

CHAPTER 7

BIO-MEDICAL WASTE

7.1 INTRODUCTION

Medical care is vital for our life, health and well being. But the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potential for diseases transmission. The hazardous and toxic parts of waste from health care establishments comprising infectious, bio-medical and radio-active material as well as sharps (hypodermic needles, knives, scalpels etc.) constitute a grave risk, if these are not properly treated/disposed or is allowed to get mixed with other municipal waste. **Its propensity to encourage growth of various pathogen and vectors and its ability to contaminate other non-hazardous/non-toxic municipal waste jeopardises the efforts undertaken for overall municipal waste management.** The rag pickers and waste workers are often worst affected, because unknowingly or unwittingly, they rummage through all kinds of poisonous material while trying to salvage items which they can sell for reuse. At the same time, this kind of illegal and unethical reuse can be extremely dangerous and even fatal. Diseases like cholera, plague, tuberculosis, hepatitis (especially HBV), AIDS (HIV), diphtheria etc. in either epidemic or even endemic form, pose grave public health risks. Unfortunately, in the absence of reliable and extensive data, it is difficult to quantify the dimension of the problem or even the extent and variety of the risk involved.

With a judicious planning and management, however, the risk can be considerably reduced. Studies have shown that about three fourth of the total waste generated in health care establishments is non-hazardous and non-toxic. Some estimates put the infectious waste at 15% and other hazardous waste at 5%. Therefore with a rigorous regime of segregation at source, the problem can be reduced proportionately. Similarly, with better planning and management, not only the waste generation is reduced, but overall expenditure on waste management can be controlled. Institutional/Organisational set up, training and motivation are given great importance these days. Proper training of health care establishment personnel at all levels coupled with sustained motivation can improve the situation considerably.

The rules framed by the Ministry of Environment and Forests (MoEF), Govt. of India, known as **‘Bio-medical Waste (Management and Handling) Rules, 1998,’** notified on 20th July 1998, provides uniform guidelines and code of practice for the whole nation. It is clearly mentioned in this rule that the **‘occupier’** (a person who has control over the concerned institution / premises) of an institution generating bio-medical waste (e.g., hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank etc.) **shall be responsible for taking necessary steps to ensure that such waste is handled without any adverse effect to human health and the environment.**

Definition : ‘Bio-medical waste’ means any solid and/or liquid waste including its container and any intermediate product, which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research pertaining thereto or in the production or testing thereof.

The physico-chemical and biological nature of these components, their toxicity and potential hazard are different, necessitating different methods / options for their treatment / disposal. In Schedule I of the Bio-medical Waste (Management and Handling) Rules, 1998 (Annexure II), therefore, the waste originating from different kinds of such establishments, has been categorised into 10 different categories (as mentioned in the box below) and their treatment and disposal options have been indicated.

Components of Bio-medical waste	
(i)	human anatomical waste (tissues, organs, body parts etc.),
(ii)	animal waste (as above, generated during research/experimentation, from veterinary hospitals etc.),
(iii)	microbiology and biotechnology waste, such as, laboratory cultures, micro-organisms, human and animal cell cultures, toxins etc.,
(iv)	waste sharps, such as, hypodermic needles, syringes, scalpels, broken glass etc.,
(v)	discarded medicines and cyto-toxic drugs
(vi)	soiled waste, such as dressing, bandages, plaster casts, material contaminated with blood etc.,
(vii)	solid waste (disposable items like tubes, catheters etc. excluding sharps),
(viii)	liquid waste generated from any of the infected areas,
(ix)	incineration ash,
(x)	chemical waste.

**Health hazards associated with poor
management of Bio-medical waste**

- (i) Injury from sharps to staff and waste handlers associated with the health care establishment.
- (ii) Hospital Acquired Infection(HAI)(Nosocomial) of patients due to spread of infection.
- (iii) Risk of infection outside the hospital for waste handlers/scavengers and eventually general public.
- (iv) Occupational risk associated with hazardous chemicals, drugs etc.
- (v) Unauthorised repackaging and sale of disposable items and unused / date expired drugs.

The environmental hazards are mentioned at 7.4.2.

7.1.1 Linkage of Bio-medical Waste Management with Municipal Waste Management

At present, the role of the civic body with respect to the management of bio-medical waste is not clearly defined, leading to confusion and laxity from either side.

- Since majority of the health care establishments are located within the municipal area, their waste management naturally has a close linkage with the municipal system. At the same time, the civic authority is responsible for public health in the whole of the municipal area. Therefore, the health care establishments must have a clear understanding with the municipality regarding sharing of responsibilities associated with this issue.
- Studies have shown that about three fourth of the total hospital waste is not hazardous / infected (provided strict segregation is practised) and can even be taken care of by the municipal waste management system, e.g., waste generated at the hospital kitchen or garden, the office or packaging material from the store etc.
- Such practices of strict and careful segregation would reduce the load and the cost of management of the actually hazardous and infected bio-medical waste (collection, transportation, treatment and disposal).

- Since, it would not be possible for each and every health care establishment to have its own full fledged treatment and disposal system for bio-medical waste, there would be need for common treatment and disposal facilities under the ownership/supervision/guidance of the civic authority (discussed in para 7.9).

From the above mentioned issues, it is clear that the success of the bio-medical waste management program depends on proper in-house management (within the health care establishment) and co-ordination and co-operation amongst the various establishments themselves as well as with the civic authority. Hence this chapter discusses both these aspects.

7.2 ASSESSMENT OF CURRENT SITUATION

An assessment of the situation obtaining within the individual health care establishments as well as the town/city as a whole is necessary before making any attempts for improvement. Essentially this involves three steps :

- survey of waste generation
- documentation of prevailing practices
- allocation of responsibilities

7.2.1 Waste Generation

Qualitative as well as quantitative survey of the waste generated is the goal of this step. This needs to be broadly carried out for :

- (i) Health care establishments - as units and
- (ii) The whole town / city

7.2.1.1 *Health Care Establishments*

Each establishment has to chalk out a programme for qualitative as well as quantitative survey of the waste generated depending on the medical activities and procedures followed by it. In order to asses the current situation, the following have to be included (as applicable) in the survey as per the time frame indicated :

Table 7.1 : Area-wise Frequency of Waste Survey

Area/Department/Unit	Frequency of data collection
Wards (each one of them)	Each shift
Operation theatre (OT)(- do -)	Each operation / surgical procedure
Out Patients Department (OPD)	Each shift
Intensive Care Unit (ICU)	Each shift
Emergency unit	Each shift
Dialysis unit	Each procedure
Radiation unit	Each procedure
Laboratories (pathological, biochemical)	Each shift
Pharmacy / Chemist's dispensation unit	Once a day
Kitchen	Twice, after every meal
Administrative unit and central store	Once a day
Surrounding premises and garden	Once a day

The concerned medical establishment should constitute a team of its experts, concerned personnel and workers (doctors, chemists, laboratory technicians, hospital engineers, nurses, cleaning supervisors/inspectors, cleaning staff etc.). If such expertise is not available, it may take the help of external experts in the field who can help them carry out the survey work. A third alternative is possible if expert agencies are available who carry out the whole work on contract as a package.

