Inception Workshop for the Project
"Management of Mercury and Mercury-Containing Waste"

Overview on Basel Convention Draft Technical Guidelines on the Environmentally Sound Management (ESM) of Mercury Wastes

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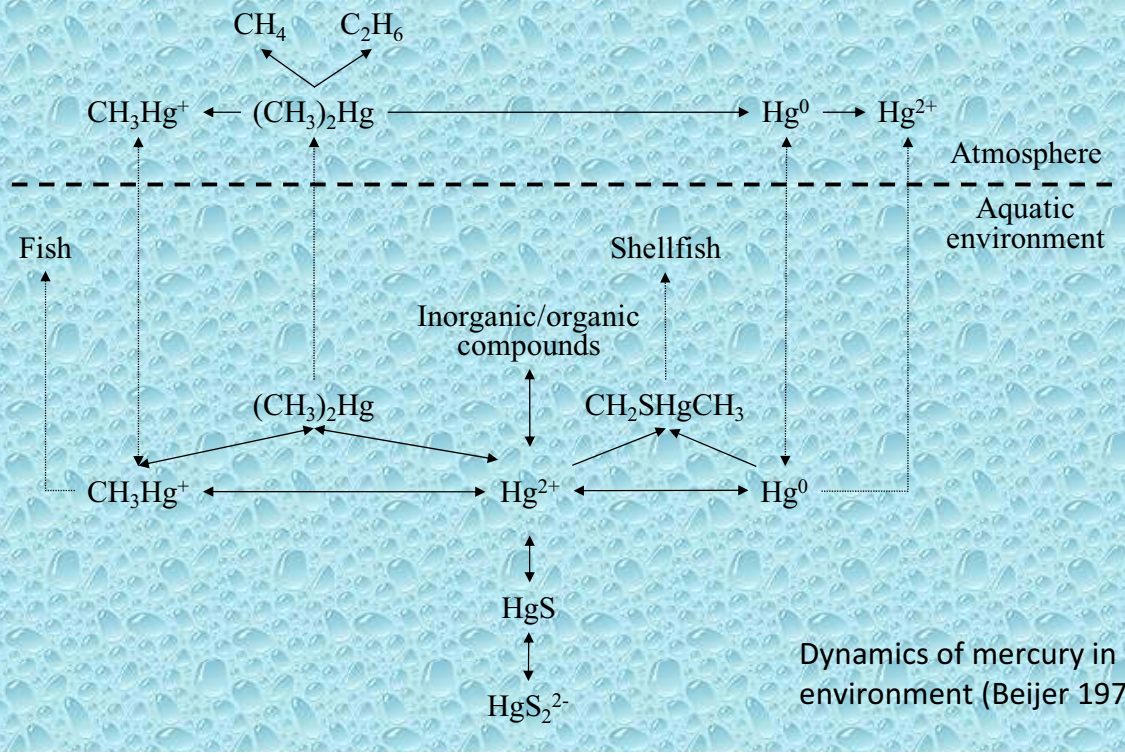
1. Background information *(1)*

- Mercury is widely used in products, such as thermometers, barometers, fluorescent lamps, etc.
- Industrial applications/uses in processes such as chlor-alkali production, vinyl-chloride-monomer (VCM) production, acetaldehyde production, etc.
- Mercury and methylmercury have triggered incidents with negative impacts on human health and the environment
- Japan (1950-60´s) , Iraq (1950´s. 1972) , Cambodia (1998)
- Mercury is recognized as one of the global hazardous pollutants due to the anthropogenic emissions.

1. Background information *(2)*

- Once released into the environment, mercury is never broken down to a harmless form and persists in the atmosphere, soil and aquatic phases.
- Due to environmental fate and transport it easily enters the food chain.
- Mercury-containing products and industrial mercury uses tend to be phased out.
- However it is still used in products such as fluorescent lamps , liquid crystal displays, etc.
- Risk reduction measures should be implemented through an appropriate ESM strategy for mercury wastes.

1. Background information *(3)*



Dynamics of mercury in the environment (Beijer 1979)

1. Background information *(4)*

- The TG follow decision VIII/33 of COP 8th of the Basel Convention
- Programme to support the implementation of the Strategic Plan focus area: B9 mercury waste
- Main focus of decision by COP is:
  - Developing partnerships for ESM of mercury waste
  - Developing capacity building and technical assistance programmes with prevention and reduction goals
  - Developing guidelines on the ESM of mercury waste, with emphasis on sound disposal and remediation practices
- The TG offer guidance for ESM of mercury waste and provide complehensive information about mercury

1. Background information *(5)*

- **Scope of Technical Guidelines (TG):**
  - Focus on mercury and mercury compunds listed in Annex I to the BC as categories of waste to be controlled
  - Metal and metal-bearing wastes, namely mercury and mercury-bearing wastes (waste electrical and electronic assemblies or scrap containing components such as mercury switches)
  - Poisonous (acute) substances – liable either to cause death or serious injury to humans when swallowed, inhaled or by skin contact
  - Toxic (delayed or chronic) substances – if when inhaled or ingested of if penetrate skin, may involve delayed or chronic effects
  - Ecotoxic substances – immediate or delayed adverse impacts to environment
  - Certain operations which may lead to recovery, recycling, reclamation, direct reuse or alternative uses (Section B Annex IV BC)
  - Disposal operations which do not lead to those alternatives (above)

1. Background information *(6)*

- **General Guidance on ESM of Mercury Waste follows on ESM criteria under the Basel Convention to ensure:**
  - Generation is reduced to a minimum, with social, economic and technical considerations into account
  - Availability of adequate disposal sites facilities
  - That those involved in mercury waste management take all steps necessary to prevent pollution or minimize consequences in the case of mishandling
  - Transboundary movement is reduced to the minimum and conducted in a sound and efficient manner to protect against adverse effects
  - International cooperation is implemented in activities among parties, organizations and private sectors to promote information exchange and technical cooperation on ESM
  - Appropriate legal, administratuve and other measures to prevent and sanction conduct in contravention of the Basel Convention are implemented and enforced
  - Transboundary movement of mecury waste is strictly controlled under the BC

