Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH

Internationale Quecksilberstrategie zum Verzicht auf Quecksilber bei industriellen Prozessen und Massenprodukten

FKZ UM08 67 200

Abschlussbericht

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Dieser Bericht enthält folgende Teilberichte:

1 Einleitung, Aufgabenstellung und Zielsetzung

Quecksilber wird aufgrund seiner einmaligen Eigenschaften seit Jahrhunderten vielfältig in Produkten eingesetzt. So wird es z. B. wegen seiner Eigenschaft der Nichtbenetzung von Oberflächen in Thermometern und Blutdruckmessgeräten verwendet oder dient als Leuchtmittel in Energiesparlampen und als Bleichmittel in Kosmetika.

Quecksilber weist jedoch auch eine hohe Toxizität auf, weswegen der Einsatz von Quecksilber in der EU stark zurückgedrängt wurde. Insbesondere in Massenprodukten wie Batterien, Farben oder Thermometern ist der Einsatz von Quecksilber heute EU-weit verboten bzw. auf ein Mindestmaß limitiert (Energiesparlampen, Knopfzellen). Leider ist jedoch in vielen Entwicklungs- und Schwellenländern Quecksilber noch immer in vielen Produkten und in hoher Konzentration verbreitet, obwohl es quecksilberfreie oder -arme Alternativen gibt.

Auf globaler Ebene werden seit 2001 im Rahmen des Umweltprogramms der Vereinten Nationen (UNEP) verstärkt Anstrengungen unternommen, um die anthropogen bedingten Emissionen von Quecksilber in die Umwelt und die damit verbundenen gesundheitlichen Gefährdungen zu reduzieren. Im Jahr 2009 hat der Verwaltungsrat beschlossen, Verhandlungen zu einem rechtlich verbindlichen Übereinkommen zu treffen, das alle Aspekte des Lebenszyklus von Quecksilber behandeln soll.

In Vorbereitung und Begleitung der Verhandlungen wurde durch die Europäische Union eine Machbarkeits- und Effektivitätsstudie zur Implementierung rechtlich bindender und freiwilliger Ansätze erstellt. Ein Ergebnis dieser auch mit Hilfe der GRS verfassten Studie war, dass bezüglich Anwendung, Verbreitung und Substitutionsmöglichkeiten von Massenprodukten in Schwellen- und Entwicklungsländern nur unzureichend Informationen vorliegen.

Um diese Kenntnislücken zu füllen, wurde im Rahmen dieses Vorhabens gemeinsam mit der international tätigen Nichtregierungsorganisation IPEN eine Marktanalyse zu Quecksilber in Massenprodukten in ausgewählten Entwicklungs- und Schwellenländern durchgeführt.

Hierzu ergänzend und begleitend wurden Studien zu ausgewählten Fragestellungen erstellt, die sich mit der Verwendung von Quecksilber in Produkten und Prozessen sowie mit den Folgen (Emissionen, kontaminierte Flächen) beschäftigen. Dies erfolgte insbesondere im Hinblick auf die sich im Zuge der Verhandlungen auf UNEP-Ebene

diskutierten Handlungsoptionen des in Entwicklung befindlichen Übereinkommens zu Quecksilber.

Der vorliegende Abschlussbericht stellt eine Zusammenstellung der im Verlauf des Vorhabens erarbeiteten Dokument und Studien dar.

Zusammenstellung Emissionen – Exposition – Toxizität von Quecksilber

1 Geogene und anthropogene Emissionen in Luft, Wasser und Land

Es wird geschätzt, dass die Erdsedimente ca. $3 \cdot 10^{11}$ t Quecksilber enthalten. Hiervon werden jährlich ca. 500 t durch natürliche Prozesse (Vulkanismus, Geothermie, Erosion) und ca. 3.400 t durch industrielle Prozesse mobilisiert und in die Atmosphäre, Böden und die Ozeane emittiert (Selin et al. 2008b). Die Neu-Sedimentation beträgt nur ca. 600 t, so dass industrielle Freisetzungen zu einer stetigen Anreicherung von Quecksilber in bioverfügbaren Umweltkompartimenten führen. Gegenüber dem vorindustriellen Niveau hat sich die Menge des Quecksilbers in der Atmosphäre und den oberen Ozeanschichten etwa verdreifacht (Abbildung 1). Dies lässt sich u.a. aus Quecksilbermessungen an Kernbohrungen in Gletschereis nachweisen (Schuster et al. 2002, Abbildung 2). Böden und tiefe Ozeanschichten wirken als große Puffer, die Quecksilber nur langsam wieder Atmosphäre und obere Ozeanschichten abgeben.

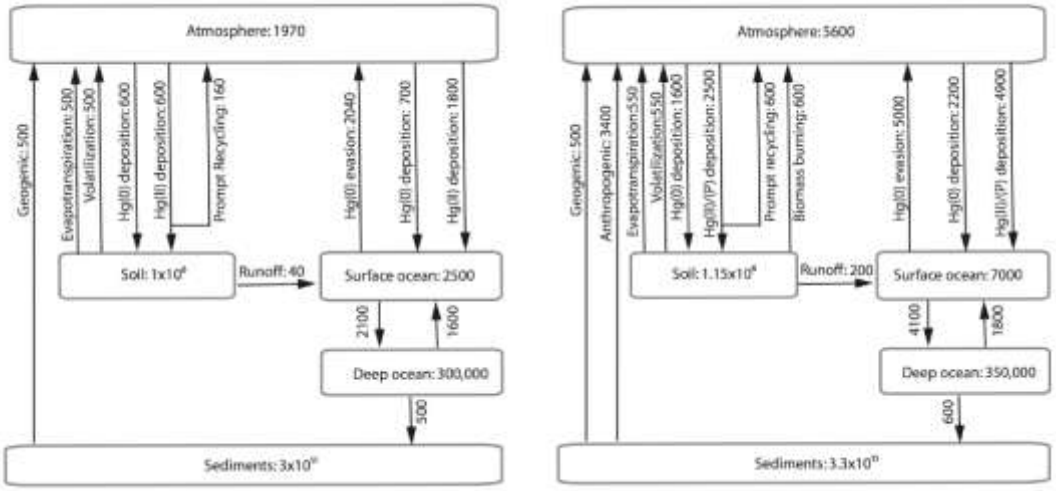

Abbildung 1: Globale Quecksilberflüsse im vorindustriellen Zeitalter und im Jahr 2000 (aus Selin et al., 2008b).

Von Mobilisierungsprozessen zu unterscheiden sind die auftretenden Stoffflüsse zwischen den Umweltkompartimenten. Tatsächlich betragen anthropogene Primäremissionen in die Atmosphäre (z.B. Kohleverbrennung, NE-Metallproduktion, Klein-Goldbergbau) nur etwa 2.000 t Hg (UNEP 2008a), während gleichzeitig die Ozeane, Flüsse und Böden ca. 4.500 t emittieren (1700 bis 9500 t, Mason 2008; 4350 t, Selin et al., 2008a, dort aber auch Schätzung anthropogener Emissionen in Höhe von 3.400 t). Diese Menge wird als natürliche Emissionen gewertet, tatsächlich handelt es sich zu mindestens 50% um Re-Emissionen von Quecksilber, das zu vorher durch industrielle Prozesse mobilisiert worden war. Eine Simulation von Selin et al. (2008b) zeigte, dass nur etwa 32% der Hg-Niederschläge auf dem Gebiet der USA auf natürliche Primär-Emissionen zurückzuführen sei, etwa 42% beruhen auf anthropogenen Primär-

Emissionen, 20% auf anthropogenen Re-Emissionen (Abbildung 2). Eine Senkung der anthropogenen Primäremissionen würde also unmittelbar zu einer wesentlichen Senkung der Hg-Einträge auf das Staatsgebiet führen.

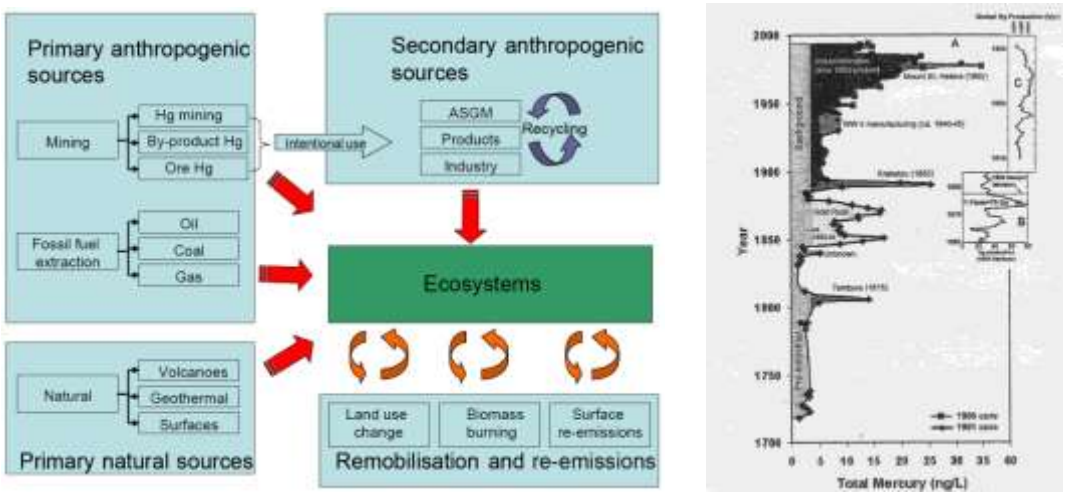

Abbildung 2: Links: Quellen der Quecksilbereinträge in die Umwelt (aus UNEP, 2008a). Rechts: Quecksilberkonzentration im Fremont-Gletschereis (Wyoming, USA, aus Schuster et al. 2002)

Global anthropogenic emissions to air in 2005 from different regions.

Continent	2005 emission, tonnes	% of 2005 emission	Low-end estimate	High-end estimate
Africa	95	5.0	55	140
Asia	1281	66.5	835	1760
Europe	150	7.8	90	310
North America	153	7.9	90	305
Oceania	39	2.0	25	50
Russia	74	3.9	45	130
South America	133	6.9	80	195
Total	1930	100	1220	2900

Abbildung 3: Anthropogene Primäremissionen in die Atmosphäre 2005 (UNEP 2008a)

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2 Exposition, Toxizität und ökonomischer Schaden

Humanexposition gegenüber Quecksilber

Die Hauptaufnahmequellen für Quecksilber sind Atemluft, Verzehr quecksilberhaltiger Nahrungsmittel (Fisch, Reis) und Dentalamalgam. Das Umweltbundesamt (1999) schätzte, dass in Deutschland bis 0,2 µg/ Tag über die Atemluft, bis 0,05 µg/Tag über Trinkwasser, etwa 3 µg/Tag über Nahrungsmittel (v.a. Fisch, besonders größere Meeres-Raubfische) und 3-12 µg/Tag über Amalgamfüllungen (v.a. durch Inhalation) aufgenommen wird. Die Quecksilberaufnahme kann höher sein bei überdurchschnittlichem Fisch-Genuss. Besonders gefährdet sind Ungeborene und Kleinkinder, die Quecksilber über ihre exponierten Mütter aufnehmen (Nabelschnur, Milch). Personen die quecksilberhaltige Bleichcremes benutzen, können kritische Quecksilbermengen auch über die Haut aufnehmen. Außerdem sind Personen zu betrachten, die Quecksilber am Arbeitsplatz aufnehmen: Chlor-Alkali-Industrie, Lampen- und Batterieherstellung, Zahnarztpraxen, industrieller Bergbau, kleinskaliger Goldbergbau.

Toxizität

Aus toxikologischer Sicht werden drei Formen unterschieden, in denen Quecksilber auftreten kann: elementar (gelöst oder gasförmig), ionisch (als Hg^{2+} gelöst) oder Methylquecksilber (v.a. gelöst). Methylquecksilber wird durch Bakterien aus anorganischem Quecksilber gebildet, ist fettlöslich und ist toxikologisch die kritischste Form.

