Analysis of gaps and needs in projects on management of mercury waste and storage of mercury

Mario Yarto, Sven Hagemann (GRS)

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1 Background and objective of this report

1.1 Mandate

GC 25/5 mandated UNEP, concurrently with the work of the Intergovernmental Negotiating Committee (INC) to develop a legally-binding instrument, to continue and enhance as part of international action on mercury the existing work, including enhancing capacity for storage of elemental mercury as well as to provide information on the environmentally sound management (ESM) of mercury containing waste.

Presently, there are several activities underway on storage of elemental mercury and on the ESM of mercury waste. These include two projects coordinated by UNEP Chemicals and funded by the Norwegian government; one sister project is implemented by the Secretariat of the Basel Convention and funded by the USEPA.

The UNEP Chemicals project on mercury waste management resulted in waste management plans in five countries. The plans constitute an initial step for national action identified as priorities through stakeholder consultations and underlined through analysis of relevant samples for total mercury content. Typically, countries have identified three priorities for mercury waste management that warrant further action. Most plans include components that a country can resolve at national level, others need international support. In general, governments are fazed with the assessment of all steps in the mercury life-cycle from source identification and quantification to final disposal whereby the options and criteria for the long-term safe disposal for waste consisting of elemental mercury, waste containing or contaminated with mercury need to be defined.

The work of UNEP Chemicals on mercury storage draws on the 2009 Assessment/Trade Reports which project excess elemental mercury coming from decommissioned chlor-alkali plants, by-product mercury from non ferrous metals mining and natural gas. This excess mercury will by far exceed mercury demand after equilibrium will have been reached in 2017 for Asia, and 2013 for Latin America. There is need to store excess elemental mercury in order to prevent its re-entry to the global marketplace as a commodity. Governments will be faced with the technological, legal, regulatory and economic challenges of storing elemental mercury.

To assist governments find environmentally sound storage solutions , UNEP Chemicals coordinated two regional mercury storage projects, one in Asia and one in Latin America in 2009-2010.

Based on requests from parties, the Secretariat of the Basel Convention (SBC) has a set of draft (5th version) technical guidelines on the environmentally sound management (ESM) of waste consisting of elemental mercury, containing or contaminated with mercury. The set of technical guidelines are based on the principles of ESM of hazardous waste. This includes principles of waste prevention and minimization, identification and inventory, handling, collection, interim storage, transportation, treatment, recycling, and recovery, long term storage, land filling, and remediation of contaminated sites. An intersessional working group led by the Government of Japan has been created to work on the draft technical guidelines. Output of the group will be presented at the next Basel COP in October 2011.

The SBC is implementing country projects in Latin America aimed at contributing to the finalization of the draft guidelines. In parallel, UNEP Chemicals in collaboration with the SBC has just completed a five country project with the same objectives.

1.2 Objective

1.2.1 Needs

It is recognized that there are gaps and potential overlaps between these projects, other related guidance and other outputs from Mercury Partnership areas such as on products. These include: Mercury device collection work does not currently include provision for the waste management of the devices; the waste guidelines do not provide guidance on elements of emergency response in the event of spillages and breakages; the storage projects currently only consider options for the safe long term storage of elemental mercury but does not address the need for interim storage of both elemental mercury and end of life mercury containing products. Further, the outcomes and experiences have not been assessed horizontally.

1.2.2 Expected outcomes

This report shall summarize the linkages and gaps between

- Mercury waste management issues and experiences from the mercury waste management projects studies towards the Basel ESM guidelines
- Mercury storage issues and experiences from the mercury storage studies towards the Basel ESM guidelines.

It shall also make indicative proposals for

- three pilot studies in developing countries facing mercury problems;
- identifying the typical scenarios (industry, household, health care) in three developing countries;
- preparation of a user-friendly and integrative guidance document (three different scenarios)

2 Projects and programs in the field of mercury waste management and storage of mercury

2.1 Basel Technical Guidelines for the Environmentally Sound Management of Waste consisting of Elemental Mercury and Wastes Containing or Contaminated with Mercury

The Secretariat of the Basel Convention with support of a multitude of stakeholders has developed draft (5th version) technical guidelines on the environmentally sound management of waste consisting of elemental mercury, containing or contaminated with mercury. They are based on the principles of ESM of hazardous waste. The guidelines aim to cover the fill life-cycle of mercury in waste and include principles of waste prevention and minimization, identification and inventory, handling, collection, interim storage, transportation, treatment, recycling, and recovery, long term storage, land filling, and remediation of contaminated sites.

The development of the guidelines is undertaken by an intersessional working group led by the Government of Japan. A new draft is expected for the second half of 2010. The output of the group will be presented at the next Basel COP in October 2011.

2.2 UNEP Mercury waste management project

2.2.1 Background

This project, dealing with the management of mercury and mercury-containing waste, will contribute to the UNEP priority area on ***harmful substances and hazardous waste*** under its ***Medium Term Strategy*** with the ultimate goal of minimizing the impact of harmful substances and hazardous waste to the environment and human beings. Specifically, the project supports the UNEP medium term strategy objective by reducing releases of mercury into the environment and reducing the exposure of workers and communities to mercury and mercury-containing waste.

2.2.2 Project objectives

The objectives of the project, which is executed by Chemicals Branch and funded by the Government of Norway, are:

a) to increase the technical capacity of selected countries and other stakeholders in assessing, managing and reducing the risks to human health and the environment posed by mercury and mercury-containing waste, and in doing so

b) to test the applicability of the Draft Basel Technical Guidelines for the Environmentally Sound Management of Waste consisting of Elemental Mercury and Wastes Containing or Contaminated with Mercury ('Basel Technical Guidelines')

2.2.3 Actions

a) Review of quantitative and qualitative data from the national inventory of mercury sources:

b) Prioritization of mercury sources and the corresponding sectors

c) Development of a national mercury waste management plan

d) ESM application in selected sources and sectors

e) Sampling and mercury analysis of environmental and human samples

f) Final national reports and final project report; lessons learned; evaluation of project

2.2.4 Expected outcomes

a) Review of quantitative and qualitative data from the national inventory of mercury sources

b) Prioritization of mercury sources and the corresponding sectors

c) Development of a national mercury waste management plan

d) ESM application in selected sources and sectors

e) Sampling and mercury analysis of environmental and human samples

f) Final national reports and final project report; lessons learned; evaluation of project

2.2.5 Project Status

The project is being implemented in

- Burkina Faso
- Cambodia
- Chile
- Pakistan
- Philippines

For the mercury waste projects coordinated by UNEP Chemicals, a results workshop took place in June 2010 where national mercury waste management plans were presented. Participating countries included Burkina Faso, Cambodia, Chile, Pakistan and the Philippines. These countries identified and prioritized mercury-waste related issues at national level by using the Draft Basel Technical Guidelines and the Mercury Toolkit.

The Basel Technical Guidelines on ESM of mercury waste and the UNEP Mercury Toolkit for developing mercury inventories are the two major guidance documents that are applied in the project. In addition, the project delivered enhanced capacities for countries in laboratory testing of human hair and environmental waste samples.

Initial feedback and responses gathered during national workshops held under the scope of this project, identified several gaps and areas of opportunity for participating countries. Those that have been acknowledged for future work under action plans, include:

a) Further reviews of the national mercury emissions inventory

b) Analysis and update of existing regulation for mercury and mercury waste

c) Promote a mandate for shared responsibility and cooperation among institutions

d) Develop and implement national guidelines for mercury waste management (e.g. by taking advantage of the BC technical guidelines for mercury waste)

e) Build/strengthen institutional capacity and infrastructure for mercury waste management

f) Develop and implement risk communication programmes and awareness raising activities

g) Leverage resources for the implementation of activities under national action plan for mercury waste, and

h) Promote cleaner production schemes and other voluntary schemes with the industrial sector, among others.

The project´s key components have been achieved in participating countries, although the implementation phase of activities considered for national action plans need to be carefully planned in the short term.

