Guidelines For Setting up of operating facility :
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GUIDELINES
FOR
SETTING UP OF OPERATING FACILITY :

HAZARDOUS WASTE MANAGEMENT

CENTRAL POLLUTION CONTROL BOARD
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FOREWORD

The Hazardous Wastes (Management & Handling) Rules, 1989 under the Environment (Protection) Act, 1986 provide for permission to an occupier / generator of waste to transport the hazardous wastes to an operator for further safe treatment and disposal.

Availability of reliable "operating facility" is an important requirement for effective management of hazardous wastes. The operator can be a government agency, an industry Association, a joint venture or a private sector company. We have an experience of common effluent treatment plants where government, nodal agency, industry Association/companies participated.

Hazardous waste treatment is a costly affair and needs continuity to run the treatment unit. The facility demands specialised supervision and instrumentation. Hazardous wastes can hardly be reliably disposed by a loose confederation and a dedicated operating agency only can offer a solution. The industry and regulatory authorities should, therefore, groom such operating agencies. To this end, it will be useful to have some guidelines for setting up of operating facility for hazardous waste management.

The present document provides a few practical tips given in a capsule form along with a few check points to the aid of State Pollution Control Board, future operating agencies and member industries.

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Comments and useful criticism would be welcome for further refinement of this document.

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GUIDELINES
FOR
SETTING UP OF OPERATING FACILITY
HAZARDOUS WASTE MANAGEMENT

1. Introduction

Handling water pollution or air pollution did not pose much problem in 70's or 80's either to the polluters or to the regulatory authorities. It was so, because it became possible for the industry to collect/capture the pollutants and treat the same on-site before satisfactorily smooth disposal into the environment. On the other hand, hazardous waste cannot be so easily treated in-situ and disposed on-site for all the time. This problem faced in 90's is nearly unsurmountable on individual basis, and is equally harsh for both large scale as well as small scale industries. The water will flow or air will disperse, but solid waste is going to stay. The law-makers were aware of this peculiarity and hence have made a departure from the established principlethat "criminal liability cannot be transferred", and have given a permission to an occupier/generator of waste to pass it to an operator for further safe treatment and disposal. This was not the case in water or air pollution regimes. The success of hazardous waste management will be directly proportional to the availability of reliable Operating in the field. This Operator can be a Government Agency, an Industries' Association, a Joint Venture or a private company as Operating Agency. We have an experience of common effluent treatment plant (CETP), wherein, Government, nodal agency, industrial co-operatives participated. The joint venture is not a success story in all the cases and in some cases frictions are surfacing in course of time. When such flash points occur, the scheme is likely to collapse. And in CETP there are many occasions of flash points. This is shown by way of Figure 1. It therefore appears that hazardous waste can hardly be reliably disposed by a loose confederation; and hence private operating agency only can offer a solution. Hazardous waste treatment is a costly affair and need a continuity to run the treatment plant. The facility demands a specialised supervision and and instrumentation and necessarily has to be away and capable to hold the waste for atleast 25 years. Hence, this cannot be done by the industries independently or by a loose confederation and hence a common operating agency, will be a welcome feature as this will be the only option for survival, the industry and regulatory authority should carefully groom such Operating Agencies.

The following documents are eloquent enough as to the requirements of such operating agency viz.

LIFE CYCLE OF CETP JOINT VENTURE

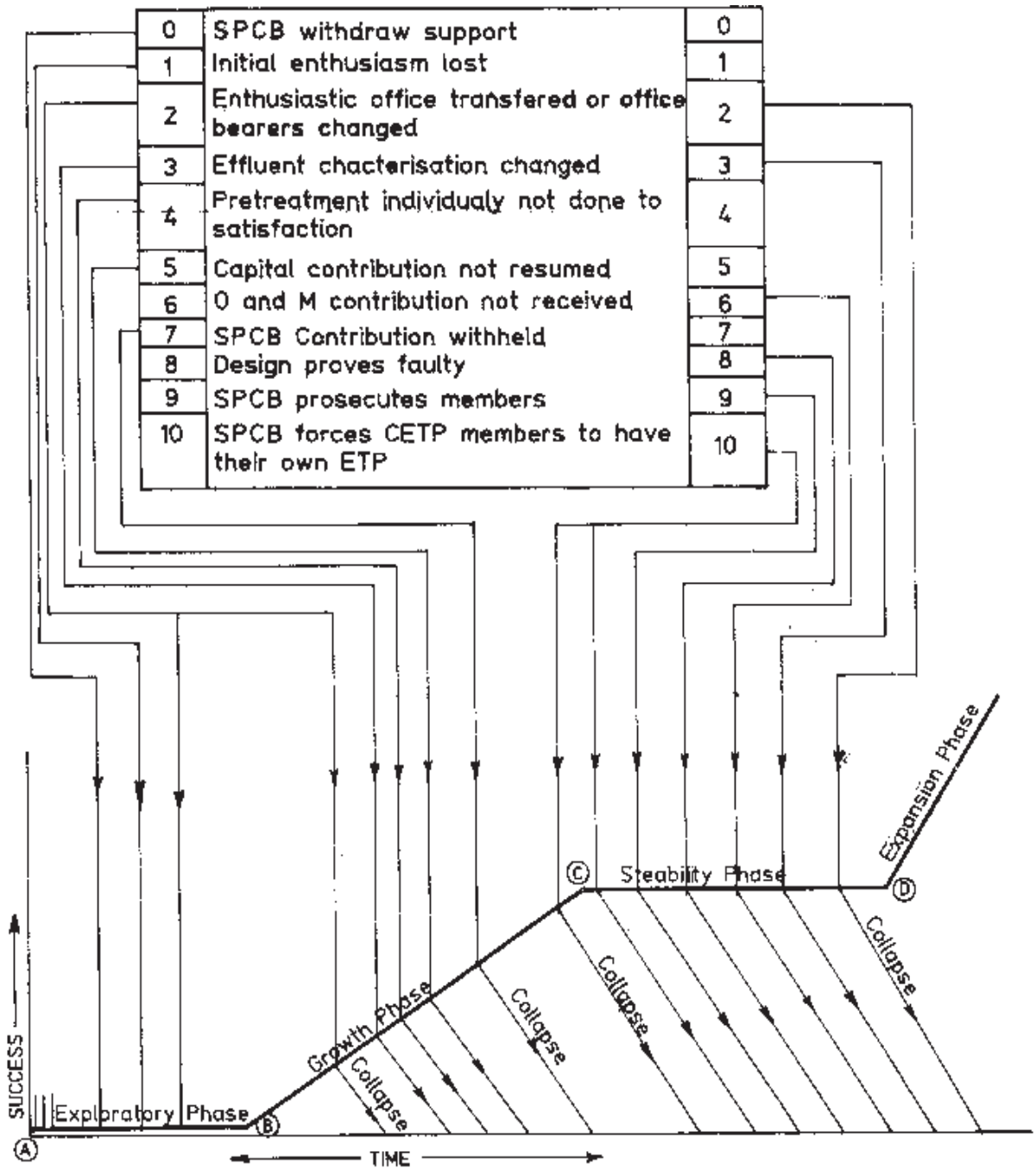


FIGURE - 1

1. Hazardous Waste (Management and Handling) Rules, 1989
2. Guidelines for Management of Hazardous Wastes, 1991
3. Guidelines for siting of hazardous wastes treatment and disposal facilities.
4. A guide to manufacture, storage and import of hazardous chemicals.
5. Manual on emergency preparedness for chemical hazards.

This paper is based on the same coupled with a few practical tips to give in capsule the check-list points for the use of State Boards, future operating agencies and member industries.

2. Expectation

The Rule 5(4) expects that the proposed operator should "possess appropriate facilities, technical capabilities and equipment to handle hazardous waste safely". Further, the very fact that the Rules provide for the transfer of responsibility by permission to the operator, means that the Rule presupposes that the operating agency wil do such work with better efficiency than the generator.

The Expectations from operating agency from A to Z [(a) to (z)] are as under :

(a) Site selection
(b) On-site storage at generator's premises
(c) Pre-treatment on-site at generator's premises
(d) Pre-transport precautions
(e) Loading and transportation
(f) Mopping up or spillage management, if necessary
(g) on-site storage at operating agency site (unloading and receiving on-site
(h) Characterisation
(i) Segregation
(j) Physical treatment facilities
(k) Chemical treatment facilities
(l) Biological treatment facilities
(m) Thermal treatment
(n) Public acceptability
(o) Recovery
(p) Composting
(q) Landfill
(r) Incineration
(s) Post-treatment/pollution control

(t) Back transportation of recovered matter (as hazardous chemicals)
(u) Monitoring
(v) Closure plan
(w) Record-keeping & reporting
(x) Research and training
(y) Safety and security
(z) Management

The ideal operating agency should, therefore be, capable to fulfill these requirements, along with a commitment to satisfy the theme in spirit and not merely in letters. Being conversant with the foreign Acts, international Acts, Conventions and technical update knowledge on resource recovery, will be essential features required for operating agency.

With the possible recovery, if the operating agency can save valuable foreign exchange and resources, then it is not merely a "cradle to grave" policy but a capability of "cradle to grave to rebirth" policy.

The chain of expectations is proposed to be discussed herein below:

3. Site selection

Under Rule 8 of the Hazardous Waste (M&H) Rules, 1989, responsibility of site selection is entrusted to the State Government. However, it may happen that such selection may not get finalised. There may be some genuine reasons behind it, but the fact remains that the industry-sector may suffer in absence of a starting point. It will be worthwhile and a good management practice (GMP) if the operating agency for the well-being of their own industrial clients, undertakes a search and finalises a site. The site along with its description, map & suitability can be suggested to the State Governments, SPCB & Industrial Association, for final approval, acquisition, presuasion or permission to purchase/making it non-agriculture NA use.

Site selection procedure be so adopted so that the distance of the site is not too close to cause impact, too far as involve heavy transporting cost and risk. A thick impervious cushion between the bottom of landfill and top of groundwater table, sufficiently big size to have 20 year's future waste, good dispersion of air pollutants, public acceptability, safe distance from habitations (present and future); are the points to be seen. Ranking has to be made by adopting Delphi technique as detailed in the Guidelines or by superimposing the rejection maps (GIS technique), as given in CPCB publication on Zoning Atlas.

The information gathered may be submitted to the State Govt. and final trade-off may be arrived at. This may prove expedient.

4. On-site storage and generator premises

Although this is a basic requirement of the generator under Rule 4(1), it may be found in practical world that the generator may not have that much awareness. Some feel that once the operating agency is appointed, the entire work they will do. Such situation has to be avoided. It will be worthwhile if operating agency takes a small step-forward and does this job.

Knowing the names of raw materials, intermediate products, bye-products, co-products and discarded products, one can find the character of the generated hazardous waste. The physical stations in the factory from where it comes is also of a routine & common knowledge. The operating agency should preferably give earmarked drums or closed trolleys where the respective hazardous waste may be dumped by the workers. Incompatibility will be automatically observed, if colour-coding is fixed on the receiving drums. The drums be of adequate size, the frequency of removal be good enough as to avoid overflow. The on-site storage to be at isolated place (six meters in normal case but 15 meters in ignitible or reactive waste) within the premises, fenced raised paltform, roofed and having a parapet wall, with signboards announcing the “hazardous waste” and “no smoking” signboards. The approach road be level, board and surface be plain without post-holes and well-illuminated. At no time the statutory limits of weight-period be crossed (say in normal case, 10 T (or a truck load) - 90 days, or if 1 T / month then 180 days or 6 T; and 1 T / month and has to be transported to 500 km then 270 days).

Record keeping must be good and should include remarks of daily inspection on abnormalities, drum-rupture, rains etc.

5. Pre-treatment on-site

Pre-treatment is a treatment given generally in-situ to a waste prior to its full-fledged further treatment at the common hazardous waste facility at a distance. The purpose of this spep of pretreatment is limited, as to be more amenable for transport and further treatment. Pretreatment has a smaller compass than treatment, though proves useful. Treatment is defined as any method, technique, or process, (including neutralisation) designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neturalise such waste or so as to recover energy or material resources from the waste, or so as to render such a waste non-hazardous or

less hazardous, safer to transport, store or dispose of; or amenable for recovery, amenable for storage or reduced in volume.

In pretreatment, therefore, agency can keep an objective of neutralisation, change in form, render it less hazardous, safer to transport or reduced in volume, and also includes addition of absorbent materials.

If the operating agency fix a pre-treatment unit in the premises of a generator, it may remain idle for most of time, with a small individual waste quantity. Any intermittant running creates problems and idle time is not wise. The operating agency may therefore consider whether he can introduce a system of portable pretreatment units, mounted on or trailed to mobile van. Simple operation like neutralisation, dewatering or absorbent-mix can be so attempted.

A good record keeping and obtaining mutual signatures be adhered to.

6. Pre-transport precautions

Transportation can be a safe and secure operation only if pre-treatment precautions are taken honesly. The pre-transportation includes examination of the transport vehicle, transport trailer, containers, packing labelling, marking, the TREM cards, the manifest book and the inerview of driver and helper.

In order to ensure that the materials are not unloaded anywhere, the operating agency is advised to paint the following at the back of the transport vehicle, viz. “This vehicle transports hazardous waste. If anybody finds it, emptying out the contents, report to the nearest police/police station”.

