Executive Body, 28th Session 13-17 December 2010
Informal document No 8,
produced by Richard Ballaman, chair of the Working Group on Strategies and Review

Mercury emissions and the waste problem

Policy Summary

Early 2009, Switzerland sent a draft text to the secretariat to substantiate its earlier submission to amend the Heavy Metals Protocol. The secretariat used this text to draw up the negotiation document (ECE/EB.AIR/WG.5/2010/6) for the April 2010 session of the WGSR.

For mercury three activities will determine the success of a revised HM Protocol:

- The first is to control emissions from the biggest source of mercury: coal fired power plants. At the September WGSR a study was presented that showed that this source is the biggest emitter of mercury to air.
- The second is what to do with mercury containing products. The review of the TFHM on that lies before the EB and it is up to the EB to add products to the mandate of the WGSR.
- The third activity is linked to mercury entering the world market to be used for gold processing outside of ECE territory. It seems that this use and emissions to air far outweigh all air emissions within the ECE.

Part of the draft text from Switzerland dealt with addressing waste resulting from measures under the (amended) HM Protocol. The present informal document explains the importance of dealing with the waste issue. This policy summary is based on the more elaborate data presented in the attached appendix.

The European mercury emissions, including Eurasia, currently are estimated to be around 250 tonnes a year according to EMEP data. As presented in September in the WGSR, emission reductions for stationary sources as proposed in the draft ELV annex are calculated to amount to about 30 tonnes (mainly cement production) and cost 2.4 billion euro. Surprisingly, emissions from the main emission source of mercury (coal fired power plants) will not be reduced significantly by the emission limit that is under negotiation. Further substantial reductions are possible from mercury containing products if an agreement can be reached to take measures for these products. Most of these measures will be cost-efficient.

Comparisons of the emission figures of the EMEP territory with emissions connected to the production of gold using mercury show the importance of addressing mercury waste. In large scale gold production and artisanal small-scale gold mining yearly more than 1000 tonnes of mercury are used of which over 500 tonnes are emitted to air. This is two times more than the total emission to air from the EMEP territory. Although these emissions take place in developing countries, emissions undergo long-range transboundary transport and thus affect health and environment in the ECE territory. Export is in this context very relevant. Europe alone exports 1300 tonnes of mercury a year, while worldwide trade amounts to 2200 tonnes. The EU27 plus Norway and Switzerland hold 34.000 tonnes in stock according to EC/DG

ENV study 2008 (see table 4 in appendix). Most of this is linked to the chlor-alkali industry where industry will abandon the mercury electrolysis process. As a consequence the amount of mercury potentially available for export will increase further.

The data above show the importance of dealing with the mercury waste to prevent the huge emissions attached to gold mining outside of ECE. UNEP advises countries to ban the export of mercury. As a result the supply will go down and the prices will go up.

In the text that Switzerland sent to the secretariat a possible way to deal with mercury waste is given in article 3.10, article 7.1(c) and annex VIII. The idea is to prevent mercury entering the market. However, the transboundary transport for disposal should remain possible since not all countries will have possibilities for storage and disposal. In the revision of the HMs Protocol UNECE should deal with one of the most important sources of mercury emissions: the export of mercury and thereby its use in gold mining. If Parties to the HM Protocol can agree on this it would be an important signal to the UNEP negotiations currently under way.

Appendix (prepared by Mr Andre PeetersWeem, AgencyNL, the Netherlands)

1. Introduction

Recently, with the increase in gold prices, mercury has established itself as a highly-traded commodity in the global market. Raw mercury or mercury waste, is the important mercury source for artisanal and small scale gold mining (ASGM) in developing countries and countries with economies in transition. Therefore, elemental mercury as commodity may currently move from developed countries to developing countries generally for use in ASGM. This document gives an overview mercury of flows, emissions to air and waste prevention / minimization options.

2. Mercury production, consumption, stocks, waste and recycling

2.1 Global mercury production

The information on global mercury production comes from U.S. Geological Survey [1]. Within ECE Kyrgyzstan is the only country currently mining significant quantities of mercury for export, mainly to China. China mines mercury for its own needs and does not export liquid mercury, while mercury mines in Spain and Algeria have closed and no longer supply mercury to the global market (see table 1).

Table 1: World mine production and reserves (metric tonnes) in 2008 [1].

	Production in 2008	**reserves**
China	800	21,000
Kyrgyzstan	250	7,500
Peru (by-product)	136	NA
Russia	50	38,000
Tajikistan	30	
Mexico	21	
Finland	20	
Morocco	10	
World total (rounded)	1,320	67,000

2.2 Global mercury import and export

Global mercury trade is much larger than the amount of mercury that is being mined. This is caused by the availability of large stockpiles of mercury or cinnabar (mercury ore) in several countries. This mercury is redundant after changes in production processes or products, e.g. the shutdown of mercury cell plants for production of chlor-alkali. Stockpiles in the USA and in Europe add up to several thousands of tonnes of mercury [1], [3].