<u>Methylquecksilber (WHO 1991; Mergler et al. 2007)</u>

Schädigung des Hirn- und Nervensystems:

- Veränderung neuropsychologischer und physiologischer Funktionen: Störung motorischer, psychomotorischer visueller und kognitiver Funktionen. Bei hoher Exposition: Minamata-Krankheit

Schädigung Ungeborener, Kleinkinder und Kinder:

- Ungeborene nehmen Quecksilber über die Plazenta der Mutter auf. Kleinkinder über die Muttermilch. Die Folgen sind u.a.: Dauerhafte Verlangsamung der geistigen Entwicklung (geringere Intelligenz), geringere Reflexe, Artikulationsstörungen, gestörte Bewegungskoordination (Ataxie)

Herzkreislauferkrankungen: koronare Herzerkrankung, Herzinfarkt, ischämische Herzerkrankung

Weitere, jedoch nur wenig untermauerte Effekte betreffen die Reproduktion (geringerer Jungenanteil bei Neugeborenen) und Einflüsse auf das Immunsystem

Elementares Quecksilber (UBA, 1999, 2009; WHO 2003, 2005)

Schädigung des zentralen Nervensystems

- u.s. Abgeschlagenheit, Konzentrationsschw che, Zurückgezogenheit (shyness)
- Defizite im Kurzzeitgedächtnis; Gewichtsverlust
- Tremor (zuerst an Fingern, Augenlidern und Lippen)
- Erethismus Übererregbarkeit, Depression
- Akrodynie

Schädigung des peripheren Nervensystems: Polyneuropathie, verlangsamte Nervenleitgeschwindigkeit, Parästhesie

Störung der Nierenfunktion: Proteinurie; Nephropathie

Mundhöhle: Gingivitis (erhöhter Speichelfluß)

2.1 Ökonomischer Schaden

Die durch die Exposition mit Quecksilber hervorgerufenen gesundheitlichen Schäden führen auch zu einer Schwächung nationaler Volkwirtschaften. Wird nur die verminderte Leistungsfähigkeit von Personen berücksichtigt, die aufgrund einer Exposition ihrer Mütter einen geringeren IQ haben, so kann der volkswirtschaftliche Schaden abgeschätzt werden. Hierbei wird angenommen, dass jeder verlorene IQ-Punkt eine bestimmte Minderung der ökonomischen Leistungsfähigkeit und damit expositionsverursachte Kosten bedeutet. Die Annahmen zum IQ/Kosten-Verhältnis schwanken, bewegen sich aber bei vielen Schätzungen um 12.000 USD je IQ-Punkt. Hochgerechnet auf die Weltvolkswirtschaft ergeben sich dann expositionsverursachte Kosten in Höhe von 3.7 Mrd. USD (Sundseth et al., 2010). Es liegen jedoch auch Schätzungen vor, die allein für die USA von wesentlich größeren Kosten ausgehen (8,7 Mrd. USD Trasande et al., 2005).

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Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH

Market analysis of some mercury-containing products and their mercury-free alternatives in selected regions

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The authors are responsible for the content of this report.

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1 Executive Summary

The goal of this project was to gather and analyze information related to the availability, suitability and cost of mercury-containing versus mercury-free mass products in developing countries (DCs) and countries with economies in transition (CiTs).

In order to have a broad picture of the global situation, two countries were selected to represent each of four UN regions (Tab. 1.1).

Tab. 1.1 Countries Involved in Surveys

Africa	Asia	Eastern Europe	Latin America
Kenya	China	Kyrgyzstan	Brazil
Senegal	India	Russia	Mexico

In each of these countries local non-governmental organizations (NGOs) carried out the survey in two or more selected major cities according to prepared questionnaires.

The study gives an overview about selected mercury-containing products and their mercury free alternatives in the above specified countries. The following widely-used consumer products were considered under this approach:

- thermometers and blood pressure meters used in hospitals and medical practices,
- thermometers for use in the home,
- skin-lightening products,
- common batteries and
- dental materials used for restoring teeth.

Information was gathered via interviews with local retailers, health care workers, professionals and consumers. Because of the rather limited number of interview partners per country (mostly between 10 and 25) the survey does not claim to give a representative picture of the individual countries. It should be understood as a first impression that allow for the identification of general challenges related to mercury-containing products.

Results were tallied and in addition, samples of batteries and skin-lightening products were collected for further analysis.

From the surveys, respondents offered a wide range of reactions regarding awareness about, and the availability of, products that traditionally – or continue to – contain mercury. In addition, the survey identified a wide variability among the countries in their efforts to address the production, sale, and use of those products. Dental and health care professionals, some of the most highly-educated individuals in any country, are well-respected by the public as a source of information on public health issues. In every country surveyed, they were extremely knowledgeable about mercury's toxicity and potential impacts on health. The survey found virtually total awareness and understanding among dental and medical professionals (90% - 100%) on mercury's toxicity with very little belief that mercury's threat was overstated. The only exception was one Asian country where all interviewed dentists know that mercury is toxic, but only slightly more than 50% were aware of the risks posed by it to human health and the environment. In most instances, the ability of dentists and doctors to speak about mercury issues was compromised by their use of mercury in their everyday practices.

Consumer knowledge about mercury often paralleled the strength of policies present for addressing its use. In countries where mercury content restrictions were placed on products and/or the government either certified mercury-free or required mercury-free, citizens and merchants showed often greater awareness about mercury's threat and the presence or absence of mercury in consumer products when making their choices for purchase.

Another segment of the population that regularly interacts with consumers, retail merchants, were only aware of mercury's presence or threat where the presence of either a regulation, government instituted seal or an implied mercury-free production credential was given to manufacturers of a of well-renowned product label. In these communities, the merchants were quick to claim mercury-free benefit and tout the benefits of a safe and healthy product.

While mercury-containing **thermometers** were still used more often, mercury-free thermometers were in wide use in hospitals and doctor offices in most countries surveyed. Especially in Asian countries mercury-free thermometers were in use in only about 25 – 30% of all visited hospitals and doctors' practices, in one country there was found no substitution at all. Ease of use, durability and safety issues were the greatest

attributes recognized for mercury-free thermometers. On the other hand, they were criticized for their high cost and lack of consistent and/or accurate readings. Health care professionals cited budget restrictions as the barrier to wider procurement and adoption for use in major hospitals. For lower-end mercury-free clinical thermometers health care professionals stated prices of mostly 3 – 5 times the price of cheap mercury-containing thermometers, but in some countries the prices given were 9 to 20 times higher for the mercury-free alternative. Purchases of low-cost items may have initiated backlash against their adoption. Availability also hampered wider adoption in some countries.

Also noted in a significant number of the responses was the vast number of mercury containing thermometers that were broken in the course of daily routines in hospitals. One survey indicated over 4,700 thermometers were broken in one year at a 250 bed hospital. Clean-up and management of broken mercury fever thermometers were also cited as a major issue in another country where these were still used.

Mercury-free thermometers for the home were readily available in 45 to 100% of the surveyed retail outlets, depending on the country. But cost was a major barrier to adoption here as well. Depending on the country, for the cheapest mercury-free thermometer, costs ranged from about twice to 5 times the price of a mercury-containing thermometer, for the more expensive offerings, price ranged up to 70 times the cost of the most expensive mercury-containing fever thermometers. Merchants were indicated to stock these items due to their high price knowing some would be purchased and give them greater profit. Even in areas where hospitals had problems getting mercury-free thermometers, merchants were able to stock these items on their shelves.

Mercury-free **blood pressure** meters were generally available in all countries (100%), but in one country it was stated that the alternatives are only stocked at few places. The major concerns raised about them related to accuracy. Least expensive offerings were similar in price or slightly more. In two countries, where mercury-containing meters had been banned for many years, no physicians cited cost or accuracy issues as a problem.

Mercury-free **batteries** (at least cylindrical batteries) were also available in all countries (100%). Most were either imported from countries restricting mercury use or from manufacturers in developed countries. No sign of increased price for mercury-free batteries was present in any country, but often only mercury-free (cylindrical or button)

batteries or batteries with mercury could be found in one country besides unlabeled batteries. In some countries selection and/or labelling was limited, but not for most. Regarding consumer awareness through product statements, only about 40% of all batteries made mention on the batteries or packaging that they were mercury-free, an additional 15% indicated they contained mercury. Overall, more cylindrical batteries (~ 60% of D-cell) had statements about mercury content than button (~ 25% of LR-44) batteries.

Mercury-free **skin-lightening products** were claimed by users and merchants to be present in every market and widely stocked in stores, pharmacies, and cosmetic clinics. Some concern was raised about the time it took to achieve results. Beside very few exceptions products had generally no claims as to mercury content. The surveyors were told in several countries, that illegal sales (black market products) exist, but in spite of local efforts, these products could not be widely procured. In one developing country one of the analyzed products had a very high mercury content (up to 0.5 wt%). Here, a mercury compound is obviously the main active agent. The presence of government seals and the implied manufacturer code of conduct for well-known products were reasons merchants claimed the products they offered were all mercury-free. Consumers gravitated to known mercury-free choices in countries that had government seals and/or regulation about mercury content. They also trusted retailers to provide them with accurate advice.

Mercury-free dental restorative materials were present in all markets (100%). Shortcomings mentioned included reduced durability and strength as well as high cost. In the countries selected for Eastern Europe, no **dental amalgam** has been used since a prohibition had been instituted. One surveyor indicated this ban had been in existence for 20 years or more. Tooth preparation was indicated as similar and many cited similarities in the equipment used. In some countries, increased costs were incurred from either additional training or additional equipment for placing alternative filling materials. In most cases, the actual alternative materials were indicated to incur greater cost than amalgam to the dentist, and therefore were passed along to the patient. The use of alternative materials was also indicated to improve aesthetics and increase patient safety from mercury exposure.

2 Introduction

2.1 Overview

Mercury is a heavy metal element that has unique physical, electrical and chemical properties which have lent themselves in many applications [1]. However, mercury has also been identified as a persistent, bio-accumulative toxic substance that has increased in the environment due to anthropogenic activities – mainly from industrialization [2]. Reducing the amounts of mercury from sources within our control has been identified as a necessary step for reducing the environmental burden [3]. Reducing purposeful uses helps eliminate direct exposures to mercury when 1) included as a component of consumer goods; 2) from spills during manufacturing, use or disposal; or 3) from other unintentional releases [4].

Once in the environment, mercury can be transformed to an organic form, methyl mercury, that bio-magnifies as it moves up the food chain in fish and wildlife, and eventually causes burdens of mercury in individuals thousands of times greater than background levels and potentially thousands of miles from the original source [5].

Developed countries like the member states of the European Union [6] have phased-out, or are in the process of phasing out, mercury use in many applications, including such common uses such as fever thermometers, sphygmomanometers, esophageal dilators, batteries, cosmetics, barometers, lamps, switches, relays, and medicines [4]. These efforts have been made to protect human and environmental health from excessive mercury exposure due to continuing uses, accidental releases or improper management. In addition to these phase outs, public education programs underway help ensure adequate understanding about these related issues and the need for action.

One of the most disturbing revelations to come out recently has been the finding of the manufacturing of mercury-containing goods may still be happening in many advanced nations for global distribution [7], [8]. The surveyors of this market analysis were told in several countries, that illegal sales (black market products) exist for some of these products in countries that have banned or restricted their use because of the belief that mercury-containing products are superior or their substitutes are vastly inferior.

