MANAGEMENT OF HAZARDOUS WASTES

GUIDELINES FOR PROPER FUNCTIONING AND UPKEEP OF DISPOSAL SITES

Central Pollution Control Board

(Ministry of Environment & Forests)

'Parivesh Bhavan', East Arjun Nagar, Delhi – 110 032

Website: www.cpcb.nic.in, E-mail: cpcb@alpha.nic.in

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Chapter 1

INTRODUCTION

The Hazardous Wastes (Management & Handling) Rules, 1989, as amended, requires that the State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC) shall grant authorization to the operator of a facility based on technical capability of the proponent. In order to facilitate implementation of the Rules, the Ministry of Environment and Forests (MoEF) and the Central Pollution Control Board (CPCB) have published several documents. These are:

1. Guidelines for management of hazardous waste (MoEF, 1992)
2. Guidelines for setting up of operating facility: Hazardous waste management (CPCB document: HAZWAMS/11/1998-99)
3. Ready Reckoner: Hazardous waste management (HAZWAMS/12/ 1998-99)
4. Criteria for hazardous wastes landfills, HAZWAMS/17/2000-01
5. Manual for design, construction and quality control of liners and covers for hazardous waste landfills, HAZWAMS/20/2002-03

The States of Andhra Pradesh, Maharashtra and Gujarat have promoted development of common facility in the private sector, for management of hazardous wastes in an environmentally sound and techno-economically viable manner. The services of treatment, storage and disposal facility (TSDF) are particularly useful for the hazardous waste generating units not only in the large category of industries but also for small & medium enterprises (SMEs), who on their own may not afford and are unable to provide on-site facility for proper disposal of hazardous wastes.

It is expected that more TSDFs would come up in the future to cater to the need for management of hazardous wastes in other States/UTs. These TSDFs are required to comply with the provisions under the Hazardous Waste (Management & Handling) Rules [HW(M&H)] and guidelines issued by MoEF and CPCB from time to time. It is, therefore, necessary to bring about certain guidelines for facilitate the regulatory compliance by the TSDF operators.

The guidelines aim at establishing the standards, which define the requirements for management of hazardous wastes (HW) at TSDF operating in the State. These guidelines shall apply to the generators of HW and the operators of the TSDF facilities.
Following aspects have been illustrated in this document:

- Definition of hazardous wastes for TSDF
- Methodology for classification, identification and characterization of hazardous wastes
- Operating procedures for TSDF
- Requirements for handling, collection and transportation of hazardous wastes
- Applicable standards for compliance of regulations
- Additional information on regulatory requirements for managing hazardous wastes

Chapter 2

IDENTIFICATION/CHARACTERIZATION OF HAZARDOUS WASTES

2.1 Regulatory definition of hazardous wastes as given in the Hazardous Wastes (Management & Handling) Rules, 1989, and further amendments made there under, is reproduced below:

Hazardous Wastes

Hazardous wastes *(HW)* have been defined to include:

a) Wastes, which are generated in the process, indicated in Column-2 of Schedule -1, and consist of wholly or partly of the waste substances, referred to in Column-3 of the same schedule

b) Wastes, which consist wholly or partly of substances indicated in Schedule-2 if the concentration of the substances is equal to or more than the limit indicated in the same schedule, and

c) Wastes indicated in Lists A and B of Schedule-3 (Part-A) applicable only in case(s) of import or export of hazardous wastes in accordance with Rules 12, 13 and 14 if they possess any of the hazardous characteristics listed in Part (B) of the Schedule.

Explanation: For the purpose of the clause: i) all wastes mentioned in column (3) of Schedule 1 are hazardous wastes irrespective of concentration limits given in Schedule 2 except as otherwise indicated and Schedule 2 shall be applicable only for wastes or waste constituents not covered under column (3) of Schedule 1. ii). Schedule 3 shall be applicable only in case(s) of import or export.

2.2 Definition of hazardous wastes – its applicability

From the viewpoint of application of the HW (M&H) Rules, waste can be classified as hazardous if:

Waste substance is solid, semi-solid or non-aqueous liquid which because of its quantity, concentration or characteristics in terms of physical, chemical, infectious quality:

(a) can cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitate reversible illness, or

(b) pose a substantial present or potential hazard to human health or the environment when it is improperly treated, stored, transported, disposed of or otherwise managed

Thus, a waste is hazardous if it exhibits whether alone or when in contact with other wastes or substances, any of the characteristics identified below:

- Corrosivity
- Reactivity
- Ignitability
- Toxicity
- Acute toxicity
- Infectious property

2.3 Hazardous waste characterization

2.3.1 Corrosivity

A waste exhibits the characteristics of corrosivity if a representative sample of the waste has either of the following properties:

(a) any liquid which has a pH less than or equal to 2 or greater than or equal to 12.5 as determined by the standard test procedure; or

(b) a waste, which can corrode steel at a rate greater than 6.35 mm per year at a test temperature of 55 °C as determined by the standard test procedure.

2.3.2 Reactivity

A waste exhibits the characteristics of reactivity if a representative sample of the waste has any of the following properties:

(a) It is normally unstable and readily undergoes violent change without detonating

(b) It reacts violently with water

(c) It forms potentially explosive mixture with water

(d) It is Cyanide or Sulfide bearing waste which when exposed to pH conditions between 2 and 12.5 can generate toxic gases, vapours or fumes in a quantity sufficient to pose danger to human health or the environment.

(e) It is an explosive.