The overview of mercury import and export worldwide in 2008 as presented in table 2 is based on information from UN data [2]. The import and export numbers (except EU27) also contain the import and export of countries within the continent. In 2008 the export of mercury out of the EU27 was 357 tonnes more than the import. This makes the EU the largest exporter of mercury worldwide.

Table 2: Global mercury import and export (tonnes) [2]

continent	average 2004-2008		2008	
	export	**import**	**export**	**import**
Africa	36	55	9	52
Asia	470	894	569	803
Europe	1,542	1,660	1,288	1,072
Europe EU27	*517*	*323*	609	252
Latin America	105	276	150	225
North America	224	136	4	174
Oceania	11	30	3	26
World total	2,388	3,050	2,023	2,353

The price of mercury on the global market is rather stable. After a peak in 1981 mercury prices have been slowly declining and are now in the magnitude of 4 to 20 US dollar per kilogram.
(US geological service, see:
http://minerals.usgs.gov/minerals/pubs/commodity/mercury/430798.pdf and wikipedia:
http://en.wikipedia.org/wiki/Mercury_(element)

2.3 Mercury consumption in the EU27 + Norway and Switzerland

The availability of data on consumption and use is limited for the UN/ECE region. For the EU27+2 the European Commission has performed a survey in 2008 [3]. In this study mercury "consumption" refers to:
- the quantity of liquid mercury applied for industrial processes (e.g. chlor-alkali) or laboratory analyses;
- the quantity of liquid mercury used for maintenance of equipment (e.g. lighthouses);
- the mercury content of products (e.g. batteries) marketed in the EU, i.e., domestic production plus imports less exports.

Total mercury consumption in 2008 in the EU27+2 is 320-530 tonnes. The main mercury consumption is dental amalgams (23.5%, see table 3). Another large application area is laboratory equipment such as porosimetry and pycnometry (12.9%). The actual mercury quantities used in laboratory equipment are uncertain. The European Commission assumes that mercury consumption for this application could be higher than consumption for other applications that have been targeted by policy-makers.
The large amount of mercury consumption in chemicals is mainly caused by catalysts for production of polyurethane elastomers; the catalysts end up in the final product in concentrations of about 0.2% mercury. Also interesting is the significant amounts still used in the paint production. As the mercury containing biocides are not included in the Review Programme under the Biocide Directive they should have been phased out by September 2006 and the mercury containing biocides are not further lawfully on the market.

Table 3: Mercury consumption in Eu27 + Norway and Switzerland (2008) [3]

	consumption (tonnes Hg/year)	**% of total**
Light sources	11-15	3.1
Batteries	7 – 25	3.8
Dental amalgams	90 – 110	23.5
Measuring equipment	7 – 17	2.8
Switches, relays, etc.	0.3 - 0.8	0.1
Chemicals *(Catalyst in polyurethane (PU) production)* *(Preservatives in paints)*	28 – 59 *(20 – 35)* *(4 – 10)*	10.2 *(6.5)* *(1.6)*
Miscellaneous uses *(Porosimetry and pycnometry)*	15 – 114 *(10 – 100)*	15.2 *(12.9)*
Total (round)	320 – 530	100

2.4 Mercury stock

a. EU27 + Norway and Switzerland

The information on the mercury stock in the EU27+2 was also retrieved from the European Commission study in 2008 [3]. Beside the quantities of mercury accumulated in product applications, there are other mercury stocks available in the EU as well as ongoing sources of mercury such as by-product mercury from non-ferrous mining operations (see table 4).
Mercury use in chlor-alkali production accounts for the majority of mercury accumulated in the EU. The total amount of mercury in the chlor-alkali production is estimated to be 13,100 tonnes [3]. The use of the mercury-cell process in the chlor-alkali industry in the EU+ Norway and Switzerland is expected to end before 2020. To prevent the release of this mercury stock on the global market the EU has established restrictions on export of mercury. The amount of mercury available at the former mercury mine in Almadèn in Spain is not exactly known, but it is estimated to be over 3000 tonnes.
About 1,800 tonnes of mercury are estimated to be accumulated in products in use in society (5% of the total mercury stock). Dental amalgams and mercury compounds in polyurethane account for more than 80% of the total amount of mercury accumulated in products in the EU.
A large amount of mercury may be accumulated in contaminated sites, but it should be noted that the estimate comes with significant uncertainties, and it is doubtful whether much of this mercury could be recovered at a reasonable cost. It is roughly estimated that only some 100-500 tonnes of the accumulated mercury in contaminated sites – apart from chlor-alkali sites– may be readily recoverable.