2. Sources and Types of Mercury Waste *(1)*

- **A number of published materials by UNEP describe information about the sources of mercury emission and types of mercury waste, as well as international trade statistics**
  - UNEP – Global Mercury Assessment (2002)
  - Toolkit for Identification and Quantification of Mercury Releases (2005)
  - Guide for Reducing Major Uses and Releases of Mercury (2006)
  - Summary of Supply, Trade and Demand Information on Mercury (2006)

2. Sources and Types of Mercury Waste *(2)*

- Extraction and use of fuels/energy sources
- Primary (virgin) metal production
- Production of other minerals and materials with mercury impurities
- Intentional use of mercury in industrial processes
- Consumer products with intentional use of mercury
- Other intentional product/process uses
- Production of recycled metals (secondary metal production)
- Waste deposition/landfilling and wastewater treatment
- Crematoria and cemeteries

2. Sources and Types of Mercury Waste *(3)*

- **Casual factors of mercury waste**
  - Industrial equipments using mercury and consumer products
  - Wastewater treatment process
  - Thermal process of natural mercury impurities in raw materials
  - Processes at artisanal and small scale gold mining

3. Provisions for Mercury in UNEP and the Basel Convention *(1)*

- **UNEP GC Decisions**
  - Global mercury assessment
  - Technical assistance and capacity building to support efforts that address Hg
  - Partnerships programme (e.g. eliminate realeases)
  - Adhoc working group to review and assess measures
- **SAICM Global Plan of Action**
  - Global Plan of Action and related work plan and activities
- **Basel Convention**
  - General provisions (e.g. waste minimization, compliance and enforcement actions)
  - Classification of mercury waste
  - Transboundary movement control (in complicance with Basel obligations)

4. Chemical Analysis of Mercury in Waste *(1)*

- Reliable analytical data is a critical element to support technical information and its interpretation, usually required by policy and decision makers
- Analytical procedures (sampling, treatment, preparation, quantification)
- Existing methods provided by Japan, USEPA, others
- Standarized and reference materials for QA / QC purposes
- Instrumentation (e.g. CVAAS, CVAFS)
- Interpretation and statistical analysis

5. Guidance on ESM Criteria and Practices of Mecury Waste*(1)*

- Basel Convention TG on recycling/reclamation of metals and metal compounds (Annex I : As, Be, Cd, Pb, Hg)
- OECD – Core Performance Elements of ESM for Government and Industry
  - Adequate regulatory infrastructure and enfocement
  - Authorized Recovery Facility should have
    - Adequate measures of occupational safety,
    - Applicable EMS, monitoring , recording and reporting programme
    - Trainning programme for operators
    - Information exchange programme
    - Emergency plan
    - Closure and after-care plan

5. Guidance on ESM Criteria and Practices of Mecury Waste*(2)*

- Application of Best Available Techniques (BAT)
  - Measures designed to prevent or reduce emissions to air, land and water, including measures concerning waste.
  - The use of low-waste technologies
  - The use of less hazardous substances
  - Recovery and recycling practices, when appropriate
  - Technological advances and changes in scientific knowledge and understanding

5. Guidance on ESM Criteria and Practices of Mecury Waste*(3)*

- Application of Best Environmental Practices (BEP)
  - Documentation of existing mecury waste management practices and policie; assessment of current mercury products and manufacturing sectors
  - Documentation of national policies regarding mercury waste management, including trade aspects
  - Establishment of clear objectives, and adoption of modifications in current practices and policies to achive implementation of ESM
  - Creation of institutional capacibility and capcity building
  - Establishment of management structures and practices to assure new policies and practices are put in place
  - Selection and development of appropriate mercury waste treatment approaches

6. Legislative and Regulatory Framework*(1)*

- Phase-out production and use of mercury
  - EU RoHS directive restricting uses (Pb, Cd, Cr, PBDE, etc)
- Identification and inventories of mercury waste
  - Sources and types of mercury waste, activity rates, estimations.
- Purchasing practices
  - Mercury-free products or mecury-less containing products
- Control of exports or imports of mercury waste
  - Complicance with BC provisions on transboundary movement
- Registration of mercury waste generators
  - Large scale (hospitals, dentists, research labs, collectors, etc)
  - Provides origin of waste stream , volume, number or products, etc.

6. Legislative and Regulatory Framework*(2)*

- Authorization of treatment and disposal facilities
  - ESM facilities exclusive for mercury waste are preferred
  - Processing and final treatment schemes are enough to deal with waste
  - Avoid emissions og mercury during processing
  - Equipment and facilities are regularly mantained
  - Training and protection gear provided for employees
  - Emergency manuals
  - Documentation of mercury amounts under treatment and disposal

6. Legislative and Regulatory Framework*(3)*

- Inspection and monitoring of T & D facilities
  - Compliance evaluation inspection (on site)
  - Compliance sampling inspection
  - Case development inspection
  - Information gathering
- Employee training
  - Provide basic knowledge of mercury waste
  - Segregation of mercury waste
  - Use of protection equipment
  - Proper labeling
  - Emergency response

6. Legislative and Regulatory Framework*(4)*

- Mercury spill prevention, response and emergency measures
  - Ensure careful and safe handling to prevent spills
  - On site response (clean up, professional care, report to authorities)
- Liability and compensation provisions
  - A suitable mechanism is recommended to cover all damages resulting from processing or illegal transboundary movement
  - The Minamata experience indicated that costs of a prior ESM investment would have been significantly lower thnt those related to compensation

