Hazardous Waste Management:

(National & International Management, Compliance mechanism, Co processing as AFR , Hazards, Contaminated sites, & Case studies)

Presented by

A. MANOHARAN

Former Sr. scientist & Zonal Officer(CPCB) Chennai

Email: mano_cpcb@yahoo.co.in

09663021846 (M)

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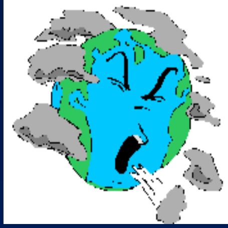
1. **Hazardous Waste Management: An Overvie**
2. **National & International Management**
3. **Compliance mechanism**
4. **Co processing as AFR Hazards,**
5. **Contaminated sites, &**
6. **Case studies)**

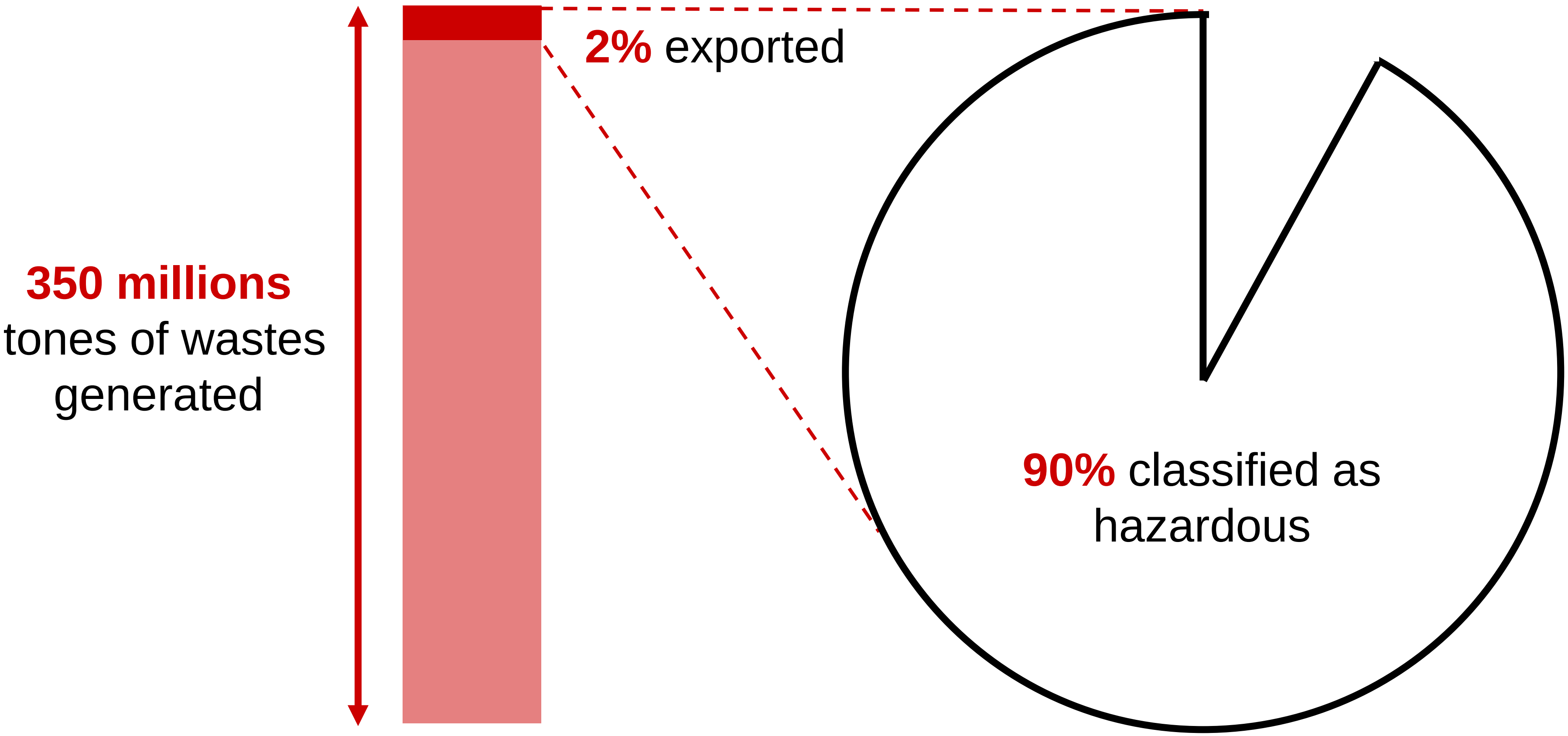
GLOBAL OUTLOOK

(Source : UN & WB,



PERCENTAGE OF WORLD'S	DEVELOPED COUNTRIES	DEVELOPING COUNTRIES
POPULATION	20	80
POPULATION GROWTH	0.1	1.5
WEALTH & INCOME	85	15
RESOURCE USE	88	12
POLLUTION & WASTE	75	25

Wastes generated worldwide in 2015



Note: The principal waste exported by volume was **lead** and **lead compounds** bound for recycling.

Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

Central Pollution Control Board

Regulations on Hazardous Waste Management

- Environment (Protection) Act, 1986
    - ➢ Hazardous Wastes (Management and Handling) Rules, 1989
    - ➢ Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008
    - ➢ Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

Hazardous Waste

“Hazardous waste” means any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances, and shall include as specified in Schedule I /II/III.

Global Environmental Conventions / Protocols

- 1972 – UN Conference on Human Development, Stockholm – created UNEP
- 1987 – World Commission on Environment & Development published Brundtland Report, Our Common Future
- 1992 – Rio Earth Summit published Agenda 21,
- 1992 UN Framework Convention on Climate Change (UNFCCC) & 1997 Kyoto Protocol
- 1992 UN Convention on Biological Diversity (UNCBD)
- 1995 UN Convention to Combat Desertification (UNCCD)
- 2000 – Millennium Development Goals
- 2002 – Johannesburg Declaration (WSSD)

INTRODUCTION

What makes a waste hazardous?

4 main characteristics of hazardous wastes

CORROSIVITY ***IGNITABILITY***

REACTIVITY ***TOXICITY***

Different shapes and forms

> liquids, solids, contained gases, sludge, etc.

WASTE COVERED BY BASEL

Classification by characteristics

4 main characteristics of hazardous wastes:

> Toxic > Corrosive
> Reactive > Ignitable

Basel Convention gives **13 characteristics**:

> Listed in Annex III;

> Based on ADR rules (UN Committee on the Transport of Dangerous Goods by Road or Rail);

> Represented as codes H1-H13.

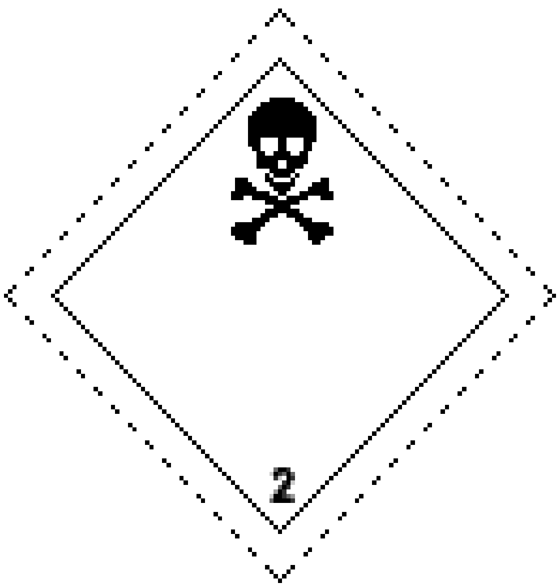
Excluded from the scope of the Convention are:

> Radioactive waste

> Waste derived from normal operation of a ship

WASTE COVERED BY BASEL

1- Toxicity



DEFINITION

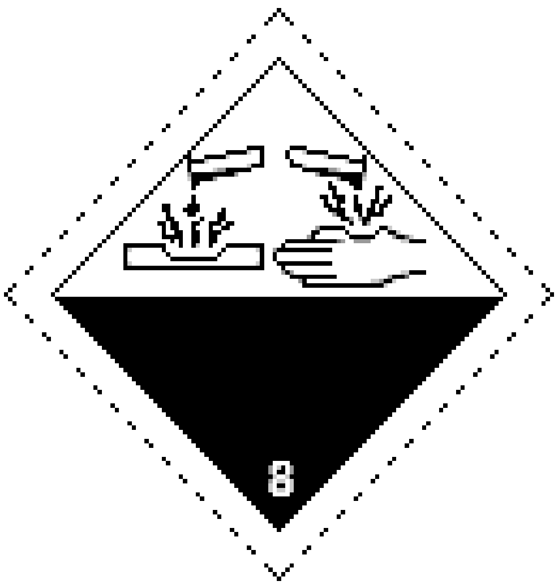
Toxic wastes are harmful or fatal when ingested, inhaled or absorbed through the skin.

EXAMPLES

> Spent cyanide solutions
> Waste pesticides

WASTE COVERED BY BASEL

2- Corrosivity



DEFINITION

Acids or alkalis that are capable of dissolving human flesh and corroding metal such as storage tanks and drums.

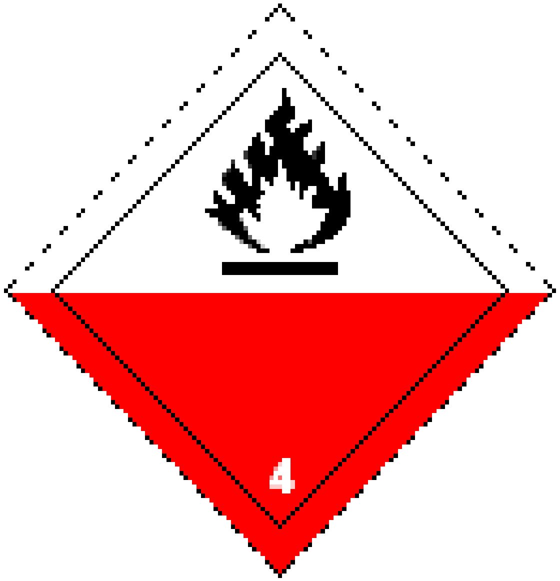
EXAMPLES

> Acids from metals cleaning processes e.g. ferric chloride from printed circuit board manufacture;

> Liquor from steel manufacture.

WASTE COVERED BY BASEL

3- Ignitability



DEFINITION

Wastes that can cause fires under certain conditions or are spontaneously combustible.

EXAMPLES

> Waste oil
> Used solvents
> Organic cleaning materials
> Paint waste

WASTE COVERED BY BASEL

4- Reactivity

DEFINITION

Reactive wastes are unstable under 'normal conditions'. They can cause: explosions, toxic fumes, gases or vapours.

EXAMPLES

> Peroxide solutions

> Hypochlorite solutions or solids

WASTE COVERED BY BASEL

5- Eco-toxicity

DEFINITION

Eco-toxic waste is harmful or fatal to other species or to the ecological integrity of their habitats.