Table 4: Stocks of mercury in EU27 + Norway and Switzerland (2007) [3]

Mercury stock, inventory or reservoir	**accumulated (tonnes)**	**% of total**
Chlor-alkali production, active	10,900	32
Chlor-alkali production, stock and easily recoverable	2,200	6
Chlor-alkali production, waste and site contamination	11,000	32

In products in use	1,800	5
On shelves in schools and laboratories	180	1
In drains in schools and laboratories	100	0.3
In highly contaminated sites (apart from chlor-alkali)	4,500	13
Stocks by suppliers	3,200	9
Total stocks (round)	34,000	100

b. Mercury stocks in USA and Canada

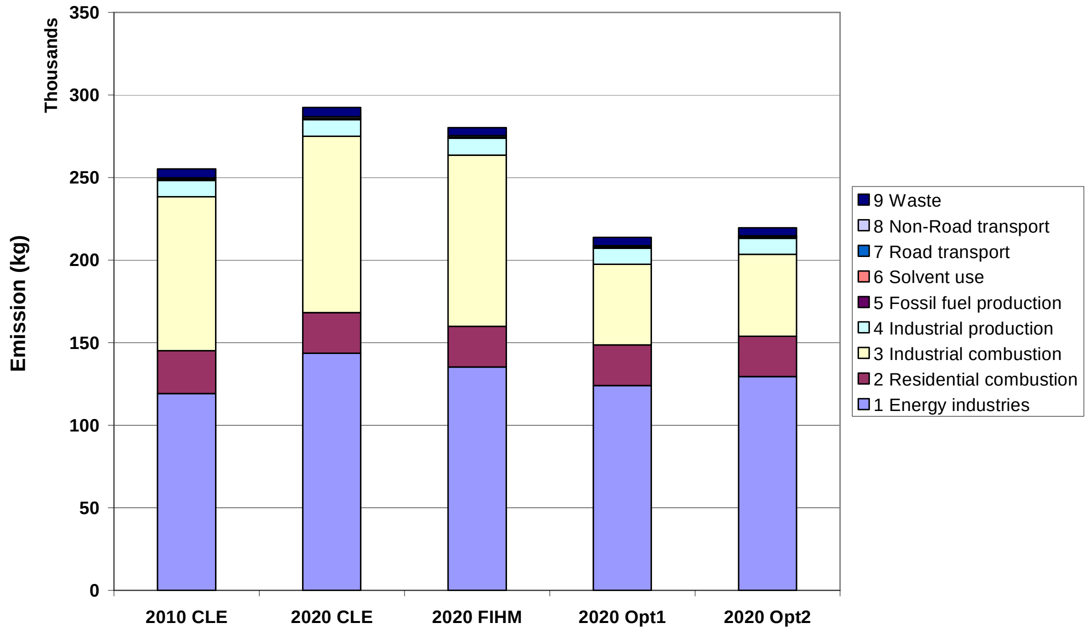
Mercury stocks in the USA are estimated by the US Geological Survey to be 4436 tonnes in 2008 [11]. Data for Canada are not available.

3. Mercury emissions to air for the UN ECE region and worldwide

In 2005 TNO estimated emissions of mercury for the UN ECE region [12]. Emissions in 1990 were estimated to be at 501 tonnes per year, in 2000 at 344, in 2010 at 328 and in 2020 at 318 tonnes per year.

In 2008 the emissions of mercury for the UN ECE region were established by MSC east based on reports by the Parties to the HM Protocol. If data were lacking these were filled in by using AMAP/UNEP estimates and estimates by TNO. MSC East estimated the total emissions of mercury in 2008 for the UN/ECE Europe region to be 227 tonnes in 2008. (ref http://www.msceast.org/hms/emission.html). This includes emission for the UN ECE countries in central Asia.

In 2010 TNO calculated various emission scenarios' [14] for a study together with MSC-E and CCE to show the exceedances of these emission scenarios for cadmium, lead and mercury. For the emissions TNO used the official 2008 emission data from the countries and filled in the missing data. TNO calculated the 2010 emissions for the European EMEP territory to be 255 tonnes (See figure).



Mercury emissions for various scenario's for the European territory (Source: TNO)[14] .

Emissions in the USA according to the EPA website were 115 tonnes in 1999 [19].
Environment Canada estimated the Canadian emissions of mercury to air to be 7 tonnes in 2003 [20] .
Total emissions for North America were estimated by UNEP/DTIE at 153 tonnes in 2005 [21]

The information of the global mercury emissions to air was retrieved from the UNEP study in 2010 [4]. Stationary combustion of coal is the largest source category of anthropogenic mercury emission to air (see table 6). Mercury is present in coal as a minor constituent which is released to air during combustion. Combustion of other fossil fuels for energy or heat production, contributes to mercury emissions but to a significantly smaller extent than coal. Mining and industrial processing of ores, in particular in primary production of iron and steel and non-ferrous metal production (especially copper, lead and zinc smelting), release mercury as a result of both fuel combustion and mercury present as impurities in ores.
Metal production sources of mercury also include mining and production of mercury itself (a relatively minor source) and production of gold, where mercury is both present in ores and used in several kinds of industrial processes to extract gold from ore. Use of mercury to extract gold in artisanal and small-scale gold mining operations is an intentional use also giving rise to large emissions both to air and to water. Water emissions are in this case larger than the air emissions and may result in significant environmental impacts on the local scale. After the coal fired power plants the mining of gold is the second largest emission source. The largest part of mercury emissions is caused by the artisanal and small scale goldmining, ASGM. About 2 kilogram of mercury is used to extract 1 kilogram of gold. ASGM's contribution to global mercury pollution is significant as long-range atmospheric transport of mercury also leads to contamination of international air and water resources. ASGM is considered the largest user of mercury globally, recently surpassing the chlorine industry.