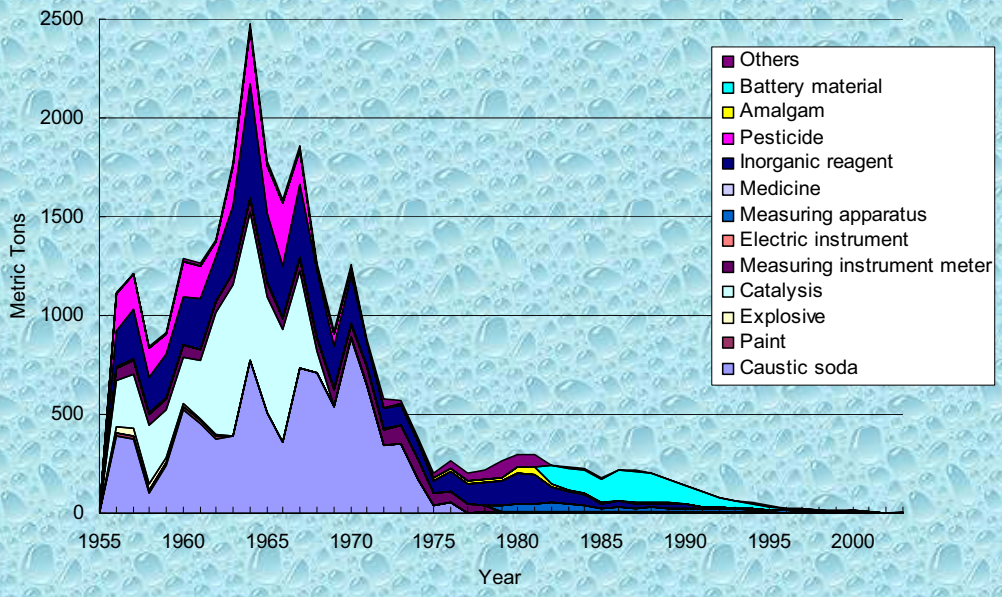
6. Legislative and Regulatory Framework*(5)*

- Compliance promotion
  - Provide education and technical assistance to community
  - Build public support
  - Publish success stories
  - Create financial arrangements
  - Provide economic incentives
  - Build environmental management capability within stakeholders (e.g.auditing)
- Penalties for non-compliance
  - Fines, imprisonment, suspension or operations
  - In the absence of a legal framework, relevant atuhorties should deal as appropriate (e.g. consideration of the PPP is adviced)

7. Application for Mercury Waste Prevention and Minimization*(1)*

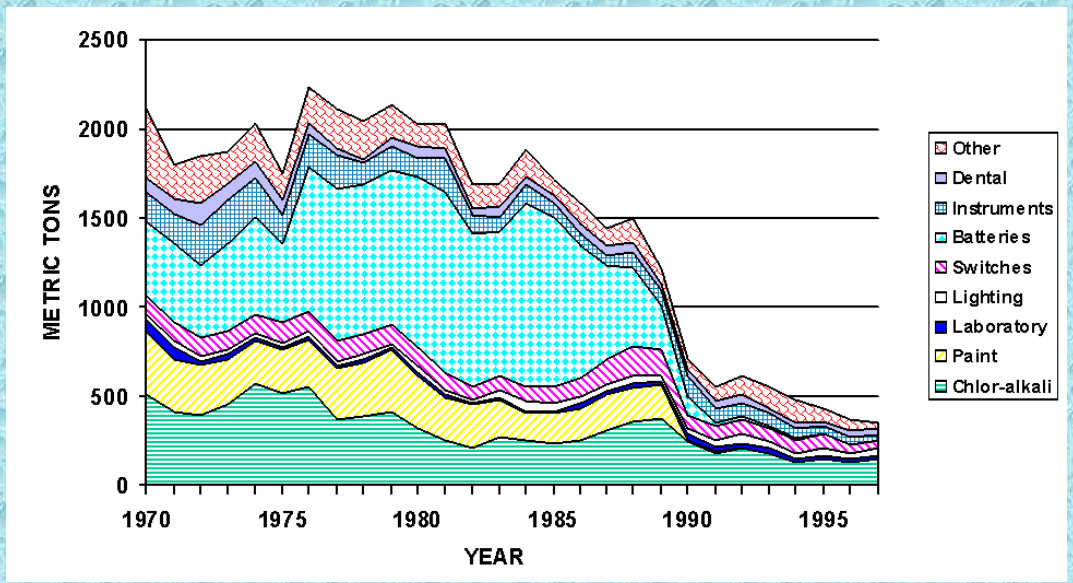
- Source Reduction – Using alternative materials or processes not requiring mercury
  - Awareness and action regarding the negative impacts of mercury are more and more common in both developed and developing countries, where better engineering controls and managegement options have been implemented

7. Application for Mercury Waste Prevention and Minimization*(2)*



Japanese industrial mercury demand in the period 1956-2003
(Ministry of International Trade and Industry 1956-1974; 1995-2003)

7. Application for Mercury Waste Prevention and Minimization*(3)*



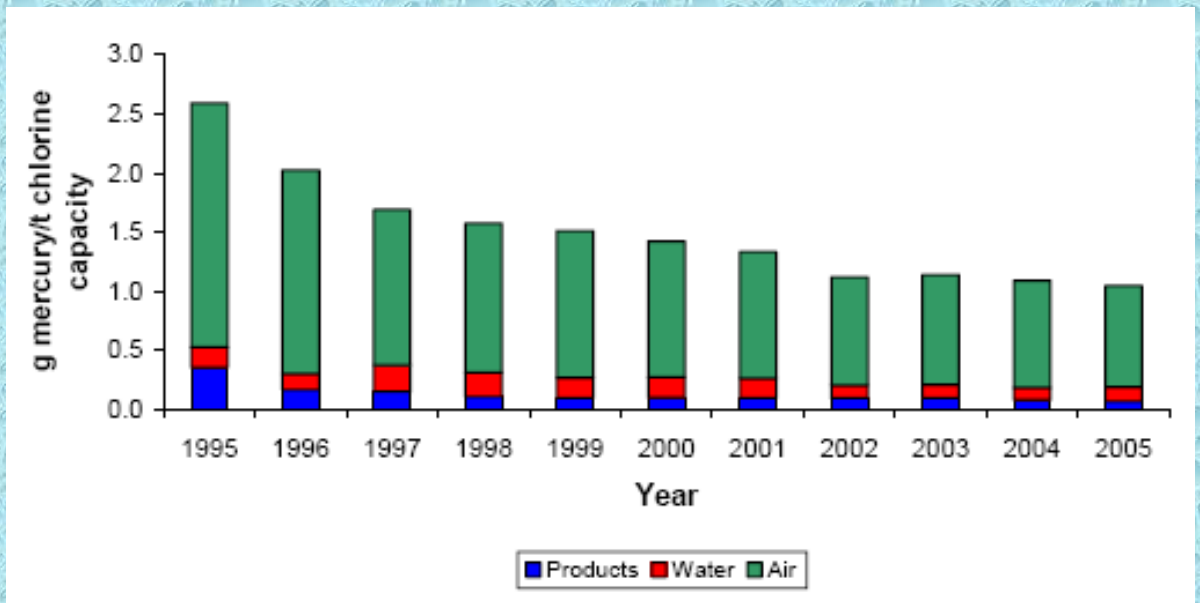
US industrial reported consumption of mercury in the period 1970-1997, distributed among industrial sectors (Sznopek 2000)

