human Rights Commission, Annual Report 2007-2008.

2.4 The health sector and beyond

As mentioned in the above sections 2.2 and 2.3, there are a wide gamut of issues that impact good health outcomes. The health sector cannot overlook such overarching issues and must recognize that it has a critical role and an ethical responsibility to take certain simple steps that could lead to a cleaner, safer, and more hygienic and pristine environment for its service delivery activities. At the same time, many of the services related to waste management are provided by the other sectoral agencies and are not under the direct control or responsibility of the health sector. Effective management of waste therefore requires the involvement and active cooperation of parties inside and outside the health sector, including private-sector providers. It is imperative therefore that the public health-care sector coordinates with other relevant bodies to ensure that basic utility services and requisite infrastructures are of high standards so as to reduce opportunistic, environmentally-related infection risks and adverse patient outcomes.

3

The Health-Care Sector in India

- *India has taken significant steps in establishing the legal and institutional context for health-care waste management.*
- *Coordination between the large number of public sector institutions involved in cross-cutting issues of environment management and health-care waste remains a challenge.*

3.1 Challenges in a rapidly developing economy

A key factor driving the growth of the Indian health-care sector, in addition to its growing population and increasing demand for health services, is the rise in both infectious and non-communicable diseases. While diseases such as poliomyelitis, leprosy, and neonatal tetanus are being targeted for elimination or eradication, some communicable diseases such as dengue fever, viral hepatitis, tuberculosis, malaria, and pneumonia continue to be persistent or have re-emerged as a result of environmental factors, or due to mutation or multi-drug resistance. The provision of high-quality health services in a clean hygienic environment is a major challenge for the Indian public health sector, which is characterized by human resource constraints and financial limitations. Concerns about the "superbug" (multi-resistant nosocomial infection) need to be addressed, not only through improved case management, but through a cleaner hospital environment. The situation is further aggravated by inadequate services provided for the health sector by other departments, including water, sanitation and sewage, and solid waste management systems, as well as weak coordination – both inter-sectoral and inter-departmental. Sub-standard environmental management carries a cost to patients in particular and to society in general. However, up to now, this cost has been mainly ignored and externalized.

With India aiming to improve its national health care delivery and evolve as an international hub of medical tourism, it is critical for the Indian health care facilities – both public and private – to provide a clean, safe and hygienic environment where patient safety and infection control is an integral component of services offered. Multiple government sectors, including the public delivery systems have made efforts to internalize infection control and waste management. These efforts need to be further strengthened and institutionalized.

3.2 Government response

The Government of India has shown strategic leadership by being one of the first developing countries to promulgate a policy framework for health-care waste management, i.e. the Bio-Medical Waste (Management and Handling) Rules of 1998, which has been followed by the recently framed draft Rules in 2011. In addition to the formalization of a policy framework, GoI has also prepared the platform for sustainable environment management in the health-care sector by allocating dedicated funds and institutionalizing public health standards. The National Rural Health Mission (NRHM) which was

launched in 2005 adopts a synergistic approach by integrating vertical programs at all levels and relating health to determinants of good health, namely nutrition, sanitation, hygiene and safe drinking water. It encourages the strengthening of existing services by the adoption of Indian public health standards and accreditation of health care facilities through the National Accreditation Board for Hospitals (NABH).

The NRHM has been an important vehicle, albeit gradual, in improving the spread, access and quality of public health-care services across the country. Other programs, such as the Mission on Community Health, focus on key determinants of health including safe water supply and sanitation. Most of the reform initiatives of the GoI are supported by multiple stakeholders, including Non-Governmental Organizations (NGOs), private partners and multinational and bilateral agencies.

The following sections outline the key aspects of the institutional mechanism and corresponding policy framework for environment management in the health-care sector in India.

3.3 Institutional arrangements for multi-sector collaboration

The different ministries and departments at central and state levels are detailed below:

Ministry of Health and Family Welfare (MoHFW)

The MoHFW is responsible for health policy in India and provision of affordable and accessible health-care services. It has two main departments – (i) Department of Health which deals with health care, including immunization campaigns, preventive medicine, and public health; and (ii) Department of Family Welfare responsible for aspects relating to family welfare, especially in reproductive and maternal health, pediatrics and rural health services, among others. Centrally sponsored programs such as National AIDS control, Tuberculosis control and Vector-Borne Diseases control are autonomous programs. Under the Indian Constitution, health is primarily a state subject, and state departments of health are responsible for service delivery and policy implementation. Typically the State Department of Health includes Directorates of (i) Health Services, (ii) Health and Family Welfare, (iii) Medical Education and (iv) Public Health Services.

The Ministry of Environment and Forests (MoEF)

The MoEF is the nodal agency for planning, promoting, coordinating and overseeing the implementation of environmental programs. The Hazardous Substances Management Division in the MoEF is responsible for the overall implementation of the rules related to waste management (solid and health-care). The Central Pollution Control Board (CPCB) establishes standards, compiles data and plays an advisory role to the MoEF on technical matters. CPCB, the State Pollution Control Boards (SPCB) and Pollution Control Committees (PCC) enforce environmental legislations in the states and in union territories, respectively. Both CPCB and SPCBs/PCCs are scientific/technical organizations which are also responsible for setting the technology standards of equipment, issuance of authorizations and licenses for operations of health-care facilities and their waste treatment equipments.

State level departments and municipal bodies

Environment management issues including water, sanitation-related diseases, and solid waste management are state subjects under the Constitution and the responsibility is also shared by various municipal bodies. Implementation and execution is through state departments (Public Health Engineering or Rural Development Engineering) or State Water Boards along with the urban local bodies. Health-care waste management is implemented by the Department of Health, with support from municipal bodies and private service providers for disposal.

International partners

Various international organizations and development partners provide technical and financial assistance

for improving environmental management in the health-care sector. These include World Health Organization (WHO), United Nations Development Program (UNDP), Global Environment Facility (GEF), United Nations Children's Fund (UNICEF), Program for Appropriate Technology in Health (PATH), Department for International Development (DfID), German Society for Technical Cooperation (GTZ) and the World Bank. Details of the activities and their programs are provided in Section XV of Volume II.

Professional and private sector associations

Professional organizations such as the Indian Medical Association, Indian Pediatric Association and Trained Nursing Association of India have been active in disseminating information on universal good practices, specifically sharps safety and waste management. Implementation of utility services such as laundry, laboratory, kitchen services, housekeeping, sanitation and waste treatment and disposal have increasingly been outsourced to the private sector, making these service providers important players in moving the agenda forward towards sound environmental management in the health-care sector.

The judiciary

The judiciary, especially the Supreme Court of India, has over the past decade become increasingly involved and has intervened in the issues of environment management within health-care facilities. This has been triggered largely by public interest litigations filed for the improvement of water, sanitation, municipal and health-care waste management. NGOs have also been instrumental in raising environmental concerns and community sensitization. They have also helped in bringing about changes at the policy level, including promoting non-burn technologies, phasing out hazardous chemicals and improving occupational safety of health-care workers.

Box 3.1: Landmark judgment and phasing out of incinerators[18]

In 1996, the Supreme Court issued a directive to all health care institutions with 50 beds and above to install an incinerator or a suitable alternative treatment technology with proper pollution control equipments approved by the Central Pollution Control Board. The judgment acted as a model for the entire country and introduced alternative technologies into the framework of the legislation. This landmark judgment was the first step towards the phasing out of incinerators from the country.

3.4 India's policies for environment management in the health-care sector

Legislative basis

The GoI has promulgated a number of environmental laws, regulations and guidelines, which impact the health-care sector, both directly and indirectly. The key regulatory framework is defined by the Bio-Medical Waste (Management and Handling) Rules, promulgated in 1998 and further amended in June 2000 and September 2003. The rules apply to all waste generated during the diagnosis, treatment or immunization of human beings or animals, or in research activities, and require generators of such waste to take the necessary prescribed steps to ensure that the waste is handled and disposed of without any adverse effect to human health and the environment.[19] New draft Rules on Bio-Medical Waste have been developed in 2011 which are more stringent and mandate all health facilities to effectively manage their waste, irrespective of the volume generated. In addition, the overarching Environment Protection Act, and the Water and Air Acts are also applicable to the utility services in the health care sector.

18 Dr. Wadhera Vs Union of India 11.03.1996.
19 Details provided in Section II of Volume II.

National health policy

In 2002, the GoI revised the National Health Policy (NHP) which recognized that issues related to water supply and sanitation needed to be addressed holistically and through coordination between various institutions. The NHP also envisaged that environment-related policies and programs needed to be interfaced effectively with health policies and programs. This inter-linkage is recognized as vital for reducing health risks to the citizens and the consequential disease burden.

Guidance tools

MoHFW has developed the primary guidance tool for environment management called Infection Management and Environment Plan (IMEP) which was supported with technical guidance from the World Bank and financial assistance from DfID. The Policy Framework under the IMEP has been accepted as an overarching policy document providing structured and systematic guidance to central and state-level institutions on systems and processes to be established for infection control and waste management. Since its publication in 2004 and wide-scale dissemination, the IMEP Guidelines have been implemented and monitored under the auspices of the NRHM. These guidelines have helped in internalizing good practices in managing health and environment risks in health-care institutions across India. More details of IMEP are provided in Section VI of Volume II.

Box 3.2: Water, sanitation and public health

Recognizing the importance of water and sanitation for public health, the Prime Minister of India stated that "Good sanitation should be a birthright of every citizen of South Asia". His statement noted that sanitation issues need to be given priority in Indian development policy approaches and its cross-cutting implications needed deeper study and greater understanding[20]. He emphasized that sanitation had to be located in an integrated framework of public health policy to ensure that sanitation activities are adequately funded.

National plans

One of the objectives of the GoI's 11th Five Year Plan (2007–2012) is to improve public health services through a comprehensive approach which includes health-care infrastructure, supply of clean drinking water, sanitation and hygiene, among others.[21] The Plan aims to facilitate convergence and development of effective and responsive public health systems and services. The NRHM and the Indian Public Health Standards (IPHS) specify minimum standards to be achieved by health-care facilities for water, sanitation, infection control and waste management. The NRHM aims to carry out necessary institutional adjustments in the basic health-care delivery system through integration of organizational structures and increasing the number of functional hospitals which meet IPHS. To address this and other shortcomings in public health service delivery, the GoI has committed to increasing expenditure on health from 2 percent of Gross Domestic Product to 2.5 percent in the 12th plan.

The WHO's manual on "Safe Management of Wastes from Health Care Facilities" and "Guidelines for Environmental Infection Control in Health Care Facilities" from the Center for Disease Control (CDC) are the most authoritative technical guidance manuals on these issues.[22] The GoI has also developed national guidelines for safe immunization programs, use and disposal of Auto Disable (AD) syringes, procedures for segregation and safe disposal of health-care waste, specifications for incinerators and Centralized Waste Treatment Facilities (CWTFs). Section XIX in Volume II provides a comprehensive list of international and national guidance documents on environment management issues in the health care sector.

20 Prime Minister's statement at inauguration of the Third South Asian Conference on Sanitation in New Delhi. November 2008.
21 Report of the Working Group on Public Health Services (including Water & Sanitation) for the Eleventh Five-Year Plan (2007-2012), MoHFW, October 2006.
22 References for these documents are provided in Sections XVIII & XIX.

Relevant conventions

As a signatory to the Basel and Stockholm Conventions, India is committed to meet its obligations related to the transportation of clinical wastes and emissions of dioxins and furans which result from incineration of hospital waste, as well as that of ensuring safe use and disposal of DDT in vector control activities.

3.5 Moving forward

Health-care waste management is a relatively new issue and the Bio-Med Rules are a decade old. Numerous guidelines, specifications and instruction manuals have been developed by the GoI and other organizations to support this activity. For the successful implementation of a cross-cutting issue like infection control and waste management, there is a need to address the challenge of enhancing coordination and effectively mesh responsibilities across the institutions and departments. Recognition and encouragement of outstanding leadership by individuals and other organizations who internalize and mainstream the ecological analysis is also a challenging task, but is a critical driving force for successful implementation of environment management initiatives.

4 Experiences of Institutional Coordination for Environmental Management

- *India has taken substantive steps to develop the policies and institutions needed for more effective infection control and waste management.*
- *Good practices are evident in some facilities while many still have a long way to go to improve; human resources are a major constraint.*
- *Good planning along with proper coordination can help to achieve better results, more efficiently.*
- *Specific funding needs to be allocated for environmental management in the budgets of health facilities.*

4.1 Implementation experience: Overview

India has taken substantive steps in addressing the challenge of infection control and health-care waste management. The efforts made by GoI, civil society, implementing departments and health-care facilities have resulted in a marked improvement in basic infection control and waste management practices in the country. Environment management in India's health sector has come a long way in terms of having a national policy framework and guidelines, allocation of funding at national and state levels, in addition to the initiatives being taken by individual institutions. Successful mainstreaming, however, remains patchy, often due to systemic limitations such as human resource shortages, insuffi cient budgets and a fragmented or "silo"-like implementation approach of the public health services sector.

4.2 Learning from experience and practice

The information presented in this document is based on more than a decade of experience in infection control and waste management practices in the field. A phased approach to mainstream environmental management has been used by the health projects supported by the World Bank in India – starting with basic sharps safety, infection control and health-care waste management systems. There has been significant progress in some states, which have moved towards an integrated approach across disease programs. These states have initiated dialogue for environmental management as a whole, including water, sanitation and solid waste issues with municipal departments and state pollution control boards. This experience has brought out a considerable variety of results – ranging from examples of high levels of worker safety practices, commitment and awareness, to cases of minimal implementation. The experience shows that, in general, there is a nation-wide increase in awareness, knowledge and understanding of the importance and need for good practices.

Health-care facilities have been the front line in initiating changes in the health-care sector in India. Such changes, despite limited resource settings, have resulted in a positive shift in the attitudes and practices towards infection control and waste management in India, although the issue is still often treated as a problem, external to the health-care delivery system.

It has been estimated that the volume of health-care waste generated in India is about 420 tons/day, of

which only about 50–55 percent is treated and disposed as per the required norms.[23]

There remains a tendency to implement health-care waste management in an ad-hoc manner, with focus on discrete activities of procurement, capacity-building and contractual arrangements. Experience has revealed that such a disjointed approach is not sustainable. Instead, a cohesive and multi-sectoral participation with constant efforts from top management and active participation from all health-care workers is instrumental in developing a comprehensive system for waste management, both within and outside the health-care facilities.

The following sections detail the implementation experiences and good practices, compiled from health programs in India and other selected case studies. It highlights the various parameters which impact and affect the task of waste management and associated occupational practices, and focuses on policy, institutions, planning, budgetary and monitoring aspects which support the overall implementation.

Most of the experiences are at the state level, under the Health Systems Development Projects (HSDP), where the dialogue on overarching health reform and policy changes provides the requisite leverage for necessary institutional and budgetary changes for implementing environmental management measures as effectively and successfully as possible. The World Bank's "Operational Policies on Safeguards" and GoI's Bio-Med Rules have provided additional leverage to advance the policy and operational dialogue (Section XIII of Volume II).

4.3 Enabling polices and regulations

The Bio-Medical Waste (Management and Handling) Rules established in 1998 provide a concise and enabling regulation for the specific management of this particular type of waste. The rules spell out roles and responsibilities of the stakeholders (generators, operators and private service providers) and define accepted technologies and mechanisms for implementation. India also took an early lead in restricting stand-alone burn technologies and mandated the establishment and utilization of Common Waste Treatment Facilities (CWTFs). While the rules were a good starting point, implementation over the past ten years have revealed shortcomings, such as overlapping color-coding for waste segregation and the lack of defined standards for consumables and chemical disinfectants. Over the years, GoI has rectified some of these shortcomings through a process of amendments; and the new draft rules of 2011 include the introduction of innovative and cost-effective new technologies, management of mercury from health-care facilities, specifying the roles and responsibilities of different stakeholders and the 'polluter pays' principle for non-complying stakeholders.

The IMEP, which has been mainstreamed within the NRHM, provides a policy framework for managing environmental risks arising from health-care facilities. There are also numerous guidelines which provide information and guidance on infection control and worker health and safety issues, along with training modules and awareness methodologies, which are critical components for bringing about behavioral change. However, their implementation and usage on the ground has been disjointed, driven by different implementing agencies and multiple stand-alone training modules.

Box 4.1: Simplifying the guidelines

To address the issue of handling health-care waste in outreach activities such as health camps, the Rajasthan Health Systems Development Project has developed state-specific guidelines in a booklet format, in consultation with the World Bank. These are easy to use and carry, and can be implemented and monitored by the local authorities.

23 CPCB Evaluation of Central Pollution Control Board (CPCB). Submitted to Ministry of Environment and Forests, Government of India by Indian Institute of Management, Lucknow, February 2010.

4.4 Institutional coordination for environmental management

A key achievement of NRHM is coordination and convergence on all health-related issues; however coordination at the national and state levels between MoH and vertical health programs on cross-cutting issues remains a challenge.

The establishment of institutional arrangements and operational systems for environment management is a key prerequisite for systematic and standardized implementation across all health services. The NRHM along with IPHS and other key quality care organizations, such as National Accreditation Board for Hospitals, provides a framework of the standards to be implemented by public health-care facilities.

Inter-departmental coordination

One of the key constraints to smooth implementation of environmental management in general, and waste management in particular, is its multi-sectoral nature. While the generation and segregation of waste take place at the level of health-care facilities, and are monitored by the Health department, the responsibility of disposal rests with municipal authorities. However, enforcement of environmental compliance lies within the jurisdiction of the Pollution Control Boards. Typically, the health-care facilities and the departments of health have little control over implementation standards for the ultimate waste disposal. Likewise, the responsibility for provision of water supply in health-care facilities and management of sewage and general waste generated from the health-care sector rests with the municipal authorities. But there is virtually no institutional interface between the various departments providing the utility services. Limited monitoring, enforcement and data-sharing on health-care waste data by the departments of Health, Environment and the Pollution Control Boards add to such existing systemic challenges. One of the problems is that inter-ministerial advisory committees, as recommended by the Rules, have not been set up in most states.[24]

Box 4.2: Success in multi-sectoral coordination

The World Bank-supported Rajasthan Health Systems Development Project has taken the lead in organizing inter-ministerial discussions on issues such as training and monitoring, rationalization of authorization fees and contractual charges for disposal service providers. A health-care waste management committee has been established in the Department of Medical Health Services and the project provides technical advice on procurement, awareness materials and other related matters. This integrated approach has allowed the resolution of strategic and policy issues, with the participation of departments of Local Self-Government and Environment, and thus has the potential for strengthened monitoring and better enforcement.

Intra-departmental and state-centre coordination

The vertical structures of the disease-specific programs of the GoI (such as Tuberculosis and AIDS Control Programs) present a challenge as regards the coordinated implementation of environment management activities. As these are central programs, often with a semi-autonomous arrangement of management and implementation, there tends to be little coordination at the national and state levels between MoH and these vertical health programs, especially on cross-cutting issues. Additionally, state autonomy of health implementation hinders a national level of standardization. This situation is further complicated with various donors and international and national implementing agencies each initiating and disseminating its own specific guidelines and modules on infection control and waste management. The impact of this lack of coordination is felt on the ground as implementation is carried out by the same set of health-care staff at

24 Controller Auditor General (CAG) Report, 2008: 180 hospitals in 15 states (12 hospitals in each).

the health-care facilities, irrespective of the program and the source of funds. Major efficiency gains could be made by better integration at the service level between programs.[25]

Coordination between the different centrally-funded national schemes would allow cost-effective and efficient implementation across all the programs at the facility level, while coordination between central and state governments would allow for a standardized approach. While the NRHM (government's flagship umbrella program for improving health services) has made attempts to synchronize services, including waste management, this is still relatively new and few results have been recorded. The country's systems are slowly getting established, but additional time, dedicated effort and planned resource utilization is required.

Box 4.3: Integrated implementation of state health programs

In Tamil Nadu and Rajasthan, there has been significant progress in improving collaboration between departments of health and the state authorities for the vertical health programs (TB, HIV/AIDS), supported by the integration mechanism provided by the NRHM. This has enabled coordinated budgetary allocations, implementation of training and dissemination of guidelines, as well as procurement of consumables and awareness materials.

4.5 Towards more strategic planning

Infection control and waste management systems require detailed guidance and strategic planning to enable related activities to be implemented in a relevant and structured manner, without duplication of efforts and resources. Most states or facilities do not have such plans for implementation and monitoring. The planning focus tends to be on procurement of consumables and contractual arrangements with outsourced agencies or service providers. Training plans, needs assessments, awareness programs, occupational safety issues and monitoring plans are often not included in the planning context. An example of poor planning is training being provided to health-care staff prior to the procurement of consumables required for segregation and treatment.

For World Bank-funded projects there is a requirement to develop infection control and HCWM plans. These operational plans include short, medium and long-term strategies for training and procurement, reporting and feedback mechanisms, institutional and contractual arrangements for implementation and budgetary planning.

Box 4.4: Planning based on situational analysis

Inadequately planned strategies, which do not take into consideration state-specific or program-specific contextual requirements, have potential for failure. In the case of the Uttar Pradesh Health Systems Development Project (HSDP), systemic issues were not incorporated into the plan during its preparation. This resulted in a two-year delay in implementation of the environment component. Following a needs assessment and systems analysis, the situation was resolved through an innovative turnkey approach which entailed the outsourcing of training, procurement and waste disposal to contracted service providers through Public Private Partnership arrangements. This arrangement was successfully implemented until project completion.

World Bank experience shows that there can be significant traction in terms of satisfactory environmental management with some effort and consistent dialogue with key stakeholders. However, sustainability of the component after termination of external support remains an important challenge. Bank-

25 This document – Mainstreaming Environmental Management in the Health Care Sector reviews environmental management across programs and projects, and providing one common tool-kit – is a reflection of attempts also being undertaken within the World Bank to better integrate efforts, such as environmental management across disease programs and health projects, by a multi-sector team.

funded projects are usually managed and implemented by a Project Management Unit (PMU), which is the focal point for project implementation. Typically, it has been observed that there is no continuity after project closure. Recent experience from Uttarakhand and Uttar Pradesh HSDPs has shown that an early transfer of responsibilities to the State Department of Health is not sufficient to maintain the pace of implementation if the state institutional mechanism is not ready or committed. Over the years, the World Bank has recommended that environmental management activities be handed over to the state authority during a project's lifetime. Accordingly, the Tamil Nadu and Rajasthan HSDP authorities have already shifted responsibility for coordination and funding to the state departments, almost three years before the end of the project, which may facilitate a higher probability of sustained implementation.

WHO documents and the IMEP provide substantive guidance to policy makers and health care facilities on developing and implementing such HCWM plans. (Section V in Volume II). The MoEF has recently disseminated an action plan for effective implementation of the Bio-Med Rules and provides good guidance and a checklist for institutions which are trying to upgrade their operational procedures. (Section VI of Volume II).

4.6 Importance of appropriate budgetary allocation

Sustainable, effective and successful environment management requires the allocation of dedicated and adequate funds. Departments of health have to budget for planning and dissemination of training, information and awareness materials, as well as monitoring and reporting. Health-care facilities have to estimate two types of costs: internal and external. Internal costs include procurement of consumables and basic equipment, operation and maintenance of equipment, training of staff, establishing worker surveillance and other monitoring systems, regular immunization of staff and other operational costs. External costs include contractual services and payments of environmental clearances and authorization fees. The cost of effective infectious waste management, at an average, constitutes about 0.5–1% of the overall budget of a hospital. The costs of private centralized service providers (Common Waste Treatment Facilities) include those of operation and maintenance of equipment, treatment and final disposal of waste.

The zero-cost approach to waste management continues to be the predominant outlook of health-sector professionals, administrators and workers. Costs for waste management are typically seen as unnecessary expenses and only committed hospital administrators and policy-makers recognize the impact of sound waste management on the value of the health services provided. Burdening hospitals with full costs of waste management at an early stage of the project may promote reversal to poor practices, and therefore enforcement and financial incentives are important requirements for successful implementation.

The World Bank projects highlight the importance of allocating a dedicated budget for infection control and waste management. This was based on experiences from the implementation of earlier generations of projects where waste management systems were poorly implemented and often dropped due to lack of funds.

Since 2008, national programs and NRHM have mandatorily allocated funds for implementation of infection control and waste management. As was mentioned in earlier sections, ongoing World Bank-funded state projects are shifting the budgetary responsibility of the project-related activities to their own state budgets during the lifetime of the project, so as to ensure long-term sustainability. The MoEF has also recently started an initiative to provide financial assistance for setting up Common Waste Treatment Facilities in the states where such facilities are either not available or present in insufficient numbers.[26] Effective utilization of these funds will certainly ensure improved implementation on the ground.

26 Report of the Committee to Evolve Road Map on Management of Wastes in India, MoEF March 2010.

Box 4.5: Innovative ways of funding environment management

In order to improve health-related quality services, Rogi Kalyan Samities (RKS) or Patient Welfare Committees have been established under the NRHM. They have the autonomy to prescribe, generate and utilize funds for smooth functioning and maintenance of high quality services in hospitals. The Block primary health centers in one district in Tamil Nadu have been using the RKS funds for facility development, better seating arrangements, provision of water purifiers and paying for waste collection and treatment.[27]

The Panchayats have also been given adequate powers to play a vital role in health- related activities. One of the functions of the Parivar Kalyan Salahkar Samiti (PARIKAS) in Himachal Pradesh includes ensuring the overall cleanliness of health institutions and providing clean and potable water.[28]

4.7 Responsibilities for monitoring and enforcement

Monitoring of environmental management in health care facilities, especially infectious waste management is the dual responsibility of both the environment and health sectors. While the Department of Health monitors the on-site practices of infection control and waste management, the practices. The Central Pollution Control Board maintains a database on annual health-care waste generation, with information received from states. This flow of information and data is not always accurate or timely, and thus weakens the feedback mechanism and planning process. Standardizing the monitoring protocols, data collection formats and including performance indicators would significantly improve data collection.[29]

Box 4.6: Instituting waste-tracking systems

A Hospital Management Information System in the World Bank-funded Tamil Nadu Health Systems Project has been designed to capture core quality indicators for every hospital, including segregation of waste. Under a newly approved Global Environment Facility and United Nations Development Project (GEF-UNDP)-funded project it is proposed to install a waste-tracking software which will compile real-time data at the point of generation and can be viewed by the Pollution Control Board through a web-enabled system. The waste transportation vehicles will be installed with Global Positioning Systems (GPS) to check on proper disposal of health-care waste.[30] The Maharashtra Pollution Control Board has initiated similar measures to check waste disposal practices and has fitted the vehicles with GPS devices.[31]

Pollution Control Boards (PCB), at the centre and states, carry out periodic monitoring of the health-care facilities and Centralized Waste Treatment Facilities (CWTFs) in order to document the generation and disposal of waste amounts and While health-care facilities and CWTFs are required to obtain authorizations to operate, the Auditor General's findings and the implementation experience from World Bank-supported projects indicate that such authorizations are often pending, leading to a

27 Innovations in Primary Health-Care with NRHM support in Tamil Nadu: presentation on NRHM from Tamil Nadu.
28 Health Sector Reforms in India – Initiatives from nine states: WHO 2007.
29 Examples of indicators have been provided in the Tool-kit, which need to be further adapted and adopted (Section XVI & XVII of Volume II.
30 GEF-UNDP global project document on health-care waste management.
31 Posted On MumbaiMirror.com on Thursday, June 03, 2010.

large backlog with the Pollution Control Boards. Such delays result in operational delays at health-care facilities and financial losses for private operators, due to the status of non-compliance.

Monitoring and supervision within health-care facilities is multi-layered and is to be undertaken on a daily basis by the designated supervisor or the infection control committee. However, experience has shown that such monitoring is not a regular feature and is often dependent on the personal commitment of the nodal officer. Issues such as clogged drains, malfunctioning toilets, and poor water supply are often not given sufficient attention by hospital administrators. The health department also conducts regular supervision, but as expected, this is a big challenge when faced with large numbers of public health-care facilities spread over vast geographical areas.

Box 4.7: Surveillance of nosocomial infections[32]

The Civil Hospital in Ahmedabad maintains a hospital infection control team which monitors and assesses changes in trends of hospital-acquired infections. Any divergence is reviewed and worker practices and environmental health links are assessed. A spike in such infections in one month in 2008 in a particular department was found to be due to increased dust, caused by a new construction in the vicinity.

The role of Departments of Health in monitoring the operations of CWTFs is typically unclear, though as the generator of waste and purchaser of its services, they should have the right to review and supervise the facility and its operations. Efforts have been made by those in charge of health projects to conduct independent assessments and reviews along with routine monitoring of the project during the implementation stage. Also, this issue has been introduced at inter-sectoral meetings held between health and environment departments for Bank-supported state projects.

Box 4.8: Monitoring services by other agencies

The Rajasthan Health Systems Project is commissioning an independent assessment of the operations and functioning of the CWTFs, in collaboration with the state Pollution Control Board. Additionally, a high-level decision was taken to allow the establishment of independent and inter-sectoral monitoring teams – which would include members of communities and individual experts – to support the monitoring and supervision efforts across the state, including solid waste management and water and sanitation issues.

Although the MoEF has notified the Bio-Med Rules, implementing agencies specified in the rules (such as municipalities, hospitals and district authorities) do not fall under its administrative control. Attempts at enforcement therefore have no 'teeth', especially within the public health-care sector. Court cases were filed against some hospitals in Madhya Pradesh, Rajasthan and Punjab for non-compliance.[33] But enforcement authorities typically cannot shut down non-complying hospitals, as it is difficult to take action against another government department, especially one providing public health services.

32 Findings of World Bank staff during mission discussions in Gujarat, 2008.
33 CAG Report on Waste Management.

Box 4.9: Impact of monitoring

Based on an inspection of 40 government and private hospitals, the Bombay High Court directed the Maharashtra Pollution Control Board to issue notices to 1,800 erring hospitals which were not registered or had not taken steps to comply with the Bio-Med Rules.[34] In Himachal Pradesh, notices were issued to municipalities for illegal dumping of waste, while in Rajasthan cases were filed in the courts for illegal collection of health-care waste by rag-pickers. 18 percent of all health care facilities, i.e. 14,959 hospitals in the country were identified as defaulters.[35]

Following the critical findings of a performance audit of waste management undertaken in 2008,[36] and a subsequent parliamentary review, MoEF has developed a "Roadmap on management of waste" in March 2010. The key recommendations include drafting new Bio-Med Rules, requirements for strict monitoring and verification of compliance, the need for random checks and stringent action to be taken against violators.

34 Express News Service: February 1, 2008, Mumbai.
35 Evaluation of Central Pollution Control Board submitted to MoEF by Indian Institute of Management, Lucknow February 2010.
36 Comptroller and Auditor General of India- (Report 14 of 2008), presented to the Parliament.

5

Operational Experiences of Environmental Management

- *An increasing number of health-care facilities are putting good waste management practices in place, although to differing degrees.*
- *Implementation in the sector still faces a range of challenges. Lessons learnt from implementing health-care waste management should be shared, to improve practices and to standardize procedures.*
- *The critical areas of segregation/sharps management can be upgraded with support from senior staff and management.*
- *On-site disposal can be safe and effective, although care and attention is needed. CWTFs can be an appropriate solution but improvements are required in its operation and monitoring.*

5.1 Health care waste management systems

A health care waste management system is a comprehensive system addressing a wide range of issues from basic waste management practices to providing a systematic approach for waste management in a health-care facility. Ideally, an effective system would include:

- Good operational practices within the facility;
- Appropriate technology for managing, treating and disposing of waste;
- Effective cooperation with other relevant bodies;
- Training and capacity-building;
- Monitoring and oversight.

For a successful waste management system, a systemic approach needs to be adopted both within and outside the facility for effective implementation of health-care waste management system. These activities are:

Internal practices (*Activities within health-care facilities*)

The activities to be carried out within the health-care facilities are:

- Segregation of waste at source;
- Effective sharps management;
- Proper collection and interim storage of waste;
- Suitable transportation of waste in the facility;
- Appropriate technologies for waste treatment;
- Occupational safety and infection control;
- An active waste management committee and appropriate organizational setup.

External practices (*Activities supported by other agencies, outside health facilities*)

- Off-site facilities for transportation, final treatment and disposal of infectious waste;

- Municipal authorities for the collection and disposal of non-infectious (general) and treated infectious waste from the health-care facilities not connected to service providers;
- Agencies providing public utility services such as water and sanitation.

A coordinated approach between the relevant agencies as mentioned in Chapter 4 and the internal and external waste management practices transmute to a good waste management system. The subsequent paragraphs discuss both good examples and the operational difficulties that have been observed in developing such a system.

5.2 Experiences with internal practices

Segregation

Segregation is the key to successful waste management, as it is the first step carried out at the point of generation, which then continues until final disposal. Good segregation practices are followed primarily due to proper training, availability of appropriate consumables, commitment and strict enforcement by senior health-care functionaries. Such good practices have helped some health-care facilities manage their waste effectively, and they are now ready to take on additional steps for heavy metal (mercury and lead) elimination and waste minimization.

Box 5.1: Good practices in segregation

Ganga Ram hospital, one of the private hospitals in Delhi has a well-defined system of waste management. Waste is segregated at the point of generation into infectious, infectious plastics, sharps and general waste. Sharps are destroyed by needle destroyer/cutters and stored in puncture-proof containers. The infectious waste and other infected plastics are collected in different wheelbarrows. General waste is carried to the final disposal site by the housekeeping staff of the respective units. The plastics and sharps are disinfected, autoclaved and shredded before being handed over to a waste dealer; infectious waste is sent to a centralized facility for final disposal. The sharps are placed in a sharps pit/handed over to a contractor while the general waste is disposed into municipal dumps. Regular monitoring by the infection control nurses and waste management committee have helped in developing a sound system of waste management in the hospital.

Photo 5.1: *Good and bad segregation practices*

Photo credit: Megha Rathi

Inadequacies in waste segregation often results in mixed waste (infectious and non-infectious hospital waste) accumulating within hospital premises, which continually attract animals and rag-pickers. One difficulty in effective segregation is the overlapping color-coding[37] prescribed under the Bio-Med Rules. This sometimes results in mixing of general and infectious waste, which is subsequently discarded in bags of all colors, including those destined for incineration. There are situations where health-care workers who adhere to good segregation practices at source get discouraged when faced with segregated waste being remixed again with general waste and burnt on premises. Incorrect placing of bins and needle cutters, insufficient training and inadequate monitoring can result in poor segregation practices among health-care staff. A number of good segregation practices in the Tamil Nadu Health Systems Project have helped reduce incinerable waste, including anatomical and pathological tissues, while other wastes are autoclaved and shredded.

Box 5.2: Using a pilot 'learning-by-doing' approach

To ensure the establishment of an appropriate health-care waste management system, the Tamil Nadu Health Systems Project undertook its implementation in 2 phases. In the first phase, a health-care waste management plan was developed and piloted in two districts. This included training and awareness programs and procurement of consumables and equipment. These districts were chosen intentionally, given that they were located near an operational centralized service provider. The pilot run was successful and the project commissioned an independent assessment to identify the shortcomings in implementation. In addition to the basic recommendations with regard to improving training modules and obtaining better quality consumables, the assessment report suggested strengthening the integrated approach across vertical disease programs. The project incorporated the suggestions and replicated the implementation across the state, with the participation of other key stakeholders.

Each point of waste generation should be provided with a different set of colored bins and bags of appropriate sizes and numbers for efficient segregation. Specially designed, covered waste trolleys are also required for waste transportation from the point of generation to final storage and treatment site within the health-care facility. Inappropriate quality, types and mismatch of sizes of consumables such as waste collection bins and trolleys critically impacts proper segregation, thereby destroying the whole waste management chain. Items such as foot-pedal bins have a very short lifespan and health care workers are reluctant to follow safe disposal if they need to touch waste bins with their hands. While the growing demand for consumables and equipments has opened the market for local manufacturers and suppliers, quality control remains an issue. Poor procurement is often linked to – improper inventory, insufficient funds and the lack of a feedback mechanism.

