National 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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Outline

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8. Treatment of mercury waste and recovery of mercury
9. Long term storage and disposal of mercury waste
10. Remediation of sites contaminated with mercury
11. Public awareness and participation

Summary & Conclusions

1. Introduction

- Mercury is a chemical element and exists as liquid at room temperature and pressure.
- 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. Introduction

- 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. Introduction

- The Technical Guidelines (TG) follow decision VIII/33 of COP 8 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 comprehensive information on mercury

1. Introduction

- **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

1. Introduction

- **Scope of Technical Guidelines (TG):**
  - 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. Introduction

- **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

1. Introduction

- **General Guidance on ESM of Mercury Waste follows on ESM criteria under the Basel Convention to ensure:**
  - 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. Provisions for mercury (UNEP, Basel Convention)

- **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. Provisions for mercury (UNEP, Basel Convention)

- **UNEP Governing Council Decisions**
- **UNEP Chemicals Mercury Programme**
- **Ad Hoc Open-ended Working Group**
- **UNEP Global Mercury Partnership**
- **Strategic Approach for International Chemicals Management (SAICM)**

2. Provisions for mercury (UNEP, Basel Convention)

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

3. Guidance on ESM Criteria and Practices of Mercury Waste

- The Basel Convention
  - Transboundary Movement (requirements and control)
- 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 Facilities

3. Guidance on ESM Criteria and Practices of Mecury Waste

- 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

3. Guidance on ESM Criteria and Practices of Mecury Waste

- 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

4. Legislative and Regulatory Framework

- 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.

4. Legislative and Regulatory Framework

- 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

4. Legislative and Regulatory Framework

- Inspection and monitoring of Treatment and Disposal facilities
  - Compliance evaluation inspection (on site)
  - Compliance sampling inspection
  - Case development inspection
  - Information gathering

4. Legislative and Regulatory Framework

- Employee training
  - Provide basic knowledge of mercury waste
  - Segregation of mercury waste
  - Use of protection equipment
  - Proper labeling
  - Emergency response

4. Legislative and Regulatory Framework

- 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)

5. Application for Mercury Waste Prevention and Minimization

- 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 management options have been implemented

5. Application for Mercury Waste Prevention and Minimization

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

5. Application for Mercury Waste Prevention and Minimization

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.

5. Application for Mercury Waste Prevention and Minimization

- There are two types of mercury-containing products
  - 1) Formulated mercury-containing products: chemical products, laboratory chemicals, cleaning products, cosmetics, pharmaceuticals, etc
  - 2) Fabricated mercury-containing products: a combination of individual components, on or more of which has mercury added, that combine to make a single unit (e.g. automobiles, thermostates, battery operated devices, electronics, other)
  - Phasing out may involve barriers which are usually country dependant (e.g. cost, efficacy, ease of use, etc)

5. Application for Mercury Waste Prevention and Minimization

- 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
- Reduction of discharge from mercury-containing products
- Product labelling
- Collection practices for reuse and recycling (e.g. actions to keep mercury wastes from other wastes)

6. Identification and Inventories

- Identification of Mercury Waste
  - This is the first step to develop inventory of standarized mercury source and also an appropriate legal framework
  - Important to understand products and processess that use mercury

6. Identification and Inventories

Sources and Types of Mercury Waste

- 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

6. Identification and Inventories

- 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)
- Chemical analysis with appropriate reference methods and materials

6. Identification and Inventories

- Inventories
  - Sources and type of mecury waste
  - Activity volume /activity rates
  - Process specific information

- Calculations to estimate mercury waste
  - Refer to UNEP´s Toolkit for Identification and Quantification of Mercury Releases (2005)

7. Handling, Collection, Storage (interim), and Transportation of Waste

- 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.

7. Handling, Collection, Storage (interim), and Transportation of Waste

- Collection of mercury-containing products
- Collection of mercury and mercury waste from spills and manufacturing sites
- Take back programmes
- Handling and Storage (under Basel Convention guidelines)

8. Treatment of Mercury Waste and Recovery of Mercury

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

8. Treatment of Mercury Waste and Recovery of Mercury

- 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

8. Treatment of Mercury Waste and Recovery of Mercury

- 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.

8. Treatment of Mercury Waste and Recovery of Mercury

- 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

8. Treatment of Mercury Waste and Recovery of Mercury

- Adsorption treatment
  - Ion exchange resin
  - Chelating resin;
  - Activated carbon;
  - Amalgamation
- Stabilization/Solidification
  - Encapsulation technologies

9. Long term storage and disposal of mercury waste

- 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.)

9. Long term storage and disposal of mercury waste

- 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.

9. Long term storage and disposal of mercury waste

- 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.

9. Long term storage and disposal of mercury waste

- 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

10. Remediation of sites contaminated with mercury

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

10. Remediation of sites contaminated with mercury

Remediation techniques

- **<u>Environmental Factors to be considered</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.

10. Remediation of sites contaminated with mercury

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

10. Remediation of sites contaminated with mercury

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).

11. Public awareness and participation

	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

11. Public awareness and participation

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.

11. Public awareness and participation

- 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

11. Public awareness and participation

- 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.

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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