While reviewing their mercury emissions inventory, countries were able to identify data gaps and information needs to refine this inventory. An exchange of information among country representatives clearly indicated that national emission factors would be useful for developing countries, so that particular conditions can be reflected when estimating mercury emissions for specific sectors and subsectors.

A review of quantitative and qualitative data from the national inventory of mercury sources showed certain difficulties while obtaining data, such as the lack of cooperation from some organizations, and the absence of specific data from certain industrial sources. Finally, input factors for certain emission sources were discussed in detail, particularly the importance of obtaining different factors that could better reflect the actual situation in developing countries.

In addition, the preliminary inventory helped countries in identifying priority sectors at the national level (e.g., the main contributors to mercury emissions and mercury waste). These were country specific and included, among others, the following:

- Small scale artisanal gold mining
- Consumer products (dental amalgams, thermometers, lightning products, cosmetics, etc.)
- Chlor alkali production
- Solid and hazardous waste

In some cases, other uses and applications of mercury could not be considered due to absence of information or recorded data on the quantity and sources from the identified sectors. In this regards, a key action considered to address this information gap is to strengthen existing tools to collect additional data directly from the source. For instance, surveys and questionnaires, inspection visits to sectors using/disposing mercury, monitoring activities, have all been considered while reviewing national emissions inventory for mercury and mercury waste.

These preliminary actions were fundamental to move forward and develop a national action plan for mercury and mercury waste. While countries participating in this project show several differences in mercury issues within the national context, several elements of the action plans appeared to be shared by all countries. One of the main aspects that are incorporated in these plans is the need to assess and review existing legislation on chemicals and hazardous waste management. This is a necessary step that should be followed by an in depth analysis aimed to identify and cover gaps, to later ensure that mercury and mercury waste are covered under national environmental legislation with a life cycle approach.

When it comes to developing action plans with an emphasis on the life cycle of a chemical, relevant environmental management practices should be a driving force to promote compliance with applicable regulation. The production, distribution (e.g. trade) and use of mercury and mercury containing products, as well as infrastructure development for the storage and disposal of mercury waste have all been considered as ESM practices that need to be implemented under the scope of action plans.

A good example of environmental management practices within the consumer products segment, considers recommendations for the government to encourage developing or using alternate equipment and materials; and promote sustainable initiatives on mercury free products at national level.

Further activities that have been considered as relevant in national action plans include the need to build capacities, as appropriate, in all sectors involved with mercury and mercury waste management. For example, the customs agencies within the public sector require specific capacities to track and manage mercury containing products that enter the country for domestic trade. Inspection and enforcement actions have also been recognized as areas that must be strengthen to follow up on obligations for mer-

cury waste management, particularly in sectors that have been identify as priority sources.

At the industrial level an increased knowledge of cleaner production technologies has been identified as a key element to implement voluntary programmes that can be effectively applied in current processes. A good example of this type of initiatives has been demonstrated in a chlor-alkali in Pakistan, where the move from a mercury technology to a membrane cell technology has proven a successful cost-effective phase out scheme for reducing mercury emissions and associated human health and environmental risks.

For those categories identified as mercury and mercury waste emissions sources, the industrial sector should have a good understanding of the situation within facilities and processing activities. In such cases, action plans should include goals to measure the amount of different types of waste generated in premises, followed by an estimation of the mercury content in them.

Another component of national action plans that was thoroughly discussed and fully recognized during national workshops in the context of this project consists of the importance of providing communication programmes to all stakeholders. These include activities on information sharing, awareness rising, and risk communication strategies. A key aspect of such programmes is the need to engage all sectors of society while recognizing a shared responsibility to effectively address mercury and mercury waste management.

An additional component of this project has supported countries in their technical capacity to carry out field work, and collect environmental samples (including human hair) to determine the levels of mercury in selected sites. Preliminary analytical results have provided countries with an indication of potential hot spots or sources that need specific environmental management practices aimed at risk reduction. However, in some cases the technical and analytical infrastructure is quite limited and not sufficient to conduct comprehensive field studies and sampling activities. In such cases, countries relied on external support to obtain data and analytical results.

2.3 UNEP project on mercury containing tailings

2.3.1 Project objectives and actions

Tailings are a common consequence of metal ore mining. Depending on the mineralogy of the mined ore and the process employed the tailings may contain elevated concentrations of toxic pollutants among them mercury. Tailings, if not properly designed and managed, may pose a serious risk to the environmental and human health. In the recent years rising prices for precious metals and improvements in processing technologies gave new economic incentives to consider the extraction of precious metals from low-grade tailings. If along with other metals mercury could be extracted and separated, reprocessing of tailings would enable economic profits and environmental benefits at the same time. The goal of the project was to provide guidance on how to assess the feasibility of reprocessing mercury containing tailings and to analyse whether reprocessing is an option to reduce the mercury related risk by tailings. The issue was to be illustrated by a case study.

2.3.2 Status

Based on available information it was concluded that reprocessing of mercury containing tailings could be a viable remediation option for certain sites. Nevertheless, a site specific analysis must be conducted to verify its technical and economical feasibility. It was found that the global economic situation is actually (2010) very in favour of reprocessing projects. With gold prices hitting record high, low grade tailings become more and more interesting for mining companies and investors. Numerous examples show that even old or scattered small tailing piles from historic or recent amalgamation procedures are now getting in the focus of prospectors. This might be a unique chance to get rid at least of some part of toxic mining wastes that have accumulated in almost 500 years intensive use of mercury in gold and silver ore processing.

A case study for the mining area of Andacollo, Chile revealed that processing of mercury-containing tailings could indeed be a feasible for eliminating the risk that is connected with this type of mining waste. Further investigations are necessary before a final decision could be made on further action. A close cooperation between the community, small-scale miners, research institutions and mining companies will contribute to the solution of the problem.

The final report of this project has been submitted to UNEP. It has been accepted and is now available on the UNEP website (UNEP 2010b).

2.4 UNEP Project 'Reduce Mercury Supply and Investigate Mercury Storage Solutions'

2.4.1 Background

The environmentally sound temporary and permanent storage of mercury has been recognized as a priority. Many countries increase their efforts to reduce the use of mercury in products and processes. In the near future the supply of mercury may exceed domestic demand for accepted applications, thus leading to an excess of mercury. Countries or regions that decide not to export excess mercury are in need of an environmentally safe approach to permanently remove mercury from the market and to isolate it from the biosphere. Worldwide, there are currently no disposal facilities available that are licensed to accept elemental mercury. While both the EU and USA have taken steps to establish temporary[1] or permanent storage (disposal) facilities for elemental mercury, there are no such initiatives underway in Asian and Latin American regions. In response to a significant interest from governments and from civil society these two regions have been chosen for a project that, among other things, should help analyze the quantity of excess mercury to be expected until 2050 and to study the feasibility of establishing temporary and permanent storage facilities for mercury in the regions. The storage project is part of a larger initiative where the other part aims to reduce mercury supply by supporting Kyrgyzstan in exploring alternatives for mercury mining in Khaidarkan (Aydarken).

2.4.2 Project objectives

The projects for the Asia Pacific Region and in the Latin America and Caribbean Region (LAC) follow two principle objectives:

a) Estimation of the amount of excess mercury to be expected in the region between 2010 and 2050 if import and export across regional borders are excluded. And based on this quantification:

[1] In the USA the current facilities for the storage of elemental mercury that should no longer be available to the market are named 'long-term management and storage' facilities. It should be mentioned that only part of the mercury stored or to be stored in these facilities is considered waste.

b) Assessment of the feasibility of implementing specified technical concepts for the temporary or permanent storage of mercury in the region

Excess mercury supply was also estimated for the Eastern Europe and Central Asia Region (EEC).

2.4.3 Expected Outcomes

The following outcomes were expected from the regional projects:

a) Identification of sources and quantification of excess mercury supply during the period 2010-2015 based on an analysis of mercury supply sources and uses in the region and their likely future development.

b) An outline of the technical options specified for consideration

c) Description and analysis of the issues for consideration in implementing the specified options (technological, environmental, public health and safety, financial, socio-political, human resources, legal, and regulatory)

d) A pre-feasibility study with clear recommendations of the most feasible options that countries in the Asian Region may consider

In the two regional projects a regional advisory groups were established, made up of interested and representative governments and non government organizations within each region.