EXAMPLES

> Heavy metals
> Detergents
> Oils
> Soluble salts

Waste Management in Germany

MAIN PRINCIPLES / OBJECTVES
of German (and European) Waste Policy

- Priority for avoidance, material recycling and energy recovery of waste
- Implementation of extended producer responsibility for products
- Stop landfilling of bio degradable waste
- Mandatory pretreatment of solid wastes
- Contribution to climate protection
- Harmonization within European Union

The new closed substance cycle

- **Implementing the vision of the 1992 world summit of Rio on sustainable development**
- **➔Closed Substance Cycle and Waste Management Act 1996 in Germany (China: Circular Economy)**
- **First priority now on substitution of resources (raw materials for production or secondary fuels for energy; priority should be given to the more environmentally friendly way)**
- **Recycling must be environmentally sound, economically reasonable and socially viable**
- **Disposal of wastes only, if recycling or recovery is not possible (problem of enforcement!)**
- **Steep increase in recycling and recovery quotas in Germany (>>50 %…80% and higher) for many types of waste**

Steps of Development (1)

- First: reduce waste for disposal
  - Inform / motivate citizens and industry
  - Start of separate collection of recycable waste
  - Promote reuse (packaging)
  - Increase gate fee for landfills
- Second: priority for recycling/(recovery)
  - Reduce waste going to landfill (no capacities)
  - Save resources (secondary raw materials/RDF)
  - Introduce extended producer responsibility (packaging, batteries, waste oil, scrap cars, WEEE)
  - Promote composting, paper recycling and others

High standards of recycling

(achieving quotas of 50...80 %)

Main fields of actions:

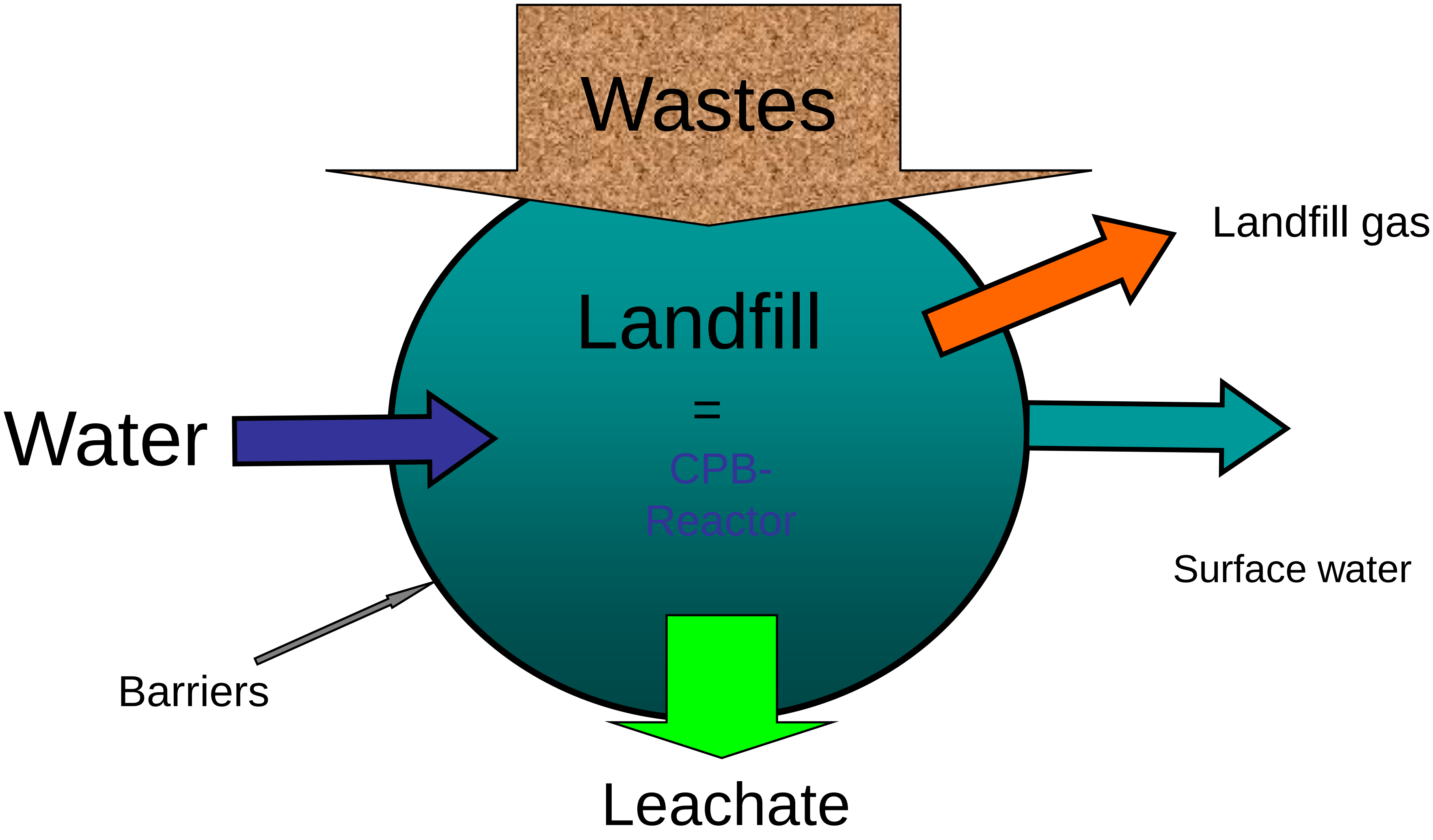
- **Bio waste for composting / anaerobic digestion**
- **Waste paper**
- **<u>Packaging of all types*</u>**
- **Construction and demolition waste**
- **<u>Batteries*</u>**
- **Waste wood**
- **Industrial waste**
- **<u>End of life vehicles*</u>**
- **<u>Electric and electronic equipment*</u>**

(* EPR-regulations in EU)

End of Life Vehicles (ELV)

- **European Directive on ELV is implemented**
- **Prohibition to use certain heavy metals (lead, mercury, cadmium, chromium-6 with certain exemptions) in new vehicles (➔new product standard)**
- **Take back obligation by producer or importer**
- **Detailed Requirements for dismantling and recycling**
- **Recycling and recovery quotas of 85% in 2006 and 95% in 2015 have to be achieved**
- **Need to change the existing techniques (either more dismantling before the shredder process or sorting out recyclable fractions from shredder light weight waste)**

Problems with Landfilling



Why landfilling of wastes is not a good solution

- Mixed waste contains organic as well as hazardous substances:
  - Production of landfill gas (only 50% can be collected and treated; the remaining 50% are a hazard to climate)
  - Production of leachate (long term collection and treatment is necessary – which is expensive)
  - Engineered barriers will not work for ever but fail in ???
- Landfilling shifts problems only to the future
- Remediation of old landfills may be necessary (problem for future generations) – but how? (examples)
- On the long term, landfill is the most expensive „solution“ and the contrary of sustainability
- Landfill of waste, therefore has lowest priority in Germany (and EU)
- Exemptions for inert wastes, if not recyclable

Steps of Development (2)

- Third: stop landfilling of untreated MSW, because of
  - Opposition from citizens against new sites
  - High costs for new landfills and aftercare
  - Old landfills became contaminated sites
  - Landfilling is the contrary of sustainability
  - Landfilling adds significantly to the emissions of climate damaging gases (methane)

→ New regulations limit the contents of biodegradable material (TOC) and of soluble hazardous substances

Wastes must be treated before landfilling

- **Goals:**
  - **Organic substances have to be mineralized**
  - **Soluble hazardous substances have to be destroyed or extracted or converted into stable condition**
- **Solution:**
  - **Thermal treatment destroys organic matter**
  - **Thermal treatment extracts soluble substances or transfers them into stable condition**
  - **Mechanical-biological treatment (alternative to incineration) needs thermal treatment for high calorific residues**
- **Additional advantage: substitution of energy**

Steps of Development (3)

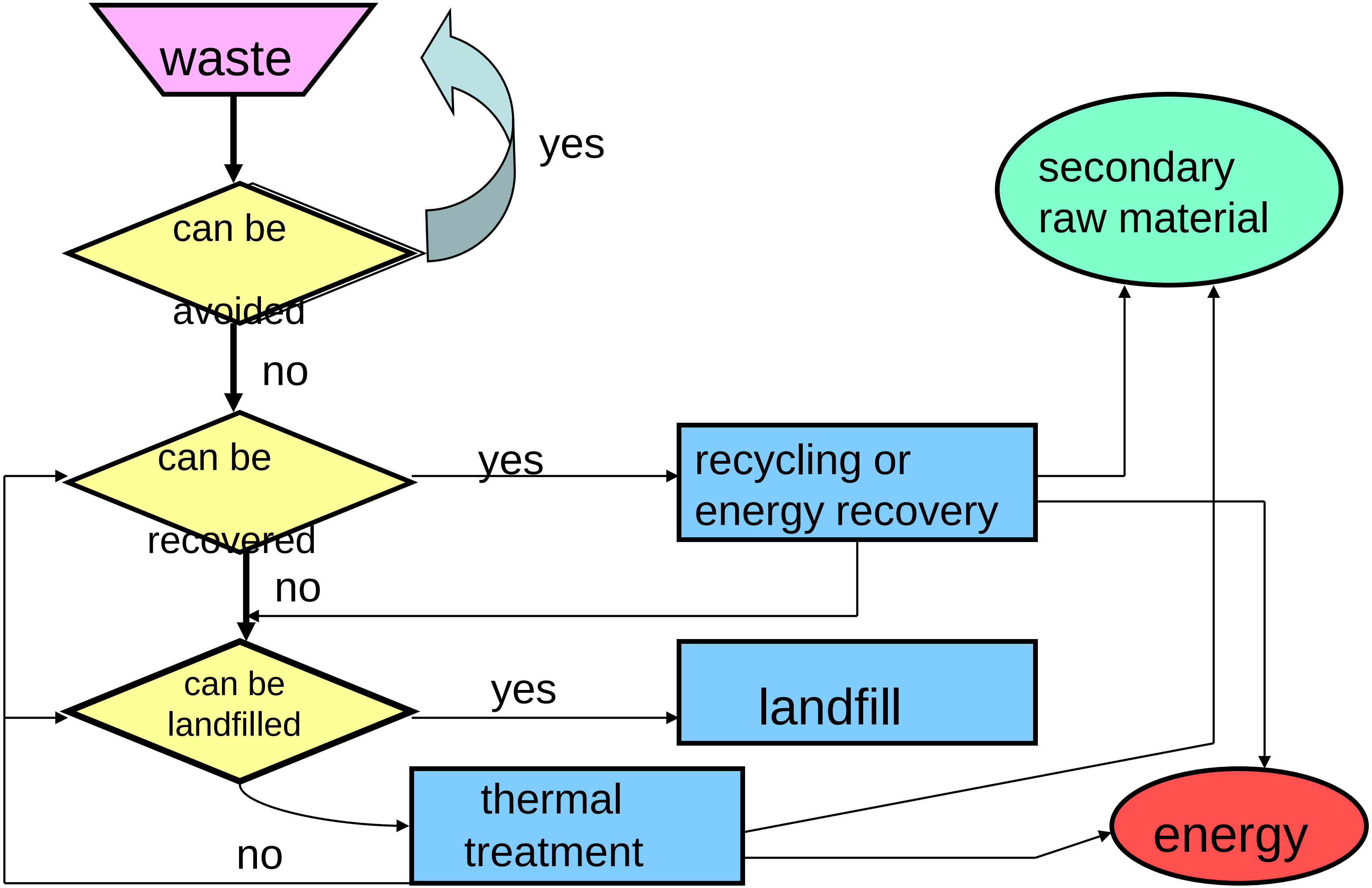
- <u>Fourth:</u> Consequences of restrictions for landfilling: All MSW has to be pre-treated since 2005

Regulations do not define the way –

but the results:

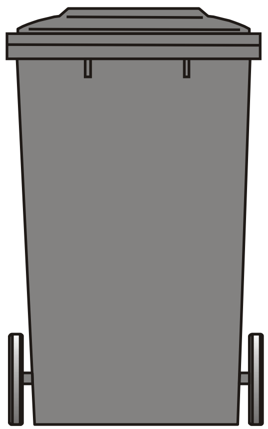
specifications of pre-treated waste + stringent requirements to protect emissions into air and water

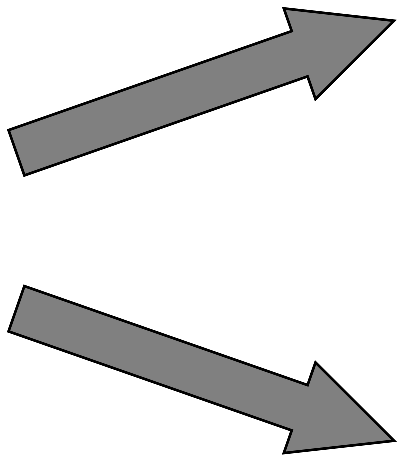
Integrated Waste Management System

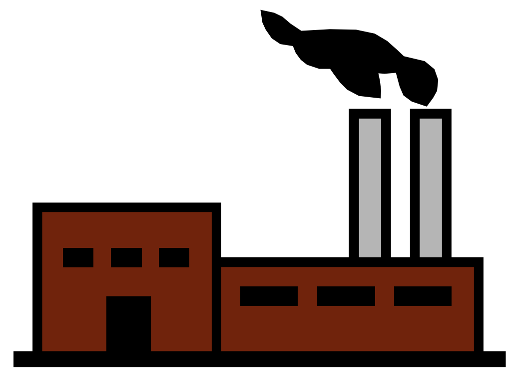


Waste Management in Germany in 2015

Landfill: 28 Mill tons







34 Mill tons of MSW

Waste Incineration
6 Mill tons

What are the solutions in Germany?