In either case, the medical establishment has to earmark a suitable place where the qualitative and quantitative tests can be carried out. This place should be an enclosed space. Depending upon the requirement, it can be a large room or a hall or at least a covered shade with proper fencing. Unauthorised entry to this space should be strictly restricted. It should be well lighted. The place should be washed and disinfected daily and preferably dry and clean.

The waste generated by all the departments has to be collected according to the prevailing practices of collection but due care has to be taken to see that no portion of the total waste generated is missed out from this survey. The waste so collected (except the liquid waste and incineration ash) has to be sorted out into the different categories according to the Schedule I of the Biomedical Waste (Management and Handling) Rules, 1998 (as applicable).

If an incinerator is operating within the hospital campus, then the **incinerator ash** produced every day has to be weighed. This can be done once a day. At the same time the total waste incinerated every day has also to be recorded.

The **liquid waste** may be divided into two components : (a) liquid reagents/chemicals discarded and (b) the cleaning and washing water channelled into the drain. The first component can be easily measured by a measuring cylinder or other suitable measuring device before discarding each time and keeping suitable records. The second component can be derived from the total water used in the hospital or by using appropriate flow metres.

Table 7.2 : Category-wise Survey of Waste Generation

Item (as per schedule)	Wt. (kg.) Shift I	Wt.(kg.) Shift II	Wt.(kg) Shift III	Total Wt.(kg.)
Human anatomical waste				
Animal waste				
Microbiology & biotechnology waste				
Waste sharps				
Medicines and cyto-toxic drugs				
Soiled waste				
Solid waste				
Chemical waste				
Incineration ash				
Liquid waste (litres)				

The survey needs to be carried out at least for 3 days a week in continuation followed by similar exercise for 4 weeks (preferably alternate weeks for better reproducibility of the data). The result is then compiled for both quantitative as well as qualitative data.

7.2.1.2 Whole Town/City

A simultaneous survey of the situation in the town or city concerned is essential for a proper planning. The first issue to be resolved is - who should get the survey done

- local body ?

- health authorities ?
- Indian Medicines Association (IMA)/association of health care establishments ?

A suitable consultant should be engaged for carrying out the job. The concerned authorities must prepare a Terms of Reference (TOR) for this job in accordance with the need of the town/city. In case this is not possible, then a calculation may be made based on the number of beds and average waste generated per bed. Since there is no prevailing practice of keeping hospital waste separate and of taking the whole of it to specific locations, it would be very difficult to get any reliable figures from the municipal collection system. Hence a separate exercise needs to be carried out.

7.2.2 Current Practices

The current practices in relation to waste management in the particular health care establishment need to be recorded with respect to the following activities for each unit (i.e., wards, operation theatres, laboratories etc.) :

- Storage of waste at the point of generation.
- Whether one container is used for all waste or different containers are used for different types of waste ?
- How frequently the waste material is removed and to where ?
- Is there any intermediate storage of the waste before it is moved in bulk outside the hospital campus ?
- Who removes the waste material from the points of generation ?
- Whether any measures are taken to deter further unauthorised reuse of the discarded items, such as cutting/ mutilating needles, plastic tubes, gloves etc. ?
- Is there an incineration plant in the hospital ? If yes, what are the materials incinerated and what happens to the ash/ clinkers?
- What happens to the waste once it is removed from the health care establishment - can it be tracked ?
- Is there any strategy/plan and administrative support for tackling this issue?

7.2.3 Allocation of Responsibilities

The administrative head of the health care establishment should carry out an exercise of documenting the current allocation of responsibilities with relation to waste management within its premises. In large establishments, specialised services of consultants/experts should be sought. Each departmental head should be involved in the exercise. Organisational chart indicating specific accountability of staff at each level in each department needs to be prepared.

7.3 BASIC ISSUES

Health care waste is a heterogeneous mixture, which is very difficult to manage as such. But the problem can be simplified and its dimension reduced considerably if a proper management system is planned. Therefore it is important to take a brief look at the management issues.

7.3.1 Management Issues of Bio-medical Waste Management

The management principles are based on the following aspects :

- Reduction/control of waste (by controlling inventory, wastage of consumable items, reagents, breakage etc.).
- Segregation of the different types of wastes into different categories according to their treatment/disposal options given in Schedule I of the Rules mentioned above.
- Segregated collection and transportation to final treatment/disposal facility so that they do not get mixed.
- Proper treatment and final disposal as indicated in the rules.
- Safety of handling, full care/protection against operational hazard for personnel at each level.
- Proper organisation and management.

7.3.2 Current Issues in Management of Health Care Waste

There are two main issues at present :

- the recent legislation by the Govt. of India and
- implementation of the same at individual health care establishments level as well as whole town / city level.

The recent legislation has fulfilled a long standing necessity. Now this sector has got clear cut guidelines which should be able to initiate a uniform standard of practice through out the country.

It would be necessary to implement proper bio-medical waste management system for each and every hospital, nursing home, pathological laboratory etc. Comprehensive management system for each and every health care establishment has to be planned for optimal techno-economic viability. **At the same time the final disposal for the whole town must not be lost sight of. Since there are a large number of small and medium health care establishments, common treatment and disposal facilities are essential.**

7.4. LEGAL ASPECTS AND ENVIRONMENTAL CONCERN

Indiscriminate disposal of infected and hazardous waste from hospitals, nursing homes and pathological laboratories has led to significant degradation of the environment, leading to spread of diseases and putting the people to great risk from certain highly contagious and transmission prone disease vectors. This has given rise to considerable environmental concern.

The first standard on the subject to be brought out in India was by the Bureau of Indian Standards (BIS), IS 12625 : 1989, entitled 'Solid Wastes-Hospitals-Guidelines for Management' (Annexure 7.1) but it was unable to bring any improvement in the situation. In this scenario, the notification of the '**Bio-medical waste (Management & Handling) Rules, 1998**' assumes great significance.

7.4.1. Bio-medical Waste (Management and Handling) Rules, 1998

The Central Govt. has notified these rules on 20th July, 1998 in exercise of section 6, 8 and 25 of the Environment (Protection) Act, 1986. Prior to that, the draft rules were gazetted on 16th October, 1997 and Public suggestion/comments were invited within 60 days. These suggestion were considered before finalising the rules. The text of the rules(English version) is annexed (Annexure-7.2).

Scope and application of the Rules

These rules apply to all those who generate, collect, receive, store, transport, treat, dispose or handle bio-medical waste in any form.

According to these rules, it shall be the duty of every occupier of an institution generating bio-medical waste, which includes hospitals, nursing homes, clinics, dispensaries, veterinary institution, animal houses, pathology laboratories, blood banks etc., to take all steps to ensure that such wastes are handled without any adverse effect to human health and the environment. They have to either set up their own facility within the time frame (schedule VI) or ensure requisite treatment at a common waste treatment facility or any other waste treatment facility.

Every occupier of an institution, which is generating, collecting, receiving, storing, transporting, treating, disposing and/or handling bio-medical waste in any other manner, except such occupier of clinics, dispensaries, pathological laboratories, blood banks etc., which provide treatment/service to less than 1000 (one thousand) patients per month shall make an application in prescribed form to the prescribed authority for grant of authorisation to carry on the work. Whenever an accident occurs concerning bio-medical waste, it has to be reported to this authority.

