Biomedical Waste Management

Biomedical Waste Management

- **"Bio-medical waste"** means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research activities pertaining to the production or testing of biological.

- **"Biologicals"** means any preparation made from organisms or product of metabolism and biochemical reactions intended for use in the diagnosis, immunisation or the treatment of human beings or animals or in research activities pertaining thereto

Source: Bio Medical Waste (Management and Handling) Rules 2011

Biomedical Waste Management

- Biomedical waste, (BMW), consists of **solids, liquids, sharps, and laboratory waste** that are potentially infectious or dangerous

- Common producers of biomedical waste include **hospitals, health clinics, nursing homes, medical research laboratories**

TYPES OF HOSPITAL WASTES

Infectious Hospital Wastes:

- Human anatomical or surgical waste
- Animal waste
- Pathological waste including tissues, organs, blood and body fluids, microbiological cultures, Cotton, Swabs etc.
- Used Syringes, tubes, Blood bags and other items contaminated with blood and body fluids.
- Items such as plaster and bandages, when contaminated by blood.
- **Waste from isolation wards.**

The amount of infectious waste is ~15-20% of the total wastes generated from the health care establishment.

TYPES OF HOSPITAL WASTES

Non Infectious Hospital Waste:

- Kitchen waste and office wastes---similar to household waste

- Non infectious wastes constitute ~80-85% of the total wastes generated from a health care unit

- In absence of proper segregation, the non infectious waste becomes infectious and poses environmental threat to the society.

Status India

- **52,000 (~53 %), health care establishments are in operation without obtaining authorization from SPCBs/PCCs which means that waste generated from such facilities goes unaccounted and is dumped without any adequate treatment illegally.**
- **~288.2 tons per day (57%) out of 506.7 tons per day wastes generated is being treated either through Common Bio Medical Waste Treatment Facilities (159 in number) or captive treatment facilities.**
- **602 bio-medical waste incinerators**
  - **~ 70 % incinerators are provided with air pollution control devices**
- **2,218 autoclaves**
- **192 microwaves**
- **8,038 shredders**

Source: Mohankumar et al. 2011; **International Journal of Pharmaceutical & Biological Archives 2011; 2(6):1621-1626**

Biomedical waste generation

Category of health care unit	Quantity (kg bed $^{-1}$ day $^{-1}$)
Paediatric unit	0.56
Eye unit	0.72
Orthopaedic unit	2.12
Gynaecology unit	1.56
Cardiology unit	0.73
Medicine unit	2.10
Surgery unit	1.52
OPD, burns, X-ray and canteen	2.63
General hospital	1.83
Multi-specialty hospital	2.53