7. Application for Mercury Waste Prevention and Minimization *(4)*

Comparison of mercury and membrane cell chlor-alkali processes

Process	Comments
Mercury Cell	**Advantages:** ▪Existing technology at older plants; no capital cost for upgrade to membrane cell; and ▪Produces high-quality caustic soda. **Disadvantages:** ▪Less efficient process – requires more energy than membrane cell (3,560 kilowatt-hours per metric ton of chlorine [kWh/t]); ▪Used in over 50% of all industrial chemical processes (World Chlorine Council 2006); and ▪Produces mercury emissions and associated environmental liability and attention.
Diaphragm Cell	**Advantages:** ▪Existing technology at older plants, particularly in ; no capital cost for upgrade to membrane cell. **Disadvantages:** ▪Less efficient process – requires more energy than membrane cell (2,970 kWh/t of chlorine); and ▪Uses asbestos in cells with the potential for release into the air and the associated environmental liability and attention.
Membrane Cell	**Advantages:** ▪More energy efficient process –2790 (kWh/t of chlorine); and ▪No mercury or asbestos emissions. **Disadvantages:** ▪Requires complete overhaul of older processes and associated capital costs

7. Application for Mercury Waste Prevention and Minimization *(5)*



Mercury emissions – European mercury cell chlorine factories (Euro Chlor 2006)

7. Application for Mercury Waste Prevention and Minimization*(7)*

Technique	Comments
Cyanide Processing **Artisanal and small scale gold mining (ASM)**	**Advantages:** ▪Requires relatively small amounts of cyanide, usually less than 1 kg of cyanide per tonne of rock; ▪Cyanide is very selective leaching gold and only minor amounts of other minerals in the ore; ▪Cyanide leaches coarse and very fine gold as well as gold that is attached to the rock; ▪Tank leaching normally takes less than one day; ▪Cyanide remaining in the waste (tailings) product can be destroyed to minimize the environmental impact; ▪Ultraviolet light degrades cyanide to less toxic forms, but complete destruction of cyanide requires chemical treatment; ▪Used responsibly, the risk of cyanide poisoning can be minimized ▪Cyanide does not accumulate in animals or plant life; **Disadvantages:** ▪Requires much more skill and technical control than amalgamation and not usually within the reach of individual or dispersed artisanal miners; ▪Cyanide is highly toxic and at high concentrations will kill fish, birds and mammals (including humans); ▪Cyanide reacts with mercury to produce soluble chemical compounds is easily transported with water; and ▪When cyanide reacts with mercury, it converts the mercury to a form in which it more easily enters the food chain and becomes more harmful.

7. Application for Mercury Waste Prevention and Minimization*(8)*

Mercury-free products

Products	Alternatives	Alternative cost
Thermometers/ other measuring devices with mercury	Electrical and electronic devices; glass thermometers with metal alloy	Widely used in many countries. Prices have gone down
Biocides and pesticides	-Processes not requiring chemicals -Easily degradable, narrow-targeted substances with minimal environmental impact	In place in many countries. Wide range of options. Costs likely to be comparable.
Dental mercury-amalgam fillings	Cold silver, ceramic, porcelain, polymers, etc. Sweden (amalgam use is less than 6%) US (less than 30%)	Variable depending on the specific alternative None requiere specialized wastewater treamtent to meet regulations

7. Application for Mercury Waste Prevention and Minimization *(9)*

- Waste Minimization – Using mercury in a more efficient way or in lesser amounts
  - Reduction of discharge in industrial processes (e.g. chlor alkali plants) by means of BMP
    - Euro Chlor´s Code of practices-Mercury housekeeping : maintenance of areas, storage, air measurements, collection of mercury, etc.
    - IPPC (EC): Monotoring of possible leakages and recovery of mercury; end of pipe measures (e.g. removal from hydrogen gas, wastewater); good housekeeping; influence of human factors (hygiene, clothing, etc)

7. Application for Mercury Waste Prevention and Minimization *(10)*

- Waste minimization in ASM

Technique	Comments
Centralized Processing Centres Miners bring gravity concentrates to a centralized facility for amalgamation by trained personnel and under controlled conditions.	▪ Must be coupled with extensive education and promotion campaign to establish trust and understanding with miners; ▪ Requires trained staff to operate the equipment and large initial expense from equipment, training, and construction; ▪ Reduces mercury exposure to miners to insignificant levels; ▪ Gold recovery from gravity concentrates is improved; ▪ Cost reduction in the processing plant; ▪ Mercury vapour exposure is greatly reduced; and miners do not need to buy mercury illegally.
BMP using Mercury	▪ Cover mercury with water inside closed containers to reduce mercury vapours formation; ▪ Use gravity concentrates whenever possible to reduce the mercury required for amalgamation; ▪ Maximize amalgamation efficiency ▪ Excess mercury can be removed from amalgam by centrifuges or presses; ▪ Use retorts to capture mercury vapour and recover and reuse up to 95% of mercury

7. Application for Mercury Waste Prevention and Minimization *(11)*

- Reduction of discharge from mercury-containing products
- Product labelling
  - Provide information to consumers
  - Right-to –know disclosure
  - End of life handling and disposal
- Collection practices for reuse and recycling (e.g. actions to keep mercury wastes from other wastes)

8. Handling, Collection, Storage (interim), and Transportation of Waste *(1)*

- Similar to those for hazardous wastes.
- General guidelines provided in the Basel Convention - General technical guidelines (GTG) for the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with persistent organic pollutants (POPs)
- Specific guidance on handling mercury wastes are provided in the TG, but it is important that generators consult and adhere to their own country's as well as local government's specific requirements.
- The Basel Convention GTG identifies the following reference documents for transport and transboundary movement of hazardous wastes:
  - BC Manual for implementation
  - Intenational maritime Dangerous Goods Code
  - ICAO Technical Instructions for the Transport of Dangerous Goods
  - IATA Dangerous Goods Regulations