Each State and Union Territory (UT) Government shall be required to establish a prescribed authority for this purpose. The respective governments would also constitute advisory committees to advise the Govts with respect to implementation of these rules. The occupier or operator can also appeal against any order of the authority if they feel aggrieved to such other authority as the Govt. of the State/UT may think fit to constitute. Prescribed Authorities, so far established by various State Governments are listed at Annexure 7.3 and the time limit as per schedule VI of the 'Bio-Medical(Management & Handling) Rules,1998.

7.4.2 Environmental Concern

The following are the main environmental concerns with respect to improper disposal of bio-medical waste management:

- Spread of infection and disease through vectors (fly, mosquito, insects etc.) which affect the in-house as well as surrounding population.
- Spread of infection through contact/injury among medical/non-medical personnel and sweepers/rag pickers, especially from the sharps (needles, blades etc.).
- Spread of infection through unauthorised recycling of disposable items such as hypodermic needles, tubes, blades, bottles etc.
- Reaction due to use of discarded medicines.

- Toxic emissions from defective/inefficient incinerators.
- Indiscriminate disposal of incinerator ash / residues.

7.5. WASTE IDENTIFICATION AND WASTE CONTROL PROGRAM FOR THE HEALTH CARE ESTABLISHMENTS

In fact waste identification is an important tool of waste control programme. The necessity of segregation has already been mentioned. The use of colour coding and labelling of hazardous waste containers provides great assistance in waste separation. Without opening a container one can easily know about the contents. Therefore, in addition to segregation, separate transportation and storage is also facilitated.

7.5.1 Identification of Various Components of the Waste Generated

The Bio-medical waste (Management and Handling) Rules, 1998 says that such waste shall be segregated into containers/bags at the point of generation in accordance with Schedule II of the rules prior to its storage, transportation, treatment and disposal. This would help in easy identification of the various components of health care waste. **All containers bearing hazardous material must be adequately labelled according to Schedule IV of the Rules (Annexure 7.2).**

7.5.2. An Exercise in Waste Control Programme

For larger health care establishments such as hospitals, a comprehensive exercise needs to be carried out for evolving its own waste management plan/programme, consisting of the following steps:

1. Documenting the medical/bio-medical practice/procedures carried out by the particular health care establishment by enlisting categories of waste generated as per schedule I of the rules.
2. Assessing current practices and responsibilities (as mentioned earlier).
3. Assessing current costs for hazardous waste management.
4. Developing an effective bio-medical waste management policy/plan according to the Rules and
5. Implementation of the plan.

It is important to identify the current costs associated with waste management. Purchasing and inventory practices, for example, must be closely examined to identify the costs related to the disposables, recyclables etc. All associated materials (e.g. gloves, boots, brushes, disinfectants etc.), cost of fuel (for incinerator, vehicles), electricity etc. as well as man hours should be accounted for.

Based on these results, a comprehensive policy has to be framed in consonance with the govt. rules so that compliance is achieved. An official statement incorporating all practices from the segregated storage through transportation, treatment and final disposal should be prepared and widely circulated after due approval.

7.6 WASTE STORAGE

Storage of waste is necessary at two points :

- (i) at the point of generation and
- (ii) common storage for the total waste inside a health care organisation.

For smaller units, however, the common storage area may not be possible. Systematic segregated storage is the most important step in the waste control programme of the health care establishment. For ease of identification and handling it is necessary to use colour coding, i.e., use of specific coloured container with liner / sealed container (for sharps) for particular wastes. It must be remembered that according to the Rules, untreated waste should not be stored beyond a period of 48 hours.

7.6.1 Recommended Labelling and Colour Coding

These have to be in accordance with Schedule II of the notified rules (Annexure 7.2). A simple and clear notice, describing which waste should go to which container and how frequently it has to be routinely removed and to where, is to be pasted on the wall or at a conspicuous place nearest to the container. The notice should be in English, Hindi and the predominant local language. Preferably, it should have drawings correlating the container in appropriate colour with the kind of waste it should contain.

7.6.2 Segregated Storage in Separate Containers (at the Point of Generation)

Each category of waste (according to treatment options mentioned in Schedule I of the rules) has to be kept segregated in a proper container or bag as the case may be. Such container / bag should have the following property :

- It must be sturdy enough to contain the designed maximum volume and weight of the waste without any damage.
- It should be without any puncture/leakage.
- The container should have a cover, preferably operated by foot. If plastic bags are to be used, they have to be securely fitted within a container in such a manner that they stay in place during opening and closing of the lid and can also be removed without difficulty.
- The sharps must be stored in puncture proof sharps containers. But before putting them in the containers, they must be mutilated by a needle cutter, placed in the department/ward itself.

The bags/containers should not be filled more than 3/4th capacity. Attempts should be made to designate fixed places for each container so that it becomes a part of regular scenario and practice for the concerned medical as well as nursing staff. The specification for the containers is mentioned in chapter 4 of this manual.

7.6.3 Certification

When a bag or container is sealed, appropriate label (s) clearly indicating the following information (as per Schedule IV of the Rules) has to be attached. A water-proof marker pen should be used for writing.

They should be labelled with the 'Biohazard' or 'cyto-toxic' symbol as the case may be according to Schedule III of the rules (Annexure 7.2).

- The containers should bear the name of the department/laboratory from where the waste has been generated so that in case of a problem or accident, the nature of the waste can be traced back quickly and correctly for proper remediation and if necessary, the responsibility can be fixed.
- The containers should also be labelled with the date, name and signature of the person responsible. This would generate greater accountability.
- The label should contain the name, address, phone/fax nos. of the sender as well as the receiver.

- It should also contain name, address and phone/fax nos. of the person who is to be contacted in case of an emergency.

7.6.4 Common/Intermediate Storage Area

Collection room(s)/intermediate storage area where the waste packets/bags are collected before they are finally taken/transported to the treatment/disposal site are necessary for large hospitals having a number of departments, laboratories, OTs, wards etc. This is all the more important when the waste is to be taken outside the premises. Two rooms - one for the general and the other for the hazardous waste are preferable (details at 7.14.1, 5th point). In case of shortage of rooms, the general waste (non-hazardous) can be directly stored outside in dumper containers with lids of suitable size.

Arrangement for separate receptacles in the storage area with prominent display of colour code on the wall nearest to the receptacles has to be made. When waste carrying carts/containers arrive at this area, they have to be systematically put in the relevant receptacle/designated area.

7.6.5 Parking Lot for Collection Vehicles

A shed with fencing should be provided for the carts, trolleys, covered vehicles etc. used for collecting or moving the waste material. Care has to be taken to provide separate sheds for the hazardous and non-hazardous waste so that there is no chance of cross contamination. Both the sheds should have a wash area provided with adequate water jets, drains, raised platform, protection walls to contain splash of water and proper drainage system.

7.7 HANDLING AND TRANSPORTATION

This activity has three components: collection of different kinds of waste (from waste storage bags/containers) inside the hospital, transportation and intermediate storage of segregated waste inside the premises and transportation of the waste outside the premises (to the treatment/disposal facility).

7.7.1 Collection of Waste Inside the Hospital/Health Care Establishment

The collection containers for bio-medical waste have to be sturdy, leak proof, of adequate size and wheeled. Two wheeled bins of 120-330 litre capacity and four wheeled bins of 500-1000 litre capacity (IS 12402, Part I, 1988) may be used. The 4 wheeled containers have two fixed wheels and two castors and they are fitted with wheel locking devices to prevent unwanted rolling. There should be

no sharp edges or corners, especially in metallic bins. Specifications of bins are mentioned in chapter 4 of this manual. For convenience as well as for avoiding any confusion, the colour code applicable for the bags / containers should also be used for the bins.