muti speciality hospital produces twice amt of waste

Average: 1.60 kg/bed/day

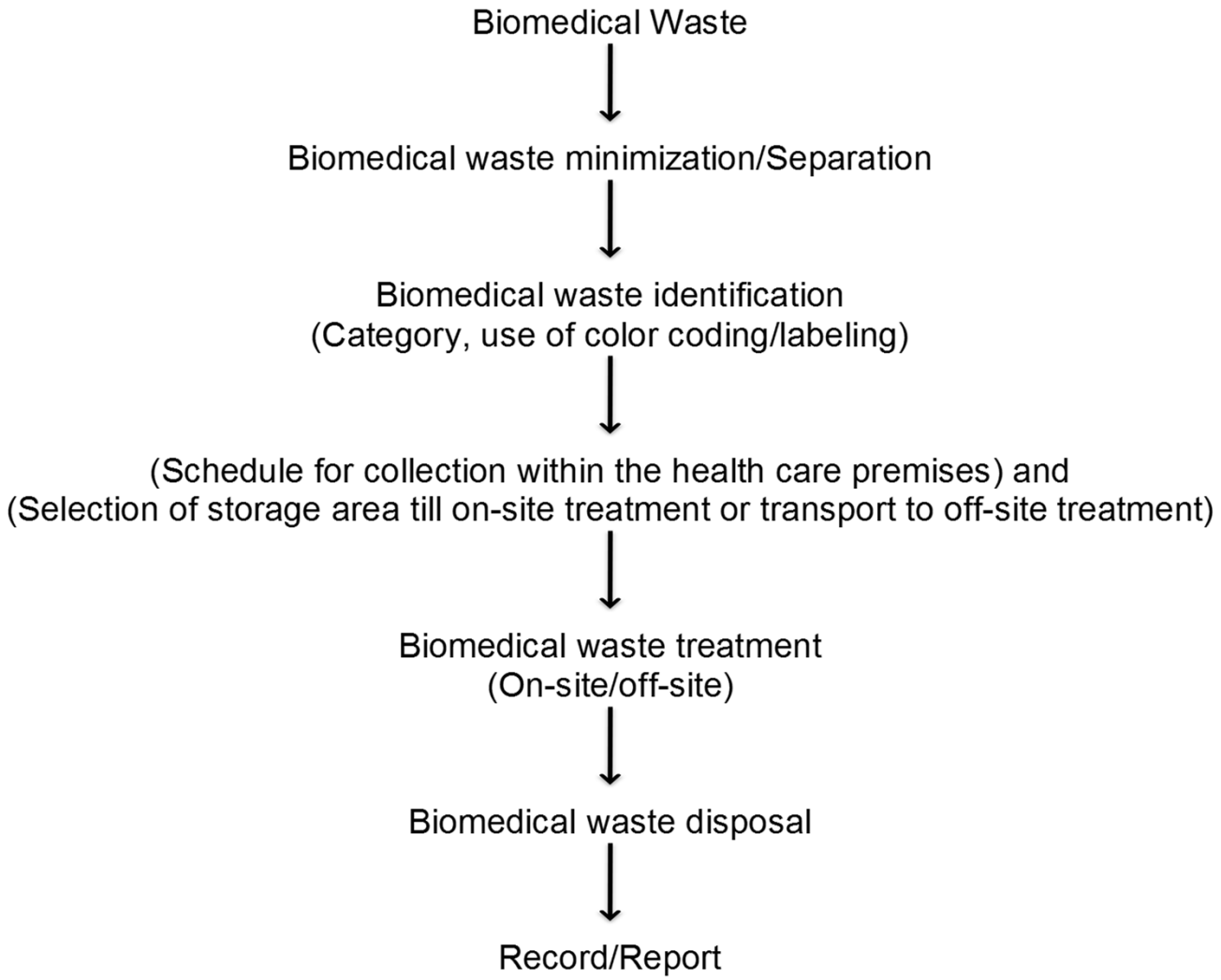
Patil and Shekdar, *Journal of Environmental Management (2001) 63, 211–220*

Bio Medical Waste : (Management and Handling) Rules 2016

- Every occupier to- (a) take all necessary steps to ensure that bio-medical waste is handled without any adverse effect to human health and the environment and in accordance with these rules

- Make a provision within the premises for a safe, ventilated and secured location for storage of segregated biomedical waste in colored bags or containers in the manner as specified in Schedule I,
- …

Elements of the Biomedical Waste Management (As per rules)



Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	**(a) Human Anatomical Waste:** Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time).	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial*
	(b)Animal Anatomical Waste : Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses.	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial*
	(c) Soiled Waste: Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial* In absence of above facilities, autoclaving or microwaving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery.

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	**(d) Expired or Discarded Medicines:** Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.	Yellow coloured non-chlorinated plastic bags or containers	Expired cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature >1200 C or to common bio-medical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at >1200C Or Encapsulation or Plasma Pyrolysis at >1200C. All other discarded medicines shall be either sent back to manufacturer or disposed by incineration.
	(e) Chemical Waste: Chemicals used in production of biological and used or discarded disinfectants.	Yellow coloured containers or non-chlorinated plastic bags	Disposed of by incineration or Plasma Pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility.
	(f) Chemical Liquid Waste : Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.	Separate collection system leading to effluent treatment system	After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other wastewater. The combined discharge shall conform to the discharge norms given in Schedule III.