8. Handling, Collection, Storage (interim), and Transportation of Waste *(2)*

- Collection of mercury-containing products
  - Advertise the programme, depot locations, time periods
  - Allow enough time of operation
  - Include, to the extent practical, all mercury-contaning products
  - Make available acceptable containers and safe-transport materials to owners
  - Establish simple, low-cost mechanisms
  - Ensure that applicable legislative requirements are met
  - Ensure segregation from other waste streams

8. Handling, Collection, Storage (interim), and Transportation of Waste *(3)*

- Collection of mercury and mercury waste from spills and manufacturing sites
  - Detailed planning is requiered and must be captured in written form
  - Field screening equipment (e.g. vapour monitor, analyzer, meter)
  - Air sampling equipment
  - Worker/occupant exposure and personal protective equipment (e.g. glassess, gloves, respirator,etc)
  - Mercury cleanup equipment (e.g. vacuum)

8. Handling, Collection, Storage (interim), and Transportation of Waste *(4)*

- **Take-back programmes**
  - One of the Best Environmental Practices (BEP) . Gives manufactures the physical responsibility for products and/or packaging at the end of their useful lives.
  - Manufactures can acquire low-cost feedstock for new manufacture or remanufacture, and offer a valued-added service to the buyer.
  - Voluntary or under requirements or guidelines.
  - Engages local stakeholders, in particularly local producers and local large-scale consumers in developing countries and countries with economies in transition.
  - Focus on household (obsolete or used) products which are widely scattered
  - The main purposes are to phase out mercury-containing products and to promote using mercury-free products or mercury-containing products whose mercury contents are as low as practically possible.

8. Handling, Collection, Storage (interim), and Transportation of Waste *(5)*

- **Handling**

Basel Convention Hazardous Waste General Handling Guidelines

(a)Inspect containers for leaks, holes, rust or high temperature, and repackage and replace labels as necessary;

(b)Handle wastes at temperatures below 25°C, if possible, because of the increased volatility at higher temperatures;

(c)Ensure that spill containment measures are adequate and would contain liquid wastes if spilled;

(d)Place plastic sheeting or absorbent mats under containers before opening them if the surface of the containment area is not coated with a smooth surface material (paint, urethane or epoxy);

(e)Remove liquid wastes either by removing the drain plug or by pumping with a peristaltic pump and suitable chemical-resistant tubing;

(f)Use dedicated pumps, tubing and drums, not used for any other purpose, to transfer liquid wastes;

(g)Clean up any spills with cloths, paper towels or absorbent;

(h)Triple rinse contaminated surfaces with a solvent such as kerosene; and

(i)Treat all absorbents and solvent from triple rinsing, disposable protective clothing and plastic sheeting as contaminated.

8. Handling, Collection, Storage (interim), and Transportation of Waste *(6)*

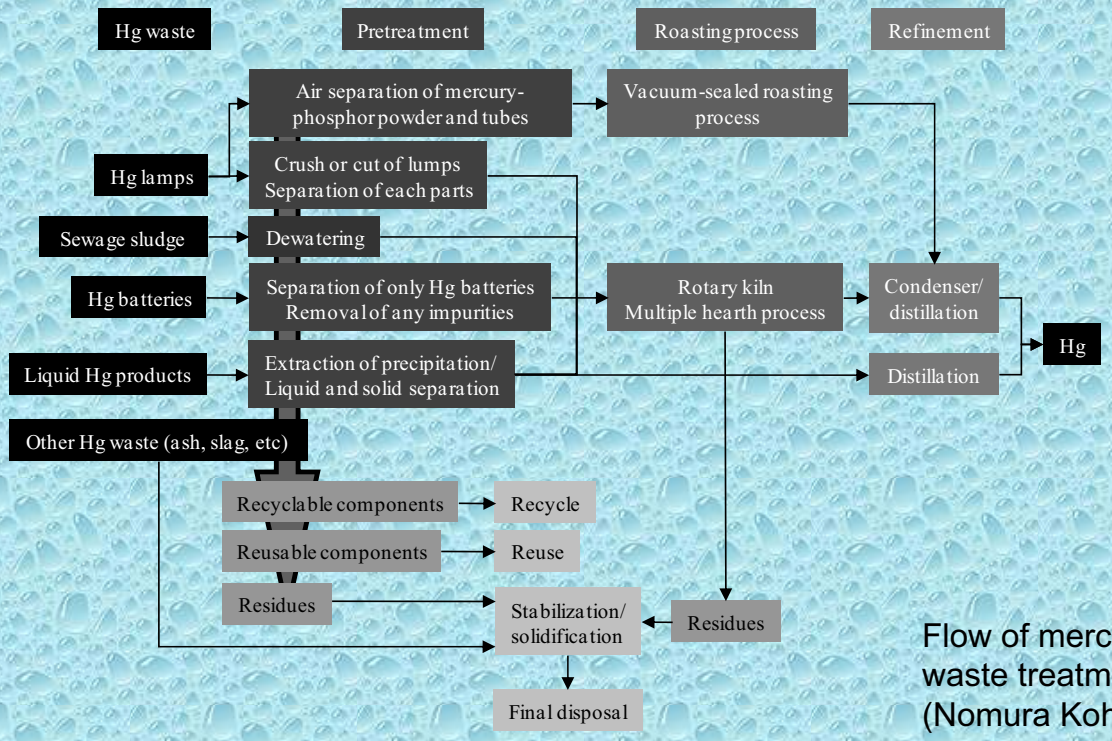
- **Storage**

Aspect	Requirements
General	▪ Storage sites inside multi-purpose buildings should be in a locked dedicated room ▪ Separate storage areas, rooms or buildings should be used for each type of waste, unless specific approval has been given for joint storage; ▪ Wastes should not be stored on or near "sensitive sites" (e.g. hospitals or other medical care facilities, schools, residences, food processing facilities, or facilities located near or within sensitive environmental sites); ▪ Storage rooms, buildings and containers should be located and maintained in conditions that will minimize volatilization; ▪ Ventilating a site with carbon filtration of exhaust gases is considered when exposure to vapours for those who work in the site and those living and working in the vicinity of the site is a concern; ▪ The storage area should be marked or delineated clearly by fencing, posts, or walls in order to limit access to it; ▪ Drainage facilities should be installed in premises where mercury and related compounds are used and handled to contain possible spillage or releases; ▪ The outside of the storage site should be labelled as a waste storage site.