Box 5.3: Revising specifications based on experience

The Rajasthan Health Systems project noted that bags and bins were of inferior quality and non-biodegradable. In a revised bidding process, they included specific requirements, such as:

- Bags to be biodegradable, virgin, made from non-chlorinated polymer material, with thickness of sheet to be minimum of 55 micron
- Bags to meet requirements under IS 9738: 2003, & drop test under IS 12395: 1988
- Government Laboratory Test Report to be enclosed with bid

Sharps management

Good sharps management practices help in reducing infections. The HIV/AIDS epidemic and subsequent attention to HIV transmission through contaminated blood has triggered improvement in sharps safety and management.[38] Mutilation, disinfection and storing of sharps in puncture-proof containers have resulted in minimizing the risk of contact of sharps by health-care

37 Both Red and Blue are assigned for Category 7 waste such as tubings, catheters, intravenous sets etc.

38 Under the National AIDS Control Program (NACP), the World Bank supported the preparation of an Infection Control and Waste Management Plan, which has been successful in disseminating training programs, IEC and consumables and increasing knowledge, awareness and implementation of good infection control and blood safety practices.

staff and others. A study reported that almost 70 percent of facilities in 3 surveyed states use needle cutters/destroyers, while a much smaller proportion (16 percent) follow the disinfection process.[39] This finding is corroborated by the experience gathered from the World Bank-funded projects. Sharps management practices also differ between urban and rural areas, which possibly reflects differences in the availability of equipment, consumables and waste management systems.

***Table 5.1:** Comparison of sharps management practices in rural and urban health-care facilities[40]*

Activity	Rural %	Urban%
Use of a needle cutter/destroyer	74	68
Disinfection with hypochlorite solution	3	21
Disposal in sharp pit	16	1

A study conducted in 2002 found that of the 4.2 billion injections administered in India each year, nearly two-thirds (62.9 percent) were unsafe owing to poor handling practices and/or improper waste disposal practices.[41] The GoI addressed this serious issue by mandating the use of auto-disable syringes for immunization. Alongside, there was a rising trend in the usage of disposable syringes due to the increasing awareness of the risks associated with unsterilized needles and HIV transmission. However, ineffective needle destruction or mutilation[42] can result in recycling and re-use of sharps.

Box 5.4: Hepatitis and reuse of infectious waste[43]

In February 2009, there was a Hepatitis B Virus (HBV) epidemic in some parts of Gujarat. A total of 125 people were infected while 69 fatalities were recorded. The doctors were accused of re-using syringes (which were contaminated) to treat other patients. Epidemiological experts concluded that one of the major reasons why HBV claimed many lives was that the particular strain was highly virulent and had undergone mutations. The subsequent police probe discovered an inter-state racket involving scrap dealers of health-care medical waste (used syringes and needles). The Ahmedabad Municipal Corporation identified 53 scrap dealers and sealed 25 warehouses with 100 tons of such waste.

***Photo 5.2:** Good and bad practices in handling and disposal of sharps*

Photo credit: Rajesh Rangarajan and Megha Rathi

39 Report: Hospital waste management — awareness and practices: a study of three states in India, P. Hanumantha Rao, Waste Management Res June 2008 vol. 26 no. 3: 297-303.
40 Ibid Rao.
41 Assessment of Injection Practices in India: India Clinical Epidemiology Network (India CLEN) and GoI; 2003.
42 Needle removers (destroyer/cutter) are widely used to mutilate sharps by destroying or cutting needles and tips of syringes by electric arc or by mechanical blades.
43 March 11, 2009, TNN and March 7, 2009, Indo Asian News Service.

In many facilities, broken syringes and needles are collected in an assortment of containers such as cardboard boxes, covers, bags and sometimes even in plastic bags, which have a tendency to tear. A study conducted in a health care facility (Table 5.2) shows that the greatest number of needle stick injuries occur during collection and transportation of waste, followed by during the process of recapping, thus increasing the risk of blood-borne infections in health-care functionaries.

keep needle cutters locked away to prevent theft. The high demand for needle cutters and stringent procurement policies has often resulted in delivery of sub-standard equipment and/or insufficient supply. As per the Bio-Med Rules, sharps such as broken vials, slides etc need to be disinfected before disposal but the implementation experience has recorded mixed results so far.

Table 5.2: *Needle stick injuries pattern from various sources in health-care facilities over a period of 4 years*[44]

Sources of needle stick injuries in health care facilities	Number of needle stick injuries over a period of 4 years				Total needle stick injuries over a period of 4 years
	2004	2005	2006	2007	
Waste collection in garbage bag	17	16	22	11	66
Needle recapping	10	15	6	4	35
OT instruments	6	8	5	5	24
Checking blood sugar	6	15	6	0	27
IV liner administration	15	12	7	9	43
Surgical blades	3	4	5	4	16
Blood collection	2	10	10	10	32
Suturing	1	4	2	0	7
Injection administration	11	16	8	6	41
Disposal practices	0	0	4	13	17
Other sources	2	8	12	12	34
Total cases/year	**73**	**108**	**87**	**74**	**342**

World Bank-supported project experiences in India have shown that mechanical and electrical needle cutters, needle destroyers and hub cutters are extensively used at the point of generation. These are the most basic equipments, and are relatively portable and light, easy to use and available at cheap prices. The implementation experience with sharps removal devices indicates a positive change in sharps management practices, although there are still some problems in the supply, use and maintenance of the equipment. Frequent fluctuations in power supply reduces the life of the electrical equipment, while in some cases, medical staff are averse to using manual ones because they become blunt quickly. Some health-care facilities

Box 5.5: Implementing a successful sharps waste management program[45]

The Children's Vaccine Program was a collaborative effort between the Government of Andhra Pradesh and PATH to strengthen immunization systems, ensure injection safety and institute a practical system for sharps waste management at 14,000 primary health centers and sub-centers. The pilot run in one district was successful in managing sharps waste by introducing hub cutters (needle removers), puncture-proof containers, needle pits, and syringe recycling. The project was subsequently extended to the entire state. It contributed to a national injection safety policy and was instrumental in introducing Auto Disable syringes and hub cutters for all immunization systems in the country.

44 Mehta A, Rodrigues C, Singhal T, Lopes N, D'Souza N, Sathe K, Dastur FD. Interventions to reduce needle stick injuries at a tertiary care centre. Indian J Med Microbiol 2010; 28:17-20.

45 Information Brochure PATH: Introducing and scaling up a sharps waste management program in Andhra Pradesh.

To further improve the system there is a need to standardize the equipment used and processes of sharps management, along with increased awareness and capacity-building. Implementing a successful sharps management system continues to be the most immediate challenge in waste management.

Storage

Under the Bio-Med Rules all health-care facilities are required to have a clearly designated waste storage area. The waste storage area has to be well-ventilated, with adequate space to store infectious and non-infectious waste, and secured from pilferage. The shortage of storage areas results in the mixture of waste or creation of overflow which allows animals and scavengers easy access to infectious waste. Initiatives have been taken by some health-care facilities under the state health systems projects and the UNDP/GEF project to construct storage areas which are secure and have separate storage rooms for infectious and non-infectious waste.

Another area of concern is the storage of insecticide stocks for vector control activities at primary health-care facilities. This tends to be poor, with insecticides often being stored close to pharmaceutical stocks or in village houses where spraying operations take place.

Occupational safety

Occupational safety measures are important for safeguarding the health of the health-care workers and others collecting and treating waste, along with the added advantages of ensuring infection control and patient safety. The benefits are many but inadequacies have been seen in the implementation of occupational safety measures, hygiene, and use of personal protective measures by hospital staff and laboratory technicians. Some of the staff in TB laboratories adopt the unsafe practice of burning chemically disinfected plastic sputum cups. Health-care workers barely take any precautions while handling chemicals and very often develop respiratory disorders and allergies. Personal protection is not widely practiced due to high temperatures and humid weather conditions.

Box 5.6: Unsafe occupational safety practices

A survey at two centralized treatment facilities in Tamil Nadu showed that workers and operators are not trained in safety procedures and do not take appropriate precautions against hazards. Use of protective gear like gloves, facemasks and boots is limited due to weather conditions and workers often get needle stick injuries.[46] The findings from World Bank projects in other states corroborate these findings.

Photo 5.3: *Improper storage of health-care waste and insecticides*

Photo credit: World Bank mission team and Megha Rathi

46 Karthikeyan, G. and Karthikeyan S.: Evaluation of Bio-medical Waste Treatment Facility in Chennai, India, 2007.

Issues like the use and disposal of mercury in health-care facilities is still an enormous challenge and many facilities are not equipped to deal with breakages and spills. Mercury is handled without protective gear and is disposed either with incinerable waste, general waste or down the drains. Unsafe practices such as recapping of needles, mouth pipetting and multiple handling of untreated sharps have been observed in many laboratories and hospitals.

Good bio-safety[48] practices in laboratories are particularly important due to the high level of risks and hazards associated with the use and presence of flammable or explosive chemicals and infectious agents.[49] Unsafe chemical safety procedures are further aggravated by the absence of proper equipment, labeling and storage of chemicals, as well as inadequate infrastructure, fire safety measures and ventilation in laboratories. However, under the HIV/AIDS, Integrated Disease Surveillance and Tuberculosis programs, significant improvements have been made in the conditions at laboratories through intensive training and awareness campaigns along with dissemination of guidelines and equipment.

Box 5.7: Requirements for improved occupational safety

Under the Bank-funded Capacity-Building for Food and Drug Laboratories project, extensive training was provided on Environmental Health and Safety (EHS) procedures, and an EHS Policy was disseminated across all laboratories. Standard Operating Procedures, Materials Safety Data Sheets (MSDS) and chemical inventory were prepared. The project recommended the identification of EHS Officers and Safety Committees, and instructed laboratories to improve storage, ventilation and fire safety norms. Despite this excellent capacity-building program, the project was unable to successfully implement occupational safety practices due to systemic issues related to infrastructural deficiencies and a weak institutional framework.

A private hospital in Delhi, Max Healthcare, has developed a series of Standard Operating Procedures (SOPs) for occupational health and safety procedures and safeguards for all its health-care services. Radiology staff is routinely monitored for radiation exposure and X-ray equipment is annually inspected and certified by the Bhaba Atomic Research Centre. All staff have been trained in specific occupational hazards and provided with MSDS or International Chemical Safety Cards. In-house occupational safety and health statistics are monitored and training programs are continuously updated to reflect the needs of staff and patients.[47]

Disinfection and liquid waste

Chemical disinfectant is effective for sanitation, cleaning of spills and disinfecting infectious waste. It has to be used appropriately and accurately, at the right concentrations and durations of contact period. Implementation problems with effective disinfection comprise poor storage and utilization practices that include concentration levels of the disinfectant, efficacy period of the disinfectant and duration of contact period with the waste. There continue to be variations in the strength of hypochlorite solutions being utilized (from 1–10 percent). The standards of disposal of chemicals and other liquid waste are quite poor across the country.

47 IFC-funded project to support construction and operation of an integrated health-care delivery system in the New Delhi area.
48 Management of biological hazards that pose serious health and safety risks to laboratory workers and general population.
49 Which include disease-causing viruses, bacteria and fungi.

Box 5.8: Instituting good liquid waste management systems

The Amrita Institute of Medical Sciences (AIMS), Cochin, has established an eight stage wastewater treatment system, which has a total capacity of treating about 450,000 liters of water. The steps include screening to separate big solids like cloth, plastic, etc. present in the wastewater before it is sent to a collection tank, and then to a first filtration tank. The aeration allows the retention of 20 per cent of the sludge while cleaning, to ensure sufficient quantity of the bacteria in the system. Aerated water is removed from the tank to the clarification tank. The next step is disinfection and final filtration through a sand filter. Treated water is disposed of by dilution into nearby backwaters. The hospital has instituted regular systems for maintenance of the effluent treatment plant, including chemical analysis. This system has helped the hospital to ensure that the water being discharged by the facility is safe for the environment and community.[50]

The Choitram Hospital, Indore has established an effluent treatment plan to manage 500,000 liters of generated wastewater. The chlorination results in complete inactivation of the multiple drug resistant bacteria and thus makes the effluent water safe, which is then used for irrigation and sanitary cleaning. The hospital does not face any water shortages and is also able to utilize more than 5,000 kg of dried sludge as manure for its gardens.[51]

The importance of wastewater treatment has been recognized by GoI though there are no clear guidelines for disposal of hospital wastewater and disinfected sludge. Initiatives have been taken by New Delhi PCC to establish a Waste Management Cell which has been given the mandate to help health-care facilities to develop treatment scenarios for hospital wastewater with regard to attainable efficiency and costs. The idea of uncoupling hospitals from public sewers is also being debated. Creative solutions are possible with some level of planning and commitment.

Water and sanitation

Adequate and potable water supply, along with good waste management and infection control practices, are essential for maintaining good hygiene and sanitation in health care facilities. However many public health-care facilities have poorly managed sewage and sanitation systems. There are many hospitals that have dirty and badly constructed toilets alongside inadequate water supply. Water-clogged drains and malfunctioning sewage systems are systemic malaises, which can lead to a high rate of nosocomial infections. It is estimated that about 1,400 deaths occur each year as a result of water-borne nosocomial pneumonias.[52]

Box. 5.9: Contaminated water supply in Indian hospitals

In 2001, the Kolkata Municipal Corporation found that more than 60 percent of water samples from hospitals and office buildings were contaminated because water tanks and reservoirs of hospitals and government offices were not cleaned regularly.[53] In 2004, the drinking water at two large medical colleges in Kolkata was found to have high concentrations of coliform bacteria (ranging between 220 to 240 coliform counts, many-folds higher than the permissible limit of 10 counts per 100 ml water). This was either due to faulty supply or storage.[54] Due to lack of running water, a private hospital in New Delhi had to depend on water supplied by water tankers, but later had to shut down its operating theater in 2006 owing to a shortage of these tankers.[55] In June 2009, 10 persons from a single ward in a Jaipur hospital were hospitalized with symptoms of diarrhea after allegedly drinking contaminated water. It was later found that sewage had seeped into the water supply lines in and around the hospital.[56]

50 Extracted from Success Stories: BHM-002: Health-Care Waste Management: Concepts, Technologies and Training; Indira Gandhi National Open University and WHO, 2006.
51 Toxics Link Factsheet Number 28/July 2006.
52 The hospital water supply as a source of nosocomial infections. Elias J. Anaissie, MD; Scott R. Penzak, PharmD; M. Cecilia Dignami, MD., *Arch Intern Med.* 2002;162:1483-1492.
53 ExpressIndia.com: July 26, 2008 and March 21, 2009.
54 Bacteria scare in hospital water - The Times of India Dec. 5, 2004.
55 *Times of India*: HC notice to hospitals on water facilities September 3, 2006.
56 Times of India: June 13, 2009.

While most facilities are connected to municipal sewerage systems, many remote and primary level facilities have stand-alone water sources and septic tanks. According to the CDC, a properly functioning and well-maintained septic system is adequate for inactivating and dischargingblood-borne pathogens.[57] However, some states have reported that during the rainy seasons, sanitary pits get flooded. Lack of adequate water supply and insufficient number of sanitary workers also prevents health-care facilities from maintaining hygienic and clean premises and surroundings. Very often it is seen that inadequate awareness and bad practices by patients and relatives also cause breakdown of the sanitation systems in health-care facilities.

facilities which are not or cannot be connected to centralized waste treatment facilities. The Rules provide technical specifications for the construction of the pits, and sufficient funds have been allocated under the Reproductive Child Health (RCH) program and NRHM to support the construction of such pits within the premises of primary and selected eligible secondary facilities. As these are simple to construct and use, such pits are prevalent across the country, especially in remote and rural areas. However, as an easy solution, many health-care facilities tend to burn their generated waste inside these pits, resulting in added problems of air and ground pollution. A sample survey of 121 facilities across some states found that 35 percent disposed their waste in deep

***Photo 5.4:** Unhygienic conditions in health-care facilities*

Photo credit: World Bank Mission team

Box 5.10: Encouraging water recycling in Delhi[58]

The Delhi Jal Board (DJB) has decided to halve its potable water supply to hotels and hospitals to encourage recycling of water. This is to better manage the demand-supply shortfall by preventing potable water from being used for horticultural and cleaning purposes. Each establishment will now get 200 litres less per resident user per day. These establishments are also being encouraged to establish their own waste management processes.

5.3 Techniques and technology for treatment and disposal of waste

On-site disposal: Deep burial pits

The Bio-Med Rules allow the construction and utilization of deep burial pits in those health-care

burial pits within their premises, while 20 percent dumped waste outside on road pavements or in municipal bins.[59]

While pits are an easy solution for small volume generators in remote areas, the challenges include

57 Guidelines for Environmental Infection Control in Health-Care Facilities: Center for Disease Control, 2003.

58 Indian Express, June 13, 2009.

59 Report: Hospital waste management – awareness and practices: a study of three states in India, P. Hanumantha Rao, Waste Management Res June 2008 Vol. 26 No. 3: 297-303.

Photo 5.5: Unsatisfactory on-site disposal of health-care waste

Photo credit: The World Bank and Megha Rathi

availability of sufficient and suitable land, appropriately distant from water sources and the ground water table. Such pits cannot be dug in hilly and coastal areas and areas with soft soil base.

There are also no prescribed solutions for pits that are filled up. The best option is to close the filled pits and construct new ones, but this is feasible only where land is plentiful. In Rajasthan, the deep burial pits in most health-care facilities had been filled up with construction rubble and un-segregated waste. In consultation with the World Bank, the Rajasthan Health Systems Project contracted private service providers to empty the pits, under stringent safety and monitoring protocols.

Due to the mandated use of centralized facilities, stand-alone treatment equipment for individual facilities has been discontinued over the past decade. Some old hospital incinerators continue to operate but are being gradually decommissioned. Since the late 1990s, the World Bank stopped financing the establishment of incinerators in India. There is also a growing awareness about the hazards of incineration, which has led to a shift to non-burn technologies.

Off-site treatment and disposal

The use of Centralized Waste Treatment Facility (CWTF) for the management of final treatment and

Box 5.11: Ground water pollution from health-care waste

In 2009, ground water samples collected in Chennai tested positive for bio-medical and other wastes, and the source was identified as the nearby University Hospital which used to indiscriminately dispose of untreated syringes, cotton and other medical wastes.[60]

It was suspected that dumped hospital waste, including contaminated hospital blankets and gowns for patients, had resulted in pollution of a drinking water source in Shimla.[61]

An inspection of dumps in Ludhiana by the Central Pollution Control Board revealed that health-care waste, mainly cotton, was being segregated and recycled for mattresses. Cotton waste from hospitals, dumped at the city's solid waste disposal plant, was being sifted, dried in the open and used for filling mattresses and quilts.[62]

60 TNN, March 5, 2009.
61 ExpressIndia.com April 15, 2008.
62 Indian Express, February 18, 2005.

disposal of waste is an evolving concept, promoted and encouraged by GoI through the policy framework. Such centralized facilities can provide economies of scale and standardized operational procedures which facilitate compliance with environmental policies, and their enforcement and monitoring. The services provided by CWTFs include collecting and transporting waste from a number of health-care facilities, which is then treated and disposed in a central facility. Most CWTFs are established under Public Private Partnership (PPP) arrangements, based on the Central Pollution Control Board guidelines for establishment, operations and reporting. (Section III in Volume II).

As prescribed by the Central Pollution Control Board, a typical CWTF in India must have an incinerator for anatomical waste, autoclave, microwave or hydroclave for chemical treatment and a shredder.[63] In addition, the operator must have an effluent treatment plant, sharps pit, storage rooms and appropriate vehicles for transportation. Establishment of a CWTF costs on average about USD$2 million, which includes the initial capital investment, amortization, operating and utility costs, personnel and overhead costs, and the cost of obtaining environmental clearances and authorizations.[64] (Section VII in Volume II provides standards for establishing and running of different treatment technologies).

Over the past decade, 157 CWTFs have become operational in India.[65] The optimal number of CWTFs for a state is determined by the state pollution control board in consultation with health departments and the municipalities which are responsible for identifying and/or providing suitable land within their jurisdiction. Contractual rates of CWTFs for collection, transportation, treatment and disposal are calculated in consultation with municipalities/urban local bodies, pollution control boards and the health department/medical association on a per bed or per kilogram basis. Operations and emissions compliance of CWTFs are overseen by State Pollution Control Boards (SPCB) and periodically monitored by the Central Pollution Control Board.

Box 5.12: Growing demand for CWTFs

A recent analysis by the Central Pollution Control Board[66] has found that of the 84,809 hospitals and health-care facilities in India, only 48,183 (56 percent) are using services provided by CWTFs. In response to the recommendation to increase the number of CWTFs, the Ministry of Environment is now providing financial assistance to states for setting up additional CWTFs.[67]

Reviews and surveys have shown mixed implementation experience at CWTF sites. While some service providers insist on high standards of occupational safety for their staff and proactively seek better technology solutions, many others operate at inefficient and low standards.

Box 5.13: Initiatives by CWTFs

G. J. Multiclave (Pvt.) Ltd has been in operation since 2003 and is responsible for managing about 4.5 tons of medical waste per day generated from the city of Chennai. In addition to the standard technology including incinerators, autoclaves and plastics shredders, the CWTF has a secured landfill arrangement, lined with a high-density polyethylene for disposal of ash and sludge. There are about 250 cement-encapsulated pits for interim storage of disinfected sharps. The wastewater is filtered through an effluent treatment plant. The transportation vehicles are specially designed with leak-proof flooring and have recently been fitted with GPS systems to track their movement and to study the route followed. The facility has also started a helpline for its customers to register all complaints, to be attended to promptly. The CWTF has also invested in the occupational health and safety of its workers and staff by providing them with protective gear, periodical medical examinations and vaccination.

63 Guidelines for Common Bio-medical Waste Treatment Facility: CPCB, 2003.
64 The size of the CWTFs are designed to cater to a bed-strength of 10,000 within a radius of 150 km, as per the Guidelines in ref 63.
65 http://www.cpcb.nic.in/wast/bioimedicalwast/CBWTF-STATUS.pdf
66 CPCB evaluation report, by IIM Lucknow, February 2010.
67 Road map on management of waste in India, MoEF, March 2010.

***Photo 5.6:** Centralized Treatment Facility*

Photo credit: GJ Multiclave, Chennai

While most CWTFs have approved technology and equipment as required for obtaining clearances and authorizations, their operations are often at sub-optimal levels. These include poorly-run incinerators, incorrect disposal of ash and sludge, inadequate disinfection of plastic waste, and poor occupational safety and infection control measures.

External constraints such as poor source segregation at health-care facilities, inaccessible roads and insufficient volume of waste further discourage high-quality performance. CWTFs are also constrained by the high turnover of employees, who have little incentive to work in waste handling. The reluctance in revising contractual rates, long procedural requirements and delays in payments further hinder good performance by CWTFs.

Box 5.14: Unsatisfactory CWTF operations

A review by the Maharashtra Pollution Control Board found that CWTF waste collection services were irregular and that infectious waste was being regularly diverted to the scrap market.[68] The study found that the installed capacity of incinerators in most CWTFs exceeded the requirement of incinerable waste, and the primary and secondary chambers of incinerators rarely achieved the recommended temperatures. Most of the facilities did not maintain daily category-wise records of waste collection from individual generators.

Recognizing the social and environmental risk management services being provided by CWTFs, financial incentives or support schemes have been initiated by various authorities. In Thane, Maharashtra, a local bank reduced the rate of interest on the initial loan to a high performing CWTF operator, which was a major financial incentive for its long-term sustainability. In Delhi and Kolkata (Howrah), land was provided at subsidized rates for the establishment of CWTFs. The Ministry of Environment has initiated a project, funded by the Global Environment Facility, for the establishment of a model CWTF and enhancement of the capacity and skills of the operators.

Box 5.15: Innovative solutions

Under the Bank-funded Uttar Pradesh Health Systems Project, the health-care waste management component was outsourced to CWTFs on a turnkey basis. They were contracted to provide consumables, training and final treatment, with the state retaining the responsibility for monitoring and programing. Additionally, the CWTFs supported the project in needs assessment and mapping, standardizing protocols and training modules and developing monitoring frameworks for supervision and monitoring.

68 *The Status of Some Common Facilities for Collection, Treatment and Disposal of Bio-medical Waste in Maharashtra,* MPCB August 2004.

5.4 Human resources and capacity-building

While India's health sector caters to a large urban and rural population, it continues to remain burdened by human resource constraints, both in terms of supply and skills. While this is a larger issue for the public health sector and is related to national human resource policies, it has an impact on all health services and associated activities including waste management. Non-availability of key personnel such as nursing staff and sanitation workers, frequent transfers of trained staff and short-term contractual agreements for sanitation services are the primary hurdles standing in the path of achieving effective implementation of infection control and waste management.

Extensive training and dissemination of guidelines and materials under all national and state health programs have brought about enhanced awareness of the risks associated with poor occupational and waste management practices. Resources include pictorial guidelines of the IMEP, distance learning certificate course provided by the Indira Gandhi National Open University (IGNOU) and regional training provided by the M.S. Ramaiah Medical College.[69] Other training guidelines and resources have been developed by multinational agencies, NGOs and even by CWTFs.

However, related constraints such as availability of consumables, coordinated and standardized training modules, and shortage of skilled training agencies all add to the challenges facing successful training and its sustained implementation. Continued and on-going refresher training programs are also required for retention of concepts and bringing about behavioral change. Relatively minor issues such as the failure to translate the training modules into local languages and not secure full participation of all health-care staff also hinder successful training programs.

Box 5.16: Lacunae in capacity-building

While class IV employees are critical players in waste management, a survey undertaken in three states in 2006 revealed that class IV employees were trained in only 40 percent of the 121 health care facilities.[70]

A survey of three states in India reveals that there is significant awareness of the Bio-Med Rules among public health-care facilities (85 percent), with at least one of its employees trained in health-care waste management.[71] Fifty-five percent of private medical practitioners surveyed were aware of these Rules but only 38 percent had received any training. Awareness of the Rules was comparatively higher in urban areas than in the rural areas.

Under World Bank-supported projects, consulting agencies or NGOs in the environmental sector are contracted to impart training across all public hospitals and laboratories. The emphasis is on Train-the-Trainer modules and continued dissemination of training by trained nurses and other designated staff. Some projects, such as Rajasthan Health Systems project has provided three rounds of training to all staff, including district level officers who are responsible for regular monitoring. Such attention to capacity-building has not been observed in other projects.

5.5 Other specific issues

a) Insecticide use

Insecticides such as DDT and synthetic pyrethroids such as malathion are widely used for vector control in India. A study undertaken in 2004 and subsequent field visits and reviews have shown that systems and practices for insecticide storage, use and disposal are inadequate and worker practices are poor.[72] These shortcomings include poor storage practices resulting in pilferage and leakage, the use of old equipment for spraying, lack of protective gear and insufficient

69 Write-up from Health-Care Waste Management Cell, Community Medicine Department M. S. Ramaiah Medical College Bengaluru.

70 Report: Hospital waste management – awareness and practices: a study of three states in India: Rao, 2008.

71 P. Hanumantha Rao, Report: Hospital waste management - awareness and practices: a study of 3 states in India, Center for Human Development, ACSI, Hyderabad.

72 Assessment of impact of pesticides used under public health program: NEERI, 2004.

community awareness and monitoring by the National Vector Borne Disease Control Program (VBDSP). The World Bank is supporting initiatives such as revision of guidelines, improvement of the insecticide supply chain management, capacity-building and promotion of occupational safety measures.

b) Medical camps and mass immunization campaigns

Medical camps help in out-reach activities geared towards provision of basic medical services to remote and rural communities. However such services also generate large quantities of infectious and hazardous wastes like sharps, which are often dumped into the open or subjected to open burning. Though there are guidelines under different programs (PATH, World Bank projects), implementation remains weak, primarily due to the lack of basic portable equipment and enforcement at these outreach activity sites.

c) Emerging issues

Mercury

Health-care facilities are large users and emitters of mercury emanating from equipments (thermometers, sphygmomanometers) and dental amalgam. The WHO has stated that health care facilities may be responsible for as much as 5 percent of all mercury released through wastewater, which, along with dental amalgam fillings containing almost 50 percent of elemental mercury, are the primary source of mercury exposure for the general population.[73] Since 2005, the issue of mercury use in health care has gained prominence in India and there have been various studies and discussions led by NGO groups on usage, disposal and its impacts on environment and human health.

The Ministry of Health and Family Welfare has responded to this call by advising all central government hospitals and health centres to gradually phase out the procurement of mercury-containing equipment. Mercury phase-out in health-care facilities is being added in the upcoming amendment to the Bio-Med Rules.[74] The GoI has initiated a project, financed by the GEF, which focuses on the development and dissemination of capacity- building materials related to mercury and the procurement of mercury-free devices for selected model facilities.

Box 5.17: Initiatives towards mercury-free health care in Delhi

In June 2007, the Government of Delhi issued orders to all hospitals to stop any further purchase of mercury-containing medical equipment. Most tertiary care corporate hospitals have shifted to mercury alternates while the government hospitals and their dental care facilities are gradually making the shift.[75] The Delhi Pollution Control Committee has established a Bio-Medical Waste Management Cell in May 2010 which has been mandated to establish a good database of all mercury waste generators in Delhi. The Department of Health in Delhi has also taken initiatives to curb the use of mercury equipment by advising facilities to budget for mercury-free alternatives and train staff in mercury spill management.[76]

Green initiatives

The Ministry of Environment's National Environmental Policy of 2006 promotes waste reduction, green procurement, and environment labeling practices, although this has not been translated into systematic guidelines or policy.[77] Within a health-care setting, resource conservation includes the issues of energy, water, and equipment consumption. It has been estimated that the health-care industry produces more than 2.4 million tons of waste each year and is one of the largest consumers of energy, spending more than USD $5 billion a year due to

73 Exposure to mercury: A major public health concern: WHO, 2007 http://www.who.int/ipcs/features/mercury.pdf and Elemental mercury and inorganic mercury compounds: Human Health Aspects. http://www.who.int/ipcs/publications/cicad/en/cicad50.pdf

74 Report of the Committee to Evolve Road Map on Management of Wastes in India, MoEF, 2010.

75 http://www.mercuryfreehealthcare.org/

76 Toxics Link, Articles' January 2010.

77 Performance Audit of Management of Waste in India; CAG Report No. PA 14: 2008.

enhanced technological dependence.[78] In India, there is an increasing recognition of Green Hospitals and the understanding that the inclusion of eco-friendly features in the base design reduces the incremental cost of buildings, including hospitals, and that the payback period is smaller.

sector. It is clear, as seen in formal evaluations by the Comptroller and Auditor General, Central Pollution Control Board, MoEF, World Bank project implementation experience and widespread press coverage that health-care waste management is still in the early stages of implementation. At the same time, there are positive experiences and promising lessons learned, which point towards a way forward. The following chapter identifies the key areas that can contribute to integrating, improving and mainstreaming environment management in India's health-care sector.

Box 5.18: Going 'eco-friendly'

Kohinoor Hospital, Mumbai (a 100-bed multi-specialty hospital) is the first in India to be awarded a platinum rating in the Leadership in Energy and Environment Design (LEED) certification for a 'green building'. It is estimated that solar hot-water generation and wind-generated power will result in 35 percent energy savings. The hospital is built to maximize absorption of natural light and has special carbon dioxide sensors which automatically trigger the injection of fresh air to ensure that the hospital premises remain clean and healthy.[79]

The Delhi Government has launched environment-friendly initiatives, which include conversion of all hospital lights to Compact Fluorescent Lamps (CFLs); installation of effluent treatment plants, solar water heating and rainwater harvesting in about 20 hospitals (along with a subsidy to the public sector).[80]

The Care Institute of Medical Sciences, Ahmedabad has been converted into a green hospital through investment in architecture and technology. It is expected to reduce its energy costs by 20 percent by initiatives such as the use of fly-ash bricks for construction which reduces heat absorption. The hospital has used biodegradable materials for flooring, a remote sensing air-conditioning system, solar heaters for hot water supply and percolating tanks for rainwater harvesting. There are two separate sewage pipelines, one for sewage waste going directly into the city drainage system and the other for low contaminated sewage water for the sewage treatment plant. The disinfected wastewater is used in the garden.[81] The hospital aims to transfer its savings by providing cheaper services to patients.

5.6 Summary

This section has outlined the current infection control and waste management systems in India and the associated challenges based on the implementation experiences of the various stakeholders in the

78 Hospitals Going Green: A Holistic View of the Issue and the Critical Role of the Nurse Leader: Nikela Harris et al: Holistic Nursing Practice: March/April 2009. Vol. 23 No. 2; Pages 101 - 111.

79 Express Healthcare: January 2010; CII – Green Buildings and Green Hospitals presentation: March 2010.

80 Presentation by K.K. Dadoo, Secretary Environment, at Conference on Biomedical Waste Management, organized by ASSOCHAM in 2007. And article in The Hindu, February 23, 2009.

81 The Economic Times, November 22, 2010.

6

Recommendations for Improving Environment Management

- *There is a need for a structured and integrated implementation approach, especially to deal with cross-cutting issues.*
- *Development of such a cohesive and integrated approach is an ongoing task and some specific recommendations have been laid out.*

6.1 Overview

Implementation experience in India has revealed that mainstreaming environment management into health sector programing can be achieved over time. It requires a concerted, well-planned and integrated approach which merges resources, services and interventions at various levels, both within and between the state and central level authorities.

Over the past year, a number of GoI commissioned reviews and analyses of overall waste management (solid, industrial, health care and electronic) have taken place along with reviews of policy and institutional requirements for improved compliance. This chapter provides recommendations which have been culled from both World Bank-supported project experiences and other published reports. The recommendations focus on policy actions and operational steps to implement an integrated approach at national and state levels for the short, medium and long terms, so as to improve environment management in the health sector in India.

6.2 Recommended policy interventions and responsibilities

In the short term at the national level

- *Amendment of the Bio-Med Rules:* The revised draft Bio-medical Waste Rules, 2011 have been formulated to include issues such as mercury management, technology options, revised color-coding and strengthening of systems for occupational safety, training and capacity-building. These rules are expected to be promulgated in 2012. This is the responsibility of MoEF and Central Pollution Control Board, in consultation with various stakeholders.
- *Revision and updating of the IMEP policy framework*: This document needs updating not only to include the requirements in the revised Bio Med Rules, but also to strengthen the guidelines related to occupational safety, training methodologies, procurement methods, equipment maintenance requirements and compliance and enforcement templates (including fact sheets, consent conditions, reporting formats, inspections, and authorizations). The revision of the IMEP will be led by MoHFW in consultation with other implementing agencies.
- *Framing of guidelines for waste management in special situations:* This is a key requirement for remote and inaccessible facilities, health camps, hilly and swampy areas where land availability is limited etc. This activity needs to be led by MoHFW, in consultation with the states.

In the medium to long-term, strategic dialogue is needed with different stakeholders on the following issues:

- *Standardization of new waste treatment technologies* and large equipment for waste management by Central Pollution Control Board in collaboration with the Bureau of Indian Standards.
- *Instituting accreditation and green performance ratings* for health-care facilities and CWTFs. This could be led by MoHFW, along with the Bureau of Energy Efficiency and MoEF.
- *Considering the incorporation of the 'Polluter Pays Principle'* in the Bio-Med Rules could facilitate better compliance. Departments of health and environment should cooperate to ensure that new hospitals are allowed to commence treatment only if they meet requirements for waste treatment and disposal.
- *Updating recommendations for eco-friendly initiatives* including environment- friendly products, green purchasing, clean technologies, alternative chemicals, waste minimization and recycling techniques. These could be led by MoEF and MoHFW with extensive discussions at the national level with various stakeholders and experts before finalization.