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	**(g)** Discarded linen, mattresses, beddings contaminated with blood or body fluid.	Non-chlorinated yellow plastic bags or suitable packing material	Non- chlorinated chemical disinfection followed by incineration or Plazma Pyrolysis or for energy recovery In absence of above facilities, shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery or incineration or Plazma Pyrolysis.
	(h) Microbiology, Biotechnology and other clinical laboratory waste: Blood bags, Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures	Autoclave safe plastic bags or containers	Pre-treat to sterilize with nonchlorinated chemicals on-site as per National AIDS Control Organisation or World Health Organisation guidelines thereafter for Incineration.

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Red	**Contaminated Waste (Recyclable)** (a) Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vaccutainers with their needles cut) and gloves.	Red coloured non-chlorinated plastic bags or containers	Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites.
White (Translucent)	**Waste sharps including Metals:** Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps	Puncture proof, Leak proof, tamper proof containers	Autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving; and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Blue	**(a) Glassware:** Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.	Cardboard boxes with blue colored marking	Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling.
	(b) Metallic Body Implants		

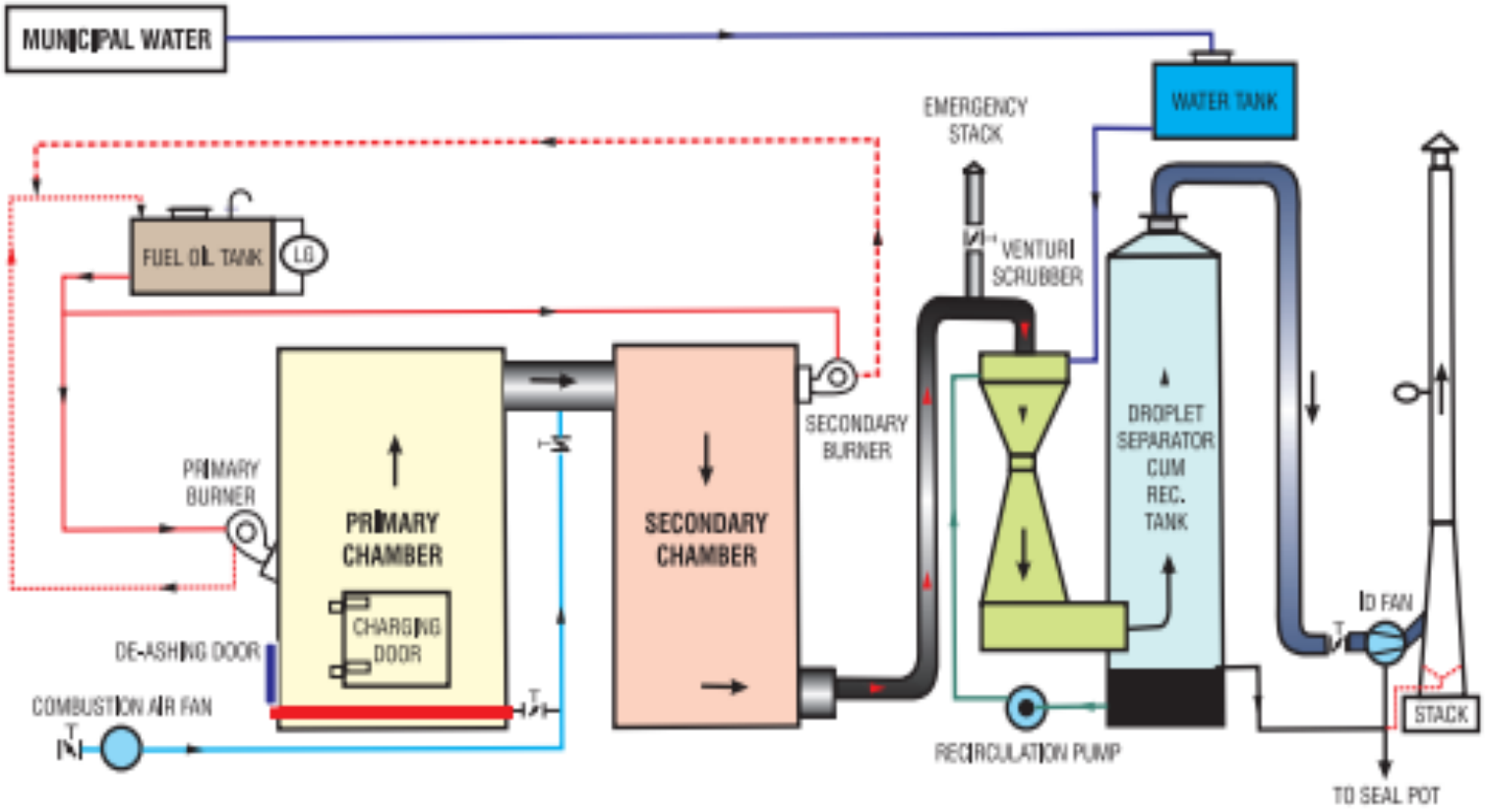
Treatment

Needle Cutter and Syringe Destroyer

Needle Cutter

Syringe & Needle Destroyer

Incinerator



Incinerator with Venturi Scrubbing System

Source: www.thermaxindia.com/Fileuploader/Files/IncineratorBrochure_new.pdf

Incinerators

It is a controlled combustion process where waste is completely oxidized and harmful microorganisms present in it are destroyed/denatured under high temperature.

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The Combustion efficiency is computed as follows:

$$C.E. = \frac{\%CO_2}{\%CO_2 + \%\ CO} \times 100$$

3. The temperature of the primary chamber shall be 800 ± 50 ºC.