Although emission data are scarce, worldwide estimates of ASGM releases add up to 1000 tonnes of mercury per year [7], including 323 tonnes [4] directly to the atmosphere. Most of the other mercury ends up in the water, part of which will react to organomercury compounds like (di)methylmercury and (di)ethylmercury, which can evaporate again to air. In the data in table 6 only the emissions from the mining and retrieval process are given. The overall emission of mercury that can be attributed to artisanal gold mining is probably higher than the 323 tonnes that is given in table 6.

Another major source of ‘by-product’ releases of mercury is associated with cement production. Mercury is released as a result of the combustion of fuels (mainly coal but also a range of wastes) to heat cement kilns and from mercury contained in the raw material (limestone etc) and additives.
Other sources are caustic soda production (chlor-alkali industry), mercury production, waste incineration and other waste disposal, cremation and diffuse releases from product use.

Table 6. Estimated global anthropogenic emissions of mercury to air in 2005 from various sectors (revised from UNEP/AMAP, 2008) [4].

	Emissions in 2005* (tonnes)	**% of total**
Coal combustion in power plants and industrial boilers	498	26
Residential heating/other combustion	382	20
Artisanal and small-scale gold production	323	17
Cement production	189	10
Non-ferrous metals	132	7
Large scale gold production	111	6
Other waste	74	4
Pig iron and steel, sec. steel	61	3
Chlor alkali industry	47	2
Waste incineration	42	2
Dental amalgam (cremation)**	27	1
Mercury production	9	0.5
Other	26	1
Total	1921	100

* Represents best estimates. See UNEP/AMAP (2008) for discussion on uncertainties.
** Does not include other releases from production, handling and disposal of dental amalgam.

4. Mercury waste and disposal

In several production processes mercury is used as a commodity. In many of these processes mercury is released after use or becomes available if the process is changed. In these cases mercury has become a material that is to be treated as waste.
Examples are mercury that was used in mercury cells in the chlor-alkali industry and mercury in products.

In other cases elemental mercury or mercury compounds are released as a by-product of a production process. Examples are the cleaning of natural gas, the cleaning of flue gases from coal fired power plants or cement kilns, mercury and compounds as by products from the mining and smelting of non ferrous metals.
These wastes have to be immobilised and stored in an environmentally sound manner.

4.1. Mercury waste and recycling in the EU27 + Norway and Switzerland
In 2008 the European Commission has published a study about waste streams of mercury connected to the use of mercury in products and applications [3]. An overview of mercury quantities ending up in waste is presented in table 5. The major sources of mercury in waste and of recycling are chlor-alkali production and dental amalgam. The overall recycling efficiency for all mercury waste ranges around 25%. The remaining waste is mainly disposed of in landfills or hazardous waste storage sites.
Relatively low recycling rates were found for light sources, batteries and mercury compounds (“chemicals”). All of the latter are characterised by a waste stream with a relatively low mercury concentration. For compounds, the low collection rate is due in particular to the fact that no specific collection or mercury recovery takes place for mercury-containing polyurethane and paints, the major application areas for mercury compounds. Note that recycling rates are generally lower than collection rates, because some collected mercury containing waste may be land filled/deposited and not recycled.
The mercury recovered from products may be expected to increase in the near term due to environmental regulations throughout the EU and then decrease as the quantities of mercury in these products and wastes decrease.

Table 5: Mercury in waste from intentional uses of mercury in EU27 + Norway and Switzerland (2007) [3]

	Quantities ending up in waste (Tonnes/year)	**Quantities recycled (Tonnes/year)**	**Contribution to total amount recycled (%)**	**Recycling efficiency within category and totally (%)**
Chlor-alkali production	119	35	34	29
Light sources	14	1.6	2	11
Batteries	30	4	4	13
Dental amalgams	95	30	29	32
Measuring equipment	21	4.5	4	21
Switches, relays, etc.	14	7	7	50
Chemicals	41	6.5	6	16
Miscellaneous uses	70	13	13	19
Total (rounded)	404	102	100	25

Besides mercury in products and applications, considerable amounts of mercury can be present in waste streams because of unintentional occurrence of mercury in fuels or in raw materials. Important waste streams containing mercury are:

- residues from flue gas cleaning on coal fired power plants,
- residues from natural gas cleaning,
- waste streams from gas cleaning at cement kilns.
- waste streams from mining and smelting of non-ferrous metals.