2.4.4 Project status: Assessment of excess mercury supply in Asia

The assessment included an analysis of the quantities of mercury arising over the next 40 years in the Asian region as a by-product from various mining and smelting activities, from the cleaning of natural gas, from the closure/conversion of mercury cell chlor-alkali plants, and from other significant sources such as end-of-life products (Concorde 2009). Regional sources of mercury were then compared with regional uses, such as lamps, measuring devices, dental amalgam, and production of vinyl chloride monomer etc., over the same time period in order to estimate excess mercury that will likely be generated in the region, and that could be temporarily or permanently stored in appropriate facilities.

The geographical scope of the study covered East, Southeast and South Asia. Not covered were Middle East, Australia, New Zealand and Oceania.

Here and with all other excess mercury assessments, some basic assumptions were necessary with respect to supply, trade, demand, and future developments of these factors. These include:

- Assume there are continuing transfers of mercury among the countries in the region
- Assume there are no imports of metallic mercury into the region and no exports of metallic mercury or by-product mercury outside the region (mercury added products are not affected)
- Assume that the main regional "sources" of mercury, other than imported mercury-added products, are closed chlor-alkali facilities, by-product mercury recovered from mining and non-ferrous metal smelting operations, natural gas cleaning, and some recycling of mercury-added products
- Assume that if and when regional policies dictate that mercury should be removed from the market, the mercury should go to terminal storage.
- Due to the special situation in Asia, the Chinese domestic market is assumed to receive no imports. Exports to other countries in the region are only considered if China generates excess mercury (without primary mining). Moreover it is assumed that domestic production from primary mining declines alongside declining domestic demand.

Current regional supply and demand were estimated on the basis of earlier global estimates ('Trade Report' UNEP 2006) and further information depending on its specific availability for the region.

The most important uses of mercury in the region are vinyl monomer production (700-800 t), small-scale gold mining (400 -630 t), measuring and control devices (340-390 t) and batteries (230-370 t), The total demand is around 2,100-2,700 t. Estimates on future demand were based on the objectives for future reductions in mercury consumption as agreed by the 'Mercury in products' partnership area under the UNEP Global Mercury Partnership.

Considered regional sources of mercury include primary mining of mercury ores (only in China: 1,100 t), decommissioning of chlor-alkali plants, by-product mercury from

non-ferrous metal production and cleaning of natural gas, stockpiles, and recycling. The study describes important mercury containing waste streams in the described industrial sectors and the current status as well as the technically achievable practice of recovery/ recycling operations.

It was pointed out that recycling of mercury containing waste (e.g. from chlor-alkali production and mercury added products) is not common practice in Asian countries and contributes only little to the overall supply. Exceptions are depleted mercury containing catalysts from vinyl monomer production that, to some degree, already undergo recycling.

Estimates on future supply were based on realistically achievable recovery/ recycling rates for the chlor-alkali, metal production and waste management. Based on Chinese data primary mining is expected to decline after 2015, going down to about 300 t.

Three scenarios have been considered when calculating excess mercury supply in 2010-2050. First, the domestic supply and demand in China was analyzed. Taking into account declining demand but constant high production from mercury mining an exceeding mercury supply is expected from 2013. The first scenario assumes that Chinese primary mining would work at maximum capacity although exceeding domestic demand. In this case substantial excess of mercury would begin in 2025. It is more realistic to assume that mercury mining would decrease in accordance to decreasing demand. In that case between 2029 and 2050 about 5,500 t excess mercury would have to be stored. A third scenario analyses the effect of restricted supply (-50%) of mercury to small-scale gold mining. Such a policy would result in 7,500 t excess mercury between 2027 and 2050, but may be even earlier (2017).

The authors pointed out that the analysis only gives a rough idea of when excess mercury might be necessary to be collected and stored. Estimates for future demand and supply are subject to significant uncertainties and have to be regarded as order-of-magnitude estimates rather than precise predictions.

2.4.5 Project status: Analysis of mercury storage options in the Asia Pacific Region

The analysis of excess mercury supply in Asia showed that up to 7,500 t of elemental mercury may have to be removed from the market and temporarily or permanently stored. Thus, the study analyzed three approaches to remove mercury from the regional market:

- Temporary storage (‘long-term management and storage’ in warehouses) based on the concept being implemented in the USA for governmental mercury stockpiles
- Permanent storage (disposal) in underground mines based on the European concept for underground disposal of hazardous waste
- Export to storage facilities outside the region.

Moreover, another type of temporary (‘interim’) storage facilities is discussed. These should be located at the place of still operating industrial plants. Here, mercury shall be accumulated, purified and filled into containers and sent to central (‘long-term’) temporary or permanent storage facilities.

General requirements for siting, constructing and operating temporary and permanent storage facilities in the region were formulated. With respect to site selection and construction the specified requirements cover infrastructure, design, environmental hazards, climate, geology and hydrology as well as political and economic stability. Requirements for operational safety include provisions on packaging and transportation, monitoring, and security measures.

In addition, legal procedure have to be in place that regulate the site selection, facility requirements, public participation, licensing procedures, acceptance criteria and reporting as well as ownership and liability.

It was proposed to introduce bilateral and multilateral financial and regulatory mechanisms to encourage the removal of mercury from the market and its environmentally sound storage. Moreover, there is a need to regulate the relationships between countries that export mercury to a storage facility and countries that operate such a facility.

Costs for constructing and operating above ground warehouse as well as permanent storage facilities in underground mine were discussed in detail. They were investigated for three phases of a construction project:

- Preparatory phase: design, feasibility study, licensing
- Construction phase: investment costs for construction, equipment, training of personal
- Operation phase: operational costs: maintenance, monitoring, transportation (including one additional interim storage facility, personal, risk management,

All three scenarios from the assessment of excess mercury supply were considered (5,500 – 12,000 t).

For above-ground storage cost structures and important features were taken from the US example but domestic Chinese costs were applied where applicable. Investment costs are estimated to about 6 million USD while operational costs might be as high as 1.2 million USD.

Underground waste disposal facilities are yet unknown to the Asian continent. Due to a lack of regional experience the estimation of costs had to be based on very rough assumptions. Some information was taken from published data on projects for underground disposal of nuclear waste. The calculated investment costs (33 million USD) and annual operation costs (0.9 million USD) are rather speculative and give no reliable picture on the potential financial impact of permanent mercury storage in underground mines.

Beside this it was stated that underground disposal of mercury would not likely be feasible on the Asian continent because there were no or too few suitable geologic formations. The authors did not discuss other formations than salt.

Export to facilities outside the region was considered as the most inexpensive approach as only a temporary ('interim') storage facility would be needed.

It was concluded that due to the presumably very high cost of underground disposal and the lack of appropriate sites it was recommended not to pursue this option but the concept of 'long-term' (temporary) storage, presumably in a desert area. Export to countries outside the region was also identified as appropriate.

A final draft of the report has been presented in March 2010 (AIT/ RRCAP 2010). A revised study is expected for January 2011.

2.4.6 Project status: Assessment of excess mercury supply in the Latin America and Caribbean Region

Objectives, methodology and general assumption within this assessment were identical to that used in the project for Asia. The study covered all countries in South America, Central America including Mexico and the Caribbean (UNEP 2009)...

In the beginning the study briefly summarizes other mercury related projects that may have relevance to future supply and demand, including the US export ban, programs to educate small scale miners to use less or no mercury, inventories (mainly atmospheric emissions) being prepared in several Latin American countries, and the development of waste management strategies.

Total mercury consumption in the region sums to 330-600 t. The most important uses are small-scale gold mining (165-330 t), dental application (60-75 t) and chlor-alkali production (25-55 t). Estimates on future demand were based on the objectives for future reductions in mercury consumption as agreed by the 'Mercury in products' partnership area under the UNEP Global Mercury Partnership. It is expected that consumption may decline to below 75 t in 2050.