4. The secondary chamber gas residence time shall be at least 1 (one) second at 1050 ± 50 ºC , with minimum 3% Oxygen in the stack gas.

B. Emission Standards

Sl. No.	Parameter	Standards	
(1)	(2)	(3)	(4)
		Limiting concentration in mg Nm^3 unless stated	**Sampling Duration in minutes, unless stated**
1.	Particulate matter	50	30 or $1NM^3$ of sample volume, whichever is more
2.	Nitrogen Oxides NO and NO_2 expressed asNO_2	400	30 for online sampling or grab sample
3.	HCl	50	30 or $1NM^3$ of sample volume, whichever is more
4.	Total Dioxins and Furans	0.1ngTEQ/Nm^3 (at 11% O2)	8 hours or $5NM^3$ of sample volume, whichever is more
5.	Hg and its compounds	0.05	2 hours or $1NM^3$ of sample volume, whichever is more

C. Stack Height: Minimum stack height shall be 30 meters above the ground and shall be attached with the necessary monitoring facilities as per requirement of monitoring of 'general parameters' as notified under the Environment (Protection) Act, 1986 and in accordance with the Central Pollution Control Board Guidelines of Emission Regulation Part-III.

Microwaving

- In microwaving, microbial inactivation occurs as a result of thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 300,000MHz.

- The waste material is first shredded and then mixed with water. Medical waste is placed into the microwave where it is heated effectively neutralizing all biological waste.

Autoclaving

Vertical & horizontal autoclave

Irradiation

- **The gamma radiation generated by the cobalt source sterilize the waste**
- **The cost is high**
- **Concern about the radiation exposure of the workers**

Plasma Pyrolysis or Gasification

- **Pyrolysis: Thermal disintegration process of carbonaceous material in oxygen starved environment.**

- **Plasma is a means to convert electrical energy into heat energy efficiently.**
  - **Plasma torch generate 20000 ℃ at the core**
  - **Prototype Plasma Pyrolysis System installed at Goa Medical College with capacity 15 Kg/hr**

Prototype Plasma Pyrolysis System installed at Goa Medical College

(System Capacity-15 Kg/hr)

Common Bio-Medical Waste Treatment Facility (CBWTF)

Installation of individual treatment facilities by small healthcare units may be difficult due to high capital and O&M cost, and space availability etc..