2.3.3 Ignitability

A waste exhibits the characteristics of ignitability if a representative sample of the waste has any of the following properties:

(a) It is a liquid other than an aqueous solution containing less than 24% organic solvents by volume and has flash point less than 60 °C as determined by a Pensky Martins closed cup tester using the standard test method.

(b) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes, and when ignited burns so vigorously and persistently that it creates a hazard.

(c) any oxidizing substance, when in contact with moisture or other materials/wastes, results in spontaneous fire or combustion.

2.3.4 Toxicity

A solid waste exhibits the characteristics of toxicity if the leachate from the representative sample by Toxicity Characteristics Leaching Procedure (TCLP) test method (as followed by USEPA, vide No: S.W 46, till Indian standards are notified by MoEF / CPCB) contains any of the contaminants listed in Table 2.1 below in excess of the concentration limits mentioned thereupon.

Table 2.1 TCLP Test Limits*

S. No.	Contaminant	TCLP Limit (mg/l)
01.	Arsenic	5.0
02.	Barium	100
03.	Benzene	0.5
04.	Cadmium	1.0
05.	Carbontetrachloride	0.5
06.	Chlordane	0.03
07.	Chlorobenzene	100.0
08.	Chloroform	6.0
09.	Chromium	5.0
10.	o-Cresol	200.0
11.	m-Cresol	200.0

S. No.	Contaminant	TCLP Limit (mg/l)
12.	p-Cresol	200.0
13.	Cresol	200.0
14.	2,4-D	10.0
15.	1,4-Dichlorobenzene	7.5
16.	1,2-Dichloroethane	0.5
17.	1,1-Dichloroethylene	0.7
18.	2,4-Dinitrotoluene	0.13
19.	Endrin	0.02
20.	Heptachlor (and its epaoxide)	0.008
21.	Hexachlorobenzene	0.13
22.	Hexachlorobutadiene	0.5
23.	Hexachloroethane	3.0
24.	Lead	5.0
25.	Lindane	0.4
26.	Mercury	0.2
27.	Methoxychlor	10.0
28.	Methyl ethyl ketone	200.0
29.	Nitrobenzene	2.0
30.	Pentachlorophenol	100.0
31.	Pyridine	5.0
32.	Selenium	1.0
33.	Silver	5.0
34.	Tetrachloroethylene	0.7
35.	Toxaphene	0.5
36.	Trichloroethylene	0.5
37.	2,4,5-Trichlorophenol	400.0
38.	2,4,6-Trichlorophenol	2.0

S. No.	Contaminant	TCLP Limit (mg/l)
39.	2,4,5-TP (Silvex)	1.0
40.	Vinyl Chloride	0.2

Note:

***** *These limits shall be applicable till the notification of leachate standards (including test method) under the E (P) Act, 1986*

1. *Best Demonstrated Available Technology (BDAT) standards shall be employed for parameters not mentioned.*
3. *Leachate collected shall be treated and disposed as liquid effluent in compliance of the standards notified under the E (P) Act, 1986.*

2.3.5. Acute toxicity

A waste exhibits the characteristics of being acutely hazardous if a representative sample contains any of the following:

(a) wastes generated in the manufacturing process of halogenated phenols and other halogenated compounds

(b) wastes generated in the manufacturing/formulating process of pesticides or pesticide derivatives

(c) wastes generated during the manufacturing process of halogenated benzene under alkaline conditions

(d) off-specification or discarded products generated from the above processes, and

(e) containers used for handling hazardous / toxic substances / wastes

2.3.6 Infectious property

Wastes containing viable micro-organisms or their toxins which are known or suspected to cause disease in animal or humans fall under this category**.**

Chapter 3

OPERATIONS AT TSDF

3.1 Introduction

All operations involving treatment, storage and disposal shall comply with the guidelines/regulations issued by CPCB/MoEF as may be adopted by the SPCB/PCC and stipulated in the authorization under Rule 5 of the Hazardous Wastes (Management & Handling) Rules, 1989, as amended. The facilities should ensure that the wastes from the generators are accepted at the facility in compliance of the manifest notified under the said rules. Additional requirements regarding screening and analysis procedures at TSDF are outlined in this section so as to help the TSDF in proper acceptance of waste.

3.2 Responsibilities of the Hazardous Waste Generator

In order to optimize and facilitate proper operations at TSDF, the hazardous waste generator shall be responsible for managing hazardous wastes before sending to TSDF for further treatment and disposal. Certain responsibilities are listed as under:

- waste minimization, re-use of wastes to the maximum extent before sending to TSDF.
- waste characterization (*Annexure I*)
- segregation of hazardous and non-hazardous wastes to reduce the quantity of waste for disposal at TSDF (refer *Annexure II*)
- proper handling of wastes at the source
- labelling and packaging of the wastes according to procedures indicated in MoEF guidelines (1992) and Chapter 6 of the Motor Vehicle**s** Act, 1988**,** as amended.
- provide information on precautions for waste handling during transportation to TSDF.
- compliance of manifest for tracking of wastes.

3.2.1 Collection and transportation of hazardous wastes

(a) The generator of the hazardous waste shall ensure that wastes are packaged in a manner suitable for safe handling, storage and transport. Labelling on packaging is readily visible and material used for packaging shall withstand physical conditions and climatic factors.

(b) The generator shall ensure that information regarding characteristics of wastes particularly in terms of being Corrosive, Reactive, Ignitable or Toxic is provided on the label.