The Hazardous Waste Management Guidelines, 1991 & Motor Vehicle Rules 1989 provide a number of pretransporting helping clues to the operating agency and the same be observed.

The vehicle as well as the trailer be inspected. The cushioning, springs, shock absorbers, sparking from silencers, engine getting hot, starting troubles, closing arrangements, conditions of tyre, tubes of wheels and stepney, batteries and radiators be checked for satisfaction, including the alertness of driver and helper.

Containers need not be discarded everytime it is used. However, it be washed carefully to see that incompatible fresh waste is not filled on the residue of previous waste. Also examine for any physical structural defects. The old labels or colour-code has to be

removed to avoid misleading messages. If a container is specifically meant for a single trip use or if it has transported in the last trip anhydrous hydrofluoric acid, the same must not be pressed into service again.

Labels are symbolic representations of the hazards associated with a particular matter. The labels must be affixed at a pre-determined location always. The label should announce the most serious hazard, if the waste is capable to produce many hazards, e.g. if the material is such which makes the driver restless due to odour nuisance and is also poison, write "poison" on the label being more hazardous prospects. The hierarchy can be fixed as follows for reporting, viz.

1. Radio-active material
2. Poison
3. Flammable gas
4. Non-flammable gas
5. Flamable liquid
6. Oxidiser
7. Flammable solid
8. Corrosive material
9. Corrosive material (solid)
10. Irritating material
11. Combustion liquid
12. Material, damaging vehicles or nuisance to crew

Packaging means assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements and includes containers, portable tanks, cargo tanks, tank cars, and multi-tank car tanks.

The purpose of packaging is to avoid vibrations, collisions, over-flows, gasification and other such unsafe occurrences. The packages, therefore, are to be secured among themselves and to the body of the vehicle. Further, there should be no possibility of reactions between the contents and the packings, nor there be any damage between packing and packing.

After packing, proper marking is required to be done. Marking means applying the descriptive name, instructions, cautions, weight or specification marks or combination

thereof to be placed upon outside containers of hazardous materials. The Motor Vehicle Rule be followed about marking which expects : As a pretransport requisite mark boldly as “HAZARDOUS WASTE” and “HANDLE WITH CARE” in Red and in English and regional languages in each and every container. The size of the label be 150 x 150 mm and should have a fluorescent background colour. The label be of water proof material and non-washable. When the container returns empty, affix a triangular label of size 100 x 125mm also the marking “THIS SIDE UP” and “THIS END UP” be displayed.

When the vehicle leaves the premises, it sould not do so unless record keeping is fulfilled, TREM cards are given, driver is instructed on the nature of contents, possible leakages, antidotes and how to manage the spills including, reporting. The manifest book must be filled and copy no. 3,4,5 & 6 should accompany the driver.

The TREM card is an important link, and a good use of it ensures relief in the situation. TREM card is a Transport Emergency Card. It describes, as shown in figure 2:

(a) The characteristics of the wastes (physical state & properties, chemical constituents and exposure hazards,

(b) Immediate first aid requirements,

(c) With special reference to the material under transport, what procedure be followed by the transporter and fire-fighters/police:

  (1) in case a fire breaks out.

  (2) in case of impending explosions and

  (3) in case of accidental spillage.

(d) For additional expert & specialised service who should be immediately contacted (name & address and phone no.). This can be done by transporter / Police / Member of public.

Before the vehicle moves out, please also see whether it carries two warning signal boards (placards), which the driver might need to put on both sides of the road, in case an accidental spill occurs en-route. Sufficient paper towels also must be handy for mopping-up the spills.

TRANSPORT EMERGENCY CARD (TREMCARD)

PRODUCT NAME ACETONITRILE (ACN) (METHYL CYANIDE)
CHEMICAL FORMULA : H_2C - C X N
SUBSTANCE UN NO. : 1648
UN HAZARD CLASS : 6.1
EAC (HAZCHEM CODE) : 2 WE
ADR HAZARD IDENTIFICATION NO. : 336

PHYSICAL PROPERTIES

Melting Point, C	-41.9
Boiling Point, C	81.6
Flash Point (cc) C	5.6
Auto-Ignition Temperature, C	524
Explosive Limits, %V	4.4 to 16.0
Vapour Density (Air - 1)	1.42
Specific Gravity	0.78

TLV	ppm	mg/m^3
TWA	**40**	**70**
STEL	**60**	**105**

OTHER CHARACTERISTICS

It is a colourless liquid with a characteristic odour. Highly polar and violently reactive. Freely miscble with water, acetone, ether, ethylacetate, chloroform etc.

Decomposes with the evolution of highly toxic hydrogen cyanide gas.

it reacts with water, steam and acids and emits toxic nitrogen oxides.

PROTECTIVE DEVICES	Face-shield/safety goggles, PVC gloves and PVC apron.	
EXPOSURE	SKIN	- May cause dermatitis.
	EYES	- Irritant
	INHALATION	- May cause dizziness, increased breathing, rapid pulse.
	INGESTION	- May cause anorexia, nausea, vomitting. Higher does may be fatal.
FIRST - AID	SKIN	- Wash the affected skin with water.
	EYES	- Wash the eyes with plenty of water.
	INHALATION	- Remove the affected person to fresh air. Give artificial respiration or oxygen, if required. Break an anmyl nitrite inhalant ampoule in ahandkerchief and let the victim inhale it for 15 seconds.
	INGESTION	- Do not induce vomitting. If conscious, give plenty of water or milk to drink. OBTAIN MEDICAL ATTENTION IMMEDIATELY
SPILLAGE	Contain the spillage by absorbing in earth, sand or saw dust and bury the same (away from wells). **Do not allow entry into water courses.**	
FIRE	Flammable. Dangerous when exposed to heat or flame. On thermal decomposition, it evolves toxic hydrogen cyanide gas. Use foam, carbon dioxide dry chemical powder of BCF/Halon. Cool the drums with water, if exposed to heat or flame.	
EXPLOSION	Explosive when heated or when it reacts with oxidisers. Cyanide fumes produced react violently with steam, acids and alkaline substance.	
EMERGENCY ACTION	- Stop engine. - No Smoking - No open flame or spark - Block road and warn other users.	
FOR EXPERT ADVICE CONTACT	(Give Name, Address, STD No.)	

NOTIFY POLICE AND FIRE BRIGADE IMMEDIATELY

FIGURE - 2

7. Loading & Transportation

Loading of the waste into vehicles and transporting out the same is an activity which the operating agency should not do mechanically without application of mind. Loading be preferably made by chain, lifting shackles and cranes. This is a regular affair and hence, any ad-hoc arrangement be avoided. Loaded material be securely fastened so as to lessen any vibrations or colliding of containers, resulting in noise, spillage or damage.

When a tragedy arising out or hazardous waste is to be avoided, precautions are required to be taken at all the steps viz. at generation, transport, storage, treatment and disposal i.e. every link in the chain. As is proverbially said that the strength of a chain lies in its weakest link, it is advisable to identify and reinforce the weakest link first. A large number of unfortuante episodes have shown as to which is the weakest link. The road accidents are on increase and hence transportation must be disciplined. There are many reasons for failures. Some of them will fall under the HW (M&H) Rules 1989, which will be considered hereinbelow; while other reasons, though genuine, are outside the purview, like say substandard road surface, defective road alignments, banking and curve designing, poor illumination or blinds etc. Majority of harsh consequences of accidents can be controlled if conscious and conscientious approach is adopted.

The change of custody is an aspect, which the court takes very seriously. Hence, proper documentation is necessary. From practical view point also, locating a hazardous waste should become easy. Manifest system is, therefore, to be implemented by the operating agency.

Manifest is a shipping document on a prescribed format, as shown in figure 3, originated and signed by the generator or operating agency (depending on Terms of Reference) in accordance with the instruction given in Rules or Guidelines. The manifest system is to be dealt more seriously for off-site rather than on-site treatment and disposal where tracking is not of any significance. Likewise the small scale generators or those who are exempted from obtaining authorisation, being producers of hazardous waste quantity lesser than regulatoty quantity; still are advised to adopt the manifest system, though may be exempted. For operating agency, this is more safe to accept manifest system.

The manifest is a one page form with multiple carbon copies (one plus five). The sender of the waste (i.e. occupier generator or operating agency as the case may be) has to make all the 23 entries in the format. The operating agency should see that the manifest

HAZARDOUS WASTE MANIFEST

(Information of hazardous waste for disposal)

1. Occupier's Name & Mailing Address : (including Phone No.)			2. Occupiers Registration No. 3. Manifest Document No.
4. Transporter's Name & Address : (including Phone No.)	5. Type of Vehicle Truck Tanker Special Vehicle		6. Transporters Registration No. 7. Vehicle Registration No.
8. Designated Facility Name & Site Address :			9. Facility's Registration No. 10. Facility's Phone
11. Waste Description:			12. **Total Quantity of Waste** m^3 t 13. Consistency: Solid Oily Semi-Solid Tarry Sludge Slurry

14. Transport Discription of Waste	15. Containers		16. Total Quantity	17. Unit Wt./Vol.	18. Waste Category No.

19. Special Handling instructions & Additional Information :

20. OCCUPIER'S CERTIFICATE: I hereby declare that the contents of this consignment are fully & accurately described above by proper shipping name and are categorised, packed, marked, and labeled and are in all respects in proper condition for transport by road according to applicable national government regulations.

Typed Name & Stamp Signature Month Day Year

21. Transporter's Acknowledgement of Receipt of Materials

Typed Name & Stamp Signature Month Day Year

22. Discripency Note Space

23. Facility Owner or Operator's Certification of Receipt of Hazardous Waste

Typed Name & Stamp Signature Month Day Year

copies which are in his possession as a transporter are duly travelling, getting signed and then returning to the desired place, as shown in figure 4.

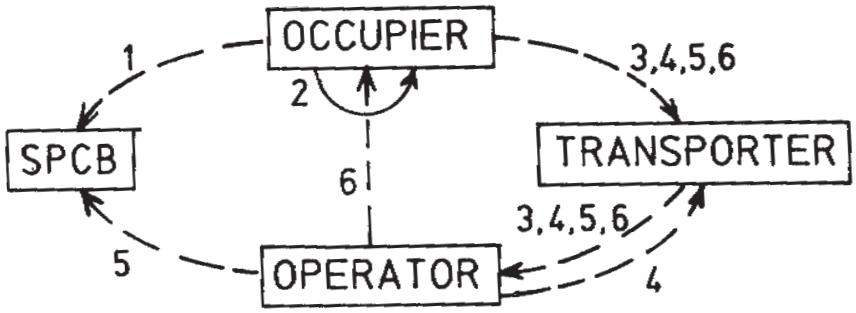


FIGURE - 4

In case the occupier generator receives the copy no. 2 (light yellow) but does not receive copy No. 6 (light brown) even after on expiry of a reasonable time period (say one month) or if SPCB receives copy no. 1 (white) but does not receive copy no. 5 (green) within a month, means there is some discrepancy, i.e. either the material is lost en-route by transporter, or has gone to different disputed designation or perhaps the operating agency has received the waste in order but has not cared to sign and send back the copies no. 5, 6 respectively to the SPCB and occupier. The manifest discrepancy arises (a) for bulk waste, variations greater than say 2 to 5 percent in weight or (b) for batch waste, any variation in piece count, such as discrepancy of one drum in a truck-load. This has to be investigated.

Finally,

With	Manifest No.	Colour
Occupier	2	Light Yellow
	6	Light Blue
Transporter	4	Dark Yellow
Operator	3	Pink
SPCB	1	White
	5	Green

The manifest copies be maintained for 3 years and the matching record be maintained both at on-site and at off-site. The record among other things should show cross reference to specific manifest document numbers and location on a map where such Hazardous waste is unloaded, stored or disposed. This record be maintained even after closure.

8. Spillage handling

Spillage is an accidental spillage. If there is a deliberate, systematic and routine purging either in the production process or transport, it will not be called as an unforeseen act or event. It will be dealt more seriously by other provisions of the law. The accidental spillage is that spillage which has occured for one time inspite of taking full precautions by the operating agency, generator, holder or transporter as to its storage, container, packing, labelling, marking, loading, transporting, unloading, etc.

The Hazardous Waste Rules exempt certain occupiers who generate the waste less than the regulatory quantity. Even such occupiers, transporters, operating agency also must take full after-care, once the spillage occurs in a public place. Likewise the Hazardous Waste (M&H) Rules, 1989 do not cover the hazardous chemicals. However, if any such chemical spills in transport, the spilled substance becomes a hazardous waste and has to be then handled equally carefully. Sometimes the quantity spilled may be small, but it spreads quickly, making the soil contaminated. The whole block of that soil becomes a hazardous waste and has to be subjected to cleaning process.

The operating agency should train transporting driver and helper as to what action they should immediately take on such accidental spillage. The first thing to do shall be to switch off the engine, put warning signals on both sides of the road, note the topography as to what path of flow it may adopt, in case of fire, try to extinguish and by the help of the public inform the nearest fire brigade and remain upwind. He will then proceed to report to the immediate police station regarding the accident, exact location, the clean-up measures needed and the name of the officers/special officers/special experts, who are to be contacted at such time. The driver must know in advance as to what are the police station enroute and what are their normal geographical jurisdictions.