- **Waste incineration with efficient energy use and stringent emission control has priority**
- **Mechanical-biological treatment with energy recovery of the high calorific fraction has second priority**
- **Co-incineration of certain wastes in fossil fired power plants and cement kilns is used increasingly; (also secondary fuel to substitute fossil fuel in district heating, paper mill, chemical industry, tyre-production, metal affinery, even food production)**
- **Anaerobic digestion of organic wastes with energy use of the bio-gas is increasing**
- **Common denominator: thermal treatment which has achieved political acceptance in Germany, even in the Green Party (pre requisites are limitation to residual waste and stringent emission standards)**

Emissions from waste incineration in Germany

(per 100 00 t of MSW)

Before 1990

210.000	t	NOX
410.000	t	SO2
180	kg	Cd
130	kg	Hg
6	g	Dioxin

Today

36.000	t	NOX
0,9	t	SO2
1,2	kg	Cd
1,2	kg	Hg
0,003	g	Dioxin

Steps of Development (4)

- Fifth: Solutions in Germany (public and private operators)
  - Rely on proven technology: Municipal Solid Waste Incineration (MSWI, mainly grate)
    - 73 MSWI facilities are operating presently
    - Total capacity of 17.9 million tons per year (65%)
  - Mechanical-biological-treatment (MBT)
    - 66 facilities with 7.2 mill t/y (26%)
  - Co-incineration in coal fired power plants and cement kilns
    - presently only 2.3 mill t/y, 8%

[Praxis is similar in some other European countries like A, CH, DK, F, NL, S]

„alternative“ Technologies failed (2)

- Pyrolysis
  - Several small sized plants were built
  - Only one is still operating (technical problems and how to dispose hazardous tar)
- Plasma Technology
  - Only experiments and test rigs; no large facility for waste has been realized
- Katalytic Depolimerisation
  - Small test rig promises to transfer waste into diesel
  - No large facility has proven to be available for mixed waste
- Deep well injection
  - In theory an ideal solution for organic sludge
  - Technical realisation failed

A new Experience: Waste Management contributes to Climate Protection

(Research Report 205 33 314 BMU/UBA/Oeko-Institut/ifeu, 8/2005)

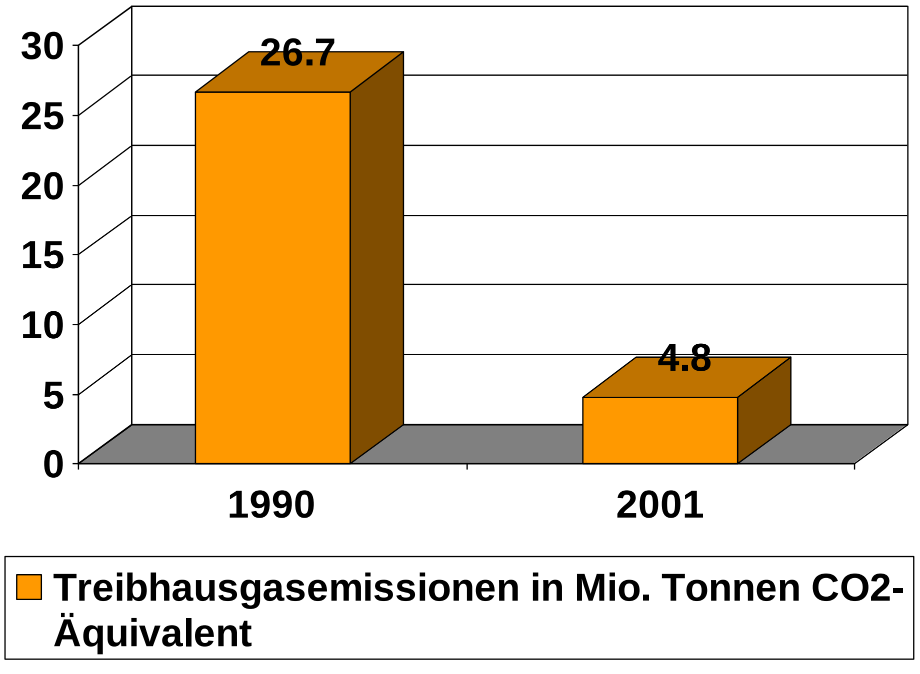
- **Methane-emissions from dumps are 21-times more effective than CO_2**
- **Out phasing landfills for solid waste in Germany has reduced such gas emissions significantly**
- **Incineration of organic waste has no impact on climate change**
- **Outphasing landfill and other waste activities contribute to a total reduction of 46 mill t CO_2 equivalents from 1990 until 2005 (which is the highest individual contribution to climate protection in Germany)**
- **Mayor contributions for reductions aside out phasing of landfills are**
  - **MSWI and Co-incineration (substitution of fossil fuel)**
  - **Metal recycling**
  - **Paper recycling**
  - **Glass recycling**
- **Total reductions from 1990 until 2020 are assumed to be 50 mill t, mainly by not landfilling (76%), MSWI (9%), co-incineration (7%) and material recycling (5%)**
- **The reduction potential for the old EU (15 MS) could be 134 mill t CO_2 equivalents, almost 100 mill t from terminating landfilling!the (USA?)**

Landfills are significant emitters

of climate changing gases

Organic substances in MSW lead to the generation of methane.

Reduction of emissions are possible by:
- reduce landfilling of wastes
- pre-treatment of wastes
- improved gas collection



Central Case: IN CANADA

The Beare Road Landfill: Making Good Use of Old Garbage

"We can't have an economy that uses our air, water, and soil as a garbage can."

–David Suzuki

- 1968 - 1983: The Beare Road pit received municipal garbage for Toronto's ever-increasing garbage
- 1983: landscape restoration was undertaken
- 1996: began to collect the methane-rich gas being generated by the decomposing garbage (LFGTE, landfill gas-to-electricity)

Approaches to waste management

- **Municipal solid waste =** non-liquid waste that comes from homes, institutions, and small businesses
- **Industrial solid waste =** waste from production of consumer goods, mining, agriculture, and petroleum extraction and refining
- **Hazardous waste =** solid or liquid waste that is toxic, chemically reactive, flammable, or corrosive
- **Wastewater =** water used in a household, business, or industry, as well as polluted runoff from our streets and storm drains

Sseveral aims in managing waste

- Three main components of waste management
  - Minimizing the amount of waste we generate (**source reduction**)
  - Recovering waste materials and finding ways to recycle them
  - Disposing of waste safely and effectively

Waste disposal is regulated by three levels of government

- Municipal:
  - Collection, diversion, and disposal of solid waste
  - Drop-off facilities for hazardous waste
- Provincial and territorial:
  - Movement of waste materials within the jurisdiction
  - Licensing of treatment facilities
  - Legislation and guidelines for landfill sites
- Federal government:
  - International agreements about waste
  - Transboundary movements of waste materials

Reducing waste is a better option

- **Source reduction** = preventing waste generation in the first place
    - Avoids costs of disposal and recycling
    - Helps conserve resources
    - Minimizes pollution
    - Can save consumers and businesses money
- Strategies
    - Reduce packaging
    - Ban or per-bag charges for plastic grocery bags
    - Increase the longevity of goods

Reuse is one main strategy for waste reduction

- Donate used items to charity
- Reuse boxes, paper, plastic, wrapping paper, and so on
- Buy groceries in bulk
- Decline bags at stores and bring cloth bags shopping
- Bring your own cup to coffee shops
- Buy rechargeable batteries
- Select goods with less packaging
- Compost kitchen and yard wastes
- Rent or borrow items instead of buying them

Financial incentives can help address waste

- **Pay-as-you-throw** = uses financial incentives to influence consumer behavior
  - The less waste a house generates the less it is charged for trash collection
- **Return-for-refund** = consumers pay a deposit, and receive a refund for returning used bottles
  - Greatly reduced beverage container litter
  - All provinces and territories in Canada except for Nunavut

Industrial solid waste

- **Industrial waste** = waste from factories, mining, agriculture, petroleum extraction, etc.

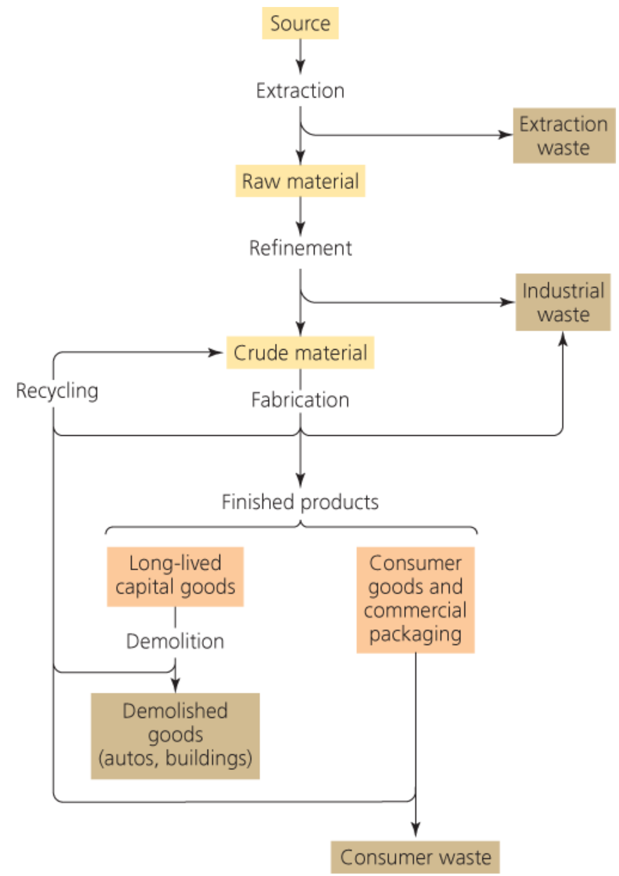


FIGURE 18.10
Industrial and municipal waste is generated throughout the life cycles of products. Waste is first generated when raw materials needed for production are extracted. Further industrial waste is produced as raw materials are processed and as products are manufactured. Waste results from the demolition or disposal of products by businesses and individuals. At each stage, there are opportunities for efficiency improvements, waste reduction, or recycling.

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Regulation and economics each influence industrial waste generation

- Most methods and strategies of waste disposal, reduction, and recycling are similar to municipal solid waste
- The amount of waste generated by a manufacturing process is one measure of its efficiency
- Physical efficiency is not equal to economic efficiency
  - It can be cheaper to generate waste than to avoid waste
- The rising cost of waste disposal encourage industries to decrease waste and increase physical efficiency

Industrial ecology seeks to make industry more sustainable

- **Industrial ecology** = redesigning industrial systems to reduce resource inputs and to minimize physical inefficiency while maximizing economic efficiency

- **Life cycle analysis =** examine the life cycle of a product and look for ways to make the process more ecologically efficient

- **Pollution prevention (P2) strategies** = aimed at reducing waste and preventing pollution at its source

Solid Waste in the United States

- Leader in solid waste problem
  - What is thrown away?

- Leader in trash production, by weight, per person

- Recycling is helping

Hundreds of Millions of Discarded Tires in a Dump in Colorado

Fig. 21-5, p. 561

Solid Waste in the United States

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  - What is thrown away?

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Hundreds of Millions of Discarded Tires in a Dump in Colorado

Fig. 21-5, p. 561

Hazardous Waste Management in Canada

Hazardous waste

- 1999: *Canadian Environmental Protection Act*:
  - **Flammable** = substances that easily catch fire
  - **Corrosive** = substances that corrode metals in storage tanks or equipment
  - **Reactive =** substances that are chemically unstable and readily react with other compounds, often explosively or by producing noxious fumes
  - **Toxic =** substances that harm human health when they are inhaled, are ingested, or contact human skin

Several steps precede the disposal of hazardous waste

- For many years, hazardous waste was discarded without special treatment
  - Public did not know it was harmful to human health
  - Assumed the substances would disappear or be diluted in the environment
  - Since the 1980s, cities designate sites or special collection days to gather household hazardous waste

FIGURE 18.13
Many communities designate collection sites or collection days for household hazardous waste. Here, workers handle waste from an Earth Day collection event.

There are three disposal methods for hazardous waste

- Secure landfills
- Surface impoundments
- Deep-well injection
- These methods do nothing to lessen the hazards of the substances but do keep the waste isolated

Deep-well injection

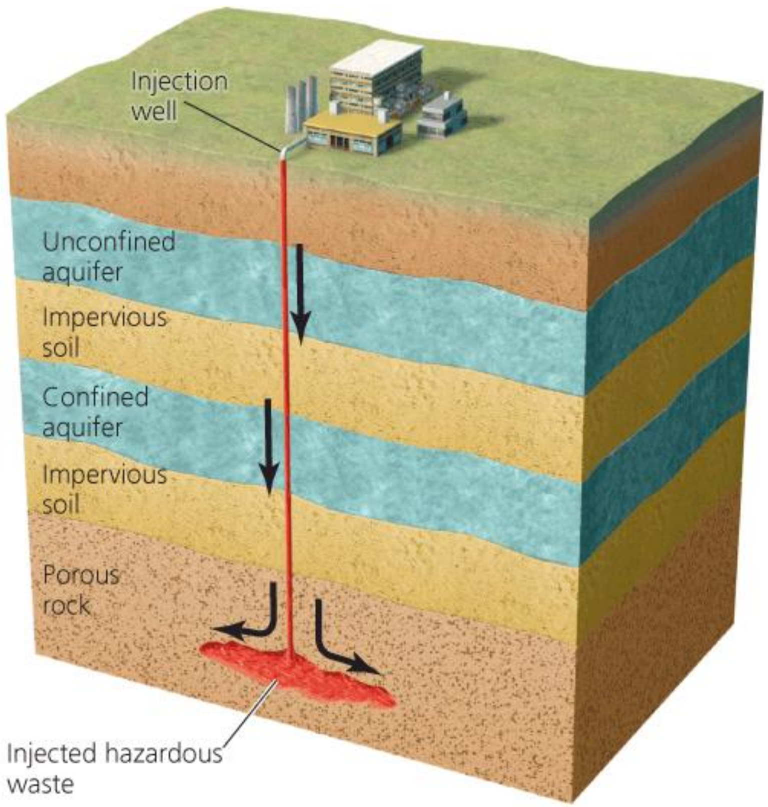

FIGURE 18.16
Liquid hazardous waste may be pumped deep underground, by deep-well injection. The well must be drilled below any aquifers, into porous rock separated by impervious clay. The technique is expensive, and waste may leak from the well shaft into groundwater.