At the state level most activities will be *short to medium-term* as the policy guidance comes from the national level:

- *Dissemination of standardized formats and guidelines* by the Department of Health to public (and private) health-care facilities on training, capacity-building schedules and monitoring and reporting requirements.
- *Feedback to MoHFW and MoEF* on experiences and lessons learnt from implementation of the infection control and waste management systems, and compliance with the Bio-Med Rules. This should be done by state departments of health and the Pollution Control Boards.

6.3 Institutional arrangements

In the short to medium-term at the national level there is scope for integration of intra-sectoral programs under the auspices of the NRHM for optimal utilization of funds and for monitoring. Recommended activities could be the following:

- *Enhancing coordination between the different departments* of the MoHFW (public health and medical services) and the vertical disease-specific programs such as HIV/AIDS and Tuberculosis Control, Reproductive and Child Health and Immunization programs.
- *Identifying one nodal officer and/or coordination committee* may be a simple way to ensure integrated and standardized planning and monitoring. This could also facilitate regular consultation with Central Pollution Control Board and state counterparts to strengthen necessary guidelines, improve clarity of responsibilities, understand national compliance trends and allow discussion on broader environment management issues.

In the short to medium-term at the state level, the Department of Health could take the following steps:

- *Appointing a nodal officer* for infection control and waste management in the state (as in the case of Gujarat, Rajasthan and Tamil Nadu).
- *Institute a coordination mechanism* within the various departments for planning and budgetary provisions of infection control and waste management. This could come under the aegis of the state and district health missions.
- *Instituting a sustained dialogue* with state Pollution Control Boards on streamlining waste management processes, including monitoring and quality standards of contracted service providers.
- *Coordinating with multiple stakeholders* such as municipal authorities, urban local bodies, water and sanitation agencies (e.g. through the establishment of a multi-sectoral taskforce) for management of water, sanitation, and proposed designs of construction and engineering controls.
- *Taking forward the recommendations of the NRHM* through the involvement of *panchayats*, village health and sanitation *samitis* and other stakeholders for community management of public health care facilities.

- *Encouraging designation of Infection Control focal points* or Waste Management Committees at each health-care facility in the state. Regular meetings with senior facility staff should be mandated to discuss implementation and/or procurement issues.

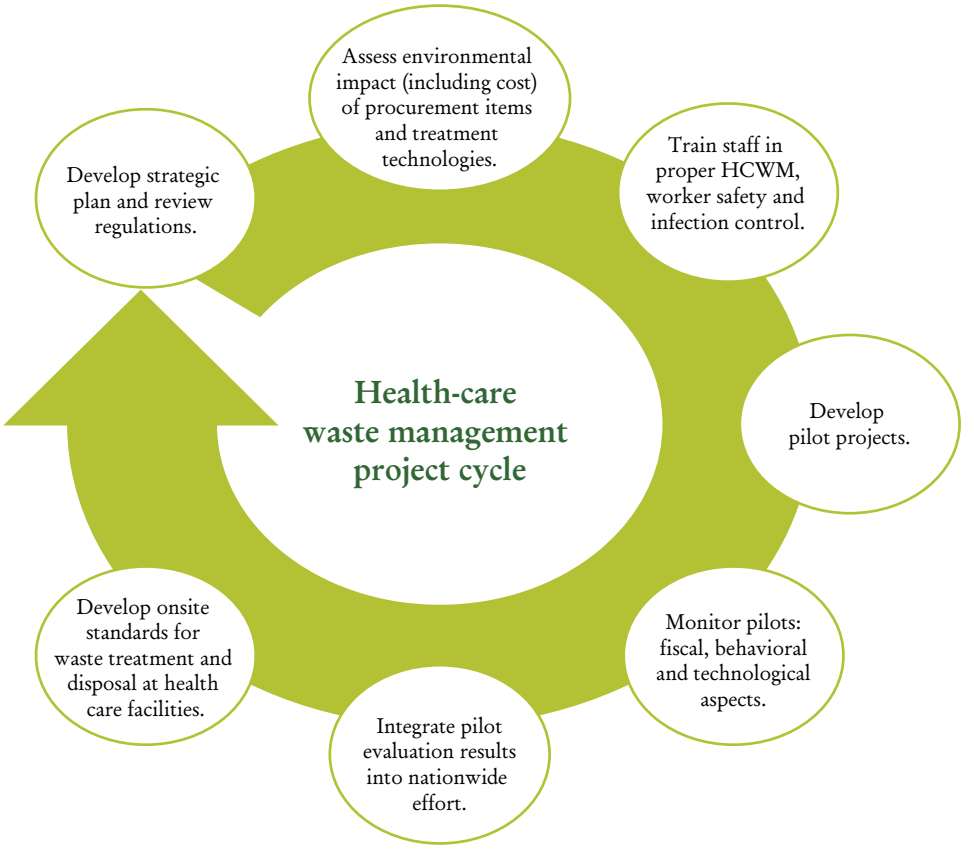
6.4 Planning framework

At the national level, there has been increasing recognition to improve the implementation of health-care waste in the country. The requirement is for the effective treatment of 1800 tons/day of health-care waste by 2012 and adequate numbers of common waste treatment facilities by 2022.

At the state level, the Department of Health will need to take the following steps for effective planning in the *short to medium-term*:

- *Developing a state-specific strategy for infection control and waste management* which can be updated with feedback from individual facilities on data related to hospital-acquired infections and waste management and occupational practices. This will require consultation with the local medical association, municipal bodies and Pollution Control Boards.
- *Encouraging the development of facility-specific environmental management plans* which will detail activities and associated timelines and budgets. Such plans will need to be continuously updated, with feedback on costs, performance standards of outsourced services and other critical issues. The hospital administration and Infection Control Committees should be made responsible for this planning process.

Figure 6.1: *Health care waste management project cycle*[82]



82 Health-care Waste Management, World Bank- WHO, 2003.

6.5 Budgetary issues

At the national level, the MoHFW, NRHM and the specific disease programs have allocated dedicated funds for state-level implementation of infection control and waste management activities. Cost-benefit analyses of good environment management and case studies could be documented for better understanding, acceptance and ownership by states.

At the state level, the Department of Health needs to:

- *Compile the budgetary estimates prepared by individual health-care facilities*. These will be prepared by hospital administrators and Infection Control Committee (ICC) and will include procurement of consumables, capacity-building and awareness activities, and outsourced services. Guidance should be provided for cost reductions without compromising on quality of environment management services.
- *Undertake a mapping and needs assessment of waste generation* and the capacity of centralized waste treatment and disposal facilities in the state, and develop proposals for accessing MoEF funds for establishing new ones, if required. This should be done in consultation with the Pollution Control Board.

6.6 Operational systems

There are numerous guidance documents on technical steps and best practices for infection control and management of health-care waste, including segregation, sharps management, disinfection and treatment, and occupational safety issues. There are also sufficient guidance documents on standards for water supply and sanitation, specifically from CDC and WHO. Standard operating procedures and bio-safety guidelines for laboratories and occupational and health safety policies are well documented for various health programs. The VBDCP has a detailed environmental management plan for insecticide management. These have been extensively listed and referenced in Section 12 & 15 of Volume II.

6.7 Capacity-building

In the short term at the national level, MoHFW, in collaboration with relevant agencies, could document and compile the numerous training modules, guides and methodologies, fact sheets and case studies of good practices into a comprehensive data base.

In the short to medium-term at the state level, the Department of Health could take the following steps:

- *Dissemination of training across all health-care facilities* is a critical requirement. Given the human resource constraint, the Department of Health could review alternative options such as involving local NGOs, medical and nursing associations, medical colleges and private service providers to ensure state-wide capacity-building. It must be ensured that all training and awareness material must be in the local language.
- *Encouraging private service providers* to get accredited and train their staff and workers in occupational safety and waste management. This could be enforced, in collaboration with the state Pollution Control Board.
- *Widespread dissemination of the IMEP* training modules (when updated).
- *Strengthening the capacity of health-care facilities* for improving their environmental management processes and timely compliance with environmental authorizations and clearances. This could be undertaken in collaboration with the State Pollution Control Board.
- *Training should be provided in train-the-trainer modules* which should be replicated within individual facilities by designated trained staff on a regular basis. The Department of Health must obtain training plans and completion reports from individual facilities, for better monitoring.

In the medium to long-term at the national level:

- *Strengthening guidelines and medical and nursing curricula on environmental management,* in collaboration and discussion with different health departments (including Medical Education, Nursing Council etc.)

- *Enforcing accreditation* of consultant firms and training agencies:
  - Institute accreditation and green performance ratings for health care facilities and CWTFs. This could be led by Bureau of Energy Efficiency and supported by MoEF and MoHFW.
- *Developing a regular system for capacity-building* and awareness of State Pollution Control Boards on emerging environmental issues and new technologies.

6.8 Monitoring and enforcement

In the short term at the national level, the following activities are recommended:

- *Strengthening the regulatory role of the Central Pollution Control Board*, as recommended by the Parliamentary Standing Committee, to effectively monitor and enforce compliance at state levels:[83]
  - Institute a waste tracking system from waste generation point to final disposal destination.
  - Encourage/institute independent environmental or waste audit to be undertaken by health care facilities.
- *Establishing a dedicated "Bio-medical Waste Management Cell"* in central or state Pollution Control Boards with dedicated manpower and infrastructure for monitoring and implementing provisions of the Bio-Med Rules.[84]
- *Instituting periodic review meetings* between MoEF, MoHFW and the Central Pollution Control Board to address and resolve issues related to improving monitoring and record-keeping systems and developing standards for performance evaluation of compliance, including a set of national performance indicators (PIs). As recommended, this will strengthen capacity to monitor national compliance rates.[85]

In the short to medium-term at the state level, the Department of Health could take the following steps:

- *Instituting a waste-tracking system* from individual generation points to final disposal. This could be done in association with Pollution Control Board and data could be reported to and compiled by the Central Pollution Control Board (CPCB).
- *Undertaking waste-related pollution impact monitoring* to study the effects of improper waste disposal on the environment and undertaking regular surveillance including epidemiological surveillance of waste-related impacts on public health. As recommended, MoEF can be responsible for these analyses using data from the states.[86]
- *Seeking innovative solutions* for monitoring, including joint departmental inspections, outsourcing to medical colleges, medical and nursing associations and NGOs or community-based organizations. This monitoring should include health care facilities and centralized treatment facilities, in collaboration with Pollution Control Board.
- *Encouraging independent environmental or waste audit* to be undertaken by health care facilities.
- *Requiring hospital administrations to undertake routine supervision* and random checks within their facilities and providing regular reports on performance indicators and the corrective measures that need to be taken. *Standardizing monitoring and reporting protocols* for infection control and waste management which can be incorporated into standard hospital reporting systems, including patient surveys.

Summary

This chapter provides recommendations for mainstreaming environmental management in the

83 Report of department-related Parliamentary Standing Committee on Science and Technology, Environment and Forests on the functioning of Central Pollution Control Board (September 22, 2008).

84 Report of the Committee to evolve Roadmap on Management of Wastes in India, MoEF March 2010.

85 Performance Audit of Management of Waste in India: CAG; Report No. PA 14 of 2008.

86 CAG Report No. PA 14 of 2008.

health-care sector at different levels – national, state and facility level in a phased manner. The recommendations are provided for key areas such as policy, institutional, planning, budgets, operational, capacity-building and monitoring in a cohesive and integrated approach to improve the overall health-care waste management and infection control in the country. These recommendations are expected to contribute to multi-sectoral participation and overall improvement of the health-care sector in India.

7

Conclusion

Good environmental management is an important aspect of providing a high quality and safe health-care service. After a decade of implementation, India has made good progress in establishing and institutionalizing environmental management measures and systems. Some health-care facilities have moved beyond the basic regulatory requirements to addressing overarching environment management through cross-sectoral coordination, sustained capacity-building and a consistent commitment to change. However implementation across the country remains patchy due to systemic challenges in the public health sector, including human resource shortages, lack of a coordinated and systematic approach and insuffi cient attention and enforcement.

Recognizing the inter-play between sound environment management and reduced disease burden and improved health outcomes, the GoI has proactively updated regulations and guidelines and incorporated this aspect into its new health reform programs and missions. International organizations, including the World Bank, have supported such initiatives through pilot projects and state level interventions.

Implementation experience from several health projects in India – ranging from the HIV/AIDS, TB and vector-borne programs to the state health reform projects – shows that comprehensive, effective and successful environmental management can be achieved in a phased manner. In the short-term, basic engineering controls and technical procedures must be improved down-stream at the facility level, where the hazards are generated and risks are the greatest. In the long-term, the larger issues of environment management need to be deliberately and diligently included into strategic planning, policy, resource management and monitoring.

The fi ndings and recommendations in this report build on identifi ed shortcomings and lessons learned in order to develop a more comprehensive and inter-sectoral approach in a phased manner. This focuses on addressing simpler, higher risk issues in the short term and gradually achieving holistic and sustainable environment management systems in the medium to long term. Recognizing that the active involvement and commitment of a wide range of stakeholders and institutions is vital for success, the document provides recommendations for multi-level coordination – horizontally (inter-departmental and inter-ministerial) and vertically (intra-departmental – across different health programs and between the central and states governments). Targeting project and program

managers, the findings also emphasize the need for appropriate budgetary support, tools and technology, and a long-term capacity-building and monitoring system, supported by a strong planning and policy framework.

Ultimately, the health care sector in India needs to continue to move towards holistic and sustainable environmental management which supports its fundamental mandate of providing better quality and higher levels of health-care services, in order to reduce the national disease burden. It is hoped that the key recommendations provided in the document will support the implementation of a cohesive and inter-sectoral approach built on policy, technical, financial, institutional and managerial pillars, overlaid by stringent enforcement and monitoring.

8

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VOLUME II

Mainstreaming Environmental Management in the Health Care Sector in India

Tool-kit for Managers

Overview of Health-Care Waste

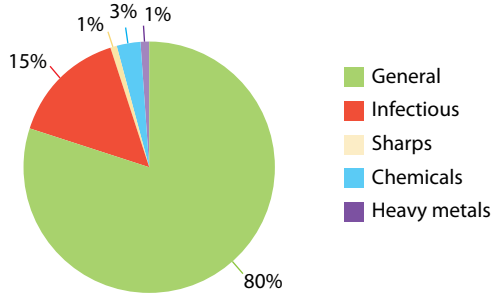
1. Issues on health-care waste management

Health-care waste includes all the waste generated by health-care establishments, research facilities and laboratories. In addition, it includes waste originating from "minor" or "scattered" sources such as that produced in the course of health-care undertaken in the home (dialysis, insulin injections, etc.).

Most waste generated in health-care establishments can be treated as regular solid municipal waste. But a varying proportion of health-care waste requires special attention, including sharps (e.g. needles, razors and scalpels), pathological waste, other potentially infectious waste, pharmaceutical waste, biological waste, and hazardous chemical waste. Collectively, these wastes are known as "special health-care waste". Also, all waste generated under certain circumstances, such as in isolation wards and microbiological laboratories, requires special attention.

A large proportion of 75-90 percent of the waste produced by health-care providers is non-risk or general health-care waste, comparable to domestic waste. It also comes mostly from the administrative and housekeeping functions and packaging of consumables and equipment in the health-care establishments, as well as the waste generated during the general maintenance of health-care premises. The remaining 10-25 percent of health-care waste is regarded as hazardous. Other waste streams generated by health-care facilities could include reusable medical equipment, condemned equipment and secondary waste created through disposal technologies.

***Figure 1:** Composition of health-care waste*



The mismanagement of health-care waste poses risks to people and the environment. Health-care workers, patients, waste-handlers, waste-pickers, and the general public are exposed to health risks from infectious waste (particularly sharps), chemicals, and other special health-care waste. Improper disposal of special health-care waste, including open dumping and uncontrolled burning, increases the risk of spreading

infections and of exposure to toxic emissions from incomplete combustion.

Transmission of disease generally occurs through injuries from contaminated sharps. Infections of particular concern are Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and the Human Immuno Deficiency Virus (HIV). HBV, for example, can remain infectious for a week, even after it has dried at room temperature, and the probability that a single needle stick will result in sero-conversion is approximately 30 percent.[1]

Proper management of health-care waste can minimize the risks both within and outside health-care facilities. The first priority is to segregate wastes, preferably at the point of generation, into reusable and non-reusable, hazardous and non-hazardous components. Other important steps are the institution of a sharps management system, waste reduction, avoidance of hazardous substances whenever possible (e.g. PVC-containing products, mercury thermometers), ensuring worker safety, providing secure methods of waste collection and transportation, and installing safe treatment and disposal mechanisms.

2. Composition of health-care waste

Health-care waste[2] is defined as the total waste stream from health-care establishments, research facilities, laboratories, and emergency relief donations. It includes several different waste streams, some of which require more stringent care and disposal. These are the following:

i. ***General waste:*** This comprises all solid waste not including infectious, chemical or radioactive waste. This waste stream can include items such as packaging materials and office supplies. Generally, this stream can be disposed of in a communal sanitary landfill or other such arrangement. Segregation of materials that can be reused or recycled will greatly reduce the impact burden of this waste stream.

ii. ***Hazardous waste:*** This waste consists of several different sub-categories:

   a. *Infectious:* Discarded materials from health-care activities performed on humans or animals, which have the potential of transmitting infectious agents to humans. These include: first of all, 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; secondly, excreta or wastes from infection isolation wards. Such wastes include, but are not limited to: (i) cultures and stocks; (ii) tissues; (iii) dressings, swabs or other items soaked with blood; (iv) syringe needles; (v) scalpels; (vi) diapers; and (vi) blood bags. Incontinence materials from nursing homes, home treatment or from specialized health-care establishments which do not routinely treat infectious diseases (e.g. psychiatric clinics) are an exception to this definition and are not considered as infectious health-care waste. Sharps, whether contaminated or not, should be considered as a sub-group of infectious health-care waste. They include syringe needles, scalpels, infusion sets, knives, blades and broken glass.

   b. *Anatomical:* This consists of recognizable body parts.

   c. *Pharmaceutical:* This consists of/or contains (i) pharmaceuticals, including those that have expired, or are no longer needed; and (ii) containers and/or packaging items contaminated by or containing pharmaceuticals (bottles and boxes).

   d. *Genotoxic:* This consists of/or contains substances with genotoxic properties,

1 World Bank, Health-care Waste Guidance Note, May 2000.
2 WHO, " Safe Management of Wastes from Health-care Activities," 1999.

including (i) cytotoxic and antineoplasic drugs; and (ii) genotoxic chemicals.

e. *Chemical:* This consists of/or contains chemical substances, including: (i) laboratory chemicals; (ii) film developer; (iii) disinfectants expired or no longer needed; and (iv) solvents, cleaning agents and others.

f. *Heavy metals:* This consists of both materials and equipment with heavy metals and derivatives, including batteries, thermometers and manometers.

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

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

Health-care waste needs to be managed appropriately to minimize the spread of infections. Segregation at source, secure collection and appropriate treatment and disposal options are important steps in waste management. These steps have to go hand-in-hand with occupational safety, infection control and patient safety for successful implementation of health-care waste management.

II

Legislative Framework

1. Bio-Medical Waste (Management and Handling) Rules, 1998[3]

The Bio-Medical Wastes (Management and Handling) Rules, 1998 provide control over the generation, collection, segregation, packaging, storage, transportation, treatment and disposal of bio-medical wastes. These rules include wastes generated from medical and health institutions, bio-technology and biological testing organizations, laboratories, animal wastes, etc., including those from veterinary institutions and wastes from slaughter houses.

The salient features of these rules are[4]:

- The Bio-Medical Wastes (Management and Handling) Rules are notified under the Environment Protection Act, 1986.
- The Ministry of Environment and Forests (MoEF) is the nodal agency for enforcement of these rules.
- These rules are applicable to persons involved in generation and handling of bio-medical wastes in any form.
- The rules are applicable to ten categories of wastes listed in Schedule I.
- The terminology defined includes bio-medical wastes, biological, authorization, etc.
- The unique feature is that it prescribes requirement for segregation of wastes at source along with appropriate packaging and labeling details.
- The details on the treatment disposal technologies are provided in the rules.
- The specific standards required for various treatment disposal techniques are given within the rules.
- Every occupier of an institution generating medical waste is to ensure handling of such wastes without causing any adverse effect on human health and environment.
- Every occupier of an institution or operator of a facility is to make an application for grant of authorization in Form I to the prescribed authority.
- The application for authorization is to accompany an authorization fee as prescribed by the state government.
- The authorization should be granted by the prescribed authority within 90 days from the date of application and should be valid for three years.

3 All GoI legislations and detailed guidelines can be downloaded from the Ministry of Environment and Forests website http://www.mohfw.nic.in/

4 Raghupathy L; Management of bio-medical wastes: World Environment Foundation, 2000 June, pg. 57-60.

- The prescribed authority should be appointed in every state and union territory within one month of the rules coming into force.
- The prescribed authority should function under the supervision of the state government.
- An advisory committee should be constituted in every state and union territory. It should include municipal administrators, NGOs, representatives from state PCBs etc. to advise the government.
- Segregation should take place at source.
- Waste should be packaged in containers as given in Schedule II.
- Containers should be labeled according to Schedule III with information in Schedule IV.
- Transportation should be in accordance with the Motor Vehicles Act, 1988 and the rules there under.
- No untreated bio-medical waste should be stored beyond 48 hours.
- Treatment and disposal should be in accordance with those given in Schedule I and in compliance with standards prescribed in Schedule V.
- Treatment disposal facilities should be set up within the prescribed time frame given in Schedule VI.
- The annual report should be submitted to a prescribed authority in Form II by January 31 every year.
- Records of generation, collection, reception, storage, transportation, treatment, disposal, and handling should be maintained. It should be subject to inspection of a prescribed authority.
- Any accident in the institution or facility should be reported in Form III.
- There should be a provision for appeal to a prescribed authority within 30 days from the date of issue of the order.

The Bio-Medical Waste (Management and Handling), Rules 1998 have been amended further in the year 2000 and 2003. The Bio-Medical Waste Rules can be downloaded from http://www.envfor.nic.in/

Table 1: *Categories as per Bio-Medical Waste (Management and Handling) Rules, 1998 (Schedule I)*

No.	Waste class	Types of waste	Treatment and disposal
1	Human Anatomical Waste	Human tissues, organs, body parts	Incineration[@]/deep burial*
2	Animal Waste	Animal tissues, organs, body parts, carcasses, bleeding parts, fluids, blood and experimental animals used in research and waste generated by veterinary hospitals and colleges, discharge from hospitals, animal houses.	Incineration[@]/deep burial*
3	Microbiology and Bio- Technology Wastes	Waste from laboratory cultures, stocks or specimens of micro-organisms including genetically engineered micro-organisms, live or attenuated vaccines, human and animal cell cultures used in research and infectious agents from research and industrial laboratories, wastes from production of biological toxins, dishes and devices used to transfer of cultures.	Local autoclaving/ microwaving/ incineration[@]
4	Waste Sharps	Needles syringes, scalpels, blades, glass, etc. that are capable of causing punctures and cuts. This includes both used and unused sharps.	Disinfection by chemical treatment[@@]/autoclaving/ microwaving/shredding[##]
5	Discarded Medicines and Cytotoxic Drugs	Wastes consisting of outdated, contaminated and discarded medicines.	Incineration[@] destruction and drugs disposal in secured sanitary landfills
6	Soiled Waste	Items contaminated with blood and body fluids including cotton, dressings, plaster-casts, linen, bedding, other materials contaminated with blood.	Incineration[@]/autoclaving/ microwaving

No.	Waste class	Types of waste	Treatment and disposal
7	Solid Waste	Waste generated from disposable items other than the waste sharps, such as tubing, catheters, intravenous sets etc.	Disinfection by chemical treatment@@/autoclaving/ microwaving/shredding##
8	Liquid Waste	Waste generated from laboratory and washing, cleaning, house-keeping and disinfection activities.	Disinfection by chemical treatment@@ and discharge into drains
9	Incineration Ash	Ash from incineration of bio-medical waste.	Disposal in municipal sanitary landfills
10	Chemical Waste	Chemicals used in production of biological, chemicals used in disinfection, such as insecticides, etc.	Chemical treatment@@ and discharge into drains for liquids and secured sanitary landfills for solids

* Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

@ There will be no chemical pre-treatment before incineration. Chlorinated plastics shall not be incinerated.

@@ Chemical treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment induces complete disinfection.

Mutilation/shredding must be such so as to prevent unauthorized reuse.

2. Draft Bio-Medical Waste (Management and Handling) Rules, 2011[5]

Salient features

These rules are based on implementation experiences of the 1998 rules and enable the prescribed authorities to implement the rules more effectively, thereby reducing hazards from bio-medical waste generation, as well as ensuring its proper treatment and disposal, so as to ensure environmentally sound management of these wastes.

These rules are in supersession of Bio-Med Rules, 1998. The rules apply **to all persons** who generate, collect, receive, store, transport, treat, dispose and handle bio-medical waste, regardless of the number of patients being serviced by them. Every occupier of a health-care facility and operator of CBWTF, irrespective of the quantum of waste generated, shall

Table 2: *Draft Bio-Medical Waste Rules, 2011 vs. Bio-Medical Waste Rules, 1998*[6]

2011 draft rules	1998 rules
Every occupier generating BMW, irrespective of the quantum of wastes, comes under the BMW Rules and requires to obtain authorization	Occupiers with more than 1000 beds required to obtain authorization
Duties of the operator listed	Operator duties absent
Categories of bio-medical waste reduced to eight	Bio-medical waste divided into ten categories
Treatment and disposal of BMW made mandatory for all the HCEs	Rules restricted to HCEs with more than 1000 beds
The Schedule VI of the rules specify the roles and responsibilities of the concerned authorities such as MoEF, MoH&F, Ministry of Defense, CPCB, SPCB, Municipal authorities, towards implementation of the rules.	This Schedule was not included earlier
A format for Annual Report appended with the Rules	No format for Annual Report
Form VI i.e. the report of the operator on HCEs not handing over the BMW added to the Rules	Form VI absent

5 MoEF website: envfor.nic.in/

6 CSE, **Sadia Sohail,** Bio-medical waste rules made more stringent, http://cseindia.org/node/3702

apply for authorization. The Rules are not applicable for radioactive waste, hazardous waste, municipal solid waste and battery waste, which would be dealt with under their respective rules.

The new Rules have incorporated that the State Ministry of Health may grant licenses to health-care facilities only after they get authorization from the SPCBs. The new Rules have bridged the gap, since earlier, the health-care facilities were only required to obtain licenses from the State Ministry of Health to carry out their functions, but now they have to obtain prior authorization before commencing their activities. SPCBs will now make sure that the health-care facilities have the necessary capacity and adequate equipments and then grant them the authorization or renew their authorization.

Duty of occupier and operators

Duties of the occupier have been elaborated in the present Rules. Proper training has to be imparted by the occupier to the health-care workers engaged in handling bio-medical waste. The training for staff concerned with hospital waste management involves a number of parameters. The Rules merely mention proper training, a set of guidelines or regulations need to be drafted by the health-care facilities in consultation with health and safety experts, as a part of the training module.

Apart from the duties of the occupier, the present rules have also listed duties for the operators of common BMW treatment facilities. The operators now have to ensure that the bio-medical waste is collected from all the health-care facilities and is transported, handled, stored, treated and disposed of in an environmentally sound manner. The operators also have to inform the prescribed authority if any health-care facilities are not handling the segregated BMW as per the guidelines prescribed in the rules.

Accident reporting formats

Accidents that take place during the management of wastes have been defined in the draft Bio-Med Rules, 2011. Accidents like injuries from sharps, mercury spills and fire hazards now have to be reported in Form III along with the remedial action taken. The Rules have also made it mandatory for all the HCEs with 30 or more beds to set up a cell or unit to deal with the BMW management. The cell has to meet every six months and minutes of the meeting have to be submitted along with the Annual Report to the prescribed authority.

Mandatory treatment and disposal

The draft Rules have made the treatment and disposal of bio-medical wastes mandatory for all the institutions generating them. The Rules clearly mention that every occupier should set up adequate treatment facilities like autoclave/microwave/incinerator/hydroclave, shredder etc., prior to commencement of its operations or ensure that the wastes are treated at a common bio-medical waste treatment facility or an authorized waste treatment facility. Another feature of the rule is the clause on promotion of new technologies. The rules state that if an occupier or operator intends to install new technologies for treatment and disposal of wastes, they can approach the Central Government or Central Pollution Control Board (CPCB) for prior approval. However, the draft Rules have omitted the necessity of an incinerator as one of the pre requisites for on-site treatment of BMW. The omission is owing to the various environmental impacts of incineration. The draft Rules say that an occupier having 500 or more beds may install an incinerator subject to compliance with all the other guidelines. However, studies in the past have shown that even the state-of-the-art incinerators lead to some emission of toxic gases. Thus there should be certain conditions for allowing the use of incinerators for disposing BMW. Incinerators can be allowed for a cluster of hospitals, or positioned at convenient locations in cities, so that health-care facilities can transport their waste to them instead of each having one installed at their premises.

Deep burial for disposal of BMW has been restricted to only rural areas with no access to CTF, with prior approval from the prescribed authority.

Simplified waste categories

The Bio-Medical Waste (Management and Handling) Rules, 1998 contained ten categories of wastes which have been reduced in the draft rules to eight categories.

Table 3: Categories as per Draft Bio-Medical Waste (Management and Handling) Rules, 2011 (Schedule I)

Category	Waste category (type)	Treatment and disposal option
1	**Human Anatomical Waste** (Human tissues, organs, body parts)	Incineration@@
2	**Animal Waste** (Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals/colleges, discharge from hospitals, animal houses)	Incineration@@
3	**Microbiology & Biotechnology Waste and other Laboratory Waste** (Wastes from clinical samples, pathology, bio-chemistry, haematology, blood bank, laboratory cultures, stocks or specimens of micro- organisms, live or attenuated vaccines, human and animal cell culture used in research, infectious agents from research and industrial laboratories, wastes from production of biological toxins, dishes and devices used for transfer of cultures)	Disinfection at source by chemical treatment@ or by autoclaving/microwaving followed by mutilation/shredding## and after treatment final disposal in secured landfill, or disposal of recyclable wastes (plastics or glass) through registered or authorized recyclers
4	**Waste Sharps** (Needles, glass syringes or syringes with fixed needles, scalpels, blades, glass, etc. that may cause punctures and cuts. This includes both used and unused sharps)	Disinfection by chemical treatment@ or destruction by needle and tip-cutters, autoclaving or microwaving followed by mutilation or shredding##, whichever is applicable, and final disposal through authorized CBWTF or disposal in secured landfill or designated concrete waste sharps pit
5	**Discarded Medicines and Cytotoxic Drugs** (Wastes comprising of outdated, contaminated and discarded medicines)	Disposal in secured land fill or incineration@@
6	**Soiled Waste** (Items contaminated with blood and body fluids including cotton, dressings, soiled plaster-casts, linen, bedding, other materials contaminated with blood)	Incineration@@
7	**Infectious Solid Waste** (Wastes generated from disposable items other than the waste sharps, such as tubing, hand-gloves, saline bottles with IV tubes, catheters, glass, intravenous sets etc).	Disinfection by chemical treatment@ or autoclaving or microwaving followed by mutilation or shredding## and after treatment final disposal through registered or authorized recyclers
8	**Chemical Waste** (Chemicals used in production of biological toxins, chemicals used in disinfection, as insecticides etc.)	Chemical treatment@ and discharge into drains, meeting the norms notified under these rules and solids disposal in secured landfills

@ Chemical treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment induces complete disinfection.

Mutilation/shredding must be such that so as to prevent unauthorized reuse.

@@ There will be no chemical pre-treatment before incineration. Chlorinated plastics/bags shall not be incinerated. Disposal of bio-medical waste by deep burial shall be prohibited in towns and cities. Disposal by deep burial is permitted only in rural areas where there is no access to common bio-medical waste treatment facility, with prior approval from the prescribed authority. The deep burial facility shall be located as per provisions and guidelines issued by Central Pollution Control Board from time to time.

Liquid waste generated from laboratories and from washing, cleaning, housekeeping and disinfecting activities, shall be appropriately treated so as to meet the discharge standards stipulated under these rules.

Incineration ash (ash from incineration of any bio-medical waste) shall be disposed of into secured landfills, if toxic or hazardous constituents are present beyond the prescribed limits as given in Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules, 2008.

out by placing chemical indicator strips on the waste packages to check whether a certain temperature has been reached, has been made mandatory for every batch of wastes being autoclaved.

One of the directives in the rules talks about setting up of 'District Level Monitoring Committees' in the districts to scrutinize compliance with the new Rules in the hospitals and other agencies generating BMW, and facilities engaged in the treatment and disposal of BMW. As per the rules, the District Level Monitoring

Table 4: Color coding and type of container for disposal as per Draft Bio-Medical Waste Rules, 2011 (Schedule II)

Color	Type of container to be used	Waste category number	Treatment options as per Schedule I
Yellow	Non-chlorinated plastic bags	Category 1, 2, 5, 6	Incineration
Red	Non-chlorinated plastic bags/ puncture-proof containers for sharps	Category 3, 4, 7 Soiled Wastes	As per Schedule I (Rule 7)
Blue	Non-chlorinated plastic bags/ containers	Category 8 (chemical wastes)	As per Schedule I (Rule 7)
Black	Non-chlorinated plastic bags	Municipal waste	Disposal in municipal dump sites

Notes:

1. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
2. Category 3, if disinfected locally, need not be put in containers/non-chlorinated plastic bags.
3. The municipal waste such as office waste (like paper waste), kitchen waste, food waste and other non-infectious waste shall be stored in black-colored containers/bags, and shall be disposed of in accordance with Municipal Solid Waste (Management and Handling) Rules, 2000.

New inclusion

The Bio-Med Rules, 1998 only mentioned about the occupiers and operators to submit an annual report to the prescribed authority but no information of what data should be furnished in the report was mentioned. A detailed format for the Annual Report has thus been included in the new Rules.

Form VI is also a new addition in the draft rules. It empowers the operator of CWTF to report against the HCEs who are not carrying out proper segregation of their wastes. For conducting the validation test during autoclaving certain changes have been introduced. For spore testing the frequency has been stipulated. It has to be conducted once in three months and records have to be maintained. Routine Tests, which are carried

Committee would be headed by the District Medical Officer or his nominee. The Committee is also entrusted with the task of preparing and submitting a half-yearly report on the status of health-care facilities under its jurisdiction to the State Level Advisory Committee. A copy of the report should also be sent to Central Pollution Control Board or Ministry of Environment and Forests and the State Pollution Control Board/Pollution Control Committee, as the case may be, for necessary action.

The Rules have also taken into account Government hospitals and their lack of capacity and resources. These hospitals generally charge a pittance and serve a large proportion of the populace. Managing the BMW wastes in these hospitals would require

adequate infrastructure, manpower and expertise, which they lack. The Rules have instructed State Governments and Union Territories to allocate and provide separate funds to all such health-care facilities for appropriate management of their BMW. The State Governments have also been instructed to procure and allocate the relevant treatment equipment for government HCFs.

3. Other regulations related to the management of health-care waste

A number of environmental laws, regulations, which impact the health care sector and services, have been promulgated. Among those that focus on health care waste management include:

3.1 Environmental Protection Act, 1986

The Government of India enacted the Environmental Protection Act (EPA) under Article 253 of the Constitution. This Act serves as an "umbrella" legislation to provide a framework for coordination of environment activities of various established central and state authorities. It also empowers the Central Government to take appropriate measures to protect and improve environmental quality, and to prevent, control and reduce environmental pollution, including collection and dissemination of information. There are rules and notifications under this Act, which are directly relevant to the health sector.

3.2 Municipal Solid Wastes (Management and Handling) Rules, 2000

As a result of the plague epidemic in Surat, Gujarat in 1994, the Supreme Court, under pressure from civic and environmental activists, directed the Ministry of Environment and Forests (MoEF) to draft the Municipal Solid Wastes (MSW) Rules in 2000. These rules apply to every municipal authority responsible for collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes.