The TREM (Transport Emergency) card at such times becomes useful as it provides instructions for saving the situation in case of fire, in case of explosion, in case of accident/spillage and further gives the names as to who are the experts in the line to be contacted. A copy of the TREM card is enclosed for ready reference as figure 2. The

accidental spillage is required to be reported in writing to the concerned State Pollution Control Board authorities & district administration authorities as well. The Form V of the Rules may be used.

The spill will bring in a discrepancy in the manifest. Either the quantity will be reduced due to flowing out and/or may be increased e.g. when contaminated soil is collected by the transporter. This shall be brought to the notice of the supervisor of the operating agency site where the material goes.

Placards or road-signs must be erected in such a way as to be visible and legible. See that the sight is not obstructed by trees, bushes, drums, other posts, pillars or standing vehicles.

The spill-management is a difficult task. In some cases, the organic halogenate solvents, beryllium and its compound, tellurium and its compounds, phenols, nickel, and its compound, it may be possible to absorb the spills on proper towel then and there, and evaporate or burn it later in controlled fashion under a hood, at operating agency site. However, in many other cases like cyanide, lead, copper, zic, chromium, selenium, barium, antimary, mercury, arsenic and their compounds, the spill control is not simple and has to be handled by using certain chemical procedure like say in case of antimony, dissolve the spill in a minium amount to concentrated hydrochloric acid, add to water until a white precipitate appears. Add 6ml-HCL, just to dissolve it again. Saturate with hydrogen sulfide. And after filtration, wash the precipitate, pack it & return to supplier. Thus it is easier to take prevention of spilling, rather than controlling it.

9. Unloading and Receiving on-site

At the on-site of operating agency facility, unloading is a regular feature, and hence proper gadgets can be easily provided. The condition of the internal roads be maintained smooth to avoid overflows. Proper fork-lifters, gantry, chain-shackles, cranes, suction pumps with non-flammable electrical connections be made available.

The manifest has to be checked on entry of the vehicle for any discrepancy, or else the copies duly signed must be distributed back, as no. 4 (dark yellow) to transporter, no. 5 (green) to State Pollution Control Board and no. 6 (light blue) to the occupier generator and retaining no. 3 (pink) in the operating agency site.

The receiving shift-in-charge shall record all the receipts and manifests, in a register as

well as on a site map, irrespective of whether it is a temporary storage or permanent disposal. Care will be taken to see that incompatible wastes are not stored in each other's vicinity. In case of doubt, better to err on safer side.

10. Characterisation

The characterisation or laboratory analysis will become necessary on many occasions, such as

1. Raw hazardous waste, to know the hazard level.
2. Pre-treatment treatability study to design a pre-treatment, if needed.
3. Waste after pre-treatment, to know the efficiency of pre-treatment, and load on further treatment.
4. Treatability studies to design any further treatment prior to disposal or reuse.
5. Waste after treatment to know the efficiency of treatment and to know suitability or re-use.
6. Waste prior to disposal to know (i) whether it is suitable for land-fill or (ii) calorific value if it is to go for incineration, including possibility of acidic fumes or dioxin.
7. Residue after disposal as to water samples (surface or groundwater monitoring), leachates, incineration ash, incineration emissions, and fugitive or stack emission deposition on top soil etc.
8. Periodical monitoring thereafter to know the kinetics of migration.

The United Nation Committee and European Communities Council have listed the hazardous characteristics. When put together these are 14, as explosive, oxidising, inflammable, irritating, harmful, toxic, carcinogenic, corrosive, infectious, liberation of flammable gasses in contact with water, liberation of flammable fumes in contact with air or water, liberation of toxic gases in contact with air or water, capable to produce leachates any of the above characteristics and ecotoxic.

For practical purposes, the raw hazardous waste need not be tested and analysed, merely to find whether it is hazardous. One can find or know, only by seeing its description and comparing it with the schedule I attached to the Rules and is more than the statutory regulatory quantity. However, five parameters can be analysed as following Schedule for decision making.

Schedule I

Characterisation of Wastes

A solid waste is a hazardous waste if it exhibits any of the characteristics identified herein below :

1. Ignitability :

A solid waste exhibits a characteristic of ignitability if a respresentative sample of the waste has any of the following properties :

S. No.	Form	Particulars
1.	Liquid (other than an acqueous solution solution containing less than 24% alcohol by volume)	has a flash point less than 60 degrees Celsius
2.	not a liquid	• under standard temperature and pressure capable of causing fire through friction, absorption of moisture or spontanieous chemical changes. • When ignited, burns vigorously and persistently
3.	Compressed gas	If ignitable
4.	Solid Wastes	If ignitable
5.	Oxidiser	

2. Corrosivity :

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

S. No.	Form	Particulars
1.	Aquesous	Has a pH less than 2 or greater than 12.5
2.	Liquid	Capable to corrode steel at a rate greater than 6.35 mm per year at a temperature 55 degrees

3. Characteristic of reactivity :

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

(1) It is normally xplosive.

(2) It reacts violently with water.

(3) It forms potentially explosive mixture with water.

(4) When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.

(5) It is cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors of fumes in a quantity sufficient to present a danger to human health or the environment.

(6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.

(7) It is readily capable of detonation or explosive decomposition of reaction at standard temperature and pressure.

(8) It is forbidden explosive.

4. Toxicity Characterstics :

A solid waste exhibits the characterstics of toxicity if using the Toxicity Characterstic Leaching Procedure, the extract from a representative sample of the waste contains any of the concentration equal to or greater than the respective value given in the table 1. Where the waste contains less thant 0.5% filterable solids, the waste itself, after filtering is considered to be extract for the purpose of this section.

Table 1

Maximum Concentration of contaminants for the Toxicity Characteristic

Arsenic	5.0	Hexachlorobenzene	0.13
Barium	100.0	Hexachlorobutadine	0.5
Benezene	0.5	Hexachloroethane	3.0
Cadmium	1.0	Lead	5.0
Carbon tetrachloride	0.5	Lindane	0.4
Chlordane	0.03	Mercury	0.2
Chloro Benzene	100.0	Methoxychlor	10.0
Chloroform	6.0	Methyl ethyl ketone	200.0
Chromium	5.0	Nitro benzene	2.0
O-Cresol	200.0	Pentrachlorophenol	100.0
m-Cresol	200.0	Pyridine	5.0
p-Cresol	200.0	Selenium	1.0
Cresol	200.0	Silver	5.0
2,4-D	10.0	Tetrachloroethylene	0.7
1,4-Dichloro benzene	7.5	Toxaphene	0.5
1,2-Dichloro ethane	0.5	Trichloroethylene	0.5
1,1-Dichloroethylene	0.7	2,4,5-Trichlorophenol	400.0
2,4-Dichlorotoluene	0.13	2,4,6-Trichlorophenol	2.0
Endrin	0.02	2,4,5-TP (Silver)	1.0
Heptachlor (and its ... oxide)	0.008	Vinyl Chloride	0.2

Note : (1) The TCLP is a procedure that generates an extract of the waste and determines the constituents in the extract.

(2) Please also refer EPA manual “Test methods for evaluating soild wastes, physical/chemical methods”. SW 846, USGAO.

From the analysis or by the experience it may be found whether any pre-treatment will be possible and is needful (which is described in para 5 above). In case any trials are required to be taken, the operating agency should have a laboratory aid available for the purpose. The engineering design can be based only on such laboratory support and when once erected, the efficiency of the unit can be judged by two parallel samples like say pH before pre-treatment say 1.5 and after primary neutralisation say 3.5 etc.

Characterisation may also be useful as a treatability studies. Treatability study means a study in which a hazardous waste is subjected to a treatment process to determine (1) whether the waste is amenable to the treatment process, (2) what pre-treatment, if any, is required, (3) the optimal process conditions needed to achieve the desired treatment, (4) the efficiency of a treatment process for a specific waste, or (5) the characteristics and volume of residuals from a partifular treatment process.

The utility of laboratory for treatability studies is the same for hazardous wastes as that for any other effluent treatment plant or emission control systems. However, sometimes the studies may also relate to liner compatibility studies, corrosion studies, toxicological or health effect studies, or material compatibility studies relating to (1) Leachate collection system, (2) pumps, (3) personal protective equipments or (4) geo textile materials.

The laboratory is required to be well equipped, suitable for the purpose for which the operating agency is working. As it is likely that the operating agency may receive any of the 18 category of waste at any time (as may be amended from time to time as per Basel Convention), the laboratory should be capable for the necessary analysis, from the beginning. Suggested equipments/instruments are as given below:

1. AAS Graphite Furnance
2. AOx Analyser
3. Internet with E-mail
4. Nitrogen Analyser (TKN Analyser)
5. GC with ECD/FID
6. Water purification System with reverse osmosis
7. Fume Hoods
8. Photocopy Machine
9. Computer
10. Precision balances
11. UV-VIS double beam Spectrophotometer
12. Voltage Regulator (Servo)
13. Noise level monitor
14. Glove Box
15. Meteorological data acquisition system
16. Refrigerator
17. Continuous Extractor
18. Fax/Telex
19. Muffle Furnace
20. Hot Air Oven
21. Freezer
22. Kjeldhal Apparatus
23. Air Compressor
24. pH Meter
25. Evaporators
26. COD Assembly
27. Vaccum Pump
28. Stack emission monitoring kit

29. Microwave digestor
30. Conductivity Meter
31. Color Meter
32. Reference Thermometer
33. Ekman Dredge
34. High volume Air sampler with RSPM
35. Micropipettes
36. Millipore suction system for SS
37. Toxic Gas Monitors
38. Walkie Talkie
39. Drager tube & app. set
40. BOD Incubator
41. Centrifuge
42. Flask Shaker
43. Heating Mantles
44. Magnetic stirrer with hot plates
45. Rotary Shaker
46. Stop Watch
47. Water Bath
48. Flame Photometer
49. Ammonia Distillation Assembly
50. Automatic Burrettes
51. Air Conditioners
52. Telephone (OYT) with Modem
53. Sampling Van
54. Electronic Typewriter
55. Zero head space extractor
56. Flash point tester
57. Corrosivity test - Fabricated
58. Bomb colorimeter
59. Volatile organic sampling
60. GC/MS with purge and trap
61. Lab Furniture (working tables, cupboards, chemical racks etc.)
62. Infrastructure like D. G. set, electrical fittings, air conditioning of cold room etc.

The laboratory should be got approved from the Central Board or State Board, and preferably from both these Boards and a neighbouring State Board too, for conducting the work with authenticity.

11. Segregation

The operating agency wil have to consider segregation from a number of view points, such as

- depending on calorific value, whether the waste be sent for incinerator or other methods of treatment & disposal.
- depending on concentration of constituent (say solvent), whether it be called as waste-water or liquid waste
- depending on concentration of constituent (say phenols), whether it be subjected to biological treatment like activated sludge plant, or be sent for incinerator

- depending on its nature, whether it should be transported in a tank of particular lining or also whether it may be allowed to commingle with another type of waste.

The decision of segregation, will have to be taken almost at every time a new waste with manifest enters the site, for storage, for identification, for pre-treatment and for final treatment and disposal.

If a spent solvent arrives and contains less than one percent total organic carbon (TOC), then as a thumb rule, it may be called as "solvent-carbon waste water" and if more than one percent it is "spent solvent". The former waste water may be segregated and sent for either biological treatment, steam-stripping or activated carbon technologies; and if later may be sent for recovery or incineration.

Likewise if certain waste constituents are higher in the waste than a limit, it be segregated and not allowed to be disposed it by land-filling. A list for guidance can be given as follows, (which may be used in consultation with SPCB/CPCB):

Constituent	**Level (mg/l)**
Free cyanides	1000
Arsenic	500
Cadmium	100
Chromium	500
Lead	500
Mercury	20
Nickel	130
Selenium	100
Tharium	130
PCB	50
Corrosive waste	< 2.0 pH

Another segregating line is suggested for halogenated organic compounds (HOC) as 10,000 mg/l of HOC in a liquid. If higher, send for incineration and if lower, for treatment to a level of 1000 mg/l.

For PCB containing waste, the dividing line is 50 ppm. Lower value bearing PCB containing waste may go for land-fill, or else must be segregated from them and treated separately.

Incompatible wastes must be segregated and kept apart at arrival. Incompatible waste means hazardous waste that is unsuitable for

(1) Placement in a partifular device or facility because it may cause corrosion or decay of containment material (e.g. container inner or tank walls)

(2) Co-mingling with another waste or material under uncontrolled conditions because the commingling might produce heat or pressure, fire or pressure, fire or explosion, violent reaction, toxic dusts, mists, fumes or gases or flammable fumes or gases.

The guidelines for Management & Handling of Hazardous Waste, 1991 issued by Ministry of Environment & Forests, have dealt on this subject, which may be referred.

12. Physical Treatment

The operating agency is expected to be of a superior status than the individual generator occupier. This being a centralised plant, it is expected that there will be a better understanding of the subject and capability of performance in all the four departments, viz.

1. Physical Treatment
2. Chemical Treatment
3. Biological Treatment
4. Thermal Treatment

In physical treatment, oil separation and solidification assumes importance.

Oil Separation

The operating agency may receive this type of hazardous waste with varying percentage of the components ranging from watery-oil to oily-water. As a first step a primary separation is done. The emulsion is then heated in insulated process tanks, and then added acid as enhancer. The water is drained and remaining passed through ultrafiltration. The oil can be returned and water be polished further by the operating agency before final disposal.

