STUDY OF TREATMENT FACILTIES FOR BIOMEDICAL WASTE IN DELHI

Six month Dissertation Project Submitted to the Delhi College of Engineering, Delhi

in Partial Fulfillment of Requirement for the Degree of

M.E (Civil)

in

Environmental Engineering

Submitted by

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CERTIFICATE

This is to certify that dissertation entitled "Study of treatment facilities for Biomedical waste in Delhi " submitted by Sumit Goel [2002]/ME(PT)/13 (university roll no. 9148) to Delhi College of Engineering, DCE, Delhi for award of degree of **Master of Engineering** in Civil Engineering (Environmental Engineering) is a record of bonafide research work carried out by him under my supervision and guidance. He has fulfilled the requirement of submission of the thesis, which to my knowledge has reached requisite standards.

To the best of my knowledge that this work has not been submitted, in part of or full to any other university or institute for the award of any degree or diploma.

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Acknowledgements

I am deeply indebted to Dr.(Mrs.) Anubha Mandal, the research supervisor, who introduced me to work on a great topic of research. . Her guidance, patience, positive ness, help and parental care are remarkable, without which I could not have completed this. The independent work environment with her nested supervision was very important. She always provides fruitful solutions.

I express my gratitude for Dr. S.K. Singh, Head of Deptt. who has constantly direct me with his technical approach towards this work. His constant encouragement and discussion have been a motivating factor always.

I take this opportunity to sincerely thank from profundity of my feeling to Dr. Jyotsna, Kavita, Raviansh, Rahul kumar, Avdesh for being nicest companions that a person could ever have.

Great were the inspiration of my father and mother, which provided the support for my work, for their support and prayer.

SUMIT GOEL

Abstract

The current investigation has major addressed three issues.

- First is review of current BMW practices adopted in India, particularly for Delhi region,
- Secondly, to make an assessment of emissions through waste incineration and thirdly to analyze the economic of the treatment facilities for BMW disposal in terms of the capital cost recovery through waste recycling .

This dissertation highlights current practices and strategies for biomedical waste management in India It discusses various options for the treatment of medical waste. This includes waste generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities pertaining there to.

In comparison to other available technologies incineration is reliable, economical and effective means to deal with large quantum of biomedical waste. It has additional advantages of minimization, stabilization, sanitization of waste and energy recovery.

The study of biomedical waste incineration emissions is also been reported. Monitoring results through stack emission have been incorporated and analyzed with the objective of assessing their compliance with the existing discharge standards.

In addition, cost related to the hospital waste management pertaining three major hospitals of Delhi with different bed capacity has been studied. Results and theoretical studies show ample scope and increasing need for environmentally friendly disposal of hospital waste.

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Chapter 1
INTRODUCTION

GENERAL

Bio-medical waste is generated

- By diagnosis, treatment or immunization of human beings or animals
- Research activities pertaining thereto or in the production or testing of biological

BMW include

Wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes etc.

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

Realising the gravity of the issue, the Central Board took up the matter, in right earnest, with the Ministry of Environment & Forests. This led to the notification of 'Bio-medical Waste (Handling and Management) Rules, 1998.

- Total health care facilities availablein Delhi there are more than 2200
- total bed strength of about 18,770
- estimated quantity of infectious biomedical waste 4693kg/day.
- The quantities of BMW generated by healthcare facilities are about 6ton/day.

Disposal practices adopted

- Many Hospitals have there own facilities while
- The others depend upon a couple of private agencies.

General treatment currently adopted

- Major portion of all the biomedical waste combusted in incinerators

- with only small fraction being disposed off using other technologies for example after disinfecting in autoclaves.

Present study analyses

- Discusses various options for its safe disposal.
- Data collected from already conducted surveys .
- Involves management of Bio-medical waste by various hospitals of Delhi of different bed capacity,
- Characterization of their hospital waste, Energy and the thermal analysis of waste.
- Results through monitoring of emissions from incinerators of various hospitals in Delhi are also been presented
- Inferences been drawn for current status of emission discharges into the environment.

1.2 OBJECTIVES

The broad objective is to focus on better disposal techniques.

This objective is divided into following specific objectives:

- To study various disposal and treatment techniques currently available in this field.
- To collect quantitative and qualitative data of health Authorities in Delhi region.
- Data have been analysed to know the actual quantity and quality of waste generated in Delhi, its characteristics and its overall management with following objectives.
  - i. general details about various hospitals/nursing homes in Delhi.
  - ii. categorize various types of hospitals/nursing homes in Delhi.
  - iii. characterize hospital waste & its quantities.
  - iv. To comprehend the details of present disposal facilities of hospital waste in Delhi and their comparison with the existing permissible norms .
  - v. To evaluate the present method used for disposal of biomedical waste by the hospital under study.

- To assess the stack emissions through waste incineration of various hospitals in Delhi and analysing the hazards associated with them.
- . To estimate the cost incurred for installing the disposal facilities for BMW from pay back value point of view.
- To provide suggestions for improvement of the overall situation.

METHODOLOGY

a. Data collection for evaluation of BMW practices in Delhi.

b. Economic analysis of installing treatment facilities

Chapter 2

Literature Review of Biomedical Waste Management

Chapter 2

LITERATURE REVIEW OF BIOMEDICAL WASTE MANAGEMENT

CATEGORIZATION OF BIOMEDICAL WASTE

Waste categorization at International level

In the united state infectious waste is categorized as follows:

- Isolation waste
- Cultural and stocks and associated biological
- Human blood and blood products
- Pathological waste
- Used sharps
- contaminated animal carcasses
- Unused sharps

Waste categorization in India

classification according to the biomedical waste (management and handling) rules, 1998, Waste divided into three major categories.

- General waste
- Infectious waste
- Hazardous waste

General Waste

- (75-90 per cent) of waste of a medical facility
- Comprises newspapers, letters, documents, packing material, cardboard containers, plastic bags / films, food wrapping, metal cans, food containers, flowers, floor sweepings and kitchen waste.
- General waste may be sorted out further for partial recycle / reuse purposes and the rest disposed of a municipal solid waste.

Infectious Waste OR Pathological OR Bio-Medical,OR Bio- Hazards, Toxic OR Medically Hazardous Waste

- About 15 per cent waste consists of infectious waste.

- Originates in many hospital departments, wards, and laboratories

Hazardous Waste

Hazardous chemicals such as the listed below are generally found in any medical facility.

- Cytotoxic chemicals (chemotherapy and antineoplastic chemicals)
- Formaldehyde
- Photographic chemicals
- Radio nuclides
- Solvents
- Mercury
- Anesthetic gases
- Cleaning and maintenance chemicals

Sources of Origin :

- Clinical laboratories and the associated services.
- Chemical waste from diagnostic and experimental work,
- cleaning, and from housekeeping and disinfecting procedures.

Summary of Bio Medical Waste (Management & Handling) Rules, 1998

With a view to control the indiscriminate disposal of hospital waste/bio medical waste, the Ministry of Environment & Forest, Govt. of India has issued a notification on Bio Medical Waste Management under the Environment (Protection) Act. Govt. of NCT of Delhi in its notification dated 6th July, 1999 has authorised Delhi Pollution Control Committee (DPCC) for the purpose of granting authorization for collection, reception, storage, treatment and disposal of bio medical waste to implement the Bio Medical Waste Management Rules, 1998. Govt. of NCT of Delhi has also constituted advisory

committee, appellate authority in exercise of powers conferred under Bio Medical rules. As per biomedical waste management and handling rules 1998, various categories have been defined as given below**Schedule-I**

CATEGORIES OF BIO-MEDICAL WASTE

Option	Waste Category	Treatment & Disposal
Category No. 1	Human Anatomical Waste (human tissues, organs, body parts)	incineration @/deep burial*
Category No. 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@/deep burial*
Category No. 3	Microbiology & Biotechnology Waste (Wastes from laboratory cultures, stocks or micro-organisms live or vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological, toxins, dishes and devices used for transfer of cultures)	local autoclaving/micro-waving/incineration@
Category No. 4	Waste Sharps (needles, syringes, scalpels, blade, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	disinfections (chemical treatment @@@/autoclaving/microwaving and mutilation/shredding##
Category No. 5	Discarded Medicines and Cytotoxic drugs (Waste comprising of outdated, contaminated and discarded medicines)	incineration@/destruction and drugs disposal in secured landfills
Category No. 6	Soiled Waste (items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, bedding, other material contaminated with blood)	incineration@autoclaving/microwaving

Category No. 7	Solid Waste (Waste generated from disposal items other than the sharps such a tubings, catheters, intravenous sets etc.)	disinfection by chemical treatment@@ autoclaving/microwaving and mutilation/shredding##
Category No. 8	Liquid Waste (Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)	disinfections by chemical treatment@@ and discharge into drains
Category No. 9	Incineration Ash Ash from incineration of any bio-medical waste)	disposal in municipal landfill
Category No. 10	Chemical Waste (Chemicals used in production of biologicals, chemicals used in production of biologicals, chemicals used in disinfections, as insecticides, etc.)	chemical treatment@@ and discharge into drains for liquids and secured landfill for solids
Note :		
@	There will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated.	
*	Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.	
@@	Chemicals treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It musts be ensured that chemical treatment ensures disinfections.	
##	Multilation/shredding must be such so as to prevent unauthorized reuse.	

Schedule-II

COLOUR CODING AND THE TYPE OF CONTAINER FOR DISPOSAL OF BIO MEDICAL WASTES

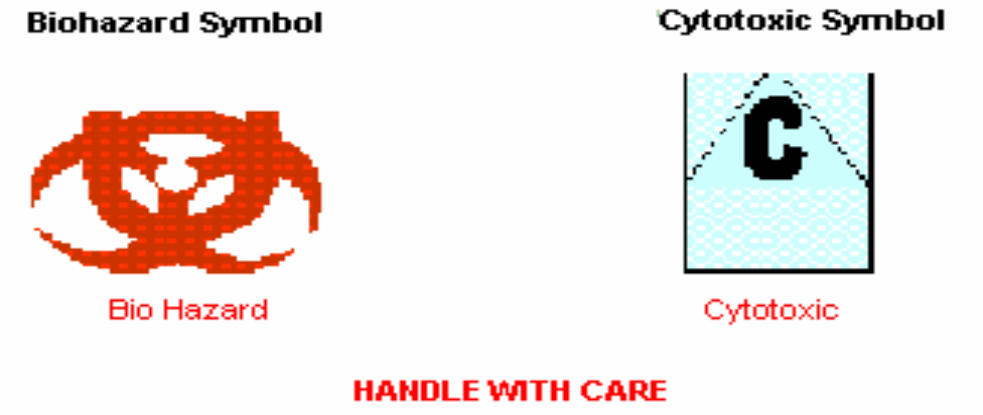
Color Coding	Type of Container	Waste Category	Treatment options as per Schedule-I
Yellow	Plastic bag	Category 1, 2 and Category 3, 6	Incineration/deep burial
Red	Disinfected container/Plastic bag	Category 3, 6, 7	Autoclaving/Microwaving/ Chemical Treatment
Blue/White translucent	Plastic bag/puncture proof container	Category 4, 7	Autoclaving/Microwaving Chemical Treatment and destruction/shredding
Black	Plastic bag	Category 5, 9 and Category 10 (solid)	Disposal in secured landfill

Note :

- Color coding of waste categories with multiple treatment options as defined in Schedule-I shall be selected depending on treatment option chosen, which shall be as specified in Schedule-I.
- Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
- Categories 8 and 10 (liquid) do not require containers/bags.
- Category 3 if disinfected locally need not be put in containers/bags.

SCHEDULE III

LABEL FOR BIOMEDICAL WASTE CONTAINERS/BAGS



If container s transported from the premises where biomedical waste is generated to any waste treatment facility outside the premise container shall apart, from label prescribed in schedule III also carry information prescribed in schedule IV.

SCHEDULE IV

LABEL FOR TRANSPORT OF BIOMEDICAL WASTE CONTAINER /BAGS

FORM

Day	Month
Waste category number	Date of generation
Waste class	
Waste description	
Sender's name and address	Receiver name and address
Phone number	Phone number
Telex no.	Telex No.
Fax No.	Fax No.
Contact person	Contact person
In case of emergency please contact	
Name and address	
Phone No.	
Note	

WASTE CHARACTERIZATION AND QUANTIFICATION [2]

Quantification of waste generated at international level

waste generated in medical for developing countries ranges from 1-3 kg/day/bed as compared to 3-10kg/day/bed in developed countries. **Table 2.2** lists a typical waste generation rate for medical facilities in different regions of the World Health Organization.

Quantification of waste generated at India

In Kanpur, waste quantification , the results of which are given below in **Table 2.3.**

In Bhopal, waste quantification , the results of which are given in **Table 2.4.**

As per "Health Information of India – 1993, 596203 beds in health care sector in India. Assuming infectious bio-medical waste generation as 250gm/bed/day, the estimated quantity of infectious bio-medical waste generated out of above numbers of beds is approximately 150 MT/day as on 01.01.1993.

REAL PICTURE OF MANAGEMENT OF BMW

Few photographs from the survey on hospital waste management in cities near by Delhi, India. Photographs present the negligence on the part of hospital authorities. These clearly depicting the unhygienic / in sanitary conditions.

PHOTO 1: A well-constructed brick dustbin for hospital waste disposal

PHOTO 2: Waste is collected at a walled corner of Hospital without segregation

PHOTO 3: Unsegregated wastes disposed off in a brick bin out side the hospital (remain unburnt for several days

PHOTO 4: Unsegregated waste disposed in a brick constructed bin inside the hospital premises

In hospitals where masonry bins (Photo 2,3 and 4) are used, waste is not regularly removed from inside of such structures and loaders cannot effectively function for removal of waste from the corners of such structures. Left over (uncollected) waste putrifies and emanates foul smell causing nuisance and insanitary conditions.

PHOTO 5: Half burnt waste lying scattered in adjacent vacant plot (whereas municipality bin is also available at the site for the proper disposal of the waste)

PHOTO 6: Waste lying haphazardly in the follow land without any management. (Create a nuisance for people residing near hospital)

PHOTO 7: Waste lying scattered outside the municipality bin

Deposition of waste at the open waste storage sites in the hospital premises is most unscientific and unhygienic. The waste is just dumped at hospital out side and remains littered around such sites causing insanitary conditions, foul smell, and environmental pollution besides giving unsightly appearance till it is removed as it could be seen from the photograph.(as shown in photo 5,6 and 7)

PHOTO 8: A stray pig is trying to get some eatable from the infectious hospital waste.

PHOTO 9: A stray cow eating hospital waste thrown by the hospital chemist Shop.

PHOTO 10: A dog eating some anatomical waste thrown along with other Hospital waste

Cow that ingests infectious waste or food, which is contaminated, could carry disease like typhoid through their milk. Pigs and dogs that hunt from their food can also spread disease (See Photo 8,9, and 10)

PHOTO 11 Plaster from an orthopedic hospital lying thrown in open (create problem for people residing nearby)

PHOTO 12: Heaps of hospital waste lying near Monument, imparting a filthy shape to this only historical monument of the city.

PHOTO 13: Regpickers showing their hands pierced by needles and other hospital waste sharps.

Rag picker rummage through the medical waste with bare hands without any gloves or even a common stick. Some of them an injury or cut while dealing with medical waste

PHOTO 17: Hospital plastic bottles at junk dealers shop (Recycling of infectious waste)

PHOTO 18: Glass bottles collected from hospital waste at Junk dealers shop.

As shown in photograph 17, 18, plastic have been used indiscriminate as well as its reprocessing and disposal of plastic waste are posing environmental problems and health hazards beside causing the public nuisance. A strategy and action programme for management of plastic waste. Task force have restricted on recycling of poor quality plastic waste, deterrent penalties for littering and improvement in plastic waste collection system

PHOTO 19: Waste thrown in random manner by several hospitals, lying scattered outside the bin placed for hospital waste disposal.

Chapter 3

Biomedical Waste Management

Chapter 3

BIOMEDICAL WASTE MANAGEMENT

The health care facility should have a waste management Policy to guide the daily operations. This policy has to be developed to provide guidance to hospitals, administrators, doctors, nurses, technicians, sanitations personnel, and other health care professionals of hospitals/Health care setup to enable them to be aware of the requirements of the proper and safe management of hospital waste as required by legislation of Govt. of India.

WASTE SEGREGATION ***[Source :*** *website:-http://dhs.delhi govt.nic.in]*

Wastes are segregated as infectious and non-infectious

- Segregation starts mainly with responsibilities of doctors and nurses,
- containers for storing segregated wastes, should be clearly identifiable. The best system is to use colored plastic bags / containers.
- The colour coding, and types of containers, shall be followed as per the schedule II of the Bio-medical Waste (Management & Handling) Rules, 1998.
- Sharps need special attention while segregating and storing
- Plastic bags for storing the waste may be suspended inside a frame or be placed inside a sturdy container. A lid should be provided to cover the opening of the bag at the top.
- Every room such as ward, laboratory, operation theatre, etc., should have containers / bags for the types of wastes that are generated in that room.
- Each container may be clearly labeled to show the ward or room where it is kept. The reason for this labeling is that it may be necessary to be able to trace the waste back to its source.

COLLECTION OF BIO MEDICAL WASTE*[Source :* *website:-http://dhs.delhi govt.nic.in]*

Collection of Bio medical waste should be done as per Bio Medical Waste (Management &Handling) Rules, 1998 (Rule 6—schedule II)

- Type of container and colour for collection of biomedical waste:

S. No.	Category	Type of Container	Colour Coding
1.	Human anatomical waste	Plastic Bag	Yellow
2.	Animal waste	-do-	-do-
3.	Microbiology & Bio-Technology waste	-do-	yellow/ red
4.	Waste sharp	Plastic bag puncture proof container translucent	Blue/White
5.	Discarded Medicines & Cytotoxic waste	Plastic bag	Black
6.	Solid waste (Soiled)	-do-	Yellow/ red
7.	*Solid waste (Plastic)	Plastic bag puncture proof container translucent	Blue/White
8.	Liquid waste	–	–
9.	Incineration ash	Plastic bag	Black
10.	Chemical waste (solid)	-do-	Black

* Those plastics, which contain liquid, like blood, urine, pus etc should be put into red colour bag for microwaving and autoclaving and other items should be put into blue or white bag for chemical treatment and destruction/ shredding..

- All the items sent to incinerator/deep burial (Cat 1,2,3,6) should be placed in Yellow colored bags.
- All the Bio-medical waste to be sent for Microwave/autoclave/Chemical treatment should be placed in Red coloured bags.
- Any waste which is sent to shredder after autoclaving/microwaving/chemical treatment is to be packed in Blue/white translucent bag.
- Location of containers:— All containers having different coloured plastic bags should be located at the point of generation of waste i.e. near OT Tables, injection rooms, diagnostic services areas. The colour of container/plastic bags used for collection of segregated Biomedical waste should be identifiable.
- Labeling:—All the bags/containers must be labeled according to the rules (Schedule III of Bio Medical Waste Rules, 1998.
- Bags:—It should be ensured that waste bags are filled up to only three fourth capacity, tie securely and remove from the site of the generation regularly and timely.
- Certain categories of waste which may need pre-treatment (decontamination/disinfection) and the site of generation such as plastic and sharp materials, etc should be removed from the site of generation only after treatment.

- The process of collection should be documented in a register, the colour plastic bags should be replaced and the garbage bin should be cleaned with disinfectant regularly.