In Latin America there are only two important sources of supply. The most prominent is by-product mercury from gold production that amounts to about 150 t with increasing tendency. Recovery from zinc production does not take place but could be implemented in the future. Primary mining of mercury ore, historically important, is no longer reported to occur, but recovery of mercury from ancient silver and gold mine tailings seems to take place in Mexico. There might be additional amounts of mercury produced by small or medium scale gold, copper and silver mines, but data are not available. Decommissioning of chlor-alkali mercury cells might become an important source of supply. Currently about 1,480 t elemental mercury are still in use. Recycling of mercury containing waste is very limited but could be increased in the future.

Based on the expectation of declining demand in the near future, the study estimated that as early as 2013 there might be an excess of mercury available in the region. It would result in 8,000 t elemental mercury until 2050. This is the base scenario. In a second scenario it was assumed that gold mining companies would export (raw) by-product mercury to the USA for long term management and storage without possibility to re-export. Moreover the recovery rate for mercury in zinc production was estimated smaller. In this case ('Minimum Storage Scenario') 2,000 t elemental mercury would accumulate between 2019 and 2050.

The authors pointed out that national or regional policy could lead to the introduction of storage obligations for mercury from certain sources. Such an accelerated reduction of mercury supply would probably reduce the availability of mercury to problematic uses

of mercury, e.g. in small-scale mining. On the other hand, storage capacities would be needed earlier and to a greater extent.

2.4.7 Project status: Analysis of mercury storage options in the Latin America and Caribbean Region

Similar to the parallel study for the Asia Pacific region the study investigated the feasibility of implementing three identified storage options (see chapter 2.4.5) in Latin America and the Caribbean. A fourth option, disposal in aboveground specially engineered landfills was briefly discussed but not considered as safe in the long-term.

The chosen methodology was based on expected mercury excess supply in 2010-2040 (see preceding chapter) and a study on transboundary trade in the LAC region in the years 2008-2009. The study lists quantitative trade data, destination of exported and origin of imported mercury as well as important trading companies for each country. It revealed that Peru is the most important exporter (of by-product mercury) as well as importer of commodity grade mercury (for small scale miners). Other important exporting countries are Mexico (by-product/ recycling), Brazil (chlor-alkali) and Chile (by-product). In general exports are rising. Most mercury is exported to the USA and Spain (where it is purified and then, re-exported). Obviously on a national scale there is sometimes already now a surplus of mercury that does not find relevant domestic demand. It is unclear how trade will develop after entering into force of the US and EU export bans. Trade in mercury compounds was lower by at least two orders of magnitude.

The authors discuss necessary measures for the safe management of elemental mercury, including packaging, handling, transport, acceptance and inspection. They also describe in detail the state (spring 2010) of science and technology with respect to stabilization/solidification technologies and discuss their costs and market availability. At the time the report was submitted (April 2010) no technology was considered as mature and available for the broader market.

The study proceeds with describing the concept, technical outline as well as general and specific requirements for constructing and operating above-ground temporary 'long-term management and storage' facilities, based on actual practice (US Department of Defence) and recent plans (US Department of Energy). Annual costs for stor-

ing one ton of mercury are given for both concepts. Also mentioned is a similar concept developed by the company Mayasa in Spain.

In the same way the report contains a detailed description of hazardous waste disposal ('permanent storage') in underground (salt) mines, as it is practiced in the European Union at five sites in Germany and the United Kingdom. According to existing EU legislation storage of elemental mercury is not allowed in underground mines, but there are more than 30 years of experience with other hazardous waste type including mercury containing waste. Disposal fees are given for storing hazardous waste. Specific not yet agreed requirements for disposal of elemental mercury may lead to increased cost.

Information is also given on the potential usage of hard rock and sedimentary rocks (clay) formations for underground waste disposal.

Based on this information the availability of geologic formation in South America is analysed. Starting with a general description of the continent's geology the abundance and suitability of clay, igneous rock and salt deposits in the study region are investigated and potential regions for establishing underground disposal facilities identified. Within the limits of the projects it was not possible to go into detail and assess potential *sites*, but it was found possible that those could be found and developed. The authors pointed out that beside technical and geological requirements legal social and cultural aspects have to be considered. Another important issue is the long-term liability. Experience with large infrastructure projects showed that the licensing process could take five years or more.

As underground disposal facilities are not available in the region now and in the near future, it was recommended to concentrate on the establishment of a temporary storage facility to manage elemental mercury until permanent storage solutions become available. For such a facility with an expected operational time of 10 years cost calculations were done on the basis of US estimates plus some local costs. The report also contains a rough estimate for the cost of exporting mercury to a foreign temporary or permanent storage facility. At the same time, the authors recommend to further explore the feasibility of concepts for permanent storage.

Beside the storage of elemental mercury the report also discusses the broader issue of managing mercury containing waste. It reports among other things the legal framework in LAC countries, interim storage of waste at end-users as well as transport, disposal

and recovery operations. It highlights the necessity to distinguish between several types of mercury containing waste because each type requires a different approach.

A draft report has been submitted in April 2010. It is now under consideration by the regional advisory group. An improved study is expected to be available in November 2010 (LATU 2010).

2.4.8 Project status: Assessment of excess mercury supply in the Eastern Europe and Central Asia Region

Objectives, methodology and general assumption within this assessment were identical to that used in the study for Asia. The study covered all countries in Eastern Europe (except EU countries) and Central Asia (UNEP 2010a). It describes important regional projects with relevance to the mercury problem that were carried by UNEP, the Arctic Council and the International Science and Technology Center (ISTC) and Eco-Accord. The latter two produced information on mercury contaminate sites, an issue not addressed by the two other assessments.

The most important applications for mercury in the region are chlor-alkali production (50-70 t) and the production of measuring and control devices (25-30). Small-scale gold mining consumes around 15 -32 t, while VCM production is the fourth largest consumer (15 -25 t). The study provides detailed information on the name, location and production capacity of chlor-alkali and VCM production facilities that still use or might use mercury in their production process. Estimates on future demand were based on the objectives for future reductions in mercury consumption as agreed by the 'Mercury in products' partnership area under the UNEP Global Mercury Partnership.

The most important sources of supply in the region include primary mining (Kyrgyzstan and Tajikistan: 300-350 t), cleaning of natural gas (12 t), recycling of waste from chlor-alkali and VCM production (12-17 t) and recycling of accumulated waste (15-40 t). The region host a large number of potential exploitable mercury deposits, but since the 1990 only one mine in Kyrgyzstan remained operable. Further potential sources of supply include by-product mercury from gold and zinc production (subject to improved flue gas control), decommissioned chlor-alkali facilities (1,000 – 1,500 t) and recovery of mercury from mercury-contaminated sites. Mercury-contaminated sites have not been considered in other regional assessment as a potential source of mercury. Thanks to the results of preceding studies in the region it became clear that there is a

vast legacy of mercury contamination due to extensive industrial operations in the former Soviet Union and other countries in Eastern Europe. The study lists country-by-country known mercury contaminated sites, the industry type that has caused the contamination and the estimated amount of mercury present in contaminated materials. Moreover, there exist storage sites for obsolete mercury containing pesticides. The study lists challenges countries face when addressing the management/ treatment/ recycling/ disposal of mercury containing waste including lack of facilities for treatment/recycling/disposal of waste, political and logistical obstacles to transport waste across country or border and the lack of registration, and collection procedures.

Whereas the two preceding studies for Asia and Latin America addressed only governmental and dealers stockpile, the study for Eastern Europe also identified stocks in households, educational and health institutions, research institutions and other places as a potential source of supply or waste.

Another specific source of supply are approximately 1.2 million t of mercury containing waste that have been accumulated for the purpose of recycling that eventually didn't take place.

For the future supply in the region a low supply scenario (constant low supply) and a high mercury supply scenario are considered. In both scenarios a closure of the Khaidarkhan mercury mine (Kyrgyzstan) is expected for 2020. The Maximum Supply scenario assumes that recovery of mercury in industrial processes is more advanced. In the Minimum Supply scenario an excess of mercury supply is anticipated for 2017, leading to an accumulation of mercury of 2,300 t until 2050. In the Maximum Supply scenario excess would begin almost immediately (in 2011) and lead to 10,000 t excess mercury until 2050.