(c) Transport of hazardous wastes shall be in accordance with the provisions of the rules made by the Central Government under the Motor Vehicles Act, 1988 and other guidelines issued from time to time.

(d) All hazardous waste containers shall be provided with a general label as given in Form 8 in Hazardous Waste (Management & Handling) Rules, 1989, as amended.

(e) Transporter shall not accept hazardous wastes from an occupier (generator) unless six-copy (with colour codes) of the manifest (Form 9) is provided by the generator. The transporter shall give a copy of the manifest signed and dated to the generator and retain the remaining four copies to be used for further necessary action prescribed in the Hazardous Wastes (Management & Handling) Rules, 1989, as under:

Copy 1 (White)	:	To be forwarded to the SPCB/PCC by the occupier
Copy 2 (Yellow)	:	To be signed by the transporter and retained by the occupier
Copy 3 (Pink)	:	To be retained by the operator of a facility
Copy 4 (Orange)	:	To be returned to the transporter by the operator of facility after accepting waste
Copy 5 (Green)	:	To be forwarded to SPCB/PCC by the operator of facility after disposal.
Copy 6 (Blue)	:	To be returned to the occupier by the operator of the facility after treatment & disposal of HW.

(f) The generator shall provide the transporter with relevant information in Form 10, i.e. Transport Emergency (TREM) Card regarding the hazardous nature of the wastes and measures to be taken in case of an emergency.

3.2.2 Test report and information

Generators sending hazardous waste to the facility for treatment, storage or disposal are required to provide necessary test report of hazardous waste to the operator along with the information on the process(s) of its generation, so as to facilitate the determination of pathway for treatment and disposal. Test report shall be submitted to the operator along with a copy marked to the SPCB.

Based on the analysis report/waste characterization, TSDF operator shall decide the suitable pathway for treatment/storage/disposal.

3.3 Responsibilities of the Hazardous Waste Transporter

Transporter of hazardous wastes shall be responsible for:

- Obtaining permission from SPCB/PCC for transport of hazardous waste [in addition to any other permissions that may be required under the Motor Vehicles (Amendment) Act of 1988]
- Suitably designing the transport vehicles to handle and transport the hazardous wastes.
- Maintaining the manifest system as required
- Transporting the wastes in closed containers at all times
- Delivering the wastes at designated points
- Informing SPCB/PCC and other regulatory authorities immediately in case of spillage, leakage or other accidents during transportation
- Cleaning up in case of contamination

3.4 Responsibilities of the Operator of TSDF

The operator of TSDF would be responsible for:

- Accepting hazardous wastes at TSDF from the generators authorized by SPCB/PCC.
- Establishing a system for optimal movement of hazardous wastes transportation, treatment and disposal operations, which may include resource recovery/ recycling as the case may be.
- Fingerprinting analysis to confirm the wastes shall be the responsibility of the operator (Annexure II of the report)
- Operating the TSDF as per conditions stipulated in the authorization.
- Ensuring waste treatment and/or disposal as per Hazardous Waste (Management & Handling) Rules, 1989, as amended.
- Undertake cleanup operation in case of contamination resulting from TSDF
- Pollution and the odour arising out of TSDF operations and subsequent abatement.
- Compliance of regulations concerning occupational safety and health of TSDF employees.

3.5 Waste disposal into a Landfill

Landfills shall have to be designed and constructed as a secured facility to contain the waste material and any leachate generated during the process. To meet these requirements, the base, slope, liner system etc. of the landfill shall have to be designed and constructed as per the guidelines of MoEF/ CPCB (Guidelines for Setting up of Operating Facility- Hazardous Waste Management, HAZWAMS/11/98-99 and Criteria for Hazardous Waste Landfills, HAZWAMS/17/2000-01), and the conditions stipulated by SPCB/PCC in the authorization to operate TSDF while granting consent to establish. Prior to the placement of waste, an engineered capping over the surface shall be placed after completion of work daily so as to minimize the infiltration of rainfall.

The base liner and capping shall be a composite system comprising compacted clay layer and synthetic membrane as may be approved by the SPCB/PCC. A leachate collection drainage system is to be provided at the base of the landfill, immediately above the liner to ensure that the head of leachate will not exceed 300 mm during any season of the year.

The following objectives have to be considered in the design of an engineered landfill:

- Minimi**z**ation of the possibility of contamination of surface and/or groundwater
- Control over gaseous emissions if any.
- Prevention and control of any other possible adverse impact(s) on the environment
- Utilization of excavated soil as cover material
- Harvest of upstream rainwater flowing into the land fill.
- Preferred use of clay with plasticity index between 10-30, which is well-graded having at least 30% passing through 75 micron. Clay fraction shall be kept at greater than 15% or more whereas gravel fraction shall be < 50% of clay lining.
- Clay having clod size less than 50 mm be compacted to optimum moisture content using a sheep foot roller.

Placement of wastes into a landfill would have to be done judiciously as it may cause impact(s) throughout the active life of the waste in the landfill. Therefore, waste disposal into the landfill be restricted as per the concentration limits/criteria for acceptance of hazardous waste in landfill as presented at *Annexure III*, besides the restrictions for waste placement into landfill stipulated by the SPCB/PCC.

Placing bulk, containerized, or non-containerized liquid hazardous wastes containing free liquids (whether or not adsorbents have been added) in any landfill shall be prohibited by SPCB/PCC.