Mercury-containing fever thermometers have been made from relatively inexpensive glass tubes housing a small reservoir of mercury. This mercury expands at a known rate due to its physical relationship to temperature. Placing a scale on the glass tube allows for measurement of this expansion. Gas, liquid or other materials that come in sufficient contact with the glass impart their temperature on the mercury and allow for their temperature to be measured. Mercury contracts as the thermometer cools, but not necessarily uniformly. This often requires the user to shake the thermometer to re-pool the mercury into the lower end to get a proper reading. Environmental releases occur when a health care provider or home user break the thermometer and/or improperly dispose of the mercury contained within. Patients have been known to bite the thermometers to the point of breakage, but the most frequent releases occur when mishandling the glass thermometer results in breakage.

Sphygmomanometers measure blood pressure by using air pressure to displace a column of mercury. Once pressure is created by pumping up a tourniquet cuff wrapped around a patient's extremity, the blood pressure is then read through a scale placed on the mercury column. Systolic and diastolic pressures are identified by a health professional monitoring the patients pulse through a stethoscope as pressure in the tourniquet is released. Maintenance and calibration is required due to the loss of mercury from the reservoir due to its connection to the ambient air. Environmental releases occur during maintenance and use since the device has direct exposure to open air. Larger amounts are released after breakage and/or disposal of these items. Aneroid (mercury-free) sphygmomanometers eliminate the mercury column and work directly with the air pressure to develop a reading. The pressure is then read through an analogue or digital readout.

Dental amalgam is made of approximately 50% silver with small amounts of copper and tin mixed with 50% mercury. Amalgam is a durable, malleable material with antimicrobial properties. For over a century, these properties have lent themselves to use in dental restorations where tooth decay has only partially affected the tooth. Low levels of mercury are released throughout the lifetime of the amalgam exposing their owner. Environmental mercury releases can occur both when amalgam materials are first placed and/or when they are removed. In addition, with increases in dental care and the growing use of cremation for dealing with loved ones after their death, large amounts of mercury from amalgam restorations now get volatilized directly to the at-

mosphere. New, less toxic, durable, cosmetically-preferable materials have been developed and are now available almost everywhere.

Manufacturers of facial creams and soaps use mercury as a melanin inhibiting agent to even and/or lighten skin tone by reducing pigmentation and darkening. Mercury or hydroquinone will initially cause the skin to lighten by inhibiting production of melanin. Without melanin formation, no brown pigmentation will be visible. This produces the much-vaunted "instant lightening" results. However, the long-term effects of mercury are problematic. Mercury has been known to cause blotchiness, uneven skin tone, easily sunburned skin, peeling skin, increased hyper-pigmentation, thickened skin, large pores, itchiness, redness, dark patches, light pink patches, and signs of premature aging such as lines and wrinkles [9]. Dermal application of mercury can absorb into the bloodstream leading to health problems for the individual and for offspring born to women of childbearing years who use these. Additional environmental releases may occur when the creams get washed or wiped off. Alternative active ingredients result in the same results without the use of mercury. These mercury-free products have been used successfully in many countries where the residents seek to lighten or even skin tones.

In any battery, an electrochemical reaction occurs that moves electrons from one pole to the other. The actual metals and electrolytes used control the voltage of the battery - each different reaction has a characteristic voltage. Mercury, because of its chemical and electrical properties, has been widely used in batteries, especially as an agent to inhibit gas production and corrosion. Environmental mercury releases can occur after breakdown when disposed of in landfills or, if incinerated, can be released immediately to the air. Mercury-free alternatives have been available for many years, but batteries using mercury technology are still in production in many areas around the world, especially “button-cell” varieties.

2.2 Goal of the present study

Under the roof of the United Nations Environmental Programme (UNEP) governments agreed in 2003 to protect human health and the environment through measures that will reduce or eliminate releases of mercury and its compounds to the environment [10]. In order to improve numerous voluntary efforts by governments, organisations, industry and other stakeholders to achieve this goal the 25. Governing Council agreed in

2009 to further international action consisting of the elaboration of a legally binding instrument on mercury [11]. Negotiations are scheduled to start in June 2010.

One important challenge of the global mercury problem is the use of mercury in products. While efforts are quite advanced in many developed countries to phase-out mercury-containing products and to replace them by non-hazardous alternatives, information on the level of substitution in developing countries and countries with economies in transition is still fragmentary. Understanding their needs and possible obstacles to substitution would greatly facilitate upcoming discussions on how to further develop the global mercury policy.

The goal of the present study was therefore to gather information on certain mercury containing products from selected developing countries and countries with economies in transition from four UN regions. This should include consumer awareness, availability and affordability of mercury-free products and experience of consumers and professionals with both mercury containing and mercury free alternatives.

2.3 Methodology

In order to compile and compare data across geographic areas, Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH developed a survey document and method tables to ensure a more uniform approach for obtaining the desired information at each location. Data was compiled by Headwater Consulting, based in Madison, WI, USA.

Urban locations, made up of communities in eight countries (two each in four UN regions) were selected to participate in the study. Arnika Association[1] was identified by GRS as a contractor to identify parties in these communities to make the assessment. The survey was undertaken in 8 countries. For the UN-Regions "Africa", "Asia-Pacific", "Eastern Europe" (plus one Asian member of the CIS (Commonwealth of Independent States; nine (9) former Soviet Union republics) and "GRULAC – Group of Latin America and Caribbean Countries" two developing countries or countries in transition within the region were choosen as examples. GRS proposed a list of countries in which these surveys might be carried out. The final selection of the countries was done in coordination with GRS, IPEN, and Arnika.

[1] Arnika Association http://english.arnika.org/

The survey was conducted by Arnika and its partner organizations. In it, information on prices, availability and applicability would be gathered from practitioners in the health care and dental sectors, as well as at the 'street' level by interviewing local merchants, shop owners, and consumers (see Tab. 2.1)[2]. Because of the rather limited number of interview partners per country (mostly between 10 and 25) the survey does not claim to give a representative picture of the individual countries. It should be understood as a first impression that allow for the identification of general challenges related to mercury-containing products.

GRS provided the accompanying document (APPENDIX A Survey Documents) for carrying out the survey and prepared questionnaires in English specific to each product group. In this form, a method of inquiry was developed to inquire about cost, availability and efficacy of both mercury-containing and mercury-free products. Doctors and clinicians answered a series of questions about their use and preference for mercury and non-mercury thermometers and sphygmomanometers (blood pressure devices). Dentists were queried about mercury-containing amalgam and non-mercury alternative dental restorations for caries (a partially decayed tooth or cavity). Consumers and retailers were questioned about their purchasing habits and related experiences for skin-lightening products (soaps and creams). For home use of fever thermometers and household batteries, the survey focused on obtaining availability and prices for the mercury-containing and the mercury-free alternative.

Consumers surveyed for their cosmetic use were broken down into categories suggested by GRS. These groups included the profession of the interviewed persons. From the total number of persons interviewed, the respondents were broken down into 1) academics (including artists, monks and other persons with “brain power”), 2) craftsmen and women, 3) sellers or merchants, 4) housewives and 5) day-labourers. This was not an exhaustive list, but was meant to represent the likely respondent categories. Some of the interviewers included other sub-categories in their responses.

[2] Questionnaires that were used in the survey may be found in Appendix A

Tab. 2.1 Respondents Included During Investigations

Product	Consumers	Merchants	Doctors	Dentists
Thermometers (clinical)			X	
Sphygmomanometers (blood pressure cuff)			X	
Dental restorations				X
Batteries		X		
Skin-lightening cosmetics (creams and soaps)	X	X		
Thermometers (household)		X		

All research was done in prices reflective of the local economy. Exchange rates for Euros (€) and US dollars (US$) can help equate the prices to a common currency (see Tab. 2.2). However, it should be noted that purchasing power of the local currency should be considered in these comparisons since the relative value should allow for a better comparison than direct conversion.

Tab. 2.2 NGO Participants and Local Currency Exchange Rate

UN Region	Country	Local NGO Participant	Community	Local Monetary System	Exchange[3] per 1 US$ and1 EUR
ASIA PACIFIC	China	Global Village of Beijing	Beijing, Tianjin, Fenyang, Kunming	Yuan (CNY)	6.82450 *9.06582*
	India	Toxics Link	Delhi NCR/Delhi, Noida	Rupee (INR)	49.65300 *65.90765*
AFRICA	Kenya	iLima Organization	Nairobi	Kenya Shilling (KES)	79.800 *105.9987*
	Senegal	Pesticide Action Network – Africa	Dakar, Thies	African Franc (XOF)	490.340 *655.957*
EASTERN EUROPE	Kyrgyzstan	Independent Ecological Expertise	Bishkek, Issyk-Ata, Chui Region	Som (KGS)	43.21090 *57.16456*
	Russia	Eco-Accord Program on Chemical Safety	Volgograd, Moscow, Novorossiysk	Ruble (RUB)	33.32790 *44.30786*
LATIN AMERICA	Brazil	APROMAC – Environment Protection Association	Curitiba City	Real (BRL)	2.16650 *2.88681*
	Mexico	CAATA	Mexico City, Chihuahua, Coatzacoalcos, Iguala, Texcoco	Mexican Peso (MXN)	13.11340 *17.37447*

There are many ways to measure the size and performance of an economy. The concept of Purchasing Power Parity (PPP) can help ensure an accurate comparison. The basis for PPP is the "law of one price". In the absence of transportation and other transaction costs, competitive markets will equalize the price of an identical good in two

[3] Conversion rates were determined on April 14, 2009 from the website http://www.oanda.com/convert/classic, website last visited April 14, 2009

countries when the prices are expressed in the same currency [12]. Fig. 2.1 shows the relative PPP throughout the world, Tab. 2.3 shows the PPP in relation to the Gross Domestic Product (GDP). The GDP is the value of all final goods and services produced within a nation in a given year. The relation of PPP to GDP demonstrates the ability of individuals to afford the goods in question in the countries surveyed.

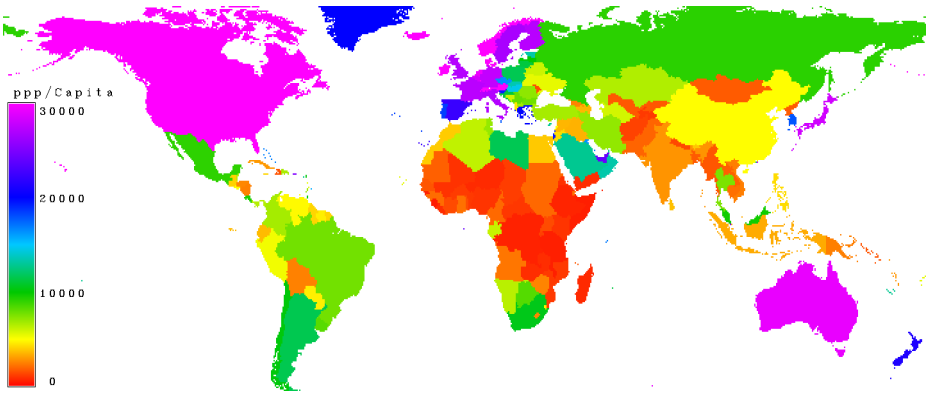

Fig. 2.1 Purchasing Power Parity (PPP). Countries with a low purchasing power parity are marked in red, moderate is in green, high values in blue and very high in magenta. Figure from Kindermann et al. (2006) [13]

In order to assess the presence of mercury in consumer goods, lab analysis for mercury in skin-lightening facial creams and soaps was undertaken at the GRS laboratory in Germany (APPENDIX B). On batteries (button and cylinder types) GRS gathered information on the mercury content from internet and other publically available sources. Randomly selected products were purchased and then sent in for further investigation.

The following report is based on the eight summaries provided by the local non-governmental organizations through AA and reflects the information collected. Data from the research has been compiled for GRS by Headwater Consulting (HC) of Madison, Wisconsin, USA into a common document including tables and illustrations (Chapters 3 to 7). The report includes a brief summary of the significant results from each country in addition to a summary of the results of the products from all countries.