It was observed that due to political and logistical reasons a free trade of mercury in the region may not be taken granted. Demand in one country could not always be met by excess supply in another country of the region. Moreover, many countries in the region still import mercury although mercury could be recovered at reasonable cost from mercury containing waste, either because of lack of investment in recovery equipment and hindered access to existing facilities beyond national borders.

2.5 Other Projects

2.5.1 SBC Sister Project on mercury waste management in GRULAC countries

2.5.2 Sub-regional Capacity Building and technical Assistance Project on Mercury Waste in Health and Other Sectors in LAC Region (SBC)

A sub-regional programme for the ESM of mercury waste in the health sector and in other sectors in several countries in Latin America and the Caribbean is being implemented by the SBC. An inception workshop for the health sector took place in Costa Rica last _. Planning for inception workshops for the health and industrial sectors in Argentina and Uruguay is underway. Project activities include mercury inventories, awareness raising workshops, drafting of national waste management plans, and a potential in-situ interim storage facility in at least one country. The project is being executed by the Basel Convention Coordinating Centre for Training and Technology Transfer for Latin America and Caribbean Region in Uruguay in cooperation with the WHO and the Pan American Health Organization (PAHO).

2.5.3 UNDP GEF Global Healthcare Waste Programme on Mercury Waste from Healthcare Facilities

Most recently, the UNDP GEF Global Healthcare Waste Programme developed 'Guidance on the Cleanup, Temporary or Intermediate Storage, and Transport of Mercury Waste from Healthcare Facilities'. The document is useful in many developing countries where healthcare facilities are moving towards mercury-free health care.

WHO currently is revising its guideline ‘Safe Management of Wastes from Health Care Activities’ (WHO, 1999) that also covers wastes containing mercury. The revision is still ongoing and, so far, did not produce new publically available material.

2.5.4 Development of BAT/BEP Guidance on Reduction of Mercury Releases from Waste Management

In relation to the Basel Convention draft technical guidelines on the environmentally sound management of mercury and the BAT/BEP guidance for waste management the current draft provides guidance for ESM of mercury waste and give comprehensive information about mercury waste, including the chemistry and toxicology of mercury,

source of mercury and mercury waste, adverse effects to human health and the environment caused by the environmentally unsound management of mercury. These guidelines provide knowledge and expertise on ESM of mercury waste and provisions for mercury waste under the legal instruments.

3 Analysis of linkages between and gaps within projects, programs and the Basel ESM guidelines

3.1 Waste Management Projects

General remarks

The UNEP waste management project focussed on building technical capacity for the environmentally sound management of mercury and mercury waste in five developing countries, and has also taken into consideration the applicability of the Draft Basel Technical Guidelines for the Environmentally Sound Management of Waste consisting of Elemental Mercury and Wastes Containing or Contaminated with Mercury ('Basel Technical Guidelines'). This project also includes a technical/chemical and economic assessment of mercury-containing and mercury contaminated tailings from the mining sector. A feasibility study was conducted in two developing countries that produce/produced precious metals or mercury and are left with mercury-containing tailings. Additionally, the sub regional SBC sister project in Latin America and the Caribbean outlines activities that include mercury inventories, awareness raising workshops, drafting of national waste management plans, and a potential in-situ interim storage facility in at least one country.

Final reports for all of the above mentioned projects have been submitted and this material provides relevant input to identify linkages between projects and a needs assessment develop follow up studies.

Linkages

Overall, relevant linkages between these projects have been identified as follows:

- Strengthening of policy and legislative framework
- Establishment of a mechanism for national coordination
- Development of national action plans for mercury and mercury waste
- Promoting stakeholder participation, including woman, workers, and other vulnerable groups
- Capacity building on technical matters (e.g. BCTG)

- Needs assessment for achieving environmental management practices for mercury waste

A basic outline with items covered during training sessions was generally agreed for all five countries for the waste management project. Some of the key aspects that were discussed included a review of the mercury emissions inventory, prioritization of sectors, identifying elements of a national action plan, and enhancing knowledge of the BC technical guidelines for the ESM of mercury waste.

Experiences shared by countries while developing their national emissions inventory, suggest that the applicability of the UNEP´s toolkit cannot be generalized as this tool was mainly developed with technical specifications for sectors in developed countries. It is possible that some sources and categories may have been over or under estimated with the input factors that were applied. This is indeed an important aspect that may be considered as a technical gap, and one that should be addressed in order to avoid or reduce errors not only at the calculation phase but also when prioritizing sectors.

While selecting priority areas to include in national action plans, the consumer products segment has been consistently discussed in countries, with the health sector possibly being the most important. Coordination within the sub-regional programme for the ESM of mercury waste in the health sector in several countries in Latin America and the Caribbean, and being implemented by the SBC is therefore necessary. Experiences gained by countries will contribute to information sharing for mercury waste management in this particular sector, and related activities as set in respective action plans.

Multi-stakeholder participation has been a strong linkage between projects, and the outcomes of discussions held both at technical and national meetings have very well reflected views and recommendations from all interested actors involved in different stages of the project. After presentation and submission of national waste management plans with regards to mercury and mercury-related waste and their mitigation strategies, linkages between projects are more easily identified, as participating countries share several similarities in their domestic issues for mercury management. In all cases, legislation on chemicals management appeared to be in place, with a few pending matters still requiring further work to cover mercury waste with a life cycle approach.

Gaps

While noting significant progress on the waste projects, the fact remains that there are several areas of opportunity that require further effort and resources. The projects on mercury waste have mainly focussed on building technical capacities, which has proven a key element to support countries in preparing a situation analysis of mercury. However, a major challenge in the implementation of national action plans for mercury waste is to test the applicability of the BCTG. The technical level of certain areas of work included in these guidelines is not so advanced in some countries, which can be a burden when management practices need to be taken into practice. During technical training workshops, those responsible for chemicals management expressed concerns on the potential difficulties due to limited knowledge or understanding of specific guidance of ESM criteria. Provision of further technical expertise is advisable in support of activities developed for waste management practices. On the same line, technical challenges were identified to find and assess cost-effective and locally appropriate alternatives for certain applications where mercury is still in use.

An additional gap in some cases is related to regulatory frameworks, where specific issues pertaining to mercury waste need to be refined or further developed to be consistent with action plans. While most activities included in national action plans are oriented towards sound environmental management practices, challenges still remain to strengthen efforts related to disposal and storage of mercury waste. This area of work provides an opportunity to strengthen links between mercury waste action plans and storage projects, aimed at identifying cooperation schemes to fill those gaps.

A review of national stakeholder's workshops also showed that risk communication strategies for awareness raising and outreach and education to support risk prevention and reduction, have not been fully developed. Sensibilization programmes have been made available through national meetings, but still do not appear to be full scale. For instance, these activities should reach vulnerable groups with accessible, timely and appropriate information on mercury and mercury waste.

The use of scientific information ensures that decisions are based on the most up to date understanding of chemicals, including their impacts on human health and the environment. While the waste projects included valuable efforts for a limited field study and analytical work, which results indicated a list of potential hot spots due to mercury exposure , countries still lack a national monitoring strategy to support assessment and

basic information for decision-making and monitoring of human populations, food (including animal feeds) and the environment (including air, water, soil, sediment, flora and fauna).

3.2 Storage Projects

General remarks

The UNEP storage projects focussed on the assessment of excess mercury supply and the potential implementation of temporary and permanent storage concepts in the Asia Pacific, the Latin America/ Caribbean and the Eastern Europe Central Asia Regions. Three reports on excess mercury supply and two reports on storage options are the result of the combined efforts. The content of these reports has been compared with the Basel Technical Guidelines on mercury containing waste (5th draft) in order to identify possible gaps and overlaps between the subprojects. The following Tab. 1 gives a short overview on the issues that are addressed by the current version of the Technical Guidelines and indicates whether these issues have been discussed by the reports as well.