3.5.1 Operations at a TSDF

Suggested sequence of the operations at TSDF is presented below:

- Operator from the generator shall receive a comprehensive report on analysis of the waste.
- The operator of TSDF shall examine the report and plan pathway for waste treatment and disposal.
- Upon confirmation of the same by the operator of TSDF to the generator, the waste shall be dispatched to the TSDF accompanied by transport manifest.
- Upon receipt at the facility, the wastes shall be weighed and properly logged.
- Waste shall then undergo a visual inspection to confirm the physical appearance.
- A representative sample of the waste shall be collected and sent to the on-site laboratory for fingerprinting analysis ***(Annexure II).***
- The results of fingerprinting analysis shall be compared with the results of earlier analysis.
- Upon confirmation, waste shall then be sent for TSD operations according to the identified pathway.

3.5.2 Waste TSD options

Waste at TSDF could be handled in different ways as follows:

- Direct disposal into landfill
- Treatment/stabilization of wastes and then disposal into landfill
- Direct incineration
- Pre-treatment and incineration
- Pre-treatment, incineration and disposal of incineration ash in landfill
- Waste processed for fuel/industrial by-products for recycling
- Others

3.5.3 Pathway of wastes accepted for direct disposal

Wastes accepted for direct disposal shall conform to the concentration limit/criteria stipulated by the SPCB/PCC (*Annexure - III).*

3.5.4 Comprehensive analysis for waste acceptance for direct disposal

Generators of hazardous wastes shall identify and provide analysis report including CRIT criteria of the waste consignments. TSD facility should require that the generator provides such information regarding:

- The throughput and process that generates the waste with quantities
- The physical and chemical description of the waste as per parameters given in *Annexure I*
- The analytical procedures and interpretation of results used to characterize the waste or process knowledge documentation
- Hazardous waste codes are placed as per Schedule 1 & 2 of the Hazardous Waste (Management and Handling) Rules, 1989, as amended.

The operator at TSD, so as to ascertain direct disposal into a landfill, shall perform the following fingerprinting analysis:

- Free liquid content (Paint Filter Liquids Test and Liquid Release Test)
- pH
- Calorific value
- Flash point
- Reactive sulfide
- Reactive cyanide
- Chemical compatibility
- Any other specific parameter, which may be decided on merit of each case.

The waste shall be placed at the toe of the working face and spread evenly by mechanical equipment in approximately 0.5 meter layers. Spreading and compaction

is an important part of operation to achieve maximum waste density within the landfill. After every day's operation, soil cover of at least 100 mm thickness shall be placed over the waste. The placement and compaction is continued to uniformly raise the level of the cell. At the point of reaching the final design height, the final cover is placed over that section, as the work proceeds.

3.6 Pathway for Hazardous Wastes not Accepted for Direct Disposal

Wastes not accepted for direct disposal into landfill shall have to either be treated / stabilized before disposal into a landfill, or would have to be incinerated, or otherwise managed as per the conditions stipulated by the SPCB/PCC.

3.6.1 Waste treatment / stabilization

Waste treatment / stabilization is a process designed to convert hazardous wastes in the form of non-aqueous liquids, semi-solids or reactive solids into less leachable solids that can then be deposited directly into the secured landfill in compliance with the concentration limits/criteria stipulated by SPCB (*Annexure III*). The treatment/stabilization operations will be carried out for all wastes identified for the purpose, so as to minimize their contaminant leaching potential. This will change the nature of these wastes to a less hazardous category. Treatment/stabilization involves immobilization of leachable materials by fixation as non-reactive solids, reduction of volume, reducing contaminant level of organic/inorganic components. Selection of technology would depend on the nature of waste, physical properties, options for technology applications, cost etc. Suggested flow chart for screening the wastes going to treatment/stabilization for developing treatment plant is given in the Figure 1 in the CPCB-document: Hazwams/17/2000-01. The treated wastes before disposal in the landfill shall be assessed for compatibility with other wastes as well as with liner system

The term treatment/stabilization is intended to cover a number of mechanisms including:

- ***Immobilization/Chemical fixation*** - the chemical binding of contaminants within a cementing structure to reduce the mobility or leachability of the waste constituents

- ***Encapsulation*** - the occlusion or entrapment of contaminant particles within a solid matrix

- ***Solidification*** - the conversion of slurries that do not readily de-water into solids by addition of solidification and adsorption agents.

Typical reagents that would be used for the stabilization process may include lime, fly-ash, bentonite (clay), cement, saw dust etc., in combination with sodium silicate solution, if required to create additional binding properties of the wastes.

General operations for waste treatment/stabilization shall include:

- Receiving waste for its storage in appropriate/designated place
- Adding of reagents as per the pre-estimated quantities
- Mixing and curing
- Thermal treatment to remove moisture, organics etc.
- Analysis of the stabilized sample (TCLP)
- Transfer of stabilized material to landfill

The above process operations generally have the potential to create gaseous and particulate emissions into the air. This can be controlled by various management practices as stipulated by SPCB/PCC including masking (and would have to be properly managed).

Also ambient odour near facility coming from the industrial wastes has to be neutralized in the following manner by the operator:

As indicated at Section 3.5, placing bulk, containerized, or non-containerized liquid hazardous wastes containing free liquids (whether or not absorbents have been added, liquids that have been absorbed in biodegradable materials and liquids that have been stabilized by sorbents but will release liquids when compressed under normal pressure that might occur during and after land-filling) in any landfill is prohibited regardless of the length of time, presence of liners or leachate collection system.