STORAGE OF WASTE [Source : website:-http://dhs.delhi govt.nic.in]

- No untreated Bio Medical Waste shall be kept, stored beyond a period of 48 hours
- The authorised person must take the permission of the prescribed authority, if for any reason; it becomes necessary to store the waste beyond 48 hours.
- The authorised person should take measures to ensure that the waste does not adversely affect human health and the environment, in case; it is kept beyond the prescribed limit.

1. **WASTE HANDLING AND TRANSPORATATION** *[Source :COEH(1999) "Bio-Medical Waste Management" A Study Report by Centre for Occupational and Environment Health Lok Nayak Hospital,Delhi}*
    - Should never be transported with general municipal wastes.
    - The transport containers should be properly enclosed.
    - The effects of traffic accidents should be considered in the design,
    - . It should be possible to wash the interior of the body thoroughly.
2. **Transportation within the Hospital.** [*Source: CPCB (2000) "Guidelines on "Bio-Medical Waste Management", Central Pollution Control Board, New Delhi.]*

- Within hospital, waste routes must be designated to avoid the passage of waste through patient care areas as far as possible.

- Separate time should be earmarked for transportation of Bio Medical Waste to reduce chances of its mixing with general waste as for as possible.
- Dedicated wheeled containers, trolleys or carts should be used to transport the waste bins/ plastic bags to the site of storage/ treatment.
- Trolleys or carts should be thoroughly cleaned and disinfected in the event of any spillage.
- The wheeled containers should be designated that the waste can be easily loaded, remains secured during transportation, does not have any sharp edges and easy to clean and disinfected.

Transportation of clinical waste to treatment/disposal outside the hospital.

- Untreated Bio Medical Waste shall be transported as specified by the Govt. under the Motor Vehicle Act, 1988.
- The containers for transportation must be labeled as given in Schedule III and IV of BMW Rules 1998.

COMPONENTS OF BIOMEDICAL WASTE MANAGEMENT STRATEGY
[Source :Joshi T.K. (2002) "Bulletin of Occupational & Environmental Health" Centre for Occupational & Environmental Health, Vol-I, Jan-June, 2002.]

Essential components of the hospital waste management strategy are

- waste classification (during waste generation) and
- subsequent appropriate waste segregation. by colour coded waste containers..

The proper segregation of wastes will allow hospitals :

- Minimise the amount of potentially hazardous waste which requires specialized and costly treatment / disposal (e.g. incineration)
- Facilitate proper packaging and labeling wastes for information and its appropriate disposal route.
- Reduce occupational health and safety risks to all health care workers.
- Improve infection control within the hospital by preventing cross-contamination of hazardous and non-hazardous waste streams.

- Enable better accounting within health care institutions of the types and quantities of hospital wastes generated and the costs associated with their proper management (i.e. handling, transport, treatment and disposal).
- Comply with national legislation in order to avoid potential prosecution and also to protect the good reputation of our hospital.
-
- **The major elements of the Hospital Waste Management Policy are** :
- waste classification,
- waste segregation,
- proper labeling and packaging,
- improved handling and transport,
- waste minimization, and
- Cost-effective treatment and disposal.

Waste minimization can be achieved through proper segregation of wastes. Thereby minimizing the amount of waste, costly treatment and disposal, and maximizing the proportion of waste that can be safely and cheaply disposed of to landfill.

Proper segregation also allows those wastes that can be recycled to be efficiently recovered from the waste stream before they become contaminated with potentially hazardous infectious and chemical substances.

Therefore, the return to reusable items, in some areas of health care, needs to be considered if waste is to be minimized beyond the recycling potential of glass, paper, plastic and putrescible garden/kitchen wastes.

3.7 MANAGEMENT AND CONTROL PRACTICES

*[*Source*: website:-http://dhs.delhi govt.nic.in]*

The use of the following management and control practices is suggested for minimizing medical waste:

- Centralize purchasing, dispensing of drugs and hazardous chemicals.

- Track/Monitor Drug and Chemical Flow within the Facility.
- Conduct Periodic Waste Audits of Each Department Generating Wastes.
- Apportion Waste Management Costs
- Improve Inventory Control (e.g. necessitate using up of old stocks before ordering new stocks of chemicals and order hazardous chemicals only when needed).
- Provide employee training on
- Spill prevention and preventive maintenance
- Emergency preparedness and response to spill cleanup.
- Implement facility wide waste reductionm program

WASTE AUDIT: BIO-MEDICAL

To ensure compliance with the regulatory requirements. It is also to ensure, that valuable resources are not being wasted, and that contamination of the general waste stream does not take place.

To improve the occupational health and safety environment for healthcare workers, protect public health and the environment, reduce the costs associated with proper biomedical waste management, minimize the amount of hazardous waste produced, encourage recycling where appropriate, and to contribute to improved infection control within the institution.

Yellow-non-plastic infectious waste to be incinerated ; Red-Sharp and plastic infectious waste to be autoclaved or hydroclaved and shredded, and black – non-hazardous general waste to be land filled. The waste audits should be conducted to determine the level of cross contamination, between the color-coded waste streams.

The Audit as a Waste Management Tool

(a) One of the most valuable elements of a product management approach to the handling of the patient care waste stream is the product-oriented waste audit. This is an audit process that is centered on identifying the problem through a product-focused waste management walk-through audit of the facility. .

Now, as healthcare facilities see their cost of disposal rise at a steep rate, and some cases have their ability to dispose of infectious waste threatened altogether, a new consciousness of waste frugality is emerging. A simple visual examination of most

Color coded containers / bags at most hospitals will demostrate that packaging in all its form (paper, plastic, glass, foil and metal) is very large, if not the largest, component of the waste stream.

Very successful efforts are made at some hospitals to segregate waste, so that there is minimum impact from packaging on the bag waste stream. In a few model programs, much of the waste is being recycled. In these cases however the emphasis has been on the **"back door"** i.e., caching the waste when it is being disposed of and setting up systems to deal with it, in its vast quantity. There is another approach: closing the **"front door"** to as much unnecessary packaging as possible.

. The product-oriented waste audit must look at the things that happen to products each day and do so in a manner that dose not disturb or interrupt the activity of the hospital.

The Audit Team

An effective waste audit is best performed by an audit team that can recognize and identify the patient care and clinical product and waste generated:

- How is it purchased, stored, distributed, and managed?
- How is it handled and used by the clinical staff?
- How is it handled, transported, and managed as a waste?

The characteristics noted above clearly suggest the need to use a "Hospital-Smart" audit team that is familiar with these characteristics, Using auditors from waste service companies and waste management consultants, who have no experience may produce unsatisfactory results. In addition, such audits by outsiders do not promote "ownership" in the process and usually do not come.

Audit team should have the following:

- A purchasing officer to evaluate the purchasing and material management issues.
- A staff nurse or clinical supervisor to evaluate the clinical and patient care issues.
- A nodal officer BMW to evaluate the waste management issues.
- An administrator or its delegate for Prompt action.

Chapter4

TREATMENT TECHNIQUES FOR BIOMEDICAL WASTE

Chapter4

TREATMENT TECHNIQUES FOR BIOMEDICAL WASTE

TREATMENT TECHNOLOGIES FOR BMW

[Source CPCB Perivesh news paper March 1998 , Vol .4 (iv)]

There are five broad categories of medical waste treatment technologies:

1. Mechanical processes
2. Chemical processes
3. Irradiation processes
4. Biological processes
5. Thermal processes

MECHANICAL PROCESSES

Mechanical processes are used to change the physical form or characteristics of the waste either to facilitate waste handling or to process the waste in conjunction with other treatment steps. The two primary mechanical processes are

- compaction : compressing the waste into containers to reduce its volume
- shredding: includes granulation, grinding, pulping etc. is used to break the waste into smaller pieces.

Compaction and shredding may result in aero soling or spilling of microorganisms. .

CHEMICAL PROCESSES

Chemical Disinfectants are

- aqueous solutions chlorine compounds,
- phenolic compounds,
- iodine, alcohols,
- hexachlorophene,

- formaldehydes, iodine-alcohol combinations,
- formaldehyde-alcohol combination etc.

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IRRADIATION PROCESS

Electromagnetic or ionizing radiation.

- Process utilizing Cobalt 60, and
- electron beam accelerator unit or election beam gun, for irradiating and sterilizing the medical waste have been developed.
- These systems require post-shredding to render the waste unrecognizable.

BIOLOGICAL PROCESSES

- Biological enzymes for treating medical waste.
- Biological reactions will not only decontaminate the waste but
- Also cause the destruction of all the organic constituents so that only plastics, glass, and other inerts will remain in the residues.

THERMAL PROCESSES

Most microorganisms destroyed at 49^0C to 91^0C, and killed at 100^0C.

There are two categories

- Low-heat systems : water, or electromagnetic radiation to heat at less than 150^0C
- High-heat systems: combustion, pyrolysis and high-temperature plasmas as low as 600^0C to more than 5500^0C

Autoclaving(stem sterilization)

Autoclave is a low-heat thermal process and is designed to bring steam into direct contact with the waste in a controlled manner and for sufficient duration to disinfect the waste. The three basic types of steam autoclave systems are

- Gravity : Steam temp of about 121^0C at cycle time of 60-90 min with press.
- Prevacuum, : cycle times to about 30-60 min at about 132^0C by vacuum pumps
- Retort systems: higher steam temperatures and pressures, and therefore their cycle times can be substantially less than those of the other

Hydroclave :

- Indirect heating is done by steam in the outer jacket of a double-walled container.
- The treatment time is 15 minutes at 132^0C or 30 minutes at 121^0C to achieve sterilization

Microwave Treatment

- By pre-shredding the waste,
- injecting it with steam, and
- heating it for 25 minutes at 95^0C.
- Microwave radiation is designated at frequencies 300 and 300,000 MHz

Plasma systems

- Plasma torch or burner temperatures are so high that some of its electrons are separated from its atoms for heating the waste to super-high temperatures.
- to operate with furnace temperatures of as high as $10,000^0$C
- Operate in an oxygen-deficient mode and off-gases need to be combusted separately.

INCINERATOR*[Source : CPCB Parivesh News Letter, September 2004]*

Incineration is a controlled combustion process.

The waste after combustion is converted to

- Gaseous constituents and
- A non-combustibles residue.
- The gases are released to atmosphere and the residue is usually disposed to landfill.
- Operation temperatures between 850 ^{O}C and 1100 ^{O}C in specially designated combustion chambers.
- It requires skilled manpower for operations.
- Capital cost and recurring expenses of incinerators are high.
- By using heat recovery system, the cost of operation can be reduced through use or sale of energy.

Part of Incineration Unit

High-temperature combustion under controlled conditions , containing infectious and pathological material to inert mineral residues and gases with primary and secondary combustion chambers to ensure maximum combustion.

The three types of incinerators used for hospital waste treatment are

- **Multiple-hearth,**
- **Rotary kiln**,: a cylindrical refractory-lined ,slight incline
- **Controlled air**. two or more chambers with primary chamber, waste is dried, heated, and burned at 40-80% of the stoichiometric oxygen . Combustible gas produced by this process is mixed with excess air and burned in the secondary chamber at usually between 100-150% of the stoichiometric requirement. A supplementary fuel burner is used to maintain elevated gas temperatures and provide for complete combustion. One advantage of using low levels of air in the primary chamber is that there is very little entertainment of particulate matter in the flue gas.

  Multiple-hearth incinerators consist of two or more combustion chambers.
- The primary chamber is for solid-phase combustion, whereas
- The secondary chamber is for gas-phase combustion.

  Controlled-air incinerators burn waste into under conditions of both low and excess stoichiometric oxygen requirements.

Figure 4.1 Incinerators complete with pollution control equipments

Figure 4.2: Primary and secondary chambers of incinerator

Wet Scrubbers

- Used on bio-medical waste incinerators.
- Venturi scrubbers are used primarily for particulate matter control
- Whereas packed-bed scrubbers are used primarily for ached gas control. & particulate matter. These units are not effective for controlling particulate emissions from controlled-air incinerators and are used exclusively on multiple-chamber units, which can emit significant quantities of large particles.

Figure 4.3: Venturi scrubber system for incinerator

Dry Scrubbers

- Removal of sulfur dioxide, hydrogen chloride, hydrogen fluoride, and other acid gases,.
- Some adsorption of vapor state organic compounds and metallic compounds also occurs in some dry scrubber applications.

- Basically, dry scrubbers use an alkaline sorbet to react with and neutralize the acid gases. The reaction product is a dry solid, which can be collected by a particular control device.
- Dry scrubbers usually are followed by either fabric filters or electrostatic precipitators for collection of the reaction products and the run-related sorbent.

TYPES OF INCINERATOR *[Source : Manufacturer Themax Ltd.]*

Electrically Heated Type

Recommended for waste,

- which has high calorific value and low moisture contents. S
- Suitable for small nursing homes, clinics, health centres, dispensaries and for official waste.

Capacity: 1 Kg/hr to 25 Kg/hr

Oil Fired Type

- Recommended for all type of waste even with low calorific value and high moisture content.
- These can be run of any fuel like light diesel oil (LDO), LPG, Natural Gas etc.
- These incinerators are suitable for hospitals, big nursing home, municipal garbage, hotels and industrial waste

Capacity: 10 Kg/hr to 1000 Kg/hr

Basic Technical Details:

- The INCINERATORS are so designed that they give best performance with lower energy consumption
- Give very less amount of pollution due to burning of the waste.
- Pollution can also control by installation of certain pollution control equipments like Cyclone separator/scrubber and the discharge parameters will reach to the

desire level as per requirement of the central pollution control board.

- Flue gases coming out of stack are free from furan and dioxin.
- Refractories are suitable to stand 1550 to 1650^0 C
- Automatic control Panel of Pyrolytic process with all interlocking safety devices.
- Optimal fuel efficiency is achieved.
- Educator system is incorporated at outlet of the secondary chamber so that the temperature of the exit gases is brought down from 1100^0 C to 300^0 C.
- Primary chamber maintains $800+50^0$ C Temperature.
- Secondary chamber maintains a minimum temperature of $1100+50^0$C
- Highly quality equipment's and accessories can be tailored to meet specific
- Requirement of user compatible to waste type.
- To burn and distill the waste by a PRYOLYTIC PROCESS with low oxygen support in combustion chamber

Safety Systems *[Source : Manufacturer Themax Ltd.]*

The firing system consists of

- Sequence controllers, temperature indicators cum controllers and photocell etc.
- The control panel has audiovisual alarm for any abnormal operation which makes burner function safe.
- Pressure S/W in eductor circuit prevents accidental start of any system. i.e. before starting of Educator fan and developing sufficient negative pressure no other system is allowed to start.
- And there is much more from safety point of view, as soon as waste charging door opens the burner switches off thereby avoiding accidental hot gas volatile coming out of furnace. Other safeties like burner cut off are provided on both

burners.

Special features

. The required temperature for Incineration is achieved by either

- electric Heaters or
- By Diesel that is pumped by a pump.

The process is very safe as the complete system is packed. To achieve efficiency of the fuel the equipment is lined from inside by fire Bricks/refractory living where as the outer body is insulated keeping in Safety factor of the Operator. The complete system remains in Negative working pressure achieved by proper stack or additional I.D. fan as per the capacity of the system is also provided. This not only keeps all the system in proper operation but also ensures 100% safety.

OPERATIONAL PROBLEMS AND SOLUTIONS ASSOCIATED WITH HOSPITAL WASTE INCINERATORS *[Source : Manufacturer Themax Ltd.]*

Incinerator operational problems include

- Excessive stack emissions in the form of white or black smoke, smoke leakage from the charging door or other openings, excessive auxiliary fuel usage and incomplete burnout of the waste.
- These operational problems can be minimized through proper operation of the incinerator together with an effective preventive maintenance program.

Excessive Stack Emissions

The proper operation of controlled air incinerators results in relatively low emission rates. Excessive emission rates can usually be attributed to one of the following causes :

- High set point for the secondary burner temperature is not high enough:
- Excessive negative draft in the primary chamber;
- Excessive infiltration air (from charging door);

- Excessive under fire air in the primary chamber:
- Operating at too high a primary chamber temperature;
- . Overcharging:
- .Problem wastes; and
- .Inadequate secondary combustion air.

Black Smoke

The appearance of black smoke indicates

- The presence of unburned carbonaceous material and
- is caused because of incomplete combustion is occurring.
- Incomplete combustion is due to insufficient amount of combustion air for the quantity of volatiles / soot present and is usually the result of overcharging the unit, charging of a highly volatile material, or operating the primary chamber at too high a temperature. The following steps may assist in eliminating black smoke :
- .Check / increase secondary chamber combustion air;
- .Check / decrease under fire air (if necessary); an air decrease should result in reducing the primary chamber operating temperature;
- .Check / increase secondary chamber temperature.
    - **Charging Instructions:**

    - waste does not contain non combustible materials like iron rods, porcelain broken pots, glass wares, rubbles, tins, etc.
    - Do not burn PVC (chlorinated plastic) in the incinerator to avoid formation of toxic compound under non-ideal condition.
    - Do not burn pressurized either, cleaning fluid, florescent tubes, fused bulbs, etc.

- Do not burn chemicals like vinyl chloride, acetic caster, Methyl-ethyl Ketone, and alcohol, benzene that may cause an explosion.
- **Running Attentions**
- It is advisable on the part of an operator to make it a practice to go around the unit and make sure that
- The temperatures in primary and secondary chambers are maintained.
- No excessive sound is coming from the motor or any moving part.
- No part of the unit is getting overheated abnormally.
- No undue vibrations are observed from any part of the unit.
- There is no sparking due to loose contact in the electrical circuit.
- The fuel pressure is as set and there is no variation mainly decrease in pressure due to fuel filter choking.

- **FUEL SAVING TIPS FOR INCINERATORS :**
- Higher negative draught leads to higher fuel consumption, carryover of unburnts and ash to stack. Hence, maintain slight negative draught in primary chamber.
- Minimize opening time of the furnace doors while charging and mixing to reduce excessive ingress of ambient air.
- After reaching operating temperature in primary chamber, feed the specified waste in the primary chamber through the auto feeder and check that the primary chamber temperature is being maintained by waste itself.
- Initial heating of the furnace should be done with available dry waste along with burners to reach operating temperature faster.
- Optimize the combustion air quantity by properly adjusting air dampers as explained earlier.
- Incinerator should be operated to the specified burning capacity of waste.

-
- Drain the recirculation tank after every 8 hours of operation

Maintenance*[Source : Manufacturer Themax Ltd.]*

- **ROUTINE MAINTENANCE SCHEDULE**
- **Daily or after every 8 hours of operations, whichever is earlier :**
- Clean the main combustion chamber thoroughly
- Clean charging door from inside and outside.
- Drain the recirculation tank

- Weekly or every 50 hours or operation whichever is earlier (all daily instructions Plus the following :
- Check the operation of electrical controls e.g. relays' indicating lamps, switches etc. Check for loose contacts in the electrical system and tighten if necessary.
- Clean the cyclone separator through its cleaning door.

- **Monthly or every 200 hours of operation, whichever is earlier (all daily and weekly instructions plus the following :**
- Inspect and clean the F.D. Fan and I.D. Fan.
- Inspect the connection between the burner motor and the fuel oil pump. Tighten the Allen screw if found necessary.
- Clean the burner nozzle with turpentine kerosene or compressed air but never with cotton waste or with a metallic wire or pin.
- Clean oil filter(s). Remove the filter element. Clean the element and refit it in its position. However, if it is found that cleaning of the filter every day is not necessary, it can be done once in two or three days.
- Lubricate all hinged joints of the doors.
- Lubricate all bearings with proper quality grease/oil.