It will be desirable if operating agency undertakes some laboratory trials and Surfactants can be tried oil-separators as it may help in isolating three distinct layers, viz. oil at top, water at bottom and surfactant film separating it.

Solidification

Solidification is appropriate for paint sludges, still bottoms from the recovery of solvents, waste treatment sludges that contain too much liquid, and similar types of wastes that offer little or no economic potential for recovery. Solidification can be a solution to cyanide bearing waste (liquid/slurry/solid), mixed inorganic acid wastes, caustic waste, metal bearing slurries or slags, chromium and cadmium bearing wastes, latex and pharmaceuticals waste. It can go for burial, but may also go as energy source if contain enough solvents. In any case, for its internal use, the operating agency shall keep the reasons of his decisions recorded for future use. If there is a heavy metal sludge, the lime addition for solidification helps also for its fixation, reducing its leaching potential. If the operating agency can afford, it can be a good practice to own a mobile belt-press filters or mobile mounted centrifuge which can go to generators and dewater the sludge in-situ to prepare for solidification. Dewatering service can have a very bright future, because S.S.I. units or CETP or even some large units can take advantage of this service. There can be countless advantages and the charges can be either on the water quantity or on separated solids quantities or time spent. This even may improve the capability of on-site ETP. Operating agency should have some capability to find right type of poly-electrolyte polymer and dose which coagulates and pulls the solids from the liquid. Without a proper find, the entire mixture may be just pushed through the screen of the belt. The operating agency will please remember that normally at least 20% soilds be in sludge before it can go to a land-fill. This is a suitable but costly proposal and the two-member crew has to be trained by operating agency.

Free flowing hazardous waste is a bigger problem. Pre-treatment can solve this inherent difficulty by converting to a solid mass before ultimate disposal. Physical solidification and chemical fixation normally goes hand in hand. The basic objective of fixation is to isolate the toxic waste from environment by producing materials having low leachability and/or low permeability and possessing mechanical and structural integrity. Thus, it is a capsuled non-hazardous form as a land reclamation media or may be reusable engineering material.

Cementation process is welcome because if offers desirable properties like low

permeability & leaching, considerable compression strength, non inflammable, non bio-degradable, non odorous, environmentally acceptable and cost-effectiveness.

Operating agency should have a laboratory which can be pressed in service for R&D to develop design/operating criteria. Depending on the available waste (Group A) and solidifying media (Group B), laboratory scale trials be taken :

Group A		Group B	
1.	Cyanide waste liquid	1.	Cement of good/bad quality
2.	Cyanide waste solid	2.	Pulverised fuel ash (of power houses)
3.	Mixed inorganic acid wastes		
4.	Caustic waste solution		
5.	Metal bearing slags		

For the above purposes, the suggested laboratory scale procedures, which operating agency may attempt will be as follows:

(1) Pre-treat waste, i.e. raise pH to 10.5 (to avoid corrosivity), add chlorine (for oxidation-stabilisation), neutralise (for obvious reasons), size reduction of metal slag (for high area/volume ratio), mixing of waste and power house slag (for cohesion), mix, add cement (for binding force), mix (for cementation process), pour in containers.

(2) Prepare quality control chart for each step and for each “how much ?”. This will be useful for the field personnel while undertaking the operation.

The operating agency is encouraged to also undertake certain trials to (1) Fix chromium in sodium silicate & cement and (2) Fix cadmium in lime & fly ash. For this purpose too, steps as indicated above be devised and good documentation maintained.

Various solidification techniques are available such as:

1. Cement based techniques
2. Silicate based techniques
3. Pozollanic process (without cement)

4. Thermoplastic technique (includes incorporation of waste in bitumen, parafin & polyethylene)

5. Organic Polymer technique (including urea, formaldehyde and unsaturated polyester).

6. Surface encapsulation (jackette)

7. Vitrification process

These solidification techniques can be divided in two systems, viz. (1) Inorganic system, (2) Organic system. The former normally used to produce a slurry which sets, while the later use thermoplast/thermosetting polymers. This is explained by some examples.

(1) Inorganic systems

A. This process involves mixing of a prepared waste "stock" with certain reagents to produce a slurry which settles in around three days and attaining maximum strength in six months. The reagents used are cementitious and pozzolanic. Various lime-containing cements and complex aluminium-silicate pozzlans can be tried. Prior laboratory analysis and/or trials are necessary. Blending of different waste and powdered reactants be tried to get inorganic polymerisation based on silicate chains. Estimate the contact time necessary. Steps can be described as follows :

1. The incoming soild waste be inspected on entry and stored separately as filter cake group, paint solids, lime cake etc, under roof.

2. The incoming liquid or slurry be kept in cordoned off drums. The acids, the alkalies, neutral solution and organically contamined, liquid wastes or wastewaters be kept in separate drums on testing and kept at separate places. The tanks be of glass-reinfored polyester or equivalent construction, so that the walls do not react with the contents.

3. The raw material is brought in either by pumps or manually/auto cars for a "stock preparation" (SP) Tank. A high speed disintegrator or homogenizing device is introduced here. The equipment be versatile to mix, blend and homogenise the hazardous waste and also break up any solid matter present in the liquid. The prepared waste at present SP is now prepared to go for polymerisation tank silos when called for. Based on laboratory

blending calculations the stock material and reagents are fed through weigh bridge.

4. The reactor vessel is horizontal, sealed mixer fitted with double-blade paddles.

5. On completion of mixing, blending, the material is discharged in awaiting transport, for final setting.

6. Test the product in laboratory for permeability, leaching and compression strength. If sophisticated test cannot be taken frequently, then atleast comparable practical tests be taken on the sample and on clay, as control by similar method of pressing and placing under a tight water column. The permeability of the newly formed be at least 10 times superior to the clay block for a permeability expressed as say cm/second. For leachate also, a simplified quick test be told to scientists to take 10 gm of sample, ground to a fine powder, add 10 times distilled water having a constant pH between 4.5 and 6. Stir for one hour mechanically and then filter on Whatman 541. The filtrate be analysed for parameters and compared. In this test, a 600 cm2 area of 10 cm. cube of waste is powdered to give about 3 to 5 x 106 cm square area. Compare the efficiency of unit performance by employing this simple test for parameters like concerned heavy metal or any desired properties.

This system can be considered for many types of wastes such as acids, alkalies, salts, heavy metal sludges, spent catalysts, pesticides, resins, paint wastes, asbestos, metal refining dust, filter cakes.

B. In chemical fixing inorganic systems, it is possible to solidify the stored waste in-situ. Trailor mounted rig is taken to site. Sodium silicate is mixed with a setting agent such as calcium chloride, cement or calcium sulfate is mixed with liquid hazardous waste.

C. Inorganic system of Thermoplastic method: The hazardous waste is first dried, is then mixed with bitumen, polyethylene or other thermoplastics, at an elevated temperature. The mixture solidfies on cooling. This is a costly method though it produces a good inflammable non-hazardous product. Thermosetting is also possible by polymerisation by mixing monomers into the waste.

13. Chemical Treatment

The objective of operating agency would be to convert hazardous liquid waste into non-hazardous residues, so that the post-treatment liquid can go to regular ETP or POT (Public Owned Treatment) and the post-treatment solids can go to simple landfill (i.e. sanitary landfill rather than secured landfill). If the chemical treatment is to be faithfully followed, the operating agency should limit their activities carefully. They should not accept all types of wastes. If the heavy metal bearing electroplating waste is to be tamed, they may accept some other wastes like alkali, spent pickle liquor from steel finishing, but should not accept in this any combustibles, phenols, cyanidic electroplating waste, pesticides or polychlorinated biphenyls. Or if oily waste of metal machining is to be taken care of you may accept in the line industrial lubricants but not chemicals. Operating agency has to run the plant much as a chemical industry runs with pure raw materials.

Operating agency should remember that chemical treatment will fail if it brings in or allows to bring in a different waste than what it tried. Therefore, in each arriving truck, sample is taken out from top, middle and bottom, analysed for cyanide, slufide, pH and nitrates and compare with the previous one. It is better if operating agency keeps a record and if it discovers that a waste received from a particular customer has caused a problem in the processing, then a second look should be taken.

The treatment plants are relatively simple in concept and design. Neutralisation, co-agulation, setting and supernatant to POT (public owned or municipal plants) is the flow sheet. Acidic effluents can be taken in and reacted with either alkaline waste, waste-lime or purchased agent. Side by side concomittantly, heavy metals too can get precipitated out. The treated waste becomes acceptable to sewer limits. In some neutralisation-setting plants, gadgets for alkaline chlorination for CN-bearing and reduction in acidified media for chromium bearing effluent, are already kept.

Because the municipality may demand a pretreatment or because fresh oil is becoming increasingly costlier and/or non-available, it is better to ave installed an oil-water separator. The basic principles are very simple, but operating agency will have to take some treatability tests to evolve proper design. In smiplest form it may be a gravity floater or may be an aided “cracking” by use of heat and/or acid. For the “dirty” portion, polishing be done by centrifugation, ultrafiltration, tilted plate separators.

14. Biological Treatment

Many engineers have reservations and hesitate to accept this approach. However, there is a possibility to get good cost-effective solution, with only small need to add to our knowledge by experimentation. Examples are two modified flow-sheets, one for tackling heavy metals and another for phenolic wastes. The operating agency will have to exert to find the bio-kinetic data, for its success.

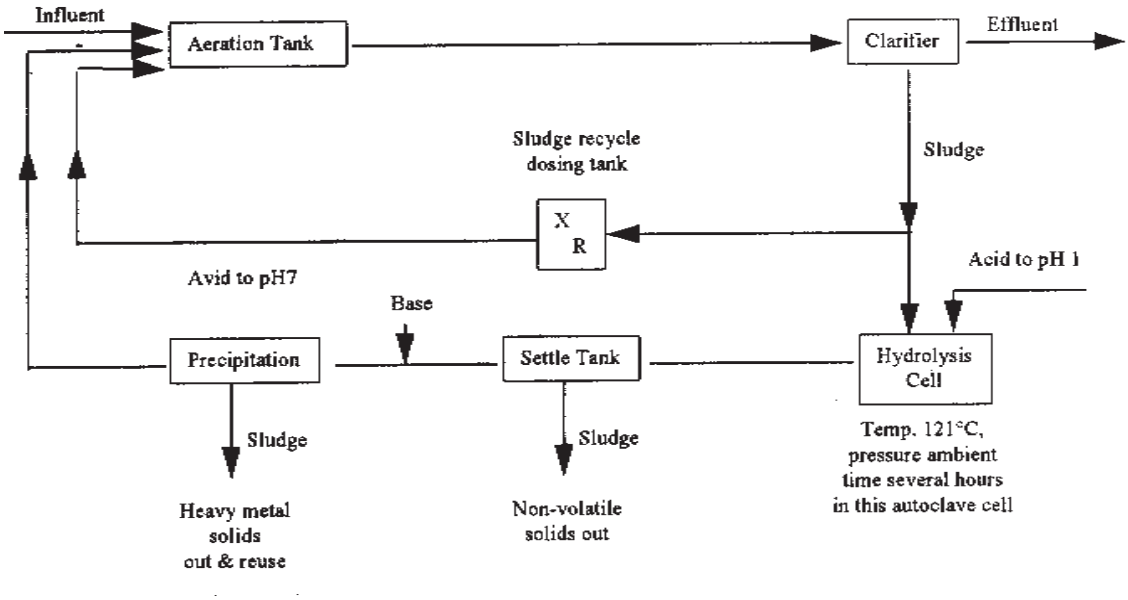
Even existing ETP can be upgraded by these simpler techniques. Experiences elsewhere has proved that the modifications are suitable to take phenol, orthochlorophenol, and 2-4-dinitrophenol.

Organic solvent conversion to methane by anaerobic digestion is possible. Organic solvent is a part of the problem that comes out from pharmaceutical, cosmetics, chemical, textile, plastic, rubber and similar industries, often in high concentration 1000 mg/l plus. It may explode (like ethanol, acetone, propane - 2-01, propan - 1, -0.1, toluene, butane - 1-0.1, pyridine). The molecule hydrogen, not only plays its role to form methane and to encourage growth of methanogenic bacteria, but also offers itself to regulate the conversion of propane -2-0-1 to acetone. This conversion reduces toxicity and inflammability.

Sometimes the industrial effluent brings in hazardous volatile organic toxic compounds. The usual ETP gets disturbed by it and its surge. Relief can be obtained by adding PACT (powdered activated carbon treatment). First make a PCT (physico chemical treatment) by flocculation, floatation. It helps not only for suspended solids and oil elimination, but also to reduce volatile aromatics and volatile organic chlorine compounds. It is possible to obtain solution for following problematic constituents, by this method.