Tab. 2.3 Comparative Gross Domestic product PPP

Country	GDP PPP (US$) [14]	Population (millions) [15]	Per Capita PPP (US$)
European Union	$ 14,960,000,000,000	491,582,852	$ 30342.31
United States	$ 14,580,000,000,000	307,212,123	$ 47459.06
China	$ 7,800,000,000,000	1,338,612,968	$ 5826.93
India	$ 3,319,000,000,000	1,166,079,217	$ 2846.29
Germany	$ 2,863,000,000,000	82,329,758	$ 34774.79
Russia	$ 2,225,000,000,000	140,041,247	$ 15888.18
Brazil	$ 2,030,000,000,000	198,739,269	$ 10214.39
Mexico	$ 1,578,000,000,000	111,211,789	$ 14189.14
Kenya	$ 66,480,000,000	39,002,772	$ 1704.49
Senegal	$ 22,980,000,000	13,711,597	$ 1675.95
Kyrgyzstan	$ 11,660,000,000	5,431,747	$ 2146.64

In addition, equivalent information was gathered in one German city, Braunschweig as an example for the fifth UN-Region (WEOG).

3 Africa

3.1 Kenya, Nairobi

Nairobi is the most populous city in East Africa, with an estimated urban population of between 3 and 4 million. According to the 1999 Census, in the administrative area of Nairobi, 2,143,254 inhabitants lived within 684 km^2 (264 sq mi). Nairobi is currently the 4th largest city in Africa. Kenya's Gross Domestic Product Personal Purchasing Parity GDP PPP economy was estimated in 2001 at US$ 66.48 billion, with a calculated per capita PPP income of US$ 1,704.49 [14].

The official currency of Kenya is the Kenya shilling (code: KES, sign: KSh). As of April 14, 2009, the exchange rate was 79.800 KES to 1 US$ or 105.9987 KES to 1 Euro[4].

3.1.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Nairobi, Kenya

3.1.1.1 Kenyan Clinical Thermometer Survey

Participants. The Clinical Thermometer Survey was undertaken in seven (7) hospitals/doctors' practices in Nairobi, Kenya. Interviews were held at public and private hospitals located in Nairobi, Kenya.

Health care professionals indicated mercury-free thermometers are in-use at most offices. Most hospitals and doctors' practices used only mercury-free clinical thermometers; one (1) hospital/doctor's practice used both; and three (3) hospitals/ doctors' practices use mercury-free clinical thermometers exclusively. Adoption of mercury-free thermometers has not yet replaced mercury thermometers.

Health care professionals stated mercury-free thermometers are widely and readily available. Almost all doctors (86%) indicated mercury free clinical thermometers

[4] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

were readily available. The remaining response (1) indicated no knowledge of mercury-free thermometer existence, so availability could not be assessed.

Health care professionals stated mercury-free thermometers were more expensive but not unaffordable. The cost for a mercury-containing clinical thermometer ranged from KES 30 to KES 100 (avg. KES 65). The cost for a mercury-free clinical thermometer was indicated to be more expensive. Actual prices were not specified, but were expected to be similar in range to consumer prices (KES 300 – KES 600).

Health care workers preferred mercury-free thermometers. According to those interviewed preferring mercury-free clinical thermometers, with proper care and good battery maintenance mercury-free thermometers gave reliable results and were safer and easier to work with. Some stated that eliminating the need to shake the thermometer was beneficial in preventing breakage.

3.1.1.2 Kenyan Household Thermometer Survey

Participants. Ten (10) retail outlets in Nairobi, Kenya participated in the Consumer Thermometer Survey regarding thermometer availability.

Mercury free thermometers were widely available. All outlets (100%) offered and stocked both mercury-free and mercury-containing thermometers for consumer purchase.

Mercury-free thermometers were significantly more expensive. Price was a major influence with the least expensive digital non-mercury option (KES 300) running five times the price of the most expensive mercury-containing thermometer (KES 60) (see Tab. 3.1).

Tab. 3.1 Kenyan Home Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price KES	40	60	300	600

3.1.2 Current status regarding availability and use of mercury-containing measuring devices in the health-care sector in Nairobi, Kenya

3.1.2.1 Kenyan Clinical Sphygmomanometer Survey

Participants. Surveys were taken in seven (7) hospitals in Nairobi, Kenya.

Health care operations have not experienced wide adoption of mercury-free devices. Most hospitals used mercury-containing blood pressure meters (86%); one (1) hospital used both; while one hospital used just mercury-free sphygmomanometers (aneroid).

Mercury-free devices are readily available. According to all doctors queried, mercury-free aneroid alternatives were readily available for purchase (100%).

Mercury-free sphygmomanometers were affordable, and only slightly more expensive than mercury-containing units. The cost for aneroid meters ranged from KES 500 to KES 1,000 (avg. KES 750). The cost for mercury-containing blood pressure meters were indicated to be less than those paid for aneroid units, but no price was stated.

Reviews on preferences were mixed. At the hospital with both aneroid and mercury devices, the doctor said the mercury-free meters were both easy and safe to use and were readily available and not prone to break-down. The hospital using only mercury-free aneroid devices indicated they were easy to use, convenient, reliable and safe. Doubts, however, were voiced regarding the reliability of their readings.

No additional costs or time were incurred to train staff. As far as the need for additional training for using aneroid units, one hospital indicated the mercury-free blood pressure units required no additional training for their staff.

3.1.3 Status of availability and use of most common types of mercury-containing batteries on the market in Nairobi, Kenya

Availability of battery options in the Nairobi, Kenya markets was poor. Very few offerings were available to the consumer with most offerings (93%) being imported, many of these from Asia, with a few from EU nations.

No information was available at point-of-sale to inform the consumer about their choices in batteries. Information regarding battery mercury content was not readily available through either manufacturer supplied information or the internet. Six D-cell (6) batteries were purchased for the survey. None of the offerings (0%) had any labelling available. Internet research found little more information with two products (33%) having information – one indicated as mercury-free, the other mercury-containing. Most offerings were major international battery manufacturers including Eveready, Duracell, and Sony and imported to Kenya for sale.

Button cell batteries were poorly marked regarding mercury content. Only three (3) brands for the button cells of the type LR44 were found in the shops. Button batteries were just as poor at point-of-sale, but the internet was more helpful. Two (66%) of the battery offerings were found to contain mercury. Batteries were indicated to be imported from China and Switzerland.

A relationship in battery cost to production could be found. The only relationship among D-cell offerings found was cost. One of the lower-priced options was the only domestically-produced battery, while imports demanded higher prices.

3.1.4 Status of the availability and use of mercury-containing skin-lightening products in Nairobi, Kenya

Participants. The Consumer Cosmetic Survey was held in Nairobi, Kenya at ten (10) outlets with the shopkeepers and twenty-four (24) interviews with consumers. From the total number of persons interviewed were fourteen (14) academics (including college

graduates, artists, monks and other persons with “brain power”), four (4) craftsmen, five (5) merchants, and one (1) housekeeper.

3.1.4.1 Kenyan Consumer Cosmetic Survey

Consumers knew that some skin lightening products contain mercury. From the survey, it was noted that all fourteen (14) academics (100%) and five (5) merchants (100%) recognized the potential for mercury in products while none (0%) of the other five (5) that included craftsmen (4) and housewives (1) recognized this. Overall, 79% of the users surveyed recognized mercury could be present in these products (see Tab. 3.2).

Consumers are aware that mercury is a toxic substance. Overall, 96% of those surveyed were aware mercury was toxic. Only one (1) of the surveyed persons (a housewife) failed to indicate she understood that mercury was toxic. All (100%) of the academics, merchants and craftsmen were aware of this.

Consumers knew that mercury-free skin lightening products were available in town/region. Of the consumers surveyed, the numbers mirrored awareness of the potential for mercury in skin-lightening products (all academics (14) and merchants (5) knew, while none of the craftsmen (4) or housewives (1) did. Overall, 79% of the users (all of the academics and merchants, but not craftsmen and housewives) understood the situation with regards to availability of mercury-free products.

Consumers indicated mercury free skin-lightening products were readily available. Of the consumers who knew about mercury-free skin lightening products, all (100%) stated that mercury-free skin-lightening products were readily available in most widely-frequented stores such as supermarkets and cosmetic shops – and at most of their locations around the city.

Mercury free skin-lightening products were widely preferred by users as safe, effective and legal. Those who deliberately decided to use a skin-lightening product without mercury (80%), did so because they find them readily available and safe, were aware of the national ban and had concerns with health (that mercury exposure has health implications), and because it does not react with their skin.

Academics and merchants overwhelmingly (100%) cited mercury exposure side-effects and health implications as their reasons for using mercury-free products. Consumer awareness was not universal with some segments showing little awareness (craftsmen and housewives).

Mercury-free products were affordable. Only one response from the merchants or consumers indicated cost as a concern when purchasing skin-lightening products.

Less than 20% of the products had any ingredients listed, and 10% were defined as poorly declared. But, a government seal indicating mercury-free was present on many products. It must be noted the Kenya Bureau of Standards allows their seal to be placed on those products that were certified mercury-free (as provided for in the policy language of Kenya's national ban).

Tab. 3.2 Kenya Consumer Cosmetic Survey Responses

Inquiry	Responses	Occupation			
	"yes" / *"no"*	*Academic (14)*	*Craftsmen (4)*	*Sellers (5)*	*Housekeeper (1)*
1) Consumers know that some skin lightening soaps contain mercury	19	14	0	5	0
	5	0	4	0	1
2) Consumers are aware that mercury is a toxic substance	23	14	4	5	0
	1	0	0	0	1
3) Consumers knowing that mercury-free skin lightening products are available in town/region	19	14	0	5	0
	5	0	4	0	1
a.) If "YES" to 3): Consumers use a mercury-free skin lightening product	19	14	0	5	0
	0	0	0	0	0
b.) If "YES" to 3):Consumers deliberately decide to use a product without mercury	19	14	0	5	0
	0	0	0	0	0

3.1.4.2 Kenyan Merchant Cosmetic Survey

Availability. In the shops of Nairobi, Kenya where the ten (10) merchants worked, more than twelve (12) products were found.

Most merchants believed they sold only mercury-free products. A clear majority of merchants (70%) stated they sold only mercury-free skin lightening products. Statement originated from the belief that mercury has been banned from such products by the Kenya Bureau of Standards. Three merchants indicated uncertainty of product content.

With most of the mercury-free creams, the information regarding mercury content was based on a product statement or Kenya Bureau of Standards seal that indicated "no mercury." In some shops the merchants were aware that mercury-containing creams were banned nationally, implying that all products legally sold in their stores must be mercury-free. Yet, to satisfy customer demand, merchants indicated mercury-containing products were stocked, when possible. Therefore about half of the sellers stated, that mercury containing products are more difficult to get.

Like consumers, merchants were aware of mercury's toxicity. Most merchants (90%) indicated awareness about mercury's toxicity in creams.

Customers indicated duration of results from products varied. According to some merchants, customers' experiences indicated there was no difference between results from mercury-containing and mercury-free creams on duration of the results. The rest could not say if customers indicated a difference. On time-to-results, half of merchants (50%) said that mercury containing skin lightening products are still used because faster results were obtained.

Demand for mercury-containing products continues. Continuing demand for mercury-containing face creams force some shops to continue stocking the banned creams and sell them illegally to these regular consumers. Some consumers said that mercury containing products were often found in backstreet shops and sold illegally – mainly to recognized customers. Most merchants stated mercury-containing soaps were more difficult to get because of the ban. One third of the merchants said mercury-containing products were still used because customers indicated they got faster results.

Analysis of the purchased products (only those without a government seal were purchased) found two (16%) contained mercury, but below 0.07 ppm. It is presumed, that mercury at these concentrations would be due to ingredient contamination rather than purposeful addition as an active ingredient (Tab. B.1). One product that merchants reported to be mecury containg was indeed mercury free (probably due to a changed formula).