Collection timings and duty chart should be put in a prominent place with copies given to the concerned waste collectors and supervisors. For general waste from the office, kitchen, garden etc., normal wheel-barrows may be used.

7.7.2 Transportation of Segregated Waste Inside the Premises

All attempts should be made to provide separate service corridors for taking waste matter from the storage area to the collection room. Preferably these corridors should not cross the paths used by patients and visitors. The waste has to be taken to the common storage area first, from where it is to be taken to the treatment/disposal facility, either within or outside the premises as the case may be.

As already mentioned under 7.6.4, the wheel-barrows containing general waste may be sent to a dumper container or further segregated as described under section 7.8.7 (later).

7.7.3 Collection and Transportation of Waste for Small Units

Smaller units, such as, nursing homes, pathological laboratories etc. do not have many departments/divisions and the generation of waste is small and normally they do not have treatment facility for the bio-medical waste.

In their case, intermediate storage area is not required. They should install a needle cutter and a small device for cutting plastic tubing, gloves etc. In case, highly infectious bio-medical waste is expected to be generated, they may consider to install a separate steam autoclave of suitable size exclusively for this purpose. Adequate precaution must be taken to ward off any occupational hazard or environmental problem. This particular autoclave should never be used for sterilising medical supplies or surgical equipment.

Such establishments require provision for segregated storage (according to the rules) which can be packed in sealed containers/sturdy bags and handed over to the agency carrying them to the common treatment/disposal facility.

7.7.4 Transportation of Waste Outside

In case of off-site treatment, the waste has to be transported to the treatment/disposal facility site in a safe manner. The vehicle, which may be a specially designed van, should have the following specifications :

- It should be covered and secured against accidental opening of door, leakage/spillage etc.
- The interior of the container should be lined with smooth finish of aluminium or stainless steel, without sharp edges/corners or dead spaces, which can be conveniently washed and disinfected.
- There should be adequate arrangement for drainage and collection of any run off/leachate, which may accidentally come out of the waste bags/containers. The floor should have suitable gradient, flow trap and collection container.
- The size of the van would depend on the waste to be carried per trip.
- In case, the waste quantity per trip is small, covered container of 1-2 cu. m., mounted on 3 wheeled chassis and fitted with a tipping arrangement can be used.

7.8 WASTE TREATMENT AND DISPOSAL : THE RULES AND THE AVAILABLE OPTIONS

Different methods have been developed for rendering bio-medical waste environmentally innocuous and aesthetically acceptable but all of them are not suitable for our condition. The 'Bio-Medical Waste (Management & Handling) Rules, 1998' has elaborately mentioned the recommended treatment and disposal options according to the 10 different categories of waste generated in health care establishments in Schedule I of the rules (Annexure 7.2). Standards for the treatment technologies are given in Schedule V of the Rules, which must be complied with. A comparison of the advantages and limitations of the different technologies for treatment of bio-medical waste is given at Annexure 7.4.

A review of the above schedule would show that there is no single technology, which can take care of all categories of bio-medical waste. A judicious package has to be evolved for this purpose. For example, small and medium hospitals can opt for local (in house) disinfection, mutilation / shredding and dedicated autoclaving plus off-site incineration at a common treatment / disposal facility followed by disposal in sanitary and secured landfills.

7.8.1 Incineration

This is a high temperature thermal process employing combustion of the waste under controlled condition for converting them into inert material and gases. Incinerators can be oil fired or electrically powered or a combination thereof. Broadly, three types of incinerators are used for hospital waste : multiple hearth type, rotary kiln and controlled air types. All the types can have primary and secondary combustion chambers to ensure optimal combustion. These are refractory lined.

In the multiple hearth incinerator, solid phase combustion takes place in the primary chamber whereas the secondary chamber is for gas phase combustion. These are referred to as excess air incinerators because excess air is present in both the chambers. The rotary kiln is a cylindrical refractory lined shell that is mounted at a slight tilt to facilitate mixing and movement of the waste inside. It has provision of air circulation. The kiln acts as the primary solid phase chamber, which is followed by the secondary chamber for the gaseous combustion. In the third type, the first chamber is operated at low air levels followed by an excess air chamber. Due to low oxygen levels in the primary chamber, there is better control of particulate matter in the flue gas.

In a nutshell, the primary chamber has pyrolytic conditions with a temperature range of about 800 (+/-) 50 deg. C. The secondary chamber operates under excess air conditions at about 1050 (+/-)50 deg. C (Schedule V of the Rules). The volatiles are liberated in the first chamber whereas they are destroyed in the second one. Some models are fitted with Eductor mechanism, which maintains the system under negative pressure and helps control the flue gases more effectively. The chimney height should be minimum 30 meters above ground level. Installation of incinerators in congested area is not desirable.

In the Bio-medical Waste (Management and Handling) Rules, Incineration has been recommended for human anatomical waste, animal waste, cyto-toxic drugs, discarded medicines and soiled waste.

7.8.2 Autoclave Treatment

This is a process of steam sterilisation under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. These are also of three types : Gravity type, Pre-vacuum type and Retort type.

In the first type (Gravity type), air is evacuated with the help of gravity alone. The system operates with temperature of 121 deg. C. and steam pressure of 15 psi. for 60-90 minutes. Vacuum pumps are used to evacuate air from the Pre-vacuum autoclave system so that the time cycle is reduced to 30-60 minutes. It operates at about 132 deg. C. Retort type autoclaves are designed to handle much larger volumes and operate at much higher steam temperature and pressure.

Autoclave treatment has been recommended for microbiology and biotechnology waste, waste sharps, soiled and solid wastes (as mentioned in the table above). This technology renders certain categories (mentioned in the rules) of bio-medical waste innocuous and unrecognisable so that the treated residue can be landfilled. Sanjay Gandhi Memorial Hospital in Delhi has installed a Pre-vacuum Autoclave.

7.8.3 Hydroclave Treatment

Hydroclave is an innovative equipment for steam sterilisation process (like autoclave). It is a double walled container, in which the steam is injected into the outer jacket to heat the inner chamber containing the waste. Moisture contained in the waste evaporates as steam and builds up the requisite steam pressure (35-36 psi). Sturdy paddles slowly rotated by a strong shaft inside the chamber tumble the waste continuously against the hot wall thus mixing as well as fragmenting the same. In the absence of enough moisture, additional steam is injected. The system operates at 132 deg.C. and 36 psi steam pressure for sterilisation time of 20 minutes. The total time for a cycle is about 50 minutes, which includes start-up, heat-up, sterilisation, venting and depressurisation and dehydration. The treated material can further be shredded before disposal. The expected volume and weight reductions are upto 85% and 70% respectively.

The hydroclave can treat the same waste as the autoclave plus the waste sharps. The sharps are also fragmented. This technology has certain benefits, such as, absence of harmful air emissions, absence of liquid discharges, non-requirement of chemicals, reduced volume and weight of waste etc.

Tata Memorial Hospital in Mumbai has installed the first hydroclave in India in September 1999.