Emissions of mercury to air from coal fired power plants were estimated by TNO at 119 tonnes per year in 2010 for the UN ECE region in Europe and Asia [14]. With the introduction of improved emission abatement part of these emissions will be captured on residues from off gas cleaning, e.g. gypsum, fly ash, limestone or activated carbon. If the efficiency of the emission abatement is in the order of 50% to 80% for mercury, this potential waste stream of flue gas cleaning residues could contain 50 to 100 tonnes of mercury per year. Depending on the mercury content, and the presence of other pollutants, these materials can be reused or have to be disposed off in an environmentally sound way. Final storage could take place in underground salt mines or in rock formations. A technical Guideline for mercury storage is currently being developed within the framework of the Basel Convention [8]
It is estimated that other waste streams are smaller than the potential waste stream from flue gas cleaning at coal fired power plants.

Only few data are available on costs of final storage of elemental mercury. The AIT-UNEP Regional; Resource Centre for Asia and the Pacific has drafted a report for the UNEP Chemicals Mercury Programme. AIT-UNEP made estimates for costs of permanent underground storage of 5,500 tonnes of mercury in Asia. Total investment costs were estimated to be 33 million USD, and annual costs to be 1 million USD. This equals 6000 USD investment costs and 200 USD annual operational costs per tonne [17]. At a long term interest rate of 5% the investment costs of 6000 USD would pose an annual cost of 300 USD/tonne, or total yearly costs of 500 USD/tonne mercury.
A study by Bertin Technologies in 2000 gives lower prices for storage in German salt mines. Prices for permanent storage range from 200 to 450 euros/tonne [18]

.4.2 Options for prevention, minimization of emissions and disposal of waste

Comment [a1]: Eens met verschuiven

a. Coal fired power plants
Coal fired power plants are globally the largest source of emissions of mercury to air. In the coming decade many new coal fired power will be constructed and many existing power plants will be equipped with new or improved emission abatement techniques. This is caused by more strict environmental legislation, aimed at reducing emissions of NOx, SO2 and particulate matter. These abatement techniques will also reduce emissions of mercury. For the UN ECE region this is regulated by the Gothenburg Protocol.
Several countries, e.g. the USA, have implemented legislation that is specifically aimed at reducing emissions of mercury. This can lead to significant reductions of emissions of mercury from coal fired power plants.
Costs of mercury abatement at coal fired power plants were estimated in an informal document to the WGSR [22]. For coal fired power plants that already apply abatement techniques to reduce NOx, SO2 and PM meet the emission limit values in the Gothenburg Protocol no extra costs are involved for additional mercury abatement. If additional mercury control measures are necessary costs could increase to 106,000 euro/kg mercury.

Comment [a2]: Gegevens over disposal costs heb ik nog niet

b. Options for emission reduction and waste from processes.
This section summarizes initiatives to use alternative materials/processes not requiring mercury or use less mercury thereby reducing mercury emissions from current sources in four areas: chlor-alkali chlorine plants, Artisanal and Small-Scale Gold Mining, mercury-containing products and dental mercury-amalgam waste.

Chlor-Alkali Chlorine and Caustic Soda Manufacturing
Main types of processes used worldwide to manufacture chlorine and caustic soda are mercury cell, diaphragm cell and membrane cell. Membrane cell technology is the most cost efficient because of lower electricity input required and also eliminates the use and emission of mercury during manufacture [8]. The European chlorine manufacturers have committed themselves to replace all mercury cell plants by 2020. Until decommissioning of these plants many well-documented Best Manufacturing Practices are available that can be implemented to reduce mercury emissions.
The total amount of mercury in use is estimated to be 13.100 tonnes in EU + Norway and Switzerland [3]. After decommissioning of the plants this elemental mercury has to be disposed in a permanent storage. Costs for permanent disposal can be estimated to be in the range of 200 to 500 euro/tonne mercury, see section 2.5

Artisanal and Small-Scale Gold Mining (ASGM)
According to a UNEP document from 2008 ASGM is a significant global development issue [7]. An estimated ten million people in more than 70 countries depend on ASGM for income, producing about 12 % of the world's gold supply. The number of gold miners is expected to increase as gold mining becomes increasingly lucrative: the price of gold has nearly quadrupled since 2001, rising to over US$900/oz in July 2008, from $260/oz in March 2001.

Mercury is a highly toxic element that is commonly used to separate the gold from the ore because it is considered effective, easy to use, abundantly available and cheap. There are serious long-term environmental health hazards in populations living in, near or downstream/wind of mining operations. At one of the United Nations Industrial Development Organization (UNIDO's) Global Mercury Project sites, almost 50 % of miners showed unintentional tremors. The World Health Organization (WHO) has estimated that the incidence rate for mild mental retardation is as high as 17.4 per 1000 infants born amongst subsistence fishing population near gold mining activities in the Amazon.
Mercury amalgamation will likely persist because (a) mercury is inexpensive and widely available, (b) the technique is simple and the required equipment is rudimentary and inexpensive and (c) the miners and the community are not aware of the health and environmental consequences [7].