3.3 The Water (Prevention and Control of Pollution) Act, 1974

The Act establishes standards for water quality and effluents, and also establishes an institutional structure for preventing and reducing water pollution. Polluting industries must seek permission to discharge waste into effluent bodies such as drains, or even other water bodies like rivers or lakes. The Central Pollution Control Board (CPCB) was constituted under this Act.

3.4 Environmental Impact Assessment Notification, 2004

This notification states that any large construction project, that is for 1,000 persons or above, or which discharges sewage of more than 50,000 liters per day, and having an investment of US$ 10.9 million or above, requires an Environmental Impact Assessment (EIA) to be cleared by the MoEF before construction work can commence. This notification is therefore applicable to investments in new facilities or modifications for secondary, tertiary and larger health-care facilities and medical colleges.

3.5 The Factories Act, 1948

This law specifically focuses on occupational health and safety, and identifies the need for Material Safety Data Sheets (MSDS). The basic provisions for a safe workplace provided under this Act can be applied as a baseline, but needs to be updated to reflect the current understanding of health and safety issues. Under this Act, waste management units such as common effluent treatment plants, and common treatment facilities are not classified under hazardous industries.

3.6 Right to Information Act, 2005

The RTI Act confers the right to every citizen to secure access to information under the control of public authorities, consistent with public interest, in order to promote openness, transparency and accountability. It provides for the constitution of a

Central or State Information Commission(s), which are empowered to enquire into complaints from persons who have not been able to secure information requested under the Act. The Indian Courts have also allowed citizens and social action groups and pressure groups access to public records, subject to the condition that disclosure may be refused for reasons of security[7].

4. The role of different stakeholders in health-care waste management

The role of different stakeholders has been described in the chapter on stakeholder participation (Chapter 3 Vol. I). The matrix below gives an overview of various activities carried out by the different stakeholders.

Table 5: *The role of different stakeholders in health-care waste management*

Stakeholder	Roles and responsibilities									
	Legislation	Enforcement	Policies and guidelines	Capacity building	Monitoring	Research and development	Executing agency	Financing and sustainability	Land allocation	Collection and disposal
MoEF	Yes*		Yes	Yes	Yes	Yes		Yes		
MoHFW			Yes	Yes	Yes	Yes	Yes	Yes		
CPCB		Yes	Yes	Yes	Yes	Yes		Yes		
SPCB		Yes	Yes	Yes	Yes	Yes		Yes		
Municipal Bodies			Yes	Yes	Yes	Yes			Yes	Yes
WHO			Yes	Yes	Yes	Yes		Yes		
Multilateral Organizations			Yes	Yes	Yes	Yes		Yes		
NGOs and others			Yes	Yes	Yes	Yes				
Health-care Facilities			Yes	Yes	Yes	Yes	Yes	Yes		Yes
Centralized Facilities and				Yes						Yes
Private sector/ Accreditation Bodies			Yes	Yes	Yes	Yes		Yes		

Yes*: This refers to the active involvement of the organization/institution in the activity specified in the column head.

7 Lal and Goswami, International Comparative Legal Guide Series on Environmental Law, India Associated Law Advisers.

III

CPCB Guidelines on Health-Care Waste Management

1. Guidelines for establishing and operating a common bio-medical waste treatment facility

A Common Waste Treatment Facility for Health-Care Facilities (CWTF) is a set up where health-care waste, generated from a number of health-care units, undergoes necessary treatment to reduce any adverse effects that this waste may pose. The CWTFs are cost effective, easy to operate and maintain, rather than individual health-care facilities having their own waste treatment and disposal options. The CPCB has developed detailed guidelines for CWTFs, wherefrom the following checklist has been reproduced here.

1.1 Treatment facility

i. The following amenities shall be provided in any common waste treatment facility:
   - Autoclave (Pre-vacuum horizontal feeding)/ Hydroclave/Microwave.
   - Incineration (for waste belonging to Categories 1, 2 and 5 only).
   - Shredder
   - Sharps pit/Encapsulation/Recovery of metal in some factory may be considered.
   - Facility for bin-washing, floor-washing, vehicle-washing.
   - Effluent Treatment Plan
   - Secured sanitary landfi ll (Until a secured sanitary landfill comes up in the area, space within the CBWTF facility shall be used).

ii. Only waste Categories 1 and 2 as described in the Bio-Medical Waste Rules shall be incinerated (if secured sanitary landfill is not available, waste Category 5 may also be incinerated).

iii. All other infected waste shall be subjected to autoclaving/hydroclaving/microwaving as applicable under the Bio-Medical Waste (Management and Handling) Rules, 1998.

iv. Incinerator, autoclave/hydroclave/microwave shall be PLC based with tamper-proof control panel and recording devices.

1.2 Location

Reasonably away from residential and sensitive area.

1.3 Land

Preferably not less than one acre land may be required to set up all the requisite facilities.

1.4 Coverage area

In any area, only one CBWTF may be allowed to cater up to 10,000 beds at the approved rate by the Prescribed Authority. A CBWTF shall not be allowed to cater to health-care units situated beyond a radius of 150 km. However, in an area where 10,000 beds are not available within a radius of 150 km, another CBWTF may be allowed to cater to the health-care units situated outside the said 150 km.

1.5 Segregation

- Segregation shall be as per the Bio-Medical Waste (Management and Handling) Rules, 1998 as well as be compatible with treatment facilities at CBWTF as suggested by the operator.
- The generator is responsible for providing segregated waste to the operator.
- The operator shall not accept unsegregated waste and report the matter to the SPCB.

1.6 Collection

- Each colored bag should be kept in a similar colored container i.e. colored bags shall not be kept directly in the transportation vehicles.
- Sharps shall be collected in puncture-resistant containers.
- Temporary storage at health-care units shall be done in designated areas.

1.7 Transport vehicle

- A dedicated vehicle should be there for the collection of bio-medical waste.
- Separate cabins shall be provided for driver/staff and the bio-medical waste containers.
- The base of the waste-carrying cabin shall be made leak-proof to avoid leakage of liquid during transportation.
- The waste cabin may be designed for storing waste containers in tiers.
- The waste cabin shall be designed such that it is easy to wash and disinfect.
- The inner surface of the waste-carrying cabin shall be made of a smooth surface to minimize water retention.
- The waste cabin shall have provisions of sufficient openings in the rear and/or sides so that waste containers can be easily loaded and unloaded.
- The vehicle shall be labeled with the bio-medical waste symbol (as per the Schedule III of the Rules) and should display the name, address and telephone number of the CBWTF.

1.8 Storage

- Sufficient ventilated storage space for untreated and treated bio-medical waste shall be provided.
- The flooring and walls (to a height of 2 m from floor) shall be finished with smooth and fine material. There shall be a minimum number of joints.

1.9 Record keeping

- Documents such as collection advice taken from health-care units for each category of waste, records of waste movements, logbook for the equipment and site records shall be maintained.
- All the records shall be available at the CBWTF site for inspection.

1.10 Disposal

- Incineration ash – Secured sanitary landfill
- Treated solid waste – Municipal sanitary landfill
- Plastic waste after disinfection and shredding – Recycling or municipal sanitary landfill
- Sharps, after disinfection (if encapsulated) – Municipal sanitary landfill
- Treated wastewater – Sewer/drain or recycling
- Oil and grease – Incineration

1.11 Setting up and operation of CBWTF

- The proponent shall submit a detailed work-plan of the proposed CBWTF to the Prescribed Authority SPCB for issuance of "Consent

to Establish". The work plan should include complete details of the project such as site details, coverage area, infrastructure set up, manner of transportation of bio-medical waste, operating procedures etc.

- The CBWTF operator shall carry out stack emission test of incinerator, incineration ash test, validation test of autoclave/microwave/ hydroclave and compliance with applicable parameters of any effluent being discharged from the CBWTF, and have it ratified at least quarterly from the approved laboratory and submit the quarterly report of the same to the SPCB/PCC.

2. Some design principles for a waste treatment and storage facility

- Waste flow from "dirty" to "clean" in a straight forward manner that prevents cross-contamination, i.e., avoid having clean materials (including treated waste) from passing through dirty areas and coming in contact with infected materials.
- A safe and easy way to bring in infectious waste (such as having the treatment system at loading dock height so that waste from a truck could simply be rolled on to the treatment platform).
- A storage area for untreated waste that meets the WHO standards and is located close to the treatment system.
- An area to wash and disinfect bins as close as possible to where the bins are emptied when the waste is placed in the treatment system.
- A space to store empty (washed) bins that is easily accessible to workers that need more bins for waste collection.
- If the CTF uses a shredder, the shredder should be on the "clean" side of the waste flow after the treatment system.
- An emergency wash area for workers who are accidentally exposed.
- A space to store clean PPE located such that the worker has access to the PPE before entering the "dirty" areas.
- A storage area for treated waste that could also be the storage for domestic waste, located for easy removal of municipal solid waste.
- Drainage to receive condensate and wastewater from the wash areas.
- Slightly sloping floor to direct water towards the drains.
- Floor and walls constructed of a material that is easy to wash.
- Good ventilation to protect workers from odors, volatilized gases and steam.

3. Guidelines for design and construction of BMW incinerator

3.1 General

i. These guidelines shall be applicable only to the new installation of incinerators. However, the existing incinerators shall be retrofitted with Air Pollution Control Device as mentioned in these guidelines.

ii. Incinerators shall be allowed only at Common Bio-Medical Waste Treatment Facilities (CBWTF).

iii. Installation of individual incineration facility by a health-care unit shall be discouraged as far as possible but approval may be granted only in certain inevitable situations where no other option is available.

3.2 Incinerator

The following design criteria may be adopted for better performance:

i. The incinerator shall be designed for a capacity of more than 50 kg/hr. For 50 kg/hr capacity, the minimum hearth area shall be 0.75 sq. m (8 sq. feet) and the minimum flow of the flue gas in the secondary chamber shall be 0.6 m^3/sec at 1050°C. Each incinerator must be installed with an air pollution control system (as specified in the Section 3).

ii. The size of the opening through which the waste is charged shall be larger than the size of the waste

bag used for feeding. The volume of the primary chamber shall be at least five times the volume of one batch.

iii. The double chamber incinerator shall preferably be designed on "controlled-air" incineration principle, as particulate matter emission is low in such incinerators. Minimum 100% excess air shall be used for overall design. Air supply in the primary and secondary chamber shall be regulated between 30-80% and 170-120% of stoichiometric amount respectively. Primary air shall be admitted near/at the hearth for better contact. Flow meter/suitable flow measurement device shall be provided on the primary and secondary air ducting. The combustion air shall be supplied through a separate forced draft fan after accounting for the air supplied through burners.

    Optional: For higher capacity incinerators, typically above 250 kg/hr, other design e.g. Rotary Kiln shall be preferred.

iv. A minimum negative draft of 1.27 to 2.54 mm of WC (Water Column) shall be maintained in the primary chamber to avoid leakage of gaseous emissions from the chamber and for safety reasons. Provision shall be made in the primary chamber to measure the Water Column pressure.

v. The waste shall be fed into the incinerator in small batches after the fixed interval of time in case of fixed hearth incinerators and continuous charging using appropriate feeding mechanisms in case of rotary kiln incinerators, or as recommended by the manufacturer. The size of the hearth i.e. primary chamber shall be designed properly.

vi. The sides and the top portion of the primary and secondary chambers shall preferably have rounded corners on the inside to avoid the possibility of formation of black pockets/dead zones.

vii. The size of the secondary chamber shall be properly designed so as to facilitate a minimum of one second of residence time to gas flow. For the estimation of residence time in the secondary chamber, its volume shall be calculated starting from the secondary burner tip to the thermocouple.

viii. The refractory lining of the chamber shall be strong enough to sustain minimum temperature of 1000°C in the primary chamber and 1200°C in the secondary chamber. The refractory and insulation bricks shall have a minimum of 115 mm thickness each and conform to IS:8-1983 & IS:2042-1972 respectively.

ix. The incinerator shell shall be made of mild steel plate of adequate thickness (minimum 5 mm thick) and painted externally with heat-resistant aluminum paint with proper surface preparation, suitable to withstand a temperature of 250°C. Refractory lining of the hot duct shall be done with refractory castable (minimum 45 mm thick) and insulating castable (minimum 80 mm thick).

x. Ceramic wool shall be used at hot duct flanges and expansion joints.

xi. The thermocouple location shall be as follows:

- In primary chamber – Before admission of secondary air.
- In secondary chamber – At the end of secondary chamber or before admission of dilution medium to cool the gas.

xii. There shall be a separate burner each for the primary and secondary chambers. The heat input capacity of each burner shall be sufficient to raise the temperature in the primary and secondary chambers to 800±50°C and 1050±50°C respectively, within a maximum of 60 minutes prior to waste charging. The burners shall have automatic switching "off/on" control to avoid the fluctuations of temperatures beyond the required temperature range:

- Each burner shall be equipped with spark igniter and main burner.
- Proper flame safeguard of the burner shall be installed.
- Provide view ports to observe the flame of the burner.
- Flame of the primary burner:
  - shall be pointing towards the centre of the hearth.

- shall have a length such that it touches the waste but does not impinge directly on the refractory floor or wall.

- The secondary burner shall be positioned in such a way that the flue gas passes through the flame.

xiii. There shall not be any manual handling during charging of waste into the primary chamber of the incinerator. The waste shall be charged in bags through an automatic feeding device at the manufacturers recommended intervals, ensuring that there is no direct exposure of furnace atmosphere to the operator. The device shall prevent leakage of the hot flue gas and any backfire. The waste shall be introduced on the hearth in such a way so as to prevent any heap formation. Suitable raking arrangements shall be provided for uniform spreading of waste on the hearth.

xiv. A tamper-proof PLC (Programmable Logic Control)-based control system shall be installed to prevent:

- Waste charging until the required temperature in the chambers is attained during the beginning of the operation of the incinerator.
- Waste charging unless primary and secondary chambers are maintained at the specified temperature range.
- Waste charging in case of any unsafe conditions such as – very high temperature in the primary and secondary chambers; failure of the combustion air fan, ID fan, recirculation pump; low water pressure, and high temperature of the flue gas at the outlet of air pollution control device.

xv. The incineration system must have an emergency vent. The emergency vent shall remain closed i.e. it shall not emit flue gases during normal operation of the incinerator.

xvi. Each incineration system shall have graphic or computer recording devices which shall automatically and continuously monitor and record dates, time of day, batch sequential number and operating parameters such as temperatures in both the chambers. CO, CO_2, and O_2 in gaseous emissions shall also be measured daily (at least ½ hour at one minute intervals).

xvii. The possibility of providing heat recovery system/heat exchanger with the incinerator shall also be considered wherever possible.

xviii. The structural design of the chimney/stack shall be as per IS:6533-1989. The chimney/stack shall be lined from inside with at least 3 mm thick natural hard rubber suitable for the duty conditions, and shall also conform to IS:4682 Part I-1968 to avoid corrosion due to oxygen and acids in the flue gas.

xix. The location and specifications of the porthole, platform ladder etc. shall be as per the Emission Regulations, Part-3 (COINDS/20/1984-85), published by CPCB.

4. Air pollution control device

It is not possible to comply with the emission limit of 150 mg/Nm^3 (corrected to 12% CO_2) for particulate matter, without an Air Pollution Control Device (APCD). Therefore, a bio-medical waste incinerator shall always be equipped with an APCD.

- No incinerator shall be allowed to operate unless equipped with APCD. The incinerator shall be equipped with High Pressure Venturi Scrubber System as ordinary APCD such as wet scrubber or cyclonic separator cannot achieve the prescribed emission limit.
- For the facilities operating for 24 hrs a day, an APCD in terms of dry lime injection followed by bag filter can be considered. The details of High Pressure Venturi Scrubber System are given in Section VII.

5. Incinerator room and waste storage room

i. The incinerator structure shall be built in a room with proper roofing and cross ventilation. There shall be a minimum of 1.5 m clear distance in all directions from the incinerator structure to the wall of the incinerator room.

ii. Adjacent to the incinerator room, there shall be a waste storage area. It shall be properly ventilated and designed such that waste can be stored in racks and washing can be done very easily. The waste storage room shall be washed and chemically disinfected daily.

iii. The floor and inner wall of the incinerator and storage rooms shall have an outer covering of impervious and glazed material so as to avoid retention of moisture and for easy cleaning.

iv. The incineration ash shall be stored in a closed sturdy container in a masonry room to avoid any pilferage. Finally, the ash shall be disposed of in a secured landfill.

6. Operator of the incinerator

i. A skilled person shall be designated to operate and maintain the incinerator. The operator shall have adequate qualification in relevant subjects and shall be trained and certified by the incinerator supplier in operation and maintenance of the incinerator.

ii. There shall be at least one assistant designated at the incinerator plant to keep track of the wastes, records of incinerator operation, cleanliness of the surrounding area and incinerator and waste storage room. They shall also take care of waste charging and incineration ash disposal.

iii. All the staff at the incinerator plant shall put on protective gears such as gumboots, gloves, eye, glasses, etc., for safety reasons.

iv. Any accident that occurs shall immediately be reported to the facility operator. The facility operator shall have well-defined strategies to deal with such accidents/emergencies.

[The guidelines will help in selection/installation of better incinerator systems. However, it shall be ensured that the incinerators shall be in compliance with the standards stipulated in the Bio-Medical Waste (Management and Handling) Rules, 1998.]

7. Details of high pressure venturi scrubber system

i. The Venturi scrubber shall have a minimum pressure drop of 350 mm WC to achieve the prescribed emission limit. The temperature of the flue gas at the outlet of the Venturi scrubber shall be approx 70-80°C to ensure the saturation of the flue gas.

ii. The Venturi scrubber shall preferably be made of stainless steel – 316L grade or better material or mild steel-lined with acid resistant bricks to avoid corrosion.

iii. The water to be used in the Venturi scrubber shall be mixed with caustic soda solution to maintain the pH of the scrubbing liquid above 6.5.

iv. The scrubbing medium shall be circulated @ 2-2.5 ltrs/m^3 of saturated flue gas at the Venturi outlet. This shall be done using a pump and piping made of stainless steel – 316 grade or better material. The scrubbing medium shall be re-circulated as far as possible.

v. The Venturi scrubber shall be followed by centrifugal type droplet separator to remove water droplets from the flue gas.

vi. The material of construction of the droplet separator and interconnecting ducting from the Venturi scrubber to droplet separator, droplet separator to ID fan and ID fan to stack, shall be mild steel-lined from the inside with minimum 3 mm thick natural hard rubber suitable for the duty conditions. It shall also conform to IS:4682 Part I-1968 to avoid corrosion due to oxygen and acids in the wet flue gas.

vii. The wastewater generated from the air pollution control device shall be properly handled so as to avoid any non-compliance of the regulatory requirements.

viii. Stack emission monitoring and ash analysis as per the requirement of the Bio-Medical Waste (Management and Handling) Rules, 1998, shall be done quarterly i.e. once in every three months and relevant records shall be maintained by the facility operator.

IV

Road Map on Management of Waste in India

The following are the recommendations from the *Report of the Committee to Evolve Road Map on Management of Wastes in India*[8] on improving health-care waste management in the country.

1. A national inventory should be made for all bio-medical waste generators (Government/ Private or others). Health-Care Facilities (HCFs)/dispensaries/blood-banks/laboratories/ animal husbandries/consultants etc. in terms of number and kg/day to be made by the State Pollution Control Board (SPCB)/Pollution Control Committee (PCC) (for HCFs as defined under the Bio-Medical Waste Management and Handling (BMWM) Rules) and HCFs falling under the purview of Director General, Armed Forces Medical Services.
2. The existing BMWM Rules should be reviewed to incorporate more stringent penalty for violation. A strategy must be evolved for safer management of bio-medical waste in the country.
3. The responsibilities of the Operator of a facility should be clearly defined.
4. SPCB/PCC/CPCB (Central Pollution Control Board) should undertake strict and periodic monitoring of HCFs/CWTFs (Centralized Bio-Medical Waste Treatment Facilities) for verifi cation of compliance of provisions of the Rules and CPCB guidelines issued from time to time.
5. SPCB/PCC/CPCB should set up a dedicated "Bio-Medical Waste Management Cell" within the organization with requisite dedicated manpower and infrastructure for monitoring and implementing the action plan and the provisions of the BMWM Rules. Requisite funds could be utilized from the authorization/consent fees. Additional fi nancial assistance may be obtained from the MoEF.
6. Adequate funds should be allocated for bio-medical waste management as well as procurement and supply of disposal equipments such as autoclaves, microwaves/hydroclaves, shredders, needle-cutters, mercury-spill kits to all the Govt. HCFs within one year.
7. All the HCFs should be brought under the ambit of BMWM Rules and not be permitted to operate without authorization of the SPCB/PCCs.
8. All HCFs in operation should be registered with the State/UT (Union Territory) Deptt. of Health/Ministry of Health and Family Welfare.

8 Ministry of Environment and Forest website http://www.mohfw.nic.in/

9. CPCB should make random checks on inventory reports submitted by the SPCB/PCC and Director General, Armed Forces Medical Services.
10. MoEF (as per SPCBs and PCCs and Ministry of Defense)/Ministry of Health & Family Welfare should finalize National Inventory on Bio-Medical Waste Generation from HCFs, Veterinary Hospitals, Armed Forces Health-Care Establishments.
11. SPCB/PCC, Director General, Armed Forces Medical Services should make an assessment of existing capacity of Bio-Medical Waste Treatment Facilities in every State/UT along with the respective coverage area. SPCB/PCC may identify additional treatment facilities required vis-à-vis existing facilities.
12. SPCB/PCC/Ministry of Health and Family Welfare/MoEF/Ministry of Defence should identify and allocate land for setting up of additional CWTFs, invite private entrepreneurs for setting up CWTFs. In cases, where no entrepreneur comes forward to set up a CWTF, submit proposals along with fund details to CPCB/ MoEF/Ministry of Defence for seeking financial assistance from MoEF. In places where the location is such that CWTFs can cater to districts in neighboring states, interstate transportation of BMW could be allowed since this helps the HCFs and makes the CWTF more viable.
13. SPCB/PCC/CPCB should initiate action against HCFs and CWTFs violating the provisions of BMWM Rules and the Guidelines issued by CPCB from time to time.
14. Ministry of Health and Family Welfare, State/ UT Department of Health should initiate action against HCFs and CWTFs violating the conditions of registration. HCFs which store and sell used plastic disposables to unauthorized contractors for repackaging, and/or resell "tainted disposables like syringes, gloves, catheters, IV sets etc" should be severely punished and their registrations cancelled.
15. Training workshops should be organized on bio-medical waste management-related activities at the district, state, national and international levels for HCFs for all the officials dealing with the bio-medical waste management-related activities. SPCB/PCC/CPCB/MoEF/Ministry of Health and Family Welfare Director General, Armed Forces Medical Services/State/UT Deptt. of Health and Centres of Excellence are to implement these programs.
16. State/nationwide awareness programs should be created for the general public for dissemination through mass media like TV, Radio, newspapers, hoardings etc.
17. It should be made mandatory for every 50- and above-bedded HCFs to have at least one person who has undertaken a three/six months distance learning program on BMWM or similar courses accredited by CPCB.
18. HCFs need to install some equipment for treatment other than captive incinerators, especially for mitigating and minimizing the spread of infection.
19. HCFs need to install a laboratory to carry out tests such as Routine Environmental checks, Disinfectant In-Use test, Validation/Efficacy tests of autoclave/microwave/hydroclave etc. installed.
20. HCFs should be encouraged to use non-mercury-based instruments in place of mercury-based thermometers and Sphygmomanometers.
21. CPCB/MoEF should review gaseous emission standards and effluent discharge norms in consultation with various Stakeholders.
22. Registrations of those hospitals that do not set up an individual treatment/disposal facility or join a common treatment facility should be cancelled. New hospitals should not be allowed to commence operations without making sure that they have the facility for treatment/ disposal of bio-medical waste or are a member of a CWTF. Segregation of bio-medical waste at source, according to its type, should be ensured in each hospital and HCF. Segregation could be simplified into 5 types of waste by clubbing the 10 categories of waste presently specified in Schedule 1 (described above).

V

Health-Care Waste Management Plan

Health care waste management needs to be integrated into the day-to-day activities of health-care facilities. A plan for developing an infection control and waste management system has been provided in this section. More detailed guidance is available from documents prepared by WHO, as referenced in Section XIX.

1. STEP 1: Waste management committee

Developing a sound Health-care waste management and infection control policy at the facility level requires the support and commitment of the administration and a carefully designed health- care waste management plan. The first step is to formulate a waste management/ infection control committee headed by the head of the institution and to appoint a waste management officer. The size of the waste management committee depends on the size and structure of the health-care facility. Before executing a waste management plan, a clear understanding of the roles and responsibilities of each member of the waste management committee and the entire hospital staff needs to be clearly defined. As health-care waste management is a cross-cutting issue, the waste management committee must ensure that, while implementing different national and state health programs, common, everyday messages are communicated to the health-care workers.

The Health-Care Waste Management Committee could include the following hospital personnel:

- Head of the Hospital
- Waste Management Officer
- Heads of the Hospital Departments
- Nursing Superintendent
- Doctor/Nurse from Infection Control Committee
- Sanitary Supervisor
- Store In-charge and
- Other departmental heads and committed individuals.

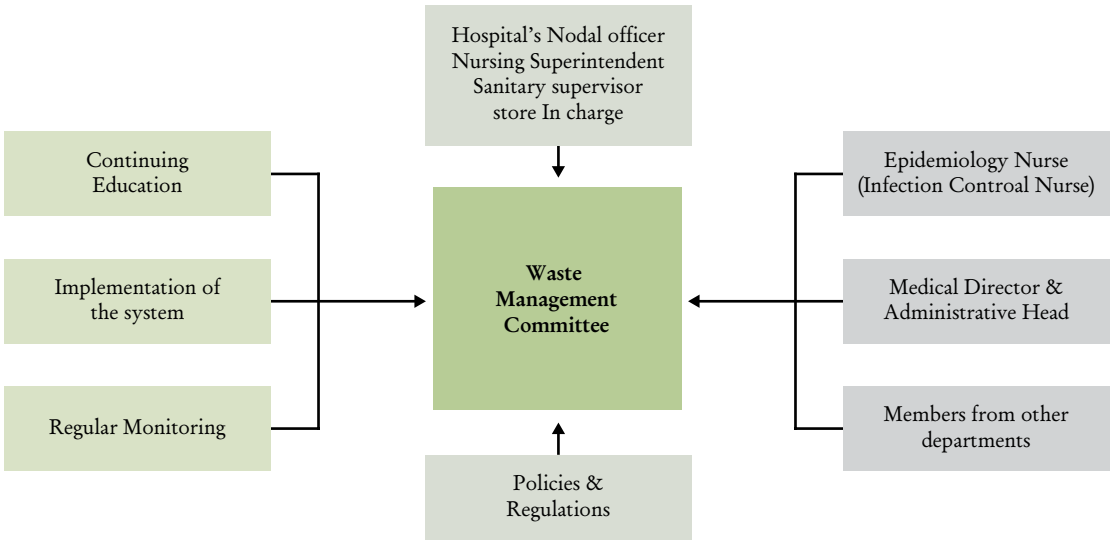
2. STEP 2: Waste management plan

The second step is to describe the activities for implementation of a waste management plan and prepare an action plan. The execution of the waste management system could be either by the members of the waste management committee or by an external agency (like consultants/NGOs working in this area).

The basic steps to be included in the waste management plan are:

- Waste assessment
- Training and capacity-building

Figure 2: Waste management committee



- Procurement of equipments and supplies
- Implementing the waste management system
- Monitoring and record-keeping
- Any other relevant issue

3. STEP 3: Waste assessment, training and procurement

3.1 Waste assessment

Before implementing the waste management system in the health-care facility, a waste audit needs to be conducted to assess: (i) the status of authorization; (ii) the points of waste generation; (iii) type and quantity of waste generated; (iv) present waste management practices; (v) sharps management; (vi) options for final treatment and disposal; (vii) level of awareness; (viii) universal precautions and infection control measures adopted by the health-care workers; (ix) mercury reduction program; (x) waste minimization measures; (xi) recycling and reuse options; and (xii) bio-safety measures in the laboratories. Based on the findings of the survey, the waste management system in the health-care facility such as procurement of bins, needle-cutters, etc should be planned.

3.2 Training and capacity-building

Training needs to be imparted to all health-care professionals on waste management issues, not only to provide them with the core knowledge, skills and attitude to effectively work for the implementation of proper waste management, but also to make them understand the importance of good waste management practices within and outside the health-care facility. The role of different health-care providers and common messages on proper waste management practices should be communicated to health care workers.

Training and awareness programs help in changing the mindset of the health-care professionals and workers towards health-care waste. Regular and ongoing training and awareness programs for all the staff members – from the top administrator to the housekeeping staff should be organized to reinforce the message of proper waste management practices.

Training programs should broadly include the following topics:

- Hazards of health-care waste
- Infection control measures
- Bio-Medical Waste (Management and Handling) Rules

- Waste management steps: waste collection, segregation, transportation, storage, treatment and disposal
- Liquid waste management
- Cleaning of spills
- Waste minimization
- Alternatives to hazardous chemicals
- Occupational safety issues.

3.2.1 Tools for training and awareness

i. *Channels for training:*
   - Distance learning
   - Workshops
   - Seminars
   - Classroom teaching
   - Practical Hands-on training – training at the place of work.

ii. *Awareness activities through:*
   - Newsletters and factsheets
   - Health-care waste management as part of the hospital accreditation system
   - Incentives for good waste management practices
   - Electronic and print media
   - Posters
   - Banners
   - Skits and plays.

3.3 Procurement

After the waste audit the health-care facilities must prepare a comprehensive quantification and specification of all the items for procurement. Procurement of waste management equipment and consumables must be as per the specified standards and in line with the demand of quantities for one-time purchase of equipment and recurrent annual supplies. Procurement of equipment should preferably be along with other implementation activities. This will ensure proper use of equipment for sound waste management.

3.4 Checklist of supplies

- Chemical disinfectants
- Bags and bins of different sizes and colors
- Equipment for personal protection and immunization of personnel
- Needle destroyer/cutters
- Waste trolleys/carts
- Waste treatment equipment like autoclave, shredder
- Construction of deep burial pits
- Mercury-free equipment
- Energy efficient purchases.

4. STEP 4: Implementation of waste management and infection control system

After waste assessment, training and procurement of supplies for waste management, the waste management and infection control system needs to be set in place. The basic steps for waste management are the following.

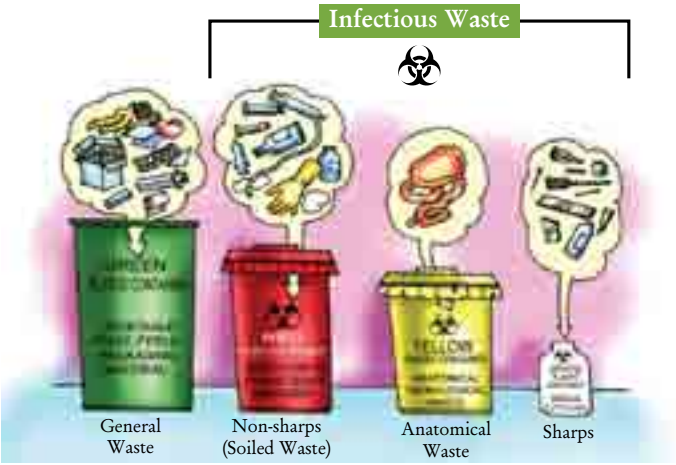
4.1 Segregation

Segregation of waste at source is the single most important step in bio-medical waste management. Once bio-medical waste gets mixed with the general waste, the problem magnifies and becomes unmanageable. Thus it is critical that segregation of waste takes place at the point of generation. The segregation of waste should be done as per the Bio-Medical Waste Rules.

4.2 Collection and storage

The segregated waste must be collected and stored in specified labeled colored containers made of good plastic or any other strong material. The containers must be smooth, without any sharp edges, and cleaned regularly. Special puncture-resistant containers must be used to hold discarded sharps.

Figure 3: Segregation of waste as prescribed in the Bio-Med Rules



(Source: IGNOU modules on health care waste management) photo credit Megha Rathi

4.3 Transportation

The waste should be transported from the point of generation to the final disposal site in properly designed transportation vehicles, such as trolleys, wheel barrows and push-carts. The transportation route and time must be such that it does not interfere with the other day-to-day activities of the health-care facility. The **waste-handlers/waste-pickers** must be provided with uniforms, aprons, boots, gloves and masks, to be worn while collecting and transporting the waste. Waste should not be stored beyond 48 hours. Final waste storage areas must be secure, and unauthorized persons should not have access to the area.

Table 6: Categories of health-care waste and their final disposal

Type of waste	Location	In-situ treatment	End treatment		Final disposal CWTF
			CWTF	No CWTF	
Human tissue, body parts and placenta	OT, Labor rooms, wards	-	Incineration at common treatment facility	Deep Burial inside the hospital	Incineration ash to be buried in secured landfill
Cotton, gauze dressings, POPs soiled with blood, pus and other human discharges	All wards, OT, Labor rooms, Lab, ICU, Acute wards, Isolation wards	-	Autoclave/ Microwave and shredding at common treatment facility	Deep burial after disinfection	Land filling after disinfection and mutilation
All types of plastics, i.e. plastic syringes, I.V. lines, I.V. bottles, bags	All wards and departments	1% Hypo chlorite solution for 30 minutes	Autoclave/ Microwave and shredding at common treatment facility	Disinfection and mutilation	Formal recycling

Type of waste	Location	In-situ treatment	End treatment		Final disposal CWTF
			CWTF	No CWTF	
Discarded medicines, Cytotoxic drugs and heavy chemicals	Stores	-	Incineration at common treatment facility	Deep burial	Secured landfilling of Incineration ash
Soiled linen	OT, Labor rooms, ICU, Isolation wards, Acute wards and other wards	1% Hypochlorite solution for 30 minutes	Washed in laundry	Washed in laundry	Reused after wash
General waste such as left-over food in patients plates, stationery, fruit waste, unsoiled dressings, gauze and cotton from Green bucket	All wards & departments	-	No treatment	Municipal sanitary landfilling of the general waste	NA
Needles, blades	All wards & departments	1% hypochlorite for 30 minutes and mutilation by needle removal devices/destroyers and storing them in puncture proof container	Deep burial/ encapsulation	Deep burial/ encapsulation	Encapsulation or formal recycling after disinfection and mutilation
Broken glass, bottles, tubes, Vials, petri dishes Pearl pet with hypo chlorite solution 1%	All wards & departments	1% hypochlorite for 30 minutes	Stored in Puncture Proof Containers	Autoclaved and stored in Puncture proof containers	Formal recycling after disinfection
Microbiological samples	Labs	5% Hypochlorite solution for 30 minutes	Autoclaving	Autoclaving	Liquid discarded in drainage
Liquid waste from wards, departments and autopsy room	All wards/ Autopsy rooms	5% Hypochlorite for 30 minutes	-	-	Liquid discarded in drainage

Type of waste	Location	In-situ treatment	End treatment		Final disposal CWTF
			CWTF	No CWTF	
Silver nitrate from X-Ray dept.	X-Ray deptt.	-	-	-	Formal recycling
Broken ther-mometers and sphygmoma-nometers	All wards & departments	Collected safely in mercury spill kits	-	-	Hazardous land filling
Chemicals used in production of biologicals, used in disinfection or as insecticides	Hospital Stores	-	Send for incineration or secured landfilling	-	Send for incineration or secured landfilling
Discarded expired infected blood or its products	Blood bank	5% hypochlorite solution for 30 minutes	Autoclaved at common treatment facility	Liquid discarded in drainage after disinfection	Liquid discarded in drainage after disinfection
Waste stationery from office	Office	-	Formal recycling	Formal recycling	
Intact glass tubes, petri dishes, empty glass bottles	Lab.	5% Hypochlo-rite for 30 minutes	Autoclaved in CSSD	Autoclaved in CSSD	Recycled in hospital

4.4 Treatment and disposal

The final step for rendering the bio-medical waste non-infectious is its treatment and disposal. There are different treatment and disposal options available according to the Bio-Medical Waste Rules. The final disposal can either be carried out in the health-care facility, or the facility can tie up with a Common Bio-Medical Waste Treatment Facility (CWTFs).