Hence, TSDF shall use the paint filter liquid test (PFLT) to comply with this requirement. This test determines whether the waste can be accepted to landfill subject to its passing the PFLT. The waste is not subject to a ban if it passes the PFLT. However, it if does not, it must be treated before it can be placed in the landfill.

Waste treatment/stabilization would have to be performed on all wastes that find their final disposal into a landfill but do not meet the landfill disposal criteria. Typical analysis protocol for waste treatment/ stabilization would be as indicated in Annexure I (comprehensive analysis). Finger printing analysis for the same would be as indicated in *Annexure II*.

3.6.2 Identification parameters required for waste treatment / stabilization

Waste treatment/stabilization parameters shall include both physical and chemical tests. Physical tests shall be performed to characterize wastes before and after stabilization/solidification/treatment. The chemical tests shall primarily be the leaching tests, which will be conducted to evaluate the performance of specific treatment processes. The analysis shall be in line with the parameters as indicated in *Annexure I.*

3.6.3 Analysis protocol to confirm treatment/stabilization of waste

Physical Tests

The TSDF operator has to conduct and document the results of the following physical tests applicable to incoming waste as well as on treated/stabilized hazardous waste.

The physical tests shall be classified into the following categories

TEST	**PURPOSE**
Index Property Tests	
Particle size analysis (PSA)	To determine the particle size distribution of a material
Moisture Content	
Paint filter liquid test (PFLT)	To determine the presence of free liquids in a representative sample of bulk or non-containerized waste.
Density Testing	
Bulk density	To determine the in-place density
Compaction testing	
Moisture density relations	To determine relation between moisture content and density of the waste
Permeability Testing	
Falling head permeability / constant head (FHP/CH)	To measure the rate at which water will pass through a stabilized waste
Strength testing	
Unconfined compressive strength (UCS)	To evaluate how cohesive the stabilized materials behave under mechanical stress
Flexural strength (FS)	To evaluate the stabilized wastes ability to withstand loads over a large area
Cone index (CI)	To evaluate a stabilized wastes stability and bearing capacity
Durability Testing	
Wet and dry durability (WDD)	To determine how the stabilized waste behaves or degrades after repeated wet-dry cycles.

Chemical Tests

Leaching tests shall be used in evaluating the performance of treatment/stabilization/solidification processes for wastes as per the recommended TCLP procedure for the identified chemical constituents in the stabilized waste. The waste stabilized should meet the Best Demonstrable Available Technology (BDAT) standards of Unites States Environment Protection Agency (USEPA) before their disposal to the landfill till the BDAT standards are notified/stipulated under the Environment (Protection) Act, 1986, and rules made thereunder.

3.7 Waste Storage

Owner/operator of TSDF shall store such wastes in lined containers solely for the purpose of the accumulation of such quantities of hazardous waste as necessary to facilitate proper recovery, treatment or disposal for which economically viable treatment/disposal techniques are presently not available at or outside the facility. Each container shall be clearly marked to identify its contents and the date(s) of accumulation at the facility and such information for each consignment is recorded and maintained in the operating records at the facility.

Separate area should be earmarked for storing the waste at TSDF. The storage area may consist of different cells for storing different kinds of hazardous wastes. In designing these cells, the following points may be taken into consideration:

Those ignitable, reactive and non-compatible wastes shall be stored separately.

That wastes containing volatile solvents or other low vapour pressure chemicals should be adequately protected from direct exposure to sunlight.

The storage area should have a proper containment system. The containment system should have a collection area to collect and remove any leak, spill or precipitation.

It should be designed in such a way that the floor level of the storage area is at least 150 mm above the maximum flood level

The operator of the TSDF should put in place a system for inspection of the storage area to check the conditions of the containers, spillages, leakages etc., and maintain proper records as may specified by the SPCB/PCC in the authorization to operate TSDF.

The hazardous wastes should not be stored for more than two weeks at this temporary storage area.

In case of waste is not in accordance with the authorization issued by the SPCB/PCC to the generator, the TSDF operator shall reject the waste for the waste for further treatment and disposal. Information to this effect shall be immediately sent to the SPCB/PCC for advice.

3.8 Acceptance / Rejection of Waste Consignments for Storage

Owner/operator of TSD facility shall store such wastes for upto two years(s) unless MoEF / CPCB / SPCB/PCC demonstrates that such storage is not solely for the purpose of accumulation of such quantities of hazardous waste as are necessary to facilitate proper recovery, treatment or disposal. Otherwise, such wastes shall be stored at the facility beyond the stipulated period and owner/operator of the facility bears the burden of proving that such storage is solely for the purpose of accumulation of such quantities of hazardous waste as are necessary to facilitate proper recovery, treatment or disposal.

The operator of TSDF shall accept the hazardous wastes as per the authorization issued by SPCB/PCC to the generator and then undertake the operations for treatment/stabilization and disposal as per the conditions stipulated by the SPCB/PCC to the operator of TSDF.

Chapter 4

INCINERATION

4.1 Introduction

Incineration is an ultimate treatment process, applied to certain wastes that cannot be recycled, reused or safely deposited in a landfill. It is a high temperature, thermal oxidation process in which hazardous wastes are converted in presence of oxygen in the air into gases and incombustible solid residue. The gases are vented into the atmosphere through gas cleaning system as may be necessary while the solid residue is sent for direct disposal into the landfill. Applicability of incineration of hazardous waste depends on certain considerations illustrated as under:

- The waste is biologically hazardous
- It is resistant to biodegradation and persistent in the environment
- It is volatile and therefore easily dispersed
- It cannot safely be disposed into a landfill even after stabilization/treatment
- Volume reduction of waste is necessary

Incineration may take place either in dedicated, custom-built facility or in suitably adapted high-temperature process plants which maintain the required temperature for complete incineration of the material and are equipped to control air emissions as per the norms stipulated by the SPCB/PCC.