Quarterly or every 600 hrs. of operation, whichever is earlier (daily weekly and monthly instructions plust the following) :

4.1Inspect refractory lining of the furnace. Repair wherever found necessary.

4.2Check and replace the door gaskets if found necessary.

4.3Check oil line for leakage's and operation. Replace/Rectify as found necessary.

. **Half yearly or every 1200 hours of operation, whichever is earlier (all daily, weekly, monthly and quarterly instruction plus the following)** :

Check the burner for fuel spray. Check the fuel oil con. Change the burner nozzle, if necessary.

6. **Year or every 2400 hours of operation, whichever is earlier (all weekly, monthly and half yearly instructions plus the following) :**
   Check the element(s) of the fuel filter and change, if necessary.
   Grease all electric motor bearings.

. Trouble Shooting Chart

OBSERVATION	POSSIBLE CAUSE	REMEDY
1. Panel does not come ON when main switch is put ON		
a) Main supply lamps L1, L2, L3 are not "ON"	Main supply not available	Correct supply, main switch and fuses
b) Main supply lamps "OFF"	Control fuse failed	Replace fuses
2. When the burner switch is "ON" the burner does not fire (flame is not established)		
i) No sparking	a) Transformer defective	Replace transformer
	b) Cracked ignition electrodes	Replace electrodes
	c) Electrodes caps defective	Replace electrodes caps
	d) H.T. cables defective	Replace HT Cables
	e) Wrong burner electrode gap adjustment	Correct it
ii) Fuel Oil Supply	a) No fuel oil in tank	Fill up oil
	b) Fuel oil inlet closed	Open the valve
	c) Fuel oil line filter choked	Clean filter. Replace if necessary
iii) Fuel pump motor	a) Direction of rotation reverse	Correct direction of rotation
iv) Burner	a) Wrong burner adjustment	Correct burner adjustment
	b) Burner nozzle choked	Clean burner nozzle

b Trouble Shooting Chart

OBSERVATION	POSSIBLE CAUSE	REMEDY
3. Fuel pump is not developing correct pressure		
i) Fuel oil service tank	No/less oil in tank	Refill tank and remove air lock if any
ii) Fuel oil inlet valve	Not/partially open	Open it
iii) Fuel oil line filter	a) Not clean	Clean it
	b) Not usable any more	Replace the element
iv) Fuel pump	a) Fuel oil not coming from air vent of fuel pump	Correct direction of rotation
	b) Direction of rotation reverse	Supply phase to be corrected
	c) Pressure adjustment tampered with	Correct pressure adjustment
	d) Fuel pump defective (gear worn out)	Replace fuel pump
4. Temperatures of furnaces not rising to the operating temp. as desired		
i) Fuel oil inlet valve	Partially open	Open the valve fully
ii) Burner fuel pressure	Pressure adjustment tampered with	Correct pressure adjustment
iii) Burner nozzle	Chocked / Not cleaned	Clean the nozzle
iv) Fuel line filter element	Fuel oil line filter choked	Clean filter. Replace if, necessary
v) Fuel solenoid valve	Jammed / chocked	Clean the solenoid coil.
vi) Temp. indicator	High / low settings tampered	Correct the temp. setting
vii) Burner combustion air	Inadequate	Adjust burner air to obtain bright and non smoky flame.

c.Trouble Shooting Chart

OBSERVATION	POSSIBLE CAUSE	REMEDY
4. Temperatures of furnaces not rising to the operating temp. as desired		
viii) Pri. & secondary chamber air	Less/Inadequate air	Adjust the chamber air so that black smoke at stack just vanishes.
ix) Charging & deashing doors	High leakage through the charging & deashing doors	Check & plug the leakage (door gaskets etc.)
x) Furnace draft	Higher negative draught	Adjust the I.D. fan inlet damper for slightly negative draught in the unit.
i) Primary burner air	Not adequate	Adjust the primary burner air for bright & non-smoky flame.
ii) Sec. burner air	Not adequate	Adjust the secondary burner air for bright & non-smoky flame.
iii) Burner nozzles	Improper atomization	➢ Clean the nozzles ➢ Tighten the swirler in the nozzle. ➢ Replace the nozzles if found necessary
iv) Burner diffuser plate	Clogged by carbon particles	Clean the diffuser plate by kerosene and adjust the fins if necessary.
v) Burner diffuser plate	Fins flattens/adequate gap	Increase the gap about 3mm adjust the fins if necessary
vi) Sec. chamber air	Inadequate air	Adjust the secondary chamber air damper.
vii) Waste quantity	Higher waste loading per charge	Regulate the waste loading as specified.

STANDARDS FOR INCINERATOR EMMISSIONS [

According to the BMW MANAGEMENT RULE 1998 Schedule -V, all incinerators should meet the following operating and emission standards.

Schedule V- Standards for Incinerators

All incinerators shall meet the following operating and emission standards:

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°C*.
4. The secondary chamber gas residence time shall be at least 1 (one) second at 1050 ± 50°C*, with minimum 3% oxygen in the stack gas.

B. Emission Standards

Parameters	**Concentration mg/Nm^3 at (12% CO_2 correction)**
1) Particulate matter	150
2) Nitrogen Oxides	450
3) HCl	50
4) Minimum stack height shall be 30 meters above ground.	
5) Volatile organic compounds in ash shall not be more than 0.01%	

Note :

- Suitable designed pollution control devices should be installed/retrofitted with the incinerator to achieve the above emission limits, if necessary.
- Waste to be incinerated shall not be chemically treated with any chlorinated disinfectants.
- Chlorinated plastics shall not be incinerated.
- Toxic metals in incineration ash shall be limited within the regulatory quantities as defined under the Hazardous Waste (Management and Handling Rules) 1989.
- Only low sulphur fuels like L.D.O/L.S.H.S./Diesel shall be used as fuel in the incinerator.

C. Standards for liquid waste

The effluent generated from the hospital should conform to the following limits

Parameters	**Permissible Limits**
PH	6.5-9.0
Suspended solids	100mg/l
Oil &grease	10 mg/l
BOD(3 days at 27^{O}C)	30 mg/l
COD	250 mg/l

COMPARISON OF TREATMENT TECHNOLOGIES

[Source: CPCB Perivesh March 1998 Vol 4]

All the treatment technologies explained above have their own advantages and disadvantages. Table 4.1 gives the relative advantages and disadvantages of the treatment technologies:

Table 4.1Comparison of Treatment Technologies for Medical Wastes

Treatment Systems	**Autoclave**	**Hydroclave**	**Microwave**	**Incinerator**	**Chemical**
Description	Steam Sterilization (Direct heating)	Steam Sterilization, (Indirect heating)	Microwave heating (pre-shredding of waste done	High temperature waste incineration	Mixing pre-ground waste with chemicals such as

		simultaneous shredding and dehydraton	in few cases)		chlorine
Sterilization Efficacy	Medium	Medium	Medium	High (total destruction of micro-organisms)	Dependent on chlorine strength and dispersment through the waste
Capital Cost	Medium	Medium	Medium	High	Moderate
Operating Cost	Low	Low	Low	High	Low
Operation / Maintenance Skills	Low skill level required	Low skill level required	Automated, but highly complex and high level maintenance skill required	High level operation and maintenance skills required	High level required for chemical control and grinder
Air Emissions	Odorous but non-toxic	Odorous but non-toxic	Odorous but non-toxic	Can be highly toxic	Some chlorine emissions
Waste Emissions	Odorous, may contain live micro-organisms	Odorous but sterile	Negligible	None	None
Treated waste characteristic	Wet waste, all material recognizable	Dehydrated, shredded waste, unrecognizable material	Wet waste (may be shredded)	Mostly ash, may contain toxic substances	Shredded wet waste, containing chemicals used as disinfectants

Chapter 5

TREATMENT OF BIOMEDICAL WASTE BY INCINERATION IN DELHI

Chapter 5

TREATMENT OF BIOMEDICAL WASTE BY INCINERATION IN DELHI

Supreme Court in 1996 directed all the

- Hospital & Private Nursing Homes with more than 50 beds to install pollution control measures.

- Recently, Ministry of Environment & Forest, Government of India had notified the rules called Bio-medical Waste (Management & Handling) Rules, 1996.
- *Hence the base line data was collected to assess the current scenario of BMW management in few of the selected hospitals and nursing homes. Details of selected hospitals and nursing homes being provided in this chapter.*

GENERAL DETAILS ABOUT VARIOUS HOSPITALS / NURSING HOMES IN DELHI [*Source : website:-http://dhs.delhi govt.nic.in]*

- In Delhi, there are more than 17000 healthcare establishments with the bed strength of more than 2500.
- Quantity of total waste generated is about 29t/day, which consists of 6.0 t/day of biomedical wastes.
- It is estimated that by the year 2010, the bed strength in Delhi will rise to 36000.
- This will give rise to total waste generated by hospital to about 33.0t/d consisting of about 9.5 t/d of biomedical wastes.

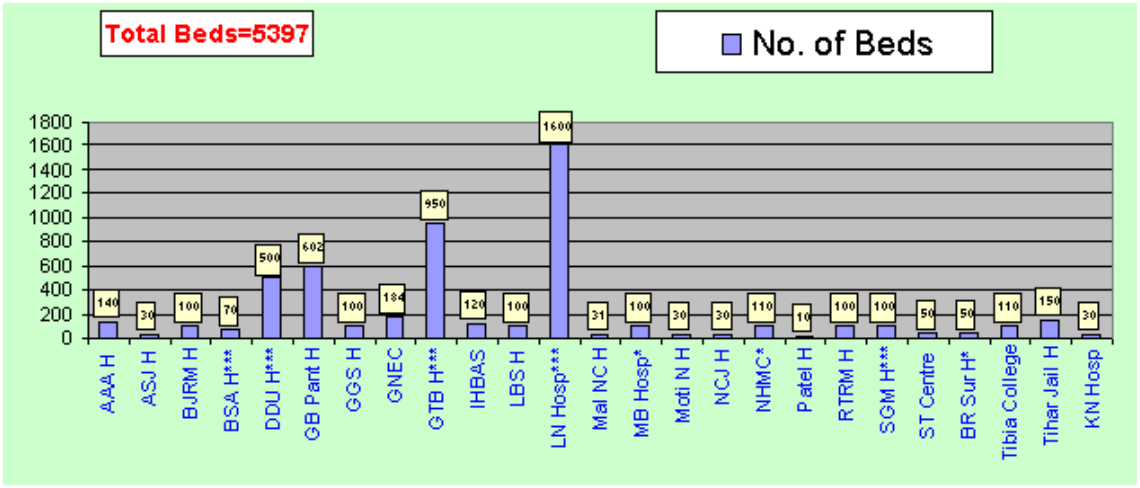
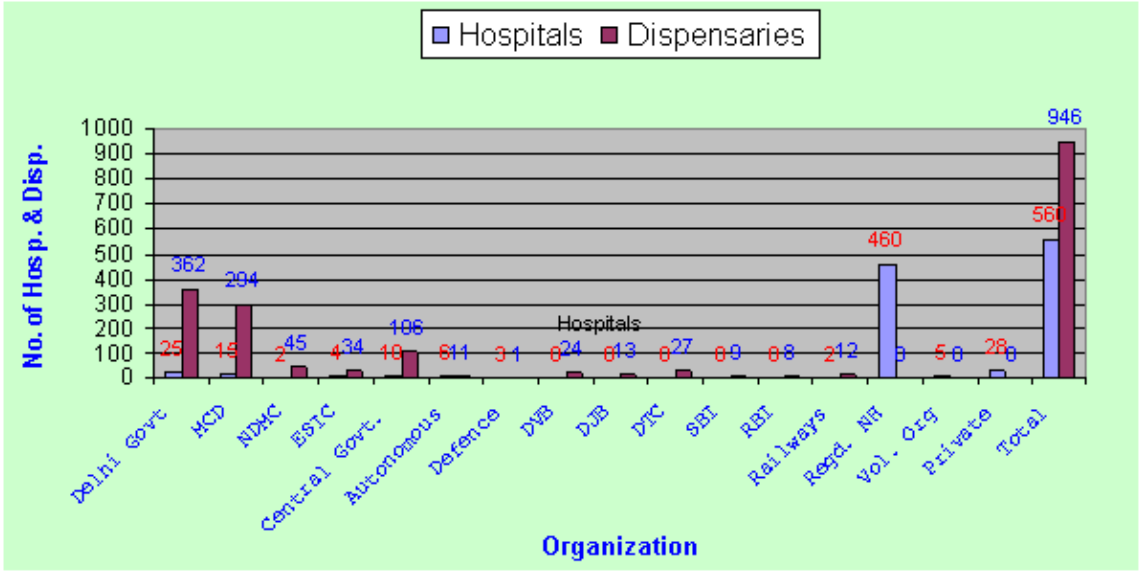


Figure 5.1: Bed strength of various major hospitals in Delhi

Network of health care institution in Delhi

There is a big network of Health Care Institutions in Delhi. Although, these are not under one banner but these can be utilized by better coordination among different organizations.

Figure 5.2: The organization-wise Institutions are as follows



These Health Care Institutions are inclusive of Allopathic, ISM and Homeopathy. The hospitals and dispensaries mainly under Delhi Government, Municipal Corporation of

Delhi, New Delhi Municipal Council, Employees State Insurance Corporation and Central Government Health Scheme require special attention.

Bed Strength In Delhi Govt. Hospitals Is As Follows (Figure5.3

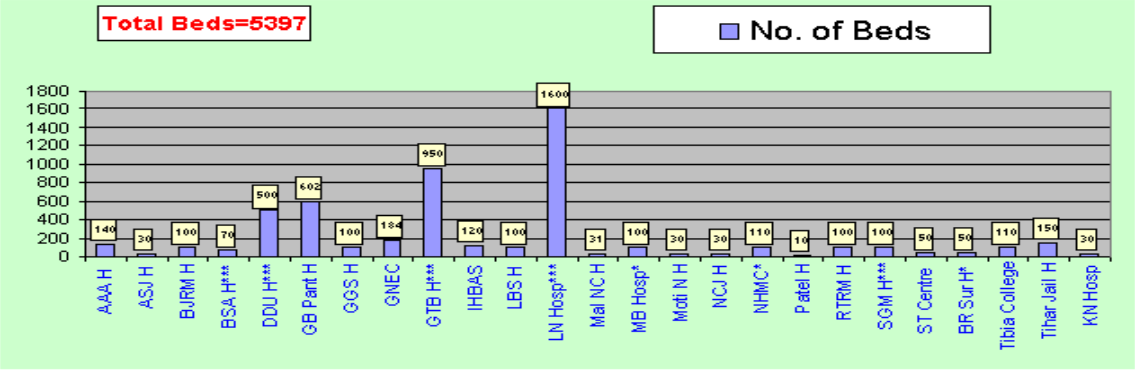
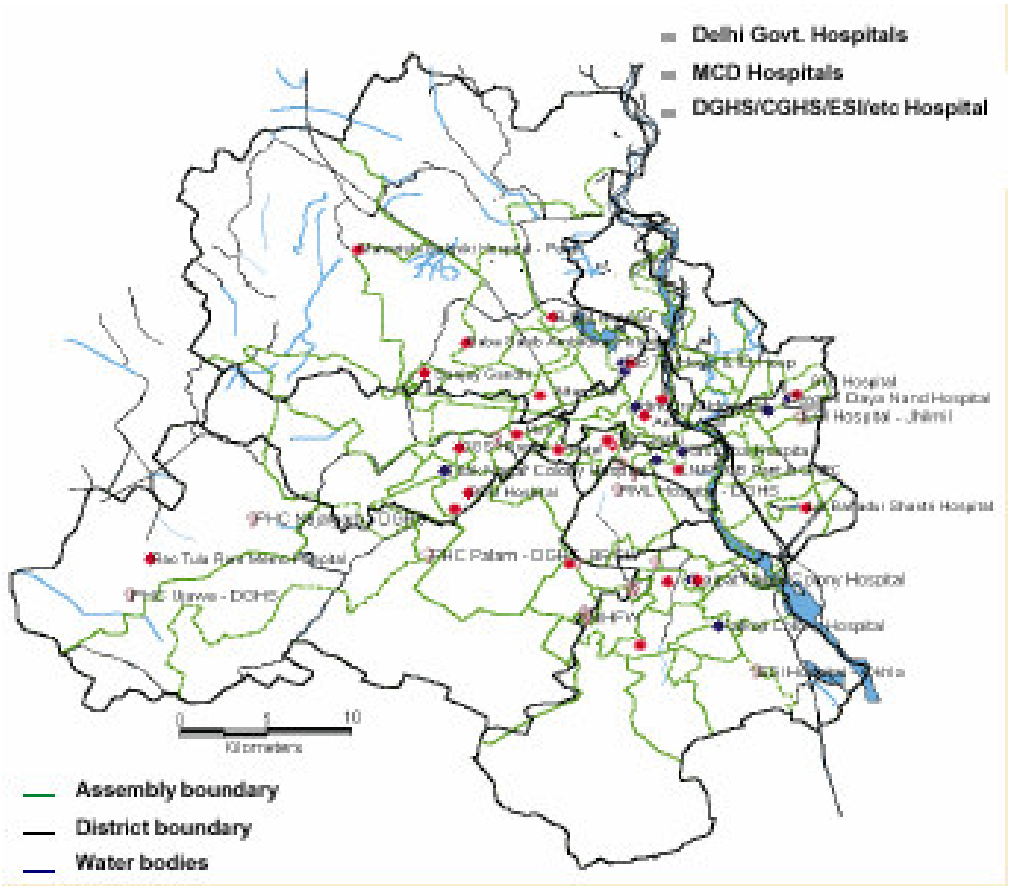
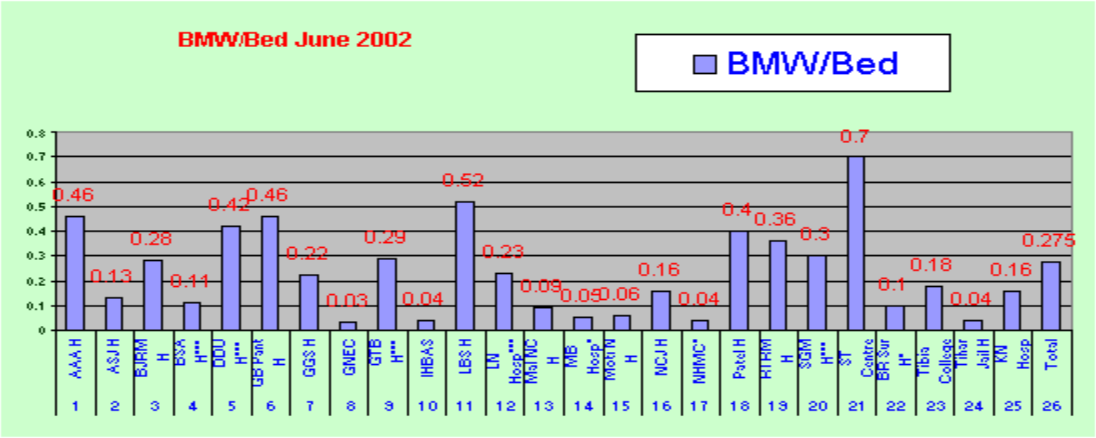


Figure 5.3: Network of Government hospitals in Delhi



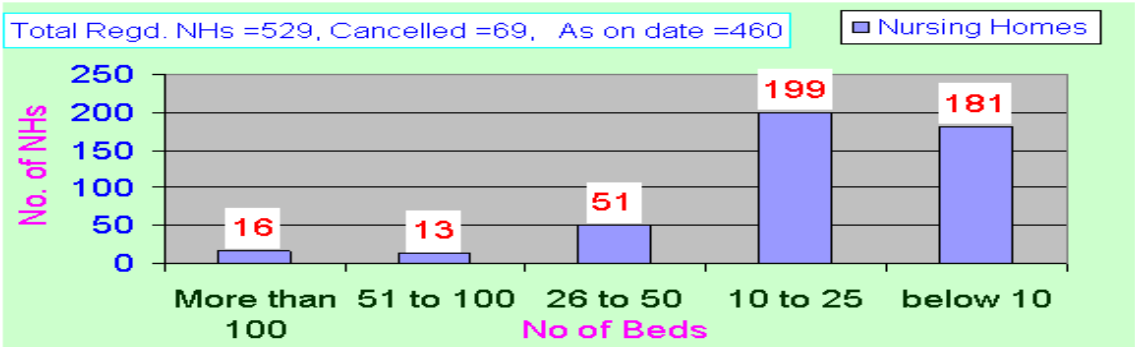
Biomedical Waste generated in Delhi Government Hospitals in June 2004(Figure 5.4)



There are 25 Hospitals under Government of Delhi, out of which 11 are under DHS. Six Hospitals are having Incinerators and 9 hospitals are having Autoclaves and Shredders for Scientific Management of Bio-Medical Waste.