- **Deep-well injection** = a well is drilled deep beneath the water table and waste is injected into it
  - Long-term disposal
  - The well is intended to be isolated from groundwater and human contact
  - Wells become corroded and leak waste into soil

Contaminated sites are being cleaned up, slowly

- 18,000 Canadian contaminated sites, including priority sites for cleanup activities:
  - Faro Mine, Yukon ($14.6 million)
  - Canadian Forces Base Esquimalt, British Columbia ($4.56 million)
  - Port Radium Mine, Northwest Territories ($7.1 million)
  - Belleville Small Craft Harbour, Ontario ($6.8 million)
- **Brownfields** = sites that have been contaminated but have the potential to be cleaned up and remediated

WASTE COVERED BY BASEL
Waste classification by origin

The Basel Convention's **list of hazardous waste categories** (Y1 to Y18) identifies wastes from specific processes (Annex 1).

Some example:

Y1 - Clinical wastes
:
Y6 - Wastes from the production and use of organic solvents
:
Y18 - Residues from industrial waste disposal operations

Note: *Besides the official, international binding, definition of the Convention, countries themselves can adopt wider and stricter definitions*.

Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries(LDCs).

The Convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate.

The BASEL Convention was opened for signature on 22 March 1989, and entered into force on 5 May 1992.

As of August 2016, 184 states and the European Union are parties to the Convention.
Haiti and the United States have signed the Convention but not ratified it

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

Type: United Nations

Treaty Signed22 (March 1989)

Location Basel, Switzerland

Effective 5 May 1992

Signatories 53

Parties186

Wastes covered by Basel Convention

- Toxicity
- Corrosivity
- Ignitability
- Reactivity
- Eco-toxicity

- Clinical wastes.
- Mining wastes.
- Industrial wastes.
- Agricultural wastes.
- End of life equipments and commodities
- (asbestos, PCB equip., stockpiles, batteries,
- e-wastes, ships, etc.)

- Currently addresses 27 specific categories of waste and 18 waste streams (Source :UNEP ,2005)

History of Basel convention

With the tightening of environmental laws (for example, RCRA) in developed nations in the 1970s, disposal costs for hazardous waste rose dramatically.

At the same time, globalization of shipping made transboundary movement of waste more accessible, and many LDCs were desperate for foreign currency. Consequently, the trade in hazardous waste, particularly to LDCs, grew rapidly.

One of the incidents which led to the creation of the Basel Convention was the *Khian Sea* waste disposal incident, in which a ship carrying incinerator ash from the city of Philadelphia in the United States dumped half of its load on a beach in Haiti before being forced away.

It sailed for many months, changing its name several times. Unable to unload the cargo in any port, the crew was believed to have dumped much of it at sea.

The Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal

4**Negotiated by UNEP.**

4**Adopted in March 1989 at Basel, Switzerland.**

4**Entered into force on 5th May 1992.**

4**India signed this Convention on 15.03.1990, ratified it on 24.06.1992 and acceded to it on 22.09.1992.**

4**162 Parties as on date.**

Key Objectives.

- Generation of hazardous wastes (and other wastes) be reduced to a minimum in terms of quantity and hazard potential (concepts of waste minimisation and cleaner production technology).
- Hazardous Wastes to be disposed off in an environmentally sound manner - whatever the place of disposal.
- Hazardous Wastes to be disposed off as close to the source of generation as possible (Proximity Principle) (contained in the preamble & Article-4)

Other Salient Features of the Convention

- Hazardous Waste shall be exported only if the State of export does not have the technical capacity and facilities to dispose of them in an environmentally sound manner (Article 4).
- The export of hazardous wastes is prohibited if the exporting State has reason to believe that their environmentally sound management and disposal would not be guaranteed in the prospective State of import (Preamble, Article 4).

Other Salient Features of the Convention Contd.

- A State shall prohibit the import of hazardous waste into its territory if it has reason to believe that they could not be managed in an environmentally sound manner (Article-4).
- The Convention provides for an elaborate control /regulatory system which is based on the principles of Prior Informed Consent (Notification system)(Article 1,4,6,7&13).
- Hazardous wastes and other wastes must be accompanied by a movement document from the point at which a transboundary movement commences to the point of disposal (Article -4).

Illegal Traffic

The movement of hazardous wastes is to be considered illegal if:

(i) it is without prior notice or

(ii) without the consent of the importing country or receiving party.

(iii) with consent obtained through falsification, mis-representation or fraud or

(iv) does not conform to the movement document.

(v) In case of illegal movements the hazardous wastes in question are taken back by the exporter or generator;

Illegal Traffic
Contd.

Or otherwise disposed of in an environmentally sound manner within 30 days or such other period of time as may be agreed from the time of obtaining information of illegal traffic.

(vi) Any transboundary movement of hazardous wastes which does not conform with the provisions of the convention is deemed illegal. The convention states that this is a criminal act. (Article 4 &8).

International co-operation

Basel Convention calls for international cooperation between Parties in areas relating to ESM of Hazardous Wastes such as:

- **Development of low-waste technologies.**
- **Transfer of cleaner technology.**
- **Training**
- **Harmonization of technical standards and guidelines.**
- **Monitoring effects of HWs on human health & environment.**

Incorporation of key provisions of the Basel Convention into National Legislation

- Major provisions of Basel Convention reflected in HW Rules 2016.
- Rule 12(6) - "Any occupier importing/exporting HWs shall comply with the articles of the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal….".
- Annexe V.A of Basel Convention incorporated as Form VII of HW Rules (Application form for Export of HWs).
- Annexe V-B of the Convention incorporated as Form VII A of HW Rules 2016- Waste Movement Document.

Incorporation of key provisions of the Basel Convention into National Legislation Contd.

- Annexe-III- Hazardous Characteristics as Part-B of Schedule 3 of HW Rules.
- Annexe-VIII-Wastes (HWs to be prohibited for transboundary movement) as List ‘A’ of Part A of Schedule 3 of HW Rules.
- Annexe -IX Wastes (Green Wastes for Recycling) as List ‘B’ of Part A of Schedule 3 of HW Rules.

Basel Ban Amendment

- Approved in COP-III - Annexe VIII & Annexe-IX finalized in 1997-1998.
- Seeks to prohibit the movement of Annexe-VIII wastes from Annexe-VII countries to non-Annexe-VII countries- even for recycling.
- This amendment is not yet in force as it is not yet ratified by requisite number of countries.

Basel Ban Amendment Contd.

- India has neither signed nor ratified this amendment as:-

- Criteria for listing of countries under Annexe VII arbitrary & non-measurable.

- Countries outside Annexe-VII do have technologies & capacities to recycle Hazardous Wastes -especially non-ferrous metal wastes.

Compatibility of Wastes

- Many wastes, when mixed with other **waste** or materials at a **hazardous waste** facility, can produce effects

  which are harmful to human health and the environment, such as (1) heat or pressure, (2) fire orexplosion, (3) violent reaction, (4) toxic dusts, mists, fumes, or gases, or (5) flammable fumes or gases.

What is Hazardous Waste

- Any waste that has the following characteristics:
  - Ignitable
  - Corrosive
  - Reactive
  - Toxic
- Is listed as a waste in Hazardous waste rules 1989 and amendments thereafter.

Characteristics of a Waste

- **Ignitable**

  Flash point $< 140^{o}$F

  <u>Examples:</u>

  Acetonitrile, alcohols, acetone, toluene, xylene, ether, other

Characteristics of a Waste

- **Corrosive**

  pH $\leq$ 2.0 or pH $\geq$ 12.5

  <u>Examples:</u>

  Acids, glass cleaner, hydroxides, bases, drain cleaners, other

Characteristics of a Waste

- **Reactive**

  Unstable and may explode under certain conditions such as heat, friction or pressure

  

  Examples:

  Picric acid, peroxide forming chemicals, ethyl ethers, dinitro compounds, other

Characteristics of a waste

- **Toxic**

  Fails Toxic Characteristic Leaching Procedure (TCLP) Test

  Examples:

  Heavy metals: mercury, lead, silver, chromic acid, other

Hazardous Combinations:

- Acid + Oil or Grease = Fire
- Flammable Liquid + Hydrogen Peroxide = Fire/Explosion
- Acid + Caustic = Heat/Spattering
- Aluminum Powder + Ammonium Nitrate = Explosion
- Caustics + Epoxies = Extreme Heat
- Sodium Cyanide + Sulfuric Acid = Lethal Hydrogen Cyanide
- Chlorine Gas + Acetylene = Explosion
- Ammonia + Bleach (or other Chlorine source) = Toxic Chloramine (i.e., Mustard Gas)

Rules of Compatibility

- Segregate REACTIVES from IGNITABLES
- Segregate ACIDS from CAUSTICS
- Segregate CORROSIVES from FLAMMABLES
- Segregate strong OXIDIZERS from EVERYTHING
- Most ORGANIC REACTIVES must be segregated from INORGANIC REACTIVES (metals)

Mallinckrodt Specialty Chemicals Co. – Chemical Compatibility List

The following provides some chemicals which are INCOMPATIBILE with other compounds.

Avoid contacting, in storage and in working,
As

Explosion or
Toxic fume or
Other hazard

may result.

(SOURCE: Mallinckrodt Specialty Chemicals Co. 5/89)

Incompatible Substances

COMPOUND(S) INCOMPATIBLE WITH:

Acetic acid -chromic acid, nitric acid, ethylene glycol, perchloric acid, peroxides and permanganates

Acetone -concentrated sulfuric and nitric acid mixtures

Acetylene -copper tubing, fluorine, bromine, chlorine, iodine, silver, mercury

Ammonia anhydrous -mercury, halogens, calcium hypochlorite, hydrogen fluoride (HF)

Ammonium Nitrate -acids, metal powders, flammable liquids, chlorates- nitrates, sulfur,finely divided organics or combustibles

Aniline- nitric acid, hydrogen peroxide

Arsenic compounds -any reducing agent

Azides- acids

Bromine- ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide,Turpentine, finely divided metals

Calcium -water, carbon dioxide, carbon tetrachloride, and chlorinated hydrocarbons

Carbon, activated -calcium hypochlorate, all oxidizing agents

Chlorates -ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles, carbon
Chromic acid -acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine, alkalis, other flammable liquids
Chlorine Dioxide -ammonia, methane, phosphine, hydrogen sulfide
Chlorine -ammonia, acetylene, butadiene, benzene, petroleum fractions,hydrogen, sodium carbide, turpentine, and finely divided metalpowders
Copper -acetylene, hydrogen peroxide
Cyanides -acids and alkalis (bases)
Flammable Liquids -ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid,sodium peroxide, halogens
Fluorine -isolate from everything
Hydrazine-hydrogen peroxide, nitric acid, all oxidizers
Hydrocarbons -fluorine, chlorine, bromine, chromic acid, peroxide

Hydrocyanic acid -nitric acid, alkalis
Hydrofluoric acid -ammonia, alkalis
Hydrogen Sulfide -fuming nitric acid, oxidizing gases
Hypochlorites -acids, activated carbons
Iodine -acetylene, ammonia, hydrogen
Mercury -sulfuric acid
Nitric acid (conc) -acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, heavy metals
Nitrites - acid
Nitroparrafins- inorganic bases, amines
Oxalic acids -silver, mercury
Oxygen -oils, grease, hydrogen, flammable liquids, solids or gases
Perchloric Acid -acetic anhydride, bismuth, alcohol, paper, wood, oil and grease
Peroxides, organic -acids, friction, heat, sparks
Phosphorous, white -air, oxygen, alkalis, reducing agents
Phosphorous pentoxide -water
)

Potassium -carbon tetrachloride, carbon dioxide, water
Potassium chlorate -sulfuric and other acids
Potassium perchlorate -sulfuric and other acids (see Chlorates also
Potassium permanganate- glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides -reducing agents
Silver -acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium carbon tetrachloride, carbon dioxide, water
Sodium nitrite- ammonium nitrate and other ammonium salts
Sodium peroxide -ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl or methyl acetate, furfural
Sulfides -acids
Sulfuric Acid -potassium (sodium or lithium) chlorate, perchlorate, or permanganate
Tellurides -reducing agents

RCRA's Chemical Waste Compatibility List

- The mixing of Group A materials with Group B materials may have the potential consequences noted.