7.8.4 Microwave Treatment

This again is a wet thermal disinfection technology but unlike other thermal treatment systems, which heat the waste externally, microwave heats the targeted material from inside out, providing a high level of disinfection.

The input material is first put through a shredder. The shredded material is pushed to a treatment chamber where it is moistened with high temperature steam. The material is then carried by a screw conveyor beneath a series (normally 4-6 nos.) of conventional microwave generators, which heat the material to 95-100 deg. C. and uniformly disinfect the material during a minimum residence time of 30 minutes and total cycle is of 50 minutes. A second shredder fragments the material further into unrecognisable particles before it is automatically discharged into a conventional / general waste container. This treated material can be landfilled provided adequate care is taken to complete the microwave treatment. In the modern versions, the process control is computerised for smooth and effective control.

Microwave technology has certain benefits, such as, absence of harmful air emissions (when adequate provision of containment and filters is made), absence of liquid discharges, non requirement of chemicals, reduced volume of waste (due to shredding and moisture loss) and operator safety (due to automatic hoisting arrangement for the waste bins into the hopper so that manual contact with the waste bags is not necessary). However, the investment cost is high at present.

According to the rules, category nos, 3 (microbiology and biotechnology waste), 4 (waste sharps), 6 (soiled waste) and 7 (solid waste) are permitted to be microwaved.

7.8.5 Chemical Disinfecting

This treatment is recommended for waste sharps, solid and liquid wastes as well as chemical wastes. Chemical treatment involves use of at least 1% hypochlorite solution with a minimum contact period of 30 minutes or other equivalent chemical reagents such as phenolic compounds, iodine, hexachlorophene, iodine-alcohol or formaldehyde-alcohol combination etc. Pre-shredding of the waste is desirable for better contact with the waste material.

In the USA, chemical treatment facility is also available in mobile vans. In one version, the waste is shredded, passed through 10% hypochlorite solution (dixichlor) followed by a finer shredding and drying. The treated material is landfilled.

7.8.6 Sanitary and Secured Landfilling

Sanitary and secured landfilling is necessary under the following circumstances :

- Deep burial of human anatomical waste when the facility of proper incineration is not available (for towns having less than 5 lakh population and rural areas, according to Schedule I of the MoEF rules - Secured landfill). A schematic of deep burial is shown as per Annexure 7.5
- Animal waste (under similar conditions as mentioned above) - Secured landfill.
- Disposal of autoclaved/hydroclaved/microwaved waste (unrecognisable) - Sanitary landfill.
- Disposal of incineration ash - Sanitary landfill.
- Disposal of bio-medical waste till such time when proper treatment and disposal facility is in place - Secured landfill.
- Disposal of sharps - Secured landfill. This can also be done within a hospital premises as mentioned below.

In case disposal facility for sharps is not readily available in a town, health care establishments, especially hospitals having suitable land, can construct a concrete lined pit of about 1m length, breadth and depth and cover the same with a heavy concrete slab having a 1 - 1.5 m high steel pipe of about 50 mm diameter. Disinfected sharps can be put through this pipe. When the pit is full, the pipe should be sawed off and the hole sealed with cement concrete. This site should not be water logged or near a borewell.

7.8.7 General Waste

The waste material generated from the office, kitchen, garden, store, chemicals counter etc., which are non-hazardous and non-toxic, may be taken care of as follows :

- Composting of green waste - to be carried to a municipal facility or a private facility, if available. If suitable land is available, a hospital may consider composting its green waste within the campus itself taking all precautions regarding health and hygiene and safety to patients.
- Recycling of packaging material (caution - medical supplies such as unused or scantily used disposable items or those of uncertain history should never be allowed to be recycled).

Certificate indicating origin and of non-contamination, issued by the concerned medical authorities of the health care establishment before these wastes

are handed over to the municipality / private operator is essential from the point of safety.

7.9 COMMON TREATMENT/DISPOSAL FACILITY

Common treatment facilities are necessary because it is not feasible for smaller health care establishments to set up a complete treatment and disposal system due to lack of space and trained manpower, minimum scale of operation and scale of economy. Even large establishments located in congested or densely populated areas can not have such units due to environmental constraints. According to the rules, different kinds of treatment are required for different components of health care waste and the post-treatment residues have to be safely disposed. Hence, it is desirable that every town/city should have at least one common treatment facility, which may be used by all the units who can not have their own facility. It can be set up at the treatment / disposal and landfill site for the municipal garbage, with adequate precaution and control.

7.9.1 Establishment of the Facility

The common treatment/disposal facility, as the name suggests, would consist of (i) the treatment unit(s) and (ii) a sanitary/secured landfill for the final disposal of the treated residues and incinerator ash. The treatment chain, of necessity would consist of a properly designed incinerator (especially for human anatomical waste) and other systems such as autoclave/ hydroclave/ micro-wave unit etc. Chemical treatment units may also be added if felt necessary.

The treatment part can also be a mobile facility, with the incinerator and the landfill located conveniently at one place. Usually these are large vans (as shown in the picture) housing small equipment for size reduction and micro-wave / chemical treatment. The van moves along a pre-planned route and is occasionally parked in certain zones, where it receives the bio-medical waste and treats the components which, according to the prevailing rules can be subjected to micro-wave treatment. Finally it reaches the static facility for incineration of human anatomical waste and for secured landfilling of mutilated sharps and other final disposable items.

The concerned medical establishments should establish such facilities by creating a common pool and platform. Proper planning followed by preparation of a feasibility report is necessary. The fund for capital investment may be raised by proportional contribution from participating institutions. The cost of operation & maintenance (O&M) may be met by monthly billing against advance deposit.

Alternatively, private entrepreneurs may be encouraged to set up such facility on build, own, operate (BOO) basis (section 7.9.3).

The State Health Authority or the Civic Authority may consider to establish at least one full-fledged facility with its own investment and operate the same through private operators on full cost recovery (capital as well as O&M) basis. Such a facility may act as a catalyst and a model for replication.

7.9.2 Tie Up of Health Care Set Ups

A clear decision has to be taken first regarding the model to be adopted, viz., Build, own and operate (BOO), Build, own and transfer (BOT), Build, own, operate and maintain (BOOM) etc. For a lasting tie up and smooth functioning of the common treatment and disposal facility, the following points must be considered :

1. Legal aspects -
 - Formulation and signing of a valid contract between the concerned parties, i.e., the health care establishments.
 - Permission from the concerned authorities, as per existing Government notification, e.g., Prescribed Authority (Pollution Control Board or other authorities notified by the State Govt.)
2. Financial aspects -
 - Costing of the whole system (capital cost, depreciation, O&M cost, interest and debt servicing etc.).
 - Working out proportional contribution for capital investment.
 - Evolving a cost sharing mechanism. For example a system of advance deposit and monthly billing for full cost recovery of all recurring cost, as mentioned above.
3. Managerial aspects – Formation of an action committee / group to facilitate day to day management and monitoring of the facility. In case O&M is handed over to a third party, this committee should be able to safeguard the interests of the participating institutions.

7.9.3 Private Sector Participation

This being a highly specialised and specific job, involvement of specialised agencies would be necessary. Private entrepreneurs with adequate background and capability may be encouraged to take up and organise such ventures. The health care establishments may find it much more workable to hand over the day to day O&M to a private concern rather than doing it on their own. In this case, proper contract agreement must be made with the party with necessary terms and conditions and safeguards (as mentioned above at 7.9.2).