Although all storage studies were restricted in their scope and objectives, they tried to analyse the problem of excess supply and storage from a broader perspective taking into account other aspects of the mercury life cycle as well.

Overlaps of the two studies on storage options

The analysis of the feasibility of implementing one or both storage options in the region was at the core of both studies. Such an analysis works with specific regional or even national data. For both studies, however, it was necessary to describe more general aspects of the storage problem. These include issues of waste management like the packaging, interim storage, transportation as well as treatment (like stabilization) and a general description of storage options. In these fields both studies show a considerable overlap. It has been observed that some issues are more thoroughly described in the LAC study, especially with regard to the description of stabilization technologies and the concepts of ‘long term management and storage’ and permanent storage in permanent storage in underground mines. Here, the LAC study provides an even more comprehensible insight into the topic than the Basel Convention.

Permanent storage in underground mines

The authors of both regional option studies faced the problem to assess the feasibility of a sophisticated concept that, until now, has never been implemented in their regions: disposal of hazardous wastes in underground mines. Little if any capacity exists with respect to this concept and the author's efforts to understand its features, principles and requirements have to be highly respected. In both regions permanent storage was considered as an option, but the lack of appropriate information did not allow the identification of suitable sites.

Linkage supply – waste management

In accordance with their main goal the excess mercury supply studies concentrated on gathering and analyzing data on sources of mercury supply and use patterns. The intersections between supply and waste management are manifold and:

- Mercury as a by-product: Mercury may be separated during the metal production and refining processes as a by-product. If separation does not take place mercury remains in mining or metal processing waste or is released into the atmosphere (not addressed by the Basel Technical Guidelines since raw material and mercury are not waste and, if the process is effective, the resulting waste does not contain considerable amounts of mercury). However, insufficient extraction results in mercury containing industrial waste and, possibly to mercury contaminated sites.
- Mercury generated by recycling of mercury containing waste (Basel Technical Guidelines 3.6.2).
- Mercury extracted from mercury contaminated soil, materials, equipment during the remediation of contaminated sites (Basel Technical Guidelines 3.6.2)
- Mercury extracted during the reprocessing of mercury containing tailings (not covered by the Basel Technical Guidelines).

The first and the last point are not addressed by the Basel Technical Guidelines. Useful information could be taken from the assessment report for the LAC region (UNEP 2009) and the UNEP report on reprocessing of tailings (UNEP 2010b).

Mercury in soil of contaminated sites could be an important source of supply. A large number of sites in the EEC region were described in UNEP (2010a). The issue of con-

Linkage Waste Management – Storage

Even if permanent storage facilities should be available at some time, there will still be a need for environmentally sound management of elemental mercury at all stages between end-user and permanent storage facility. This includes temporary ('interim') storage at the end-user, collection and separation, transport and temporary storage at waste disposal centres, treatment and recycling. These issues are addressed by Basel Technical Guidelines in chapters 3.5 to 3.6. A brief discussion is part of the Asia options study, and an extended discussion may be found in the LAC options study. A critical issue is the establishment of temporary storage facilities (above-ground warehouses). The LAC study made clear that the site selection, site assessment and licensing procedure for permanent storage facilities would need considerable time during which elemental mercury would have to be accumulated in temporary storage facilities.

Site selection procedure

Elements of a site selection process like the definition of requirements and criteria are to some extent part of both option studies. But they are not presented in a systematic way. The Basel Technical Guideline does not provide insight into this issue either.

Treatment and disposal of mercury containing waste other than waste elemental mercury

Both option studies focussed on the management, storage and disposal of elemental mercury, but the management of other mercury containing waste types is discussed as well. The LAC study gives valuable general insight into the management of mercury containing waste based on US regulations and practice. By doing so most aspects of the Basel Technical Guideline (sections 3.2 to 3.6) are addressed as well. An annex of the study reports about the status of legislation on hazardous waste management in several countries of the region. However, if legislation exists, it is often fragmented and poorly enforced. There is for example no legislation on the disposal of mercury containing waste and few if any suitable treatment, recycling and disposal facilities for mercury containing waste. Little information is given on concepts for the environmentally sound

disposal of mercury containing waste besides the requirement that these should either be treated or submitted to recycling.

The Asia study gives rather little information on the type and quantities of mercury containing waste in the region. Some more data is given in the Asia excess mercury supply report based on assumptions about the mercury use and (very low) recycling rate of mercury containing waste.

It should be noted that in some countries of the European Union mercury containing waste is required to be permanently stored in underground waste disposal facilities – the very same facilities that are currently discussed for permanent storage of elemental mercury. At the moment underground disposal of mercury containing waste (possibly after stabilization) is not discussed in the Asia and LAC option studies. In the same way the Basel Technical Guidelines do not mention it as a concept either, although it is already practiced in the EU.

Linkage Stabilization/ Solidification – disposal/ permanent storage

In the recent past two European studied reviewed the status, applicability and costs of technologies for the stabilization of elemental mercury and mercury-containing waste (GRS 2009b, BIPRO 2010). The information from the latter report was summarized in the LAC options study. The Basel Technical Guidelines provide only limited orientation that is not up-to date and lack comprehensiveness. The Asia options study relied on the latter source. In none of the three documents the consequences and potential benefits of stabilizing elemental mercury for temporary and permanent storage are explored. Quantitative stabilization, e.g. to mercury sulphide results in a material that no longer has hazardous properties like vapour pressure, toxicity, liquid state. Safe management of stabilized mercury might pose fewer challenges to developing countries.

Temporary storage

In both regional option studies temporary storage in above-ground warehouses (‘long-term management and storage’) was discussed as one possible approach to manage excess mercury for a certain time. While the LAC study made clear that storage in above-ground warehouses is only a transitional solution until a disposal solution is found (time line 10 years), the Asia study did not foresee an end to ‘long-term’. Despite the limited life-time of man-made structures it was not explored what will happen when

the above-ground warehouse can no longer be operated be it that the construction is no longer sound or be it that the economic/ political circumstances no longer allow a safe operation.

Permanent storage in underground mines was considered as the safest concept to store mercury, but it was stated that suitable geological formations do not exist in the region (Asia) or need further investigation in order to find potential sites for a disposal facility (LAC). In any case considerable time has to be calculated before an underground disposal facility becomes operable. In the meantime temporary storage facilities will be necessary

- At the place of generation (e.g. chlor-alkali plants or non-ferrous metal production)
- In form of centralized national or regional facilities that collect mercury from different origins and store until it can be disposed or temporarily stored at another place

Status of mercury/ storage of commodities and products

By definition the Basel Convention is restricted to the management of waste and does not cover the temporary or long-term storage of commodities and products consisting of or containing intentionally added mercury. Nor do the UNEP mercury waste management projects address these issues. Only elemental mercury that by national definition is considered as waste falls under the scope of the Basel Convention, its guidelines and other international and national waste management regimes. This fact is not clearly addressed in the option studies.

Terminology

Both option studies provide a glossary of technical terms in order to help readers to better understand the treatment of the various issues covered in the report. Not all selected terms seem to be as important that they need further description. Some terms appear only in the glossary but not in the text (e.g. ‘competent authority’ in the LAC study). On the other hand some important terms are missing (e.g. ‘stabilization’). Furthermore, some definitions are not consistent with the Basel Convention (e.g. ‘disposal’ in LAC). It must be noted that the Basel Technical Guidelines do not contain a glossary.