Group 1-A	**Group 1-B**
Acetylene Sludge	Acid sludge
Alkaline caustic liquids	Acid and water
Alkaline cleaner	Battery acid
Alkaline corrosive liquids	Chemical cleaners
Alkaline corrosive battery fluid	Electrolyte, acid
Caustic wastewater	Etching acid liquid or solvent
Lime sludge and other corrosive alkalies	Pickling liquor & other corrosive acid
Lime wastewater	Spent acid
Lime and water	Spent mixed acid
Spent caustic	Spent sulfuric acid

- **Potential consequences:**
- **Heat generation;**
- **Violent reaction**

RCRA's Chemical Waste Compatibility List

- **Group 2-A**
- Aluminum
- Beryllium
- Calcium
- Lithium
- Magnesium
- Potassium
- sodium
- Zinc powder
- Other reactive metals and metal hydroxides

Group 2-B

Any waste in Group 1-A or 1-B

- **Potential consequences:**
  - **Fire or**
  - **Explosion;**
  - **Generation of flammable hydrogen gas**

RCRA's Chemical Waste Compatibility List

Group 3-A	Group 3-B
Alcohols	Any concentrated waste in Groups1A or 1B
Water	Calcium
	Lithium
	Metal hydrides
	Potassium
	SO_2Cl_2, $SOCl_2$, PCl_3, CH_3SiCl_3
	Other water-reactive waste

- **Potential consequences:**

Fire,
Explosion, or
Heat generation;
Generation of flammable or
Toxic Gases

RCRA's Chemical Waste Compatibility List

Group 4-A	Group 4-B
Alcohols	Concentrated Group 1-A or 1-B wastes
Aldehydes	Group 2-A wastes
Halogenated hydrocarbons	
Nitrated hydrocarbons	
Unsaturated hydrocarbons	
Other reactive organic compounds & solvents	

- **Potential consequences:**

Fire,
Explosion or
Violent reaction

RCRA's Chemical Waste Compatibility List

- **Group 5-A**
- Spent cyanide
  and sulfide solutions

Group 5-B

Group 1-B wastes

- **Potential consequences:**

Generation of

- **Toxic Hydrogen Cyanide or**
- **Hydrogen Sulfide**
  Gas

RCRA's Chemical Waste Compatibility List

- **Group 6-A**
- Chlorates
- Chlorine
- Chlorites
- Chromic acid
- Hypochlorites
- Nitrates
- Nitric acid, fuming
- Perchlorates
- Permanganates
- Peroxides
- Other strong oxidizers

Group 6-B

Acetic acid and other organic acids

Concentrated mineral acids

Group 2-A wastes

Group 5-A wastes

Other flammable and combustible wastes

- **Potential consequences:**

Fire,

Explosion or

Violent reaction

Hazardous Waste Compatibility Chart
Source - USA EPA

Reactivity Code

H ---------------------- Heat generation
F ---------------------- Fire
G ---------------------- Innocuous and non-Flammable gas generation
GT --------------------- Toxic gas generation
GF --------------------- Flammable gas generation
E ---------------------- Explosion
P ---------------------- Violent polymerisation
S ---------------------- Solubilisation of toxic substance
U ---------------------- May be hazardous but unknown

Example

H
F — Heat generation, fire and toxic gas generation
GT

GROUP NO.	GROUP NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Acids, Mineral, Non-oxidising	1																			
2	Acids, Mineral, Oxidising		2																		
3	Acids, Organic		G H	3																	
4	Alcohols and Glycols	H	H P	H P	4																
5	Aldehydes	H P	H F	H P		5															
6	Amides	H	H GT				6														
7	Amines, Aliphatic and Aromatic	H	H GT	H		H		7													
8	Azo and Diazo Compounds and Hydrazines	H G	H GT	H G	H G	H			8												
9	Carbamates	H G	H GT						G H	9											
10	Caustics (Alkalis)	H	H	H		H				G H	10										
11	Cyanides	GT GF	GT GF	GT GF					G			11									
12	Dithiocarbamates	H GF F	H GF F	H GF GT		GF GT		U	H G				12								
13	Esters	H	H F						H G		H			13							
14	Ethers	H	H F												14						
15	Fluorides, Inorganic	GT	GT	GT												15					
16	Hydrocarbons, Aromatic		H F														16				
17	Halogenated Organics	H GT	H F GT					H GT	H G		H GF	H						17			
18	Isocyanates	H G	H F GT	H G	H P			H P	H G		H P G	H G	U						18		
19	Ketones	H	H F						H G		H	H								19	
20	Mercaptans and Other Organic Sulphides	GT GF	H F GT						H G									H	H	H	20
21	Metals, Alkali and Alkaline Earth, Elemental	GF H F	GF H F	GF H F	GF H F	GF H F	GF H	GF H	GF H	GF H	GF H	GF H	GF GT H	GF H				H E	GF H	GF H	GF H
22	Metals, Other Elemental and Alloys as Powders, Vapours or Sponges	GF H F	GF H F	GF					H F GT	U	GF H							H E	GF H		H GF F
23	Metals, Other Elemental and Alloys as sheets, Rods, Mouldings etc	GF H F	GF H F						H F G									H F			
24	Metals and Metal Compounds, Toxic	S	S	S			S	S			S										
25	Nitrides	GF HF	H F E	H GF	GF H	GF H			U	H G	U	GF H	GF H	GF H				GF H	U	GF H	GF H
26	Nitriles	H GT GF	H F GT	H							U										
27	Nitro Compounds, Organic		H F GT			H					H E										
28	Hydrocarbons, Aliphatic, Unsaturated	H	H F			H															
29	Hydrocarbons, Aliphatic, Saturated		H F																		
30	Peroxides and Hydroperoxides, Organic	H G	H E		H F	H G		H GT	H F E	H F GT		H E GT	H F GT					H E	H	E	H F GT
31	Phenols and Cresols	H	H F						H G										H P		
32	Organophosphates, Phosphothioates	H GT	H GT						U		H E										
33	Sulphides, Inorganic	GT GF	HF GT	GT		H			E										H		
34	Epoxides	H P	H P	H P	H P	U		H P	H P		H P	H P	U								H P
35	Combustible and Flammable Materials, Misc	H G	H F GT																		
36	Explosives	H E	H E	H E					H E		H E			H E							
37	Polymerisable Compounds	P H	P H	P H					P H		P H	P H	U								
38	Oxidising Agents, Strong	H GT		H GT	H F	H F	H F GT	H F GT	H E	H F GT		H E GT	H F GT	H F				H GT	H F GT	H F	H F GT
39	Reducing Agents, Strong	H GF	H F GT	H GF	H GF F	GF H F	GF H	H GF	H G				H GT	H F	H F		H F	H E	GF H	GF H	GF H
40	Water and Mixtures Containing Water	H	H						G										H G		
41	Water Reactive Substances	← Extremely Reactive →																			

GROUP NO.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
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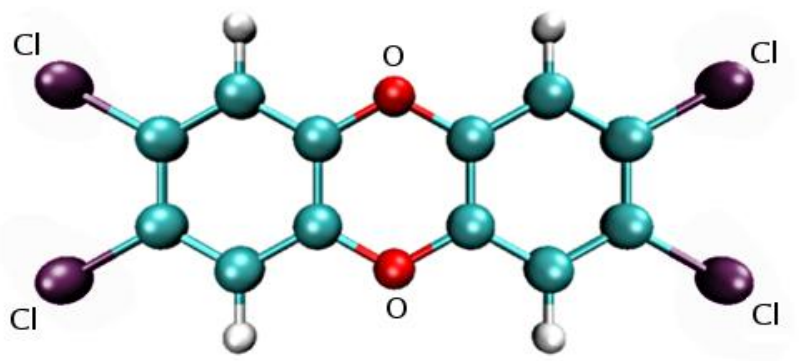
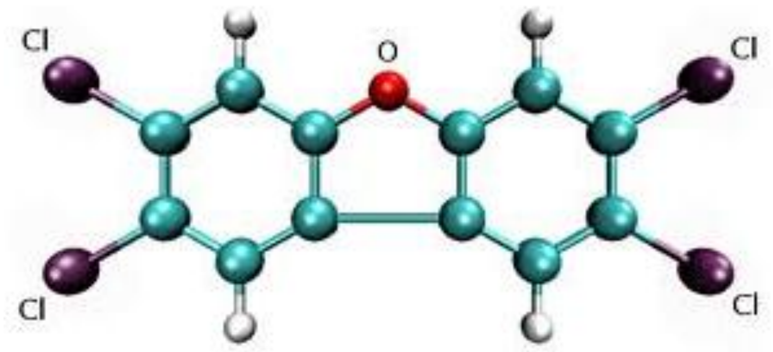
24				24																	
25	E				25																
26	H P			S	GF H	26															
27	H GF E				H GF E		27														
28		H E						28													
29									29												
30	H E	F G		H G	H GF E	H P GT		H P		30											
31	GF H				GF H					H	31										
32	H									U		32									
33										H GT			33								
34	H P	H P		H P	H P					H P	H P	U	H P	34							
35	H G F				H GF F					H F GT					35						
36	H E	H E		E	E					H E	H E		H E	H E	H E	36					
37	P H	P H	H E P	P H	P H					P H	P H		P H			H E	37				
38	H F E	H F E	H H F		H F E	H F GT	H E	H F	H F	H G	H F	H F GT	H F GT	H F G	H F G	H E	H F GT	38			
39						H GF	H E			H E	GF H	GT GP H		H	GF H	H E	H P GF	H F E	39		
40	GF H	GF H		S	GF H								GT GF						GF GT	40	
41																					41

DIOXIN AND FURAN - FACTS

Dioxin and Furan are the popular names for the family of chlorinated organic compounds comprising of Polychlorinated Dibenzo Dioxins (PCDD) and Polychlorinated Dibenzo Furans (PCDF)



Dioxin



Furan

Dioxin History

- 1960s, 1970s Most people hear of dioxins in relation to use of Agent Orange in Vietnam
- 1949 - 1976 Dioxins produced in industrial accidents in plants making 2,4,5 Trichlorophenol. Most famous accident Seveso, Italy in 1976.
- 1977 - Dioxins found in trash incinerator emissions (Olie et. al.)
- 1977 -'85 Engineers argue that dioxin problem solved by running incinerator furnaces at high temps. They were wrong
- 1985 - Ozvacic et. al. found that dioxin formed after the furnace.
- 1990 onwards - Dioxin are extensively researched, monitored, and controlled globally
- May 2001 - Stockholm Convention adopted which came into force in May 2004.
- 13th Jan 2006 - India ratifies Stockholm Convention

How Dioxin and Furan are Formed ?

- Dioxin are produced at Waste Incinerators, Biomedical Waste Incinerators, industrial processes etc.
- Dioxin are also produced by non-industrial sources like residential wood burning, backyard burning of household trash, oil heating, and emissions from diesel vehicles.
- Burning of Plastics gave rise to Dioxin
- Cigarette smoke also contains a small amount of dioxin.



Dioxin - major health concerns

- Dioxin enters the general population largely from ingestion of food, specifically through the consumption of fish, meat and dairy products.
- Some illnesses connected to inhalation of the levels of Dioxin are lung cancer, soft-tissue sarcomas, lymphomas, and stomach carcinomas
- Dioxins are fat-soluble and readily climb the food chain.
- Dioxins' danger for humans, stems from the fact they are stored in fatty tissues over time (bioaccumulate) and are neither readily metabolized nor excreted.
- This means that even small exposures may eventually reach dangerous levels.

Dioxin Health Effects

BEFORE Ukraine President AFTER

Yushchenko endured dioxin poisoning, likely by political foes, which, along with nearly killing him, left his skin severely disfigured. WILLisms.com

Hazardous wsate dump site in Orissa

Unscientific Disposal of Hazardous Wastes

Contamination of Surface waters

Contamination of Soil


USED GLOVES


Attention!