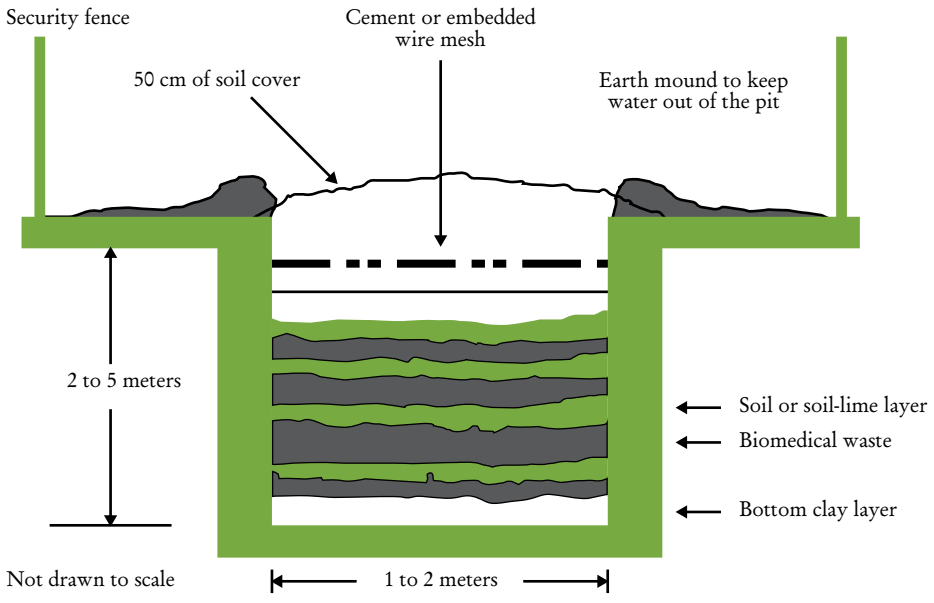
- *Chemical disinfection*: This is the process of chemically disinfecting the waste by use of disinfectants such as bleaching powder, 1 percent sodium hypochlorite, etc. While using chemical disinfection it is important to achieve the proper concentration and contact time with the waste. The advantages of chemical disinfection are that it is easy to use, has low cost of operation, requires no electricity and can be carried out at the point of generation.
- *Incineration*: This is a high-temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight. However, due to the hazardous emissions associated with incineration and the high cost of treatment, incineration is not a preferred option any longer.
- *Autoclaving*: Autoclaving is an efficient wet thermal disinfection process that disinfects the waste using steam sterilization at 121°C for 60 one bar (100k Pa) pressure. This technology is user-friendly, easy to operate and is a low-cost form of treatment.
- *Hydroclaving*: This is an advanced form of autoclaving where the waste is not in direct contact with steam and it is fragmented into small pieces at the time of disinfection.

- *Microwaving*: Microwave disinfection is a steam-based process wherein disinfection occurs through the action of moist heat and steam generated by microwave energy. The technology is automated and easy to use but has a slightly higher cost of operation.
- *Deep burial*: After disinfection, the bio-medical waste can be sent for deep burial. The cost of construction of the waste pit varies between INR 5000-10000/- depending on its size and the material of construction. The average life of a deep burial pit in a PHC is between one to five years. The health-care facilities can construct a deep burial pit as per the standards specified in the Bio-Medical Waste Rules.

Specifications for a waste burial pit[9]

1. A pit or trench should be dug about 2 meters deep. It should be half-filled with waste, and then covered with lime up to 50 cm of the surface, before filling the rest of the pit with soil.
2. Animals should not have any access to the waste burial sites. Covers of galvanized iron/wire meshes may be used to protect the area from trespassing.
3. On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.
4. Waste disposal into the pits should be performed under close and dedicated supervision.
5. The deep burial site should be relatively impermeable and no shallow well should be close to the site.
6. The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.
7. The location of the deep burial site should be authorized by the prescribed authority.
8. The institution should maintain a record of the kind of waste sent for deep burial.

***Figure 4:** Deep burial pit*



9 *Infection Management Environment Plan, Policy Framework*. Ministry of Health and Family Welfare, Govt. of India, March 2007.

Table 7: Overview of waste treatment and disposal technologies[10]

Indicator → Technology ↓	Availability	Acceptability	Access	Sustainability	Occupational safety	Regulatory acceptance
Needle Destroyer/ Cutter (for Sharps)	Easy availability, many vendors and local manufacturing.	Easy to operate.	Easily accessible by health care workers at each point of generation.	Low initial and operating cost but frequent maintenance required.	Safe for health-care workers.	Used for mutilation of sharps at the point of generation.
Autoclave	Easy availability, many vendors and local manufacturing.	Easy to operate, ensures sterilization of waste and regulatory compliance; after shredding the waste is acceptable for reprocessing	Easy access when located in a centralized facility or the capacity of the machine is large enough to be shared by other institutions	Medium to high capital cost, low operating cost, and regular maintenance required; Operators training essential.	Safe for health-care workers.	Approved technology. All kinds of waste but for anatomical, genotoxic and cytotoxic can be treated
Hydroclave	Easy availability, couple of vendors and local manufacturing.	Easy to operate, ensures sterilization of waste and regulatory compliance, waste is acceptable for reprocessing.	Easy access when located in a centralized facility or the capacity of the machine is large enough to be shared by other institutions.	Medium to high capital cost, low operating cost, and regular maintenance required. Operators training essential.	Safe for health-care workers.	Approved technology. All kinds of waste but for anatomical, genotoxic and cytotoxic can be treated.
Microwave	Easy availability, couple of vendors and mostly imported machines.	Easy to operate, ensures sterilization of waste and regulatory compliance, waste is acceptable for reprocessing (*metal sharps are presently not treated due to apprehension of sparks*).	Easy access when located in a centralized facility or the capacity of the machine is large enough to be shared by other institutions.	Medium to high capital cost, high operating cost, and regular maintenance required. Operators training essential.	Safe for health-care workers.	Approved technology. All kinds of waste but for anatomical, genotoxic and cytotoxic can be treated.
Chemical Disinfection	Easily availability, many vendors, local manufacturing.	Easy to use, disinfects the waste, regulatory compliance, waste is acceptable for reprocessing.	Easy access at different points of waste generation in both primary and tertiary care settings.	Low capital and running cost.	Safe for health-care workers.	Approved technology. Used for treating soiled waste, sharps and liquids.

10 Adopted from Safe Management of Bio-Medical Sharps Waste in India. WHO-SEARO, 2005.

Indicator → Technology ↓	Availability	Acceptability	Access	Sustainability	Occupational safety	Regulatory acceptance
Encapsulation (for sharps)	Can be done in small containers and later be disposed of according to the availability of space.	Simple technique with little investment and does not require skilled manpower.	Is available in a centralized facility, when individual health-care facilities have one.	Low capital and running cost. Need to ensure that the encapsulated sharps are not accessible to scavengers.	Safe for health-care workers and the community.	Does not have a mention in the rules or the guidelines.
Waste burial pit	Due to lack of space, construction of waste burial pit is a major problem.	Simple technique with little investment and does not require skilled manpower.	Due to lack of space, presently individual health-care facilities find it difficult to share with other facilities. Life of the sharps pit is small.	Low initial and running cost. Due to lack of space cannot be sustained for long.	Safe for health-care workers and the community. Need to ensure that the pit is leach-proof and not accessible to scavengers.	Does not have a mention in the rules but the guidelines mention the deep burial of sharps.
Double chamber, pyrolitic incineration	Technology widely available now.	Requires engineering skills for operation and maintenance. Skilled manpower required for supervision. Good disinfection efficiency and large reduction in waste volume is achieved.	Suitable for medium to large facilities or as CWTF for treatment of moderate to large amount of waste.	Moderate capital and operating cost. Costs reduced by establishing CWTF. Require set up in designated area.	Safe for health-care workers provided appropriate PPE and Standard Operating Procedures are followed.	Approved technology, specific guidelines available. Approved for infectious waste.
Deep burial pits	Simple to construct. Due to lack of space construction of sharps pit is a major problem in cities, hence suitable for rural and remote areas. Unsuitable for specific terrains e.g. high water table near sea, deserts, hills.	Simple technique with little investment and does not require skilled manpower.	Due to lack of space presently individual health-care facilities find it difficult to share with other facilities. Life of the burial pit is small.	Low initial and running cost. Due to lack of space cannot be sustained for long.	Safe for health care workers and the community. Need to ensure that the pit is leach-proof and not accessible to scavengers.	Approved by legislation. Standardized guidelines for construction and operation present.

5. STEP 5: Monitoring, reporting and feedback

Monitoring and reporting protocols for infection control and waste management should be institutionalized into the waste management plans from the time of inception of the plan. Regular monitoring by the members of the waste management committee, different health-care workers, external agencies and self-monitoring will help in establishing a sound waste management system.

Records on the quantity of waste generated, different worker practices and accident reporting should be maintained at each point of waste generation. In case of any emergency, protocols specifying the immediate actions and long-term actions must be developed by the facility. Monitoring and reporting protocols provide feedback about the waste management system and help in improving the system. To effectively monitor the system, other than just physical monitoring, a waste-tracking software needs to be installed at each nursing station which will maintain records and raise an alarm in case of any mismanagement.

The waste management plan cannot be complete without the mention of proper sanitation systems. As poor sanitation and water quality results in a large number of infections, health-care facilities need to take mitigation measures that comply with national standards. Prototype designs of wastewater sewerage system for various groups and types of health-care facilities could be developed and implemented for onsite disposal or treatment of wastewater. Further initiatives need to be taken by the state governments to improve the overall situation of water quality and sanitation in the state.

5.1 Monitoring and reporting checklist

- Points of waste generation;
- Sharps management;
- Waste collection and transportation in appropriate containers;
- Use of Personal Protective Equipment;
- Staff immunizations;
- Accident reporting;
- Authorization;
- Final treatment and disposal;
- Infection control and hand-washing measures;
- Hygiene and sanitation.

6. STEP 6: Sustaining the system

***Recognition*:** In order to encourage setting up of infection control and waste management systems, trophies, awards and incentives for good performance should be introduced. This will boost the morale of health-care workers and help achieve a better waste management.

Budget allocation: A dedicated system of funding has to be allocated to waste management and infection control activities to sustain and improve the waste management system further.

Ongoing efforts: Along with ongoing training and monitoring, it is important to look at the problem of health-care waste management in a holistic manner. It needs to be integrated with water and sanitation, patient safety and infection control all of which are important factors to fight infections in health-care facilities. Safety is a fundamental principle of patient-care and a critical component of quality management. Its improvement demands a complex system, wide effort, involving a broad range of actions in performance improvement, environmental safety and risk management, including infection control, safe use of medicines, equipment safety, and safe clinical practice. The various issues that need to be looked into for sustained health-care waste management, patient safety and infection control measures broadly include:

- Regular update/review of the infection control measures;
- Adhering to universal precautions;
- Emphasis on hand washing;
- Monitoring of infectious agents;
- Identifying hazards as well as the steps to reduce them;

- Blood safety measures;
- Injection safety policy;
- Architectural modifications for patient safety;
- Hygienic environment;
- Sharps management;
- Accident reporting and post exposure prophylaxis;
- Appropriate staff health program;
- Immunizations and vaccinations for health-care workers;
- Waste minimization;
- Elimination of mercury from health care settings;
- Switching to energy efficient systems and reducing the carbon footprints of the facility.

VI

Infection Management and Environment Plan

The Infection Management and Environment Plan (IMEP) was developed by the Ministry of Health and Family Welfare (MoHFW) in 2004 under the Reproductive and Child Health Program. The document was developed with technical assistance from the World Bank and DfID. IMEP provides a structured and systematic approach to manage the environmental and public health risks associated with health-care activities. It describes appropriate disinfection and sterilization techniques, management of nosocomial infection control and maintenance of sanitary conditions, appropriate technology, basic infrastructural requirements for delivery of primary services, good occupational work practices and the effective institutional framework required to manage these risks effectively.

The IMEP comprises two volumes:

- A Policy Framework document which gives a broad overview and contains generic guidance to central and state level institutions on the type of systems and processes to be established for infection control and bio-medical waste management.
- A set of Standard Operational Guidelines which are designed as instruction manuals for healthcare workers at primary level health-care facilities, i.e. Community Health Centers, Primary Health Centers and Sub Centers. These guidelines are in the form of simple pictorial representations of the various steps needed to manage infectious waste in a hygienic, safe and environmentally sound manner.

Since its publication and wide-scale dissemination, the IMEP Guidelines have been implemented and monitored under the auspices of the National Rural Health Mission (NRHM) and has made headway in internalizing good practices in managing health and environment risks in the health- care institutions across India.

VII

Selection Criteria for Health-Care Waste Treatment Technologies

These selection criteria for health-care waste treatment technologies have been prepared under the Global Project on Health care Waste Management, funded by GEF/UNDP[11]. These criteria can be used as the basis for the Terms of Reference and technical specifi cations in for an impartial and systematic process for the selection of the technologies.

*Table 8: Technical selection criteria for bio-medical wastes: Autoclaves**

Criterion	Units	Basis for selection	Priority
Related to size			
Capacity	kg/hour	Closest value to capacity calculated from base-line assessment	High
Typical operating cycle (for batch systems only)	Minutes	The lower the better	High
External dimensions (length x width x height)	mm	The smaller the better	Low
Related to design			
Type of autoclave (gravity or vacuum)	Description	Multiple vacuum > pre/post vacuum > pre-vacuum > gravity displacement	High
Material of construction of the sterilization chamber	Type of metal	Stainless steel for the inside walls that are in contact with steam	Medium
Typical service life of equipment	Years	The longer the better	High
Maximum rated pressure	In psig or kPa gauge	The higher the better	Medium
Type of chamber door	Description	Rotating locking ring breech-lock or wedge-lock, radial locking wheel, multiple locking nuts (evaluate safety, ease of opening, minimum maintenance)	Medium

11 www.gefmedwaste.org

Criterion	Units	Basis for selection	Priority
Steam generation	Specification	High efficiency boiler	Medium
Electrical requirements can be adapted to 220V, 50 Hz, single-phase	Yes or No	Yes	High
Availability of optional features and auxiliary equipment	List the available features and auxiliary equipment	For example: autoclavable bins or autoclavable carts, tracks or lift tables, automatic loaders, conveyors, odor removal, cart washing equipment, etc.	
Related to operating parameters			
Range of working pressures	In bar, psig, mm Hg or kPa gauge	1 to 2 bar gauge, or 15 psig to 30 psig, or 1540 to 2280 mm Hg absolute, or 103 – 207 kPa or higher	High
Range of working temperatures	°C	121 – 134 °C or higher	High
For vacuum autoclaves: vacuum level	Negative pressure	The higher the vacuum the better	Medium
Related to safety and ergonomics			
Number and description of safety features to prevent overpressure	Description	At least two safety features: a pressure release valve plus a spring-loaded safety release valve or replaceable rupture disk; the more safety features for overpressure the better	High
Worker safety features	Description	Insulation to maintain low surface temperatures and prevent burns, door interlock to prevent opening chamber when under pressure, ergonomic design	High
Ease of placement and removal of waste	Description	The easier the better	Medium
Ease of operation	Description	Computer controls to minimize operator error, simple electronic controls, ergonomic design	Medium
Related to standards			
Data on microbial inactivation efficacy showing compliance with STAATT II or III standard	Test results showing compliance	Test by regulatory authority or certified lab; test by independent third party; test by hospital;, test by vendor (evaluate also challenge test procedure)	High
Compliance with international standards for pressure vessels	Specify	Compliance with EN 13445, EN 285 and/or ASME section VIII or equivalent	High
Related to procurement, vendor, and cost			
Equipment cost and freight	USD/local currency	Lowest price	High
Delivery time for equipment after order is placed	Weeks	The shorter the better	Medium
Cost of spare parts, including most common maintenance items (e.g., gaskets and heating elements)	USD/local currency (unit cost of spare parts)	The lower the better	Medium
Cost of optional features and auxiliary equipment	USD/local currency (unit cost of features and auxiliary equipment)	Lowest cost for autoclavable bins or autoclavable carts, automatic loaders, odor control, cart washing equipment, etc.	Medium
Equipment warranty	Provisions	Evaluate coverage and length of time of warranty	High

Criterion	Units	Basis for selection	Priority
Local Vendor/Representative of vendor in the region	Yes or No	Yes	High
Track record and history of the vendor/manufacturer	Description	Good track record; The longer in business the better	Medium
Customer service		Evaluate	Medium
Number of existing installations of the technology in operation	List of installations or customers	Evaluate list	Medium
Related to installation, maintenance, and repair			
Ease of installation	Description	Site installation requirements, typical length of time for installation	Medium
Installation, maintenance, and repair manual	Description	The more comprehensive the better	Medium
Ease of replacement of heating elements and gaskets	Description	The quicker the better	Medium
Availability of technical support and repair technician in the region	Yes or No	Yes	High
RELATED TO TRAINING			
Training of maintenance and repair technician provided?	Yes or No	Yes: included in package	Medium
Operator training	Yes or No	Yes: included in package	High

* The World Bank does not recommend any specific technology.

***Table 9:** Technical selection criteria for bio-medical waste shredder*

Criterion	Response	What we need	Priority
Related to size			
Approximate capacity	kg/hr	Closest value to capacity calculated from baseline assessment	High
Hopper opening (length x width)	mm	The larger the better	High
Throat opening (length x width)	mm	The larger the better, but depends on cutter geometry	Medium
Screen size	mm	10 to 20 mm	Medium
External dimensions (length x width x height)	mm	The more compact the better	Low
Related to design			
Specially designed for shredding all types of medical waste	Yes or No	Yes	High
Type of shredder	Description	Usually, multiple shaft shredders are better	medium
Typical service life of equipment	Years	The longer the better	High
Number of cutters/knives and cutter geometry	Description	Evaluate	Medium
Drive motor horsepower	HP or kW	The higher the better	High
Hydraulic ram to push waste	Yes or No	Yes	Medium
Rotor bearing	Description	High quality with long service life; evaluate	
Vibration damping	Description	Evaluate	

Criterion	Response	What we need	Priority
Reinforcements	Description	Evaluate	
Materials of construction	Description	Corrosion resistant, durable, heavy duty	
Electrical requirements	Voltage, frequency, phase	230V, 50 Hz, single-phase	High
Other features	Description	Automatic bin-loader, self-cleaning, conveyor, magnetic separator, liquid waste, etc.	Low
Related to safety and ergonomics			
Safety feature: protection of worker from projectiles from the hopper	Description	Evaluate	High
Safety feature: emergency cut-off switch	Yes or No	Yes, easily accessible to the operator	High
Safety feature: lock or security switch to prevent unauthorized use	Yes or No	Yes	Medium
Safety feature: rails, shields, and other barriers to protect the operator	Description	Evaluate	High
Safety feature: hopper viewing mirror	Yes or No	Yes	Low
Special features for bio-medical waste	Description	Shaft protection for excessive torque or overload protection, cutting blade protection for hard waste	High
Special features for bio-medical waste	Description	Auto-reverse feature to disentangle soft waste	High
Noise level during operation	dB	The lower the better	Low
Ease of operation	Description	Computer/electronic controls, ergonomic design	Medium
Ease of introducing waste into the hopper	Description	Evaluate	Medium
Ease of removal of shredded waste bin		The easier the better	Low
Related to procurement, vendor, and cost			
Equipment cost and freight	USD/local currency	Lowest price	High
Delivery time after placement of order	Weeks	The shorter the better	Medium
Cost of spare parts including replacement cutters or knives, belts, and screens	USD local currency (unit cost of spare parts)	The lower the better	Medium
Cost of optional features and auxiliary equipment	USD/unit currency (unit cost of features and auxiliary equipment)	Lowest cost for automatic bin-loader, self-cleaning system, conveyor, magnetic separator, liquid waste management system, etc.	Low
Equipment warranty	Provisions	Evaluate coverage and length of time of warranty	High
Local vendor/Representative of vendor in the region	Yes or No	Yes	High

Criterion	Response	What we need	Priority
Track record and history of the vendor/manufacturer	Description	Good track record; The longer in business the better	Medium
Customer service		Evaluate	Medium
Number of existing installations of the technology in operation	List of installations or customers	Evaluate list; verify maintenance requirements and equipment life span	Medium
Related to installation, maintenance, and repair			
Ease of installation	Description	Site installation requirements, typical length of time for installation	Medium
Maintenance and repair manual		Evaluate maintenance requirements and manual	Medium
Ease of repair		Evaluate repair manual	Medium
Ease of replacement of cutters or knives, belts, and screens	Description	The quicker the better	High
Availability of technical support and repair technician in the region	Yes or No	Yes	High
Related to training			
Training of maintenance and repair technician provided?	Yes or No	Yes: included in package	Medium
Operator training	Yes or No	Yes: included in package	High

Table 10: *Technical selection criteria for advanced steam systems (hybrid autoclaves) and microwave units*

Criterion	Units	Basis for selection	Priority
Related to size			
Capacity	kg/hour	Closest value to capacity calculated from baseline assessment	High
External dimensions (length x width × height)	km	The smaller the better	Low
Related to design			
Type of treatment technology	Description	Evaluate	Low
Technical capacity to treat pathological waste (i.e., anatomical waste, tissue, body parts)	Yes or No	Evaluate	High
Typical operating cycle (for batch systems only)	Minutes	The lower the better	High
Type of internal shredding or mixing in the treatment chamber, if applicable	Description	Evaluate	High
Material of construction of the sterilization chamber	Type of metal	Stainless steel for the inside walls that are in contact with steam	Medium
Typical service life of equipment	Years	The longer the better	High
Type of chamber door (*if the system operates above atmospheric pressure only*)	Description	Rotating locking ring breech-lock or wedge-lock, radial locking wheel, multiple locking nuts (evaluate safety, ease of opening, minimum maintenance)	Medium
Steam or microwave generation	Specification	Efficiency of boiler or magnetron	Medium

Criterion	Units	Basis for selection	Priority
Electrical requirements can be adapted to 220V, 50 Hz, single-phase	Yes or No	Yes	High
Availability of optional features and auxiliary equipment	List the available features and auxiliary equipment	For example: bins or carts, automatic loaders, conveyors, odor removal, cart washing equipment, etc.	
Related to operating parameters			
Range of working pressures (*for systems that operate above atmospheric pressure only*)	In bar, psig, mm Hg or kPa gauge	1 to 2 bar gauge, or 15 psig to 30 psig, or 1540 to 2280 mm Hg absolute, or 103 – 207 kPa or higher	High
Temperature range which the waste is exposed to	°C	The higher the better	High
For systems that use a vacuum in the treatment chamber: vacuum level	Negative pressure	The higher the vacuum the better	Medium
Related to safety and ergonomics			
Number and description of safety features to prevent overpressure (*for systems that operate above atmospheric pressure only*)	Description	At least two safety features: a pressure release valve plus a spring-loaded safety release valve or replaceable rupture disk; the more safety features for overpressure the better	High
Worker safety features	Description	Evaluate	High
Ease of placement and removal of waste	Description	The easier the better	Medium
Ease of operation	Description	Computer controls to minimize operator error, simple electronic controls, ergonomic design	Medium
Related to standards			
Data on microbial inactivation efficacy showing compliance with STAATT II or III standard, especially in relation to pathological or surrogate animal waste	Test results showing compliance	Test by regulatory authority or certified lab; test by independent third party; test by hospital; test by vendor (evaluate also challenge test procedure)	High
Compliance with international standards for pressure vessels (*for systems that operate above atmospheric pressure only*)	Specify	Compliance with EN 13445, EN 285 and/or ASME section VIII or equivalent	High
Related to procurement, vendor, and cost			
Equipment cost and freight	USD/local currency	Lowest price	High
Delivery time for equipment after order is placed	Weeks	The shorter the better	Medium
Cost of spare parts, including most common maintenance items	USD/local currency (unit cost of spare parts)	The lower the better	Medium
Cost of optional features and auxiliary equipment	USD/Local currency (unit cost of features and auxiliary equipment)	Lowest cost for bins or carts, automatic loaders, conveyors, odor removal, cart washing equipment, etc.	Medium

Criterion	Units	Basis for selection	Priority
Equipment warranty	Provisions	Evaluate coverage and length of time of warranty	High
Local Vendor/Representative of vendor in the region	Yes or No	Yes	High
Track record and history of the vendor/manufacturer	Description	Good track record; The longer in business the better	Medium
Customer service		Evaluate	Medium
Number of existing installations of the technology in operation	List of installations or customers	Evaluate list; verify maintenance requirements and equipment life span	Medium
Related to installation, maintenance, and repair			
Ease of installation	Description	Site installation requirements, typical length of time for installation	Medium
Installation, maintenance, and repair manual	Description	The more comprehensive the better	Medium
Ease of replacement of spare parts	Description	The quicker the better	Medium
Availability of technical support and repair technician in the region	Yes or No	Yes	High
Related to training			
Training of maintenance and repair technician provided?	Yes or No	Yes: included in package	Medium
Operator training	Yes or No	Yes: included in package	High

Guidelines on best available techniques for medical waste incineration under the Stockholm Convention

Under the guidelines, "single-chamber, drum and brick incinerators" are not allowed. An incineration plant should consist of the following units:

i. Furnace or kiln as the primary combustion chamber
ii. Afterburning chamber as the secondary chamber
iii. Flue gas cleaning device system
iv. Wastewater treatment plant if a wet flue gas cleaning system is used.

The thermal treatment process used in the furnace or kiln could be one of the following: pyrolysis or gasification, rotary kiln, grate incineration specially adapted for health-care waste, fluidized bed incineration, or modular excess air or controlled air incineration.

Emission limits

For best available techniques, performance levels in air emissions of dioxins should not exceed 0.1 nanograms I-TEQ/normal cubic meter at 11% O_2. Moreover, dioxins in the wastewater of treatment plants treating effluents from any gas treatment scrubber effluents should be well below 0.1 nanograms I-TEQ per liter.

General and organizational measures

When incinerating wastes that contain chlorine and heavy metals (as is generally the case for medical waste), a combination of primary and secondary measures, as described below, are needed to meet the emission limits. Health-care wastes should be incinerated only in dedicated incinerators or in larger incinerators for hazardous waste. If a dedicated incinerator is not used, a separate charging system should be used.

Operation of the incinerator requires trained, qualified personnel. The personnel should wear protective clothing. Periodic maintenance should include cleaning

of the combustion chamber and de-clogging of air flows and fuel burners. As part of secondary measures, frequent cleaning of those sections of the incinerator wherein flue gas passes, especially at the critical temperature range, is important. There should be regular and/or continuous measurement of pollutants, as well as auditing and reporting systems.

Primary measures

The guidelines list the following primary measures to reduce dioxin emissions:

i. Introduction of the waste in the combustion chamber only at temperatures of 850°C; the plant should have an automatic system to prevent waste feed before the above-mentioned temperature is reached.

ii. Installation of auxiliary burners (for start-up and shut-down operations).

iii. Avoidance of starts and stops of the incineration process.

iv. Avoidance of temperatures below 850°C and no cold regions in the flue gas.

v. Control of oxygen input depending on the heating value and consistency of feed material.

vi. Minimum residence time of 2 seconds above 850°C in the secondary chamber after the last injection of air, or at 1100°C for wastes containing more than 1% halogenated organic substances (as is generally the case for medical waste), and 6% oxygen by volume.

vii. High turbulence of exhaust gases and reduction of air excess by injection of secondary air or re-circulated flue gas, pre-heating of the air-streams, or regulated air inflow.

viii. On-line monitoring for combustion control (temperature, oxygen content, carbon monoxide, dust), and operation and regulation of the incinerator from a central console.

Cold starts, upset conditions, and shutdowns generally create the conditions for dioxin formation. Therefore, preheating and initial co-firing with a clean fossil fuel is recommended, and continuous operation (as opposed to batch processes) should be the method of choice. Upsets should be minimized through periodic inspection and preventive maintenance. Operators should not feed waste during severe combustion upsets or during a filter bypass (dump stack) operation.

Secondary measures

In order to reduce dioxin emissions to less than 0.1 ng TEQ/m^3, the secondary measures below (an appropriate combination of dedusting and other equipment to further reduce dioxins) should be applied as best available techniques.

i. *Dedusting:*
   - Fabric filters used at temperatures below 260°C
   - Ceramic filters used at temperatures between 800 to 1000°C
   - Cyclones used for pre-cleaning of flue gases
   - Electrostatic precipitators used at temperatures of around 450°C
   - High-performance adsorption units with activated charcoal (electrodynamic venturi)

ii. *Techniques to further reduce emissions and PCDD/F:*
   - Catalytic oxidation
   - Gas quenching
   - Catalyst-coated fabric filters
   - Different types of wet and dry adsorption systems using mixtures of activated charcoal, coke, lime and limestone solutions in fixed-bed reactors (adsorption with activated charcoal or open hearth coke), moving-bed reactors, or fluidized bed reactors (entrained flow or circulating fluidized beds with activated coke/lime or limestone followed by the use of fabric filters).

Notes: Fabric filters used at temperatures above the critical temperature range for dioxin formation can reduce emissions efficiently. However, the operating temperatures would depend on the type of fabric material used. Cyclones are efficient

only in removing the larger particles. Note that electrostatic precipitators could promote *de novo* synthesis of dioxins especially if operated at the critical temperature range for dioxin formation. Electrostatic precipitators are inefficient for removal of fine particles and may result in higher nitrogen dioxide emissions. High-performance adsorption units with activated charcoal can be used for removal of fine dust.

Disposal of residues

Fly and bottom ash, as well as wastewater, should be treated appropriately. Proper treatment of these residues includes:

- Disposal in safe sanitary landfills (Note: Examples of disposal methods are land filling in proper double-walled containers, solidification and subsequent land filling, or thermal post-treatment).
- Catalytic treatment of fabric filter dusts.
- Scrubbing of fabric filter dusts by the 3-R process (extraction of heavy metals by acids).
- Thermal post-treatment (e.g., rotary kiln or Hagenmeier trommel followed by a fabric filter and scrubber; plasma technology).
- Vitrification of fabric filter dusts and subsequent land filling.
- Immobilization methods (e.g., solidification with cement) and subsequent land filling.

Bottom and fly ash should be handled, transported and disposed of in an environmentally sound manner, including the use of covered hauling and dedicated sanitary landfills.

Monitoring

With regards to monitoring, carbon monoxide, oxygen in the flue gas, particulate matter, hydrogen chloride, sulfur dioxide, nitrogen oxides, hydrogen fluoride, airflows and temperatures, pressure drops, and pH in the flue gas should be routinely monitored.

Periodic measurement or semi-continuous measurement (continuous sampling and periodic analysis) of polychlorinated dioxins and furans help insure that the incinerator is operating properly. Unfortunately, sampling and analysis of dioxins are difficult and expensive for most developing countries. In general, stack sampling requires 4 to 8 hours of continuous iso-kinetic sampling, and analysis is carried out using high resolution gas chromatography-high resolution mass spectrometry. Stringent quality control procedures are required. For waste incinerators with a capacity of less than 2 tons per hour, simplified bioassay methods for dioxins could be used for periodic measurements.

VIII

Wastewater Treatment Systems in Health-Care Facilities

The following section focuses on the requirements for starting wastewater treatment plants in health-care facilities and describes the various parameters for analysis of wastewater from health-care facilities.[12]

Efficient on-site treatment of health-care wastewater should include the following operations:

1. Primary treatment

To prevent the damage or clogging of the wastewater treatment equipment and to produce a generally homogeneous liquid capable of being treated biologically, a mechanical treatment is carried out. A raked screen is used to remove large objects; afterwards the velocity of incoming wastewater is reduced to allow the settlement of sand, grit and stones. For the skimming of floating material such as grease and plastics and to allow fecal solids to settle, primary sedimentation tanks are installed.

2. Secondary treatment

The task of the secondary treatment is the removal of dissolved carbon and nitrogen components by microbes. The bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc particles. For mineralization and nitrification the micro-organisms require oxygen and a substrate on which to live. To provide these two essentials, different systems are available which can be divided in fixed film systems or suspended growth systems.

In fixed film systems such as trickling filters, rotating biological contactors, fluidized bed reactors or biological aerated filters, the biomass grows on media and the sewage passes over its surface. Oxygen is either supplied to the biota by spraying or trickling the wastewater over the filter materials or the systems are mechanically aerated.

In suspended growth systems the biota is living on the sludge (called activated sludge). The activated sludge is mixed with the sewage and is aerated in a tank or basin. In a clarifier, the activated sludge can settle and is returned to the aeration tank. Typical systems are activated sludge plants or surface-aerated basins.

12 (Extracted from WHO –'Safe Management of Wastes from Health Care Activities', UNDP/GEF project documents, Guidelines for Healthcare Wastewater Management, prepared by ET Log, Germany).

As fixed-film systems are more able to cope with drastic changes in the amount of biological material, can better adjust to specific wastewater and can provide higher removal rates for organic material and suspended solids, these systems are normally used for health-care wastewater treatment.

To remove nitrogen a biological oxidation of nitrogen from ammonia to nitrate takes place by nitrification involving nitrifying bacteria such as Nitrospira and Nitrosomonus. This is followed by the reduction from nitrate to nitrogen gas (de-nitrification), which is released to the atmosphere. De-nitrification requires anoxic conditions and might be carried out during the tertiary treatment in a sand filter or a reed bed. Nitrification and de-nitrification requires carefully controlled conditions to encourage the appropriate biological communities to form.

3. Tertiary treatment of wastewater

Tertiary treatment, also called "effluent polishing" is the final step in the wastewater treatment process before the effluent is discharged to the receiving environment. More than one tertiary treatment process can be used. If disinfection of the effluents as the final treatment step is required, always another step to remove suspended organic matter must be carried out prior to the disinfection.

To remove suspended organic matter, sand filtration, lagooning by means of planted horizontal gravel filters can be done. Also constructed wetlands and engineered reed bed systems are in use today.

Disinfection of wastewater from health-care establishment is often required and should be carried out, especially if the wastewater is discharged into any water body used for recreational activities or used as a source of drinking water (including aquifers). Disinfection of the wastewater is particularly important if it is discharged into coastal waters close to shellfish habitats, especially if local people are in the habit of eating raw shellfish.

Before the wastewater treatment facility becomes operational, it is essential to analyze wastewater samples of the health-care facility in order to determine if the proposed facility can effectively treat the wastewater produced according to the required regulations. The data thus collected will be supplemented into the wastewater treatment plant operating procedures.