9. Treatment of Mercury Waste and Recovery of Mercury *(1)*

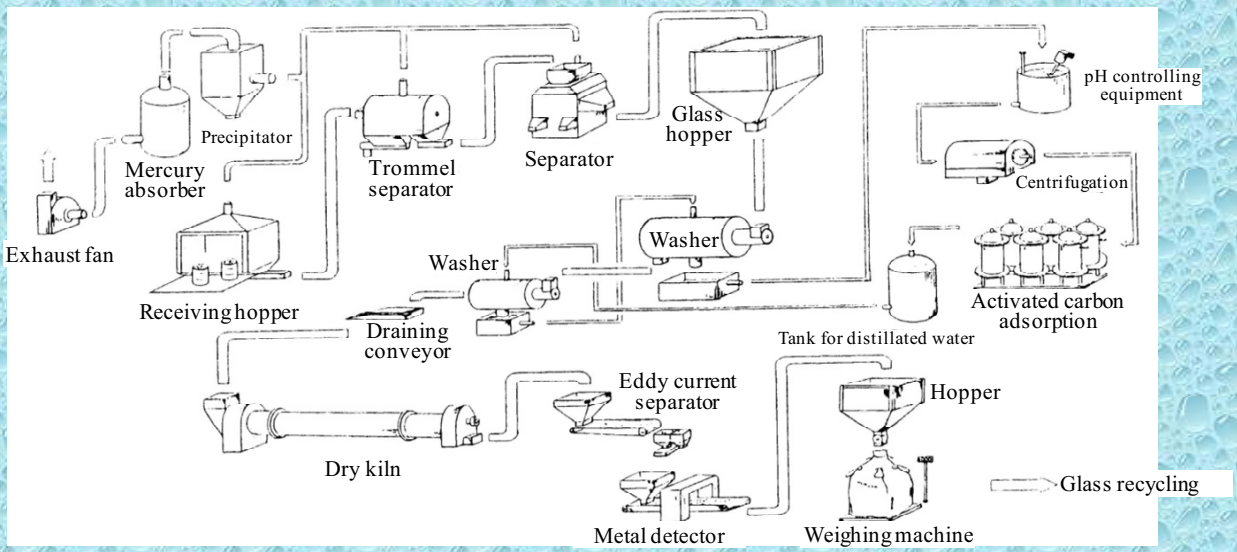
- Mercury recovering processes – Solid waste
  - Pretreatment
  - Roasting process
  - Recovery of mercury - purification
  - Other processes (thermal, chemical leaching, etc)

9. Treatment of Mercury Waste and Recovery of Mercury *(2)*



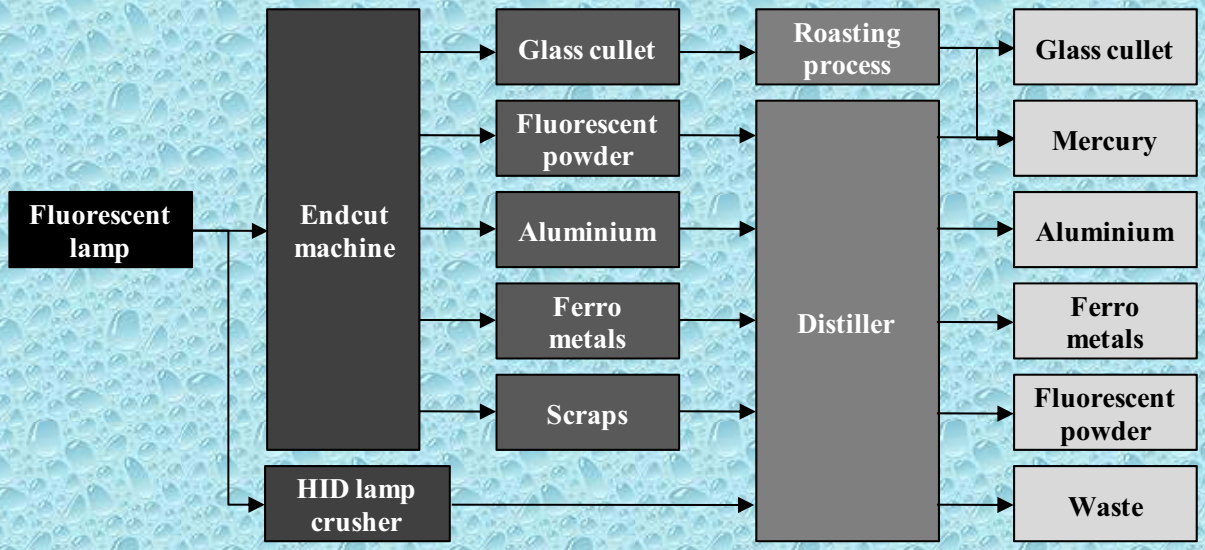
Flow of mercury waste treatment (Nomura Kohsan Co. Ltd. 2007)

9. Treatment of Mercury Waste and Recovery of Mercury *(3)*



Recovering flow of mercury from fluorescent lamps – **Mechanical Crushing** (Nomura Kohsan Co. Ltd. 2007)

9. Treatment of Mercury Waste and Recovery of Mercury *(4)*



Recovering flow of mercury from fluorescent lamps – **Air separation** (Kobelco Eco-Solutions Co. Ltd. 2001)

9. Treatment of Mercury Waste and Recovery of Mercury *(5)*

- Mercury batteries
  - Waste segregation
  - Remove impurities
  - Mechanical (size) screening for effective roasting
  - Recovery similar to that of Flamps (w/o pret.)
- Liquid mecury-containing products
  - Ensure collection w/o breakages
  - Extraction of mercury
  - Distillation – purification process

9. Treatment of Mercury Waste and Recovery of Mercury *(6)*

- Roasting process
  - Use of an automatic loading device for bags and containers of mercury waste, rather than manual loading, would protect the safety of workers;
  - The combustion efficiency should be checked. It should be at least 97% during incineration of mercury waste.
  - Mercury waste should be introduced into the furnace only when the normal conditions of process have been established – never during start-up or shutdown of the combustion process; and
  - The process should be designed to prevent contamination of ashes or wastewater by mercury waste.