Sources of the products were generally other African nations, but included domestic products and imports from England and Germany. Products manufactured in Dubai and Kenya contained mercury. Prices ranged from 0.40 KES to 6.78 KES, no relationship was seen with price or other attributes.

3.1.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restorations in Nairobi, Kenya

Participants. The Amalgam Survey was done with six (6) dentistries in Nairobi, Kenya.

Dentists indicated materials for mercury-free tooth restorations were readily available. All dentists (100%) used mercury amalgam as a tooth filling, most (83%) use both, and none (0%) used alternatives exclusively.

Dentists indicated alternative materials were affordable to their patients. According to the dentists, dental restorations were affordable to most – ranging from the average patient to all patients. According to the survey, the average patient could afford restorations.

Dentists indicated their patients requested alternative materials. All dentists interviewed (100%) said their patients requested alternative filling materials. At the hospital where patients could only get amalgam, dentists justified it as more permanent and indicated patient preference for long-lasting restorations.

Many types of alternative materials were available and in demand. Of the dentists interviewed, the five (5) using alternatives listed composite materials, temporary materials, zinc engenol, zinc phosphate, and glass ionomer (fujir,vitmor) as those alternatives in use. The main materials used by dentists who use both mercury amalgam and non-amalgam were composites and temporary fillings (zinc oxide engemol).

The costs for the amalgam option is not low compared to the cost for mercury-free materials. According to the patients, composite fillings were both, more and less expensive than mercury amalgam fillings.

Dentists indicated material costs did influence their price to patients. Dentists indicated a difference in material costs of about KES 1,400 for the mercury-free alternatives. According to the dentists, the cost of alternative filling range from KES 2,500 to KES 6,000. The price difference for the patient choosing an amalgam filling compared to an alternative filling was 1,000 KES less than the price for the alternative filling.

Costs incurred for training and equipment to place alternative materials did not affect dental charges. Dentists interviewed indicated no special training was called and that no special equipments are needed.

Dentists were aware of the problems posed by mercury use. All dentists (100%) were aware of risks posed by mercury to human health and the environment, none thought mercury was not as dangerous as stated/spoken about.

3.2 Senegal, Dakar and Thies

Dakar is the capital of Senegal, located on Africa's Atlantic coast and the Cape Verde Peninsula. It is Senegal's largest city with a population of 1,030,594 in Dakar proper (2005), whereas the population of the Dakar metropolitan area, including Thies, is estimated at 2.45 million people (2005). Thies is to the east and has a population of about 250,000. The PPP GDP of the country is US$ 22.98 billion (2001 estimate) giving a per capita income of US$ 1,675.95 [14].

The national currency is the Communaute Financiere Africaine franc (code: XOF, sign FCFA); since Jan 1, 1999, has had a fixed exchange rate to the Euro: 100 FCFA Francs = 1 French (nouveau) Franc = 0.00152449 Euro; or 1 Euro = 655.957 CFA Francs.

3.2.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Dakar and Thies, Senegal

3.2.1.1 Senegalese Clinical Thermometer Survey

Participants. The Clinical Thermometer Use Survey was done in ten (10) hospitals and four (4) doctors' practices in Dakar and Thies, Senegal.

Health care professionals used mercury-free thermometers in many settings. All hospitals and doctors' practices used mercury-containing clinical thermometers; almost all (93%) had mercury-free thermometers in use as well.

Health care professionals indicated mercury-free thermometer availability and cost were barriers to adoption. Of surveyed doctors, almost four of five (78.5%) said availability of mercury-free thermometers in Senegal is a problem. Meanwhile, mercury-containing thermometers are readily available and widely used in all pharmacies and hospitals. The alternatives are rarely stocked or used because of their relatively high cost compared to the mercury containing ones. Costs for clinical thermometer according to the staff ranges from 500 to 1,200 XOF, averaged 850 XOF for mercury-containing thermometers and from 1,000 to 7,000 XOF, averaged 4,000 XOF for mercury-free thermometers.

Health care professionals preferred working with the mercury-free alternative. They cited the quick results, the indicator signal, and safety issues as their major reasons for their preference. Many commented on safety, citing mercury thermometers relative potential for breakage, the high numbers that did break, and the dangers this posed to patients. According to the staff, mercury-free clinical thermometers give faster results (30 seconds compared to about ten minutes for the mercury-containing thermometers to reach an end point) this allowed them to consult more patients. Those who preferred working with mercury-containing thermometers also indicated they trusted them to give more reliable results.

Some staff faulted mercury-free thermometer reliability. Staff faulted mercury-free thermometers because of 1) high sensitivity and 2) false results (i.e. older people with high blood pressure). Sensitivity was felt to influence the result. Also cited was the mercury-free thermometers' need for batteries, which can become discharged and lead to false readings.

3.2.1.2 Senegalese Household Thermometer Survey

Participants. The Consumer Thermometer Survey was done with twelve (12) pharmacies and two (2) medical equipment shops. Medical equipment shops sell only medical supplies. (Noted from surveyor, in Senegal medical supplies are generally sold only at pharmacies and medical shops and not at other retail outlets).

Mercury-free thermometers were widely available in stores. Most pharmacies and medical shops (57%) sold both mercury-containing thermometers and mercury-free thermometers; the rest sold only mercury-containing thermometers.

Mercury-free thermometers were relatively affordable to consumers. Prices differences between these products were much less than those indicated by other countries. The least expensive mercury-free thermometer was twice the price of the cheapest mercury-containing thermometer which lies below the average for a mercury-containing thermometer (see Tab. 3.3).

Tab. 3.3 Senegalese Home Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price XOF	500 XOF	3,537 XOF	1,000 XOF	5,000 XOF

3.2.2 Current status regarding availability and use of mercury-containing measuring devices in the health-care sector in Dakar and Thies, Senegal

3.2.2.1 Senegalese Clinical Sphygmomanometer Survey

Participants. The Clinical Sphygmomanometer Survey was done in ten (10) hospitals and four (4) doctors' practices in Dakar and Thies, Senegal.

Health care professionals indicated mercury-free blood pressure meters were in use at all hospitals and doctors' offices surveyed. All hospitals and doctors' practices (100%) used both mercury-containing and mercury-free (aneroid) blood pressure measuring devices. None of the surveyed hospitals and doctors' practices (0%) used mercury-free blood pressure meters exclusively. Availability was raised as the major issue when seeking mercury-free (aneroid) meters by all doctors and nurses surveyed. They stated only a few places in Senegal stock them.

Doctors and nurses preferred working with mercury-free blood pressure devices. Of interviewed doctors and nurses, 57% preferred working with aneroid devices because they gave faster results and the mercury-containing ones posed safety con-

cerns. Those preferring to work with the mercury-containing device said so because of perceived improvements in reliability.

Training costs have not added to the cost of adoption. Additional training for staff has not been necessary. “The usage is very easy” said those doctors and nurses interviewed.

Cost for mercury-free devices is comparable to mercury-containing ones. The costs for a mercury-containing blood pressure meter range from 50,000 XOF to 55,000 XOF the mean value is 52,500 XOF. The cost for a mercury-free blood pressure meter range from 42,500 XOF to 75,000 XOF, the mean value is 58,750 XOF. The prices varied with brand name. According to the interviewed medical personal, blood pressure meters can sometimes be found on the black market at a lower price (about 20,000 XOF for containing mercury and 25,000 XOF for the mercury-free ones).

3.2.3 Status of availability and use of most common types of mercury-containing batteries on the market in Dakar and Thies, Senegal

Availability problems in acquiring D-cell and button batteries were not found.

D-cell batteries labelling on the market was adequate to inform most consumers about their purchasing habits. Of the fourteen (14) products selected, almost two thirds (64%) were indicated on the package or the battery to contain no mercury, about one fourth (29%) had no indication, and one was indicated to contain mercury. Internet review of the remaining products found additional information on one of them (mercury-free). Interestingly, Senegal had the most off-brands (non-recognized brands) listed of any country. Only one brand was produced domestically. The majority of others were indicated to be imported from Asia (80%), with the major segment of all D-cell batteries coming from China (65%).

Price was relatively consistent with a few offerings costing much more than others, but the offerings lacking any statement were the least expensive of the (D cells) products. Costs ranged from 200 XOF to 1,000 XOF per battery. No relationship was seen to country for import or brand.

Mercury-free button cell options (LR44) were not as simple to identify as D-cell batteries. Unfortunately only one of the button cells sent to GRS was of the size requested. This indicated that many varieties and likely sources of button cells were available. Therefore, a button cell battery analysis was unavailable due to low response in the survey.

3.2.4 Status of the availability and use of mercury-containing skin-lightening products in Dakar and Thies, Senegal

Participants. The Cosmetic Survey was done in twenty-one (21) retail outlets, and with twenty-seven (27) persons in Dakar and Thies, Senegal who use skin lightening products. Among the users were four (4) academics (including college graduates, artists, monks and other persons with "brain power"), two (2) craftswomen, two (2) merchants, four (4) labourers, and fifteen (15) farmers (see Tab. 3.4).

3.2.4.1 Senegalese Consumer Cosmetic Survey

Lack of knowledge about availability, cost, and preference with regard to mercury in skin-lightening products was extremely prevalent. All participants were unaware of the potential for mercury to be in skin-lightening products (100%). Almost all participants were unaware mercury is toxic (96%) or even understand about mercury. All participants were unaware that mercury-free alternatives were available (100%). Participants were unaware of any cost difference between skin-lightening products due to their mercury content (100%).

Labelling Information about active ingredients for the various soaps and creams were listed on all soaps, with a minor exception.

3.2.4.2 Senegalese Merchant Cosmetic Survey

Availability. In the eighteen (18) shops surveyed in Dakar and Thies, Senegal, fifteen (15) products were identified for inclusion in the survey.

Participants. In addition to the two (2) merchants who took part in the consumer survey, eighteen (18) merchants who do not use skin lightening soaps themselves were

interviewed bringing the total to twenty (20). Interestingly, while only women used skin lightening products, most of the merchants were men. Soaps are purchased more frequently due to cost-related issues.

Tab. 3.4 Senegalese Consumer Cosmetic Survey Responses

Response		**Occupation**				
Inquiry	***"yes"*** / ***"no"***	***Academics (4)***	***Crafts-women (2)***	***Merchants (2)***	***Farmers (15)***	***Labourers (4)***
1) Consumers know that some skin lightening soaps contain mercury	0	0	0	0	0	0
	27	4	2	2	15	4
2) Consumers are aware that mercury is a toxic substance	1	1	0	0	0	0
	26	3	2	2	15	4
3) Consumers knowing that mercury-free skin lightening products are available in town/region	0	0	0	0	0	0
	27	4	2	2	15	4
a) If "YES" to 3): consumers using a mercury-free skin lightening product	0	0	0	0	0	0
b) If "YES" to 3): Did you deliberately decide to use a product without mercury?	0	0	0	0	0	0

Merchants could not provide consumers with information about mercury. All the surveyed sellers (100%) said that they do not know what mercury is. And they could not confirm if skin-lightening soaps contain mercury or not.

Price and perceived performance were the two driving factors concerning product choice. Consumers' only concerns regarding procuring skin-lightening products were result and price differences.

Products were analyzed for mercury content and other relationships. In all of the fifteen products surveyed, mercury analysis was undertaken. None (0%) of the products tested were found to contain even trace amounts of mercury. The majority of the products were imported, coming from either the Ivory Coast or France (Tab. B.2). None (0%) of the products offered a statement to indicate mercury content.

Prices ranged from 0.15 XOF to 33.33 XOF per gram of product. Of those products, the French imports demanded the highest prices, from five to ten times more than those coming from other African countries. The one USA import also carried a high price tag.