Imported Biomedical & other Hazardous waste from USA: Container Tutiucorin Port 2005

Hazard Potential Rating

S. No.	Criterion	Qualitative Negative Impact Assessment Low/Medium/High
1.	Existence of water body such as pond/ river/ canal etc. in area	
2.	Population density in surrounding area	
3.	Likely impact on human health due to yellow patches appearing on walls of houses in the vicinity of dump site	
4.	Existence of water supply source in area	
5.	Depth of ground water table	
6.	Contamination in soil	
7.	Contamination in groundwater	
	Overall Hazard Potential	

Hazard Potential Rating

1. The following sites have **'High, 'Medium to High'** or **'Medium'** hazard potential ratings:
    i. Ganganagar Vasahat
    ii. Gamania Talawadi
    iii. Amrapali Society
    iv. Jayshree Gayatrinagar
    v. Indira Nagar
    vi. Opposite – M/s. Sayaji Iron
    vii. Near Samta Mangalmurti Apartments

Hazard Potential Rating

1. The following sites have **'Low'** hazard potential ratings:
    i. Railway D-cabin road
    ii. Gorwa Talab
    iii. Nileshnagar Society, Karodia Road
    iv. Near Gorwa Police Station
    v. Near Hema-Unit-II, Jyoti Ltd. Road
    vi. Near ESI Gorwa Unit
    vii. Near Hema-Unit-II, Khatrinagar Road
    viii. Near Hema-Unit-I
    ix. Near Bombay Alkaloids
    x. Panchwati Jagat Naka

Remediation Plan

Step-I : Immediate Action

- Unspent material (raw & processed) within unit allowed to be utilized by other authorized & interested unit for Resource Utilization, if Supreme Court permits.

- All the Hazardous wastes lying in the unit, should be disposed off in SLF.

Remediation Plan

Step-II : Closure of Hand Pumps & Open Wells

Step-III : Waste Delineation & Shallow Aquifer Investigation

- Based on discussions with experts of several agencies:
  - Extensive Geophysical investigations required

Remediation Plan

Step-IV : Remediation of Waste Dump Sites

- Actual remediation of site (s) would depend upon results of Step – III, however, the following approaches are suggested:
  - Containment & Capping
  - Waste excavation & disposal in SLF

Constraints in Remediation

- Houses, industries & roads have developed over a period of time.
- Many places service lines like electrical, telecom, water supply, etc. laid below ground.
- Excavation & removal of waste below structures may create socio-economic, political & technical (inter-disciplinary) problems.

Estimated Cost of Remediation

- Disposal of waste lying & soil (2 m deep) within unit into SLF = Rs. 96 lakh

- Remediation of waste dump sites (7 sites having Medium to High hazard potential)
  - Containment & capping = **Rs. 74 lakh**
  - Excavation of soil (2 m deep), stabilization, disposal into SLF, filling of excavated space with native soil, laying of 10 cm thick cement concrete layer = **Rs. 74 crores**

Estimated Cost of Remediation
Sample Calculation : Site-4 (Ganganagar Vasahat)

- **Containment & Capping**

Approximate area for capping= 600 m x 4 m = 2400 m^2

No.	Cost component	Quantity	Unit rate (Rs.)	Cost (Rs. in lakh)
1	Excavation of soil up to 0.3 m depth	720 cum	100 per cum	0.72
2	Laying 150 mm thick Lean Cement Concrete, LCC (1:4:8)	360 cum	1200 per cum	4.32
3	Laying 100 mm thick Plain Cement Concrete (PCC) (1:2:4) over LCC	240 cum	1800 per cum	4.32
			Total Cost	**9.36**

Estimated Cost of Remediation

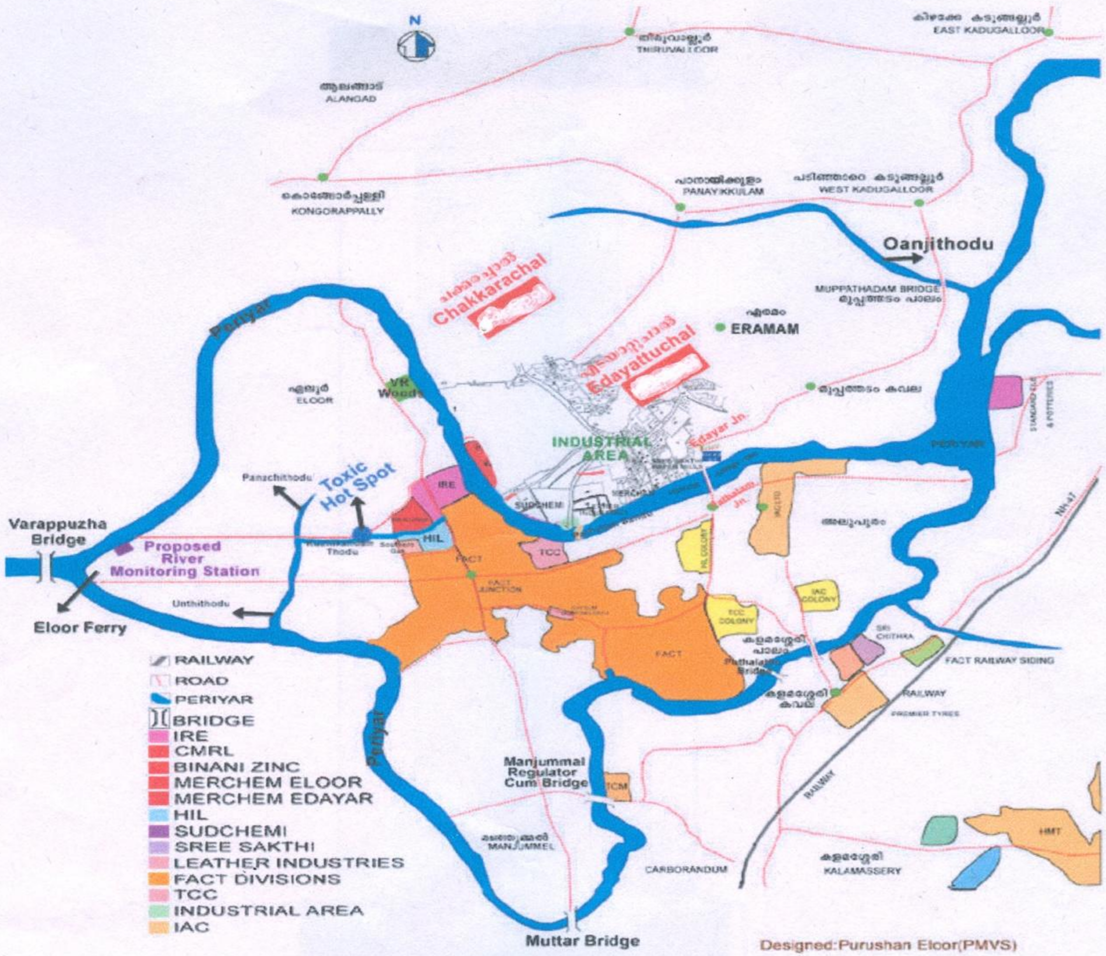
Sample Calculation : Site-4 (Ganganagar Vasahat)

- **Excavation & disposal into SLF**

No.	Cost component	Quantity	Unit rate (Rs.)	Cost (Rs. in lakh)
1	Excavation of contaminated soil up to 2 m depth 200m (L)x200m (W)x2m (D)	80,000 cum	100/- per cum	80.0
2	Stabilization of excavated soil (80000x1.1)	88,000 ton	600/- per ton	528.0
3	Disposal of stabilized soil into Secured Landfill Facility (SLF), including transportation cost for 10 km (on average)	88,000 ton	725/- per ton	638.0
4	Filling of excavated space with native soil	80,000 cum	150/- per cum	120.0
5	Laying 100 mm thick Lean Cement Concrete, LCC (1:4:8) over soil filling 200m(L)x200m(W)x0.10m(D)	4000 cum	1200 per cum	48.0
6	Laying 100 mm thick Plain Cement Concrete (PCC) (1:2:4) over LCC 200m(L)x200m(W)x0.10m(D)	4000 cum	1800 per cum	72.0
			Total Cost	**1486.0**


INDIA
KERALA

MAP OF ELOOR-EDAYAR INDUSTRIAL BELT



MAIN DUMPSITES

1. Kuzhikandom Thodu and precincts

➢ Kuzhikandom Thodu	:	2700m x 3m	= 8100m^2
➢ Banks of Kuzhikandom Thodu	:	2700 m x 30m	= 81000m^2
➢ Panachi Thodu	:	100m x 3m	= 300m^2
➢ Banks of Panachi Thodu	:	100m x 50m	= 5000m^2
➢ Paddy fields	:	200m x100m	= 20000m^2
➢ MERCHEM & HIL Campus	:		= 84600m^2
➢ TOTAL	:		= 200000m^2

RESIDENTIAL AREA FLOODED WITH TOXIC WATER
NEAR THE BANK OF KUZHIKANDAM THODU

2. Ammanthuruthu – Karipadam Area

Ammanthuruthu	:	=	$200000m^2$
Karipadam	:	=	$6200m^2$

-

- TOTAL : = $206200m^2$

3. Chakkarachal – Edayattuchal Area

Chakkarachal	:	= 15500m^2
Edayattuchal	:	= 30000m^2

-

- TOTAL : = 455000m^2

Edayattuchal - A sampling spot at Edayar

Chakkarachal Paddy Field a seen of agricultural operation - futile effort

CONTAMINATION

1.Kuzhikandom Thodu and precincts

DDT	: BDL – 315mg/kg
BHC	: BDL – 20mg/kg
Endosulphan	: BDL – 60mg/kg
Organic Halides	: BDL –250mg/kg

2. Ammanthuruthu – Karipadam Area

Zinc	: 116 – 1449 mg/kg
Iron	: 18900 -50260 mg/kg
Lead	: 180 - 598mg/kg
Cadmium	: 6- 19 mg/kg
Copper	: 56 -186 mg/kg
Chromium(6)	: 9 -79 mg/kg

3. Chakkarachal – Edayattuchal Area

Zinc	: 72 – 188060 mg/kg
Iron	: 8600 -139640 mg/kg
Lead	: 90 – 424 mg/kg
Cadmium	: 3- 568 mg/kg
Copper	: 20 -804 mg/kg
Chromium(6)	: 2 -19.2 mg/kg

Mercury Management in Compact Fluorescent Lamps (CFLs)

INTRODUCTION

CFL contains a gas that produces invisible ultraviolet when it is excited by electricity and this light hits the white layer (phosphor, which contain Mercury) coating inside the bulb, which changes it into visible light. About 30 % of the energy consumed is emitted as heat and 70% produces light.

In the case of Incandescent light bulbs, 90% energy is converted into heat and only 10% of energy is converted into visible light.

Advantages of Compact Fluorescent Lamps (CFLs) over incandescent light bulb

- For the same light output, a CFL uses 75% less energy than an incandescent light bulb and also it lasts at least 6 times longer. (US EPA)
- A power plant will emit 10 mg of Hg to produce the electricity to run an incandescent bulb compared to only 2.4 mg of Hg to run a CFL for the same time. (US EPA)
- Significant energy savings can be realized with minimal capital investment
- Less emission of green house gases from Thermal Power Plants will result if CFLs replace incandescent light bulb.

Comparison of Incandescent & CFLs Light Intensity

Incandescent Bulbs (watts)	CFL (watts)	Light Output (lumens)
40	9	450
60	13	800
75	20	1,100
100	23	1,600

Increase in Mercury Load due to switchover to CFLs

According to International Energy Experts, electricity consumption is estimated at 18000 MW. If this consumption Indian House Holds is assumed to be due to 60 W Incandescent Bulbs only. Thus, the number of Bulbs works out to be 300 million (18000 MW / 60 W = 300 Million Bulbs).

Since 12 W CFL (Compact Fluorescence Bulb) produces same amount of light as 60 W Incandescent Bulb, if Indian households switch over to CFLs, it is believed that electric consumption in India could be reduced to <u>6000 MWs from 18000 MW</u>. The required number of 12 W CFLs would be 6000 MW / 12 W = 500 Million CFLs.

On an average, a CFL contains 4 mg of Mercury, Thus the quantum of Mercury Load due to switching over from Incandescent Bulb to CFLs would be <u>2000 kg of Mercury (4 mg x 500 Million = 2000 Million mg)</u> .

- **Mercury is an essential ingredient for CFLs. The amount of Mercury in a CFL's glass tubing is varies from 1.3 mg to ≤ 5 mg, as per German Development Cooperation report**
- **Although this amount of Inorganic Hg is not directly toxic, the deposition of CFLs in normal sanitary landfills could lead to the emission of <u>organic Methyl Hg compounds</u> which can easily enter the food chain. Unregulated disposal would create a larger environmental impact.**
- **EU countries and some US states oblige manufacturers/ dealers to take back and recycle CFLs**

Status in Other Country

- **In USA annual CFL production is around 3 billion i.e. about ≤15000 kg of Mercury per annum consumed in CFL (based on ≤5 mg/ per CFL).**

Best practice for collection and recycling of used CFLs

- Reduction of Mercury content per lamp (< 1.3 mg per CFL)
- Manufacturers take responsibility to collect and recycle the used CFL (recycling)
- Collection of scrap at point of sales or designated hazardous waste collection points (consumer awareness)
- Safe disposal of used mercury containing items properly .