Mercury-free alternatives to the amalgam gold mining process are available and currently in use. According to the Basel Convention document May 2010, the most commonly cited alternative for the use of mercury in ASGM, processing gold using cyanide, cannot be regarded as BAT or BEP due to the toxic effects of cyanide in the environment. One example of a mercury- and cyanide-free gold mining is the Colombian Green Gold programme [23] that promotes the use of plant extracts in stead of mercury to obtain the gold from the ore.

Other process routes are being developed, e.g. the iGOLI process based on the use of common chlorine compounds (hydrochloric acid and sodium hypo chlorite [13].
However, a successful transition away from mercury use is likely to require large-scale training and education efforts, initiatives to overcome cultural, logistical and economic barriers and a reduction in the supply of low priced mercury [6].

ASGM is economically based on the low price of mercury compared to the price of gold. As long as mercury availability is high and prices are low there will be no incentive for the miners to change the process. Substitution of the mercury process is hampered by economic disadvantages of the alternative process route.
Because the current high gold prices there will be room to take the higher costs of alternative process routes into account. This implies that substitution of the mercury process by a mercury-free process that is more expensive will not have unacceptable consequences for the economic operation of the artisanal mining activities.

c. Options for emission reduction and waste from products containing mercury
Depending on the product and country, some barriers exist for phasing out mercury-containing products and replacing them with alternatives that use less mercury or are mercury free [8]. The barriers associated with the alternatives include: cost, efficacy, and ease of use, as well as difficulties associated with locating and identifying mercury-containing products. Table 7 summarizes the products used worldwide that typically contain mercury and the mercury-free alternatives.

Table 7: Mercury-free alternatives to Mercury-containing products

Products with mercury	alternative
Thermometers and other measuring devices	Many alternatives including liquid, dial and digital thermometers and “disposables” designed for a single use. Thermostats: those with mechanical switches and electronic ones are available as mercury-free alternative.
Electrical and electronic switches, contacts and relays	almost no technical obstacles for replacement with equivalent mercury-free components; no significant price differences
Light sources	LED lamps; A take-back programme for used fluorescent lamps is implemented in many countries for recycling.
Batteries	- Virtually mercury-free zinc-air batteries and other button-cell alternatives (actually still containing less than 10 mg of mercury). - reducing the use of batteries using rechargeable accumulators, solar energy or crank handle for battery-free devices.
Biocides and pesticides	Banned in many countries; two main alternatives have been promoted in their place: 1) Use of processes not requiring chemical pesticides/biocides, and 2) Easily degradable, narrow-targeted substances with minimal environmental impact.
Paints	Mercury-free paint is available; no significant price

	differences
Pharmaceuticals for human and veterinary uses	Single-dose vaccines do not require thimerosal (sodium ethylmercuric thiosalicylate, also known as thiomersal) as preservatives. According to WHO, there are other chemicals such as 2-phenoxy-ethanol also used as vaccine preservatives; however, WHO believes that thimerosal is better than the alternative preservatives.
Cosmetics and related products	Banned in many countries. Most common alternative as an active ingredient in skin lightening soaps and cosmetics is hydroquinone or corticosteroids; no significant price differences
Dental mercury-amalgam fillings	alternatives: cold silver, gallium, ceramic, porcelain, polymers, composites, glass ionomers, etc. A ban on mercury in dental amalgam took effect in January 2008 in Sweden and Norway.
Manometers and gauges	Three alternatives: needle/bourdon gauge, aneroid manometer and digital manometer.
Laboratory chemicals and equipment	It is entirely possible to restrict mercury use in school or university laboratories to a few specific, controllable uses. This initiative has already been implemented in Swedish and Danish legislation. The alternatives are generally no more expensive.

After instituting mercury-free alternatives and outright bans on mercury-containing products, reducing incidental releases from incinerators and landfills can best be accomplished by separation of mercury-containing wastes from the waste stream. The two most common waste streams containing mercury are regular solid waste and waste generated at healthcare facilities. Relying on “end-of-pipe” engineering controls that scrub incinerator emissions or treat landfill leachate are necessary precautions, but it is much preferable to prevent mercury contamination of the waste streams in the first place. This is most successfully implemented by (a) product labelling to prompt proper end-of-life recycling and disposal; and (b) collection and “take-back” initiatives for common mercury-added products.
TF HM in its conclusions to the Working Group on Strategies and Review concludes that alternatives for mercury containing products are cost-efficient and widely available [15].

d. Options for emission reduction and waste from dental mercury-amalgam
According to the study of the European Commission in 2008 a general ban of the use of mercury in any form for preparation of dental fillings, with exemptions for specific applications, is expected to be the simplest and most effective measure, which will produce the most significant mercury input reductions [3]. Due to the mercury amounts already accumulated in the teeth of European citizens, mercury releases to the environment and to waste disposal from this sector will continue for an anticipated 15-20 years after the elimination of new mercury inputs.