Figure 5: *Thematic representation of wastewater treatment process*

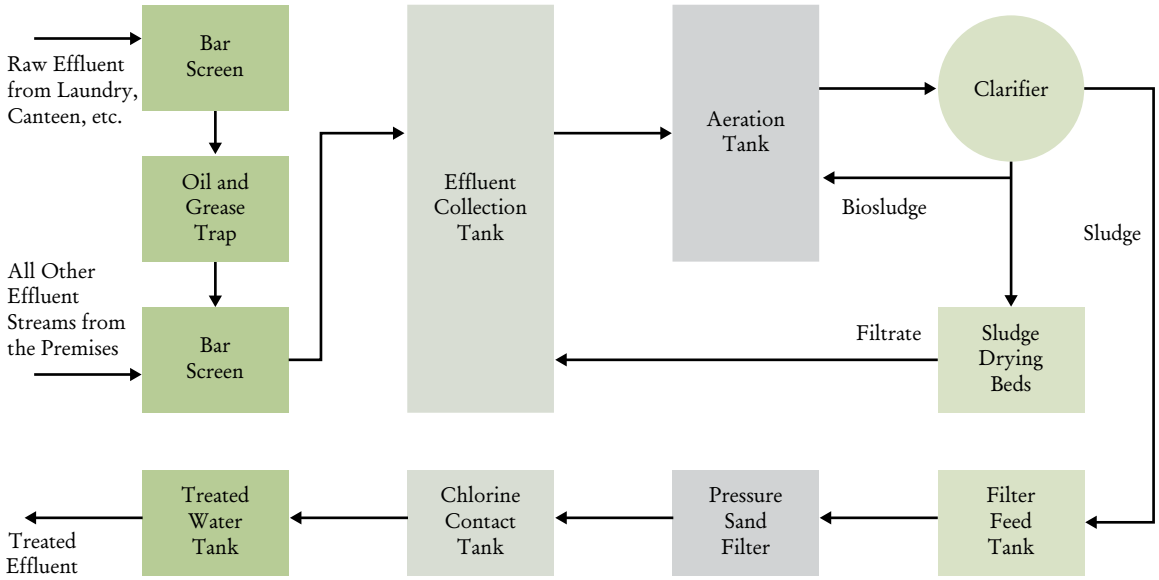
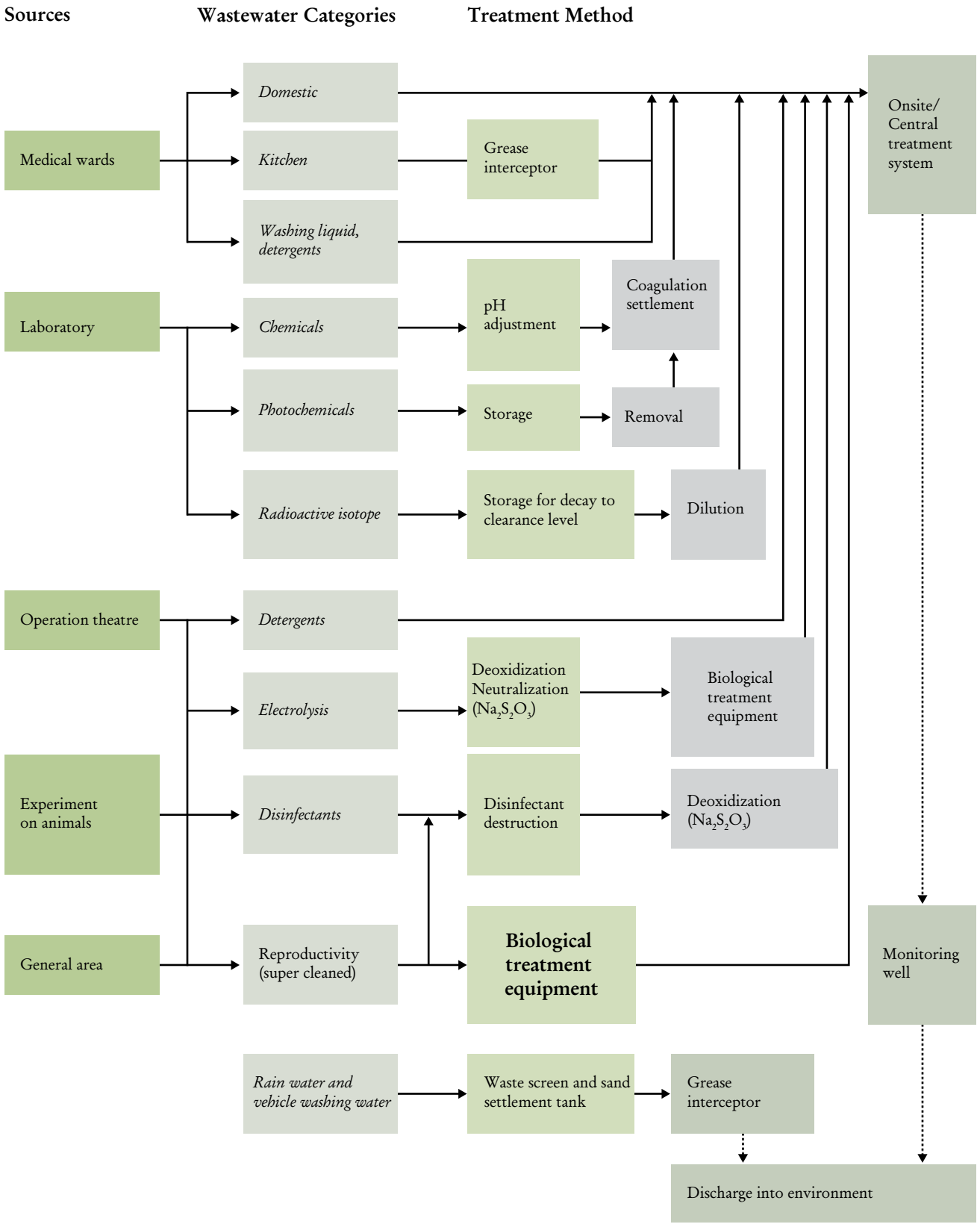


Figure 6: Organizational structure for health-care wastewater treatment



The table below gives a list of parameters that should be considered in the testing of wastewater from general hospitals. These parameters are based on an EU directive,[13] an EPA study in 1991,[14] and on pollutants that may be reasonably expected to be found in hospital wastewater.

***Table 11:** Suggested parameters for the analysis of wastewater from health-care facilities*

Parameter	Concentration	Reference
pH	6-9 is a typical acceptable range*	
BOD5 at 20°C	25 mg/l O_2	EU Council Directive 91/271/EEC
COD	125 mg/l O_2	EU Council Directive 91/271/EEC
Total suspended solids	35 mg/l	EU Council Directive 91/271/EEC
Oils and grease (also called fats/oils/grease or FOG)	100 mg/l	From North Carolina Department of Environment and Natural Resources[15]
Phosphate or total phosphorus	6-15 mg/l is the range for several US cities	Major pollutant found in hospitals by EPA (see footnote 14)
Surfactants	See examples*	Major pollutant found in hospitals by EPA (see footnote 14)
Phenols	See examples*	Major pollutant found in hospitals by EPA (see footnote 14)
Formaldehyde	0.1 mg/l (based on the 96-hr LC50 environmental toxicity to blue gill)	Major pollutant found in hospitals by EPA (see footnote 14)
Fluoride	See examples*	Major pollutant found in hospitals by EPA (see footnote 14)
Arsenic, barium, cadmium, chromium (total), copper, iron, lead, nickel, selenium, silver, and zinc	See examples*	Major pollutant found in hospitals by EPA (see footnote 14)
Mercury	See examples*	GEF project and WHO
Trihalomethanes and chlorinated organics	(0.08 for trihalomethanes**)	Major concern since chlorinated organics can lead to dioxin formation in wastewater
Haloacetic acid and trichlorophenols	(0.06 for haloacetic acid**)	Major concern since trichlorophenols can lead to dioxin formation in wastewater
Ammonia	See examples*	Ammonia in the wastewater is expected
Nitrate	See examples*	Nitrates expected due to ammonia and other nitrogen compounds
Fecal coliform	See note below***	Expected in hospital wastewater**
Total coliform	See note below***	Expected in hospital wastewater**

* For examples of concentration limits, see examples below for the EU, two cities in the US and Canada, the Philippines, and various countries in Latin America.

** These values are for informational purposes only and may not apply to wastewater since they are based on the Maximum Contaminant Levels (MCLs) for *drinking* water in the US as regulated by the US EPA.

*** If the wastewater goes directly to a river or coastal waters without treatment, the coliform count should be tested. Also, if the wastewater goes directly to a river or coastal waters without treatment, other microorganisms of interest should be tested: pathogenic *E. coli*, enterococci, *Clostridium perfringens*, and *aeromonas* are the typical indicator species tested in wastewater.

13 EU Council Directive 91/271/EEC http://ec.europa.eu/environment/water/water-urbanwaste/directiv.html

14 In a study by the US EPA of hospital wastewater, the following pollutants were found to have the highest average concentrations: total dissolved solids, chemical oxygen demand (COD), phosphate, surfactants, formaldehyde, phenol, and fluoride. In addition, the most frequently detected pollutants in hospital wastewater were: COD, phenol, silver, lead, copper, and zinc. Other pollutants found were: total chromium, nickel, arsenic, cadmium, selenium, and mercury. Reference: "Supplemental Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program: Residential and Commercial Toxic Pollutant Loadings and POTW Removal, US EPA, Office of Water Enforcement and Compliance, May 1, 1991 http://www.epa.gov/npdes/pubs/owm0013.pdf

15 "Considerations for Management of the Discharge of FOG to Sanitary Sewer Systems," Appendix F, NC Department of Environment and Natural Resources, North Carolina, USA, June 2002.

4. Sampling and frequency of testing wastewater

Flow-proportional or time-based 24-hour samples should be collected at the same well-defined point in the outlet. Flow-proportional or time-based sampling is generally done using an automatic sampler linked to a flow meter or timer. International standards for laboratory practices to minimize degradation of samples between collection and analysis should be followed. These include following recommended sample containers, preservation techniques, and maximum holding times.

The frequency of testing is generally based on population equivalent (p.e.), also called the unit per capita loading. The p.e. refers to the ratio of the organic biodegradable load produced during a 24-hour period by the facility in relation to the individual organic biodegradable load in household sewage produced by one person in the same period of time. For calculations, one unit is generally assumed to be equal to 54 g of BOD per 24 hours or a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per 24-hour day. The BOD5 values for a wide range of hospitals correspond to about 3 p.e. per patient.[16] Thus, the sewage treatment plant for a 700-bed hospital would be equivalent to a very small urban wastewater treatment plant (2000 to 9999 p.e.). For this size, EU Council Directive 91/271/EEC requires 12 samples for the first year and four samples in subsequent years if the effluent complies with all the provisions. If one of the four samples fails, 12 samples have to be taken the following year. Some regulatory authorities may allow a deviation of individual parameters not exceeding 100% or may require that the annual average conform to the parametric value.

5. Wastewater treatment plants for smaller health-care facilities[17]

The size of the liquid disinfection unit is determined according to the size of the facility and quantity of liquid waste generated. Separate plumbing is done to carry the bio-medical liquid waste to the disinfection unit uniquely designed for the purpose which is approved by Karnataka State Pollution Control Board. These designs have been implemented under the World Bank funded Karnataka Health System Development & Reform project. The design allows sufficient contact time between the liquid waste and chlorine for effective disinfection, and is innovative in that it has no moving parts.

Figure 7: *Liquid disinfection unit for small facilities (10 beds and below)*

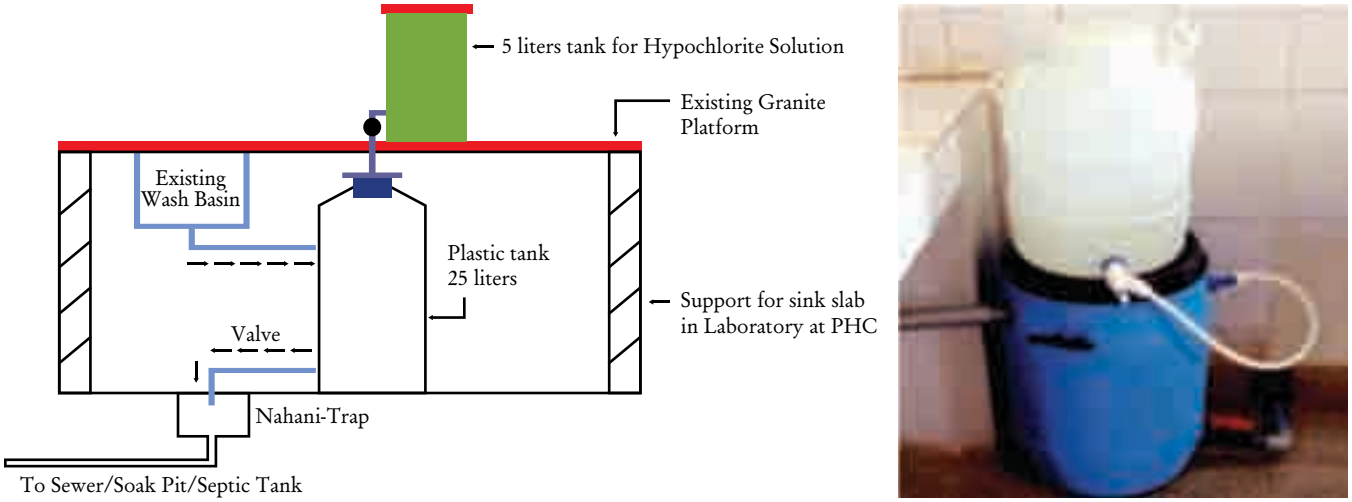


Photo credit: World Bank Missions

16 "Hospital effluents as a source of emerging pollutants: An overview of micropollutants and sustainable treatment options," P. Verlicchi et al., *Journal of Hydrology*, 389, 416–428 (2010).

17 From Karnataka Health System Development & Reform Project.

The operational guidelines

Step 1: Fill the top 5 liter can with 1% hypochlorite solution.

Step 2: Start collection of the liquid bio-medical waste from the wash basins to the 50 l can below and keep the outlet valve closed.

Step 3: Drain the 1% solution from the 5 l can to the 50 l can and adjust the quantity of the solution such that it contains > 2 mg/l of chlorine next day morning. The residual chlorine should be measured using a Chloroscope.

Step 4: Open the outlet valve of the 50 l can every day morning so that entire disinfected liquid is drained to the sewer.

Step 5: Close the outlet valve of the 50 l can and start filling the liquid bio-medical waste.

Repeat every day. Keep the records for the consumption of the bleaching powder/Chlorine solution daily for the verification.

Figure 8: *Liquid disinfection unit for small facilities (30-400 beds)*

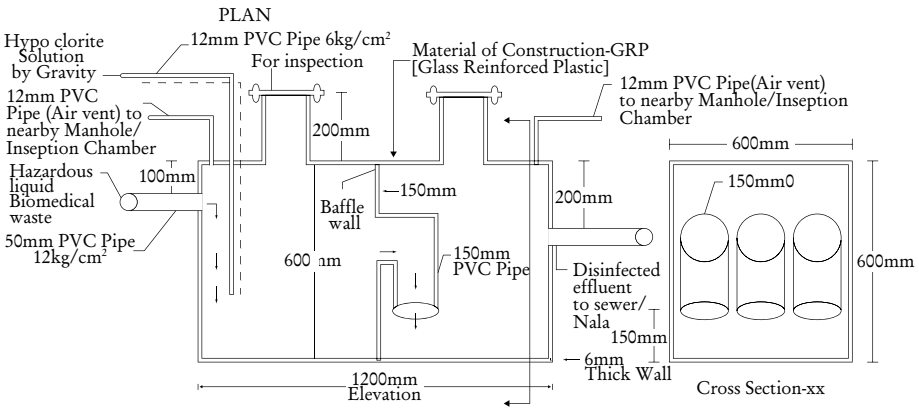


Photo credit: World Bank Missions

The operational guidelines

Step 1: Fill the top 10 liter can with 1% hypochlorite solution.

Step 2: Drain the liquid bio-medical waste from the wash basins to the disinfection unit provided.

Step 3: Drain the 1% disinfection solution from the 10 l can to the disinfection unit provided and adjust the quantity of the solution such that out flowing effluent contains >1 mg/l of chlorine by trial and error. The residual chlorine should be measured using a Chloroscope.

Repeat every day. Keep the records of the receipts and consumption of the bleaching powder/Hypochlorite solution daily for the verification.

Note: Sewage should not be allowed inside disinfection unit.

IX

Costs of Health-Care Waste Management

All hospitals need to establish accounting procedures to document the costs they incur in managing health-care waste. Accurate record-keeping and cost analysis must be undertaken by a designated individual. Health-care waste costs should be the subject of a separate budget line; this allows costs for different periods to be compared and helps to reduce management costs.

Table 12: Cost of construction and operation of a health-care waste treatment plant[18]

Site Cost of land Rights of way Site preparation and infrastructure Provision of utilities to site	**Direct operating costs** Manpower requirements (manager, operators, drivers etc.) Yellow bags with tags for infectious wastes Black bags for non-risk waste Sharps containers Transportation costs Utilities (fuel, water, electricity) Chemicals (for flue-gas cleaning)
Consultancy fees Environmental/waste management consultant Engineering Architectural Legal fees	
Infrastructure costs Building for treatment technology such as incinerator and autoclave Waste storage room Offices	**Indirect operating costs** Training Treatment technology (such as incinerator's and autoclave's) maintenance and parts replacement Vehicle maintenance Uniforms and safety equipment Ash disposal cost Compliance monitoring of flue-gas emissions Project management and administrative costs for the organization responsible for the execution and long-term operation of the project
Treatment technology cost Cost of incinerator, autoclave or any other technology Freight and storage charges	
Waste transport costs Waste collection trucks Bins/containers for transporting waste from hospitals to incinerator site	

18 Adapted from Safe Management of Health-Care Waste, WHO, 1999.

Table 12: Cost of construction and operation of a health-care waste treatment plant (Contd...)

Equipment costs Trolleys for collecting waste bags from wards Bag-holders to be located at all sources of waste in hospitals Weighing machines for weighing waste bags Refrigerators for storage of waste if necessary	
Financing charges Interest Taxes Accounting and audit fees	

The above box lists the elements that should be included in the cost assessment for – in this example – a health-care waste management system comprising an treatment facility.

If a waste treatment project is undertaken by a private concern, charges for the service should be computed, so that all costs can be recovered from those using the services, i.e. both government and private health-care establishments. To ensure that the project is self-supporting, charges should reflect the full cost of operations, maintenance, depreciation, debt amortization, and interest. The inclusion of an amortization factor ensures the availability of funds for future plant and equipment replacements. If the charges levied do not cover all costs, the system will need to be subsidized and a financing plan should be designed accordingly.

Recommendations for cost reductions

Cost reductions can be achieved by taking particular measures at different stages in the management of wastes:

i. *On-site management*
   - Comprehensive management of chemicals and pharmaceuticals stores.
   - Substitution of disposable medical-care items by recyclable items.
   - Adequate segregation of waste to avoid costly or inadequate treatment of waste that does not require it.
   - Improved waste identification to simplify segregation, treatment, and recycling.

ii. *Comprehensive planning*
   - Development and implementation of a comprehensive health-care waste management strategy, within the framework of the hospital waste management plan, which includes the above recommendations.
   - Planning collection and transport in such a way that all operations are safe and cost- efficient.
   - Possible cooperative use of regional incineration facilities, including private sector facilities where appropriate.
   - Establishment of a wastewater disposal plan.

iii. *Documentation*
   - Waste management and cost documentation: assessment of the true costs makes it easier to identify priorities for cost reduction and to monitor progress in the achievement of objectives.

iv. *Choice of adequate treatment or disposal method*
   - Selection of a treatment and disposal option that is appropriate for waste type and local circumstances.
   - Use of treatment equipment of appropriate type and capacity.
   - Out sourcing of final treatment and disposal of the waste to a centralized waste treatment facility.

v. *Measures at personnel level*
   - Development of training programs for workers 1to improve quality and quantity of work.
   - Protection of workers against occupational risks.

X

Mercury in Health-Care

1. Overview[19]

Mercury is a naturally occurring heavy metal. At ambient temperature and pressure, mercury is a silvery-white liquid that readily vaporizes and may stay in the atmosphere for up to a year. When released to the air, mercury is transported and deposited globally. Mercury ultimately cumulates in lake-bottom sediments, where it is transformed into its more toxic organic form, methyl mercury, which accumulates in fish tissue. Mercury is highly toxic, especially when metabolized into methyl mercury. It may be fatal if inhaled and harmful if absorbed through the skin. Around 80% of the inhaled mercury vapor is absorbed by the blood through the lungs. It may cause harmful effects to the nervous, digestive, respiratory, immune systems and to the kidneys, besides causing lung damage. Adverse health effects from mercury exposure can be: tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, and attention deficit and developmental delays during childhood. Recent studies suggest that mercury may have no threshold below which some adverse effects do not occur.

2. Contribution from the health-care sector and regulation

Health-care facilities are one of the main sources of mercury release into the atmosphere because of emissions from the incineration of medical waste. The Environment Minister of the Canadian province of Ontario declared on December 2002 that emissions from incinerators were the fourth-largest source of mercury. In the United States, according to the US Environmental Protection Agency (EPA) in a 1997 report, medical waste incinerators may have been responsible for as much as 10% of all mercury air releases.

Health-care facilities are also responsible for mercury pollution taking place in water bodies from the release of untreated wastewater. According to a 1999 report, health-care facilities may also have been responsible for as much as 5% of all mercury releases in wastewater. Environment Canada estimates that more than one-third of the mercury load in sewerage systems is due to dental practice.

Dental amalgam is the most commonly used dental filling material. It is a mixture of mercury and a metal

19 Extracted from WHO policy paper on Mercury in Health Care, 2005.

alloy. The normal composition is 45-55% mercury; approximately 30% silver and other metals such as copper, tin and zinc. In 1991, the World Health Organization confirmed that mercury contained in dental amalgam is the greatest source of mercury vapor in non-industrialized settings, exposing the concerned population to mercury levels significantly exceeding those set for food and for air[20].

According to a report submitted to the OSPAR Commission, in the United Kingdom, annually 7.41 tons of mercury from dental amalgam is discharged to the sewers, atmosphere or land, with another 11.5 tons sent for recycling or disposed with the clinical waste stream. Together, mercury contained in dental amalgam and in laboratory and medical devices, account for about 53% of the total mercury emissions.

Waste incineration and crematoria are also listed as major sources of mercury emissions. Many countries, such as Armenia, Cameroon, Ghana, Honduras, Pakistan, and Peru, recognize the contributions from hospital thermometers, dental amalgams, hospital waste and/or medical waste incinerators but lack quantitative data. Despite the lack of data, there is good reason to believe that mercury releases from the health sector in general are substantial.

Some countries have restricted the use of mercury thermometers or have banned them without prescription. A variety of associations have adopted resolutions encouraging physicians and hospitals to reduce and eliminate their use of mercury containing equipment.

3. Occupational health hazard

The most common potential mode of occupational exposure to mercury is via inhalation of metallic liquid mercury vapors. If not cleaned up properly, spills of even small amounts of elemental mercury, such as from breakage of thermometers, can contaminate indoor air above recommended limits and lead to serious health consequences. Since mercury vapor is odorless and colorless, people can breathe mercury vapor and not know it. For liquid metallic mercury, inhalation is the route of exposure that poses the greatest health risk. A variety of studies demonstrate that mercury containing health-care equipment will invariably break. Small spills of elemental mercury on a smooth, non-porous surface can be safely and easily cleaned up with proper techniques. However, beads of mercury can settle into cracks or cling to porous materials like carpets, fabric, or wood, making the mercury extremely difficult to remove. Spilled mercury can also be tracked on footwear. Inadequate cleaning and disposal may expose already compromised patients and health-care staff to potentially dangerous exposures.

4. Alternatives

A recent study found that at least one manufacturer of the non-mercury alternative was identified where the cost differences between mercury and non-mercury technologies were minimal. The research findings suggest that many non-mercury alternatives are available to address the full range of functions required by consumer products.

For health care, these include blood pressure devices, gastrointestinal devices, thermometers, barometers, and in other studies, include the use of mercury fixatives used in labs. Both mercury and aneroid sphygmomanometers have been in use for about 100 years, and when working properly, either gives accurate results. Of all mercury instruments used in health care, the largest amount of mercury is used in mercury sphygmomanometers (80 to 100g/unit), and their widespread use, collectively make them one of the largest mercury reservoirs in the health-care setting. By choosing a mercury-free alternative a health-care institution can make a tremendous impact in reducing the potential for mercury exposure to patients, staff and the environment.

Aneroid sphygmomanometers provide accurate pressure measurements when a proper maintenance

20 Source:http://www.who.int/ipcs/publications/cicad/en/cicad50.pdf

protocol is followed. It is important to recognize that no matter what type of blood pressure measurement device is used, both aneroid and mercury sphygmomanometers must be checked regularly in order to avoid errors in blood pressure measurement and consequently the diagnosis and treatment of hypertension.

5. The way forward

To understand better the problem of mercury in the health-care sector, it is recommended that countries conduct assessments of current mercury usage and waste management programs. WHO proposes to work in collaboration with countries through the following strategic steps:

***Short-term*:** Develop mercury clean up and waste handling and storage procedures. Until countries in transition and developing countries have access to mercury-free alternatives, it is imperative that safe handling procedures be instituted which minimize and eliminate patient, occupational, and community exposures. Proper procedures should include spill cleanup response, educational programs, protective gear, appropriate waste storage containment, staff training, and engineered storage facilities. Countries that have access to affordable alternatives should develop and implement plans to reduce the use of mercury equipment and replace them with mercury-free alternatives. Before final replacement has taken place, and to ensure that new devices conform with recommended validation protocols, health-care facilities will need to keep mercury as the "gold" standard to ensure proper calibration of mercury sphygmomanometers.

***Medium-term*:** Increase efforts to reduce the number of unnecessary use of mercury equipment. Hospitals should inventory their use of mercury. This inventory should be categorized into immediately replaceable and gradually replaceable. Replaced devices should be taken back by the manufacturer or taken back by the alternative equipment provider. Progressively discourage the import and sale of mercury-containing health-care devices and mercury use in health-care settings, and also use global multi-lateral environmental agreements to this end. Provide support to countries to make sure that the recovered mercury equipment is not pushed back in the supply chain.

***Long-term*:** Support a ban against the use of mercury-containing devices and effectively promote the use of mercury-free alternatives. Support countries in developing a national guidance manual for sound management of health-care mercury waste. Support countries in the development and implementation of a national plan, policies and legislation on mercury health-care waste. Promote the principles of environmentally sound management of health-care waste containing mercury, as set out in the UN Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal. Support the allocation of human and financial resources to ensure procurement of mercury-free alternatives and a sound management of health-care waste containing mercury.

Engineering Controls for Infection Prevention in Health-Care Facilities

XI

According to the World Alliance for Patient Safety[21], at any given time over 1.4 million people worldwide are suffering from infections acquired in hospitals. In the US, one out of every 136 hospital patients becomes seriously ill as a result of acquiring an infection in hospital; this is equivalent to 2 million cases and about 80,000 deaths per year. In England, more than 100,000 cases of health care-associated infection lead to over 5,000 deaths directly attributed to infections each year. In Mexico, the estimated 450,000 cases each year of health care-associated infections caused 32 deaths per 100,000 inhabitants. According to the Center for Disease Control and Prevention (CDC), Health Care-Associated Infections (HAI) are estimated to be 1 of the top 10 causes of death in the United States.

1. Hierarchy of infection control measures[22, 23]

Controlling infections in health care facilities by working with occupational health and safety groups and building engineers has created a framework that includes: engineering controls, administrative controls and personal protective measures in health-care facilities.

i. Engineering controls are built into the design of a health-care facility. An Infection Control Risk assessment should be done to evaluate and mitigate potential risks for micro-organism transmission by means of air, water and environmental sources, and trained professionals should be involved in the design and planning.

ii. Administrative controls include protocols for hand hygiene, immunization of residents and care-givers, protocols for managing care-givers and clients during an outbreak, and protocols for caring for clients with communicable diseases.

iii. Personal protective equipment helps to control hazards as it does not eliminate them, but merely contains the hazard and is dependent on its appropriate use by educated, knowledgeable staff.

2. Air

A variety of airborne infections in susceptible hosts can result from exposures to clinically significant micro-organisms released into the air when environmental reservoirs (i.e., soil, water, dust, and decaying organic matter) are disturbed.

21 World Alliance for Patient Safety, Global Patient Safety Challenge 2005- 2006, Clear Care is Safe Care, World Health Organization, 2005.

22 Source: Guidelines for Environmental Infection Control in Health-Care Facilities, Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC), CDC, 2003.

23 Adapted from BC Centre for Disease Control Document on Respiratory Outbreaks.

Heating, ventilation, and air conditioning (HVAC) systems in health-care facilities are designed to maintain the indoor air temperature and humidity, control odors, remove contaminated air, facilitate air-handling requirements to protect susceptible patients and minimize the risk for transmission of airborne pathogens from infected patients. Decreased performance of health-care facility HVAC systems, filter inefficiencies, improper installation, and poor maintenance can contribute to the spread of health care–associated airborne infections. Construction design and function considerations for environmental infection control are detailed in the original CDC document (as referred above).

3. Water

There are many water-related infections in health-care facilities. These can be reduced by taking special care of the water supply in health-care facilities. Details of water systems in health-care facilities is provided in Section VI.

3.1 Supplemental treatment of water with heat and/or chemicals

In addition to using supplemental treatment methods as remediation measures after inadvertent contamination of water systems, health-care facilities sometimes could use special measures to control water-borne micro-organisms on a sustained basis. This decision is most often associated with outbreaks of infections.

3.2 Primary prevention of infections

Health-care facilities could use at least two general strategies to prevent health care–associated water-borne infections when no cases or only sporadic cases have been detected. The first is an environmental surveillance approach involving periodic culturing of water samples from the hospital's potable water system to monitor the growth of organisms. If any sample is culture-positive, diagnostic testing is recommended for all patients with health care–associated pneumonia. If >30% of the samples are culture-positive, decontamination of the facility's potable water system is warranted.

4. Green buildings and energy efficiency in health care facilities[24]

'Green' or 'sustainable' buildings use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code. With more natural light and better air quality, green buildings typically contribute to improved employee and patient health, comfort, and productivity.[25]

While building healthy hospitals the following strategies can be adopted[26]:

- Energy Efficiency – integrated design and HVAC systems
- Process water efficiency
- Sustainable flooring-Proper material selection
- Indoor air quality: Proper materials selection
- Lighting efficiency – optimizing artificial and natural lighting.

Green buildings provide financial benefits that conventional buildings do not. These benefits include energy and water savings, reduced waste, improved indoor environmental quality, greater employee comfort/productivity, reduced employee health costs and lower operations and maintenance costs.

The advantages of green buildings, when compared to conventional buildings, are:

- On average 25-30% more energy-efficient
- Characterized by even lower electricity peak consumption
- More likely to generate renewable energy on-site

24 Green Building Costs and Financial Benefits, by Gregory H. Kats, 2003.
25 Green Building Costs and Financial Benefits, by Gregory H. Kats, 2003.
26 Top 5 Green Building Strategies for Health Care: http://www.epa.gov/region9/waste/p2/greenbldg.html

- More likely to purchase grid power generated from renewable energy sources (green power and/or tradable renewable certificates).

5. Environmentally preferred purchasing

Hospitals purchase thousands of different products requested by dozens of different departments. Often unknowingly, hospitals may purchase items that are toxic to workers or patients, or have serious environmental impacts. Environmentally Preferable Purchasing (EPP) is a system that identifies and avoids these problems. From eliminating unnecessary packaging, to seeking substitutes for products containing mercury or other toxic substances, purchasing decisions can have a major impact in providing health care without harm.

Environmentally preferable products are generally:

- Less toxic
- Minimally polluting
- More energy-efficient
- Safer and healthier for patients, workers, and the environment
- With higher recycled content
- With less packaging
- Fragrance-free.

XII

Standard Operating Procedures for Laboratories

Laboratories are unique workplaces where a wide variety of chemicals are handled on a routine basis. This section briefly outlines the required good practices with regard to safe handling of chemicals, which are to be followed by laboratory technicians.

1. General guidelines[27]

i. Carefully read the label before using a chemical.

ii. The manufacturer's or supplier's Material Safety Data Sheet (MSDS) will provide special handling information.

iii. Be aware of the potential hazards existing in the laboratory and the appropriate safety precautions.

iv. Know the location and proper use of emergency equipment, the appropriate procedures for responding to emergencies, and the proper methods for storage, transport and disposal of chemicals within the facility.

v. Employees should not work alone in the laboratory.

vi. Anyone considering running an experiment unattended should consider the possible hazards that could occur as a result of failures, malfunctions, operational methods, environments encountered, maintenance error and operator error.

vii. Label all chemical containers with appropriate identification and hazard information.

viii. Use only those chemicals for which there are appropriate exposure controls (such as a chemical fume hood) and administrative programs/ procedures (training, restricted access, etc.).

ix. Always ensure that there is adequate ventilation when working with chemicals.

x. Operations using large quantities (500 milliliters) of volatile substances with workplace standards at or below 50 ppm should be performed in a chemical fume hood.

xi. Use hazardous chemicals and all laboratory equipment only as directed or for their intended purpose.

xii. Inspect equipment or apparatus for damage before use and before adding a hazardous chemical.

xiii. Do not use damaged equipment.

xiv. Inspect personal protective apparel and equipment for integrity or proper functioning before use.

27 Extracted from Standard Operating Guidelines for World Bank Funded project on Capacity -Building of Food and Drug Laboratories, prepared for Govt. of India by Centre for Environmental and Occupational Health (COEH) of the Maulana Azad Medical College, New Delhi.

xv. Malfunctioning laboratory equipment (hood) should be labeled or tagged "out of service" so that others will not inadvertently use it before repairs are made.

xvi. Handle and store laboratory glassware with care.

xvii. Do not use damaged glassware.

xviii. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them before-hand to contain chemicals or fragments should implosion occur.

xix. Do not purchase or dispense more of a hazardous chemical than is needed for immediate use.

2. Protective clothing and laboratory safety equipment

Personal protective clothing and equipment should be selected carefully and used in situations where engineering and administrative controls cannot be used or while such controls are being established. These devices are viewed as less protective than other controls because they rely heavily on each employee's work-practices and an effective training. The engineering and administrative controls which should always be considered first when reducing or eliminating exposures to hazardous chemicals include:

- **Substitution** by a less hazardous substance
- **Scaling down the size of experiment**
- **Isolation** of the operator or the process
- **Local and general ventilation** (e.g., use of fume hoods)

The Material Safety Data Sheet (MSDS) will list the Personal Protective Equipment (PPE) recommended for use with the chemical. The MSDS addresses worst case conditions. Therefore, all the equipment shown may not be necessary for a specific laboratory scale task.

The Environment Health Safety Officer (EHS Officer) can assist in determining which personal protective devices are required for each task.

Remember, there is no harm in being overprotected.

Appropriate personal protective equipment should be put on by employees.

3. Laboratory safety equipment

In the laboratory, the chemical hood is the primary means of controlling inhalation exposures. Hoods are designed to retain vapors and gases released within them, protecting the laboratory employee's breathing zone from the contaminant.

This protection is accomplished by having a curtain of air (approximately 100 linear feet per minute) move constantly through the face (open sash) of the hood. Chemical hoods can also be used to isolate apparatus or chemicals that may present physical hazards to employees. The closed sash on a hood serves as an effective barrier to fires, flying objects, chemical splashes or spattering and small implosions and explosions. Hoods can also effectively contain spills, which might occur during dispensing procedures, particularly if trays are placed in the bottom of the hoods. When using a chemical fume hood keep the following principles of safe operation in mind:

- Keep all chemicals and apparatus at least six inches inside the hood (behind sash).
- Hoods are not intended for storage of chemicals. Materials stored in them should be kept to a minimum.
- Stored chemicals should not block vents or alter air flow patterns.
- Keep the hood sash at a minimum height (4 to 6 inches) when not manipulating chemicals or adjusting apparatus within the hood.
- When working in front of a fume hood, make sure the sash opening is appropriate. This can be achieved by lining up to arrows placed on the sash door and hood frame. This sash opening will ensure an adequate air velocity through the face of the hood.
- Do not allow objects such as paper to enter the exhaust ducts. This can clog ducts and adversely affect their operation.

Follow the chemical manufacturer or supplier's specific instructions for controlling inhalation exposures with ventilation (chemical fume hood) when using their products. These instructions are located on the products MSDS and/or label.

However, it should be noted that these ventilation recommendations are often intended for non-laboratory work environments and must be adapted to suit the laboratory environment as well as the specific procedure or process.