4.2 Incinerable Wastes

In general, if the waste is organic, then it has a high potential for incineration in view of its high calorific value. Typical wastes that would need to be incinerated by the operator of TSDF may include:

- Solvent wastes (spent solvents)
- Waste oils, oil emulsions and oil mixtures
- Hospital wastes of categories 1,2,3,.....and 10 of the Schedule I of the Notification No. S.O. 746 E, dated 20th July 1998, of MoEF, GOI, subject to authorization by the SPCB.
- Pesticide wastes

- Pharmaceutical wastes
- Refinery wastes
- Phenolic wastes
- Grease and wax wastes
- Organic wastes containing halogens, sulphur, phosphorous or nitrogen compounds
- Capacitors containing PCBs
- Solid materials contaminated with oils
- Others with calorific value >2500 Kcal/Kg.

Whether or not these wastes can be properly incinerated depends on the choice of incinerator temperature and its gas cleaning system - an important qualification, since the act of disposal should not itself cause a threat to the environment.

4.3 Guidelines for Incineration

The primary aim of incineration is completely destroy the toxicity of wastes and to get products (solids and gases) of combustion that are harmless. To achieve these aims, attention must be given to the "Three Ts of Combustion":

- Temperature
- Time
- Turbulence

Availability of oxygen is an additional parameter, which forms an integral part of the incineration system. When the waste is burnt at the higher temperature destruction would be complete and formation of un-burnt waste, formation of organic by-products etc. would also be eliminated. The longer the waste is held at high temperature, the greater will be the degree of destruction and the less-likelihood of formation of Products of In-complete Combustions (PICs).

Turbulence relates to the degree of mixing between the waste and oxygen in the combustion air and to the absence of temperature gradients within the furnace. Greater turbulence provides better control, better access to air and more complete oxidation destruction of the waste being burnt.

Finally, availability of oxygen is important for combustion of material.

Guidelines for operation of incineration:

- Temperature of 900-1100 ˚C for hydrocarbon wastes and 1100-1200 ˚C for certain wastes like PCBs, waste oil residues etc. For certain halogenated organics this has to be decided on a case-to-case basis.

- Time: Minimum gas phase residence time of 2 seconds. Residence time of hearth solids is measured in hours and thus control would be on complete destruction of solids.

- Combustion Air: 100% in excess of stochiometric requirements

- Turbulence: is achieved through good incinerator design.

The destruction and removal efficiency (DRE, %) of persistent organic pollutants in the hazardous wastes [particularly by Persistent Organic Hazardous Compounds - POHC] is to be calculated as indicated below:

$$\mathbf{DRE = \frac{(W_{in} - W_{out}) \times 100\ \%}{W_{in}}}$$

Where,

W_{in} - Concentration of the compound in the waste feed X mass rate of feed.
W_{out} - Concentration of the compound in the stack gas X volumetric flow rate of stack gas.

As a rule DRE must be greater than 99.99%.

4.4 Gas Cleaning

The constituents of flue gas depend on the composition of wastes and the severity of combustion conditions. The purpose of gas cleaning is to remove, as completely as is practicable, particulates and non-combustible contaminants such as fly-ash and metal oxides and acidic gases (particularly HCl). Un-burnt wastes and tract organic by-products shall be removed in the gas cleaning equipment. Air pollution control system for combined incineration of hazardous wastes at the TSDF is required to meet the emission standards as may be stipulated by the SPCB/PCC *(Annexure IV*).

4.5 Fuel Blending of Organic Wastes

Fuel blending and thermal treatment at lower temperatures in certain cases can be a low cost option for waste disposal as alternate to incineration, however, the emission standards applicable for these would be the same as applicable to incinerators.

Chapter 5

LEACHATE TREATMENT AND DISPOSAL

Having considered leachate quantity, quality and the variations associated properties, it is also essential to identify the components of the leachate that are to be treated or removed such as:

- Removal of high concentrations of degradable organic compounds
- Removal of high concentrations of non-degradable organic compounds
- Removal of varying concentrations of specific hazardous organics
- Removal of varying concentrations of specific hazardous inorganics
- Removal of ammonia
- Denitrification of nitrates/nitrites
- Removal of odours including sulphides
- Removal of suspended solids and
- Disinfection (if required)

TSDF operations shall comply with the consent conditions stipulated by the SPCB/**PCC** under the provisions of the Water (Prevention and Control of Pollution) Act, 1974, with reference to collection, treatment and disposal of leachate originating from the secured landfill *(Annexure - III).*

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Annexure I

COMPREHENSIVE ANALYSIS REQUIREMENTS FOR HAZARDOUS WASTES – GENERATOR /TSDF OPERATOR

Method of Analysis	**Comprehensive Analysis to be submitted by the Generators of Hazardous Wastes**
Physical Analysis	Physical State of the waste (liquid / slurry / sludge / Semi-solid / solid: inorganic, organic, metallic)
	Description of different phases of the wastes (in cases of solid wastes slurries and sludge) contained in aqueous / non-aqueous liquids / solutions
	Colo**u**r and Texture
	Whether the waste is multi-layered (Yes/No)? If yes, quantify each layer
	Specific Gravity
	Viscosity
	Calorific Value
USEPA, SW-846; Method 1010 and 1020	Flash Point
	% Moisture content **l**oss on ignition at 105˚C
	% Organic content loss on ignition at 550 ˚C
USEPA, SW-846; Method 9095	Paint Filter Liquid Test (PFLT)
Chemical Analysis	
USEPA, SW-846; Methods 9040, 9041 and 9045	pH