During the 10th five-year plan special vehicles will be procured to monitor biomedical waste management from the hospitals under Govt. of NCT of Delhi. All hospitals under GNCT Delhi have already been requested to have separate budget head in their hospitals for Biomedical Waste Management.

5.1.1.6 The Registered Nursing Homes In Delhi Are As Follows:



- Delhi is generating approximately 6000 metric tons of waste out of which 60 tons are Biomedical Waste.

- Total no of beds in Delhi government hospitals are 5397.
- Keeping in view the difficulties faced by smaller Nursing Homes/Clinics/Blood Banks/Diagnostic Laboratories etc., Government is taking initiatives to establish centralized waste treatment facilities.

CATEGORIZATION OF HOSPITALS SELECTED FOR STUDY

Base line data was collected to assess the current scenario of BMW management in few of the selected hospitals and nursing homes. Details of selected hospitals and nursing homes studied is provided below

SELECTED HOSPITALS LABS FOR THE STUDY

Table 5.1 List Of Hospitals Selected For Study

Sl.No.	Category	Name and Address of Hospitals.
H-1	A	M.C.D. Ayurvedic Hospital,
		Ballimaran, Delhi
H-2	A	Leprosy Mission Hospital,
		Nand Nagri, Delhi
H-3	B	Rajiv Gandhi Cancer Institute and Research
		Center, Rohini, New Delhi.
H-4	B	Mrs. Girdhari Lal Maternity Hospital
		Ajmeri Gate, Delhi
H-5	C	Lala Ram Saroop Institute of Tuberculosis
		Mehrauli, Delhi
H-6	C	Indreprastha Apollo Hospital
		Sarita Vihar, Mathura Road, New Delhi
H-7	C	Batra Hospital and Medical Research Centre,
		Tughlakabad Industrial Area,
		New Delhi,
H-8	D	St. Stephens Hospital,

		Tis Hazari, Delhi
H-9	D	Guru Tegh Bahadur Hospital,
		Shahdara, Delhi
H-10	D	Sucheta Kriplani Hospital
		Panch Kuian Road, New Delhi
H-11	E	Safdarjung Hospital,
		Ring Road, New Delhi
H-12	E	Lok Nayak Hospital (Irwin)
		J.L.N. Marg, New Delhi-2

Table 5.2: Distribution Of Hospitals According To Bed Capacity

Category	Bed Capacity	No. of Hospitals	Percentage	Number Selected for study
A	Below 50	31	37.3	2
B	50 - 100	13	13.6	2
C	100 - 500	24	28.9	3
D	500 - 1000	11	13.2	3
E	1000 and above	4	7.0	2
	Total	**83**	**100**	**12**

SELECTED NURSING HOME AND PATHOLOGICAL LABS FOR THE STUDY

Table 5.3: List of nursing homes selected for study

Sl.No.	Category	Name and Address of Nursing Homes
N-1	A	D.R. Maternity and Nursing Home
		C-2/3, Ashok Vihar-II, Delhi-52
N-2	B	Delhi Nursing Home
		1-A, Ansari Road, Daryaganj, Delhi
N-3	C	Indra Deep Nursing Home
		31, Wazirpur Industrial Community Centre,
		Delhi-52
N-4	D	Orthonova Hospital
		23, LSC Madangir, New Delhi-62
N-5	E	Red Cross Society Maty. Welfare and
		Child Care Hospital
		Seema Puri, Delhi
N-6	F	National Heart Institute
		49, Community Centre, East of Kailash,
		New Delhi
N-7	G	Jaipur Golden Hospital
		2, Institutional Area, Sector-3
		Rohini, Delhi

Table 5.4: List of pathological laboratories selected for study

Sl.No.	Name and Address of Pathological Lab.
PL-1	Lal Central Clinical Laboratory
	Eskay House, 54, Hanuman Road,
	New Delhi-1
PL-2	The Clinical Laboratory
	E-30/8, Vasant Vihar,
	New Delhi-57

Table 5.5:Distribution of Nursing Homes According to Bed Capacity

Category	Bed Capacity	No. of Nursing Homes	Percentage	Number Selected for study
A	Below 10	29	18.5	1
B	10 - 20	47	29.9	1
C	20 - 30	33	21.0	1
D	30 - 40	12	7.6	1
E	40 - 50	8	5.1	1
F	50 - 100	12	7.6	1
G	100 and above	16	10.0	2
	Total	**157**	**100**	**8**

5.3 WASTE GENERATION AT THE SELECTED HOSPITALS

Table 5.6: Waste Generation in the Hospitals (Kg/Day)

S. No.	Name of the Hospitals	Total Bed capacity	Occupied bed	Total Waste (kg.)
1.	MCD Ayurvedic Hospital	40	19	No biomedical
2.	Leprosy Mission Hospital	35	20	19.75
3.	Rajiv Gandhi Cancer Institute	149	94	273.00
4.	Mrs. G.L. Maternity Hospital	97	17	23.5
5.	Indraprastha Apollo Hospital	583	372	1694
6.	Batra Hospital	310	273	824
7.	St. Stephens Hospital	555	390	875.15
8.	GTB Hospital	950	721	816.3
9.	Sucheta Kriplani Hospital	729	549	528.5
10.	Safdarjang Hospital	1550	1550	1758
11.	Lok Nayak Hospital	1600	1240	1972
12.	Lala Ram Saroop Institute of Tuberculosis	376	356	197]

1.	**Name of Hospital**	**:**	**RAJIV GANDHI CANCER INSTITUTE & RESEARCH CENTRE**
2.	Address	:	Sector-V, Rohini, Delhi
3.	Govt./Semi Govt./Private	:	Private
4.	Total Bed Capacity	:	149
5.	Major Facility Available	:	OT (6) ICU, ICW, General Ward, Kitchen
6.	Waste Disposal Facility	:	Autoclave, Incinerator (20kg/hr) Needle and Syringe cutter, covered waste storage room
7.	Date of Study	:	16.7.2004
8.	Colour/Type of Bags Used	:	Red and Black
9.	No. of Bed Occupied	:	88 and 6 operation
10.	Waste Estimation	:	
	Non Infectious (Black)	:	99.5 kg
	Infectious (Red)	:	22.5 kg
	Needle and Syringes (Red)	:	1 kg
	Kitchen Waste	:	150 kg

	Total	:	273.0 kg

H-8:

1.	**Name of Hospital**	**:**	**ST. STEPHENS HOSPITAL**
2.	Address	:	Tis Hazari, Delhi
3.	Govt./Semi Govt./Private	:	Private (Voluntary Organization)
4.	Total Bed Capacity	:	595
5.	Major Facility Available	:	Labor Room, General Ward, ICU, OT & CW, Surgical Ward, Ortho Ward.
6.	Waste Disposal Facility	:	Incinerator (50 kg/hr) Needle and Syringe destroyer Shredar, Covered Waste storage room, Autoclave
7.	Date of Study	:	6.5.2004 (24 hourly)
8.	Colour/Type of Bags Used	:	Black, Blue & Yellow
9.	No. of Bed Occupied	:	390
10.	Waste Estimation	:	
	Non Infectious (Black)	:	256.5 kg
	Infectious Waste (Yellow)	:	74.25 kg
	Syringe, Needle, Plastic bottles, Vials (Blue)	:	244.4 kg
	Kitchen Waste	:	300.0 kg
	Total	:	875.15 kg

H-9:

1.	**Name of Hospital**	**:**	**GURU TEGH BAHADUR HOSPITAL**
2.	Address	:	Shahadara, Delhi
3.	Govt./Semi Govt./Private	:	Government
4.	Total Bed Capacity	:	950
5.	Major Facility Available	:	OT, ICU, CCU, Causality, Maternity, Labor Room, Laboratory
6.	Waste Disposal Facility	:	Incinerator (150 kg/hr) Needle & Syringe destroyer Covered waste store shed MCD
7.	Date of Study	:	6.5.2004 (24 hours)
8.	Colour/Type of Bags Used	:	Black, Blue, Yellow & Red
9.	No. of Bed Occupied	:	721
10.	Waste Estimation	:	
A.	Black	:	494.2 kg
	Blue	:	134.95 kg
	Yellow	:	17.05 kg
	Red	:	131.5 kg
	Kitchen	:	38.6 kg
	Total	:	816.3 kg.

H-11:

1.	**Name of Hospital**	**:**	**SAFDARJUNG HOSPITAL**
2.	Address	:	Ring Road, New Delhi
3.	Govt./Semi Govt./Private	:	Government
4.	Total Bed Capacity	:	1550
5.	Major Facility Available	:	OTs, Burns, Maternity, Surgical, Emergency, Orthopedic, Laboratories & Wards etc.
6.	Waste Disposal Facility	:	Incinerator, Needle cutter & Syringe cutter, Auto Clave, Shredder
7.	Date of Study	:	25.5.2004
8.	No. of Bed Occupied	:	1550
9.	Waste Estimation	:	

Total Waste	:	1758 kg
Infectious Waste	:	214 kg
Cotton etc.	:	346 kg
Plastic Waste	:	118 kg
Glass	:	55 kg
Glows	:	16 kg
Syringes	:	11 kg
Rubber	:	6 kg
General Waste	:	469 + 523 = 992 kg

N-1:

1.	**Name of Hospital**	**:**	**D.R. MATERNITY HOME**
2.	Address	:	C-2/3, Ashok Vihar-II, Delhi-52
3.	Govt./Semi Govt./Private	:	Private
4.	Total Bed Capacity	:	10
5.	Major Facility Available	:	Maternity, Orthopedic
6.	Waste Disposal Facility	:	None
7.	Date of Study	:	24.4.2004
8.	Colour/Type of Bags Used	:	Red & Black
9.	No. of Bed Occupied	:	5
10.	Waste Estimation	:	
	Infectious Waste	:	2.5 kg
	Non Infectious Waste	:	1.5 kg

N-2 :

1.	**Name of Hospital**	**:**	**DELHI NURSING HOME**
2.	Address	:	1-A, Ansari Road, Darya Ganj, Delhi-92
3.	Govt./Semi Govt./Private	:	Private
4.	Total Bed Capacity	:	24
5.	Major Facility Available	:	OT
6.	Waste Disposal Facility	:	All the waste goes to MCD landfill sites.
7.	Date of Study	:	15.4.2004
8.	Colour/Type of Bags Used	:	Dust bin
9.	No. of Bed Occupied	:	15
10.	Waste Estimation	:	Total Waste 11.850 kg.

N-6:

1.	**Name of Hospital**	**:**	**NATIONAL HEART INSTITUTE**
2.	Address	:	49, Community Centre, East of Kailash, New Delhi
3.	Govt./Semi Govt./Private	:	Private
4.	Total Bed Capacity	:	79
5.	Major Facility Available	:	OT, ICU, CCU, Dressing Room
6.	Waste Disposal Facility	:	Needle & Syringe destroyer (Not working)
7.	Date of Study	:	15.6.2004 (24 hour)
8.	Colour/Type of Bags Used	:	Black
9.	No. of Bed Occupied	:	35
10.	Waste Estimation	:	
	Gloves	:	3.5 kg (500gm = 45 gloves)
	Glass bottles	:	34.0 kg
	Plastic + Tins	:	16.0 kg
	General waste	:	56.5 kg
	Kitchen waste	:	65.0 kg
	Card board box	:	4.0 kg
	Infectious Waste	:	1.25 kg

	Total	:	180.25 kg.

N-7

1.	**Name of Hospital**	**:**	**JAIPUR GOLDEN HOSPITAL**
2.	Address	:	2, Institutional Area, Sector-3, Rohini, Delhi
3.	Govt./Semi Govt./Private	:	Private
4.	Total Bed Capacity	:	204
5.	Major Facility Available	:	Special & General Wards, Labs, ICUs, CCUs, OTs, Dressing room, Maternity, Minor OTs etc.
6.	Waste Disposal Facility	:	Incinerator, Needle cutter, Syringe cutter.
7.	Date of Study	:	27.4.2004
8.	Colour/Type of Bags Used	:	Black, Green & Red
9.	No. of Bed Occupied	:	168
10.	Waste Estimation	:	
	Total Waste	:	209 kg
	Infectious Waste (Red)	:	49 kg
	Waste in Black Bag	:	174 kg
	Waste in Green Bag	:	35 kg

FINDINGS FROM BMW MANAGEMENT DATA COLLECTED FROM SELECTED HOSPITALS/NURSING HOMES

Table 5.7 :Waste Generation in the Nursing Homes (kg/day)

S. No.	Name of the Hospitals	Total Bed capacity	Occupied bed	Total Waste (kg.)
1.	D.R. Maternity	10	5	4
2.	Delhi Nursing Home	24	15	11.85
3.	Indra Deep Nursing Home	20	11	7
4.	Orthonova Hospital	28	7	12.7
5.	Red Cross Soc.Maty.Welfare	35	13	12.95
6.	National Heart Institute	79	35	180.25
7.	Jaipur Golden Hospital	204	168	258
8.	Dr. Lal Pathological Lab.	-	-	10

5.4.1 Present Status of Hospital Waste Management in the Selected Hospital

Table 5.8: Present Status of Hospital Waste Management in the Selected Hospital.

S. No.	Name of the Hospitals	Waste Management Status
1.	MCD Ayurvedic Hospital	No biomedical waste is generated.
2.	Leprosy Mission Hospital	Using Dust bin & Segregation is not being practiced and burn all the waste using kerosene oil.
3.	Rajiv Gandhi Cancer Institute	Segregation is proper and food waste is handled separately. Gloves reused after proper washing and autoclaving. Needles and syringes destroyed disinfectified (savlon) and then sent to MCD in black bags.
4.	Mrs. G.L. Maternity Hospital	No segregation and all the waste carried in Red bag to the incinerator of ID Hospital by MCD Van. No arrangement for Needles & syringes destruction and disinfections.
5.	Indraprastha Apollo Hospital	The Hospital is using excess resources for waste management but segregation is not proper in the hospital. Needles & syringes send to contractor without destroying.
6.	Batra Hospital	Hospital authority contracted private party to segregate all the waste and infectious waste goes to incinerator after segregation. Needles & syringes send to contractor without destroying.
7.	St.Stephens Hospital	Segregation is proper and all the food waste carried separately in black bags to MCD waste bin. Needles and syringes destroyed and disinfeatified in 1% hypochlorite solution before disposal.
8.	GTB Hospital	No segregation occur and almost all the waste containing food waste, water and other incinerated. Needles & syringes not destroyed but disinfectified (1% hypochlorite solution) and goes to incinerator.

9.	Sucheta Kriplani Hos.	No segregation of waste occur. Highly infectious waste including tissue, blood also carried in open trolley. No needles and syringes cutter working. Incinerator was not properly working & no temperature maintained.
10.	Safdarjang Hospital	Improper segregation systems is used. Shredder is available but not in working condition. Food waste is mixed with other hospital waste. Rag pickers are involve in picking the valuable waste from the source point. Needles & syringes goes to incinerator after destroying and disinfectifying.
11.	Lok Nayak Hospital	No segregation of waste. All the Black & Yellow bags contain mixed type of waste containing water, food waste, general waste, infectious waste. Hospital have syringe & needle destroyer, but most of the needles & syringes remained undestroyed. About 90% of waste goes to incinerator, only minor part of waste goes to MCD.
12.	Lala Ram Saroop Institute of Tuberculosis	There is no segregation followed. All waste including kitchen waste is brought at one point. Incinerator is not used regularly and waste is dump on land. Hospital is partially using 1% hypochlorite solution for disinfecting the needles & syringes.

Table 5.9: Present Status of Hospital Waste Management in the Selected Nursing Homes and Pathological Lab.

S.No.	Name of the Nursing Homes	Waste Management Status
1.	D.R. Maternity	Infectious waste buried into nearby land.
2.	Delhi Nursing Home	Segregation is not practiced, they are collecting all waste in dust bin without segregation.
3.	Indra Deep Nursing Home	Segregation not practiced & all waste goes to MCD landfill sites openly.
4.	Orthonova Hospital	Segregation is practiced.
5.	Red Cross Soc.Maty.Welfare	Needle and syringes destroyed & disinfectified in 1% hypochlorite solution and burn all biomedical waste by using kerosene oil in a tomb like incinerator and disposed ash on land.
6.	National Heart Institute	Needle & syringe destroyer not working and all the waste carried by contractor after segregation.
7.	Jaipur Golden Hospital	They are using different colour bag but segregation is not proper. Food waste is handled separately. Needles & syringes carried by contractor after destruction and disinfections.
8.	Dr.Lal Pathological Lab.	Incinerate all biomedical waste and ash disposed into NDMC Dust bin. Needless & syringes destroyed disinfectified and then disposed into NDMC waste bin.