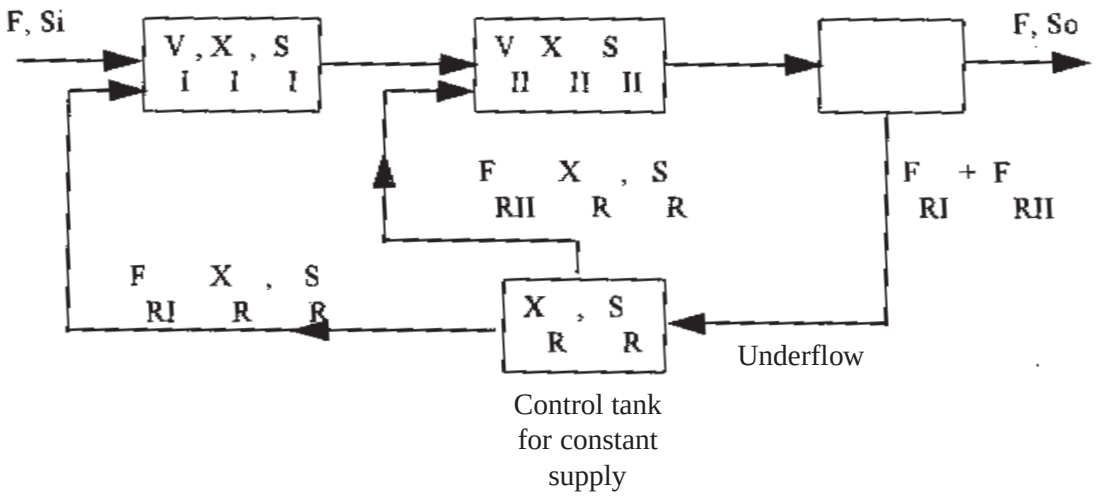
Contents	Influent	AS	PACT
t-butanol	50-1500	1.4	1-2
t-methyl-butyl ether	108	16	6
di-chloro ethane	39560	620	220
tri-chloro ethane	1810	54	13
trichloromethane	5280	340	170

(**AS** = Activated sludge plant, **PACT** = Powdered activated carbon treatment)



Legend : R.H.S. = Return Hydrolysate Supernatant
X_R = MLSS recycled

Figure 5-A: Schematic for modified external Aeareation system augmented for heavy metal removal and recovery.



LEGEND

S	=	BOD	F	=	Flow
Si	=	BOD inlet	F_{RI}	=	Return flow at stage I
S_I	=	BOD first stage	F_{RII}	=	Return flow at stage II
S_{II}	=	BOD second stage	X_I	=	MLSS at stage II
S_R	=	BOD recycled	X_R	=	MLSS of return sludge
So	=	BOD outlet	V_{II}	=	Volume second tank
V_I	=	Volume first tank			

Figure 5-B : Schematic of high rate biological process for toxic waste treatment

Two modified flow-sheets (figure 5A & 5B) are reproduced to show the treatment possiblities. For attempting the above suggestions successfully, operating agency shall maintain a good laboratory support.

15. Thermal Treatment

Thermal treatment involves subjecting waste to elevated temperature to change its physical, chemical or biological character or composition. Thermal treatment is different than incineration, which oxidises hazardous waste using flame combustion. Thermal treatment also differs from open land burning or detonation of outdated explosives. Thermal treatment includes pyrolysis, wet air oxidation, calcination, etc.

In India, high carbohydrate molasses based distillery waste, is subjected to a thermal treatment, (pyrolysis) in Utter Pradesh unit and or other unit is subjected to incineration in Maharashtra.

16. Public Acceptability

The Operating Agency should keep in mind that they are in the business as long as the public around is not against them. Normally there is always a tendency of NIMBY (not in may back yard). But it can stay, with transperancy and confidence with press and public, not only with the pollution control authorities. In a public hearing, an operating agency will come in trouble for three reasons. Number one- they sometimes did not know their facts. Number two- some might have tended to be a bit secretive about what they were doing. Number three - they might not have appeared open and straight forward enough to inspire public confidence. Operating agency may explain them that their activity is nearly like any other chemical industry. There are no hazardous substances, only the situation can be hazardous if not properly controlled.

17. Solvent Recovery

Although it may look an ambitious programme, it will be a good step forward if operating agancy can take up the work of solvent recovery in hand. A variety of solvents are in normal use in the cheimcal unit processes such as :

(a) Aliphatic hydrocarbons : Pentane, hexane, heptane

(b) Aromatic hydrocarbons : Xylene (o,m,p), toluene, benzene

(c) Alcohols : Methanol, ethanol, isopropanol, n-butyl alcohol

(d) Acetates : Ethyl acetate, n-butyl acetate

(e) Ketones : acetone, methyl ethyl ketone, MEK

(f) Halogenated solvents : Trichloroethane, methylene chloride, freon

(g) Solvent blends : Thinners, ink-washes, spray head cleaners,

In addition, there also can be some toxic materials such as polychlorinated biphenols, insoecticides, pesticides. If the operating agency does not have capability to simultaneously handle, these better be refused to accept.

The operating agency enganed in solvent recovery work must bear in mind the following checklist, viz.

(a) Solvent return and refill areas are free of solvent-strains

(b) Rerutn and refill pipes are properly colour codes and labelled

(c) Work areas are free of solvent residues

(d) Houses are properly hung to prevent solvent leakage

(e) Yards are cleaned and free from litter and weeds.

(f) All safety equipments are in proper working order.

The operating agency should have a laboratory equipped with GC (Gas Chromatograph) as it can tell the components within the recovered solvents (and displayed on a print out like say 42% ethanol, 39% methanil, 14% propyacetate, 2% isopropanol, 1% ketone and 2% something else). This is helpful to seek the customers. The laboratory should also be capable to estimate specific gravity, pH, salt test, Karl Fischer Test, flash point test etc.

Sometimes the same customer giving a dirty solvent will repurchase it after reclamation. For them a GC certificate will be handy.

The operating agency shall make a proper preventive maintenance of its plant because the downtime cannot be afforded.

18. Composting

Composting offers several potential benefits while dealing with biodegradable waste. Hazardous waste, however, is a different class. However, Guidelines of 1991 have used composting as a restoration, remedial method or for clean-up process.

Any sludge will not compost directly and requires processing with a bulking agent (filter material) to improve the aeration characteristics. Bulking agent addition also encourages effective composting by increasing the dry solids content and carbon-nitrogen ratio of feed stock. Cereal straw, bagasse or other agricultural residues can be used.

Aerated static pile and turned windrow methods are established practice. Aim is organic matter stabilisation.

Biological aspects of compost include microbial population diversity and rate of activity, pathogen kill (through relevant in hospital wastes) and nitrogen transformation. But heavy metals remain unchanged. In fact in one study made on copper, zinc and cadmium concentration; cadmium concentration increased (as mg/kg) during composting and were found to be inversely proportional to compost volatile solids content. Result indicated that 20 to 40 percent increase in metal content may occur in the mature compost relaive to the parent sludge.

In the clean up process of waste dump sites, the matter mopped up after spill, the contaminated soil is mixed with compostable material such as municipal soild waste, sewage sludge, and other organic residue prior to treatment. A specialised culture by bio-augmentation of specific microflora will have to be inoculated and maintained.

Operating agency is advised to go in for composting only in consultation with SPCBs.

19. Secure Landfill

The common centralised facility of the operating agency is likely to consist of land-fill type of disposal and hence, it will be worthwhile to know certain definitions to begin with.

A. Definitions :

Disposal is the discharge, deposit, injection, dumping, spilling, leaking, or placing of any soild waste or hazardous waste into or on any land or water, so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

Land disposal is defined to include, but not limited to, any placement of hazardous waste in a landfill, surface impoundment, waste-pile, injection well, land treatment

facility, salt dome formation, or underground mine or cave. It can also consider placement of hazardous wastes in concrete vaults or bunkers intended for disposal purposes as methods of waste management subject to certain restrictions. However, it does not include and permit open burning on land and detonation.

Landfill means a disposal facility or a part of facility where hazardous waste is placed in or on land and is not a land treatment facility, a surface impoundment or an injection well.

Landfill cell means a discrete volume of a hazardous waste landfill that uses a liner to provide isolation of wastes from adjacent or wastes. Examples of landfill cells are trenches and pits.

Land treatment facility means a facility or part of a facility at which hazardous waste is applied onto or incorporated into the soil surface, such facilities are disposal facilities if the waste will remain after closure.

Liner means a continuous layer of natural or man-made materials, beneath or on the sides of a surface impoundment, landfill or landfill cells, that restrict the downward or lateral escape of hazardous waste, hazardous waste constituents or leachates.

Surface impoundment means a facility or part of a facility that is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), that is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and that is not an injection well. Examples of surface impoundments are holding, storage, setting and aeration pits, ponds and lagoons.

B. Why landfills ?

While new methods of hazardous waste disposal are being developed, it appears that landfills will, atleast for the time being, contiune to be the most favoured techinique. In many countries, land is a readily available commodity and often areas of non-productive or derelict land may be made available for waste disposal. In many instances, land can be utilized in the near vicinity or on the premises of industrial companies, thereby reducing transportation costs. The potential also exists to reclaim certain areas for recreational purposes.

Landfilling is still the major disposal method in many countries. Yet in many instances landfilling sites are not properly chosen in terms of geophysical soil properties, hydrogeology, topography and climate. On a proposed site there is a need to carefully consider the potential for ground or surface water contamination from pollution by leachate migration or surface run-off from the site. Nonetheless, even when a site appears to have the right geophysical properties, its selection and use are not an absolute guarantee that contamination of groundwater can be avoided. Hence continual surveillance of the site and its surroundings must be maintained to check that the disposal of hazardous wastes can continue without posing a threat to the environment and to the general public. To reduce this threat landfill sites have been lined, for example with plastic materials, in order to prevent leaching into groundwater supplies.

C. Design

While preparing the lay-out of a land-fill site, it may be seen that it comprises atlest the following units, viz.

I. Vehicle weigh bridge
II. Vehicle and instrument work-shop
III. Laboratory for sample analysis
IV. Operational area
V. Operational building with amenities
VI. Controls systems
VII. Illumination, roads, fencing, trenches

The principle objective of a hazardous waste landfill is to isolate the waste materials within a confined area and prevent uncontrolled leakage of liquid contaminants. Design of the facility, therefore, requires provisions for an impermeable liner, a leachate collection and treatment system, and a suitable cover that is resistant to erosion and rainwater infiltration.

In certain situations, hazardous wastes may be disposed of in landfills under semi-controlled conditions. Co-disposal of hazardous wastes with domestic refuse, demolition waste, fly ash, municipal waste and inert industrial wastes in unlined landfills has, for example, been widely practised in the U.K. for many years. Co-disposal is advantageous from the point of view of enhanced neutralisation, detoxification and stabilization of the waste pile. Where suitable

soils exist, attenuation of waste leachate from waste piles is restricted to a relatively small area, thus reducing the potential for ground water contamination.

The MoEF guideline of 1991 has suggested a double liner system with synthetic or clay liner for landfill (two designs) as shown in figure 6.

In a German experience, M/s Bayer AG have found the following arrangement satisfactory. The controlled dumps run by Bayer AG have a multiple seal to protect the groundwater. The bottom layer of this seal consists of in-situ or specially deposited and compacted clay forming a 50 cm-thick impermeable layer. To compensate for unevenness in the clay layer, a 10 cm sand layer is spread on top and lined, in turn, with a 3 mm-thick, elastic polyethylene sheet, forming a second water-tight layer. This is covered by 30 cm of gravel which takes up the leachate from rainwater or from moist sewage sludge in the dump and channels it to the wastewater treatment plant through a system of drainage pipes. On top of this gravel layer is a 70 cm covering of soil and slag. On this layer the waste itself is deposited. During the period of use, i.e. while waste is still being deposited, the dumps look like enormous throughs. On completion of the controlled dump - when it has reached its projected size - the hill is sealed with an impermeable covering. By planting vegetation and by other measures the hill becomes integrated into the surrounding landscape. The groundwater in the vicinity of all the controlled dumps is required to be carefully monitored. The dumps are surrounded by observation wells. The water from these wells is regularly analysed.

Another secure landfill site in Bavaria (Germany) has following features.

Clay pad construction

- depth of pads : 60 cm
- permeability : 10 cm/sec
- Depth of sidewalls : 60 cm
- Final cover : 0.75 meters

Water-soluble soild wastes containing heavy metals are deposited in drums and covered with concrete to reduce the contamination in the leachate. In addition to daily cover, a plastic membrane is intermittently placed over completed lifts to reduce infiltration. A hand operated vibrator is also utilised to compact daily cover in an effort to reduce the volume of leachate generated.