5. Policies and legislation in the UN/ECE region

The USA and the EU have established a mercury reduction policy, including legislation. No information about Canada and EECCA countries was available.

a.EU policy

The EU has established a strategy to prevent mercury pollution ((COM/2005/0020). Important steps in this strategy are a ban on export of mercury from the EU, from 15 March 2011 onwards, and standards for safe storage of mercury over a longer period of time. The European Commission also envisages underground safe storage of elemental mercury in salt mines or hard rock formations. The export ban is implemented via EU regulation N0 1102/2008.

b. USA Policy

In 2008 the USA have established the ‘Mercury Export ban Act of 2008’ (S.906). The export of elemental mercury from the USA is banned from 2013 onwards and an obligation was created for the administration to provide a facility for safe storage of elemental mercury for a longer period of time by 2013.

c. National legislation in Europe going beyond current EU legislation

Only three EU Member States and Norway have reported having broad national legislation on the use of mercury that exceeds the current EU legislation [3]. Norway has introduced a general prohibition on production, import, export, sale and use of mercury and mercury compounds that entered into force on 1 January 2008. Norway’s regulation does not address products already covered by existing EU legislation, and provides a few general exemptions until 31 December 2010. The extensive prohibition clearly indicates that viable (but not necessarily cost-effective) alternatives are available for virtually all applications not already addressed by the EU legislation.

Of the Member States, Denmark and the Netherlands have a general prohibition on import, export and sale of mercury and mercury-containing products, but a wide range of products with mercury, under exemptions, are permitted in both countries. Sweden has a prohibition on production, sale and export of thermometers and other measuring equipment, level switches, pressure switches, thermostats, relays, circuit breakers and electrical contacts, but has a few exemptions within these application areas. Sweden intends to enforce a general prohibition in the near future.

6. Addressing waste in the revision of the HM Protocol

Measures in the Protocol will result in vast amounts of mercury that could find its way to the market (e.g. gold mining) if this is not regulated. In the draft text sent by Switzerland to the secretariat early 2009 (ECE/EB.AIR/WG.5/2010/6) [16] a possible solution to address this problem is given. Article 3 paragraph 10 below deals with the export and the disposal of mercury. The obligations of paragraph 10 requires a special reporting paragraph in the reporting article 7.1 (c) plus a new annex VIII to define the conditions and timescales and to define mercury and its compounds/mixtures under the export regulation, to define waste and to regulate the disposal in an environmentally sound manner. The obligations, reporting and the annex VIII have been drafted after EU regulation 1102/2008. Please note that the export ban is meant to prevent mercury export for entering the market. Export for reasons of environmental sound disposal under Basel conditions is of course allowed.

Text to deal with mercury waste as sent in by Switzerland (ECE/EB.AIR/WG.5/2010/6)

<u>Article 3. Basic Obligations</u>

Para10. Each Party shall:
(i) prohibit metallic mercury, mercury containing products and mercury compounds as specified in and in accordance with the conditions and timescales specified in Annex VIII;
(ii) ensure to dispose waste containing metallic mercury in accordance with the conditions and timescales specified in Annex VIII;

<u>Article 7. Reporting</u>

Para 1 (c). Each Party shall report through the Executive Se<u>cretary of the Commission, </u>to the Executive Body, on a periodic basis and using as a minimum the methodologies to be specified and to be determined by the Steering Body of EMEP and approved by the Parties at a session of the Executive Body, information on:

(i) the amount of metallic mercury in use in the country;
(ii) the amount of metallic mercury generated from mining in the country;
(iii) the amount of metallic mercury and mercury compounds generated as waste as specified in paragraph 3 of Annex VIII in the country;
(iv) the amount of metallic mercury waste that is temporarily stored in the country;
(v) the amount of metallic mercury entering and leaving the country as waste; and

the amount of metallic mercury that is permanently stored in the country.

ANNEX VIII

Export measures on metallic mercury and certain mercury compounds and mixtures and the disposal of waste of metallic mercury

Export

1. The export of metallic mercury (Hg, CAS RN 7439-97-6), mercury containing products as prohibited in Annex VI, cinnabar ore, mercury (I) chloride (Hg_2Cl_2, CAS RN 10112-91-1), mercury (II) oxide (HgO, CAS RN 21908-53-2) and mixtures of metallic mercury with other substances, including alloys of mercury, with a mercury concentration of at least 95 % by weight from the Parties shall be prohibited one year after the entry into force of the present Protocol for the Party in question.

2. The mixing of metallic mercury with other substances for the sole purpose of export of metallic mercury shall be prohibited one year after the entry into force of the present Protocol for the Party in question.