Awareness to Consumers

- **Awareness programme should be launched to educate the people about the risk and impact of mercury.**

- **The policy on mercury usage, handling procedures, safe guards, spill clean up, etc. needs to be formulated.**

- **Regulation on recycling and recovery of mercury from various products and also prohibition on disposal of mercury bearing products along with garbage and disposal to landfills.**

Way Forward

- **The manufacture should try to reduce the Hg content per lamp in CFL**
- **A high powered committee should be constituted, which looks into proper mercury waste disposal, handling and recycling using best practices worldwide.**
- **Buy back scheme as done in Battery Rule, may be considered for the Mercury Waste Management in CFL.**
- **Repacement of CFL to LEDs which Is Mercury free**

STATUS OF HAZARDOUS WASTE MANAGEMENT IN TAMIL NADU

LEGACY SITES

- FOLLOWING PASSIVE SITES HAVE BEEN IDENTIFIED FOR CLEANUP.
  - MERCURY CONTAMINATED SITES IN THE PREMISES OF M/s. HINDUSTAN LEVER LIMITED (THERMOMETER FACTORY), KODAIKANAL, DINDIGUL DISTRICT.
  - CONTAINMENT OF SPREAD OF HEXAVALENT CHROMIUM POLLUTION FROM THE CHROMATE SLUDGE DUMPSITE IN THE CLOSED UNIT OF M/s. TAMILNADU CHROMATES & CHEMICALS LTD, RANIPET, VELLORE DISTRICT

M/s HINDUSTAN LEVER LIMITED, (HLL) KODAIKANAL

- **Major strides have been made in achieving the directions of the SCMC in executing the Mercury decontamination in the thermometer factory.**
- **The site has been cleared of elemental mercury, mercury bearing glass scrap and ETP sludge containing mercury. Approximately 259 tonnes of mercury bearing glass scraps, 28 tonnes of ETP Sludge and 3 tonnes of elemental mercury has been safely exported to the United States of America for recovery of mercury.**

M/s HINDUSTAN LEVER LIMITED, (HLL) KODAIKANAL

- Initially the NGOs, former workers and public obstructed the above operations raising concerns about safety, occupational health issues, monitoring the despatch and receipt of the packed wastes at the concerned ports.
- Health study carried out by ITRC
- Due to meticulous planning and implementation of protocols for safety and health monitoring, the concerns of the NGOs and public were properly addressed and the entire operation was smoothly completed.

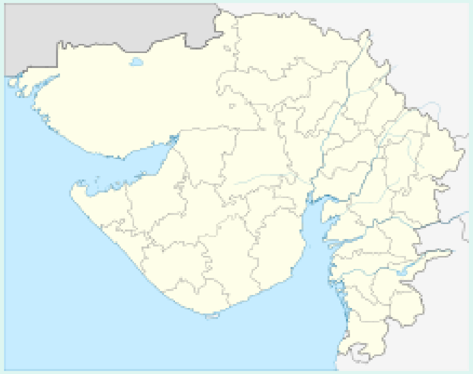
M/s HINDUSTAN LEVER LIMITED, (HLL) KODAIKANAL

- **The decontamination and scrapping of machinery was carried out based on the protocol evolved by experts. The above mentioned operations were carried out under the direct supervision of officials of TNPCB.**
- **Decontamination work completed on 7-5-06.**
- **Total mercury recovered 85.9 kg**
- **Scrap from machinery and material recovered and disposed 274.695 tonne**
- **Used PPEs 151.5 kg, Swabs 256.0 kg**

M/s HINDUSTAN LEVER LIMITED, (HLL) KODAIKANAL

- TNPCB is pursuing action for the soil decontamination and remediation which is likely to commence after the study report based on trial runs by NEERI
- Pilot Plant Studies for soil washing & retorting for recovery of mercury is completed.
- Permission is accorded.

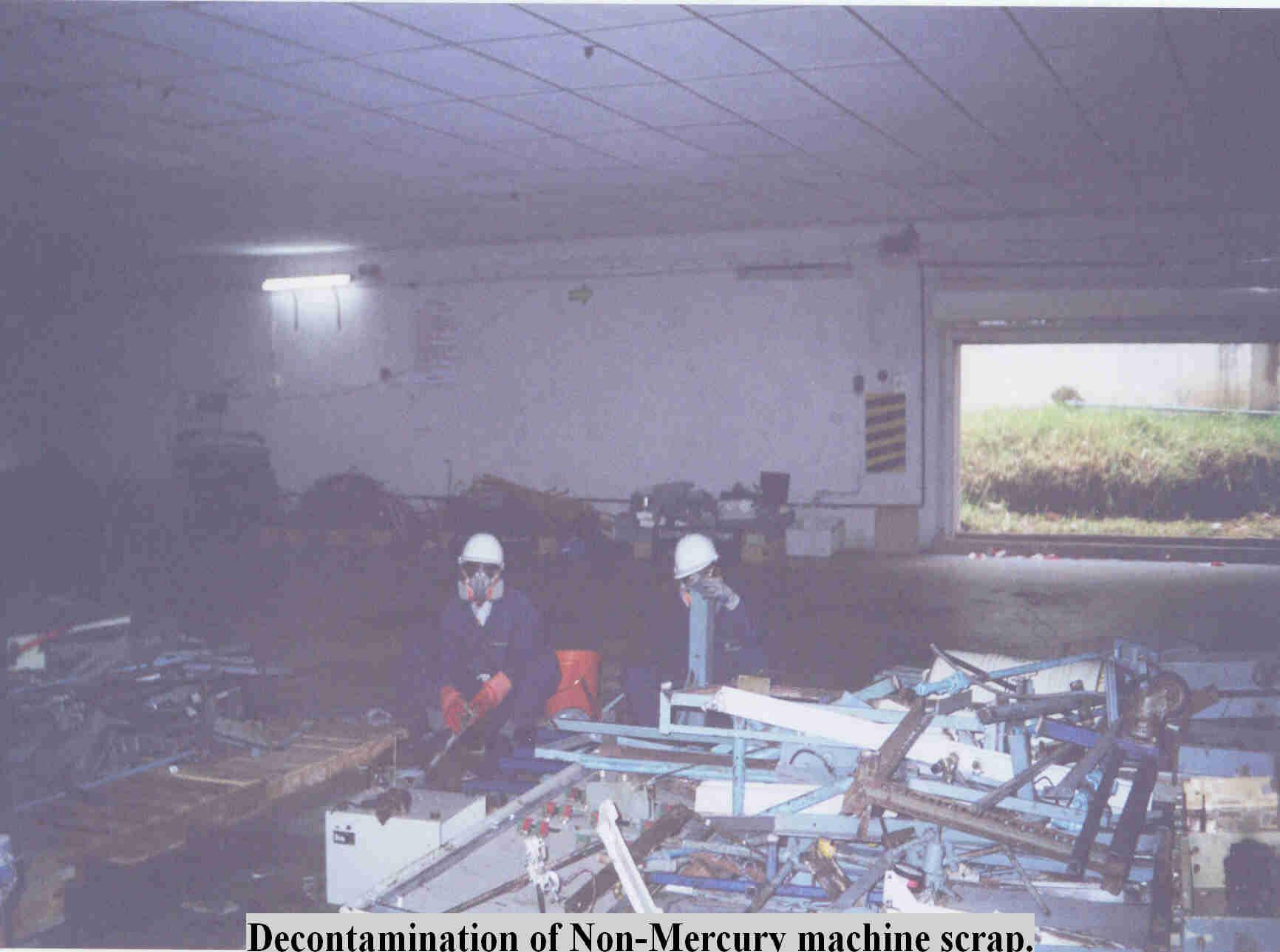
SHIP BREAKING IN ALANG , GUJARAT



Alang is a census townin Bhavnagar district in the Indian state of Gujarat.

In the past three decades, its beaches have become a major worldwide centre for ship breaking. The longest ship ever built, *Seawise Giant*, was sailed to and beached here for demolition in December 2009.

Safety Operating Procedure given training daily.



Decontamination of Non-Mercury machine scrap.

Truck sealed by TNPCB

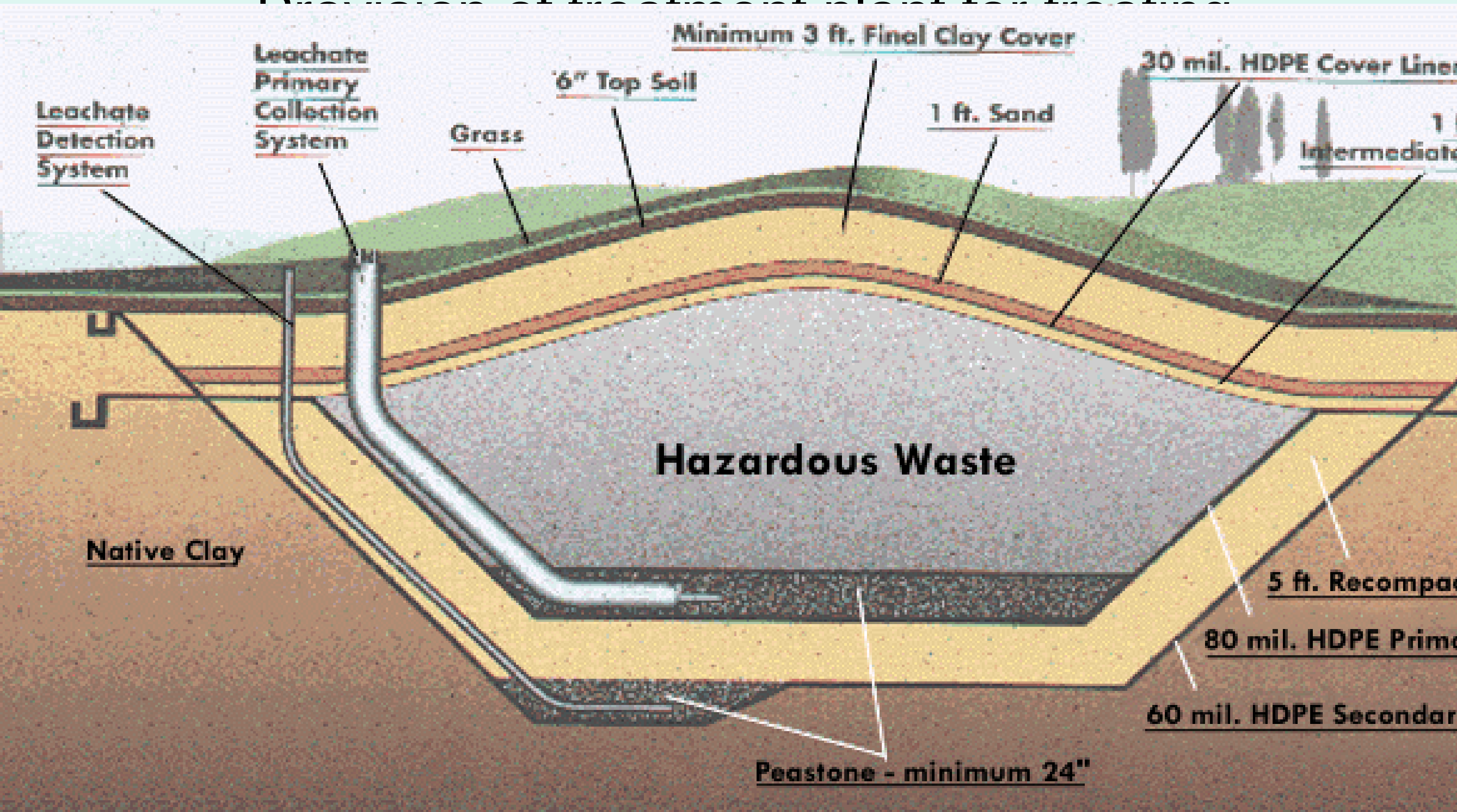
TN CHROMATES AND CHEMICALS LTD

- WAS A JOINT VENTURE PROJECT., LATER HANDLED BY 2 OTHER MANAGEMENTS
- FUNCTIONED FROM 1975 AND CLOSED OPERATIONS BY 1998
- ABOUT 2.27 LAKH TONNES OF CHROMIUM BEARING SLUDGE GOT ACCUMULATED OVER 2 HA AREA WITHIN THE PREMISES
- TNPCB INITIATED AN INVESTIGATION THROUGH NGRI TO DETERMINE THE SPREAD OF CHROMIUM POLLUTION
- ALSO LAUNCHED A STUDY BY NEERI TO SUGGEST IMMEDIATE CONTAINMENT OF THE SPREAD OF POLLUTION AND REMEDIATION OF POLLUTED SITES
- ON RECEIPT OF REPORT FROM NEERI, TNPCB WILL INITATE MEASURES