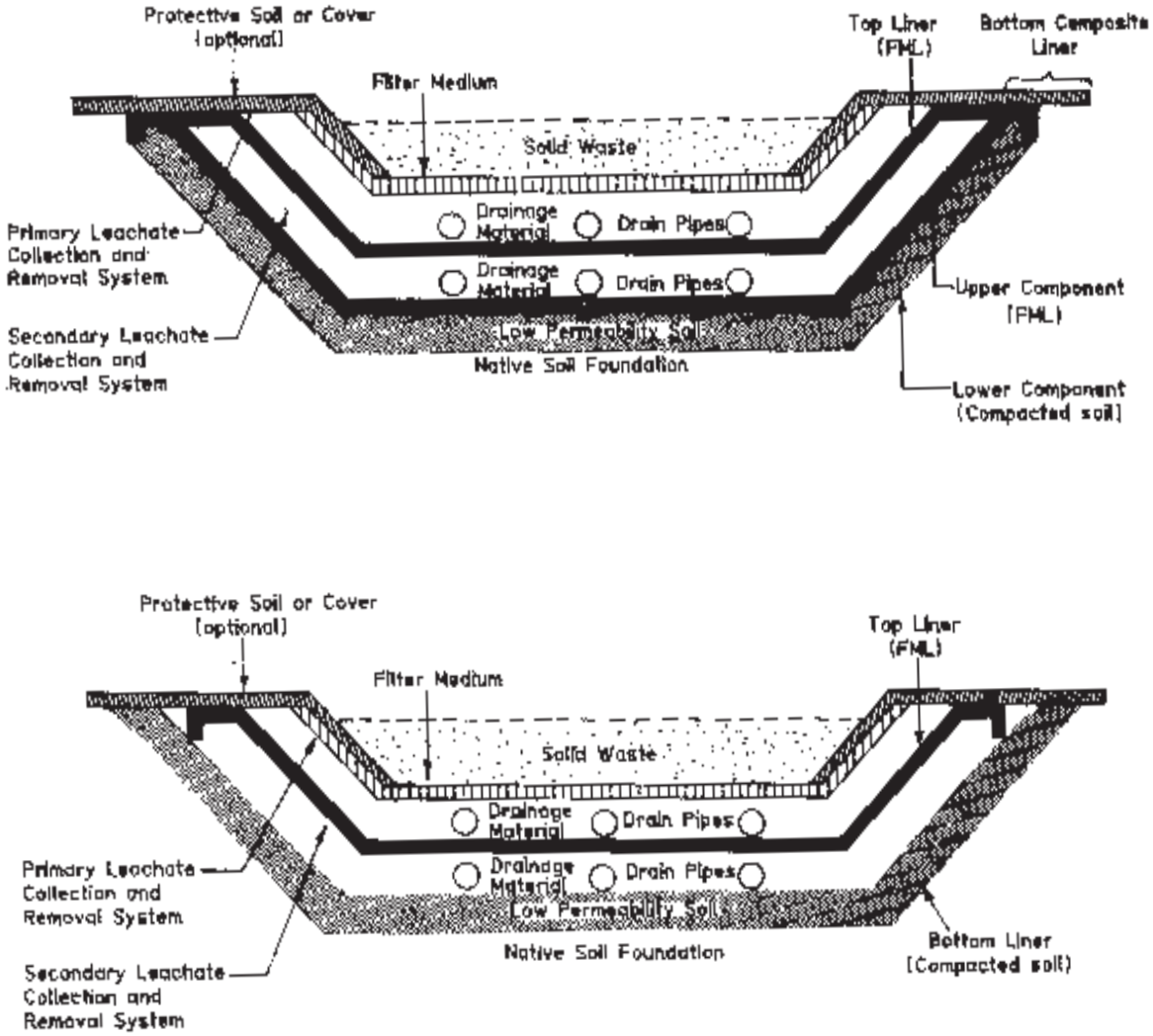

Protective Soil or Cover (optional)
Top Liner (FML)
Bottom Composite Liner
Filter Medium
Solid Waste
Drainage Material
Drain Pipes
Drainage Material
Drain Pipes
Primary Leachate Collection and Removal System
Secondary Leachate Collection and Removal System
Low Permeability Soil
Native Soil Foundation
Upper Component (FML)
Lower Component (Compacted soil)
Protective Soil or Cover (optional)
Top Liner (FML)
Filter Medium
Solid Waste
Drainage Material
Drain Pipes
Drainage Material
Drain Pipes
Primary Leachate Collection and Removal System
Secondary Leachate Collection and Removal System
Low Permeability Soil
Native Soil Foundation
Bottom Liner (Compacted soil)

FIGURE - 6

Leachate is collected by a series of under-drains, located in the clay pad. Leachate is then channelled to a plastic lined (3 mm) retention pond from where it is trucked.

The United States Environmental Protection Agency has published regulations. These regulations, implemented primarily in the interest of protecting groundwater resources and the long-term security of facilities, required that all new landfills be constructed with a leachate collection system and a liner that is capable of preventing migration of leachate throughout the opertional life of the facility. Preference is given to synthetic liners. Unless facilities are constructed with a double liner system with a leak detection system between the liners and a leachate collection system at the base of the landfill (figure 7), groundwater has to be monitored both upstream and downstream of the site. At closure, the construction of an impermeable cap is required and maintenance of the facility must be continued throughout the period specified in the permit, which in most cases will be about thirty years.

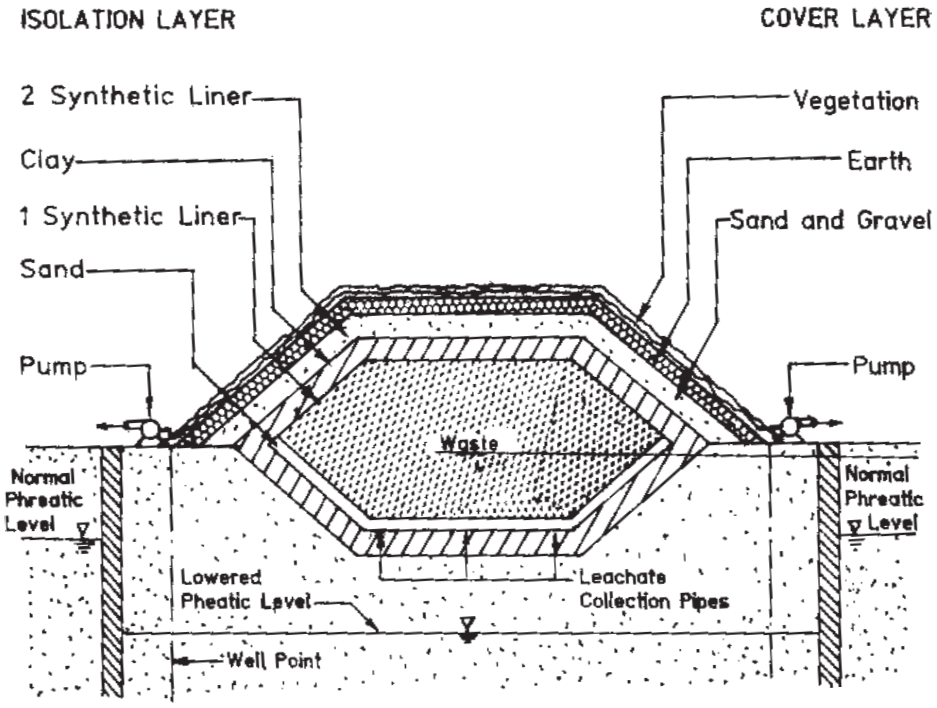


FIGURE - 7

Figure 7 : Cross Section - conceptual design of a double-lined hazardous waste landfill

The operating agency in out context, shall take cognisance of all the above experiences and derive a good formula for themselves. Such reasoned communication be submitted to the State Pollution Control Boards while obtaining an Authorisation. In case any new developments come up, the operating agency should keep an eye on it and adopt the same.

D. Construction

The landfill should be as secure as possible, because hazardous waste howsoever treated, lies there as a tickling time-bomb. New construction materials are getting developed everyday. These improved techniques be followed. Before going in for construction, the operating agency should first do a complete geological survery of the property to look for fissures, determine the depth of bed rock, check the percolation rate, and other pertinent factors. Any landfill construction be at least 3 m above groundwater or as may be directed and above the 100year floodplain. Take all this complied data along with proper drawings to SPCB and get approval. They may have any new suggestion. If a 3 m of packing clay is to be put at bottom, it should be placed in 20 layers of 150 mm each by using such clay which has grains long and flat, and layers are continuously compacted to form a very tight, impermeable barrier. This should be checked on Proctor's scale. On the clay blanket, is spread a polyethylene high density sheet welded to each other and weld tested thrice. Once the synthetic liner has been installed, another 300 mm clay is sprayed and compressed on the same. This layer protects the liner and works as third barrier too. On top, there is kept a layer of crushed stone to aid leachate collection and this is a place to house the leachate collection pipe system, described in others experiences.

The operating agency is better advised to report to State Pollution Control Board if there is any change made in their facility after obtaining authorisation, even minor such as replacement of liner or change in crop pattern.

The operating agency, should not make an oversimplification that landfill is a panacea and any hazardous waste can be dumped into it. A treatment in most cases is necessary and landfill at best can serve as a mode of disposal thereafter, like for say, PCBs, HOC, other wastes, and free liquids (unless they are first solidified).

E. Land Treatment

The operating agency may undertake the path of land treatment if the SPCB gives them authorisation to do the same. In this method, the waste is simultaneously treated and disposed. Hazardous waste must not be placed on the land unless the waste can be made less hazardous or non-hazardous by biological degradation or chemical reactions in the soil. It is desirable if the operating agency conducts a treatment demonstration prior to the application of wastes to verify that the hazardous constituents will be treated by the unit. In such case, monitoring will have to be made in the soil beneath the treatment area to know the vertical migration. Any waste containing arsenic, cadmium, lead, and mercury should not be allowed as else it may enter into the food chain. Even afterwards tilling of soil, control of soil pH, and moisture content, and fertilisation be continued for sometime. Finally, a normal vegetative cover be arranged so that by wind or air any residual erosion of waste should not happen. There are some successful land treatment experiences where refinery waste is treated and demonstrated that there is “no migration” condition achieved (to air, groundwater, and surface water).

20. Incinerator

The operating agency will find that the incineration is a costly alternative, but sometimes it is the only alternative. It reduces the volume of waste requiring the land-fill capacity, is suitable for most clinical, commercial and house-hold wastes, is the only suitable disposal option for certain waste (practical or legal point of view) and can recover heat system.

Incinerator means any enclosed device usine controlled flame combustion. In designing an incinerator the operating agency should take into consideration the thermal feed rate, waste feed rate, organic chlorine feed rate (where relevant), minimum combustion gas temperature, minimum combustion gas residence time, primary and secondary combustion units, removal of HCI, SPM and other air pollutants, minimum oxygen concentration in secondary chamber, controlling fugitive emissions (by keeping combustion zone totally sealed or by maintaining the combustion zone pressure negative), stack height, eventuality of alternative fuel, eventuality of change in waste containing POHC (principal organic hazardous constituent). The operating agency should convey these criteria to the State Boards for any comments and if there is any change subsequently in the gadget or geometry the same too must be informed or authorisation got so amended. This will enable them to take a new trial burn if necessary.

Incineration is not an open burining. Open burning means the combustion of any material without the following characteristics :

(1) Control of combustion air to maintain adequate temperature for efficient combustion

(2) Containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion

(3) Control of emission of the gaseous combustion products as per retulations.

Open burning on land is not a method for disposal as it does not have a status of either incinerator or landfill. The operating agency should assure the State Pollution Control Boards that they will undertake only controlled method and it is open for their inspection any time of combustion, emissions, attendant units (like pumps valves, conveyors) or housekeeping.

In genera, industrial incinerators comprise a storage pit, fuel tanks, a furnace (generally of a rotary klin type), a heat recovery boiler, off gas purification (possibly a scrubbing water treatment unit, and even ESP in good installations), an induced draft ID fan, a reheating unit (if necessary) and a stake (incidentally, even co-generations is possible).

In a reported experience of Bayer, AG, Germany plant temperature in rotary kiln is maintained at 1000-1200^{0}C, with oxygen concentration kept at 11% by volume, and detention of 4 seconds. The detention is 18 seconds in after burner chamber. In the waste heat recovery boiler, the temperature comes down to 320-350^{0}C. The HCI, SO2 is washed down. PCBs are found destroyed. The flow-sheet is shown in a figure 8 which may encourage the OA to put up an incineration train on such sound footing.

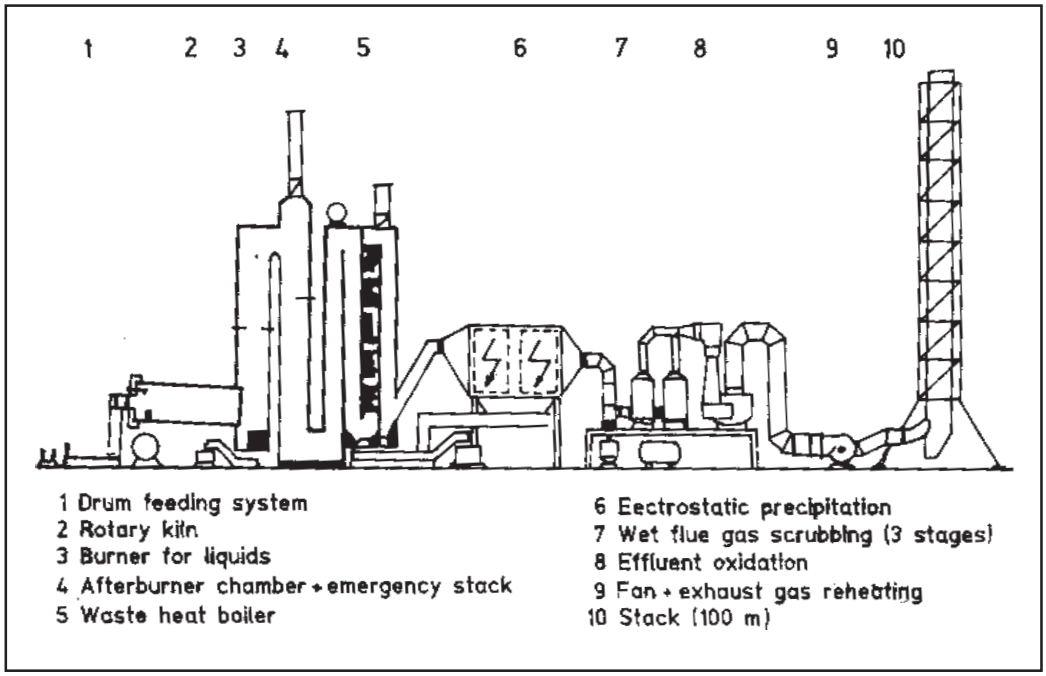


FIGURE - 8

Figure 8 : Hazardous waste incinerator 2, Bayer AG, Leverkusen

If the Operating agency desires to get rid of organics like halogenated solvents, petroleum refinery waste, Venyl chloride monomer, plastics, pesticides, off-spec pharmaceuticals etc, with a chemical destruction efficiency of 99.99%, then incineration will be his only choice, regardless as to whether he feeds as gas, liquid, semi-solid, or soilds.