Table 5.10 : ESTIMATION OF WASTE IN KG./BED. DAY IN HOSPITAL IN DELHI

WASTE IN Kg./bed/day

S. No.	Name of Hospital (bed occupied)	Incinerable Plastic	Incinerable Glass	Incinerable Food Infectious	Non-incinerable Total Infectious		
1.	MCD Ayurvedic Hospital (19)				No Biomedical Waste		
2.	Leprosy Mission Hospital (20)			----------> 0.28 <----------	0.70 <----------	0.98	
3.	Rajiv Gandhi Cancer Institute (94) 88+6			0.24	0.01	(1.06)	1.6
4.	Mrs. G.L. Maternity Hospital (28) 17 + 11						1.38
5.	Indraprastha Apollo Hospital (372)			0.47	0.04	2.7 <-----1.34	4.55 ---->
6.	Batra Hospital (273)			0.70	3.02	2.32 <----------	>
7.	St. Stephens Hospital (390)	0.19	0.77	1.59	---------->	0.63	<----------
8.	GTB Hospital (721)			---------->	0.18	1.13	<--------- ----------> 0.90 <---0.05
9.	Sucheta Kriplani Hospital (549)			0.04	0.008		0.96
10.	Safdarjang Hospital (1550)			0.36	0.020	1.13	----------> 0.75 <----
11.	Lok Nayak Hospital (1240)						0.86

12. <-------- ---------->		Lala Ram Saroop 0.185 <-- Institute of Tuberculosis (356)	0.55	----------> 0.37

Table 5.11: Disposal facility available in hospitals in Delhi

S. No.	Name of Hospital (Bed Capacity)	Bag used	Incinerator	Shredder	Needle & Syringe destroyer	Autoclave	MCD	Other
1.	MCD Ayurvedic Hospital (40)	Dust bin	No	No	No	No	Yes	--
2.	Leprosy Mission Hospital (35)	Dust Bin	No	No	No	No	No	Burn all the waste using kerosine oil
3.	Rajiv andhi Cancer Institute & Reserach Centre (149)	Red & Black	Yes	No	Yes	Yes	Yes	
4.	Mrs. G.L. Maternity Hospital (97)	Red	No	No	No	No	No	Send all the waste to incinerator of I.D. Hospital
5.	Indraprastha Apollo Hospital (583)	Black, Blue, Green, Red	Yes	No	Yes	Yes	Yes	All the general waste sold to contractor
6.	Batra Hospital & Medical Research Centre (310)	Black & Red	Yes	No	Yes	Yes	Yes	All the general waste sold to contractor
7.	St. Stephens Hospital (595)	Black, Blue, Yellow	Yes	Yes	Yes	Yes	Yes	
8.	GTB Hospital (775)	Black, Red, Blue, Yellow	Yes	No	Yes (normally not used)	No	Yes	--
9.	Sucheta Kriplani Hospital (729)	Black & Yellow	Yes	No	Yes	No	Yes	-
10.	Satdarjang Hospital (1550)	Red, Yellow, Blue & Black	Yes	Yes (Not working)	Yes	Yes	Yes	-
11.	Lok Nayak Hospital (1750)	Black, Yellow	Yes	No	Yes (but not used)	No	Yes	-
12.	Lala Ram Institute of Tuberculosis	Dust bin	Yes (not	No	Yes	No	No	Incinerator ash disposed in hospital

	(376)		properly working)					compound.

Table 5.12 : Incinerator details of the hospital

S.No.	Name of the Hospital	INCINERATOR							
		Manufacture	Type (Chamber)	Capacity (Kg./hr)	Model	Fuel	Temperature		Stack height (0)
							Primary	Secondary	
1.	Rajiv Gandhi Cancer Institute	Three M Envirotech (P) Ltd.	2	20	--	HSD	750	700±50	30
2.	Indraprastha Apollo Hospital	Mc Lelant Engg. Puna	2	110	--	LDO	850	1150	33
3.	Batra Hospital	Thermax	2	90	PY-200	LDO	850	1050±50	30
4.	St. Stephen Hospital	Hialtech	1	50	--	HSD	--	--	30
5.	G.T.B. Hospital	Thermax	2	150	PY-400	LDO	850	1050±50	30
6.	Safdarjang Hospital	Thermax	3	150	PY-400	LDO	--	--	30
7.	Lok Nayak Hospital	Thermax	2	--	PY-400	LDO	1000	600±100	30
8.	Lala Ram Saroop Institute of Tuberculosis	Thermax	2	180	150BPCO	LDO	800	1050±50	30
9.	Sucheta Kriplani Hospital	Thermax	2	165	--	LDO	700±50	--	30

Note :
HSD-High Speed Diesel
LDO – Light Diesel Oil

Table 5.13 Estimation of Waste In Kg./Bed. Day In Nursing Homes In Delhi waste in kg./bed/day

S. No.	Name of Hospital (bed occupied)	Plastic Glass Infect-ious	Inci-Food Infect-ious	Noninci-Total nerable
1.	D.R. Maternity (5)	0.3 <----- 0.8	---------->0.5 <---------	---------->
2.	Delhi Nursing Home (15)			0.79
3.	Indra Deep Nursning Home (11)			0.64
4.	Orthonova Hospital (7)	0.8<----- 1.84	-------> 1.04 <---------	---------->
5.	Red Cross Soc. Maty. Welfare (13)	0.76<---- 0.99	-------> 0.23 <---------	---------->
6.	National Heart Institute (35)	5.156	-------> 0.036	<--------- ---------> 3.26 <------1.86
7.	Jaipur Golden Hospital (168)	-------> 0.29 <---------	----------	------>1.24 <----------1.53

Table 5.14 : Disposal Facility Available In Nursing Homes In Delhi

S. No.	Name of Hospital (Bed Capacity)	Bag used	Incinerator	Shredder	Needle & Syringe destroyer	Autoclave	MCD	Other
1.	D.R. Matenity	Red & Black	No	No	No	No	Yes	Infectious waste burried into near by land
2.	Delhi Nursing Home (24)	Dust Bin	No	No	No	No	Yes	All waste goes to MCD landfill site
3.	Indra Deep Nursing Home (20)	--	No	No	No	No	Yes	--
4.	Orthonova Hospital (28)	--	No	No	No	No	Yes	--
5.	Red Cross Soc. Maty. Welfare (35)	Dust Bin	Yes (Kerosine oil)	No	Yes	No	Yes	--
6.	Natinoal Heart Institute (79)	Black & covered dust bin	No	No	Yes	No	Yes	--
7.	Jaipur Golden Hospital (204)	Black, Green, Red	Yes	No	Yes	No	Yes	--
8.	Dr. Lal Pathological Lab	Black & Dust Bin	Yes	No	Yes	No	Yes	--

Table 5.15 : CATEGORIES OF BIO-MEDICAL WASTE SEGREGATED IN SAFDARJANG, APOLLO & NATIONAL HEART INSTITUTE

S.No.	Name of the Hospital & Nursing Home with Bed Capacity	CATEGORIES OF BIO-MEDICAL WASTE								
		Infectious Waste (kg)	Non-Infectious Waste (kg.)							Tota Was (kg.
		Infectious Waste including every-thing produced in Hospital	Cotton Non-infectious	Plastic	Glass	Gloves Tubings & Rubber	Syringes	Kitchen Waste	General Waste	
1.	Safdarjang Hospital (1550)	214	346	118	55	22	11	--	992	175
2.	Indraprastha Apollo Hospital (585)	176	Nil	43	102	24	15	500	834	169
3.	National Heart Institute (79)	1.25	Nil	13	34	3.5	3	65	60.5	180.2

Chapter 6

EMISSION OF BIOMEDICAL WASTE INCINERATION IN DELHI

Chapter 6
EMISSION OF BIOMEDICAL WASTE INCINERATION IN DELHI

6.1 EMISSION THROUGH STACK *[Source : Emission Regulation Part 3 ,July 1996 ,CPCB]*

The earlier view on emissions of medical waste incineration have changed dramatically in the past few years. In the past the medical waste incinerators were not addressed by Regulations since they usually are small compare to the municipal waste incinerators. The only restriction on their operation in many parts of the country was that they should not create a public nuisance. This meant that they could not generate detectable adour and had to operate within prescribed opacity limits3. Chamberlain (1973) et al point out that the main potential pollutants from medical waste incineration are fly ash, dust and smoke, and both sulphur and chlorine contents of hospital waste are low and compounds of these elements which are produced do not constitute any serious potential pollution problem.

Emissions from incinerator of medical waste and their potential health impacts have become an increasing concern, especially since most of them are located in close proximity to populations. Emissions of concern include particulate matter (soot and smoke), inorganic gases (CO, NOx, HCI and Sax), organic gases (pCBs, PCDD and PCDF) and heavy metals (Hg, Cd, Pb, Cr etc). Lately emission of trace organic such as dioxin and furans and trace metals have received much attention because of their relatively high toxicity, despite the low quantities emitted.

The emission from incinerator is due to incomplete combustion of the wastes. Complete combustion can be assured by operating the incinerator at proper temperature (Above 750°C), by providing sufficient air for combustion, by providing sufficient and by inducing sufficient turbulence in the combustion chamber to mix the combustible gases and aerosols with the necessary air. In addition to all these, incinerator design characteristics such as heat recovery, modular design, combustion system (single as two stage), combustion air (excess or starved) may effect the emissions. It should also be noted that the difference in waste composition may effect emissions, this is more pronounced for metal emissions because metals originals only in the waste and are not

formed, but are only transformed during combustion.

New USEPA standard, effective from February 1995 requires that all medical waste incinerators meet a standard of Maximum Achievable Controlled Technology (MACT). In order to meet this standard it has been estimated that as many as 90% will be forced to close down, or compelled to spend as much as USD 300,000 for new pollution control equipment. Arguments have been made by the general public that as long as a dangerous substance is emitted to the air from a process, that process should be cease. To carry this philosophy to its extreme, where dioxins are concerned for instance, would require a shut down of all coal fired power plants, paper mills, all automobiles, would prohibit cigarette smoking and would prohibit forest fires, all of which generate a measurable amount of dioxins).

Harmful emissions should be decreased to safe levels. In India, Ministry of Environment and Forests include Emission standards in Notification, dated 20th July 1998 known as Bio-medical waste (management and Handling) Rules, 1998.

The New Sources Performance Standards (NSPS) were signed by the EPA Administration on 15th August 1997 and published in the Federal Register on 15the September 1997 which are effective ITom 16th March 1998. In table the standards given by Bio-medical waste *I* management and Handling Rules, 1998, USEPA and British Columbia Ministry of Environment are shown:

Table 6.1: standards given by Bio-medical waste *I* management and Handling Rules, 1998, USEPA and British Columbia Ministry of Environment are shown

Pollutant	Ministry of Environment and Forests, India (12% CO_2 correction)	British Columbia Ministry of Environment (corrected to 11% O_2 at 20^0 C)	New source performance standards USEPA (corrected to 7% O_2)	
			New small incinerators	New medium and large incinerators
Total Particulate	150 mg/Nm_3	20 mg/Nm^3	69 mg/dscm	34 mg/dscm
Carbon Monoxide	-	55 mg/Nm^3	40 ppmdv	40 ppmdv
Sulphur dioxide	-	180 mg/m^3	55 ppmdv	55 ppmdv
Nitrogen oxides (as NO_2)	450 mg/Nm^3	380 mg/m^3	250 ppmdv	250 ppmdv
Hydrogen chloride	50 mg/Nm^3	50 mg/Nm^3 (or 90% removal)	15 ppmdv (or 99% reduction)	15 ppmdv (or 99% reduction)
Hydrogen Flouride	-	4 mg/m^3	-	-
Total Hydrocarbons (as CH_4)	-	32 mg/m^3	-	-
Arsenic	-	4 μg/m^3	-	-
Cadmium	-	100 μg/m^3	0.16 mg/dscm (or 65% reduction)	0.04 mg/dscm (or 90% reduction)
Chromium	-	10 μg/m^3	-	-
Lead	-	50 μg/m^3	1.2 mg/dscm (or 70%	0.07 mg/dscm

			reduction)	(or 90% reduction)
Mercury	-	200 µg/m^3	0.55 mg/dscm (or 85% reduction)	0.55 mg/dscm (or 85% reduction)
Chlorophenols	-	1 µg/m^3	-	-
Chlorobenzenes	-	4 µg/m^3	-	-
Polycyclic Aromatic Hydrocarbons	-	5 µg/m^3	-	-
Polychlorinated Biphenyls	-	1 µg/m^3	-	-
Total PCDDs and PCDFs	-	0.5 ng/m^3 (or Toxicity Equivalent)	2.3 ng/dscm TEQ or 125 ng/dscm (total dioxin and furan)	0.6 ng/dscm TEQ or 25 ng/dscm (total dioxin and furan)
Opacity	-	5%	10%	10%

Note: mg/dscm = milligrams per dry standard cubic meter [25^0C]

Ng/dscm = nanograms per dry standard cuic meter [25^0C]

Ppmdv = parts per million by dry volume

TEQ = Toxic equivalent quantity of 2, 3, 7, 8, - TCDD using international toxic equivalency factors.

6.2 MONITORING RESULTS OF INCINERATORS AT VARIOUS DELHI HOSPITALS *[Source : DPCC]*

There are around 615 no. of hospitals *I* nursing homes in Delhi on the basis of those registered with Directorate of Health Services. Out of these medical facilities, only some of them have installed incinerator. The exact number of incinerators are not known. According to the Central Pollution Control Board record, there are more than 25

incinerators, but from the recent survey carried out by Shrishti, NGO, the number exceed 45.

The fourth Shrishti survey reported that most of the incinerators are operating at temperature lower than the required temperature i.e. 800 +- 50°C for primary chamber and 1050 +-:50 ^{o}C for secondary chamber. Burning of plastics in the incinerators is a problem that still persists. In some of the hospitals nearly all the plastics is being incinerated.

The tests were carried out by some authorized laboratory on contract basis. The test results showed that the emissions of all the hospital waste incinerators were below the permissible limit. The emissions test result collected from DPCC are shown in Table 6.2.

Table 6.2 : Monitoring results of incinerators *[Source : DPCC]*

S.No.	Name of Hospital	SPM	SO2	NOX	HCl	CE
1	All India institure of medical science Ansari Road , New Delhi	1011*	131	98$^{\Phi}$	n.d	99.9
2	Moolchand Kairati Lal Hospital lajpat nagar –III, New Delhi	664*	139	96$^{\Phi}$	nd	98.3
3	VIMHANS,1,Institutional Area, Nehru Nager , New Delhi	686*	27	58$^{\Phi}$	nd	99.5
4	BatrraReserach Cene and Hospital,1,Institiutional Area , Mahrauli Badapur Road, Delhi	126	83	79$^{\Phi}$	nd	96.2
5	Majidia Hospital, Jamia <delhi	369*	69	83$^{\Phi}$	nd	99.5
6	Holy family , Okhla Road, New Delhi	57	60	102$^{\Phi}$	nd	99.6
7	Indrapastha Medical Corp.Ltd. Sarita Vihar < Mahatama Road < Delhi	181*	79	88$^{\Phi}$	nd	99.0
8	Lala Ram Swarop ,T.B. Hospital	324*	91	144$^{\Phi}$	nd	99.6
9	Research and Reffral Hospital, Delhi Cant =-10	325*	96	14$^{\Phi}$	nd	99.7
10	ESI Hospital	252*	5	88$^{\Phi}$	nd	99.7

11	DDU Hospital	815*	120	135^{Φ}	nd	99.6
12	Rao Tula Ram Hospital , Delhi-13	172*	53	90^{Φ}	nd	9.5
13	Safdarjang Hospital	288*	107	91.4^{Φ}	nd	99.8
14	St. Stefen Hospital	202*	80	106^{Φ}	nd	99.8
15	RajanBabu T.B. Hospital	772*	137	86^{Φ}	nd	99.6
16	Maharishi valmiki Hospital	502*	144	106^{Φ}	n.d	93.0
17	Hindu Rao Hospital	203*	39	56^{Φ}	nd	98.4
18	Swami Dayananad Hospital	200*	39	66^{Φ}	nd	97.5
19	Ganga ram Hospital	362*	61	76^{Φ}	nd	99.5
20	L.NJP Hospital	252*	88	96^{Φ}	Nd	99.8
21	Lal Bahadur Hospital	592*	71	86^{Φ}	Nd	99
22	ESI Hospital	171*	60	86^{Φ}	Nd	99.7
23	Dr. RML	237*	80	96^{Φ}	Nd	99.8
24	Safdarganj Hospital	219*	95	83^{Φ}	Nd	98.4
25	Sir Ganga Ram Hospital	546*	110	88^{Φ}	Nd	99.0

Note: Φ mark indicates that value of parameter is within the limits

∗Mark indicate that the value of parameter is not within the limits

Standard for

SPM 150mg/nm^3

SO_2 No standards

NO_x 450mg/nm^3

HCl 50

CE 99%

Parameter concentration measured in mg/nm^3 at (12 % CO_2 correction)

6.3CONSTITUENTS OF EMISSIONS AND THEIR HAZARDS *[Source : CPCB Emission Regulation part 3 July 1996]*

(i) Particulate Matter: The amount of particulate emission is a function of the waste characteristics, combustion chamber design, grate type, burning rate, incinerator design and under fire air rate. Particulate emission cause visibility reductions and also health effects as metals are generally absorbed in particulate matter.

Particulate matter is measured in microns where 10 microns are visible as dust on a table. The particle size range from fractions of micrometer to over 50 microsz4. Particles smaller than 10 J.1ID (10 x lO-6m) are critical because they can be inhaled

deeply into the being.

(ii) Carbon Monoxide: Carbon monoxide is produced when oxygen provided is insufficient for complete combustion. It is, therefore, an indication of combustion efficiency. Carbon monoxide reacts with hemoglobin in the bloodstream to form carboxyhomoglobin, which cause lack of oxygen. This lack of oxygen can cause headaches, nausea and even death at extremely high concentrations. At 1000 ppm it may be fatae.

(iii) Nitrogen Oxides: The amount of nitrogen oxides (NOx) generated is a function of temperature, excess air, refuse composition etc. The greater the amount of nitrogen and the higher quantities of NO x would be expected. Nitrogen is an extremely active substance forming a wide variety of compounds with oxygen such as nitrous oxide (NzO), nitric oxide (NO), dinitrogen trioxide (N203), nitrogen dioxide (N02), and nitrogen pentoxide _207). Among all these compounds, nitrogen dioxide is the most significant air pollutant. Nitrogen oxides are precursors to the formation of ozone (03) and peroxyacetal nitrate (PAN), the photochemical oxidants known as smog. Nitrogen oxides also contribute to the formation of nitrate aerosols, which can cause acid fog and acid rain.

(iv) Sulfur oxides: Sulfur can present in wastes and fossil fuels and after burning released to atmosphere in the form of sulfur oxide mostly S03 and S02. Sulfur dioxide are oxidized to S03 and form H2SO4 which are acidic in nature. Sulfur oxides have gross atmospheric effects such as plant damage, and can result in eye irritation and respiratory diseases such as emphysema and bronchitis.

(v) Hydrogen Chloride: Polyvinyl chloride (PVC) and other halogenated polymer and copolymer make up a significant fraction of plastics in hospital waste. Halogenated organics when burned completely will usually generate hydrochloric acid (HCI) and / or chlorine (Ch) acid gases depending on combustion conditions. Hydrochloric acid (HCI) emissions can corrode metals, irritate the eyes, nose and throat and can contribute to acid rain problems.

(vi) Heavy metals: Heavy metal emission originate only in the waste. These are not formed but are only transformed during combustion. These compounds are mostly bound to particles. However, gaseous emission also occur, mainly mercury, which is

especially difficult to eliminate. Mercury unlike other heavy metals, are released completely into the off-gas due to its high volatility. Mercury causes blindness, muscle deterioration, birth deformations, and death. Arsenic is carcinogenic and can cause respiratory irritant, Cadmium also is a carcinogen, and cause cardiovascular disease and is extremely toxic to aquatic life. Chromium is generated in the hexavalent state with excess air operation, and in the trivalent state in a reducing atmosphere. Trivalent chromium has not been found to be a significant danger to life while hexavalent chromium is carcinogenic, causes respiratory disease, and is skin irritant.

(vii) Organic compounds: Different chlorinated organic micropollutants (OMPs) such as chlorinated dibenzo-p-dioxin (DCDD) and chlorinated dibenzofurans (CDFs) , chlorinated biphenyls (CBs), chlorinated benzenes (CBzs) and chlorinated phenols (CPhs) are formed during hospital waste incineration. They can be formed either through primary. Formation at high temperature (> 650°C) or through secondary formation at a lower temperature range (650-200°C). Studies have shown than secondary formation is very important. .