7.10 OPERATION AND MAINTENANCE

Once the bio-medical waste management system is in place, its operation and maintenance assumes crucial importance.

The administration of the establishment, whether big or small, should provide written instructions to all the departments generating or managing waste, stating the policy of the organisation and the decisions taken which are to be adhered to. Charts and schedules should be made with the help of experts/consultants and displayed at strategic points.

Co-ordination between the civic authority and the common treatment / disposal facility is extremely important for timely removal of the waste. There should be no confusion regarding placement of the waste components, their containers and colour coding, removal schedule etc.

Monitoring of the whole process, whether in-house or out side the hospital, is essential. Monitoring schedules for both must be made. Contingency plan needs to be prepared in case there is any problem or difficulty in carrying out the assigned jobs.

7.11 OCCUPATIONAL HAZARDS AND SAFETY MEASURES

The staff of the health care establishments, who are either in contact with the patient or the infectious waste generated, are continuously at risk during their working hours. Therefore it is essential that adequate protection measures are provided against occupational health hazards. The administration of the health care establishment (Infection Control Officer in case of large ones) should have a detailed deliberation on this subject.

7.11.1 Occupational Hazards

The following types of occupational hazards occur / can occur in case of medical/para-medical personnel or staff involved with cleaning/collection or transportation of waste etc.:

- Accidental cut or punctures from infected sharps such as, hypodermic needles, scalpels, knives etc.
- Contact with infected material like pathological waste, used gloves, tubing etc., especially from the operation theatre.
- Bedding and dress material of the patient or from the doctors (used during check up/ surgery etc.)
- Contact with stool, urine, blood, pus etc of the patients during cleaning job.

7.11.2 Safety Measures for the Medical and Para-medical Staff

The following instructions need to be notified and strictly adhered to :

- Clear directives in the form of a notice to be displayed in all concerned areas.
- Issuance of all protective clothes such as, gloves, aprons, masks etc. without fail.
- Sterilisation of all equipment and issue of only properly sterilised equipment and tool, such as, surgical tools to the medical personnel. Maintenance of registers for this purpose.
- Provision of disinfectant, soap etc of the right quality and clean towels/tissue paper.
- Regular medical check-up (half-early).

7.11.3 Safety Measures for Cleaning and Transportation Staff

- Display of illustrated notices with clear instructions for do's and don'ts in Hindi and the local language.
- Issuance of all protective gears such as, gloves, aprons, masks, gum boot etc. without fail.
- Provision of disinfectant, soap etc of the right quality and clean towels.
- Provision of a wash area, where they can take bath, if needed/desired.

- Washing and disinfecting facility for the cleaning equipment and tools.
- Regular medical check-up (at least half-yearly).

7.12 FINANCIAL ASPECTS

Compared to the cost of medical facilities, capital as well as operation and maintenance, the additional cost required for a proper bio-medical waste management is not high. The following points are important for consideration :

- Provision of proper management of bio-medical waste is mandatory now under the Bio-medical Waste (Management & Handling) Rules, 1998 apart from being a social and ethical obligation of the concerned organisations and individuals.
- With the introduction of a streamlined system, better control of man and material and avoided cost of accidents and compensation, it should be normally possible to make some savings.
- Mobilisation of resources, such as loans, grants and own contribution for making capital investments. The possibility of introducing a small incremental charge over the existing service charges for various medical facilities for meeting O&M cost and debt servicing may be explored.
- In case of Common Treatment Facility, similar considerations have to be deliberated upon by the concerned institutions. In case, the civic authority decides to set up the facility from its own resources or through loan (BOT or BOOT model), proportional charges, incorporating capital as well as O&M cost has to be levied from the user institutions. If private capital be involved for making a BOO model, similar considerations would still be valid but the transactions would be between the concerned parties and the facility. In this case, the civic authority may provide land on lease and levy a suitable lease charge.
- Finance (loan) is available from Financial Institutions.

7.13 TRAINING AND MOTIVATION

The training programme aims at sensitising the management and equipping the medical, para-medical and auxiliary staff with necessary working knowledge and clear instructions about their respective roles. At the same time a core group of trainers should be organised for continued in-house training of the auxiliary and sanitation staff. For the success of the programme, it is essential that training and orientation courses are planned for the following categories of functionaries and

people according to their qualification and experience, their role and responsibility:

- Policy Makers
- Civic Authorities
- Hospital Administration, Medical Superintendent, Deans and Head of the Departments
- Doctors, surgeons and specialists
- Auxiliary and nursing staff
- Ward boys and cleaning/sanitation staff

The training programme for the various categories need to be repeated, especially for the auxiliary staff. The interval between two programmes has to be decided by the management, depending upon available staff strength, resources etc.

7.13.1 Training Modules for Different Levels of Staff

Training modules should be developed for the following category of personnel :

- Medical and laboratory personnel
- Para-medical personnel, e.g., nurses, ward boys etc.
- Sweepers/cleaning staff, guards etc.
- Administrative and management staff

Each category has different duties and accordingly, they should (i) understand their specific role regarding waste management, (ii) comply with the policy decisions taken by the management of the establishment and (iii) contribute to the success and betterment of the overall bio-medical waste management plan in their own health care establishment as well as in their town.

(i) Medical and laboratory personnel:

This training capsule should include :

- Detailed discussion regarding the existing rules and regulations, supply of copies of the rules to each individual.

- Review of the hazards and impact of improper management of bio-medical waste, citing case studies if possible.
- Discussion regarding the policy of the specific health care establishment.
- Detailed description of each step involved, including use of equipment and tools (for example, needle cutter/melter, containers for used sharps, sterilising equipment etc.), use of forms, monitoring etc.
- Discussion regarding their specific role.
- Measures for accidents, incidents and emergency situations (regarding hospital waste management).
- Comments and suggestions which subsequently be considered for the success and betterment of the system.

(ii) Para-medical personnel:

This training capsule should include :

- Health hazards and impact of improper management of bio-medical waste, implication of neglect and not following the instructions, examples.
- Brief outline regarding the existing rules in simple language which they can understand.
- Supply of relevant charts indicating the practical implications of the rules and the policy of the hospital management.
- Detailed description of each step involved from their point of view.
- Discussions and instructions regarding their specific role and activities in this respect.
- Do's and don'ts regarding bio-medical waste management.
- Measures to be taken during accidents/ incidents/emergency situations.
- Incentives and punishments.
- Comments and suggestions.

(iii) Sweepers, cleaning staff, guards etc.:

This training should preferably be carried out in the local language. The material for this category may contain the following :

- Awareness generation, highlighting the importance of proper management of infectious and hazardous bio-medical waste and the health hazards and diseases caused by them.
- A brief introduction of the rules framed by the Ministry of Environment and Forests, Government of India and the advantages in following them.
- Providing them simple illustrated charts showing their responsibilities, the pit falls, how to be vigilant (especially for the guards).
- How to cope with accidents / incidents related to infectious, toxic and hazardous waste, how to help their colleagues in such situations.
- How to maintain personal hygiene in the environment of a health care establishment, the use and importance of protective gear such as, gloves, gum-boots, mask, apron etc. as well as of disinfectant and soap.
- How to co-operate with the management in this matter and how to report in case of any problem.
- The incentives and punishments programme of the management.