Operating agency has to put only selected crew to run this unit as the precautions are necessary at every place right from unloading the incoming tankers (preferably with nitrogen blanket), segregately storing as per high or low BTU value. Some, if in a mixed from are arriving, has to be sent to a specific gravity based separators through vibratory screen, as also a separate storage for high or low pH wastes. This helps in blending, because the success of Operating Agency's incinerator cannot be ensured if the feed is non-uniform in quality and quantity. In this system organics are destroyed and the inorganics are converted. The clays, dissolved salts or silica are release within the incinerator flue gas and the same ash is required to be trapped and then disposed of in the landfill. The volume reduction be estimated and recorded.

The operating agency should also record the temperatures at various points (actual against designed) such as say (1) initial temperature in the primary chamber 1400^0C, (2) after injecting aqeous waste as 800^0C, (3) after passing through scrubber/spray dryer, (4) after fabric filter 200^0C in the stack. In the emission monitoring be done for levels of oxygen, unburnt hydrocarbons, sulfur dioxide and opacity (-a measure of particulate matters going up the stack) and record the same, in computer. The residence time in seconds also be recorded.

The operating agency should keep a safety and security in its plant to boast that nothing moves in the premises without permission, even the rain water (which is collected as run-on, analysed, pH adjusted or settled and then pumped run to allow it out).

21. Post Treatment

The post treatment precautions to be undertaken by the operating agency depend much on what treatment he has offered to the subjected hazardous waste. The treatment given to the waste shall be complete and not half-way.

If physico-chemical-biological treatment is successfully given, the outgoing post-treatment streams will be three fold. The oil may be sold or sent for incineration, the sludge after dewatering be sent to secure landfill and the water after analysis may join a stream on permission from the SPC Board or may be used on adjoining land by irrigation. Operating agency to maintain a full record.

If the treatment-disposal is a secured landfill, if post-treatment leachate appear, the same be collected and recycled into the operating agency's facility for retreatment. One will find that leachate exhibit very high polluting and hazardous characteristics.

In incineration or thermal treatment is adopted, the captured post-treatment ash be sent for burial and scrubber water be sent back into the facility for treatment. Operating agency at every step should maintain a computerised record.

If recovery is a treatment method, it converts a hazardous waste into a non-hazardous non-waste. This post-treatment, is acceptable to the customers and can be so sold. It may be a hazardous chemical, but no more a hazardous waste.

22. Back-transport

There can be only three types of back-transport. Number one, where there is a manifest discrepancy, number two where the waste sent by generator to operating agency facility is not as per contract and number three, when a renovated material after recovery returns back to a customer. The former two be avoided, while the third one is a welcome step.

It will be a good practice if the operating agency keeps a discipline of collecting the waste by himself from the generators' premises. Operating agency can get an opportunity of supervising the waste before loading or even adjusting the form of waste. This will avoid any eventuality of returning. The returning not only involves engaging the transport tankers for one trip during which three normal trips would have been performed, it also means increase of risk. It is, however, also true that operting agency should not accept such material which he cannot handle such as say PCB, coming suddenly to him unawares. If the return becomes necessary due to discrepancy in the manifest then the operating agency has a room to use his discretion. If the discrepancy is marginal and the material can be accepted by writing a note, he may preferably do so rather than relaying the hazardous waste back all along.

If the operating agency has an acceptable recovered material and a demand for the same, he should make its analysis on GC and send the examination report to prospective customer by fax and on his acceptance message the goods be sent. This transport should be done in clean tankers. The dirty tankers should not be pressed for this service, as else unacceptable contamination may take place. The outgoing recovered waste is no more a hazardous waste and hence, manifest system will not be needed. However, it still is a hazardous chemical and whatever obligations under Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 are placed on transport, will have to be studied and followed by the operating agency.

23. Monitoring

Monitoring and laboratory examination is important in many fields, but more so in the field of hazardous waste management. In monitoring we collect a sample and from its analysis we infer about the universe (i.e. full batch). Monitoring will tell to the operating agency about the dividing line between hazardous and non-hazardous waste, about the treatability of the hazardous waste, about incompatibility of different wastes, about the performance efficiency of hazardous waste treatment and disposal facility, about

the impact, about the quality of the recovered material, and about the post-closure effect if any. Monitoring gives a final signal if something is going wrong in the facility of operating agency, giving an opportunity of rectification. Monitoring becomes handy in investigation of compliants, and during the time of any accidental leakages or spills. The operating agency, therefore, should have an excellent set up of materials and methods.

Monitoring should commence one year before the facility is brought in existence by the operating agency, should continue while the facility is in use, to know the migration kinetics and contemporary concentrations, to take a decision as to whether it is a time to abandon a particular site, and till five years after it is abandoned to see that the "ghost" does not reappear as mere 'cradle to grave' is not sufficient precaution, it should be "cradle to grave to ghosh".

In consultation with the State Pollution Control Board, the Operating agency will have to draw samples of air, water, groundwater, leachate waters, soils, ash, solid wastes and aesthetics. The periodicity and station selection be done carefully and following locations might prove appropriate :

(a) Air : upwind, downwind, three stations at 120 around the facility, distance depending on stack height and location of any particular sensitive feature. This is for ambient. Samples be selected in stack, vents and ducts.

(b) Surface waters : upstream and downstream in the stream adjoining local nullah, upstream and downstream in the rivulet, on both the banks, upper stream and benthal deposits, and add as per sanitary survey.

(c) Groundwater : From wells specially due one upgradient and atleast three on down gradient, and deep enough.

(d) Soil : Surrounding soil at ground level be sampled in a circular grid.

(e) Vegetative cover : Whether mal effect is occured and if yes, in what direction.

(f) biological indicator : by planting sensitive plants in all directions and at different distances and to note periodically as to what is the health status of each plant, indicating the operating agency as to what further precautions are required to be taken. Figure 9 below conceptually shows that if the operating agency incinerator is at centre and specially selected species of plants/bushes are planted in eight directions at two distances, the health effects are as shown by vertical bars when quantified. This is botanists job, which can be hired by operating agency.

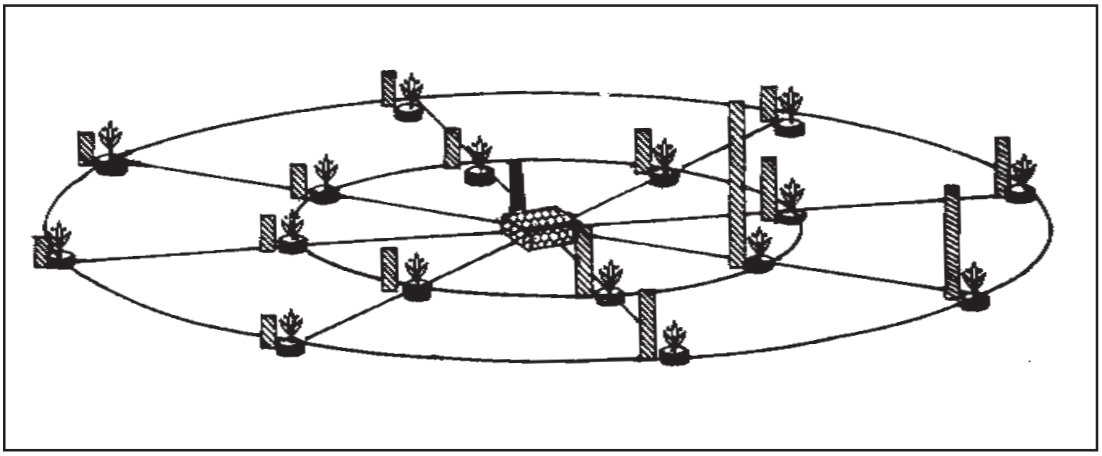


FIGURE - 9

Among all the above, ground water monitoring is a more serious and complicated matter of which the operating agency has very little experience. The groundwater monitoring is of great significance to such operating agency, who are engaged in land treatment, land application, sanitary landfills, secured landfills, surface impoundments or composting. This monitoring is more significant when the groundwater is popularly used either for agricultural or personal purposes. However, it may be of low or no significance if it is found that the operating agency facility is an engineered structure, does not receive or contain free liquids, is designed and operate to exclude liquid, rains, other run-off, has both inner and outer layers of containment enclosing the waste, and has an eye on leak detection, i.e. there is no potential for migration of liquid from regulated units to the uppermost aquifer (during the facilities active life and to some extent thereafter). This monitoring is also not significant, if there is no groundwater. This is the first stage of self-examination that the operating agency should keep his findings recorded, supported by expert documents which he should gather by contacting universities.

There are three types of groundwater monitoring, depending on its purpose, viz. (i) detection monitoring, (ii) assessment monitoring and (iii) compliance monitoring. This is shown in a logic chart. The detection on monitoring is to determine whether land disposal facility has leaked hazardous waste or constituents into an underlying aquifer in quantities sufficient to cause a significant change in groundwater quality. This can be found out within the first year itself. But if it is detected within say three months, one should not wait for one year, but should immediately commence the assessment

monitoring. In detection monitoring, only a few indicator parameters may be analysed to establish, if migration is occuring. The indicator parameters used may include specific conductance, total organic carbon, total organic halogen or any specific waste constituents which the operating agency receives.

Assessment monitoring is a more aggressive programme, if a significant change is discovered in groundwater quality during the detection monitoring. In the place of non-specific generality, specific chemicals are estimated and vertical, horizontal concentration profiles are attempted. Rate and extent of contaminant migration is studied. This study will lead to design corrective steps to be taken by operating agency. The success of corrective steps so designed and implemented should be reflected in compliance monitoring.

The goal of the compliance monitoring programme is to ensure that leakage of hazardous constituents into the groundwater does not exceed acceptable limits.

The operating agency will know from his experience that these hazardous constituents will be no different than the list of hazardous chemicals given in the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 in its Schedule I, Part II. The State Boards may not normally announce these limits in the Authorisation. However, if assessment monitoring finds the presence of hazardous chemicals, corresponding standards will be prescribed, so that the groundwater remains usable. The corrective action programme by operating agency should include, to remove or treat the constituents specified within an agreed time-frame. The corrective action programme does not terminate, till correction is seen in the groundwater quality.

The operating agency will keep in mind that the groundwater monitoring does not mean a generalised blanket analysis. Specific parameters are required to be selected as a three tier system, viz. (i) indicator parameters, (ii) groundwater quality and (iii) drinking water quality. These can be :

(i) Indicator parameters : to know the pollution grossly are pH, colour, specific conductance, total organic carbon (TOC) and total organic halogen (TOX)

(ii) Groundwater quality parameters : to know its suitability for other (non-drinking) purposes like agriculture, are chloride, iron, manganese, phenols, sodium, sulfates etc.

(iii) Drinking water suitability parameters for its obvious purpose as a source are, arsenic, barium, cadmium, chromium, fluoride (temperature dependent), lead, mercury, nitrate, selenium, silver, Endrin, Lindane, methoxy chlor, toxaphene, 2-4D, 2-4-5-TP, radio-activity and coliform bacteria.

For a groundwater quality understanding, there should be sampling points (well) on hydraulically upgradient and a minium of three on the downgradient, for a small facility of operating agency. However, the number required may increase depending on the complexity of facilities, of geography and of geology. The monitoring well must give a true picture of the groundwater and nothing else. The monitoring wells must be caused in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated and, if necessary, packed with sand or gravel to enable sample collection at depths where appropriate aquifer flow zones exists. The annular space (the space between the bore hole and the well casing) above the selected sampling depth must be sealed with a suitable material, such as bentonite slurry or grout.

The operating agency shall keep a frequency of sampling as once in three months normally, unless the circumstances compel to do it more often to develop confidence. They should continue even after abandoning the site for a fixed period. All this should be done by the operating agency in constant consultation with the State Pollution Control Boards.

A sequence is suggested by a logic chart (figure 10).

It may not be out of place to mention that 175 wells are reportedly monthly monitored by a U.S.A. operating agency CECOS (M/s Chemical and Environmental Conservation Systems Inc.) for their secure chemical landfilling at Niagara Falls site, spending a quarter million dollars a year (1986) to check and ensure that groundwater does not become contaminated.