6.4 DISCUSSION

Hospitals investigated for stack emissions are not achieving the standard parameters of latest CPCB norms. It can be achieved by modernizing treatment facilities by installing air pollution control equipments like high-pressure venturi scrubbers to remove particulate matter and acidic pollutants present in the flue gas generated during the incineration , cyclones with educator system as per CPCB norms.

The flue gas then enters tangentially into the droplet seperator, which is cyclonic type.

Hence by the action of centrifugal force the large droplet present in the gas were removed.

Educator system drop the flue gas temperature coming out from the secondary chamber from 1000 ^{O}C to 300 ^{0} C.

Chapter 7

ECONOMIC EVALUATION FOR TREATMENT FACILITIES

Chapter 7

ECONOMIC EVALUATION FOR TREATMENT FACILITIES

The study on cost related to hospital waste treatment was carried out by taking into account of all major factor involved in management process. In order to have the complete assessment of the cost incurred in treatment hospitals, hospitals selected were having all types of disposal treatment facilities. Three hospital namely, St. Stephens Hospital, Rajiv Gandhi Cancer Institute, safdarjung hospital were selected were of different bed capacities of 595, 149, 1550 with incinerator capacity of 50kg/hr, 20 kg/hr and 150 kg/hr respectively. All elements were studied thoroughly involving in infrastructure set up and operation & maintenance. The capital recovery was analyzed further by using the recyclable cost to reduce the disposal costs of hospital waste.

7.1 TOTAL COSTS OF A WASTE MANAGEMENT SYSTEM

[Source: G. D. Ulrich, A guide to chemical engineering process design and economics, Wiley, New York, 1984]

Total cost of waste management involves following factors

- Initial capital investment.(Land and Building)
- Salvage value over the effective life of plant and equipment.
- Operating and maintenance.
- Contractual and overhead costs.

7.2 COST ESTIMATION

7.2.1 It is mandatory to establish accounting procedures to document the costs incur in managing bio-medical waste in all the hospital because hospital waste treatment involve high cost of treatment. In India, most of the hospitals are having common budget line including the treatment cost of waste. Since it is highly cost effective issue, a designated individual / department must undertake accurate record

keeping and cost analysis. So Biomedical waste treatment costs should be subject of as separate budget line; this allows costs for different periods to be compared and helps to reduce management costs.

7.2.2 The elements that should be included in the cost assessment for in for bio-medical waste management system are studied in two groups, which are as follows:

A. Cost of setting up infrastructure to treat the hospital waste.

B. Cost of operation and maintenance (running cost).

7.3 COST OF SETTING UP INFRASTRUCTURE TO TREAT THE HOSPITAL WASTE

Elements that should be included are as follows:

7.3.1 Site

- Area of land.
- Cost of land.

7.3.2. Consultancy fees

- Environmental/waste management consultant
- Engineering, architectural
- Legal fees (if any)

7.3.3. Construction costs

- Right of way
- Incinerator / Autoclave / Shredder building
- Waste storage room
- Office.
- Utilities (plumbing and electrical works).

7.3.4. Cost of treatment technologies

- Cost of incinerator/ autoclave/ shredder/ needle destroyer.

7.3.5. Equipments costs

- Trolleys for collecting waste bags form wards to the treatment site.
- Bag holders / Bins / Containers
- Weighing machines for weighing waste bags
- Refrigerators for storage of waste if necessary

The above elements were studied in detail in coordination with the hospital personnel of three Hospitals. The Hospitals were having their own on-site treatment facilities. Basic input for calculations was drawn from various Govt. /private consultants specifications, which have been provided as Appendices at the end of report.

7.4 ANALYSIS OF COSTS

II. St. Stephens Hospital

7.4.1 SITE

A. Area of Land.

a) Plan Area (say 12.5m length and 6 m wide)+ 18 X 3 = 130 m^2

Calculated on the basis of layout plan drawing [*Refer Annexure 1]*

i) For incinerator Room	=	108.0m^2
ii) Waste storage Room	=	6 m^2
iii) Operator Room	=	6 m^2
c). For autoclave	=	10.0 m^2
d). For shredder	=	8.0 m^2
e). Office	=	12.0 m^2
f). Waste storage dept	=	150.0 m^2
Total Area	=	310 m^2

B. Cost of land

The cost of land is taken as Rs. 3000 per square meter from the commercial land rates of Delhi Development authority, which is an

average in urban areas. At some places the cost may go high or low as per the location of hospital in a city

310.0 m^2. @ Rs. 3500 / m^2. = Rs. 1085000 or Rs. 10.85 1ac.

7.4.2 Construction costs

- **Plan Area**

Plan Area (say 12.5m length and 6 m wide)+ 18 X 3 =130 m^2

Lean concrete l: 5: 10 (1 cement, 5 coarse sand, 10 stone aggregate of 25mm size), 150mm thick.

130 m^2x.15 = 19.5 m^3 @ Rs. 1200/ m^3 = Rs. 23400/-

Cement concrete l : 2 : 4 (1 cement, 2 coarse sand, 4 stone aggregate of 15 mm size), 150mm thick.

130 m^2 x 0.15m = 19.5 m^3 @ Rs. 1850 / m^3 = Rs. 36075.00

Total cost of Plan Area: 23400 + 36075 = Rs. 59475.00 or Rs. 457.51/ m^2

- **Incinerator / Autoclave / Shredder office building**

  Total covered area: 130 + 10 + 8 + 12= 160 m^2 @ 5340 Rs. / m^2 = Rs. 854475.00

  [Refer Annexure 2]

- **Waste storage depot**

  Usually this area left open where sealed bags of waste are placed. This area needs only cement concrete floor.

  Area of waste storage depot = 130 m^2 x Rs. 457.5/m^2 =Rs. 59475.0

  TOTAL COST OF CONSTRUCTION:

  59475 + 460000 + 95000 + 15000+70000+10000 +145000 = Rs 854475

  Or Rs. 8.54 lac.

7.4.3 Consultancy fees

- **Environmental / waste management consultant**
- **Engineering, architectural**
- **Legal fees (if any)**

Environmental / waste management consultant & engineering, an architectural cost is taken % of the cost of construction of building i.e 8.54 lac

5 % x8.54 lac = Rs. 42700.00 or Rs.0.427 lac.

7.4.4 Cost of treatment technologies

1. Cost of incinerator with capacity of 50 kg / hr can cost approximately (including the cost of 30 mts chimney, droplet seperator, ID Fan, recirculation system, and pumps, tanks and pipelines)= Rs.1000000.00 or Rs. 10 lac. *[Refer Annexure 3]*

2. a. Cost of Automatic weight feeding device =2 lacs
   b. Temper proof PLC control system =95, 000
   c. 3mm thick natural hard rubber lining inside chimney stack as per CPCB Norms =105000

3. Cost of autoclave (manual) = Rs. 205000.00 or Rs. 2.05lac.

   (Source: Manufacturer Thermax Limited)

4. Cost of shredder (manual) = Rs. 45000.00 or Rs. 0.45 lac.

5. Cost of needle destroyer: needle destroyer comes in manual and electrically operated cost of manual needle destroyer = Rs. 350.0 each

   Cost of 35 No. Manual needle destroyer = 35 x 350 = Rs. 12250 or 0.122 lac

   Cost of electrically operated needle destroyer = Rs. 3500.00 each

   Cost of 35 No. Electrically operated needle destroyer=35 x 3500

   = Rs. 1.22500 or 1.22 lac

   <u>TOTAL COST</u>:

   15.85+ 2.05+. 45+0.1225+ 1.225 = Rs. 19.6975 lac (Approx. 20 lac)

7.4.5. Equipment Cost

1.	Trolley	1 No.	=	Rs. 3000/-
		10 No.	=	Rs. 30000/-
2.	Weighting Machine	1 No.	=	5000/- (Manual)

3. Bag holders / Bins / Containers

100 litres 60 No. @ Rs. 350 each	=	Rs.21000.00
60 litres 60 No. @ Rs. 250 each	=	Rs.15000.00
10 litres 700 No. @ Rs. 50 each	=	Rs.35000.00

Total	=	Rs. 71000.00or Rs. 0.71 lac

Table 7.1: Total cost of setting up infrastructure to treat the hospital waste at St. Stephens Hospital

Item No.	Elements	Total Cost (in lac)
1.	Site (cost of land)	Rs. 10.85
2.	Consultancy fee	Rs. 0.427
3.	Construction cost	Rs. 8.54
4.	Cost of treatment technologies	Rs. 20.00
5.	Equipment Cost	Rs. 0.71
Total cost of setting up infrastructure to treat hospital waste (595 beds)		Rs. 40.527

In the above estimation, autoclave and shredder are manually operated. In India automatic autoclave with loading of 100 kg / hour cost Rs. 25 lac and shredder cost Rs. 4 lac. Therefore, cost of infrastructure including automatic autoclave and shredder excluding the manual ones comes to Rs. 69.527 lac.

7.5 COST OF OPERATION AND MAINTENANCE (O & M)

- O & M of treatment technologies: Incinerator, Autoclave, Shredder, Needle destroyer
- Equipment Cost : Trolley, Weighing machine, bag holder / bins / container
- Poly bags for collection of waste
- Yellow bag with tags for infectious waste
- Blue bag for non-infectious waste

- Black bags for general waste
- Chemical (for disinfecting)

7.5.1 Analysis of cost of O & M

1. O & M of treatment technologies

- Operation and maintenance cost of incinerator:

Fuel consumption	=	Rs. 46500 / month
Electricity charges	=	Rs. 2000 / month
Constructor + Operator	=	Rs. 8000 / month
Maintenance charges	=	Rs. 3000 / month
Total	=	Rs. 59500 /month

- Operation and maintenance cost of Autoclave cost (manual)

Electricity consumption for 6 hour/day

18 kw load/hour	=	Rs 2100/ month
Water consumption	=	Rs. 800/ month
Operator	=	Rs. 4500/ month
Maintenance & others	=	Rs. 150 / month
Total		= Rs. 7550/ month

- Operation and maintenance of shredder (manual)

Electricity consumption for

4hour/day; 1kw load/hour	=	Rs. 720/ month
Operator	=	Rs. 2500/ month
Others	=	Rs.100/ month
Total	=	Rs. 3320/ month

- Operation and maintenance of needle destroyer cannot be obtained from the hospital. For theoretical calculation [35 no. (Manual); 35 no. (Electrical) needle destroyer]

  It is taken as Rs. 3300/ month or Rs. 110/ day

<u>TOTAL COST OF O & M OF TREATMENT TECHNOLOGIES</u> =

RS. 73370 / MONTH OR RS. 2445 / DAY SAY 2445 / DAY

7.6 EQUIPMENT COST

- Trolley, Weighing machine, bag holder / bins / container

Trolley (20 no.)	=	Rs. 600 / month or Rs. 20 / day
Weighing machine	=	Nil
Bag holder / bins / container	=	Rs. 2400 / month or Rs. 80 / day

- **Total cost of O & M of equipment = 3000 / month or Rs. 100 / day**

7.7 POLY BAGS FOR COLLECTION OF WASTE

Yellow bag with tags for infectious waste
(Average daily consumption 400 no. / day)= 400 no.x 3.0 Rs. / bag = Rs. 1200 / day

Blue bag (average daily consumption
160 no. / day) = 160 no. x 5.0 Rs. / bag = Rs. 800.0 / day

Black bag (average daily
Consumption 1100 / day) = 1100 no. x 2.0 Rs. / bag = Rs. 2200 / day

- **Total cost of poly bags = Rs. 4200 / day**

7.8 CHEMICAL (FOR DISINFECTING)

NaOCl (sodium hypochloride solution for disinfecting) consumption: 605 liters consumption per month @ 41.14 Rs. / litres

605 x 41.14 = 24889.7 / month

or Rs. 829.65 / day say 830 Rs. / day

Table 7.2: Cost of operation and maintenance (running cost)

S. No.	Items	Total cost Rs. / Day
1.	O & M of treatment technologies: Incinerator, Autoclave, Shredder, Needle destroyer.	2445
2.	Equipment Cost: Trolley, Weighing machine, bag holder / bins / container	110
3.	Poly bags for collection of waste: Yellow bag with tags for infectious waste, Blue bag, Black bag for general waste.	4200
4.	Chemicals (for disinfecting)	830
Total cost of O & M	**=**	**7585 Rs. Day**

For a 595 beds hospital treating 2kg of waste / bed / day

Cost of treatment / bed per day = Rs. 13.67 per bed per day

or per kg. Rs 6.83 / kg / day.

The above value is much low if it is compared with other countries for example in European Union it US $ 1- 3 per bed per day (Source: WHO (1994)].

or Rs.49 -147 per bed per day

Several elements like, training, monitoring of flue-gas emissions, ash disposal cost and management and administrative costs are not studied in this assessment.

Actual recyclables values from table 7.7 for St. Stephens's hospital is Rs. 4225.35/ day, which is used to calculate capital recovery of Rs. 69.52 lacs that is calculate cost of the infrastructure .

Table 7.3: Generation of Waste in Kg/Day in Different Color Code Bags At St Stephens Hospital when 390 beds occupied

Type of Waste	Daily generation (kg/day)			Percentage
	Minimum.	Maximum.	Average.	
Infectious waste(Yellow)	50	98.5	74.25	8.4%
Non- infectious waste(blue)	195	318	256.50	29.30%
General waste(Black)	490	623	556.50	63.5%
Total waste:			875.15 kg/day	

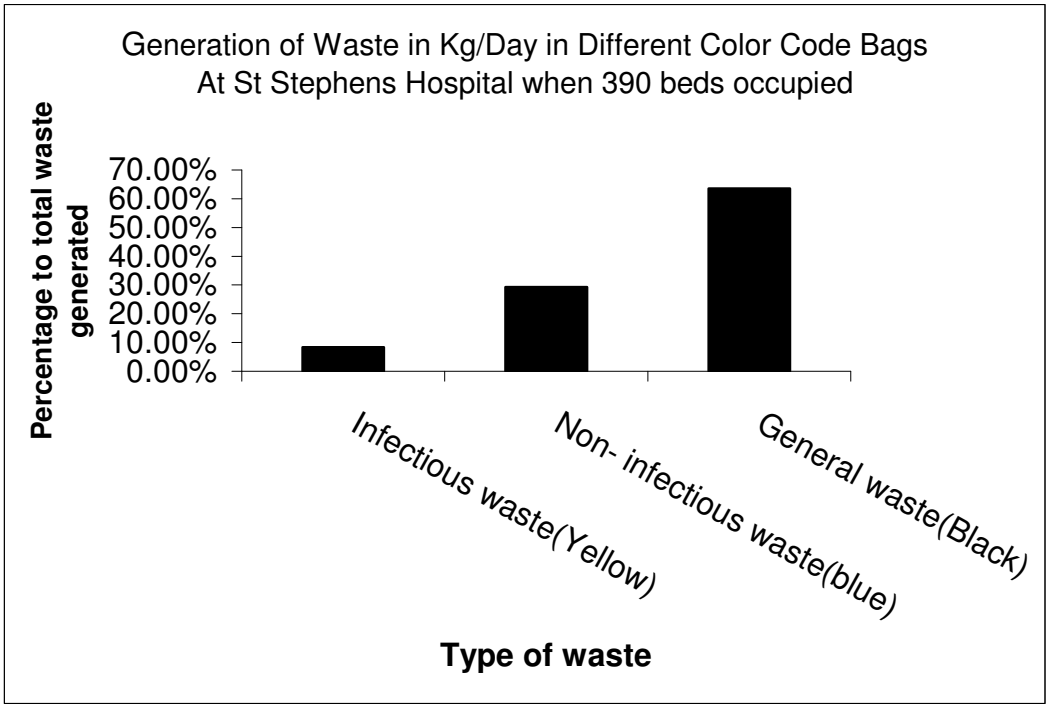


Table 7.4 Components of hospital waste with product type of St. Stephens Hospital

S.No.	Description		Weight (kg/d)	Recycle Value (Rs./kg.)	Total Value (Rs.)
	Component	Product Type			
General waste	Paper	Towel papers, newspapers, office papers, etc.	23.85	2.0	47.7
General waste	Cardboard	Packing etc.	21.10	3.50	73.5
Non-Infectious waste	Glass	a. White bottle (blue bags) b. Colored bottled (blue bags)	321 51	2.0 1.754	642 89.25
General	Plastics	a) Color PP	12	13	156

waste					
Non-Infectio		b) Needle Cap(blue bags)	1.5	19	28.5
Non-Infectious waste		c) Tubes (blue bags)	10	13	130
General waste		d) LDP	7	25	175
General waste		e) PP	0	23	0
General waste		f) Crystal Type	9.0	19	171
Non-infectious		g) Gloves(blue bag)	21	8	168
Non-infectious		h) HDP syringe part (blue bags)	8	21	168
General waste		i) Micro Pipette	7	16	112
General waste		j) Containers	5	14	70
General waste		k) Black Bag	23.0	4	92
Non-infectious		l) Blue Bags	20.0	4	80
General		m) Mix Black / Blue Bags	48	1.5	72

waste					
Non-infectious		n) Syringe Cut Part (blue bags)	2.5	17	42.50
General waste		o) Cups / Glasses	11	9	99
General waste		p) Water Bottles	24.0	4	96
General waste		q) Electricity Items	5.0	10	50
Non-infectious		r) Blood /Urine Bags(blue bags)	7.6	4	30.40
General waste		s) Mix Plastics	15.0	3	45
Non-infectious	Metals	a) Needle, Sharp, etc.(blue bag)	4		
General waste		b) Aluminum Foil	0	22	0
General waste		c) Metal Cans / Container	16	3	48
General waste	Textile	Laundries, etc.	19	.4	7.5
General waste		a) Wards, Kitchen, Canteen etc.	300		
Infectious waste		Bandages, Moist clothe, Plastics, Cotton, Paper,	113.7	13.5	1525.50

		Human Anatomical Waste, Glass, etc.			
	Ash	Residue	8	.75	6.0
Total value from recyclable in rupees per day from 595 bed hospital					**4225.35**

Let

A = Cost from the recyclable in a year i.e. 4225.35 x 365 = Rs. 15.42lac / year

P = Initial cost of setting up infrastructure = Rs. 69.52 lac.

n = no. of years.

i = Rate of interest in this case take 8%

From Engineering Economics by Leyland T. Blank page 48 expressions [2.6]

$P = A [(1 + i)^n – 1 /i (1 + i)^n]$ ……[1]

$69.52 = 15.42 [(1 + 0.08)^n – 1/0.08 (1 + 0.08)^n)$

n = 5.89

say = n = 6 years.

Similarly for Safdarjang Hospital (refer Table 7.5 and 7.6) and Rajiv Gandhi hospital (refer Table 7.7 and 7.8) cost of recyclable waste in a year were calculated as done for St. Stephen's Hospital.