Inorganic Parameters Analysis	
USEPA; SW-846; Vol. 1C Part II; Test Method to determine HCN released from Wastes	Reactive Cyanide (ppm)
USEPA; SW-846; Vol. 1C Part II; Test Method to determine H_2S released from wastes	Reactive Sulfide (ppm)
USEPA; SW-846; 9010, 9011, 9012	Sulphur (elemental)
USEPA; SW-846; Vol. 1A, 1B, 1C and Vol. 2	Concentration of In-organics [as per Schedule 2 of HW (M&H) Rules, 1989, as amended].
Organic Parameters Analysis	Oil & Grease
	Extractable Organic (in special cases only)
	% Carbon
	% Nitrogen
	% Sulphur
	% Hydrogen
USEPA; SW-846; Vol. 1A, 1B, 1C and Vol. 2	Concentration of individual organics [as per **S**chedule 2 of HW (M&H) Rules, 1989, as amended]
USEPA; SW-846; Method 1311, 1330	Toxicity Characteristics Leaching Procedure (For the parameters identified in **Section 2, Annexure -III** and the listed parameters as presented in Method 1311 of SW 846; USEPA)

Annexure II

FINGERPRINT ANALYSIS REQUIREMENTS FOR HAZARDOUS WASTES - TSD FACILITIES

Method of Analysis	**Fingerprint Analysis by the Operators of TSD Facilities**
Physical Analysis	Physical State of the waste (liquid/slurry/sludge/semi-solid/solid: inorganic/organic/metallic)
	Identification of different phases of the wastes (in cases of solid wastes contained in aqueous/non-aqueous liquids/solutions for slurries and sludge)
	Colo**u**r & Textures
	Whether the waste is multi-layered (yes/no)? If yes, quantify each layer
	Specific Gravity
	Viscosity
USEPA, SW-846; Method 1010 and 1020	Flash Point
	Loss on ignition at 10 ˚C
	Loss on ignition at 650 ˚C
USEPA, SW-846; Method 9095	Paint Filter Liquid Test (PFLT)
USEPA, SW-846; Method 9096	Liquid Release Test (LRT)
Chemical Analysis	
USEPA, SW-846; Method 9040, 9041 and 9045	pH
USEPA, SW-846; Vol. 1C Part II; Test Method to determine HCN released from Wastes	Reactive Cyanide (ppm)
USEPA, SW-846; Vol. 1C Part II; Test Method to determine H_2S released from Wastes	Reactive Sulfide (ppm)

Annexure III

CONCENTRATION LIMITS/CRITERIA FOR ACCEPTANCE OF HAZARDOUS WASTES FOR DIRECT DISPOSAL TO SECURED LANDFILL

Leachate Quality *	**Concentration**
pH	4 - 12
Total Phenols	< 100 mg/l
Arsenic	< 1 mg/l
Lead	< 2 mg/l
Cadmium	< 0.2 mg/l
Chromium-VI	< 0.5 mg/l
Copper	< 10 mg/l
Nickel	< 3 mg/l
Mercury	< 0.1 mg/l
Zinc	< 10 mg/l
Fluoride	< 50 mg/l
Ammonia	< 1,000 mg/l
Cyanide	< 2 mg/l
Nitrate	< 30 mg/l
Adsorbable organic bound Chlorine	< 3 mg/l
Water soluble compounds except salts	< 10%
Calorific value	**< 2500 K.Cal/kg**
Strength	
Transversal strength (Vane Testing)	> 25 KN/m^2
Unconfined Compression Test	>15 KN/m^2
Axial Deformation	< 20 KN/m^2
Degree of Mineralization or Content of Organic Materials (Original Sample)	
Annealing loss of the dry residue at 550°C	< 20% **by weight** (for non-biodegradable waste) < 5% **by weight** (for biodegradable waste)
Extractible Lipophilic contents (Oil & Grease)	< 4% **by weight**

***** *Leachate quality is based on Water Leach Test*

Leachate Disposal Standards

S.No.	Parameter	Standards (mg/l)			
		Inland Surface	**STP**	**CETP (See note)**	**Marine Coastal Areas**
Additional Parameters Recommended					
1.	Adsorbable Organic Halogens (AOX)	0.50	-	-	0.50
2.	Poly Aromatic Hydrocarbons (PAH) (each)	0.059	-	-	0.059
3.	Benzene	0.14	-	-	0.14
4.	Toluene	0.08	-	-	0.08
5.	Xylene (sum of o, m, p-xylene)	0.32	-	-	0.32

Note :

1. In addition to the above, General Standards for discharge of environment pollutants Part-A: Effluents notified, vide G.S. R. 422 (E), dated 19.5.1993 and published in the Gazette No. 174, dated 19.5.1993 under the Environment (Protection) Act, 1986, and rules made thereunder, shall also be applicable for disposal of leachate into sewage treatment plant, common effluent treatment plant, Inland surface water bodies or coastal areas.

2. For each CETP and its constituent units, the SPCB/PCC shall prescribe standards as per the local needs and conditions; these can be more stringent than those prescribed above. However, in case of clusters of units, the SPCB/PCC may prescribe suitable limits.