Common Bio-Medical Waste Treatment Facility treat biomedical waste, generated from number of healthcare units

DEEP BURIAL

(1) A pit or trench should be dug about two meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.

(2) It must be ensured that animals do not have any access to burial sites. Covers of galvanised iron or wire meshes may be used.

(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) Burial must 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.

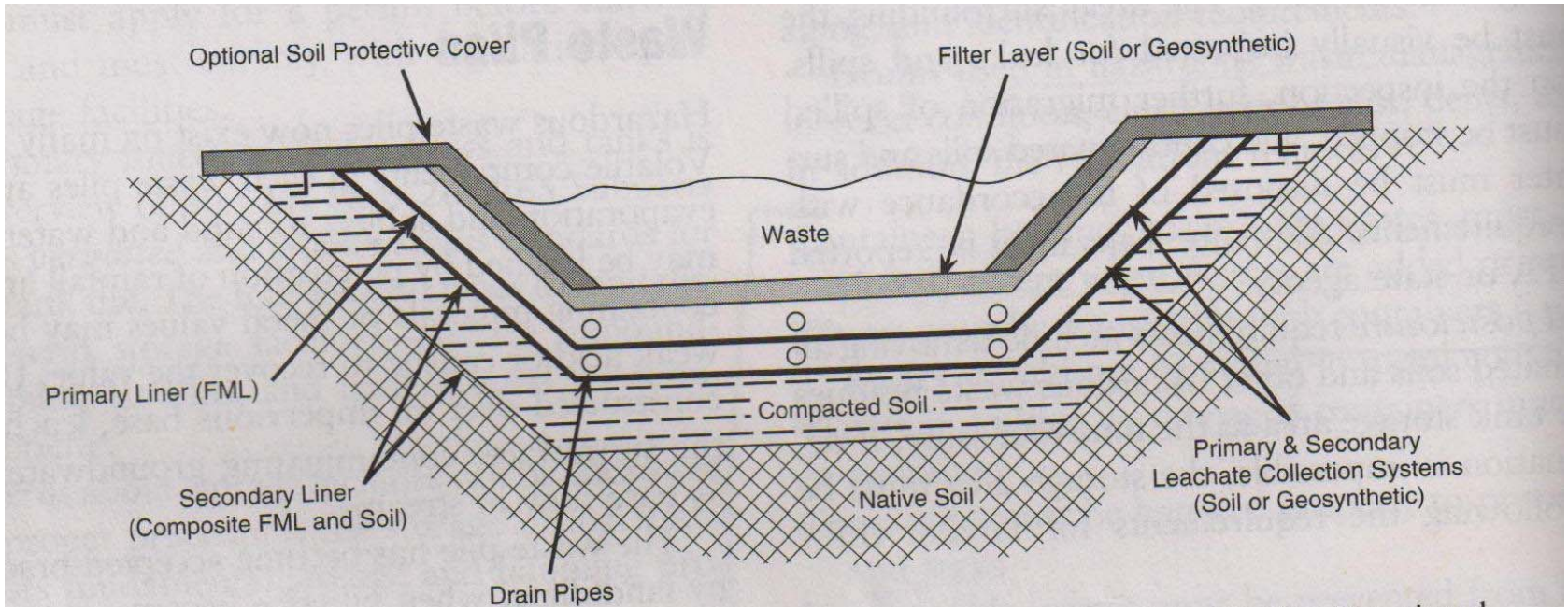
(6) The pits should be distant from habitation, and located so as to ensure that no contamination occurs to surface water or ground water. The area should not be prone to flooding or erosion.

(7) The location of the deep burial site shall be authorised by the prescribed authority.

(8) The institution shall maintain a record of all pits used for deep burial.

(9) The ground water table level should be a minimum of six meters below the lower level of deep burial pit.

Cross-section of a secure landfill double liner system



Source: http://www.healingtalks.com/wp-content/uploads/2011/11/medical-wastes.jpg