Values of A=Cost from the recyclable in a year Safdar jang Hospital is 9397.54 x 365 = Rs. 34.30 lacs / year

Values of A=Cost from the recyclable in a year Rajiv Gandi Hospital is 1795.5x 365 = Rs. 6.55 lac / year

Calculated cost of infrastructure (=P) was 89.0 lacs and 60.0 lacs for Safdarjang and Rajeev Gandhi respectively (Refer Annexure 1,2,3)

Substituting A and P values for respective hospitals in formula NO. 1

Values of n= No. of years required for recovering infrastructure cost

Safdarjang hospital: **n=3 years**

Rajeev Gandhi hospital: **n= 29 years**

Table 7.5: Generation of Waste in Kg/Day in Different Color Code Bags At Safdarjung Hospital when 1550 beds occupied

Type of Waste	Daily generation (kg/day)			Percentage
	Minimum.	Maximum.	Average.	
Infectious waste(Yellow)	180	248	214	12 %
Non- infectious waste(blue)	485	619	552	31%
General waste(Black)	780	1204	992	56%
Total waste:	1758 kg/day			

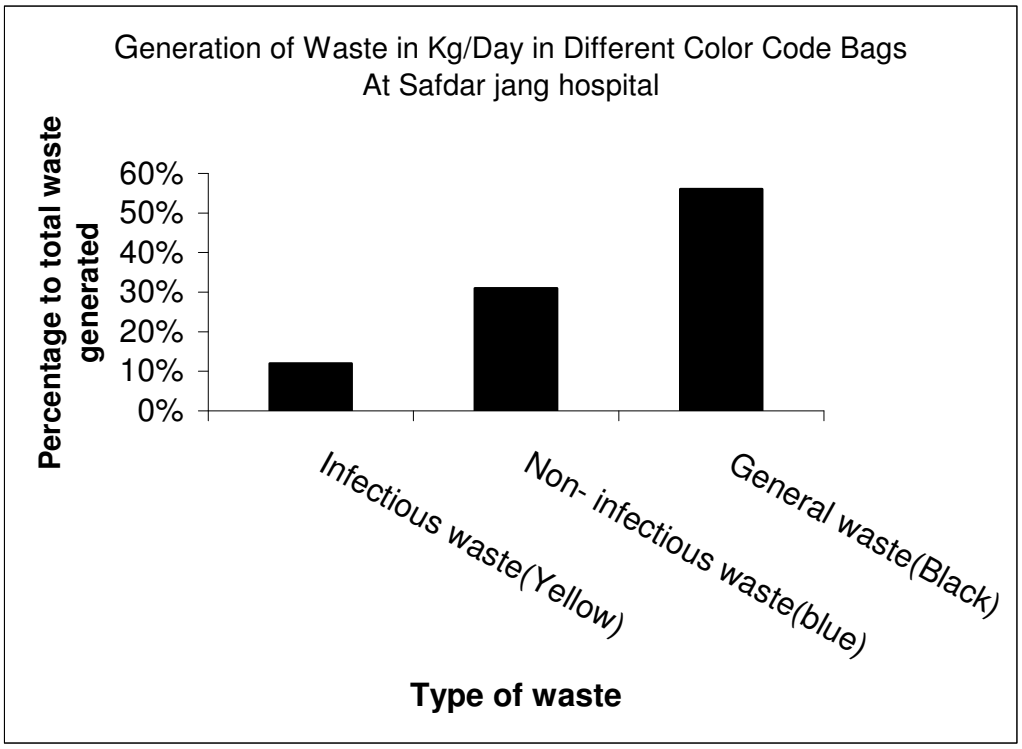


Table 7.6 Components of hospital waste with product type of SJH

	Description		Weight (kg/d)	Recycle Value (Rs./kg.)	Total Value (Rs.)
	Component	Product type			
General waste.	Paper	Towel papers, newspapers, office papers, etc.	125	2.0	250
2.	Cardboard	Packing etc.	96	3.50	336
3.	Glass	a. White bottle b. Colored bottled	250 42.5	2.0 1.754	500 74.54
4.	Plastics	a) Color PP	45	13	585
		b) Needle Cap	1.5	19	28.5
		c) Tubes	42	13	546
		d) LDP	26	25	650
		e) PP	1.50	23	34.5
		f) Crystal Type	0.5	19	9.5
		g) Gloves	27	8	216
		h) HDP syringe part	5.0	21	105
		i) Micro Pipette	0.5	16	16.0
		j) Containers	0.5	14	7.0
		k) Black Bag	3.0	4	12
		l) Blue Bags	38.0	4	152

		m) Mix Black / Blue Bags	39.0	1.5	58.5
		n) Syringe Cut Part	1.5	17	25.5
		o) Cups / Glasses	15	9	135
		p) Water Bottles	2.0	4	8
		q) Electricity Items	2.5	10	25
		r) Blood /Urine Bags	4.0	4	16
		s) Mix Plastics	14.50	3	43.5
	Metals	a) Needle, Sharp, etc.	3		
		b) Aluminum Foil	19.2	22	418
		c) Metal Cans / Container	40	3	120
	Textile	Laundries, etc.	1	.4	0.4
	General Waste	a) Wards, Kitchen, Canteen etc.	503		
		b) Garden Trimming, Sweeping, etc.	25	46	1150
	Infectious Waste	Bandages, Moist clothe, Plastics, Cotton, Paper,	214	13.5	2889

		Human Anatomical Waste, Glass, etc.			
	Ash	Residue	64	.75	48
Total value from recyclable in rupees per day from 1550 bed hospital					**9397.54**

Table 7.7: Generation of Waste in Kg/Day in Different Color Code Bags At Rajiv Gandhi Cancer Hospital when 94 beds occupied

Type of Waste	**Daily generation (kg/day)**			**Percentage**
	Minimum.	**Maximum.**	**Average.**	
Infectious waste(Yellow)	19	24	22.50	8.24 %
Non- infectious waste(blue)	90	111	100.50	36.8%
General waste(Black)	110	190	150	54.9%
Total waste:			273 kg/day	

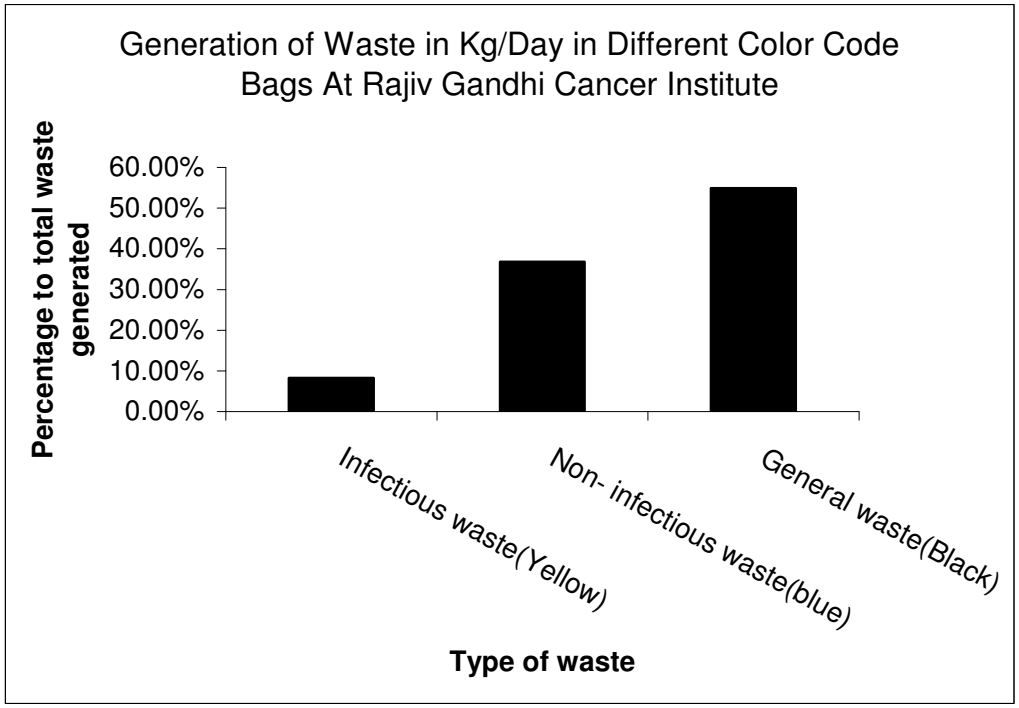


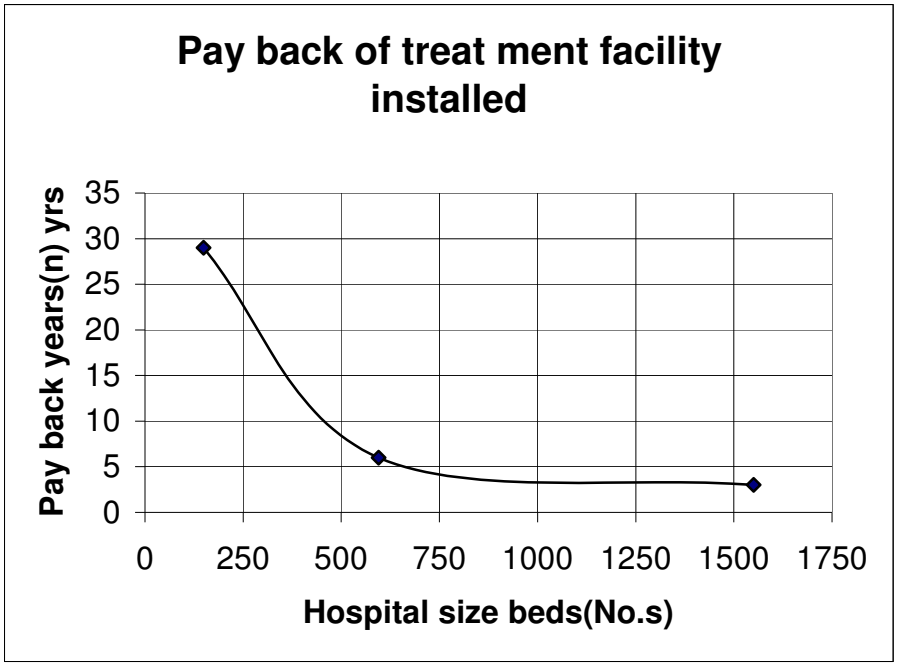
Table 7.8 Components of hospital waste with product type of Rajeev Gandhi Cancer hospital

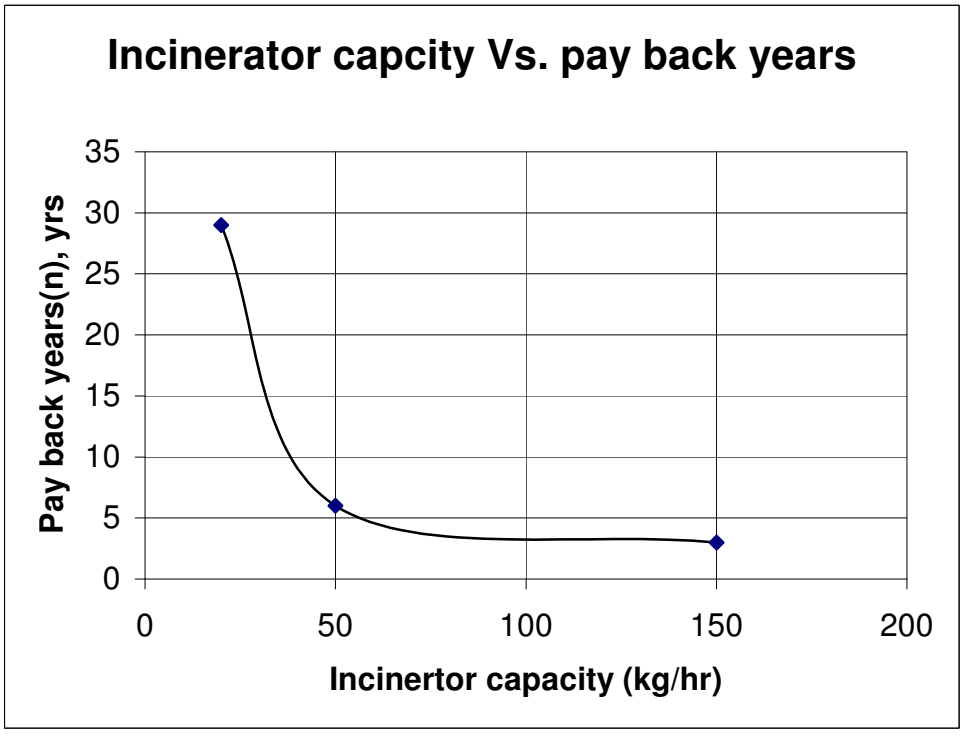
S.No.	Description		Weight (kg/d)	Recycle Value (Rs./kg.)	Total Value (Rs.)
	Component	Product Type			
General waste	Paper	Towel papers, newspapers, office papers, etc.	12	2.0	24
General waste	Cardboard	Packing etc.	8	3.50	28
Non-Infectious waste	Glass	a. White bottle b. Colored bottled	50 10	2.0 1.754	100 17.54
General	Plastics	a) Color PP	4	13	42

waste					
Non-Infectio		b) Needle Cap	1.5	19	28.5
Non-Infectious waste		c) Tubes	11	13	143
General waste		d) LDP	4.0	25	100
General waste		e) PP	5.0	23	115
General waste		f) Crystal Type	5.0	19	95
Non-infectious		g) Gloves	22	8	176
Non-infectious		h) HDP syringe part	2	21	42
General waste		i) Micro Pipette	1	16	16
General waste		j) Containers	1.5	14	21
General waste		k) Black Bag	10	4	40
Non-infectious		l) Blue Bags	15	4	60
General		m) Mix Black /	20	1.5	30

waste		Blue Bags			
Non-infectious		n) Syringe Cut Part	2.5	17	42.5
General waste		o) Cups / Glasses	0	9	0
General waste		p) Water Bottles	2	4	8
General waste		q) Electricity Items	1	10	10
Non-infectious		r) Blood /Urine Bags	2	4	8
General waste		s) Mix Plastics	0	3	0
Non-infectious	Metals	a) Needle, Sharp, etc.	4		
General waste		b) Aluminum Foil	4	22	88
General waste		c) Metal Cans / Container	4	3	12
General waste	Textile	Laundries, etc.	0	.4	0
General waste	General	a) Wards, Kitchen, Canteen etc.	520		0

General waste	Waste	b) Garden Trimming, Sweeping, etc.	5	46	230
Infectious waste	Infectious Waste	Bandages, Moist clothe, Plastics, Cotton, Paper, Human Anatomical Waste, Glass, etc.	22.5	13.5	303
	Ash	Residue	8	.75	6
Total value from recyclable in rupees per day from 149 bed hospital					**1795.5**


Pay back of treat ment facility installed
Pay back years(n) yrs
35
30
25
20
15
10
5
0
0
250
500
750
1000
1250
1500
1750
Hospital size beds(No.s)


Incinerator capcity Vs. pay back years
Pay back years(n), yrs
35
30
25
20
15
10
5
0
0
50
100
150
200
Incinertor capacity (kg/hr)

7.9 DISCUSSION

The graph clearly indicates that as the bed capacity of the hospital increases pay back years decreases. Hence it is concluded that hospital can recover its capital on setting up the treatment units by recycling the waste .and the above findings of the graph matches with the "Polluter pay back principle graph" mentioned in the Book : Pollution Engineering Oct 1990 , page 55.

7.10 RECCOMENDATION OF COST REDUCTION

Cost reduction can be achieved by taking particular majors at different stages in the management of wastes;

7.10.1 On – Site Management

- Comprehensive management of chemicals and pharmaceuticals stores
- Substitution of disposable of medical care items by recyclable items
- Adequate segregation of waste to avoid costly and inadequate treatment of waste that does n't required it.
- Improved waste identification to simplify segregation, treatment and recycling

7.10.2 Comprehensive planning

- Development and implementation of comprehensive biomedical waste management strategies, with in the framework of hospital waste management plan, which includes the above recommendation.
- Planning, collection and transportation 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.

7.10.3 Documentation

Waste Management and cost documentation; Assessment of the true cost makes it easier to identify priorities for cost reduction and to monitor progress in the achievement of objectives

7.10.4 Choices of Adequate treatment or disposal methods

- Selection of a treatments and disposal options that is appropriate for waste type and local circumstances
- Use of treatment equipments of appropriate type and capacity

7.10.5 Measures at personnel level

- Establishment of training programme for workers for improve the quality and quantity of work
- Protection of workers against occupational risks.

Chapter 8

SUMMARY AND CONCLUSIONS

Chapter 8

SUMMARY AND CONCLUSIONS

In Delhi, hospitals or health care facilities produce around six tones of Bio-Medical Waste daily. Some of it is discharged to the sewer system and some of it is released in gaseous form. However, most of it is in solid or liquid state. The waste management system, specially the facilities like incinerators were closely examined. Stack monitoring data was analysed . The existing system of bio-medical waste management in the hospitals is not found satisfactory. It is suggested to sensitize the people involved in the handling of bio-medical waste management.

The following conclusions are based on the study:-

1. In Delhi, there are about 52 Government Hospitals/Private Hospitals with a bed strength of more than 100. Apart from these there are about 1600 dispensaries, polyclinics, primary health centers and maternity centers. The total bed strength of Delhi in all health care facilities is about 25000. It is necessary to prepare a database about the hospitals and waste generated from these facilities.

2. Quantity of total wastes generated is about 25 t/day, which consist of about 6.0 t/day of biomedical wastes. It is estimated that by the year 2010, the bed strength in Delhi will rise to 36000. This will give rise to total waste generated by hospitals to about 33.0 t/day consisting of about 9.5 t/day of bio-medical wastes.

3. The biomedical waste is segregated at source and placed in three different color coded bags e.g. the biodegradable waste in black color bags, infectious in yellow bags and sharps in blue color bag. Analysis of results reveals that segregation minimizes considerably the Bio-Medical Waste volumes.

4. Incineration is the most widely used technique in Delhi for disposal of biomedical waste. There are about 33 hospitals in which incinerators have been installed.

Fifteen Hospitals use autoclave while there is only one hospital (Ram Manohar Lohia Hospital) where, Microwave, Treatment of Bio Medical Waste is being practiced. The efficient use of the incinerators and optimizations of treatment facilities is essential. Therefore, it is suggested that for optimizing use of the disposal facilities, small health care establishments should be clubbed with these facilities.

5. The indiscrimate disposal of the waste generated from hospital, nursing homes, dispensaries, clinic, veterinary institutions, animal house, pathological laboratory and blood bank and other similar organization (call by whatever name), poses a potential source of health risk and environmental contamination. Apart from general health hazards, occupational risks are also involved during handling and disposal of such wastes.
6. It is also necessary to burn only incinerable infectious waste in incinerator and other wastes such as plastic, glass, rubber gloves, food etc. should be strictly avoided as it not only increases load on incinerator but also results in inefficient combustion and reduces life of incinerator. Incinerable infectious waste can be taken as 0.5 kg./bed/day i.e. 25% of total waste generated.
7. All the segregation should be done at generation point, as it becomes very tedious and difficult to carry out the same at later stage when wastes are allowed to mix.
8. In contrast to MOEF norms that hospital of bed capacity 50 and above should have their own incinerator, our suggestion is that lower limit for such hospital should be 200 bed capacity, since in case of very small incinerators maintaining temperature of 800 deg. C could be a problem and there is always a risk of toxic gas emission. Hospitals below 200-bed capacity can have a common incinerator.
9. Among all the technologies available, incineration system is the most widely used in the worldwide. The incineration technique has proved to be reliable technique for the destruction of infectious agents and reduction of waste.

10. Stack monitoring reveals that there is need to install air pollution control devices of the incinerators for control of emission level.
11. Total average waste generation in St. Stephens Hospital, Safdar Jang Hospital and Rajeev Gandhi Cancer Institute Hospital was 875.15, 1758 and 273 kg/day (including general waste) when bed occupied were 390,1550 and 94 respectively.