Active ingredients did not show any relationship to price. Labels for products offered were well-defined and included more than just active ingredients and listed most product ingredients. One active ingredient listed frequently in products in Senegal is hydroquinone. Many of the products offered strictly cosmetic solutions related to sunscreens and were prevalent in many higher-priced offerings.

3.2.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restorations in Dakar and Thies, Senegal

Participants. The Dental Survey was done with fourteen (14) dentistries. The survey was done in two types of dentistries: eight (8) public dentistries (which belong to Senegalese state) and six (6) private dentistries.

Alternative restorative materials have been widely adopted in dental practices. None of the dentists used only amalgam as a restorative material (0%); most used both amalgam and non-mercury materials; and some dentists used only non-mercury materials.

For dental materials, public dental offices offer a lower-cost service while private dentists cater to the more affluent. According to public health dentists, all people can afford a non-mercury tooth restoration at public dentistries. But, according to most private dentistries, only those earning an average income or better can afford a non-amalgam filling at a private dentistry.

Some of the patients requested mercury-free fillings. All of the dentistries stated that some (likely 5 – 20%) of their patients ask for mercury-free fillings.

A wide variety of alternative materials and prices were offered at dental offices. Of the dentists interviewed, five (5) used composite materials only; four (4) used composite and silver fillings (made up of silver and zinc); five (5) used composite and glass ionomer as an alternative filling material. The main alternative filling type/filling material used by dentists who use both, mercury-containing and mercury-free fillings is composite.

Prices to patients for either material were somewhat comparable, but alternatives cost more. The price difference for patients at public dentistries goes between 5,000 XOF to 20,000 XOF for mercury-free alternatives and 3,000 XOF to 10,000 XOF for mercury amalgam. This range overlap fails to indicate that in all offices, amalgam was less expensive than a mercury-free alternative. The price difference for patients at private dentistries goes from 12,500 XOF to 60,000 XOF for non-mercury restorations; and from 3,000 XOF to 10,000 XOF for mercury amalgam.

Training for placing alternatives is widespread and has not affected prices, while equipment costs have. According to all interviewed dentists, the methodology for mercury amalgam or alternatives (composite, CVI or silver fillings) is similar and both are taught in dental school. So, no additional training costs are necessary. But equipment purchases for placing alternative fillings were estimated to run about 656,000 XOF[5] (lights e.g. for photo curing etc.).

Dentists indicated material costs differed significantly requiring them charge more for alternatives. In addition to equipment costs, the materials costs for alternatives are responsible for the price differential between the amalgam/alternative materials.

Dental offices understood the risks posed from mercury. None of the dentists interviewed used only amalgam. All dentists (100%) were aware of the risks posed by mercury to human health and the environment, believe references to mercury's dangers are not overstated, and have heard about mercury's health risks.

[5] Cost for equipment estimated as 1,000 EUR, conversion from EUR to XOF is fixed at 655.957 XOF = 1 Euro

4 Asia Pacific

4.1 India, Delhi NCR/Delhi, NOIDA

The Economy of India generated an estimated US$ 3.319 trillion GDP PPP in 2001 with an estimated per capita PPP income of US$ 2,846.64 [14].

Delhi is the second-largest city in India and, with over 11 million residents, the eighth largest metropolis in the world by population. It is a federally-administered union territory officially known as the National Capital Region (NCR) which, including the surrounding metro area, has over 17 million residents. Delhi is the second largest commercial centre in South Asia after Mumbai. Located in the north of India, NOIDA (the **New Okhla Industrial Development Area**, usually shortened to **NOIDA)** is proximate to Delhi. It is bound on the west and south-west by the river Yamuna, on the north and north-west by Delhi, on the north-east by Delhi and Ghaziabad and on the north-east, east and south-east by the river Hindon.

The rupee (sign Rs and code: INR) is the currency of India. On 14 April 2009, the exchange rate was 49.653 INR to 1 USD or 65.907 INR to1 Euro[6].

4.1.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Delhi, Delhi NCR and Noida, India

4.1.1.1 Indian Clinical Thermometer Survey

Participants. The Clinical Thermometer Survey was held in fifteen (15) hospitals and twenty-nine (29) doctors' practices in Delhi, Delhi NCR and Noida, India.

Health care facility adoption of mercury-free thermometers was limited. The vast majority of hospitals and doctors' practices used only mercury-containing clinical ther-

[6] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

mometers (65%); a fair segment of the doctors and hospitals had both devices in their inventories (30%). Exclusive use of mercury-free thermometers was very limited (5%).

Health care professionals indicated mercury-free thermometers' positive attributes. Most doctors were quick to point out the positive qualities of mercury free thermometers, consistently citing their resistance to breakage. Some doctors (25%) with exposure to both alternatives preferred working with the mercury-free alternatives. Variable impressions were given on the ability to read with some brands getting higher marks while other electronic readouts were found to be more difficult to read than even a glass thermometer's linear scale.

Health care professionals also indicated mercury-free thermometer problems. Regarding personal preference, three concerns were mentioned most often – accuracy, reliability and to a lesser degree readability. The most frequent responses referenced short-comings of mercury-free thermometers as a lack of accuracy and/or inconsistent readings.

Costs for mercury-free thermometers were not considered a barrier. Doctors stated that cost issues related to mercury-free products was less of a concern than the accuracy and reliability issues. Responses indicated that prices ranged from 2.6 - 8.6 times greater for purchasing mercury-free thermometers, but were not felt to be a barrier.

Health professionals indicated hospitals required use of mercury thermometers. Doctors indicated little choice in the equipment used when working outside of their own private practice. When serving as an attending physician at a hospital or clinic they were limited to the equipment on-hand and had little influence over purchasing decisions.

Health professionals understood the risk posed by mercury exposure. All doctors (100%) understood the hazards of mercury and the majority expressed a desire to see a shift to mercury-free devices.

4.1.1.2 Indian Household Thermometer Survey

Availability. Consumer options for mercury-free thermometers were widely available. Regarding the survey for home use, seventeen (17) shops in Delhi, Delhi NCR and Noida, India were surveyed. All (100%) offered both types of thermometers for sale.

Prices for mercury-free thermometers were much higher. The surveyor noted the costs for all types of thermometers purchased by consumers were similar to those purchased for clinical use. Prices ranged from 28 - 65 Rs for mercury-containing thermometers, and 170 - 240 Rs for mercury-free thermometers (see Tab. 4.1).

Tab. 4.1 India Household Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price – Rs (INR)	28	65	170	240

4.1.2 Current status regarding availability and use of mercury-containing blood pressure measuring devices in the health-care sector in Delhi, Delhi NRC and Noida, India

4.1.2.1 India Clinical Sphygmomanometer Survey

Participants. The Sphygmomanometers Survey was held in fifteen (15) hospitals and twenty-nine (29) doctors' practices in Delhi, Delhi NRC and Noida, India.

When used, mercury-free blood pressure devices were well-supported. Mercury-free (aneroid) blood pressure meters were in use at about one quarter (27%) of the doctors' practices and hospitals. Where used, digital aneroid versions were found to be easier to use when compared to mercury devices. Only one doctor's office and one hospital used them exclusively. Ultimately, most medical purchasing offices still procured only mercury-containing blood pressure meters.

Health care professionals acknowledged non-mercury device benefits. Although aneroid blood pressure meters were not widely used, experiences with those who used them were positive. Most doctors using digital aneroid devices (> 90%) prefer working with the mercury-free alternative. They felt it made it easier to get readings and it was faster to work with. The doctors further stated breakage losses were low and did not pose the threat that mercury-containing devices did. Physicians found digital versions of mercury-free instruments quite user-friendly.

Little or no training was necessary to use the mercury-free devices. Given the similarity between the use of mercury and non-mercury sphygmomanometers, no training was necessary except where power management was an issue (battery-operated devices). This was done in-house and did not incur additional cost.

Cost to purchase mercury-free devices was high. The costs for a mercury-containing blood pressure meter range from Rs 600 to Rs 1,000, (median = Rs 800). The cost for a mercury-free blood pressure meter range from Rs 800 to Rs 2,000 (median = Rs 1,400), double the price of purchasing mercury-containing ones.

4.1.3 Status of availability and use of most common types of mercury-containing batteries on the market in Delhi, Delhi NRC and NOIDA, India

Availability problems in acquiring D-cell and button batteries were not found.

D-cell batteries were not labelled. Six (6) different brands of D cells were found in retails shops around Delhi, Delhi and NOIDA, India, none of which (0%) had messaging on either the package or the battery regarding mercury content. Internet research found more information on mercury content for only one of the D-cells.

Button cell batteries were not labelled. Concerning the button cell LR 44, four (4) battery brands were found, but none (0) were labelled. No additional information on the brands purchased could be found via the internet.

Brands were limited. Most of the major brands seen in other countries for D-cells and button cells LR 44 were not seen in India. All D cell batteries were indicated to have

been produced domestically and not imported. Two button cells that could be assessed under the survey guidelines were imported from China and Japan.

Price and import relationships could not be analyzed. Prices were not significantly different, but without knowledge of mercury content, no comparison about cost, source of manufacturing and content could be assessed.

4.1.4 Status of the availability and use of mercury-containing skin-lightening products in Delhi, Delhi NCR and Noida, India

Participants. The Consumer Cosmetic Survey was done at twenty-five (25) retail outlets in Delhi, Delhi NCR and Noida, India with twenty-five (25) skin lightening product-users. Of the persons interviewed, seven (7) were academics (including college graduates, artists, monks and other persons with "brain power"), nine (9) were merchants/sales persons, five (5) were service sector and four (4) were students. (See Tab. 4.2)

4.1.4.1 Indian Consumer Cosmetic Survey

Consumers were unaware of the potential presence of mercury in skin-lightening products. Consumers (~10%) had knowledge about the potential for mercury in skin-lightening products. About the same percentage knew that mercury-free products were locally available.

Consumers were generally unaware that mercury was toxic. Of the consumers surveyed most (76%) indicated no knowledge of mercury's toxicity.

Mercury content was not a reason for choosing skin-lightening products. None of the consumers (0%) who chose to purchase mercury-free skin-lightening products did so because they desired to eliminate mercury from the product purchased. Consumers indicated "Mercury-free" is not a regular labelling practice or selling point and rarely bought products by looking at the contents/ingredients. Consumers were least concerned about the content of products. Drivers for purchasing products were cost, brand recognition, sales promotion and word-of-mouth.

Mercury-free products were not readily available to consumers. Persons who knew mercury-free skin-lightening products were available indicated the availability was low and only found at specific locations. The most common places to find skin-lightening products (both mercury and mercury-free) were in cosmetic shops, chemists, general stores, departmental stores/hypermarket etc.

Tab. 4.2 India Consumer Cosmetic Survey

Responses		**Occupation**			
Inquiry	***"yes"*** ---------- ***"no"***	***Academics*** ***(7)***	***Merchants*** ***(9)***	***Service provider*** ***(5)***	***Student*** ***(4)***
1) Consumers know that some skin lightening creams contain mercury	2	0	0	2	0
	23	7	9	3	4
2) Consumers are aware that mercury is a toxic substance	6	1	2	3	0
	19	6	7	2	4
3) Consumers knowing that mercury-free skin lightening products are available in town/region	2	0	1	1	0
	23	7	8	4	4
a) If "YES" to 3): consumers using a mercury-free skin lightening product	2	0	1	1	0
	0	0	0	0	0
b) If "YES" to 3): Did you deliberately decide to use a product without mercury?	0	0	0	0	0
	2	0	1	1	0

4.1.4.2 Indian Merchant Cosmetic Survey

Availability. Twenty five (25) shops in the Delhi, Delhi NRC and NOIDA, India area were surveyed on skin-lightening products. Fifteen (15) separate products were identi-

fied and were indicated to be displayed in similar amounts at all markets. Most were domestically produced but appeared to have been done under authority from multi-national corporations.