If specific guidance is not available from the chemical manufacturer or supplier, or if the guidance is inappropriate for the laboratory environment, contact the EHS Officer/supervisor and/or review the hood using the guidelines given below.

4. Chemical procurement, distribution and storage

4.1 Procurement

i. Before a new substance that is known or suspected to be hazardous is received, information on proper handling, storage, and disposal should be known to those who will handle it.

ii. It is the responsibility of the supervisor to ensure that the laboratory facilities in which the substance will be handled are adequate, and that those who will handle the substance have received the proper training.

iii. The necessary information on proper handling of hazardous substances can be obtained from the Material Safety Data Sheets that are provided by the vendor.

iv. Because storage in laboratories is restricted to small containers, order small-container lots to avoid hazards associated with repackaging.

v. No container should be accepted without an adequate identifying label.

4.2 Distribution

i. When hand-carrying open containers of hazardous chemicals or unopened containers with corrosive or highly acute or chronically toxic chemicals, place the container in a secondary container or a bucket.

ii. Rubberized buckets are commercially available and provide both secondary containment as well as "bump" protection.

iii. If several bottles must be moved at once, the bottles should be transported on a small cart with a substantial rim to prevent slippage from the cart.

iv. Wherever available, a freight elevator should be used to transport chemicals from one floor to another.

4.3 Chemical storage in the laboratory

i. Carefully read the label before storing a hazardous chemical.

ii. The MSDS will provide any special storage information as well as information on incompatibilities.

iii. Do not store un-segregated chemicals in alphabetical order.

iv. Do not store incompatible chemicals in close proximity to each other.

5. Emergency preparedness program

In case of an emergency like fire, spill, electrical shock or natural disaster immediately follow these procedures:

i. Call the required help (fire department, medical department, etc.).

ii. Activate the building alarm. If not available or operational, verbally notify the people in the building.

iii. Isolate the area immediately.

iv. Shut down all the equipment if possible.

v. Evacuate to the exit point and follow the instructions of the Supervisor or the person In-charge.

vi. Notify about the hazard and emergency to the concerned team of rescue/help.

6. Chemical spills & accidents

i. Try to anticipate the types of chemical spills that can occur in the laboratory and obtain the necessary equipment (spill kits and personal protective equipment) to respond to a minor spill.

ii. Learn how to safely clean up minor spills of the chemicals used regularly.

iii. A MSDS contains special spill clean-up information and should also be consulted.

iv. Chemical spills should only be cleaned up by knowledgeable and experienced personnel.

v. If the spill is too large to handle, is a threat to health safety or the environment, or involves a highly toxic or reactive chemical, call CHO/ EHS Officer for assistance immediately.

7. Fire and fire-related emergencies

If a fire or fire-related emergency such as abnormal heating of material, a flammable gas leak, a flammable liquid spill, smoke, or odor of burning is noticed, the procedures mentioned below must be followed:

i. Notify the Fire Department.

ii. Activate the building alarm (fire pull station). If not available or operational, verbally notify people in the building.

iii. Isolate the area by closing windows and doors and evacuate the building.

iv. Shut down equipment in the immediate area, if possible.

v. Use a portable fire extinguisher to:

- Assist oneself to evacuate;
- Assist another to evacuate; and
- Control a small fire, if possible.

vi. Provide the fire/police teams with the details of the problem upon their arrival.

8. Pesticides and disinfection

The laboratory area should be free from the pests like rodents, cockroaches, termites, etc. These pests cause a variety of diseases and may lead to a mishap resulting in injury or illness. The rodents cause illnesses like rat bite fever and Weil's disease. To make the laboratory pest-free a pesticide program should be in place. The disinfection of laboratory equipment should be done by less or non-hazardous chemicals.

Pesticide and disinfection programs should be as follows:

i. Before carrying out pesticide or disinfection programs the laboratory staff should be informed.

ii. The person using the pesticides should be well-trained and qualified in the use of the pesticides.

iii. The person should wear all the required personal protective equipment while using the pesticides in the laboratory.

iv. Only non-hazardous or less hazardous pesticides should be used in the laboratory.

v. Borax powder is a good pesticide which may be used against German Cockroaches.

vi. The disinfection of the laboratory should be done using 1% – 10% hypochlorite solution as required.

vii. The person carrying out disinfection should know how to prepare the solution of hypochlorite as required.

Additional Standard Operating Procedures under World Bank-funded projects are detailed below:

i. Laboratory Manual for Technicians (ICTCs, PPTCTCs, Blood banks and PHCs): National AIDS Control Organization (NACO).

ii. Biosafety Manual for Public Health Laboratories: Directorate General of Health Services Ministry of Health and Family Welfare.

iii. Manual for Laboratory Diagnosis of Common Epidemic-prone Diseases for District Public Health Laboratories: Integrated Disease Surveillance Project, National Centre for Disease Control (NCDC).

iv. Environmental and Bio-medical Waste Management Plan for RNTCP-II: Universal precautions and SOPs for TB technicians and centres; Revised National Tuberculosis Control Program (RNTCP).

XIII

World Bank Safeguard Policies

The operations of the World Bank are guided by a comprehensive set of policies and procedures[28], dealing with the Bank's core development objectives and goals. Of these, there are ten key Safeguard Policies which are critical to ensuring that potentially adverse environmental and social consequences are identified, minimized, and mitigated. The World Bank classifies the proposed projects into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. Health sector projects are typically classified as Category B (issues are relatively straightforward and mitigation measures are well-defined and implementable).

Environmental issues associated with health sector projects deal with:

- Infection control practices of health-care workers and management of health-care waste from the preventive and curative activities of the health-care sector;
- Management of waste generated during construction and refurbishing of health centers;
- Water and sanitation-related issues.

1. Extract of OP 4.0 – Environmental assessment

Environmental assessment (EA) is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation, by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favors preventive measures over mitigatory or compensatory measures, wherever feasible.

EA takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and trans-boundary and global environmental aspects. EA considers natural and social aspects in an integrated way. It also takes into account the variations in project and country conditions; the findings of country environmental studies; national environmental action plans; the country's overall policy framework, national legislation, and institutional capabilities related to the environment and social aspects; and obligations of the country, pertaining to project activities, under relevant international environmental treaties and agreements.

The borrower is responsible for carrying out the EA. The Bank advises the borrower on the Bank's

28 http://go.worldbank.org/L0WZ82PW60

EA requirements. The Bank reviews the findings and recommendations of the EA to determine whether they provide an adequate basis for processing the project for Bank financing.

Depending on the project, a range of instruments can be used to satisfy the Bank's EA requirement: environmental impact assessment (EIA), environmental audit, hazard or risk assessment, and environmental management plan (EMP). The Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EA. The Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project as well as the nature and magnitude of its potential environmental impacts.

A proposed project is classified as Category B if it has potential adverse environmental impacts on human populations or environmentally important areas–including wetlands, forests, grasslands, and other natural habitats. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed readily. The EA examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

When the borrower has inadequate legal or technical capacity to carry out key EA-related functions (such as review of EA, environmental monitoring, inspections, or management of mitigatory measures) for a proposed project, the project includes components to strengthen that capacity.

For all Category B projects proposed for IBRD or IDA financing, during the EA process, the borrower consults project-affected groups and local Non-Governmental Organizations (NGOs) about the project's environmental aspects and takes their views into account. Public availability in the borrowing country and official receipt by the Bank of any Category B EA reports for projects proposed for IDA funding, are prerequisites to Bank appraisal of these projects. Once the borrower officially transmits any separate Category B EA report to the Bank, the Bank makes it available through its InfoShop.

During project implementation, the borrower reports on (a) compliance with measures agreed with the Bank on the basis of the findings and results of the EA, including implementation of any EMP, as set out in the project documents; (b) the status of mitigatory measures; and (c) the findings of monitoring programs. The Bank bases supervision of the project's environmental aspects on the findings and recommendations of the EA, including measures set out in the legal agreements, any EMP, and other project documents.

2. Timeline for environmental assessments

Historically, projects have been most effective when the EA process begins as soon as the project is conceptualized. Incorporating plans to discuss these project requirements with the borrower in the very early phases of the project is vital. Potential borrowers should be provided with information and resources prior to the identification of specific projects. This will enable them to begin the process of establishing a country framework that will meet World Bank safeguards in the future, and lessen the number of issues that future projects must address.

3. Public consultation and disclosure

In Category B, the borrower consults project-affected groups and local Non-Governmental Organizations (NGOs) about the project's environmental aspects and takes their views into account.

The Bank's document on "*Simplifying Safeguards Addressing Environmental and Social Issues in Health Projects", prepared by Safeguards Management and Review Team (SMART), February 2004* is a process-oriented guide to simplify safeguards compliance and reduce transaction costs by helping project task teams to: (i) anticipate safeguards considerations early in the project preparation process; (ii) design projects and project schedules to avoid downstream problems and delays; and (iii) assist borrowers in complying with safeguards work requirements. Another document to be referred to for HIV-AIDS projects is "*Special Procedures for Compliance with Safeguard Policies to Support Accelerated Implementation of HIV/AIDS Projects; March 17, 2003*.

XIV

World Bank Guidelines for Small Construction Works

1. Guidelines for Small Construction Works[29]

While health-care waste management is related to operational activities of the health services, implementing proper standards for construction and related waste management are up-front, one-time activities. Construction activities generate varied kinds of waste which have the potential of polluting the surrounding air, water and land. The neighborhood and surrounding areas of any construction can be adversely affected by the huge amounts of construction materials, waste and large number of temporary construction workers, if they are not managed properly. The health, safety and sanitation of these temporary workers are an added concern which needs to be addressed during the course of the construction activity.

Additionally, improper constructions that do not follow standard practices and legislations can have both an adverse short-term and long-term impact on the environment and continuing services provided by the health facility. Faulty design and poor quality of construction can cause inconvenience to patients and even pose a danger to them and the staff within the facility. Improper drainage and sanitation systems can result in water-logging around the premises which can damage equipment and infrastructure, make the premises accident-prone or be a source of vector breeding. Inferior quality of pipes can result in contamination of the water supply, while sub-standard or banned materials such as asbestos can cause long-term damage to patients and workers.

2. Environmental screening

Usually, the construction of this type of project does not create an environmental impact of high magnitude and importance. Most projects are classified as Category B for environmental purposes. However, it is advisable to screen sub-projects and construction sites in order to ensure that signifi cant issues are identifi ed and proper measures included in the project design. The potential issues depend on the type of construction (small rural schools vs. multi-storied buildings for instance), area available (congested vs. open area), and the location (urban vs. rural) of the proposed construction. In most cases, construction activities would probably be of some concern especially in urban areas in which avoiding the creation of inconveniences or nuisances to certain communities during construction will require careful planning of construction activities.

Future project sites and projects should be screened for:

29 Extracted from World Bank Latin America Toolkit for Health Projects.

i. The need for resettlement of families and businesses, the presence of squatters or any other land titling conflicts;

ii. Potential interruption or limitation of accesses to dwellings or businesses, either permanently or temporarily (during construction);

iii. Encroachment/reduction of green areas, parks, and other recreational areas;

iv. Demolition of buildings of high architectural or historical value;

v. Potential deterioration of urban quality and property value in the immediate vicinity of the works or deterioration of unique architectural characteristics in the neighborhood;

vi. Potential for increased accidents in areas with high density of schools, hospitals, and commercial use;

vii. Effect on urban infrastructure (sidewalks, power and telephone lines, water and sewerage mains, etc.);

viii. Potentially unacceptable nuisances during construction (dust, wastes, and heavy construction traffic); and

ix. Potential issues regarding natural hazards (floods, instability).

3. Environmental criteria for the design and construction of small works

The criteria should include:

- The designs should avoid or minimize the need for resettlement of population, as well as the impact on green and recreational areas, and buildings of historical or architectural value. If the above impacts are unavoidable, resettlement plans, mitigation and compensatory measures will have to be included in project costs.
- Access to dwellings and businesses should be guaranteed for both the construction and operational phases. Any restriction or limitation of accessibility to properties should be properly mitigated or compensated.
- Safe and secure pedestrian and bicycle crossings should be integrated into the design and construction of any road/rail crossings.
- The design should harmonize with urban surroundings, including landscaping and planning for other uses, for all additionally created spaces (for instance under-bridges, cul-de-sacs, and pedestrian-only streets) in order to minimize negative impacts on environmental quality and property values.
- Alternative solutions and final designs should be subject to public and community consultation with special emphasis on the property owners directly affected, local NGOs and community organizations, and business and professional organizations.
- To minimize public nuisances, construction activities should follow strict environmental guidelines. Construction schedules and the timing of necessary interruption of public utilities (electricity, water and telephone) should be informed to the affected community.
- All areas and infrastructure affected during construction should be restored to their original condition, specially sidewalks, green street dividers, gardens, sidewalk trees, utilities, and side streets impacted by traffic diversion.
- The design should contemplate and stimulate the better integration of surrounding urban areas.

4. Environmental management tools

4.1 Environmental considerations for the engineering design

The engineering design of the project should take into consideration: (i) the connection of the building or infrastructure to the potable water system and the capacity of the existing water distribution network, or the need to establish a water supply system for the building (well, storage tank, pumping station, etc.); (ii) the connection to the sewerage network and the need for capacity expansion for receiving collectors or the need for a wastewater treatment system for the building (septic tank, infiltration ditch);

(iii) the treatment of wastewater from cafeterias and restaurants before being discharged to the sewerage networks or the wastewater treatment system; (iv) the adequate management of runoff and the facilities for its recollection and evacuation, having in mind the existing downstream systems; (iv) the systems of recollection, storage and transportation of solid wastes generated in the building, incorporating the structures for separation and recycling; (v) appropriate access systems for pedestrians, municipal and inter-municipal buses, bicycles, children and handicapped people; (vii) the need to integrate building design with architectonic characteristics of the surrounding neighborhood; and (viii) avoiding the use of materials such as wood from tropical forests, lead-based paints, asbestos.

4.2 Environmental enhancement

The architectural and engineering designs of projects should incorporate and reinforce the criteria of environmentally friendly buildings. This should take place during the conceptualization stage and should include: (i) solar panels to satisfy totally or partially the electricity needs; (ii) rain water storage for the irrigation of gardens and green zones; (iii) recycling of wastewater for irrigation; (iv) separation of the potable water systems from irrigation systems; (v) maximizing natural light in order to minimize artificial light needs; (vi) planting of native species in gardens and green areas; (vii) using windmills for groundwater exploitation for irrigation water; (viii) natural ventilation systems, minimizing the necessities of air-conditioning; and (ix) the stabilization of slopes using vegetative measures.

4.3 Environmental management of construction activities

Construction activities could cause a serious impact or nuisance to surrounding areas. Such an impact merits careful planning of construction activities and the application of strict environmental measures during construction. Among the aspects that should be kept in mind are: (i) pedestrian safety and traffic congestion during construction due to the increase of heavy traffic (of the construction itself and from traffic detours) in high-traffic avenues and exit ramps; (ii) dust and particulate materials, causing a nuisance to surrounding families and businesses, specially to vulnerable people (children, elders); (iii) undesirable noise levels due to machinery and equipment specially in areas with hospitals, homes for the elderly, schools; (iv) degradation of lateral streets due to heavy equipment machinery and traffic detours; (v) interruption of services (water, electricity, telephone, bus routes) during construction; (vi) the adequate disposal of garbage, metals, used oils, and excess material, generated during construction; (vii) the need of informing the population about construction and work schedules, interruption of services, traffic detour routes, provisional bus routes; and (viii) pedestrian security measures, specially for school children, during construction. All these measures can be included in an environmental manual that would be part of bidding documents.

Some projects may generate substantial amounts of construction waste that require appropriate environmental handling. The identification of suitable sites for waste disposal, the environmental management necessary (compacting, re-soiling and re-vegetation, drainage control), and the associated transportation costs should be included in project design and cost estimates. The engineering design will then consider: (i) the preparation of environmental specifications that the contractor should follow during the construction; and (ii) the constructive design and activity programming having in mind the minimization of impacts and nuisance to the population.

4.4 Environmental supervision during construction

The supervision of the construction will include compliance with the manual and environmental specifications by the contractor.

4.5 Environmental measures during the operational phase

During the operational phase of some type of construction works (large isolated buildings, for instance) adequate provisions should guarantee:

(i) the maintenance of the systems of collection and treatment of wastewater; (ii) the adequate collection and disposal of solid waste, incorporating recycling systems and the separation of materials; and (iii) the maintenance of complementary systems (solar panels, wind mills, etc.). The engineering design should include the preparation of operational manuals and maintenance of all systems.

5. Public consultation

The public and community organizations to be consulted include: (i) local professional associations (including engineering and architectural associations); (ii) local chambers of commerce and industries; (iii) community organizations (neighborhood organizations) and local NGOs. The consultation program may involve: (i) both formal and informal presentations and meetings with the target groups; (ii) information dissemination campaigns through fliers, posters and radio announcements; and (iii) an opinion survey.

6. Environmental requirements during project preparation

Based on the screening exercise, the environmental work for this type of project may fall within the following categories:

For projects in which specific sites are known in advance

- *No major issues identified*: apply environmental guidelines for design and construction.
- *Some issues of concern*: apply environmental guidelines for design and construction, and further environmental assessment of specific projects may be required.
- *Major issues identified*: prepare resettlement plans, compensation programs (for green areas/natural habitats, for instance), and archaeological salvage/restoration plans as required.

For projects in which specific sites are not known in advance

- Agree on basic environmental and social principles;
- *No major issues are envisioned*: apply environmental guidelines for design and construction;
- *Some issues of concern are envisioned*: agree on screening criteria and procedures, agree on TORs for further environmental work, apply environmental guidelines for design and construction;
- *Major issues are envisioned*: agree on screening criteria and procedures, agree on site-specific environmental studies, prepare framework to deal with resettlement plans, compensation plans (for green areas and natural habitats), and archaeological salvage/restoration plan, apply guidelines for design and construction, design community consultation/information methodology.

XV

World Bank Projects in the Health Sector

The World Bank is the largest external financier in the health sector in India. The primary focus of these projects has been improving health care for all. Within the above operations, environment issues have been receiving increased attention, primarily the need for cradle-to-grave management of infectious and other health-care wastes. Although these issues are not central to the objectives of each operation, they tend to recur in all of them and it is accepted that they should be taken into account, in a proportionate manner.

The health sector projects are typically classified as Category B (issues are relatively straightforward and mitigation measures are well-defined and implementable). For the health sector projects the environmental issues are routinely addressed through the inclusion of a Health-Care Waste Management Plan (HCWMP) or similar management plan which puts responsibility for the issue under the broad mandate of Infection Control. Vector Management in public health projects is governed by The World Bank Operational Policy 4.09. The OP and BP apply to all projects involving vector management, whether or not the project finances pesticides.

India is now a global front-runner in the health-care waste management agenda. Some of the key achievements are:

- A policy framework developed by the Ministry of Health for the planning, implementation and management of infection control and waste management in health-care facilities and standardized operational guidelines to be disseminated under the auspices of the National Rural Health Mission.
- Increased awareness amongst health-care workers in the primary and secondary health sector of the country.
- Providing necessary institutional arrangements for proper waste segregation, collection, transportation, storage, treatment and disposal.
- Mandatory establishment and use of centralized facilities.

Health-care waste management has been an integral part of the World Bank health sector sponsored projects at the national and state level. A brief overview of the projects financed by the World Bank in India is provided below:

1. Reproductive and Child Health Programme II

The GoI's national family program has been in place since the 1950s and was expanded to include aspects

of maternal and child health beyond family planning, child immunization, ante- and post-natal care and emergency obstetric care.

The Reproductive and Child Health Program (RCH-II) encompasses a number of innovations and reforms. Its development objective is to bring about improved and equitable child health, maternal health and population stabilization through assured, responsive, quality health services, especially in states with low human development indicators. In the RCH II program, an Infection Management and Environment Plan (IMEP) was prepared which consists of a set of national guideline documents for safe management of health-care waste at the policy level and at different institutional levels.

2. National AIDS Control Programme

The National AIDS Control Program Phase III (NACP-III, 2006-2011) aims to support the GoI in achieving its goal of halting and reversing the HIV/AIDS epidemic through: (i) integrating prevention, care, support and treatment programs; (ii) focusing on increasing awareness of HIV/AIDS; (iii) screening of blood for HIV; and (iv) testing of individuals practising risky behavior.

Provision of preventive and treatment services under the NACP-III is expected to generate infectious bio-medical wastes such as sharps (infected needles and syringes, surgical equipment, IV sets) infected blood, HIV test kits used in Voluntary Counseling and Testing centers, blood banks and laboratories and pharmaceutical wastes. These wastes, if not managed and disposed of properly, can have direct environmental and public health implications. Health-care workers are at great risk as most blood-borne occupational infections occur through injuries from sharps contaminated with blood through accidents or unsafe practices. Systematic management of such clinical waste from source to disposal is therefore integral to prevention of infection and control of the epidemic.

3. Revised National Tuberculosis Control Programme

The Revised National Tuberculosis Control Program (RNTCP) is being implemented in the country since 1997 with DOTS (Directly Observed Treatment, short-course), a comprehensive strategy for TB control. The basic unit of the program is the Designated Microscopy Center which is a sputum microscopy laboratory set up for a population of about 1,00,000 in normal areas and 50,000 in tribal and hilly areas.

The RNTCP is implemented through the state health system and is just one of the many national programs being implemented in any given health center. The RNTCP forms a small component of a multi-pronged infrastructure, and exists at most centers in the form of a laboratory and/or designated treatment center. Though a separate waste management policy has been formulated for the RNTCP program, the management of waste generated under RNTCP is to be seen as an integral component of the peripheral institutions' overall waste management activities.

4. Food Safety and Quality Control of Drugs

The Food Safety and Quality Control of Drugs program strives at improving the quality and safety of food and drugs in the country. The long-term strategy includes creating common standards and approaches and policy reforms related to existing government regulations regarding licensing, transparency and enforcement of quality of drugs and food safety in the country. A number of initiatives have been taken in last few years to improve the capacity of testing laboratories and to upgrade systems and procedures.

One of the keys areas proposed within the Food and Drug Capacity-Building project relates to the upgradation of capacity and competency of the central and state food and drugs testing laboratories. At the policy level, the project allows the enhancement of the existing set of laws and regulatory provisions to clearly and specifically address the handling and management of hazardous chemicals and bio-hazardous wastes used and generated in such drug and food testing laboratories. An environmental management action plan has been implemented to minimize negative environmental impacts of current and future operations and to increase the overall safety at these laboratories. The environmental plan accords the existing national good

laboratory practices guidelines with an environmental management health and safety component and standard codes of practice.

5. Vector-Borne Disease Control Project

The Vector-Borne Disease Control Project (VBDCP) supports GoI in achieving its stated goal of reducing mortality and morbidity from vector-borne diseases, namely malaria, dengue, Japanese encephalitis, visceral leishmaniasis, and lymphatic filariasis.

The VBDCP has a certain amount of environmental risk, as provision of preventive and treatment services involves the use, storage, transportation, and disposal of insecticides and pesticides in various applications. The management of these insecticides requires stringent and systematic cradle-to-grave management, otherwise there could be direct environmental and public health implications. The Environmental Management Plan (EMP) for the VBDCP consists of a set of mitigation, monitoring, and institutional measures to be taken during implementation and operation of the project to eliminate these adverse environmental and social impacts, offset them, or reduce them to acceptable levels. Many of these requirements are provided for in GoI's Insecticides Act, 1971.

Under the Pest Management Policy, the World Bank supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides. It emphasizes that the pesticides used must: (i) have negligible adverse human health effects; (i) be effective against the target species; (iii) have minimal effect on non-target species and the natural environment; and (iv) take into account the need to prevent the development of resistance. The policy requires that pesticides used for vector control be manufactured, packaged, labeled, handled, stored, disposed of, and applied according to national standards and the standards acceptable to the World Bank. The World Bank promotes the institutions to support sound, effective, and environmentally viable pest management practices, such as integrated vector management through judicious use of biological and engineering control measures, in addition to pesticide use that would be reduced under this strategy.

6. State Health Systems Development Projects

The World Bank, through the State Health Systems Development Projects, aims at assisting the states in improving their health-care services. In order to ensure better health for all, the states are working towards: improving efficiency in the allocation and use of health resources through policy and institutional development; strengthening their institutional capacities; upgrading community/sub-divisional and district hospitals; upgrading clinical and support services; and improving access to primary health care in remote and underdeveloped areas, that is, upgrade primary health centers in the state and increase access to primary care services. In the process of strengthening the health systems, the environment of the health care facility plays a vital role.

The World Bank has supported the following states in strengthening their health systems:

Andhra Pradesh, West Bengal, Maharashtra, Orissa, Punjab, Uttar Pradesh, and Uttarakhand, Karnataka, Rajasthan, and Tamil Nadu.

7. Integrated Disease Surveillance

The project objective was to improve the information available to the government health services and private health-care providers on some high-priority diseases and risk factors, with a view to improving the on-the-ground responses to such diseases and risk factors. Subsequent to the Avian Influence epidemic, the project was revised to include support for preparedness for the prevention, control and response to an influenza pandemic, including Avian Influenza and other zoonoses from domestic poultry. In 2010, the project was further restructured to support the GoI to strengthen the integrated disease surveillance system for epidemic-prone diseases by enhancing central level monitoring and coordination functions, and improving state/district surveillance and response

capacity with emphasis on selected states. Under this project, infection control and bio-medical waste management practices have been strengthened in laboratories. Standard Operating Procedures have been developed and disseminated and all technicians have been vaccinated and trained. Personal Protective Equipment and antiviral drugs have been provided to all laboratories. Training videos, developed with WHO support on occupational and bio-safety practices has been developed and disseminated.

XVI

World Bank Supervision Template

1. Checklist for state project implementation unit

1.1 Organizational structure and functions

i. What is the organizational structure of PMU?

ii. What is the staffing status for implementation of infection control and waste management?

iii. Are the roles and responsibilities of PMU staff specifi ed? Is there duality in roles and responsibilities?

iv. What is the level of importance and commitment accorded to infection control and waste management by the state government?

v. Has the project resulted in a modification/ orientation in the state government's policies and plan with regard to infection control and waste management?

vi. Has the state department of health instituted a multi-sectoral committee to review policy, compliance and implementation issues?

1.2 Planning and implementation

i. Is the health-care waste management plan comprehensive and adequate?

ii. What is the mechanism for monitoring segregation of health-care waste at project sites?

iii. What corrective actions are undertaken in case of non-compliance at one or more sites?

iv. What is the present status of procurement of waste management equipment and materials at various project sites? Are all facilities well equipped?

1.3 Procurement checklist

i. How is the procurement plan prepared for the state? How often do facilities provide their estimates and requirements?

ii. What are the reasons for delay in procurement? How can this be corrected?

iii. What actions may be planned for prevention of such delays in future?

iv. What provisions are there in place to assure quality of equipment and material procured?

v. Has the supply been subjected to or planned for third party quality inspection?

vi. What provisions are there in place for repair and maintenance of equipment? Is there a maintenance plan for equipment? Are critical components spares available for early repair?

vii. What is the status of power supply and are facilities provided with power back-up generators?

viii. What systems are in place for monitoring water, sewage, sanitation and municipal waste management at the facilities? In case of inadequacies, what role is the PMU playing for improving implementation?

1.4 Storage and disposal of health-care waste

i. Do all project sites have separate storage areas for general and hazardous waste? What provisions are in place for regular cleaning and prevention of access to unauthorized persons?

ii. How is regular transportation of hazardous waste from hospital to disposal site ensured? What corrective and preventive actions are there for the delay in transport?

iii. What is the present status of construction of deep burial pits at different project sites?

iv. How is the construction quality of the deep burial pits assured by PMU? What is the mechanism for determining the number of such pits required for the state or facility?

v. What criteria have been followed for assessing capabilities of transportation agencies for safe transport of health-care waste to? What contingency plans are there in place for failure of transportation of health-care waste?

vi. How many facilities are currently availing of the services of the centralized treatment facilities authorized by the state government? Are more project sites being planned for such services in the near future?

vii. What measures are taken to increase compliance with waste treatment and disposal?

viii. What are the charges for contracted services? What is the comparison of the cost of contracting treatment and disposal services as compared to having a dedicated treatment option? Provide rough estimates.

ix. Are sanitation activities at health facilities being outsourced? If yes, how is their technical competencies assessed?

1.5 Occupational health and safety

i. What is the medical surveillance plan for the employees of facilities and its implementation;

ii. Who ensures adequacy and appropriateness of protective equipment required for different categories of workers?

iii. What are the operational control procedures for collection, segregation, transportation, on-site storage, hand washing, equipment hygiene, building and general sanitation;

iv. Is there a plan for immunization of health-care workers against tetanus and Hepatitis B? What is the present status of immunization?

v. How is the monitoring of accidents, e.g. needle stick injuries and waste spills carried out?

vi. Are quality circles functioning in project facilities? Do these include coverage of infection control and waste management activities?

vii. What are the prevalent rates of hospital-borne infection in different state hospitals? Are these statistics available? If yes, provide details. If not, is the system going to be instituted?

1.6 Information, Education and Communication (IEC)

i. Are health-care waste management committees constituted and functioning at project facilities? How is their performance monitored by PMU?

ii. What is the procedure for providing proper information to project functionaries posted at different facilities? Is there in existence a newsletter that could be useful for this purpose?

iii. Is PMU considering developing a web-based data collection system on health-care waste management?

iv. Are awareness materials, for example posters, booklets, etc. available with project facilities? Is the health-care waste management plan available at all project sites for reference?

v. What are the current channels for communication with external interested groups, for example

urban local bodies, *gram panchayats*, NGOs etc.? How are they consulted in decision making on health care waste management?

1.7 Health-care waste management training

i. Are trained master trainers available at all project facilities?

ii. What is the present status of training by these master trainers?

iii. Do all facilities provide training plans and schedules? How does PMU monitor progress of on-going training activities?

1.8 Future plans and sustainability

What are the plans of the project to ensure future sustainability with regard to on-going training and contracting of private services and coordinating with other agencies and stakeholders?

2. Check list for health-care facilities

2.1 General

i. Name & address of health-care facility

ii. Name & designation of responding person

iii. Population of city/town

iv. No. of beds in hospital

v. What is the average occupancy rate for the last six months?

vi. What is the average OPD attendance for the last six months?

vii. What kind of care is primarily provided, for example surgery, intensive care, deliveries, laboratory, radiology, dental, immunizations etc.?

viii. Who is in-charge of health-care waste management activities, and has the designated focal point received appropriate training?

ix. Is there a site-specific health-care waste management plan available at the facility?

x. Does the facility have all its environmental clearances and authorizations? What specific compliance requirements have been specified by the state Pollution Control Board?

xi. What is the quantity of different types of wastes generated at the facility?

xii. What is the mode of collection and transportation of different types of waste? Specify the following:

- Are trolleys, drums, etc. available in sufficient number?
- Are these cleaned and maintained on a regular basis?
- What are the provisions in place for disinfection of sharps before disposal?
- What provisions are there in place to dispose of the liquid waste?

xiii. Are the containers and bags for waste collection available in sufficient quantities and are they in accordance with the color-coding as per the Bio-med Waste Management Rules?

xiv. Does the facility use reusable syringes? Do you have sterilization equipment in place? If yes:

- Are there standard procedures available for sterilization?
- Is there a preventive maintenance schedule for repair and maintenance?
- What is the availability of alternatives, for example, disposable syringes in case of procedural failure?

xv. Are needle cutters available in the facility? If yes, specify:

- Are these available in all required work areas?
- Proportion of functioning needle cutters out of total present at workplace.
- Main reasons for non-functioning or difficulties in their usage.

xvi. Are deep burial pits constructed within the premises? If yes, specify:

- Total number of pits planned and constructed
- Are these constructed as per specifications in the Bio-med Waste Management Rules?

- What is the present state of the pits operation and maintenance?

xvii. Are autoclaves used at the site for waste treatment? If yes, please specify:

- Number of autoclaves available and operation and maintenance conditions.
- Validation testing status for performance by spore testing.
- Contingency plan in case of breakdown of equipment.

xviii. If the facility is contracted to centralized treatment and disposal facilities, please specify:

- Method of storage of segregated waste at the site.
- Status of storage area, for example cleanliness, accessibility, maintenance, etc.
- Frequency and mode of transportation.
- Authorization of transporter.
- Measures for safe transportation including protective gear of transport workers.
- Contingency plan in case of failure of transportation.

xix. What are the contractual rates with the service provider?

xx. What is the average quantity of waste sent for treatment? Please specify in categories.

xxi. What is the level of awareness and training provided to the different levels of facility staff? How often has training been provided? Is there ongoing refresher training?

xxii. Who supervises training and refresher training?

xxiii. Who is responsible for monitoring day-to-day segregation and collection practices within the facility? Is there a reporting system?

xxiv. What is the composition of the health-care waste management committee at the facility, their frequency of meeting and major decisions taken in the past three months?

xxv. Does the facility provide regular reports to the PMU/Department of Health/Pollution control Board?

xxvi. How is the monitoring done for:

- Adequacy of segregation of waste during generation
- Segregation during storage
- Duration of on-site storage
- Day-to-day disposal into the deep burial pits
- Day-to-day functioning of on-site treatment equipment
- Transportation by external treatment facility

xxvii. What are the provisions for the health and safety of health-care workers? Specify:

- Availability of adequate number of protective gear e.g., gowns, aprons, gloves etc.
- Usage of protective gear by different categories of workers.
- Immunization schedule for employees against Hepatitis B and Tetanus.
- Periodic medical surveillance of health-care workers on annual basis.
- Provisions for hand, equipment and building hygiene.
- Provisions for reporting and management of needle-stick injuries and chemical spills, and associated management procedures, equipment, training.

xxviii. How frequently is the site inspected by PMU/ Department of Health/Pollution Control Board? What have been major observations and recommendations?

xxix. What has been the attitude of the community/ NGOs towards waste management by the facility? Have there been any complaints?

xxx. Does the municipality regularly clean up the solid waste? Are there problems with rag-picking?

xxxi. Does the facility plastic waste get sent off for treatment and disposal or is it sold for recycling?

xxxii. What are the concerns with clean water and sanitation within and outside the facility premise?

xxxiii. What are the five major constraints faced in implementing health-care waste management systems? Have there been any actions taken to further improve these systems?

xxxiv. Is the facility interested in moving towards higher environmental standards?

3. Check list for common treatment facility

i. Name, address and location.

ii. How many facilities (public and private; and number of beds) are contracted?

iii. What is the quantum of health waste generated/ day?

iv. What is the timing and frequency of collection of waste?

v. What are the modes of collection – how many vehicles? What is standard of operation and maintenance? Are the drivers trained in infection control?

vi. What are the contractual charges? Has there been a revision in rates? Is the facility viable?

vii. Are there specific guidelines or directives specified by the Pollution Control Board?

viii. What are the environmental clearances and authorizations required? How often does the facility get monitored? How often and what are the reports that have to be submitted?

ix. Have the employees received training in infection control?

World Bank Performance Indicator Template

1. Monitoring indicators: Department of health

i. Number of health-care facilities with medical offi cers and hospital authorities and staff trained in health-care waste management.

ii. Number of facilities attached to centralized treatment facilities.

iii. Institutional mechanism set up across departments, and disease control programs for coordination of health care waste management.

2. Monitoring indicators: Health-care facilities

i. All staff trained in infection control and waste management.

ii. Segregation and storage practices are at 100%.

iii. Reducing number of needle-stick injuries and chemical spills.

iv. Strict monitoring of hospital-acquired infections.

v. Excellent sharps safety systems in place.

vi. Storage of waste not longer than 48 hours.

vii. 100% immunization coverage of all health-care workers and staff.

viii. Clean water and proper sanitation maintained in the facility.

ix. Facility attaining NABH standards.

x. Innovative measures being taken for eco-friendly environment.