12. Total cost of setting of infrastructure to treat hospital waste for 595, 1550 and 149 bedded hospitals (St. Stephens , Safdar jung and Rajeev Gandhi cancer institute) , were found to be 69.527, 89.0 and 60.0 lac respectively. Hospitals namely St. Stephens, Safdar jung and Rajiv Gandhi Cancer Institute can recover thier capital on setting up treatment unit by recycling waste into the local market in 6, 12, 5 years of periods respectively.

RECOMMENDATIONS

- The hospital should prevent and minimize the waste production by organizing training to the staff at various levels and treat waste by safe and environmentally sound methods.
- The hospital does not have any standard operation procedure of handling wastewater. It is recommended to treat the wastewater before the final disposal by having treatment plant.
- It is recommended that 'the infectious waste should be segregated from the other waste carefully. Strategies should be planned not to put plastics in yellow bag. It is recommended to use non- chlorinated plastics products.
- Sterilization and shredding of recyclable products should be done carefully as these materials go to local market.
- The kitchen and canteen waste can be utilized for the production of manure from vermicomposting.
- The thermal energy during incineration can be use in boilers to generate hot water and electricity, which can be useful in the hospital. That may help in cost reduction in the hospital budget.
- The hospital should have separate budget line for their, waste management programme as this is very cost intensive.
- On – Site Management , Comprehensive planning, Waste Management and cost documentation, Choices of Adequate treatment or disposal methods and Establishment of training programme for workers are strongly recommended for smooth management of bio-medical waste

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ANNEXURES-I, II &III

ANNEXURE I : LAY OUT PLAN DRAWING

ANNEXURE II: GOVERNMENT SPECIFICATIONS FOR INCINERATOR

GENERAL SUMMARY

1.	Lump sum price worked out by the contractor for the building works including Earth Work/Excavation/Returning Filling/Removing & earth filling works	* Rs._460000
2.	Lum sum price based on rates quoted by the contractor for Foundation of Chimney/Stack	*Rs.95000
4.	Lump sum price worked out by the contractor for the Water Supply works	* Rs.15000
5.	Lum sum price worked out by the contractor for Electrification works	* Rs.70, 000
7.	Lump sum price worked out by the contractor for Sewage Disposal	*Rs.10,000
9.	Lum sum price worked out by the contractor for Road/Path/Culvert	*Rs102000
10	Lum sum price worked out by the contractor for Security fencing/Gate	*Rs.43000_____

Total Amount Rs.6 lac 50 thousand

Annexure III : " DGS and D"

DESCRIPTION OF ITEM SPECIFICATION, UNIT AND RATE.

ITEM NO.	DESCRIPTION OF STORES & SPECIFICATION		UNIT	RATE PER UNIT
1.	Oil fired incinerator for disposal of bio-medical waste of category no. 1,2,3,5 & 6 (m/o of environment & forests bazette notification no. 460 dated 27.07.1998) generated from hospitals in the following nominal bu… rates / capacities with control panel pre-wiring and pre-pipins, main combustion chamber / primary chamber, post combustion chamber / secondary chamber, electrical control panel, cyclone separator, ducting, i.d. Fan, forced draft fan, fuel dil tank & pipings, burner, chimney (self supported type of 30 meters, height), one set of tools (pocker, shovel, hoe and …..) And one set of operation manul. Controls provided in circuit. Temperature indicator-cum-controller (indicates temperatures and controls firing in the primary chamber). Temperature indicator cum controller (indicates temperature and controls firing of burner in combustion chamber) limit switch (prevents firing of burner in pyrolytic chamber when charsing door is not closed property). Temperature indicator cum controller (indicates temperature of outlet bases). Overload relays (prevents motors from burning out).			
1.	BMW-10	10 KGS/Hr.	ONE	Rs 1,95000.00
2.	BMW-15	15 KGS/Hr.	ONE	Rs 2,00000.00
3	BMW-25	25 KGS/Hr.	ONE	Rs.225000.00
4	BMW-40	40 KGS/Hr.	ONE	Rs.490000.00
5	BMW-50	50 KGS/Hr.	ONE	Rs.590000.00
6	BMW-70	70 KGS/Hr.	ONE	Rs.1055000.00
7	BMW-100	100 KGS/Hr.	ONE	Rs.1330000.00
8	BMW-150	150 KGS/Hr.	ONE	Rs.2480000.00

NOTE FOR FURTHER TECHNICAL DETAILS OF ABOVE MODELS REFER ANNEXURE

6.	TERMS OF DELIVERY	:	F.O.R. Destination (Nearest Rly. Station Indentor's Premises Anywhere In India With Installation, Commissioning and Training to Indentor's Operator without any extra charges.
7.	EXCISE DUTY	:	Extra as applicable at the time of delivery.
8.	SALES TAX	:	Extra as against form C/D or @ 10% if form is not provided.
9.	DELIVERY PERIOD	:	Within 3-4 weeks after the receipt of supply order.

ITEM NO. **DESCRIPTION OF STORES & SPECIFICATION** **UNIT** **RATE PER UNIT**

2. **Venturi Scrubbing Unit**

S.No.	Description of Stores & Specification	Unit	Rate per Unit
1	10 KGS / HR	ONE	800000.00
2	15 KGS / HR	ONE	125000.00
3	25 KGS / HR	ONE	175000.00
4	40 KGS / HR	ONE	250000.00
5	50 KGS / HR	ONE	350000.00
6	70 KGS / HR	ONE	375000.00
7	100 KGS / HR	ONE	400000.00
8	150 KGS / HR	ONE	450000.00

3. Accessories required alongwith the scrubbing unit are the Droplet Separator, Re-circulation Tank, Inter Connecting Pipeline and Inter Connecting Ducting. The Prices for the same are as under :-

S.No.	Description of Stores & Specification	Unit	Rate per Unit
1	10 KGS / HR	ONE	50000.00
2	15 KGS / HR	ONE	50000.00
3	25 KGS / HR	ONE	50000.00
4	40 KGS / HR	ONE	60000.00
5	50 KGS / HR	ONE	60000.00
6	70 KGS / HR	ONE	70000.00
7	100 KGS / HR	ONE	70000.00
8	150 KGS / HR	ONE	80000.00

DIRECTOR GENERAL OF SUPPLIES & DISPOSALS

TECHNICAL PARTICULARS

Detailed technical specification of Incinerator 10 Kgs./hr. to 150 Kgs./hr.

SCRUBBING UNIT CONSISTING OF THE FOLLOWING :

VENTURI SCRUBBER

1.	Type	High Pressure jet type
2.	Material of Construction	Stainless Steel
3.	Outlet temperature of flue gases	Approx. 80 deg. C.

Accessories required along with the scrubbing unit

1. DROPLET SEPARATOR
2. RE-CIRCULATION TANK
3. RE-CIRCULATION PUMP
4. INTER CONNECTING PIPING
5. INTER CONNECTING DUCTING

The equipment I.S. incinerator shall have the following essential features.

i. GENERAL – The Incinerator should contain two chambers primary and secondary, enabling complete destruction of Bio-Medical Waste.

ii CONSTRUCTION – Welded and bolted steel construction body, inside line with suitable refractory bricks conforming to IS : 8/1994 to withstand high operations temperatures, insulation bricks conforming to IS : 2042/1972 Amdt. No. 1 are also to be provided inside the body. Alternatively lining with castable high …. Refractory of equivalent properties cold face protection with ceramic wool and SS anchors to be used (Details of construction including details of refractory lining and its properties to be amply explained in the offer :-

iii. OPERATION TEMPERATURE :

PRIMARY CHAMBER	-	800 – 50 C
SECONDARY CHAMBER	-	1050 – 50 C

iv. FUEL BURNER(S) – Suitable automatic pressure Jet Oil fired monoblock burner(s) incorporating fuel pump, motor, blower, fan nozzle, solenoid value etc. operating with fuel L.D.G./L.S.H.S./H.S.D. with power supply 220/440 V, SO Hz., A.C. to achieve operating temperatures.

v. LOADING DOOR – Provision of refractory lined large size loading door for case of charging and removal of ASK RESIDUE.
Door I have refractory lining with sealing …

vi. CHIMNEY : Self supported MS Cylindrical Base suitable chimney of minimum 1.20 Mtrs. Height with inside lined with refractory material. It shall be with suitable ducting arrangement for connecting to 30 Mtrs. Stack height chimney.

vii. CONTROL PANEL & INSTRUMENTS : Floor mounted CRCA sheet body, digital temperature indicator and controller thermostatic auto control electrical controls with switches, push button, indication lamp, meters relays, contractors, temperature sensor the couples for chambers and sequence controller.

viii. DIESEL TANK – Suitable capacity fuel tank with pipelines, filters and valves and necessary fittings to be provided.

ix. ASH RAKE : Suitable Ash rake.

x. MISCELLANEOUS ACCESSORIES : Fuel pressure gauge, diesel oil level indicator and alarm to be provided.

xi. The incinerator shall meet the requirements of standards for incinerators of schedule V of Gazette of India, M/O Environment and forests notification no. 460 dated 20/27.07.1998. Copy reproduced at Annexure ‘A’.

TECHNICAL DATA INCINERATOR 10 KGS/HRS.

INCINERATOR

1.	Rated Capacity	10 KGS / HR.
2.	Model No.	BMW – 10
3.	Type of Design	Double Chambered Oil Fired
4.	Total Electrical Load Required	2.5 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 45 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OF COMBUSION CHAMBERS

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	475 X 425
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	900 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	$1050 + 50^0$ Centigrade

BURNERS

1.	No. of Burners	2 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	0.5 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	2 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE ANK

1.	Capacity	200 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital

4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel 200mm.
2.	Top & Bottom Dia of Chimney	Top- 200mm, Bottom – 400mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 3 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 15 KGS / HR.

INCINERATOR

1.	Rated Capacity	15 KGS / HR.
2.	Model No.	BMW – 15
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	3 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 45 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OFCOMBUSTION CHAMBER

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	500 X 425
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	$1050 + 50^0$ Centigrade

BURNERS

1.	No. of Burners	2 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	1 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	2 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	200 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phae, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated

6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel
2.	Top & Bottom Dia of Chimney	Top- 225mm, Bottom – 450mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 3.5 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 25 KGS / HR.

INCINERATOR

1.	Rated Capacity	25 KGS / HR.
2.	Model No.	BMW – 25
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	3.75 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 450 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OF COMBUSION CHAMBERS

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	500 X 450
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042

4.	Operating Temperature	$1050 + 50^0$ Centigrade

BURNERS

1.	No. of Burners	2 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	1 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	3 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	300 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel
2.	Top & Bottom Dia of Chimney	Top- 300mm, Bottom – 600mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING :4 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 40 KGS / HR.

INCINERATOR

1.	Rated Capacity	40 KGS / HR.
2.	Model No.	BMW – 40
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	5.5 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 450 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OF COMBUSION CHAMBERS

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	525 X 475
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	1050 + 50^0 Centigrade

BURNERS

1.	No. of Burners	2 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	1 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	5 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	500 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	**M.O.C.**	Mild Steel
2.	**Top & Bottom Dia of Chimney**	Top- 350mm, Bottom – 700mm
3.	**Height From Ground**	30 Meters
4.	**Type of Chimney**	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 4.5 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 50 KGS / HR.

INCINERATOR

1.	Rated Capacity	50 KGS / HR.
2.	Model No.	BMW – 50
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	7 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 450 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OF COMBUSION CHAMBERS

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	525 X 475
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8

3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	$1050 + 50^0$ Centigrade

BURNERS

1.	No. of Burners	2 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	1 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	7.5 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	500 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided

7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel
2.	Top & Bottom Dia of Chimney	Top- 400mm, Bottom – 800mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 5.2 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 70 KGS / HR.

INCINERATOR

1.	Rated Capacity	70 KGS / HR.
2.	Model No.	BMW – 70
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	7.5 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 450 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OF COMBUSION CHAMBERS

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	550 X 500
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	1050 + 50^0 Centigrade

BURNERS

1.	No. of Burners	2 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	1.5 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	7.5 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	700 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel
2.	Top & Bottom Dia of Chimney	Top- 425mm, Bottom – 850mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 6 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 100 KGS / HR.

	INCINERATOR	
1.	Rated Capacity	100 KGS / HR.
2.	Model No.	BMW – 100
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	9.5 KW Approx.
5.	Mode of Heating	Oil Fired Burners
	EMISSION STANDARDS	
1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 450 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level
	DETAILS OF COMBUSION CHAMBERS	
1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062
	PRIMARY COMBUSTION CHAMBER	
1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	600 X 500
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade
	SECONDARY COMBUSION CHAMBER	
1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	1050 + 50^0 Centigrade

BURNERS

1.	No. of Burners	3 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	150 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	2 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	10 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	1000 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel
2.	Top & Bottom Dia of Chimney	Top-450mm, Bottom – 900mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 7 TONS INCLUDING CHIMNEY (APPROX.)

TECHNICAL DATA
INCINERATOR 150 KGS / HR.

INCINERATOR

1.	Rated Capacity	150 KGS / HR.
2.	Model No.	BMW – 150
3.	Type of Design	Double Chambered Oil Fired Incinerator
4.	Total Electrical Load Required	11.5 KW Approx.
5.	Mode of Heating	Oil Fired Burners

EMISSION STANDARDS

1.	Particulate Matters	Less than 150 mg/NM^3 at 12% CO_2 Correction
2.	Nitrogen Oxides	Less than 450 mg/NM^3 at 12% CO_2 Correction
3.	HCI	Less than 50 mg/NM^3 at 12% CO_2 Correction
4.	Combustion Efficiency	Minimum 99.00%
5.	Volatile Organic Compound in Ash	Not more than 0.01%
6.	Minimum Stack Height	30 Mtrs. From Ground Level

DETAILS OF COMBUSION CHAMBERS

1.	No. of Chambers	Two Numbers (Primary & Secondary)
2.	M.O.C. / Thickness of Casing	Mild Steel Confirming to IS-2062

PRIMARY COMBUSTION CHAMBER

1.	Waste Charging Door	Provided with Refractory lining with sealing gaskets
2.	Charging Door size (L&W)	650 X 550
3.	Ask Removal Door	Provided with Refractory lining with sealing gaskets
4.	Cold Face Insulation	Ceramic Wool
5.	Anchor	Anchors of stainless steel
6.	Material & Thickness of Casing	Mild Steel 5mm thick
7.	Refractory Bricks Thickness	115mm Thick confirming to IS-8
8.	Insulation Bricks Thickness	115mm Thick confirming to IS-2042
9.	Operating Temperature	800 – 50^0 Centigrade

SECONDARY COMBUSION CHAMBER

1.	Material & Thickness of Casing	Mild Steel Min. 5mm thick
2.	Refractory Bricks	115mm thick confirming to IS-8
3.	Insulation Bricks thickness	115mm thick confirming to IS-2042
4.	Operating Temperature	1050 + 50^0 Centigrade

BURNERS

1.	No. of Burners	3 Nos.
2.	Type	Mono Block Fully Automatic Oil Fired
3.	Make	"THERMAX"
4.	Motor Power	240 W
5.	Electrical Supply	Single Phase 220 V (-15% + 10%) 50 Hz.
6.	Details	The Burner is complete with Electric Motor, Fuel Pump, Nozzles, Blower, Sequence Controller, Ignition Transformer, Solenoid Valve etc.

FORCED DRAUGHT FAN

1.	Type	Centrifugal
2.	M.O.C.	Mild Steel
3.	Make	"THERMAX"
4.	Motor Rating	2 HP
5.	Motor Make	Bharat Bijlee Ltd./Siemens / Crompton

INDUCED DRAFT FAN (I.D. FAN)

1.	Type	High Pressure Centrifugal Type
2.	Motor Rating	12.5 HP
3.	Motor Make	Kirloskar / Crompton / Siemens

FUEL STORAGE SERVICE TANK

1.	Capacity	1000 Ltrs.
2.	M.O.C.	Mild Steel
3.	Other Standard Accessories	Diesel Oil Level Indicator, Piping with Valves & N.R. Valve

CONTROL PANEL

1.	Type	Floor or Wall mounted
2.	M.O.C.	Mild Steel
3.	Type of Temp. Controller	Digital
4.	Main Electrical Supply Required	3 Phase, 440 V, 50 Hz.
5.	Finish and Painting Type	Powder Coated
6.	Audio-Visual Alarm System	Provided
7.	Details of Electrical	Temp. Indicator and Controller, Auto Controls, Electrical Controls Switches, Push Button, Indication Lamp Meter Relays, Contractors, Thermocouples, Temperature Sensors, Sequence Controller and Audio and Visual Alarm.

CHIMNEY

1.	M.O.C.	Mild Steel
2.	Top & Bottom Dia of Chimney	Top-500mm, Bottom – 1000mm
3.	Height From Ground	30 Meters
4.	Type of Chimney	Self Supported

WEIGHT OF EQUIPMENT WITHOUT LINING : 8 TONS INCLUDING CHIMNEY (APPROX.)

ANNEXURE IV :TEST RESULTS

PLANT DATA:

1. Name & Address of the Industry	:	M/s. Director Intelligence bureau 35, Sardar Patel Marg. New Delhi –110020
2. (a) Plant Representative	:	Mr. G.C. Chawala (DCIO)
(b) Product manufactured	:	N.A.
(c) Production capacity	:	N.A.
2. Date of Sampling	:	25/10.2001
3. Name of the plant/Section	:	Paper waste Incinerator
4. Normal operating schedule of the plant (hrs/day)	:	8 hrs./day
5. Name of the emission source monitored	:	Paper waste Incinerator (Electrically operated)
6. Stack identification	:	Stack attached to Incinerator
7. Type of Chimney (R.C.C./Metal)	:	Metal
8. Location of the sampling point	:	11.5 m. from ground level
9. Stack height (m)		
(a) From ground level	:	30
(b) From bend/disturbance	:	24
(c) Above roof level	:	25
(d) From sources of emissions	:	NA
10. Dimension of the Stack (cm)	:	45
11. Sampling duration	:	Two hours
12. Parameters required	:	PM, SO2, HCL, NOX, CO, CO2, 2, & C.E. (%)
13. Purpose of monitoring	:	For DPCC purpose
14. Control measures	:	Cyclone and wet scrubber
(a) Status	:	Working
(b) Recovery of material	:	Ash / Slurry
15. Fugitive emissions, if any	:	Nil

OBSERVATIONS

1. Ambient air temperature (0C)	:	29
2. Stack temperature (0C)	:	95
3. Stack gas velocity (m/s) average	:	6.0
4. Volumetric flow rate (Nm3/hr)	:	2395
5. Temp. of the primary chamber	:	855 (Recorded from Panel)
6. Temp. of the Secondary chamber	:	1240 (Recorded from Panel)

RESULTS

			Protocol
1. Particulate Matter (PM), mg/Nm3	:	388	IS :11255 (Pt-1)
2. Sulphur dioxide (as SO2), mg/Nm3		BDL	IS : 11255 (PT-2)
3. Nitrogen Oxides (as NO2), mg/ Nm3		83.3	USEPA (Method-7)
4. Carbon Monoxide (as Co), % V/v		0.0445	B NDIR
5. Hydrogen chloride (as HCl) mg/Nm3		BDL	IS: 10496
6. Oxygen % v/v		17.3	By Calculation
7. Carbon dioxide % v/v		3.6	ORSAT
8. Combustion Efficiency, %		98.78	By Calculation

Detection Limit : HCL and S02: 1mg/m3.