9. Treatment of Mercury Waste and Recovery of Mercury *(7)*

- Chemical oxidation
  - Conversion to a soluble form (e.g. halide compounds)
  - Uses hypochlorite, ozone, hydrogen peroxide, chlorine gas
  - Continuous or batch process in mixing tanks or flow reactors
  - Treatement of collected compounds by leaching or precipitation
- Precipitation
  - Typically the final step in mecury treatment process
  - Reagents include lie, caustic soda, phospahte, ferrous sulphide
  - Sulphide is preferred to avoid matrix dissolution of Hg(OH)2 under certain (wide) pH conditions

9. Treatment of Mercury Waste and Recovery of Mercury *(8)*

- Adsorption treatment
  - Ion exchange resin
    - Useful in removing mercury from aqueous streams, particularly at concentrations on the order of 1 to 10 parts per billion.
    - Ion exchange applications usually treat mercuric salts, such as mercuric chlorides, found in wastewaters.
    - The anion exchange resin can be regenerated with strong acid solutions, but this is difficult since the mercury salts are not highly ionized and are not readily cleaned from the resin.
    - The resin usually needs to be treated or disposed. In cases, the resin must be disposed in a hazardous waste unit.
  - Chelating resin; Activated carbon; Amalgamation

9. Treatment of Mercury Waste and Recovery of Mercury *(9)*

- Stabilization/Solidification: Encapsulation technologies
  - Mercury stabilization and solidification is one of the conventional treatments of mercury.
  - Not one-hundred percent effective at the long-term stabilization of mercury.
  - Stabilization refers to techniques that chemically reduce the hazard potential of a waste by converting the contaminants into less soluble, mobile, or toxic forms. The physical nature and handling characteristics of the waste are not necessarily changed by stabilization (US EPA 1999)
  - Solidification refers to techniques that encapsulate the waste, forming a solid material, and does not necessarily involve a chemical interaction between the contaminants and the solidifying additives. The product of solidification, often known as the waste form, may be a monolithic block, a clay-like material, a granular particulate, or some other physical form commonly considered “solid” (US EPA 1999).

10. Long term storage and disposal of mercury waste *(1)*

- Overpacking mercury-filled flasks into steel barrels (US)
  - Injected into carbon steel flasks
  - Mercury flows into head tank
  - Flasks are placed into carbon steel drums with cushion provided between them
  - Drums lines with an epoxyphenolic lining
  - Drums placed on pallets for cushioning
  - Warehouse with concrete floor, solid block wall construction, air vents, point of entry/exit
  - Emergency response equipment
  - Leak-proof floors
  - Avoid areas prone to natural disasters (e.g. earthqiake, floods, hurricanes, etc.)

10. Long term storage and disposal of mercury waste *(2)*

- European Mercury Storage solution
  - Large surplus of mercury in Europe. Half of the chlorine capacity currently depends on a process that utilises mercury.
  - Euro Chlor signed an agreement with the state-owned Miñas de Almadén of Spain
  - The company accepts all surplus mercury from western European chlorine producers, under the condition that it displaces, ton for ton, mercury that would otherwise have been newly mined and smelted to satisfy legitimate uses (UNEP 2002).
  - 1,500 tonnes of pure mercury from decommissioned plants has been returned to the Spanish mining and trading company
  - The method of mercury storage is the steel flasks with lacquered interiors and put on suitably strapped wooden pallets (Euro Chlor 2005).
  - A strategy being prepared by Euro Chlor is a development and enforcement of a legally-binding sound management of mercury.

10. Long term storage and disposal of mercury waste *(3)*

- There are 4 mercury waste streams which might end at a specially engineered landfill:
  1. Mercury waste under uncontrolled waste mechanism;
  2. Mercury waste mixed with other solid wastes;
  3. Stabilized/solidified mercury waste; or
  4. Mercury contained in residue/ash of incineration.

10. Long term storage and disposal of mercury waste *(4)*

- A specially engineered landfill should be used when disposing mercury containing waste .
- A landfill should be engineered to be environmentally safe in a site with proper precautions and efficient management practices.
- Preparation, management and control of the landfill must be of the highest standard to minimize risks to human health and the environment.
- Such preparation, management and control procedures should apply equally to the process of site selection, design and construction, operation and monitoring, closure and post closure care (SBC 1995a).
- Landfill sites should be preferably outside environmentally sensitive areas.
- The entire landfill is enclosed in watertight and reinforced concrete, and covered with the sort of equipment which prevents rainwater inflow such as a roof and a rainwater drainage system
- Any type of mercury waste or waste containing mercury should be placed at a specially engineered landfill (Ministry of the Environment 2007).

11. Remediation of sites contaminated with mercury *(1)*

- Remediation programmes (World Bank, CEC NARAP)
- Remediation techniques
- Emergency response
- Case study
  - Restoration of Minamata Bay

11. Remediation of sites contaminated with mercury *(2)*

Remediation techniques

- **<u>Environmental Factors</u>**
  - Amount of mercury released during operation (e.g. ASM, large-scale mining, or manufacture of mercury-added products);
  - The number, size, and location of mercury hotspots (requiring remediation);
  - For mining operations, the properties from which the mercury is mined including, soil characteristics, etc.;
  - Methylation and leaching potential of mercury from the contaminated media (e.g., soils and sediments);
  - Background mercury contamination - regional atmospheric mercury deposition not related to localized sources;
  - Mercury mobility in aquatic system; and
  - Local/State/Federal Cleanup Standards: Water, soils/sediment, air.

11. Remediation of sites contaminated with mercury *(3)*

Remediation techniques

- Excavation and treatment
  - Physical separation; Thermal treatment; Hydrometallurgical treatment
- In-situ recovery
  - Soil vapour extraction; Electro-kinetic separation; Phytoremediation
- Containment
  - Pump and treat; Stabilization and solidification; Sediment capping

11. Remediation of sites contaminated with mercury *(4)*

Emergency response

- Visual observation of the site conditions or potential contaminant sources, or of manufacturing or other operations known to use or emit a particularly dangerous contaminant;
- Observed adverse effects in humans, flora, or fauna presumably caused by proximity to the site; Physical or analytical results showing contaminant levels
- Reports from the community to authorities of suspected releases.
- The first priority is to isolate the contamination from the receptors to the extent possible to minimize further exposure.
- If the site is residential and a relatively small site, ample guidance for emergency response is available from U.S. EPA in their Mercury Response Guidebook written to address small-to medium-sized spills in residences (US EPA 2001b).
- Alternately, for larger sites resulting from informal mercury use in developing countries (e.g., ASM), good recommendations for response are outlined in *Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small –Scale Gold Miners* (GMP 2004).