Tab. 1: Mapping of mercury storage projects against Basel Technical Guideline (5th draft)

Issue in Basel Technical Guidelines	Basel Guide.	Asia Ex-cess	Asia op-tions	LAC Excess	LAC Options	EEC Excess
3.2 Legislative and Regulatory Framework						
3.3 Waste Prevention and Minimization						
3.4 Identification and Inventory						
3.5 Handling, Collection, Packaging, Labelling, Interim Storage, Transportation						
3.5.3 Interim Storage at End Users						
3.5.4 Segregation and Collection						
3.5.5 Transportation						
3.5.6 Storage at Waste Management Centres						
3.6 Treatment and Recovery						
3.6.2 Mercury Recovery Solid Wastes						
3.6.3 Mercury Recovery Liquid and gaseous wastes						
3.6.4 Stabilization/Solidification						
3.7 Long Term Storage and Landfilling						
3.7.2 Best Management Practices						
3.7.3 Packaging, Storage, Storage Building						
3.7.4 Examples of Long-Term Storage						
3.7.5 Specially Engineered Landfill						
3.8 Remediation of Contaminated Sites	?					
Glossary						
Storage of commodities and products						
Legend		***Issue covered***		***Issue covered only partially***		

4 Recommendations for the improvement, better cooperation and coordination between running projects and for designing future projects

4.1 Proposals for enhancing cooperation and synergies among projects and programs

4.1.1 Waste management projects

The overall scope of national action plans developed by countries in the context of the waste project is the implementation of sound environmental management practices. Clearly the objectives and goals set in these plans should reflect a coherent legislation and coordination between ministries, by identifying responsibilities for all agencies involved. Important agreements with provisions to implement project activities under an adequate legislation framework should be encouraged through collaboration with stakeholders.

Progress made so far in these projects should also consider follow up plans to achieve sustainability over time. This implies cooperation efforts to strengthen institutional, technical and legal capacities for development, implementation and enforcement of measures for sound management of mercury and mercury waste, including through legal actions, economic instruments, voluntary agreements, substitution with less hazardous chemicals, etc., together with the necessary institutional infrastructures and coordination mechanisms. Such tasks require an initial analysis and review of past and present initiatives underway that deal with mercury and mercury waste, with the objective of identifying linkages and gaps between them, and thus avoiding overlaps and duplication of efforts, and instead promote synergies among them.

Remediation of mercury containing sites

In the current draft the remediation of mercury contaminated sites (often as a consequence of improper waste management and disposal) is shortly addressed but there are voices that demand to have this issue completely deleted. Contaminated sites are not necessarily considered as waste or as containing waste. However, in many cases they are the consequences of improper waste management and disposal. Mercury contaminated sites are a serious problem not only for developing but also for developed countries. Often, industrial or mining activities stretched for decades or even centuries

and lead to widespread contamination of soil, aquifers and sediments. In many cases, remediation is very costly and not performed due a lack of resources. Instead, management approaches are employed in order to minimize, where feasible impact on environment and human health. There are already several well written guidelines available, both on management and remediation of contaminated sites in general as well as of mercury contaminated sites (e.g. Ebinghaus et al, 1999; Hinton and Veiga, 2001;GRS 2009). A first cost-effective step would be to list these documents on a dedicated UNEP website. A second step would be to have discussions among stakeholder how available information in developed (and possibly developing) countries regarding management and remediation of mercury contaminated sites could be made applicable in (other) developing countries.

Describing environmentally sound management of mercury containing mining waste (especially from small scale mining) and contaminated sites would certainly go beyond the current scope of the Basel Technical Guidelines. But because they are still an important issue in several countries they should be addressed in form of an additional document.

4.1.2 Storage projects

Description of more general issues in the two studies on storage options

In both studies more general aspects of the storage problem were described. This was done in parallel and with different depth and coverage. Since both studies are to be updated or revised it would be beneficial to elaborate only on a set of descriptions that could then be used for both studies. It might be advisable to remove some chapters and put them into a separate document that could then be referred to. The regional studies would then concentrate on specific regional issues.

Description of storage concepts and stabilization technologies

It was found that the description of the concepts ‘long term management and storage’ and permanent storage in underground mines was considerably more up-to-date and more illustrative in the LAC options study than in the Basel Technical Guidelines. The same applies for technologies for the stabilization/ solidification of elemental mercury. It might be considered to improve the Basel Technical Guideline by including information

from the LAC study and additional very recent information on the industrial-scale implementation of one stabilization technology.

Permanent storage of mercury

Due to its complex nature the concept of underground waste disposal (permanent storage) is not easily understood by experts from outside Western European Countries. A concise description, going beyond the Basel Technical Guideline and possibly based on the LAC study and other material is needed as a first step. As underground disposal might become the concept of choice to remove mercury permanently from the biosphere, it is necessary to capacitate experts from the Asia and LAC regions with respect to this option. At the same time the potential use of underground disposal facilities for the environmentally safe disposal of other hazardous waste types should be looked into as well.

Site selection process

Site selection is a sensitive issue during the development of a concept for temporary or permanent storage. It requires a systematic approach where different aspects like site requirements, legal mechanisms, and public involvement have to be considered. At the moment neither of the two option studies nor the Basel Technical Guideline provides an outline of a site selection procedure. When implemented it would have to follow national specifics, but a general description of typical steps would certainly help national authorities and stakeholders in preparing for a site selection process.

Treatment and disposal of mercury containing waste other than waste elemental mercury

Information on legislation on hazardous waste management in the Asian region is rather limited. It might be valuable to prepare a list of national regulations as it was done in the LAC options report and the Philippines National Action Plan on Mercury and Mercury-Containing Wastes Management that was developed under the UNEP Mercury Waste Management Project (Environmental Management Bureau 2010). Instead of listing fragmented and in part insufficient legislation, it might be a way forward to develop a regulatory toolkit that describes how important aspects of mercury waste management could be regulated on a national basis The Toolkit for Institutional, Policy and Legislative Improvements in Support of the IWCAM (Integrating Watershed and

Coastal Areas Management) Approach in Caribbean SIDS could serve as an example (Environmental Advisors 2008). Such a tool kit would also be beneficial for the issue of temporary and permanent storage of hazardous waste in underground mines because at the moment beside Japan and Mexico no country has any experience with underground disposal or its regulation.

Disposal of (stabilized) mercury-containing waste in engineered above-ground landfills or underground mines has not been investigated in detail by the Asia and LAC option studies. It should be analyzed under which circumstances these two concepts could be implemented in the region taking into account climatic, geological, political and social aspects.

Regarding the quantity of mercury containing waste it would be advisable to use the updated UNEP 'Toolkit for Identification and Quantification of Mercury Releases' to get an impression how much mercury must be expected in waste streams at least in some countries of the region.

Temporary storage

Temporary storage is time-limited. A discussion of reasons that may lead to an unplanned end of operating storage facilities and measures that would have to be taken in such a case should be part of any risk analysis (e.g. economic, political, technical reasons). Such an analysis should be done and added to the general description of the technical concept and requirements.

Storage of commodities and products

The environmentally sound management of mercury containing commodities and products is part of a broader mercury life-cycle approach, because proper management helps avoiding or at least reducing the generation of mercury containing waste and contamination. In many cases the substitution of mercury added products by mercury-free alternatives is probably the most effective approach to avoid mercury releases and waste, but there are some products where the introduction of mercury-free alternatives is not yet feasible. A description of measures and prearrangements to ensure the environmentally sound management of mercury containing commodities and products could be a complementary to the guidance on the management of mercury containing wastes.

Mercury containing mining waste

The option studies do not address the management, disposal, treatment or reprocessing of mercury containing mining waste such as tailings. Because mercury is a widespread impurity in metal ores or has been used in ore processing (gold, silver), mining waste often contains considerable amounts of mercury that may pose a serious hazard. Mining waste, if of hazardous nature due to its origin, enormous volume and properties, has little similarities with other waste streams. Because of this it might be indicated to discuss this issue separately. It should nevertheless be mentioned in the Basel Technical Guidelines, possibly with reference to the UNEP report on reprocessing of tailings (UNEP 2010) and other relevant literature. A next step could be the development of a guideline for the management of mercury containing mining waste, based on good practice in affected countries.

Terminology

Future studies on the temporary and permanent storage of mercury as well as the Basel Technical Guidelines would benefit from a well based glossary that is consistent with the terminology used in the Basel Convention but also takes into account terms and concepts relevant for the management of mercury containing waste.