(iv) Administrative and management staff:

This capsule would contain material for awareness generation, the responsibilities and accountabilities formulation of policy.

- Awareness generation, highlighting the social, ethical and legal responsibilities of the management, case studies.
- Discussion on the Bio-medical Waste (Management and Handling) Rules, 1998, emphasising the legal, financial and contractual issues.
- The steps required for formulating a policy for the specific health care establishment, keeping in view the Govt. rules.
- Co-ordination with the civic and health authorities as well as with the prescribed authority of the State.
- Administrative and managerial support mechanism necessary for implementing and sustaining a proper bio-medical waste management system.
- How to motivate and elicit co-operation from various staff members.
- The concept of common treatment facility – the legal, financial and contractual issues.

7.13.2 Incentives and Motivation

These are important components for the success of the programme. Awards and punishments – both are required for this purpose. The following steps are recommended :

- The medical, surgical, laboratory and research staff should be encouraged to think on this problem and suggest innovative ideas/ designs/systems etc., which may be adopted for improvement in the waste management situation. Suitable awards may be instituted for this purpose.
- Similarly, the nursing and the auxiliary staff may also be encouraged to suggest practical ideas for improvement in their sphere of activities.
- Awards should be instituted on annual basis for the sanitation staff for the best work in each ward/ suitable units.
- Awards may also be instituted for the most hygienic and clean department for which the award may be given to the respective team.
- Punishment for dereliction of duty and non compliance or not obeying the orders / directives should be decided in advance and notified prominently. Prompt action should be taken for such lapses.

7.13.3 Awareness Generation

Sustained awareness generation is essential. The management of the hospital should organise awareness programmes, especially for the auxiliary staff. Debates, drama, essay competition etc. may be considered for this purpose.

7.14 PLANNING ELEMENTS

From a planner's point of view, the topic of hospital waste management may be divided into two parts :

- (i) Internal (planning of the hospital/nursing home, various movement routs, service corridors, storage area for hospital waste, treatment site if so planned, availability of open area, buffer zone etc.).
- (ii) External (for off-site treatment/disposal, common treatment/disposal facility) - site selection for such facilities according to land use plan, transfer route etc. of the town.

These have been outlined keeping in view the requirements at the time of initial planning, but some of these may be valid for existing facilities or for the purpose of expansion / extension.

7.14.1 Planning Inside the Health Care Establishment Premises

The hospital buildings are broadly divided into three parts/areas : Out Patient Department (OPD), Investigative facility area and In-patient department. OPD deals with patients on their first contact and those who do not need to be admitted in the hospital. It also has an Emergency unit, which takes care of patients under trauma, injury or other life threatening emergencies. This area generates bio-medical waste. The investigative area contains Operating Theatre (OT), investigating equipment like X-ray, Ultra sound, Electro Cardio Gram (ECG), stress tests (including Thallium stress test, which uses radioactive compound), bio-chemical/pathological laboratory etc. and is usually sandwiched between the OPD and the In-patient department (wards). The investigative area and the wards are the main generators of hazardous and bio-medical waste in the health care establishments. Other important utility areas in a hospital are the laundry, chemist's counter etc.

- In general, an attempt should be made to keep the areas generating infectious and hazardous waste (OT, maternity area, emergency area, infectious disease area, isolation area etc.) separated from those which generate non-hazardous waste (administration/office, kitchen, store etc.) so that there is a broad demarcation and proper management of waste becomes more effective and more convenient.
- Each point of waste generation should have adequate storage space for storing different kinds of waste matter. This should include any exigencies so that the system does not fail. For areas, which have potential to generate more infectious and hazardous waste, twice the average requirement should be taken. The storage area should be easily accessible from the service corridors meant for this specific purpose (discussed below).
- Arrangement for separate receptacles in the storage area with prominent display of colour code on the wall nearest to the receptacles.
- Separate service corridors for taking waste matter from the storage area to the collection room must be provided. These corridors should not cross the paths used by patients and visitors.
- Collection room (s) where the waste packets/bags are collected before they are finally taken/transported to the treatment/disposal site. This is more important when the waste is to be taken outside the premises. Two rooms - one for the general and the other for the hazardous waste are preferable.

The latter should be secured, cool and provided with fine wire mesh to prevent access of flies, mosquitoes etc. Proper gradient and drains should be provided so that this area can be cleaned and washed daily. In the event of shortage of rooms, the general waste (non-hazardous) can be directly stored outside in dumper containers (with lids) of suitable size.

- A shed with fencing should be provided for the carts, trolleys, covered vehicles etc. used for collecting or moving the waste material. Care has to be taken to provide separate sheds for the hazardous and non-hazardous waste so that there is no chance of cross contamination. Both the sheds should have a wash area provided with adequate water jets, drains, raised platform and protection walls to contain splash of water.
- If treatment of the hazardous/bio-medical waste is planned within the hospital premises, then its location has to be considered very carefully.
- If incineration is the chosen technology, it has to be installed at a place where there is least chance of contamination or pollution, especially from the emission, either for the hospital or its surroundings. Normally it should be away from the main building but should have sufficient buffer zone from the outside buildings, roads etc. so that there is no real or ethical nuisance perception. The recommended stack height (minimum 30 metres) has to be followed. In some hospitals in high-density areas, incinerators have been installed on the roof top to save space and to have extra stack / chimney height with relation to the ground. But such practices are fraught with danger unless very careful planning is done for fire fighting, movement of hazardous waste with separate lifts, safe removal of ash etc.
- If autoclave technology is chosen for treatment, then a decision has to be taken whether the boiler used by the laundry would also be used for the autoclave or a separate boiler would be installed. Accordingly, the equipment may be housed near the boiler of the laundry. However, these areas must be separated by a wall so that there is no chance of contamination of the laundry area. Only steam pipes (properly insulated) have to pass through the dividing wall. Proper drainage and outlet for spent steam / gases (with adequate filter elements) have to be provided. The steam condensate should be put in the underground sewer, after cooling, if necessary. The facility should be well connected with special service corridors for bringing the hazardous material and also for removal of the treated waste.
- Hydroclave technology, which is somewhat similar to the autoclave, requires less steam (only for the outer jacket and occasional supplementary steam for the main vessel in case of very dry waste) from an external source. Hence its proximity to a boiler is not a necessity. Small dedicated steam generators may also be installed for small to medium size facility.

- If Microwave technology is chosen, then also, the installation can be suitably at one side of the building or a separate building. Other conditions are the same as those for the hydroclave.
- The hospital may like to have its own secured disposal sites within the premises for sharps, incinerator ash, treated denatured waste etc. Such facilities should be planned after appropriate site qualification (at a mini scale), such as, distance from water sources, accessibility of birds, rats, vermin etc. as well as ragpickers, children and visitors.
- Separate roads and entry/exit gates should be provided for taking out the hospital waste, be it general waste or treated waste or incinerator ash.

7.14.2 Planning Outside the Health Care Establishment

The main concerns outside the establishment are - siting of common treatment facility and secured engineered landfills for sharps, incinerator ash and similar hazardous material for their ultimate disposal.