Waste

3. The following shall be considered as waste and shall be disposed of in an environmentally sound manner, one year after the entry into force of the present Protocol for the Party in question, taking into account relevant sub-regional, regional and global regimes governing the management of hazardous wastes and their disposal, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal:
(a) metallic mercury that is no longer used in the chlor-alkali industry;
(b) metallic mercury resulting from the cleaning of natural gas;
(c) metallic mercury and mercury compounds resulting from the cleaning of exhaust gasses of stationary sources;
(d) metallic mercury resulting from non-ferrous mining and smelting operations;
(e) metallic mercury extracted from cinnabar ore; and
(f) obsolete mercury containing products.

Disposal

4. The disposal of mercury containing waste and the transboundary movement of waste shall be carried out in an environmentally sound manner, taking into consideration applicable sub-regional, regional and global regimes governing the transboundary movement and the management of hazardous wastes and their disposal, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

7. References

1. U.S. Geological Survey, Mineral Commodity Summaries (January 2010) and Mineral yearbook 2008

2 UNdata database, Mercury Trade of goods , US$, HS 1992, 28 Inorganic chemicals, precious metal compound, isotope (http://data.un.org)

3 European commission, Directorate general for environment, December 2008, Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society, ENV.G.2/ETU/2007/0021

4. UNEP, 2010-03-04, Study on mercury-emitting sources, including emissions trends and cost and effectiveness of alternative control measures, “UNEP Paragraph 29 study”, Zero Draft report, Contributing authors: John Munthe, Karin Kindbom, Jenny Arnell (IVL Swedish Environmental Research Institute), Jozef Pacyna, Kyrre Sundseth, Elisabeth Pacyna (NILU), Damian Panasiuk (NILU PL), Simon Wilson (AMAP), Peter Maxson (Concorde East/West)

5. UNEP chemicals, April 2010, final draft, excess mercury supply in Eastern Europe and central Asia, 2010-2050

6 UNEP, October 2008, Report on the major mercury containing products and processes, their substitutes and experience in switching to mercury free products and processes (DTIE/Hg/OEWG.2/7)

7 UNEP, October 2008, Draft guidance document on developing a National Strategic Plan for Artisanal and Small Scale Gold Mining (DTIE/Hg/OEWG.2/INF/13)

8 Basel Convention, May 2010, Technical Guidelines for the Environmentally Sound Management of Waste consisting of Elemental Mercury and Wastes Containing or Contaminated with Mercury – 5th Draft

9 Communication from the Commission to the Council and the European Parliament- Community Strategy Concerning Mercury (SEC(2005)101/COM/2005/0020)

10. Regulation (EC) No 1102/2008 of the European Parliament and of the Council of 22 October 2008, on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury.

11. website metalprices.com, http://www.metalprices.com/FreeSite/metals/hg/hg.asp

12. H.A.C. Denier van der Gon et al, Study to the effectiveness of the Un ECE Heavy Metals Protocol and costs of possible additional measures; phase 1 Estimation of emission reduction resulting from the implementation of the HM Protocol, TNO-report, B&O-A R 2005/193, 2005, The Netherlands.

13. The iGoli Mercury-free Gold Extraction Process Small-Scale Mining Division, Mintek, April 2006
http://www.innovamineria.cl/archivos/iGOLIBOOKLET.pdf

14. Visschedijk, A, H. Denier van der Gon, J. Kuenen en H. van der Brugh. Emissions, emission reductions and costs of options for a revision of UNECE Heavy Metal Protocol for the priority heavy metals cadmium, mercury and lead. TNO, Utrecht, 2010, TNO-034-UT-2010-01318_RPT-ML.

15. Options for revising the Protocol on Heavy Metals, report by the chair of the Task Force on Heavy Metals, (ECE/EB.AIR/WG.5/2010/9).
http://unece.org/env/documents/2010/eb/wg5/wg47/ECE.EB.AIR.WG.5.2010.9_e.pdf

16. Options for revising the Protocol on Heavy Metals, Note by the secretariat, (ECE/EB.AIR/WG.5/2010/6).
http://unece.org/env/documents/2010/eb/wg5/wg46/ece.eb.air.wg.5.2010.6.e.pdf

17. AIT-UNEP Regional Resource Centre for Asia and the Pacific: Development of Options Analysis and Pre-Feasibility Study for the Long Term Storage of Mercury in Asia and the Pacific, A. Karazhanova et al., Draft Report, 10 February 2010

18. Bertin Technologies: Feasibility Study of the Salt Mines Storage Route, Step 1 report, C. Kirrmann, 2000, France

19. webpage: http://www.epa.gov/hg/control_emissions/emissions.htm

20. webpage: www.ec.gc.ca/mercure-mercury/default.asp?lang=En&n=CF513593-1

21. UNEP Chemicals Branch, 2008. The Global Atmospheric Mercury Assessment : Sources, Emissions and Transport, UNEP-Chemicals, Geneva.

22. CLRTAP, WGSR 47th session, Informal document No 6: Reduction of mercury emissions from coal fired power plants, A. Peeters Weem, 2010, The Netherlands

23. webpage green gold: http://www.mysinchew.com/node/42347