Merchants were unaware if mercury was in the products they sold. No merchants (0%) indicated they were aware of mercury content in products sold. Merchants were keen to sell products that were perceived as widely accepted and in-demand. Even if products contained mercury, merchants had no problem offering them for sale (i.e. fever thermometers). Many believed even if mercury were present in cosmetic products, that the presence of mercury was insignificant or posed no risk.

Merchants were unaware of mercury's toxicity. Only a few merchants (12%) were aware that mercury is toxic, most (88%) were not.

Merchants indicated mercury free products were widely available. All outlets surveyed stocked similar products. Since no product indicated mercury's presence or absence, merchants (100%) assumed the products were mercury-free, although they had no basis to prove this.

Merchants were unable to differentiate between products' efficacy and safety. All merchants (100%) lacked capacity to compare products based on mercury content because of their lack of knowledge about mercury and mercury levels in products.

Most merchants hadn't received complaints regarding performance of products, so believed them all to be safe. Merchants also stated their products have no side effects and had received extensive testing with no documented problems. It is believed, that to improve sales, merchants may have indicated the products they sold were mercury-free. Very few issues were found to affect availability of products except the brand.

Price varied and was unrelated to content, manufacturer or active ingredients. For the creams, prices of products varied from lows for the least-expensive options of about one (1) to three (3) rupees per gram, to one very high-priced selection costing almost ten (10) rupee per gram.

No significant mercury contents in the products. In all samples mercury concentrations were below the limit of quantification (0.07 ppm). Only in one case mercury was

detectible. The low concentration of mercury in this product indicated that mercury was likely not included as an active ingredient in the product. It was well declared and listed other non-mercury active ingredients. It was among the most expensive options offered (Tab. B.3).

Product labelling indicated active ingredient information to consumers. Information about active ingredients of the different creams was listed on most (93%) products. Only a few, usually the higher-priced options, listed all ingredients. No product packaging gave indication of mercury's presence (or absence).

4.1.5 Status of availability and use of dental amalgam and mercury-free alternatives in Delhi, Delhi NRC and Noida, India

Participants. The Dental Restorations Survey was done at twenty (20) dentistries in the Delhi, Delhi NRC and Noida, India area.

Mercury-free alternatives were widely available. Most dentists used mercury-free materials (93%), about one-third (30%) used only non-mercury alternatives. Of those using amalgam, just one dentist used mercury amalgam exclusively.

Many options for alternative materials were available. Of the respondents, most (90%) used composite filling materials while many employed both resin and composite. One used a ready-made solution, one used glass ionomer cement, and a few used white ceramic.

Patients can afford to get mercury-free tooth restorations. In general, it was indicated most of the people (> 75%) can afford care but the choice of dentists was strongly influenced by income level. Government Hospitals provide less expensive options which appealed to most residents. High-end hospitals and dentistries were preferred by the wealthier patients.

Alternative materials were more expensive than amalgam, but not significantly so. The main filling types/materials used by dentists who use both, mercury-containing and mercury-free fillings were composites. The price difference for the patient ranged from Rs 200 to Rs 2,000 more for composites compared to the mercury amalgam filling (for an average-size filling) according to the dentists.

Some dentists claimed prices between amalgam and alternative materials were similar others responded mercury-free alternatives were almost double the cost. Dentists who responded indicated that to place alternatives, additional personal or staff training was not necessary since most dentists and dental assistants were young enough to have received this training while in school. So, the cost for including alternative restoration services was near zero.

While training did not add to the cost of placing alternatives, materials did add to the cost for the patient. Dental offices indicated that special equipment was not necessary for placing alternative materials but a difference in cost of up to 3 times more for alternative restorative materials over amalgam existed. From others, we know some alternative materials require additional equipment. Since these were used, some misunderstanding of the inquiry may have occurred.

Some patients sought alternative restorations. Most (85%) did not know and/or understand about the mercury in amalgams. According to dentists, some (about 10%) dental patients seek alternative restorations because of the mercury present in amalgam. If the visiting dentist could not provide this, patients shifted to another dentist. An additional 5% knew mercury was present in amalgams, but were indicated to not be overly-concerned about the associated hazards and did not demand a mercury-free restoration. Another 10% asked about the variety of options but were not seeking specific information about amalgams and mercury. In general, most (75%) of the patients visiting the surveyed dentists never inquired about alternatives and were unaware of amalgam's mercury content.

Dentists were aware of mercury's risk to patients and the environment. The vast majority of dentists (90%) were aware of the risks posed by mercury to human health and the environment, some (10%) dentists did not think mercury is as dangerous as indicated/ talked about, and all had heard about health risks due to mercury.

Dentists felt amalgamation reduced the toxic effects of mercury. According to one (1) dentist, traditional amalgam use has no side effects. This dentist indicated other aspects were more harmful than amalgam – including potential mercury contamination from breakage of mercury thermometers and blood pressure instruments.

4.2 China, Beijing, Tianjin, Fenyang & Kunming

The Renminbi (code: RMB) is the currency of the People's Republic of China (PRC), whose principal unit is the renminbi or yuan (sign: ¥; code: RMB). As of 14 April 2009 current value against the US Dollar is 6.8245 RMB to 1 US$ or 9.0658 RMB to 1 Euro[7]. The 2001 estimate of GDP was US$ 7.8 trillion or $ 5,826.93 PPP GDP [14].

In China, communities in Beijing, Tianjin, Fenyang and Kunming were surveyed.

Beijing is a metropolis in northern China and the capital of the People's Republic of China (PRC). It is one of the four municipalities of the PRC, which are equivalent to provinces in China's administrative structure. The municipality of Beijing borders Hebei Province to the north, west, south, and for a small section in the east, and Tianjin Municipality to the southeast. In 2007, the population estimate for the metropolitan area was 11,940,000, while the municipality held 17,430,000 people.

Tianjin is the sixth largest city in the PRC in terms of urban population. Administratively, it is one of only four municipalities that have provincial-level status and report directly to the central government. Also, its land area is the fifth largest in China, ranked only after Beijing, Shanghai, Guangzhou and Shenzhen.

Fenyang is a county-level city under the administration of Lüliang prefecture-level city, in Shanxi Province, China.

Kunming covers an area of 21,501 km² and its urban area covers 6,200 km² it has an estimated population in the city of 5,740,000 including 3,055,000 in the urban area.

[7] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

4.2.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Beijing, Tianjin, Fenyang and Kunming, China

4.2.1.1 Chinese Clinical Thermometer Survey

Participants. The Clinical Thermometer Survey was held in sixteen (16) hospitals and sixteen (16) doctors' practices in Beijing, Tianjin, Fenyang and Kunming, China.

Mercury-free thermometers use was very low. Almost all hospitals and doctors' practices used mercury-containing clinical thermometers (75%); only one (6%) doctor's practice used both; and only two (2) hospitals and one (1) doctor's practice used mercury-free clinical thermometers exclusively.

Most believed mercury thermometers were superior. All doctors know mercury-free thermometers. But many respondents (63%) believed that mercury containing thermometers were more precise, reliable, convenient, cheaper, and gave more consistent results. These respondents were also indicated to be strongly acclimated to mercury fever thermometer use.

The cost for mercury-free thermometers was significantly higher (20 - 120 times greater, avg. = 12.5x). The cost for a mercury-containing clinical thermometer ranged from 1 RMB to 10 RMB (avg. = 4 RMB). The cost for a mercury-free clinical thermometer range from 20 RMB to 120 RMB (avg. = 50 RMB).

Medical staff understood the risk posed from mercury. According to the surveyor, survey respondents all had medical science backgrounds, so they all understood mercury is harmful to the human body (100%).

Mercury-free alternative device availability and options were relatively unknown by health care professionals. When asked about existing mercury-free thermometer and sphygmomanometer brands available on the market, most knew nothing about them – either price or availability. Of those recognized, imports had better recognition among health care professionals than domestic brands. Some smaller domestic brands were relatively unknown. But, according to the surveyor, there is no problem with the availability of mercury-free thermometers.

4.2.1.2 Chinese Household Thermometer Survey

Mercury-free alternatives were available in the marketplace to consumers. The survey for home use thermometers were conducted in eighteen (18) shops in Beijing, Tianjin, Fenyang and Kunming, China. In just over half, about 55% (10 out of 18 shops) both types of thermometers were readily available.

Costs for alternatives were much higher than mercury-containing devices (2.6 – 180 times greater). This investigation also showed that price was the main reason for continuing public use of mercury-containing thermometers and sphygmomanometers (see Tab. 4.3).

Tab. 4.3 China Household Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive Product	Most expensive product
Price (RMB)	2.5 RMB	7.6 RMB	20 RMB	450 RMB

4.2.2 Current status regarding availability and use of mercury-containing measuring devices in the health-care sector in Beijing, Tianjin, Fenyang and Kunming, China

4.2.2.1 Chinese Clinical Sphygmomanometer Survey

Participants. The Sphygmomanometer Survey was done in sixteen (16) hospitals and sixteen (16) doctors' practices in Beijing, Tianjin, Fenyang and Kunming, China.

Wide adoption of mercury-free sphygmomanometers has not yet happened. Most every hospitals and doctors' practices use mercury-containing blood pressure meters, about half (50%) of both hospitals and doctors' practices use both; and only one (1) hospital and one (1) doctors' practice use mercury-free (aneroid) blood pressure meters exclusively. Some doctors stated their hospital (12.5%) would not buy mercury-free blood pressure meters because of the higher costs.

Health care professionals preferred working with mercury-free devices. Most health professionals (75%) citing preference for working with mercury-free alternatives this was indicated because they were more convenient, as well as easier and simpler to use. The remaining doctors preferred mercury-containing meters mainly because they were more accustomed to using them.

Health care professionals felt mercury-containing devices were superior in some areas. Over half of the doctors (56%) stated the aneroid devices failed to give reliable and consistent measurements compared to the mercury containing devices.

Additional costs for staff training to use mercury-free devices were either minimal or non-existent. Most respondents stated there is no need for additional staff training to work with aneroid meters. About one-fourth said 4 hours of staff training was needed to familiarize them and adapt to the servicing and adjustments needed for aneroid use with some saying their hospital paid less than 1,000 RMB for the training.

Costs for adopting mercury-free technology were not excessive. Health care professionals stated the costs for a mercury-containing blood pressure meter range from 50 RMB to 200 RMB (avg. = 100 RMB). The cost for a mercury-free blood pressure meter range from 180 RMB to 1,400 RMB (avg. = 500 RMB).

4.2.3 Status of availability and use of most common types of mercury-containing batteries on the market in Beijing, Tianjin, Fenyang and Kunming, China

Availability problems in acquiring D-cell and button batteries were not found.

All D-cell batteries surveyed had labelling indications of mercury content. Of the fourteen (14) batteries in the survey, ten of them (71%) were labelled mercury-free, the rest (29%) were labelled as low-mercury or containing mercury.

Button batteries were fairly well labelled. Of the six (6) LR 44 button batteries submitted, one-third had a mercury statement on the battery or their package. For one other, a statement in the internet could be found. All of these indicated mercury's presence. For the remaining three (50%) no statements were available. None of the batteries (0%) were indicated to be mercury-free.

Price relationships were conflicting. For D-cell batteries, low-end prices were relatively comparable with mercury-containing battery prices being only slightly less (0.50 RMB) than mercury-free offerings.

Most batteries were produced in China. In both categories some imports were available, all coming from Japan. All mercury-containing options were domestically produced.

4.2.4 Status of the availability and use of mercury-containing skin-lightening products in Beijing, Tianjin, Fenyang and Kunming, China

Participants. The Consumer Cosmetic Survey was done in seventeen (17) shops and market places in Beijing, Tianjin, Fenyang and Kunming, China; and by interviewing thirty-eight (38) skin lightening product users. The interviewed persons' occupations included twenty-two (22) academics (including college graduates, artists, monks and other persons with "brain power"), five (5) craftsmen, eight (8) merchants, and three (3) unskilled labourers (see Tab. 4.4).