COURSE OF ACTION REQUIRED

Remediation strategies

Provision of treatment plant for treating



LEACHATE COLLECTION & REMOVAL

- Drainage Layer
  - Granular (Sand or gravel, no fine, 2-5 cm dia particle, min.30 cm thk, min K=1 cm/s)
  - Synthetic (nets, mats, geo-textiles)
- Pipes and Appurtenances
- Cushions

LEACHATE STORAGE & TRANSFER

Epoxy coated RCC Sump with level control submersible pum

LEACHATE TREATMENT

SURFACE WATER CONTROL SYSTEMS

RUN-OFF

❖Collect and control run-off from active and inactive portions of the landfill from 24 hour – 25 year storm

❖Collect and contain leachate contaminated storm water that accumulates in active fill area

❖Protect integrity and effectiveness of landfill cover system

RUN-ON

❖Intercept and divert run-on away from active and closed land fill cells from peak discharge of 25 year storm

❖ Minimise site erosion

GROUND WATER MONITORING

- Designed to detect contaminant leakage shortly after its occurrence and before significant contamination of ground water
- Hydraulically up-gradient and down-gradient wells
- Placed around perimeter of fill area within several hundred feet of SLF
- No. of wells- Site specific, depends on Size of SLF, Hydro-geology
- Minimum Requirements
    - 1 well in up-gradient (Background)
    - 3 wells in down-gradient

IDENTIFICATION OF WASTES THAT CAN BE LANDFILLED

1.Wastes that will definitely need to be landfilled as no other options are practicable

e.g. Asbestos

2. Wastes that could be safely landfilled without prior treatment

e.g. Bio-degradable wastes – technically possible; Better options often exist.

3.Wastes which could be landfilled after pre-treatment

e.g., Liquid wastes; heavy metal salts.Pre-treatment options can include detoxification, precipitation, solidification as appropriate

4. Wastes that should not be landfilled

e.g., Explosives, Compressed toxic gases, Liquid PCBs for technical reasons

CRITERIA FOR DISPOSAL OF H.W IN SLF

- To be dewatered up to the level of 60 – 70% solids
- Following are not be allowed to dispose of directly in SLF

if waste

- Is a fluid, slurry or paste
- Is delivered under pressure or under vacuum
- Has an obnoxious odour
- Reacts with moisture to generate high heat or gases
- Is highly inflammable (flash point < 40^oC)
- Contains very strong oxidising agents
- Contains volatile substances of significant toxicity

CRITERIA FOR DISPOSAL OF H.W IN SLF

- Contains > 10 mg/Kg Cyanide in the original sample
- Contains > 10 mg/kg Chromate in the original sample
- Contains > 0.5% (Wt.) Mercury
- Falls below a pH value of 2, if eluated 1/10
- Contains > 10 mg/1 of water soluble Arsenic in a 1/10 eluate
- Contains > 10 mg/1 of water soluble Mercury in a 1/10 eluate
- Contains > 3% solvents free from Halogen
- Contains more than 0.5% Halogenated solvents
- Contains > 0.1% poly-halogenated substances of Significant toxicity (PCBs)

Criteria for Hazardous Waste Landfilling in Germany due to “Technical Instructions for HWM”

ELUATE QUALITY -Germany

PARAMETER	VALUE
pH	4 – 13
Conductivity	<100,000 S/cm
Total Organic Carbon	<200 mg/1
Phenols	<100 mg/1
Arsenic	<1 mg/1
Lead	<2 mg/1
Cadmium	<0.5 mg/1
Chromium VI	<0.5 mg/1
Copper	<10 mg/1
Nickel	<2 mg/1
Mercury	<0.1 mg/1
Zinc	<10 mg/1
Fluoride	<50 mg/1
Ammonia	<1,000 mg/1

ELUATE QUALITY -Germany

PARAMETER	VALUE
Chloride	<10,000 mg/1
Cyanide	<1 mg/1
Sulphate	<5,000 mg/1
Nitrite	<30 mg/1
AOX	<3 mg/1
Water sol. Content	<10%
STRENGTH	
Transversal Strength (Vane Testing)	>25 kN/m^2
Unconfined Compression Test	>50 kN/ m^2
Axial Deformation	>20%
DEGREE OF MINERALISATION OR CONTENT OF ORGANIC MATERIALS	
Annealing loss of the dry residue at 550^{o}C	<10 W.%

CPCB CRITERIA FOR NON- ACCEPTANCE OF WASTE IN SLF

- ❑ Bulk or non-containerized liquid hazardous waste
- ❑Slurry type hazardous waste containing free liquid or waste sludge
- ❑Incinerable / compostable waste or any other type of waste from which energy recovery is feasible
- ❑In-compatible wastes not to be placed in same landfills

CPCB CRITERIA FOR NON-ACCEPTANCE OF WASTE IN SLF

- Wastes in-compatible with liner material without containerisation
- Extreme hazardous waste (e.g radioactive waste)
- Non-hazardous waste (e.g MSW) not to deposited in HW Landfills

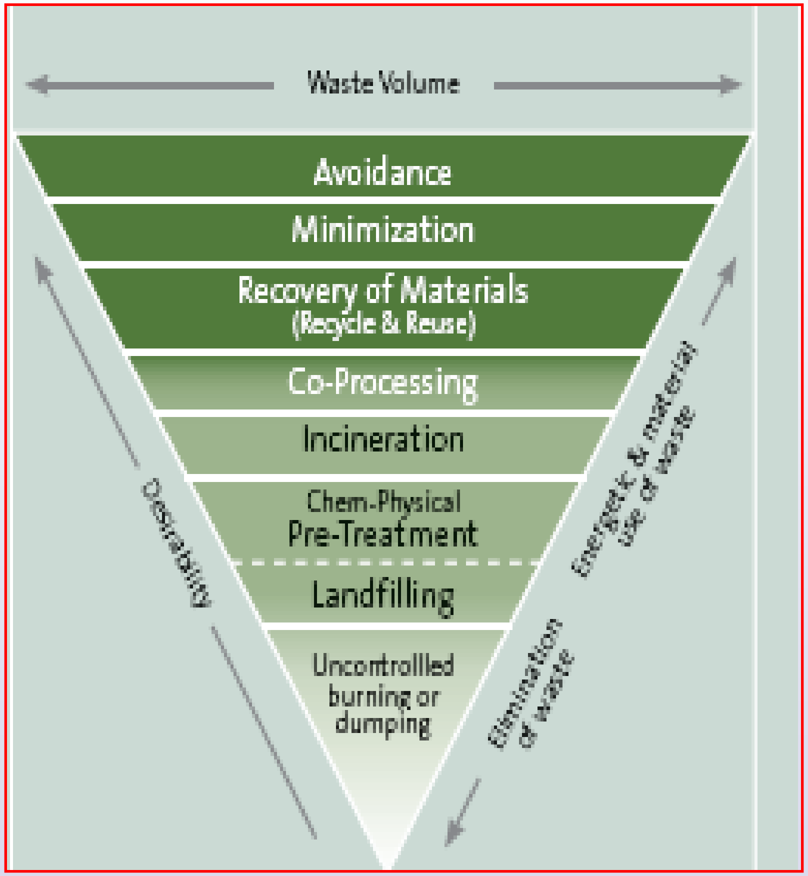
STATUS OF HAZARDOUS WASTES IN TAMILNADU FOR CO-PROCESSING IN CEMENT INDUSTRIES

NATIONAL ENVIRONMENTAL POLICY

- Adoption of Clean Technology
- Encourage Reuse & Recycling
- Strengthening Informal Sector
- Establish System for Collection and Recycling of Materials
- Environmentally Safe Disposal

HIERARCHY OF WASTE MANAGEMENT

- Minimisation
- Recovery of material (recycle & reuse)
- Co processing (energy conservation)
- Incineration
- Landfill



CEMENT KILNS, AN OPTION FOR CO-PROCESSING

- High Flame Temperature of 2000 Deg C
- High Material Temperature of 1400 Deg C
- Longer residence time of 4-5 Seconds which ensures complete combustion of Organic products.
- Neutralization of acidic gases by alkaline raw material
- Non Combustible material and heavy metals get trapped in clinker and immobilized.

WASTE ACCEPTABLE TO CEMENT KILNS (AS FUEL)

- Combustible Wastes -solvents, printing ink residues, paint & thinners, degreasing solvents.
- Organic Chemical Wastes –from chemical & pharmaceutical Industries.
- Waste Oil -spills of crude oil, tank bottom sludge, slop oil from petroleum refineries, if it meets Part-B of Schedule 5.
- Spent Pot Liners -from Aluminum industries, chemical tar, reactor still bottoms, asphalt, shredded tyres.
- Plastics, Bis-Phenol, Degraded Plastics and other Flammable Wastes.

WASTE ACCEPTABLE TO CEMENT KILNS (RAW MATERIAL)

- Other Non Combustible Wastes such as Lime Sludge from Effluent Treatment Plants
- Metal Bearing Waste including Copper Slag

<u>KEY FACTOR INFLUENCING</u>

- Economic Return
- Processing Viability

BENEFITS

- Reduction of clinker production cost
- Continuously generated waste streams destined for disposal can be recovered and reused as fuel/ raw material
- CO_2 emissions can be reduced, as fuel is substituted.
- No solid residues are produced, since ashes are incorporated into the cement clinker

BENEFITS

- Energy Conservation
- Disposal costs are significantly reduced or even eliminated
- Waste prevention / recycling are critical for stopping climate change
- Reuse as fuel adds further to green house gases savings by reducing the need for energy intensive extraction

NATIONAL POLICY ADOPTED FOR DISPOSAL OF WASTE IN CEMENT KILNS

- Incineration of High Calorific Value Hazardous Waste in Cement Kiln considered as Safe Alternative to Conventional Incineration.

- Sludge from Petrochemical Industry, Oil Refinery, Spent Solvent from Pesticide and Paint Industry is identified as suitable waste streams.

NATIONAL POLICY ADOPTED FOR DISPOSAL OF WASTE IN CEMENT KILNS

- Sulphur Containing Residues shall be regulated.
- Trial runs will have to be undertaken before arriving at final decision.
- Such operations will have to be carried out with the authorization of State Pollution Control Board and approval of CPCB.

INITIATIVES IN TAMILNADU -GRASIM INDUSTRIES

- CPCB had accorded permission to M/s. Grasim Industries Limited, Reddipalayam, Ariyalur.
- Waste co-incinerated are
  - ✓Refinery sludge
  - ✓Tyre chips
  - ✓Paint wastes
- Hazardous Wastes are completely burnt in cement kiln at a very high temperature of more than 1,800 deg C in controlled manner, along with proper monitoring devices at various locations.

Fuel Transfer Tower of M/s. Grasim Industries

INITIATIVE FOR USE OF GYPSUM SLUDGE AS RAW MATERIAL IN CEMENTKILNS

M/s. Grasim industries has been authorized to utilise gypsum sludge generated by M/s. Exide Industries, Hosur as raw material

ADVANTAGES

- Large capital investment for hazardous waste incinerators is avoided (however it envisages retrofitting of ancillary equipment for feeding & emission control)
- Rotary kilns can handle
- Diverse type of wastes and wastes in various states i.e solid, liquid, sludge & semi solid forms Economic Benefits
- Low cost fuel
- Generates energy
- Raw material substitute

CONCLUSION -CHALLENGES

- Use of Hazardous Waste Streams in Cement Kilns can have impact on process/ product.
- Waste suitability study supported by scientific investigation and proof is essential to convince cement manufacturers to modify an existing kiln which is working efficiently.
- Cement Plants APC measures are designed primarily to control Dust and Conventional gases.
- Air Pollution Control systems to be designed to treat and control emissions arising due to various types of waste used as raw material/ fuel.

WAY FORWARD

- Towards Zero Waste for effective utilization of waste by management, elimination of waste generation
- Reduction of green house gases by saving energy – especially by using recycled material as raw material instead of virgin raw materials
- Increasing carbon uptake by forest
- Reducing and Eventually eliminating the need for landfills

Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty

CPCB

January 2016

Central Pollution Control Board
(Ministry of Environment, Forest & Climate Change, Government of India)
Parivesh Bhawan, East Arjun Nagar,
Shahdara, Delhi – 110032


THANK
YOU
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