24. Closure & Post closure

The operating agency has a limited land area, on which he is doing his activities of hazardous waste treatment and disposal. This limited area will eventually get filled and then he will have to close the present establishment carefully and go somewhere else. The closure is a period after which wastes are no longer accepted and during which the owner or operator completes all treatment, storage or disposal operations. Partial closure is also possible. The purpose of the closure standards is to ensure that all hazardous

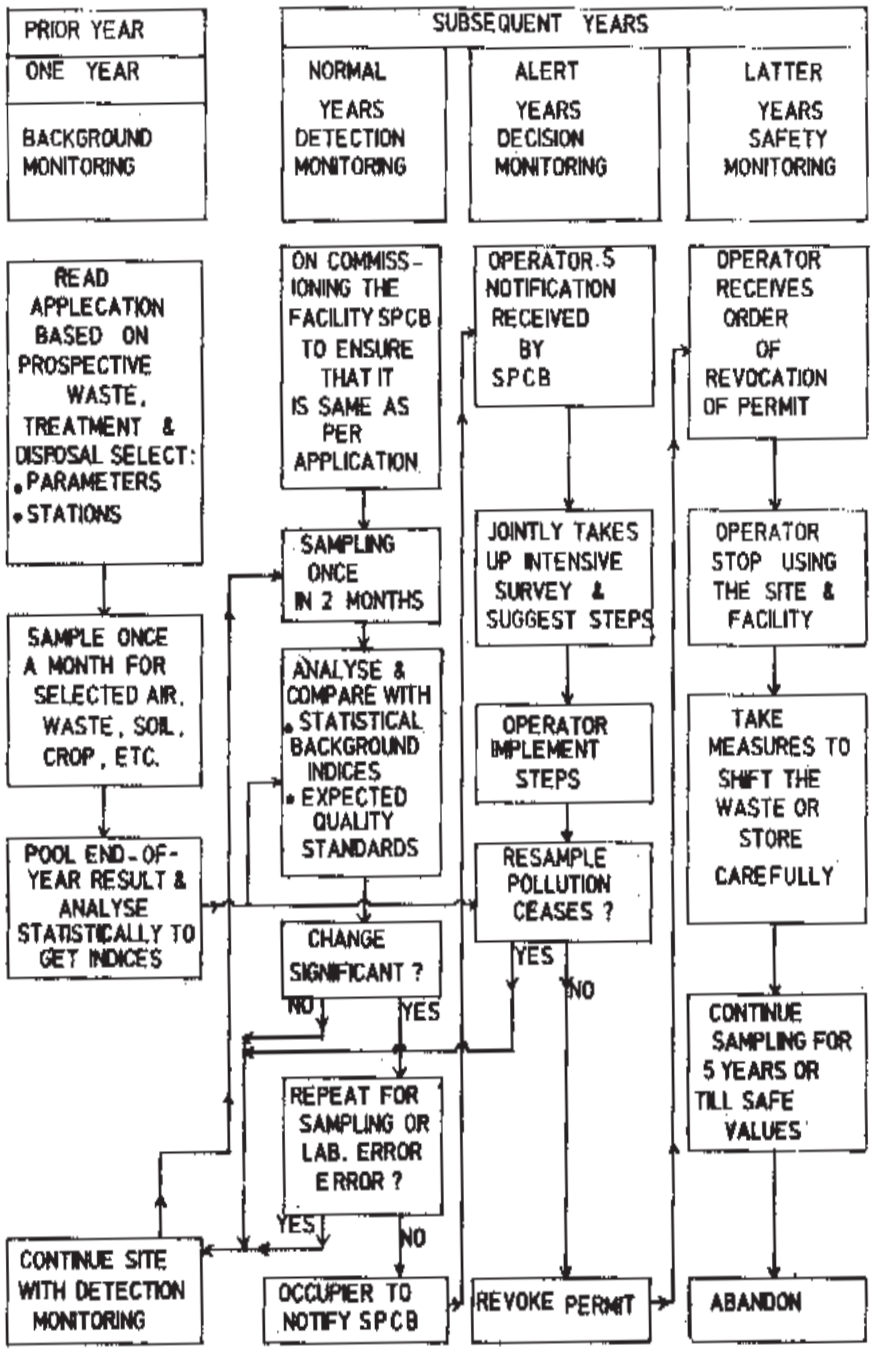

PRIOR YEAR
ONE YEAR
BACKGROUND MONITORING
SUBSEQUENT YEARS
NORMAL YEARS DETECTION MONITORING
ALERT YEARS DECISION MONITORING
LATTER YEARS SAFETY MONITORING
READ APPLECATION BASED ON PROSPECTIVE WASTE, TREATMENT & DISPOSAL SELECT: • PARAMETERS • STATIONS
SAMPLE ONCE A MONTH FOR SELECTED AIR, WASTE, SOIL, CROP, ETC.
POOL END-OF-YEAR RESULT & ANALYSE STATISTICALLY TO GET INDICES
ON COMMISSIONING THE FACILITY SPCB TO ENSURE THAT IT IS SAME AS PER APPLICATION
SAMPLING ONCE IN 2 MONTHS
ANALYSE & COMPARE WITH • STATISTICAL BACKGROUND INDICES • EXPECTED QUALITY STANDARDS
CHANGE SIGNIFICANT ?
NO
YES
REPEAT FOR SAMPLING OR LAB. ERROR ERROR ?
YES
NO
CONTINUE SITE WITH DETECTION MONITORING
OCCUPIER TO NOTIFY SPCB
OPERATOR'S NOTIFICATION RECEIVED BY SPCB
JOINTLY TAKES UP INTENSIVE SURVEY & SUGGEST STEPS
OPERATOR IMPLEMENT STEPS
RESAMPLE POLLUTION CEASES ?
YES
NO
REVOKE PERMIT
OPERATOR RECEIVES ORDER OF REVOCATION OF PERMIT
OPERATOR STOP USING THE SITE & FACILITY
TAKE MEASURES TO SHIFT THE WASTE OR STORE CAREFULLY
CONTINUE SAMPLING FOR 5 YEARS OR TILL SAFE VALUES
ABANDON

FIGURE - 10

wastes management facilities are closed in a manner that to the extent necessary (i) protect human health and the environment; and (ii) controls, minimises or eliminates post-closure escape of hazardous waste, hazardous constituents, leachate or contaminated rain run-off or waste decomposition to the water, air or soil. If the site is housefull, then it is called as a closure, but if due to mismanaged leachates and groundwater pollution, activity is forced to be stopped, then it is not closure it is abandoning the site.

The operating agency while developing its first application for Authorisation has to plan as to in what time period, the accommodation provided by him will be full. Depending on that type of waste he is transporting in, he will have to imagine a closure plan. It should contain

(1) A description how each of his unit in the facility will be closed.

(2) A description of how final closure of the entire facility will be conducted

(3) An estimate of the maximum inventory of hazardous wastes on-site at any time during the active life of facility

(4) A description of the steps needed to remove or decontaminate all hazardous waste residue

(5) A sampling and analysis plan to know as to how much decontamination will be necessary

(6) A time-table of commencement of closure prospects and completion.

The operating agency should prepare a closure plan on paper at least 6 months in advance so that opinion of the State Pollution Control Board can be obtained. It is better to complete the closure as per plan speedily, but not hastily. A period of 3 months to 6 months from the State Pollution Control Boards approval should prove adequate.

There can be two options for closure. In one, the residues, spent liners etc. are removed and shifted from the place or in another, the residues are left in place and operating agency taking its post-closure precautions. The post closure care is:

(1) Eliminate all free liquids by either removing the liquid wastes/residues from landfill/ impoundment or by solidifying them

(2) Stabilise the remaining waste and waste residues to a bearing capacity sufficient to support a final cover

(3) Install a final cover that provides long-term minimisation of infiltration into the closed unit

(4) In course of time, the material inside a landfill is likely to face setting or subsidence in a small way. The cover be such that all such subsidence of support, it should not get cracked, but its integrity be maintained.

(5) Provide drainage diversions to prevent any run-on

(6) To grow an appropriate vegetation on the top of the cover.

The operating agency should submit a certificate of completion of closure and post-closure to the state Boards.

The operating agency will please remember that money is required not only for establishing or for running a facility, but the closure too costs money. Therefore, provision of funds should be made during the process or insurance may be purchased during operating life, that assures funds for closure and post closure care.

25. Record keeping

The operating agency will please remember that no job is complete unless paper work is complete. The record keeping and reporting is especially important when dealing with waste which is hazardous. The operating agency should maintain the minimum record as is required by the hazardous waste rules, but should additionally keep other records like health statistics, insurance, cost analysis and whatever may be required by other departments. The statutory authorities sometimes demand only an annual figure. However, to arrive at, the operating agency has to have a daily record. The minimum requirement can be summarised as follows :

For Form No.	Preparatory figures
1.	Hazardous waste generation - category number - category - origin of manufacturing activity

3. Description of hazardous waste
   - physical form
   - chemical form
   - quaantity (volume and weight)

   Description of
   - daily method of storage of hazardous waste
   - daily method of treatment of hazardous waste

   Details of transportation
   - name and address of consignee of package
   - mode of packing
   - mode of transportation
   - date of transportation
   - quantity transportation

   Details of disposal of hazardous waste (datewise)
   - date of disposal
   - concentration of hazardous material in the final waste form
   - site of disposal (identify the location on the relevant layout drawing for reference)
   - method of disposal
   - name of persons involved in the disposal

   Date on environment surveillance
   - Date of measurement
   - Groundwater (sampling location, depth of sampling, results)
   - Soil (sampling location, depth of sampling, results)
   - air (sampling location, data)
   - any other (keep record)

4. Details of waste disposal operations

   Description of hazardous waste
   - physical form and contents
   - chemical form
   - total volume of hazardouw waste disposed
   - no. of packages

   Mode of transportation to the site of disposal

   Site of disposal (attach sketch showing the location of disposal)

   Brief description of method of disposal

   Date of disposal

   Remark (like discrepancy in manifest etc.)

	Details of environment surveillance - Date of measurement - Groundwater (sampling location, depth of sampling, results) - Soil (sampling location, depth of sampling, results) - air (sampling location, data) - any other (keep record)
5.	Accident Reporting - Date and time of the accident - Sequence of events leading to accident - Name of hazardous waste involved in the accident - chemical datasheet assessing effect of accident on health and environment - Emergency measures taken - Step to prevent recurrence of such wastes
7.	Description of imported hazardous waste - physical form - chemical form - total volume & weight (kg) Description of storage, treatment and disposal of hazardous waste - Date - Method of storage - Method of treatment & reuse (give details)

The operating agency should also maintain a record about the inspection visits of the State Pollution Control Board officials and other inspectors, if any and the instructions given by them on the spot. This should also follow by the compliance letter of the instructions in a reasonable time, (and acknowledgement obtained). The operating agency shall maintain his own record of treatability studies and characterisation of raw or recovered wastes with various parameters. Record of training too be maintained.

The operating agency will please keep it in mind that if he takes care of record daily, the record will take his care in case of an emergency.

26. Research and Training

The operating agency should certainly do their job of hazardous waste control as a business and trade. They should, however, also undertake this as a noble cause and support some research and provide some training. They should subscribe to foreign

journals or periodicals which are normally not available here, but which can spark an idea for developing an implement. Constant rapport with the State Pollution Control Boards where you are located and those of contiguous states and CPCB will prove to be a good and paying public relations. Training imparted by you to your own customers or ther industries, will not only spread knowledge, but by improvement in their working, your off-site or transportation work will become light. The Govt. of India encourages donations for creditable research, by allowing income-tax rebates. The research supported by you, may become useful for developing a technology base. The operating agency, therefore, should sincerely attempt this.

27. Safety and Security

The operating agency will be well advised to read the instructions prescribed by the Guidelines for Management and Handling of Hazardous Wastes, published by MoEF, Government of India, New Delhi regarding security requirements and contingency plans.

28. Management

In para 1 above, it is narrated as to how a CETP joint venture can fail due to various flash point possiblities. In the operating agency common facility too there can be some points against which one has to guard oneself. The operator can manage the affairs only if following favourable points are secured, viz.:

(1) The Authorisation be for a longer time than merely a two years (renewable). If it is for ten years, both the generator as well as operator can have safe, long range signed contracts. A longer tenure will bring financial stability and confidence to purchase new technologies.

(2) The SPCB be kept constantly informed about the activity, and there should be such relations as to be able to seek their guidance in case of difficulties or if sometimes is going wrong. Development of this mutual confidence is a key to remain in business for long period.

(3) The operating agency, at the same time, will have to excellent relations with their client industries, and their secrets they should feel, not being exploited. In fact, the operating agency should rectify the situation weekly and quitely. This confidence will go a long way.

(4) The operating agency will keep excellent public relations. People find that

approaching operating agency is not difficult, that itself is a success. Creating a situation which doesn't give cause to complaint is ideal, and attending a complaint as soon as is received is essential. The smoke of suspicion, spark of complaint and explosion of conflict-litigation are such rapid steps, where dividing lines are very thin.

(5) The operating agency will not survive if it does not have a uniform inflow of waste. Staggering of the time table and owned fleets may be advisable. Further, if the rated capacity is not reached, due to non availability of raw material (hazardous waste), the overheads will increase. A helping hand from industries association and SPCB will have to be secured for funnelling in, the waste.

(6) The operating agency will gain if recovery can be achieved. Knowledge and upgradation will be necessary.

(7) The regular contribution as operation charges from client industries and as subsidy from SPCB/Bank, will indeed be a basic assumption for survival.

Survival of operating agency is not merely necessary for the agency but also for the industries, SPCBs and public at large.

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