12. Public awareness and participation *(1)*

	Contents	Expected results
Publications	• Booklet, magazines, posters, web sites, etc to easily explain mercury issues • Guidebooks how to dispose of mercury waste	• Knowledge sources • Explanation how people can dispose of waste
Environmental Education Programmes	• Voluntary seminars • Demonstration of recycling programme • Scientific studies • Environmental tours to facilities, etc • eLearning	• Raising knowledge • Sharing common issues • Opportunities to directly expose environmental issues
Activities	• Take-back programmes • Mercury-free product campaigns • Waste minimization campaigns • House-to-house visit	• Implementation of environmental activities among all partners • Environmental appeal for citizens • Closer communications
Risk Communication	• Mercury exposure in general living environment • Safe level of mercury exposure • Mercury pollution levels • Fish consumption advisories	• Proper understanding of safe and risk levels of mercury exposure • Avoidances of overreactions

12. Public awareness and participation *(2)*

1. Officials and staff in governments who work for environmental issues;
2. People who are interested in environmental problems and have high potential to understand quickly and disseminate to others:
   - Children and students at schools, undergraduate students at universities; teachers of primary and middle schools; women at local communities and groups; others
3. People who work at environmental fields of local and community level:
   - Non-governmental organizations (NGOs); small and medium enterprises; local producers, collectors and recyclers, the disposal facility owners of mercury waste.
4. People who used to live at polluted sites:
   - Local organizations; city residents; enterprises.

12. Public awareness and participation *(3)*

- Type II Initiative is the concept of "Local Capacity-Building and Training for Sustainable Urbanization: Public-Private Partnership", namely the collaboration among all sectors to tackle common environmental issues.
- Considered as one the most important concepts for ESM of mercury waste (UNITAR, 2006)
- It is one of the most attractive tools being used help address the urban environmental crisis and is effective tool to implement ESM of mercury waste.
- In addition, this initiative helps governments and private sectors craft the approach that best fits their local needs for ESM of mercury waste

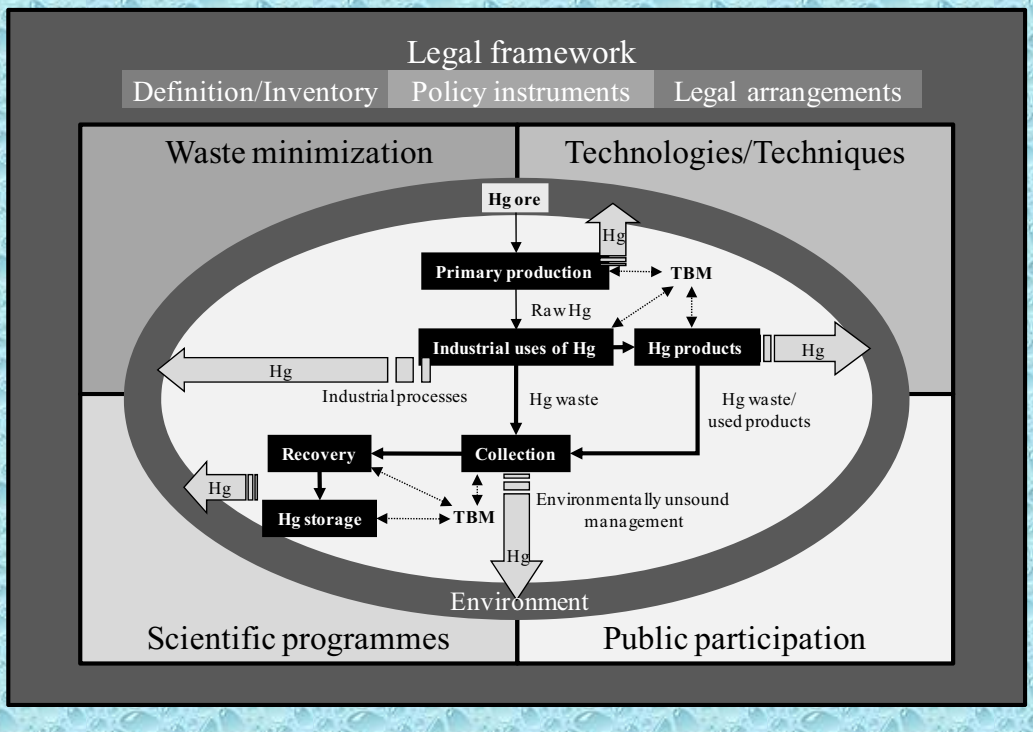
12. Public awareness and participation *(3)*

- Producers shall plan to phase out use of mercury to manufacture products or use mercury as low as possible if mercury-free alternatives are not available, and participate in or support a recycling programme on used mercury-containing product;
- Recyclers shall deal with used mercury-containing products and recycle those products as much as possible, and store or stabilize mercury collected from used mercury-containing products on the environmentally sound technologies if recycling is not available;
- Collectors and transporters shall ensure a safety transportation of mercury waste and used-mercury containing products;
- Users shall appropriately segregate and dispose of mercury-containing products;
- Government shall fully enforce the environmental law and enhance the national capacity to manage mercury waste;
- Public sectors shall supervise and manage all activities of dischargers and dealers of mercury waste.

13. Recommendations on policies dealing with Environmental Sound Management of mercury waste *(1)*

- **Legal framework**
  1. Definition/identification of mercury waste and an inventory programme
  2. Policy instruments
  3. Legal and administrative arrangements
- **Activities**
  1. Mercury waste minimization
  2. Env sound technologies and techniques
  3. Scientific programmes
  4. Public participation and partnerships

13. Recommendations on policies dealing with Environmental Sound Management of mercury waste *(2)*



14. Summary & Conclusions

- BC- TG seem to provide a solid framework and guidance for mercury waste management
- Comprehensive review of several key aspects necessary for an action plan
- Promotes multistakeholder participation
  - Public awareness; Partnesrships among sectors
- Mostly based on experiencies from developed countries
- Considerations must be made to adapt TG as appropriate (e.g. needs of developing countries)
  - Socioeconomic, technical, political, sector-specific, etc.

Thank you for your attention!

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