- Common treatment facilities should be planned with an eye at the future development prospects of the town/city. The sites have to be properly evaluated from the environmental angle as well as location of the clients (health care establishments). As mentioned earlier (7.9), the local landfill site may also be considered for installation of the common treatment facility.
- The ultimate disposal site for incinerator ash, sharps, toxic matter etc. should be planned in the same way as a secured landfill site is made for other toxic and hazardous waste. In fact, the local body (municipality) may consider to have a secured landfill site for all hazardous substances within its boundaries and allow its use on payment of charges / cost sharing basis.

7.14.3 Relation to Overall Town Planning

Proper planning, whether at the hospital (or other health care establishment) level or at the town planning level, is of utmost importance. Obviously, the best and the most effective system can evolve in an establishment, where the building itself has been designed accordingly. Similarly, it would be prudent to consider the points involved for siting of common treatment/disposal facility in the town-planning document. Then only optimal solutions and results can be expected.

7.14.4 Examples

Authentic data is still not available. However, estimated amounts have been taken here for working out the examples.

50 bed hospital/nursing home :

- Estimated generation of total waste @ 1.5 kg/bed - 75 kg/day
- Estimated generation of bio-medical waste
@ 25% of the total waste generated - 18-20 kg/day

Waste management system :

1. **Bio-medical waste** - Segregated storage at source in coloured plastic bags (according to the rules) which are to be kept inside sturdy covered containers. For collection, dedicated wheel-barrows are to be used for carrying the containers directly to the storage area. For transportation, covered vans are to be used as indicated under section 7.7.4. For treatment and disposal, the bio-medical waste should be taken to a common treatment and disposal facility having incineration facility also. Till the common treatment facility is in place, the bio-medical waste should be properly put in secured pits at the landfill site as shown in the figure 7.1 and the sharps in a covered pit which can even be located within the premises if suitable space is available.

2. **General waste** (not infected or hazardous)

- (a) Dry waste from office, store etc. to be kept segregated and sold to the recycling chain existing in the town.
- (b) Wet biodegradable waste from kitchen, garden etc., which are not infected, should be put into the municipal collection system.

200 bed hospital/nursing home :

- Estimated generation of total waste @ 1.5 kg/bed - 300 kg/day
- Estimated generation of bio-medical waste @ 25%
Of the total waste generated - 75-80 kg/day

Waste management system :

1. **Bio-medical waste** - Collection as above. The size of the carts should be according to the necessity. Treatment and disposal may be through common treatment and disposal facility as mentioned above. Alternatively, autoclave/microwave facility of suitable size may be installed if so desired. But installation of incinerator should only be planned if sufficient buffer zone is available around the facility.
2. **General waste** - As mentioned above. However, in this case, composting of garden and other bio-degradable waste may be undertaken if suitable land and trained manpower who can do the job in a proper manner is available without causing any degradation to the environment.

Examples of Common Treatment Facilities:

1. **For 15000 beds** (corresponding to about 40-50 lakh population)

Expected total waste generated : 20-25 TPD (approx.)

Expected generation of bio-medical waste : 5-6 TPD (approx.)

The common treatment facility may contain the following :

- Incinerator (preferably with a standby), compatible with the new emission norms, capacity 100 kg./hr., to be run in 3 shifts – for anatomical/pathological waste and cyto-toxic drugs.
- Autoclave/ hydroclave/ micro-wave equipment, compatible with the rules, capacity 100 kg./hr., to be run in 2-3 shifts – for soiled waste, solid waste, waste sharps and microbiology/biotechnology waste. A shredder may be installed with hydroclave for further shredding of the treated material if so desired.

- Sanitary landfill for incinerator ash, treated material from autoclave/hydroclave and other waste material which are not contaminated /infected.
- Secured pits for sharps.

2. For 5000 beds (corresponding to 10-15 lakh population):

Expected total waste generated : 4-5 TPD (approx.)

Expected generation of bio-medical waste : 1-1.5 TPD (approx.)

The common treatment facility may contain the following :

- Incinerator (preferably with a standby), compatible with the new emission norms, capacity 30-35 kg. /hr., to be run in 3 shifts – for anatomical /pathological waste and cyto-toxic drugs.
- Autoclave/hydroclave/micro-wave equipment, compatible with the rules, capacity 30-35 kg./hr., to be run in 2-3 shifts – for soiled waste, solid waste, waste sharps and microbiology /biotechnology waste. A shredder may be installed with hydroclave for further shredding of the treated material, if so desired.
- Sanitary landfill for incinerator ash, treated material from autoclave/hydroclave and other waste material which are not contaminated /infected.
- Secured pits for sharps.

7.15 MANAGEMENT ASPECTS

From the planning stage to day to day execution of a proper waste management system in the health care establishments, management aspects are of crucial importance. The management of waste requires continuous involvement of a long chain of people, such as, doctors, nurses, ward boys, cleaning staff etc. Dereliction of duty and carelessness at any stage can affect or even spoil the whole system. Therefore, all staff should know about their precise role – what is expected of them and why it is important for them to act according to the directions given to them.

According to a recent World Health Organisation (WHO) publication “Safe Management of Waste from Health-care activities”, apart from categorisation, assessment of current situation, the management of the hospital should develop and implement an effective Waste Management Programme.

7.15.1 Organisational Set Up

The above-mentioned document of WHO clearly lays down that the Head of the Hospital should form a Waste Management Team to develop and implement the Waste Management Programme. The team should have the following members:-

- Head of Hospital (as Chairperson)
- Head of Hospital Departments
- Infection Control Officer
- Chief Pharmacist
- Radiation Officer
- Matron (or Senior Nursing Officer)
- Hospital Manager
- Hospital Engineer
- Financial Controller
- Waste Management Officer (if already designated)

The structure is indicated in Fig.7.1

The Waste Management Committee should regularly meet at least once a month to review and make recommendations directly to the Hospital Director regarding any changes in the Management, Purchase Procedures, Training, Review and Remedial Measures for compliance of the Bio-medical Waste (Management and Handling) Rules, 1998 etc. All these recommendations should be duly documented.

7.15.2 Administration and Managerial Aspects

The management of the health care establishment should make an action plan to implement the recommendations of the rules framed by the Government of India (Ministry of Environment of Forests). This would include the following :

- Formation of a Waste Management Committee as outlined above.
- Clear indication of the role of each member of the committee.

- Action Plan for proper waste management in the particular health care establishment and its documentation. This plan should be reviewed once a year.
- Development of a format for reporting accidents and incidents relating to bio-medical waste management and its meticulous following.
- Assessment of all the survey results and their utilisation– once in every 6 months

7.16 ANIMAL WASTE

Animal waste comprises animal tissue, organs, body parts, experimental animal carcasses (used for research), animal waste from veterinary hospitals, animal houses etc.

According to Schedule I of the Bio-medical Waste (Management and Handling) Rules, 1998, these wastes fall under Category 2. According to these rules, such waste has to be incinerated. In towns with population less than 5 lakh, such waste can be subjected to deep burial. The pits for deep burial have to be in accordance with the specification given in Schedule V of the Rules.

In towns having more than 5 lakh population, the animal waste can be sent to the Common Treatment Facility meant for other type of bio-medical waste and incinerated there. The animal waste must be put in leak proof bags and should be transported safely taking precautionary measures as detailed in section 7.7. For further details, refer Chapter 5 .