4.2 Identification of priority areas/issues and proposal for the design of the pilot studies in three developing countries

4.2.1 Waste Management

General remarks

One major problem for an efficient legislation on the sound management of mercury and mercury waste in developing countries is the lack of adequate institutional capacity and structures for enforcement of the legislation. One of the main causes of this is the lack of financial and technical resources to develop or increase such capacities. This is also the case for those countries that may have adequate legislation in place for chemicals and hazardous waste, but lack enough technical expertise to implement activities within environmental management programmes.

Potential priority areas for pilot studies

- Testing applicability of BCTG on priority sectors. As a first step, several sources of information should be made available prior to selecting the working area to be applied in the context of the BCTG. Such sources would ideally include the following: a) national inventory on mercury emissions, b) descriptive information about the sources of mercury emission and types of mercury waste in the country, c) clear selection of priority sectors , d) national action plan for mercury waste.

- Implementation of phase out programmes for mercury-containing products at selected sources. Potential projects aimed to avoid the use of mercury in products and the generation of mercury wastes could be developed based on site-specific environmental procurement policies and practices (e.g. hospitals). These types of practices would focus on phase out programmes and on identifying safe and effective supplies, chemicals and instruments that do not contain mercury, and/or that avoid material components or packaging materials mostly likely to contribute to formation and/or release of mercury during their life cycle.

- Emissions and waste reductions at source.

- Risk communication and awareness raising programmes. This priority area is generally agreed among stakeholders during national workshops and when drafting action plans. A feasible study in this area should consider elements for the provision of information and education to the public, to users and to producers about the environmental consequences of choice of particular activities and choice of products, their use and ultimate disposal.

4.2.2 Temporary storage of mercury containing waste

General remarks

Design, construction and operation of temporary and permanent storage facilities for elemental mercury that were at the core of the regional option studies is a complex challenge that must be based on an advanced level of technical capacity and an elaborated system of technical and legal requirements. Handy guidance is not sufficient for this issue. Comprehensive documentation and capacity building is needed in order to support countries and regions to develop national and regional temporary storage and disposal facilities. The same applies for the disposal of mercury containing waste. Both issues are of top importance for all other steps in the management of mercury contain-

ing waste. In the end the availability and accessibility of environmentally sound disposal facilities decides whether a mercury waste management system is effective or not. A system without disposal facilities inevitably leads to a release of mercury into the environment – sooner or later - , and renders all prior efforts useless. Therefore, disposal of waste consisting of elemental mercury or containing mercury should be given the highest priority after measures to avoid the use of mercury in products and processes. However, developing disposal facilities is out of the scope of the envisaged pilot projects,

As long as disposal facilities are not available temporary storage of waste consisting of elemental mercury or containing mercury is an important measure to bridge the gap. For a certain, but always limited time such facilities could provide an opportunity to keep mercury from re-entering the market or the environment. Temporary storage take place throughout all stages of waste management, starting from end-users of mercury added product or waste generators, to local waste collection centres to centralized national or even regional temporary storage facilities. At some stage some of the waste might be diverted to recycling and recovery operations, but it must be made clear that then mercury will be used and at least in part released into the environment elsewhere.

Temporary storage in households, health care institutions or small- to medium-scale industry will be in the focus of the following project proposals.

Temporary ('interim') storage of mercury and mercury containing waste at health care institutions:

Mercury added products like thermometers, sphygnomanometers and dental amalgams are still in widespread use in most hospitals around the world. Their use, breakage and replacement cause significant amounts of toxic waste that have to be managed and stored in a safe manner. For hospitals well written guidance on mercury waste management is now available (UNDP, 2010). However, as it was pointed out in the Final Report on the Mercury Wastes Management Project in Cambodia (Cambodian Ministry of Environment 2010) application of (English) guidance material at the national or local level is often hampered by the language barrier, limited awareness and capacity among concerned staff members. Translation of compressive guidelines into numerous local languages is often expensive and often not fully covered by projects. It is necessary to present core information in a way that it is comprehensible for affected personal with limited background knowledge and no foreign language skills. There is

no way to do without written information, but many messages can be more easily conveyed through illustration, pictures and videos.

Therefore, as one potential approach to more effectively help people to understand the main features of temporary ('interim') storage of mercury containing waste it is proposed to develop a video guidance. Based on an example of good practice in a developing country basic features and requirements of temporary ('interim') storage at health care institutions or waste collection centres are explained in a comprehensible and illustrative manner. This might include:

- Types of mercury added products in a hospital, types of mercury containing waste.
- Effective response in the case of spillage
- How to establish a storage room for mercury containing waste
- Proper packaging of mercury containing waste
- Destination of stored mercury containing waste

Realisation: The video may be produced by skilled employees of health care facilities using available devices or by local media agencies with the aid of experienced experts in the field of mercury waste management. Localization may be done by introducing subtitles in local languages, a widespread inexpensive practice in many developing countries that import media from abroad. The video should be in a compatible format so it could be played and shown under all major personal computer operating systems with typically installed free media players.

Such a video guidance on interim storage could be the core of a virtual library on best practice that could later cover other aspects of management of mercury containing waste as well. The library should be made accessible via internet, but their contents should also be available in hard copies (CD-ROM, DVD, USB-Sticks) for those actors that have no or no fast internet access. The video should be accompanied by already available material such as the above mentioned UNDP report.

A similar approach could be used to address the temporary storage of mercury containing waste at waste-collection centres.

Temporary storage of mercury containing waste in households, small companies and waste-collection centres

A similar approach as described above could be used to address the storage of mercury containing waste at households and small companies.

Mercury containing waste that could be found in households and small companies includes: measuring devices (thermometers, barometers), batteries, fluorescent lamps, cosmetics (skin lightning products) and some other products like electronic devices as well as elemental mercury and mercury compounds.

Households and small scale companies normally do not have specialized containers for storing mercury containing waste. For short-time storage pending collection it is necessary to give them advice how this type of waste could be safely managed and stored using available and cheap materials. Written Information on this topic is available on websites of some national environmental agencies, but for most people in developing countries it is inaccessible and because of the language barrier incomprehensible.

In order to provide information that is useful for a broad range of people it is proposed to prepare guidance for households and small companies in comic-style. It would consist of a short story with comprehensible illustrations with a minimum of text that could easily be replaced by text in local languages and supplemented by relevant country- or location specific information. Such comics could be distributed in a large number of copies through schools, or as an insert of newspapers. They could be produced by local artists taking into account national specifics or, alternatively, in a generalized manner so that they might be used in other regions of the country or in other countries as well.

Possible contents could be:

- Types of mercury containing products in households
- What to do in case of a mercury spill (e.g. broken thermometer)
- How to safely package end-of-life products using available cheap material
- Where can I deliver mercury-containing products?

It has to be noted that such an approach only makes sense if the next steps in the waste management chain, e.g. transport to waste-collection centres is available in the chosen country/ community.

The issue of disposal remains an open point. If in the countries there is no adequate demand for socially accepted uses, there will be a surplus of mercury in elemental form or in form of mercury containing. There might be the need for environmentally sound temporary storage until disposal or recycling can take place. For such centralized storage facilities the development of an easily replicable standard layout, description of standard procedures (like waste acceptance, overpacking, documentation, monitoring, inspection) requirements and criteria would be beneficial for all countries that plan to have such an institution. Such a guideline could be based on information already available, e.g. in UNDP (2010) or the LAC options study but should also take into account experience from other countries.

Temporary storage of mercury containing waste in industry:

Mercury is still in use in many industrial applications including electronic parts, measuring devices, batteries, lamps and chemical compounds. Sometimes the mercury content or its toxicity is unknown, so that mercury containing wastes are disposed together with other waste streams.

It is proposed to prepare a guidance that informs persons within companies who are responsible for occupational and environmental industry in developing countries about main problems of mercury added products and how these should be stored before they could be sent for disposal or recycling. The guidance could include

- Mercury added products likely to be found in industrial facilities
- Safe packaging and transport of mercury added products
- Measures to address spillage
- Safe temporary storage

The guidance would not cover lager-scale use of mercury and mercury compounds in chemical industry (like chlor-alkali, vinyl chloride monomer and possibly acetaldehyde production)

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