3. Leachates having high COD shall be concentrated through evaporation (forced) and fed to the incinerator of the integrated TSDF in view of its high calorific value, and the residue ash shall be disposed off in their secured landfill.

4. The Bioassay test shall be substituted by ‘Fish Toxicity’ test, and a dilution factor of 2 (two) may be considered.

ANNEXURE -IV

EMISSION STANDARDS FOR COMMON HAZARDOUS WASTES INCINERATOR

A. Emission limit of incinerator while operating properly at 100% rated capacity, shall have an emission limit from the discharge stack to atmosphere of less than or equal to:

Parameter	**Emission limit (mg/Nm^3)**
Particulates	50
HCl	50
SO_2	200
CO	100
Total Organic Carbon	20
HF	4
NO_x (NO and NO_2 expressed as NO_2)	400

Note: All values corrected to 10% oxygen on a dry basis

B. Hydrocarbons: 10 ppm, over an hourly rolling average dry basis, measured as propane.

C. Opacity: While operating properly at 100% rated capacity, the system shall have a visible emission rate of less than or equal to 10%, except for condensed water vapour, from the discharge stack to atmosphere (one hour rolling average).

D. Dioxins/Furans: While operating properly at 100% rated capacity, the system shall have an emission of dioxins and furans of less than or equal to 0.1 ng TEQ/Nm^3 corrected to 10% oxygen. Sampling period shall be minimum 6 hours and maximum 8 hours. Analysis of dioxins and furans as well as reference measurement methods to calibrate automated measurement systems shall be carried out as given by CEN-standards. If CEN-standards are not available, ISO standards, National or International Standards, which will ensure the provision of data of an equivalent scientific quality, shall apply.

E. Metals: While operating properly at rated capacity, the system shall have an emission rate from the discharge of stack to atmosphere less than or equal to

Metals	**Emission Limit (mg/Nm^3)**
Cd + Th (and its compounds)	0.05
Hg (and its compound)	0.05
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V (and their compounds)	0.50

Note: All values corrected to 10% oxygen on a dry volume basis

F. Operating standard:

1. Combustion efficiency (CE) shall be at least 99.9% and shall be computed as follows:

$$CE = \% CO_2 \div [\% CO_2 + \% CO] \text{ X } 100 \%$$

2. Temperature of the primary chamber shall be at least 850 °C.

3. Secondary chamber gas residence time shall be at least 2 (two) seconds at 1100°C, with minimum 3% oxygen in the stack gas.

4. Destruction and Removal Efficiency (DRE) for each principal organic hazardous constituent (POHC) in the waste feed shall be at least 99.99%.

5. DRE for hazardous waste containing PCBs, PCTs and other chlorinated compounds shall be 99.9999%.

G. Air pollution control device: The emission control system shall be installed for gas cleaning and removal of air pollutants. The system shall comprise the following equipment, singly or in combination, with design efficiencies to meet the emission norms:

(i) Waste heat boiler / heat exchanger / quencher

(ii) Bag filters / ESP / Cyclone

(iii) Dry / wet scrubber with hydrated lime or sodium hydroxide injection

(iv) Chimney / stack of minimum 30 m height or as per formula: $H = 14 (Q)^{0.3}$ [where, Q is the emission rate of SO_2 in kg/hr] which ever is more.

(Note: Dry/wet ESP, spray dryer, dedioxide filter and mist eliminator shall also be considered as may be required)

H. Operating conditions: Incineration plants shall be operated in order to achieve a level of incineration such that the Total Organic Carbon (TOC) content of the slag and bottom ashes is less than 3%, or their loss on ignition is less than 5% of the dry weight of the material. If necessary appropriate techniques of waste pretreatment shall be used.

Incineration plants shall be designed equipped, built and operated in such a way that the gas resulting from the process is raised, after the last injection of combustion air, in a controlled and homogenous fashion and even under the most unfavorable conditions, to a temperature of 850 °C, as measured near the inner wall or at another representative point of the combustion chamber as authorized by the competent authority, for two seconds. If hazardous wastes with a content of more than 1% of halogenated organic substances, expressed as chlorine, are incinerated, the temperature has to be raised to 1200 ± 100 °C for at least two seconds.

Each line of the incineration plant shall be equipped with at least one auxiliary burner. This burner must be switched on automatically with the temperature of the combustion gases after the last injection of combustion air falls below 850^{o}C or 1100 °C as the case may be. It shall also be used during plant start-up and shut-down operations in order to ensure that the temperature of 850 °C or 1100 °C, as the case may be, is maintained at all times during these operations and as long as unburnt wastes is in the combustion chamber.

During the start-up and shut-down or when the temperature of the combustion gas falls below 850 °C or 1100 °C, as the case may be, the auxiliary burner shall not be fed with fuels which can cause higher emissions than those permitted.

I. Monitoring requirements: Continuous monitoring and recording system for opacity, CO, SO_2 and NO_x shall be; installed and reports shall be sent to the State Pollution Control Board/Pollution Control Committee on regular basis. Interlocking arrangements for CO and temperature controls (in primary and secondary chamber) with feeding devices shall also be provided.

Waste feed has also to be terminated on loss of ignition in the afterburner.

Safety valve shall be provided in case of high-pressure development in the furnace.

J. Notification of compliance: The operator of the incinerator shall undertake comprehensive performance test. Within 90 days of completion of comprehensive performance test, the operator shall issue a notification of compliance documenting compliance or non-compliance, as the case may be, for public information / notice.

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