XVIII

Key Resource Documents for Health-Care Waste Management and Infection Control

In this section a brief description of the key resource documents used in environment planning of the health sector has been described. The intention is to provide the different stakeholders working in health sector with brief and handy descriptions of key and useful documents. This section has been divided topic wise for easy navigation and understanding.

I. Key documents on health-care waste management

1. *A Global Inventory of Alternative Medical Waste Treatment Technologies, Health Care without Harm, 2007.*

This document is intended to provide a global listing of alternative technologies for the treatment of infectious waste. The inventory is intended for use by different agencies and organizations, planners, policymakers, etc.

2. *Aide-mémoire for a National Strategy for health care waste management, WHO, 2000.*

To assist health-care planners at the national level, an aide-mémoire has been produced which provides an overview of the main aspects that have to be dealt with: a checklist for actions at the national and local level is also included.

3. *Basic Steps in the Preparation of Health-care Waste Management Plans for Health Care Establishments, Mr. Raki Zghondi - WHO EMRO/CEHA, 2002.*

The lack of policies, strategies and enforcement of legislation for the handling and disposing of health-care waste in many Eastern Mediterranean countries has resulted in poor management of such waste. This document provides practical steps for the development of plans for small, medium and large health care establishments in the region.

4. *Better Health-Care Waste Management: An Integral Component of Health Investment Raki Zghondi - WHO/CEHA and Philip Rushbrook, World Bank, 2005.*

The overall objective of this publication is to demystify the topic of health-care waste management and demonstrate that positive improvements are possible in almost every situation with relatively modest levels of effort and investment.

5. *Bio-Medical Waste Management Case Study NCT – Delhi, CPCB, June 2000.*

This CPCB manual has been prepared to help health-care facilities with setting up a sound health- care waste management system and provide a final treatment

and disposal option as per the bio-medical waste management and handling rules.

6. *Bio-Medical Waste: Status in National Capital Territory of Delhi, DHS, Govt. of NCT Delhi, 2006.*

This document provides the overview of health-care waste management in Delhi hospitals and provides the recommendations proposed by the Government of Delhi to further improve the situation of waste management.

7. *Certificate in Health-Care Waste Management, IGNOU – WHO-SEARO, 2006.*

IGNOU in collaboration with WHO-SEARO has prepared a 14 credit, six- month certificate program on health-care waste management for health-care professionals and others who have passed the twelfth class examination. The program highlights the importance of capacity-building and training of health-care professionals.

8. *Compilation of Steam-based Treatment Technology Vendors, UN/GEF Global Health-care Waste Project. May 19th, 2010*

This document provides a partial list of non-incineration technologies for the treatment of health-care waste. The technologies include autoclaves, microwave units, hybrid steam treatment systems, and other steam-based technologies. It does not include vendors of chemical disinfection, irradiation, biological treatment, and incineration or incineration-like technologies. Please note that the UNDP GEF Project does not endorse any of the technologies, companies, or brand names in this list.

9. *Core Competencies Related to Health-care Waste Management, September 2009 UNDP GEF Project, UN/GEF Global Health-care Waste Project, January 12th, 2010.*

This outline provides core competencies related to health-care waste management that can be used to define standards that become the basis for training curricula, professional development, and accreditation. Some countries may have to modify the core competencies to reflect their current practices, the level of development of health-care waste management in their country, and the availability of resources.

10. *Core Principles for Achieving Safe and Sustainable Management of Health-Care Waste Management, WHO, 2007.*

This document was prepared during the international meeting organized by WHO in Geneva in June 2007. It highlights the core principles required for health-care waste management by all those who are directly linked with the health sector. While financing and supporting health-care, provision for the costs of managing health-care waste should be incorporated in the health plans.

11. *Draft Regional Guidelines for Hospital Waste Management in Developing Countries, Dennis C. B. Saw, WHO - Western Pacific Regional Office – EHC, 1993.*

This document is among the initial guidelines provided by the WHO and covers issues such as hospital waste categories; basic steps of waste management; and planning.

12. *Environmental and Bio-Medical Waste Management Plan for RNTCP-II, Revised National Tuberculosis Control Programme, DGHS, MoHFW, GoI, June 2005.*

These guidelines are prepared as a part of the RNTCP. They specify how to deal with specific waste generated during activities related to TB and also specify the importance of integrating these guidelines and activities in health-care facilities with the overall activities related to health-care waste management.

13. *Environmentally Sound Management of Mercury Waste in Health-Care Facilities (Draft report), Central Pollution Control Board (Ministry of Environment & Forests), September 07, 2010.*

The Central Pollution Control Board has prepared draft guidelines on management of mercury waste from health-care facilities. These guidelines are prepared to help health-care facilities manage their mercury waste and switch to non-mercury based devices.

14. *Findings on an Assessment of Small-Scale Incinerators for Health-Care Waste, WHO 2004.*

This report provides an analysis of low-cost, small-scale incinerators used to dispose of health-care waste in developing countries, specifically sharps waste (used and possibly infected syringes and needles). The report includes a situation analysis, a "best practices" guide to small-scale incineration, a screening-level health risk assessment for ingestion and inhalation exposure to dioxin-like compounds, and other information related to the operation and evaluation of the incineration option for health-care waste.

15. ***For Proper Disposal: A Global Inventory of Alternative Medical Waste Treatment Technologies: Health Care Without Harm, 2007.***

Health Care Without Harm (HCWH) developed this inventory to provide a global listing of alternative technologies for the treatment of infectious waste. These alternative technologies operate under conditions that help to avoid the formation of dioxins and furans. The inventory is intended for use by health and environment ministries, international organizations, aid agencies, multilateral lending institutions, national and local planners, policymakers, health-care professionals, and non-governmental organizations involved in health-care waste management or in the development of national and local health-care waste management plans.

16. ***Four Steps for the Sound Management of Health-Care Waste in Emergencies, Y Chartier, WHO, 2005.***

This four-step document expresses public health risks, management, simple disposal options and a long-term approach for emergency situations.

17. ***Global Movement for Mercury-Free Health Care, Health-care Waste Management, Oct. 2008.***

This report documents the state of the global movement toward mercury-free health care by describing the relevant issues, the challenges the health-care sector faces in replacing mercury-based medical devices, and a series of successes including pilot projects and policy models that are already achieving meaningful changes on the ground.

18. ***Guidance on Clean-up Storage and Transport of Mercury from Health Care, UN/GEF Global Health-care Waste Project, July 22nd, 2010.***

As health facilities phase out mercury devices, proper methods of storage and transport are needed. This document is intended for project countries where national norms and guidelines for clean-up, storage, and transport of mercury waste do not exist at this time. These suggested guidelines should become part of a broader plan for sequestration and phase-out of mercury.

19. ***Guidelines for Safe Disposal of Unwanted Pharmaceuticals in and after Emergencies, WHO, 1999.***

In this document guidance is provided on the disposal of drugs in difficult situations in or after emergencies, in relation to armed conflicts, natural disasters or others. In such situations, it is possible that large quantities of unwanted drugs accumulate due to difficulties, mismanagement of stocks and inappropriate donations. The guidance provided consists of relatively simple and low-cost measures and is addressed to local authorities, health-care personnel or other professionals confronted with this type of problem. The main thrust is on existing disposal methods, and recommended disposal methods by waste category.

20. ***Guidance on the Microbiological Challenge Testing of Health-care Waste Treatment Autoclaves UN/GEF Global Healthcare Waste Project, September 22nd, 2010.***

Two components of the UNDP GEF Project on Global Health-care Waste involve the demonstration of non-incineration health-care waste treatment technologies, the most common of which is the autoclave. This document provides a microbiological challenge test protocol for validation testing of gravity-displacement or vacuum autoclaves used for the treatment of medical waste. The objective of the test protocol is to demonstrate the ability of an autoclave to effectively treat medical waste according to accepted treatment standards.

21. ***Handbook of Hazardous Health-Care Waste Management in 10 and 30 bed Community Hospitals, Sanitation Division and Environmental Health Center, Ministry of Public Health, Thailand, 1995.***

This document deals mainly with waste collection, transportation and final disposal. The other steps (minimization, generation, storage) are briefly mentioned. As the title shows, this handbook is intended to help manage hazardous health-care waste in small to medium sized community hospitals.

22. ***Health-care Waste Management: Costing Analysis Tool (CAT), The Protection of the Human Environment Departments/Water, Sanitation and Health Unit at WHO, 2006.***

This costing tool has been created to help estimate and calculate costs related to health-care waste management at national and health care facility levels.

23. ***Health-care Waste Management: Expanded Costing Analysis Tools (ECAT), WHO, 2007.***

Allocating insufficient financial resources to manage health-care waste properly has an even greater financial cost in the medium and long term in terms of morbidity and mortality, as well as environmental damage that will in the end impact negatively on peoples' health. The Expanded Costing Analysis Tool (ECAT) is a modified version of the Cost Analysis Tool (CAT) and provides more options and approaches than CAT. It was created to help the user estimate costs related to health-care waste management at the health-care facility, CWTFs or cluster, and national levels.

24. ***Health-care Waste Management: Rapid Assessment Tool (RAT), WHO, UNEP/SBC, 2004.***

This assessment tool has been created to help get an overall picture of the health-care waste management situation prevailing within a country at all levels (ministerial down to small health-care facilities). It helps assess management, training, regulatory, technical and financial issues; its analysis should help pinpoint critical issues that need to be addressed within the framework of a National Action Plan (NAP).

25. ***Health-Care Waste Management, World Bank and WHO, December 2003.***

This is a five-page document highlighting the importance of good health-care waste management, the do's and don'ts, and describes the related project cycle.

26. ***Health-care Waste Management Guidance Note, Lars M. Johannessen, et al, The World Bank, 1999.***

The main focus of the document is to: describe the scope of the problem; provide guidance for small and large health-care facilities; offer guidance for municipal, metropolitan or regional health-care waste projects; and provide guidance for national health-care waste projects along with information sources and references. This guidance note should be viewed as an internal World Bank working document that attempts to synthesize the currently available knowledge and information in the field of health-care waste management.

27. ***Health-Care Waste Management: Guidance for the Development and Implementation of a National Action Plan, WHO, 2005.***

This document provides guidance to assess and analyze the health care waste management situation at the national level, and to draft a national HCWMP, with the aim of improving the overall systems in the country. The draft Plan would then be reviewed by persons involved in the national or regional policy setting, interested donor agencies, NGOs and other concerned organizations or stakeholders; roles and resources for its implementation would be identified.

28. ***Health-Care Waste Management in India; Onsural B, The World Bank, October 2003.***

This report presents an overview of the responses and concerns in India, associated with health-care waste management at the central, state, and local levels. The report is based on the World Bank's experience in working with clients and draws heavily on an internal review of the World Bank's operations.

29. ***Healthy Hospitals – Healthy Planet: How the Health Sector can Reduce Its Climate Footprint , WHO-Health Care Without Harm, 2009.***

This discussion draft is based on WHO's mandate from member states to develop a program for the health sector that will reduce their greenhouse gas emissions. The paper defines a framework for analyzing and addressing the health sector's climate footprint and demonstrates that the health sector is already beginning to provide examples in setting up climate-friendly hospitals.

30. ***Hospital Waste: Time to Act, Compilation of Facts Sheets, Srishti, 2002.***

This document is a compilation of 14 facts sheets published by Srishti in the area of health-care waste management. These fact sheets provide information on a wide range of issues such as universal precautions, plastics, incineration, mercury and alternative technology in health-care facilities.

31. ***Infection Management and Environment Plan, Policy Framework, MoHFW, GoI, March 2007.***

This document contains generic guidance to central- and state-level institutions on the type of systems and processes to be established for infection control and waste management.

32. ***Infection Management and Environment Plan, Guidance Manuals, MoHFW, GoI, March 2007.***

Guidance Manuals for Community Health Care, Primary Health Care and Sub-centres are designed as instruction manuals for health-care workers at the primary level facilities. These guidelines are in the form of simple pictorial presentations of the various steps needed to manage infectious waste in a hygienic, safe and environmentally sound manner.

33. ***Islamic Republic of Iran Management of Health-Care Waste Policy Note, Water, Environment, Social and Rural Development Department, Middle East and North Africa Region, The World Bank, October 17, 2005.***

The objective of this policy note is to present a diagnosis of the main issues and barriers towards a well-structured health-care waste management system, and set a recommended action plan for better performance. The policy note focuses on accomplishments and future challenges for sector actions to increase efficiency of the institutional framework, at both the national and municipal levels.

34. ***Key Steps in Sharps Waste Disposal, PATH, 2006.***

This training aid was developed as part of *Training Health Workers in the Management of Sharps Waste*. The aid includes a graphic representation of the key steps involved in the safe management of health-care waste: segregation, containment, handling and storage, transport, treatment or destruction, and disposal.

35. ***Land-filling Health-Care Waste: Sustainable Methods of Disposal or Threat to Public Health? Kristof Bostoen, WEDC - Department of Civil and Building Engineering, 1997.***

This report analyses the risk linked to land filling of health care wastes, the risk of transmission of infectious diseases, toxicology as well as an overview on sanitary landfill practices. The report argues that in low-income countries, land-filling health care-waste is more likely to be a benefit to public health, compared to crude dumping commonly practiced in many of these countries.

36. ***Lurking Menace: Mercury in the Health-Care Sector, Toxics Link, 2005.***

This report highlights the use of mercury in the health sector, the hazards caused by mercury use and case studies of good practices and benefits of moving towards non-mercury devices.

37. ***Management of Solid Health-Care waste at Primary Health Care Centres: A Decision-Making Guide, WHO, 2005.***

The objective of this document is to provide guidance for selecting the most appropriate waste management methods for safely managing solid waste generated at primary health-care centres in developing countries. The main tool of this guide consists of six decision-trees aimed at assisting the user in identifying appropriate waste management methods. The guide takes into consideration the most relevant local conditions, the safety of workers and the general public as well as environmental criteria.

38. ***Management of Waste from Injection Activities at the District Level: Guidelines for District Health Managers, WHO, 2006.***

This guide is designed as a simple and practical tool to help district health managers formulate a realistic district-level plan to reduce improper disposal of waste from injection activities.

39. ***Management of Wastes from Immunization Campaign Activities: Practical Guidelines for Planners and Managers, WHO, 2004.***

This document, developed by WHO and UNICEF, provides practical guidelines for planners, managers of health-care facilities or mobile vaccine team leaders to improve planning and coordination at the central level, as well as waste management practices at the local level where immunization activities are conducted.

40. *Managing Health-Care Waste Disposal, WHO Africa and PATH Children's Vaccine Program, 2005.*

The guidelines focus on the product specification, installation, operation and maintenance of a waste disposal unit for managing health-care waste.

41. *Managing Hospital Waste: A Guide for Health-Care Facilities, Megha Kela, Samir Nazareth, Anu Goel, Ravi Agarwal, Srishti, 1998.*

This is a hands-on manual on hospital waste, describing the different kinds of waste generated in health-care facilities and their handling and disposal options at different points of waste generation. It also highlights the importance of training and awareness, and the role of rag-pickers and the municipality.

42. *Mercury in Health Care, Policy Paper, WHO, 2005.*

The technical paper on mercury recommends that countries conduct assessments of current mercury usage and health-care waste management programs. The WHO proposes to work in collaboration with countries through short- medium- and long-term strategic steps presented in this document.

43. *National Guidelines on Hospital Waste Management, MoH&FW, GoI, March 2002.*

These guidelines, apart from covering the aspects included in the Bio-Medical Rules, also lays down recommendations for safety measures, training, management and administrative functions.

44. *National Steering Committees and National Working Groups for Health-Care Waste Management Policy Development and Planning, WHO, 2006.*

This paper describes an organizational model and strategy for developing health-care waste management policies and plans through National Steering Committees and National Working Groups.

45. *Non-Incineration Medical Waste Treatment Technologies, Health Care without Harm, 2001.*

This document provides in detail the advantages of non-burn waste treatment technologies and an overview of non-incineration technologies (thermal, chemical, irradiative, biological, mechanical), describing each of them as well as discussing factors to consider while selecting a technology.

46. *Preparation of National Health-Care Waste Management Plans in Sub-Saharan Countries: A Guidance Manual. WHO and UNEP/SBC, 2004.*

The manual aims at identifying appropriate practices for health-care waste management by providing assessment and planning tools applicable in most Sub-Saharan countries of Africa.

47. *Recommended Elements of a Model Facility Policy on Health-Care Waste Management, UNDP, GEF, April 2009.*

This is a policy document to be used by hospitals for setting up and running health-care waste management especially the hospitals under the Global Environment Facility (GEF).

48. *Regulated Medical Waste Reduction, Hospitals for a Healthy Environment, 2003.*

The manual describes different steps for implementing a regulated medical-waste reduction plan in health-care facilities. The manual provides 10 steps for waste reduction.

49. *Report of the Committee to Evolve Road Map on Management of Wastes in India, MoEF, GoI Delhi, March 2010.*

This report provides recommendations and suggested future actions to be taken up by the Government and other implementing agencies to improve the overall waste management situation in the country. It covers all the different kinds of waste, including health-care waste, and provides a specific action plan to improve health-care waste management in the country.

50. ***Report: Non-Incineration Medical Waste Treatment Pilot Project at Bagamoyo District Hospital, Tanzania, Health Care Without Harm & Partners, September 22nd, 2010.***

Since October 2008, Bagamoyo Hospital in Tanzania has been using an autoclave and shredder to render their waste harmless before disposal. A year of monitoring after the project initiation demonstrated that this technology can work well in the African context. This report shows how steam-based disinfection rather than incineration was used in the hospital to treat medical waste.

51. ***Review of Health Impacts from Microbiological Hazards in Health-Care Wastes, WHO, 2004.***

This technical guideline aims at reviewing the scientific literature for findings on health impacts from microbiological hazards of health-care wastes. It also reviews health impacts of similar exposures in identical circumstances, to evaluate health risks by analogy. The document is targeted at scientists and public health professionals, and those involved in policy setting.

52. ***Risks and Costs Associated with the Management of Infectious Wastes, WHO Regional Office for Western Pacific, 2003.***

This report deals with the risks associated with the treatment and disposal of health-care wastes by means of technologies that have been demonstrated in the field. Information regarding the risks associated with each one of the treatment or disposal methods has been reported in the document from the results of research, and in some cases from research conducted on the treatment or disposal of medical wastes.

53. ***Rules and Regulation on Health-Care Waste Management US EPA, 1997.***

These legal documents deal with standards of performance for new stationary sources and emission guidelines for existing sources: hospital/medical/ infectious waste incinerators.

54. ***Safe Management of Bio-Medical Sharps Waste in India: A Report on Alternative Treatment and Non-Burn Disposal Practices for Sharps Disposal, WHO-SEARO, 2005.***

The study documents successful sharps management systems by use of non-burn treatment and disposal technologies in urban health-care facilities in India. The document also provides recommendations of the possibilities of material recovery of these syringes.

55. ***Safe Management of Wastes from Health-Care Activities, Annette Pruess, E. Giroult, P. Rushbrook, WHO, 1999.***

This handbook provides a one-stop solution to health-care waste management. It covers all the issues including financing and minimal requirements for rural settings. By publishing this handbook WHO aims not only to promote a sound managerial approach and the use of appropriate technologies, but also to inform countries about the health risks that result from inadequate management of health-care waste. The advice and guidance offered are intended to assist national bodies and individual medical institutions.

56. ***Segregation of Medical Waste, PATH, 2006.***

This training aid was developed as part of "Training Health Workers in the Management of Sharps Waste." The aid includes a graphic representation of the segregation of medical waste into three categories: non-infectious, infectious, and sharps. Over the last few years a number of countries have adapted the basic concepts and developed country-specific versions of this for use in training as well as posters in health facilities. An example adapted for Kenya is also available.

57. ***Small-Scale Autoclaves to Manage Medical Waste: A Buyer's Guide to Selecting Autoclaves Manufactured in India, USAID and PATH, Sept. 2008.***

This document shows that there is a growing interest, globally, in more sustainable non-incineration approaches to the treatment of medical waste. However, currently there is very little information on practical alternatives for treating medical waste in low resource settings. In this guide, PATH has gathered information from manufacturers of small-scale Indian autoclaves as one option for treatment of medical waste. India was chosen as the focus country for the guide because of its large number of manufacturers of low-cost, small-scale autoclaves.

58. ***Starting Health-Care Waste Management in Medical Institutions: A Practical Approach, Philip Rushbrook et al. WHO, Regional Office for Europe, 2000.***

This document has been prepared in response to numerous requests for advice and assistance by staff in ministries of health and health-care institutions, particularly from those who are responsible for introducing better waste management practices in medical institutions, so as to reduce infection risks and improve hygiene.

59. ***Teacher's Guide: Management of Waste from Health-Care Activities, A. Prüss, W.K. Townend, WHO, 1998.***

The teacher's guide accompanies the WHO publication on management of wastes from health-care activities. It provides teaching materials (ready-to-copy texts for overhead transparencies, lecture notes, handouts, exercises and course evaluation forms) and recommendations for a three-day training course. It is designed mainly for managers of health-care establishments, public health professionals and policy makers. A selection of pictures to support training in health-care waste management is available on line.

60. ***Technical Guidelines on the Environmentally Sound Management of Bio-Medical and Health-Care Waste, Basel Convention (SBC - UNEP), 2000.***

This document provides the guidelines prepared for use under the Basel Convention. It describes definition and the hazards of bio-medical and health-care wastes; source identification of waste; applicable state-of-the-art management, treatment and disposal technologies; and waste management auditing techniques.

61. ***Technical Guidelines on the Environmentally Sound Management of Bio-Medical and Health-Care Wastes (Y1, Y2), (SCB - UNEP), 2003.***

The guidelines provide information on the proper treatment of wastes from health-care establishments (public and private). The information provided takes due consideration of the waste management requirements of disposal and recovery measures as well as hygiene requirements. In addition to ecological aspects, the information and recommendations should be economically feasible and easy to undertake. It also makes allowances for technical progress

62. ***Testing and Evaluation of Needle Destroyers, PATH, 2000.***

This is a report published by PATH on the testing and evaluation of several needle destroyers available in the market. The report classifies the needle destroyers according to functional, safety and user considerations.

63. ***The Costs of Recycling the Plastic of Auto Disable Syringes in Ukraine, WHO, 2005.***

The objective of this study is to estimate the costs of recycling the plastic of Auto Disable (AD) syringes as carried out in a pilot project launched in April 2003 in Khmelnytsky Oblast and Kiev city in Ukraine with the support of the WHO European Regional Office. Information on cost is essential to assess the feasibility and sustainability of expanding the new waste management system to a wider scale.

64. ***Toward the Tipping Point: WHO-HCWH Global Initiative to Substitute Mercury-Based Medical Devices in Health Care by World Health Organization & Health Care Without Harm, June 3rd, 2010.***

The report documents the progress of dozens of countries from around the world moving toward mercury-free health care. The progress report finds that, "Momentum is growing and mercury-free health care is increasingly becoming the status quo in many countries. The Global Initiative is moving closer to a tipping point that will shift the dynamics of supply and demand in the global thermometer and blood pressure device markets away from mercury and toward the alternatives."

65. ***Training of health-care professionals- GoI, MoHFW Bio-medical waste management self-learning document for doctors, superintendents and administrators, prepared by EPTRI, Hyderabad, for MoEF, GoI, 2010.***

This manual is useful for refreshing and or upgradation of knowledge of doctors, superintendents and administrators on bio-medical waste management. This

will sensitize the reader about the impacts of improper waste management and acquaint them with laws and practices in India

66. *Training Health Workers in the Management of Sharps Waste PATH, 2006.*

This document contains a set of training modules designed to be adapted for use in various health-care settings. The purpose of these materials is to train health workers in the management of sharps waste. These materials are divided into two training guides: one for training injection providers, and second for training waste-handlers.

67. *Treatment Alternatives for Medical Waste Disposal , PATH, 2005.*

The purpose of this document is to inform the reader about different technology options for the treatment of infectious medical waste, particularly for developing countries. It describes incineration, chemical treatment, autoclaving, microwaving, and shredding/compacting. Performance issues, environmental impact, and perspectives from several developing countries are described.

68. *Union Audit (CAG) Reports, Scientific Departments, Management of Waste in India (Performance Audit - Report No. 14 of 2008), 2006-2007.*

This report has been prepared by the Comptroller and Auditor General of India for the year ended March 2007 to assess and audit the management of waste in India. The auditing conclusions and recommendations of the report are based on the current situation and good practices regarding waste management in India and in other countries.

69. *Waste Management and Disposal during the Philippines Follow-Up Measles Campaign 2004, Health Care Without Harm (HCWH) and Department of Health, Philippines, June 2004.*

This report focuses on the waste disposal of the Philippines Follow-Up Measles Elimination Campaign, targeted at an estimated 18 million children during February 2004. The report documents the disposal method of the large quantities of waste generated during the immunization campaign, without incineration or open burning during a mass immunization campaign.

70. *WHO Policy Paper on Safe Health-Care Waste Management, WHO, August 2004.*

The policy document calls on countries to develop and implement national plans, policies, and legislation on health-care waste.

II. Key documents on infection control, sanitation and water supply

71. *Bio-Safety in Microbiological and Bio-Medical Laboratories, U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention and National Institutes of Health, Fourth Edition, April 1999.*

This publication describes the combinations of standard and special microbiological practices, safety equipment, and facilities constituting Bio-Safety Levels 1-4, which are recommended for working with a variety of infectious agents in various laboratory settings.

72. *Bio-Technology: Laboratories for Research, Development and Analysis – Guidance for Handling, Inactivating and Testing of Waste, European Committee for Standardization "CEN", 1997.*

This document was prepared by the technical committee CEN/TC233. It provides guidance on methods for handling, inactivating and testing of waste containing micro-organisms arising from bio-technology and microbiology laboratory activities and processes. It focuses on methods to reduce the risks arising from exposure to waste derived from laboratory-scale activities both for humans, animals and the environment in general.

73. *Environmental Management for Construction Activities, Addendum, NACP-III, MoHFW, GoI, September 2006.*

These guidelines deal with the issues related to construction activities and provide measures for environment management of construction activities in the health care facilities.

74. ***Environmental Management Plan for the Vector-Borne Disease Control Project India, National Institute of Malaria Research (Indian Council of Medical Research), December 2006.***

These environment management plans (EMPs) are prepared to help in setting up an environmentally sound VBDC program in the country. These guidelines will help in ensuring that the project is environmentally sound and sustainable by recommending measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental management performance.

75. ***Essential Environmental Health Standards in Health Care, edited by John Adams, Jamie Bartram, Yves Chartier, WHO 2008.***

This document deals specifically with essential environmental health standards required for health-care settings in medium- and low-resource countries to: (i) assess prevailing situations and plan for the improvements that are required; (ii) develop and reach essential safety standards as a first goal; and (iii) support the development and application of national policies. These guidelines have been written for use by health managers and planners, architects, urban planners, water and sanitation staff, clinical and nursing staff, and other health-care providers, and health promoters.

76. ***Guidance Note on Health-Care Worker Safety from HIV and other Blood-Borne Infections, Julian Gold, Maggy Tomkins, Phillip Melling, Nicholas Bates, May 2004.***

This guidance document is to focus on the occupational safety issues of health-care workers and encourage policy makers to include health-care waste safety as a component in all health policies, protocols and guidelines. The guidance note provides some strategies as to how this may be achieved as well as guidelines for the content of policies.

77. ***Guidelines for Hand Hygiene in Health-Care Settings, Recommendations of the Health Care Infection Control Practices, Advisory Committee and the HICPAC/SHEA/APIC/IDSA, Hand Hygiene Task Force, Morbidity and Mortality Weekly Report, CDC, Oct. 2002.***

The "Guideline for Hand Hygiene in Health-Care Settings" provides health-care workers with a review of data regarding hand washing and hand antisepsis in health-care settings. In addition, it provides specific recommendations to promote improved hand-hygiene practices and reduce transmission of pathogenic micro-organisms to patients and personnel in health-care settings. This report also reviews studies published since the 1985 CDC guidelines on infection control.

78. ***Guidelines for Infection Control in Health-Care Personnel, Elizabeth A. Bolyard, RN, MPH, a Ofelia C. Tablan, MD, Walter W. Williams, MD, B Michele L. Pearson, MD, A Craig, N. Shapiro, MD, A Scott, D. Deitchman, MD, C and The Hospital Infection Control Practices Advisory Committee CDC, 1998.***

This guideline updates and replaces the previous edition of the Center for Disease Control and Prevention (CDC), "Guideline for Infection Control in Hospital Personnel," published in 1983. The revised guideline, designed to: (i) provide methods for reducing the transmission of infections from patients to health-care personnel and from personnel to patients; and (ii) provide recommendations for infection control.

79. ***Guidelines for Isolation Precautions: Preventing Transmission of Infectious Agents in Health-Care Settings 2007, Jane D. Siegel, MD; Emily Rhinehart, RN MPH CIC; Marguerite Jackson, PhD; Linda Chiarello, RN MS; The Health-Care Infection Control Practices Advisory Committee, 2007.***

This guideline updates the *1996 Guideline for Isolation Precautions in Hospitals*. This document is intended for use by infection control staff, health care epidemiologists, health care administrators, nurses, other health-care providers, and persons responsible for developing, implementing, and evaluating infection control programs for health-care settings across the continuum of care.

80. ***Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Health Care Infection Control Practices Advisory Committee (HICPAC), U.S. Department of Health and Human Services***

Centers for Disease Control and Prevention (CDC) Atlanta, GA 30333, 2003.

This report reviews previous guidelines and strategies for preventing environment-associated infections in health-care facilities and offers recommendations. These include: (i) evidence-based recommendations supported by studies; (ii) requirements of federal agencies; (iii) guidelines and standards from building and equipment professionals; (iv) recommendations derived from scientific theory or rationale; and (iv) experienced opinions based upon infection-control and engineering practices. The report also suggests a series of performance measurements as a means to evaluate infection-control efforts.

81. *Health through Safe Health Care: Safe Water, Basic Sanitation and Waste Management in Health-Care settings, WHO, 2005.*

This document combines the need for sanitation and good health. It states that health-care facilities require access to safe water, basic sanitation, hygiene and safe disposal of wastes. Goal 4, target 5 of the Millennium Development Goals aims at reducing the death rate for children under five by two-thirds, while goal 5, target 6 aims at reducing maternal mortality by three-quarters.

82. *Healthy Hospitals: Controlling Pests without Harmful Pesticides, Kagan Owens, Beyond Pesticides, Beyond Pesticides and HCWH, 2003.*

This report is intended to inform hospital officials, the public and policy makers about: (i) a number of potential health hazards associated with the use of pesticides in hospitals; (ii) the findings of a national hospital pest management practices survey; and (iii) the availability of and need for safer pest management practices and disclosure of hospital pesticide use to patients, visitors and staff.

83. *India: Review of the Effectiveness of Environmental Assessments in World Bank–Assisted Projects, Fiscal 1990–97, Environment Sector Management Unit South Asia Region, The World Bank, 1999.*

This report is published to communicate to the development community the results of the World Bank's work by identifying areas requiring further attention, and make recommendations to improve the EA effectiveness.

84. *Infection Control Annual Report, 2006- 2007, Royal National Orthopedic, Vishal Sookhoo.*

This report outlines the activities of the organization relating to infection control from April 2006 to March 2007. The report states that control of infection has always been taken very seriously by the Royal National Orthopaedic Hospital and describes the reasons for the 50 percent reduction in health care-associated infections up to March 2008.

85. *Laboratory Bio-Safety Manual – Third Edition, WHO 2004.*

This manual is intended to provide practical guidance on bio-safety techniques for use in laboratories at all levels. This revised edition covers risk assessment and safe use of recombinant DNA technology, and provides guidelines for the commissioning and certification of laboratories. It also includes the latest regulations for the transport of infectious substances.

86. *Management of Waste from Blood Transfusion Activities, WHO, 2008.*

These WHO guidelines recommend best practices in the management of waste related to blood transfusion activities in the health-care system (blood transfusion services, blood banks and hospitals).

87. *Municipal Waste (Management and Handling) Rules, 2000, GoI.*

These are the national regulations for managing municipal waste and do not cover bio-medical waste.

88. *National Environmental Auditing Manual for Hospitals, Lebanese Ministry of Environment and UNDP.*

This manual has been prepared to assist health-care establishments with environmental auditing tools to provide a clear and detailed way of assessing the overall performance of audited facilities by pinpointing the potential threats and suggesting a series of mitigation measures and recommendations.

89. *Occupational Health and Safety, Susan Wilburn, MPH, RN American Nurses Association, Seattle, Washington.*

This document highlights the occupational hazards in the health-care facility, the existing legislation, and recommendations for a safe and healthy work environment.

90. ***Practical Guidelines for Infection Control in Health-Care Facilities, World Health Organization, Regional Office for South-East Asia and Regional Office for Western Pacific, 2004.***

These guidelines should help countries strengthen their infection control practices in health-care facilities. This would help prevent further spread of infection and deal effectively with new infectious diseases like SARS as well as other hospital-associated infections. The guidelines address all aspects of an infection control program with special attention on SARS. Since information on SARS is still evolving, these guidelines will be updated as more specific information becomes available.

91. ***Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health, Prüss-Üstün A, Bos R, Gore F, Bartram J. World Health Organization, 2008.***

This document provides evidence and information related to water and health. It compiles information on drinking water supply, sanitation, hygiene, and the development and management of water resources. The document further provides data that support policy decisions, namely the disease burden at stake, the effectiveness of interventions, their costs and impacts, and implications for financing.

92. ***Sanitation of Hospitals, Nursing Homes, Adult Care Homes, and Other Institutions, Chapter 18, Environmental Health, 18a Sanitation, Department of Environment and Natural Resources, NC Department of Environment and Natural Resources, February 2004.***

This document describes the various regulatory provisions for environmental health and sanitation in health-care facilities by the New York Department of Environment and Natural Resources.

93. ***The Environmentally Responsible Dental Office: A Guide to Proper Waste Management in Dental Offices, Northeast Natural Resource Center of the National Wildlife Federation and the Vermont State Dental Society, June 1999.***

This guide shows how dental offices can limit the amount of mercury and other chemicals entering the environment by using common-sense pollution prevention and waste management techniques. It also provides tips for the proper handling of other harmful chemicals present in dental offices.

94. ***The Evolution of Environmental Assessment in the World Bank from "Approval" to Results, World Bank 1999.***

This paper suggests that the quality of EA of a project is necessary, but insufficient for successful EA. There are three main constraints to successful EA in developing countries at present. First is lack of political will; second, the institutional capacity; and third adequate financial resources. For a successful EA, it is very important to conduct an EMP, and provide funds and capacity before the project is accepted.

95. ***World Alliance for Patient Safety, Global Patient Safety Challenge 2005 – 2006, Clean Care is Safer Care, WHO 2005.***

This document describes the prevention of infection associated with health care, the Elements of the Global Patient Safety Challenge and steps for implementing the Global Patient Safety Challenge.

XIX

Website References

1. Ministry of Health and Family Welfare: http://www.mohfw.nic.in/
2. Ministry of Environment and Forests: http://www.envfor.nic.in/
3. Central Pollution Control Board: http://www.cpcb.nic.in/
4. World Health Organization: http://www.who.int/en/
5. World Health Organization – Health Care Waste Management site http://www.healthcarewaste.org/ http://www.who.int/immunization_safety/waste_management/en/
6. World Bank: http://www.worldbank.org
7. PATH: http://www.path.org
8. Health Care Without Harm: http://www.noharm.org/
9. Global Environment Facility: http://www.gefmedwaste.org/
10. Toxics Link: http://www.toxicslink.org
11. Centre for Environment Education: http://www.ceeindia.org/cee/waste.html
12. Mercury-free Health Care; www.mercuryfreehealthcare.org
13. Centre for Diseases and Control and Prevention: www.cdc.gov
14. Occupational Safety and Health Administration: www.osha.gov

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