4.2.4.1 Chinese Consumer Cosmetic Survey

Consumers knew that mercury can be an ingredient in skin-lightening products. Over half (53%) indicated they know that mercury can be an ingredient in skin-lightening products.

Consumers were aware that mercury is a toxic substance. Most respondents (89%) knew that mercury exposure posed health risks.

Consumers knew mercury-free skin-lightening products were locally available. Most respondents (66%) indicated they knew mercury-free products were available in shops and stores in their community. As this percentage is higher than the percentage of people knowing that mercury could be in skin-lightening products, it is to be assumed, that some people just believe the products they are using are not harmful. Of the persons who knew that mercury-free skin-lightening products were available in the town/region; most of the people said, that both mercury-containing and mercury-free products were sold everywhere. About half of the surveyed people said, that distinctive brands of mercury-containing or mercury-free skin-lightening products were only sold in

special places. But that the mercury-containing creams contained less than the State Standard so did not need to be labelled mercury-containing. A few said mercury-free creams were often sold out.

Most consumers did not choose mercury-free skin-lightening products deliberately. Of all the twenty-five (25) respondents who knew mercury-free skin-lightening products existed, most (88%) used them but only some (40%) chose mercury-free deliberately.

Product choice was based on health and trend-setting but not due to mercury content. Although the minority, those persons (40%) choosing to use a skin lightening product without mercury did so because they either wanted healthier products or were following trends. Academics stated they desired healthier products, and knew mercury was toxic, so they wanted to avoid heavy metals and toxic substances; the craftsmen responded saying they desired healthier products; and the merchant replied they followed the fashion trend to use a skin lightening product without mercury.

4.2.4.2 Chinese Merchant Cosmetic Survey

Availability. In the seventeen (17) shops surveyed in Beijing, Tianjin, Fenyang and Kunming, China: nineteen (19) products were procured.

Participants. The Merchant Cosmetic Survey was done with seventeen (17) merchants.

Merchants were unaware of mercury's toxicity. Most merchants (70%) were aware that mercury is a toxic substance, the rest were not. Most stated that even if skin creams contain toxic substances including mercury, this would not lead to a fatal result. Retailers trusted major product lines; they claimed this ensured product safety.

All (100%) merchants stated their products were safe and would not admit if they sold creams containing toxic substance, even if some of them knew that some of their products contained toxic substances, including mercury. Their products were well-known international brands, and their confidence was based on their belief that global, high-profile manufacturers only produce universally-acceptable products.

Tab. 4.4 China Consumer Cosmetic Survey

Responses		Occupations			
Inquiry	**"yes"** / ***"no"***	**Academics (22)**	**Craftsmen (5)**	**Merchant (8)**	**Unskilled Labourer (3)**
1) Consumers know that some skin lightening soaps contain mercury	20	11	4	4	1
	18	11	1	4	2
2) Consumers are aware that mercury is a toxic substance	33	21	4	6	2
	5	1	1	2	1
3) Consumers knowing that mercury-free skin lightening products are available in town/region	25	12	4	8	1
	13	10	1	0	2
a.) If "YES" to 3): consumers using a mercury-free skin lightening product	22	11	4	6	1
	3	1	0	2	0
b.) If "YES" to 3): Did you deliberately decide to use a product without mercury?	10	5	4	1	0
	15	7	0	7	1

Most merchants could not inform customers if the products they sold contained mercury. Over half (53%) of the merchants did not know if the creams they sold contained mercury or not. The other merchants believed that their products were mercury-free because they sold well-known brands or that they contained mercury because they were small homemade brands.

Merchants said availability of products strongly depends on popularity. In cases where the merchants knew which skin lightening creams contained mercury or if the active ingredient was stated on the packaging: merchants stated mercury-containing soaps and mercury-free creams were more difficult to get.

Merchants stated problems existed with mercury-free skin lightening alternatives. Many merchants stated mercury-free product prices were higher; they were less effective and/or shorter-lived. Some said brand name was the sole indicator of efficacy, with widely-recognized products achieving better results.

Mercury-containing products were still fairly-widely used despite the fact that mercury-free skin lightening creams were readily available. Some merchants stated this was because the price of mercury-free creams was higher and no risk difference existed between mercury-free and mercury-containing to customers because they were never told about mercury. Many merchants said mercury was not indicated on any labelling, so customers were unaware of this potential.

Products generally had labelling information, but many times only about key ingredients. Information about active ingredients for the different creams was listed on the majority (74%) of products surveyed with the most oft-listed active ingredients in skin-lightening products sold in China was vitamin C.

No labelling informed consumers of the presence or absence of mercury in the products surveyed. Customers' conclusions that products did not contain mercury were based on advertising, package listings of active ingredients, and/or the merchant's promotion of a product.

No mercury was found in the products tested. Of the six products selected for testing, none (0%) tested positive for mercury (Tab. B.4).

Prices were relatively competitive with the products breaking into two categories – the very high-priced and low-priced options. The majority of products offered fell into the lower-priced options and were under 1 RMB/gram. Generally, with other products, internationally-recognized cosmetic manufacturers including L'Oreal, Olay, Danzi and Procter and Gamble demanded prices from over 1 RMB/gram to a high of almost 13 RMB/gram. There was no relationship between price and the active ingredients contained in the products.

Imported products were few. None (0%) appeared to be imported from other countries except for two indicated to come from Hong Kong.

4.2.5 Status of availability and use of dental amalgam and mercury-free alternatives in Beijing, Tianjin, Fenyang and Kunming, China

Participants. A total of nineteen (19) dentists working in nine (9) dental clinics in Beijing, Tianjin, Fenyang and Kunming, China participated in the Dental Restorations Survey. China has no visible personal/private dental practices.

Dentists offered mercury-free restorative materials to their patients. All of the dentists surveyed (100%) offered mercury-free restorative materials; some dentists offered amalgam as well; while half of all dentists (3 of the dental clinics) used only alternative materials.

Mercury-free restorative materials were slightly more expensive than amalgam. According to the dentists price differences for patients ranges from 100 RMB to 150 RMB more for compound resin when compared to amalgam. Glass ionomer and cement materials ranged from 20 RMB to 200 RMB more.

Dentists offered a wide range of options in alternative materials (n = 6). With all dentists using alternatives, a large number of materials were in use. All dentists (19 = 100%) interviewed use compound resin, glass ionomer, or gutta-percha. Seven (7) dentists (37%) interviewed also use cement with polyacrylic acid, polycarboxylate, or calcium hydroxide and aluminium alloy in addition. The main alternative materials used by dentists who offered both types of fillings were compound resin, glass ionomer, and cement.

Most patients could afford to get teeth restored. All dentists stated either most patients or that only the poorest patients could not afford restorations.

Training and equipment for placing mercury-free restorations added to patients' cost but not as much as materials. The overall cost to dental clinics for offering other alternative filling materials was 8,000 RMB on average. On average, according to the dentists interviewed, composite material cost is 1.5 times more than amalgam, and composite time cost is 2 times greater than amalgam. About a third of the dentists said the cost for additional equipment and training staff on the other filling materials were below 5,000 RMB; the same amount said it ranged from 5,000 to 10,000 RMB.

According to the dentists, it took about a year on average to train staff to place alternatives. Once trained, over half of the dentists said it took their clinic less than a year to recover cost; a few said it took one to two years; and only one said it took more than four years.

Patients requested mercury-free materials for restorations. The clear majority of dentists (84%) said their patients often ask for mercury-free fillings and also compare the cost, effectiveness, and durability. A few said their patients normally follow their dentist's suggestion.

Dentists were aware mercury is toxic. All (100%) dentists knew mercury was toxic. Just over half of the dentists (53%) were aware of the risks posed by mercury to human health and the environment with the rest (9) thinking mercury was not as dangerous as indicated/spoken of.

5 Eastern Europe

The Eastern European UN region includes here one Asian member of CIS (CIS = Commonwealth of Independent States; organization of former Soviet Union Republics).

5.1 Russia: Volgograd, Moscow, Novorossiysk

The economy of Russia was estimated to generate US$ 2.225 trillion in Gross Domestic Product Personal Purchasing Power (GDP PPP) in 2001. Per capita PPP income was estimated at US$ 15,888.18 [14].

Moscow, the capital and largest city in Russia, is also the largest metropolitan area in Europe. Moscow's 10 million-plus residents cover over 400 square miles, making it the major political, economic, cultural, religious, financial, educational, and transportation centre of Russia. It ranks among the largest urban areas as the seventh largest city proper in the world, giving it the title of a global megacity.

Volgograd (formerly Stalingrad) is the administrative centre of Volgograd Oblast, Russia. Over 80 kilometres (50 mi) long, north to south, Volgograd is situated on the western bank of the Volga River. The over 1 million residents of this mainly industrial city inhabit over 220 square miles.

Novorossiysk, the main Russian port on the Black Sea in southern Russia's Krasnodar Krai is one of the few cities honoured with the Soviet title of the Hero City.

The ruble or rouble (code: RUB, sign RUB) is the currency of the Russian Federation. As of 14 April 2009, the exchange rate against the Russian ruble for accounting purposes and customs payments was 33.3279 RUB for 1 USD or 44.3079 RUB to 1 Euro[8].

[8] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

5.1.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Moscow, Volgograd and Novorossiysk, Russia

5.1.1.1 Russian Clinical Thermometer Survey

Participants. The Clinical Thermometer Survey was done at twenty-eight (28) hospitals and with (58) doctors' practices including five (5) family physicians[9].

Health care professionals indicated mercury-free thermometers were available but not widely adopted. All of the hospitals and clinics (100%) and all doctors' practices (100%) used mercury-containing clinical thermometers, over half of the hospitals (54%) and doctors' practices (62%) used both and none of the hospitals (0%) or doctors' practices (0%) used only mercury-free clinical thermometers.

The majority of the medical professionals surveyed saw no problems on the availability of mercury-free thermometers. The majority of respondents indicated products were readily available at pharmacies and stores where medical equipment was sold, as well as via the internet. The problem was not in the availability of mercury-free thermometers, but in the high prices when compared to conventional thermometers.

Health care professionals stated mercury-free thermometer use was cost-prohibitive. Most health care professionals stated the price difference between mercury-containing and mercury-free thermometers forced choices due to cost-prohibition.

Some doctors and nurses from Volgograd (8%) complained their hospitals did not purchase mercury-free thermometers. Chief Medical Officers of the hospital or, sometimes the Chief Nurse generally made purchasing decisions. Their decision was indicated to be based on the available budget of the clinic or hospital.

All medical personnel stated a preference for mercury-containing clinical thermometers. Health care staff preferred mercury-containing thermometers because they

[9] Family practice doctors work privately in consult with individual family units. They were usually paid directly by the family at a rate of 100 dollars per family member per month.

considered them more accurate, more reliable, more affordable, more user-friendly, and more hygienic than mercury-free thermometers. (The experience of low reliability and accuracy of mercury-free thermometers in the hospitals could be due to cheap digital devices or poor battery life.) One physician recommended mercury-free thermometers only be used by an individual or family, and not for general use in hospitals.

Doctors interviewed indicated mercury-free thermometers required special handling. Traditional methods of disinfection were considered insufficient by health care professionals and special antiseptic solutions were indicated to prevent the spread of disease. Professionals indicated these solutions were generally unavailable or required additional cost to general hospitals and clinics.

Conventional mercury-containing thermometers were found to have some limitations as well. The time needed to obtain a reading with a mercury-free thermometer was much shorter than for mercury-containing thermometers. Mercury-free thermometers were also indicated to prevent the risk of mercury contamination and eliminate threats from broken glass following breakage. Family doctors indicated their preference for mercury-free thermometer for family use.

5.1.1.2 Russian Household Thermometer Survey

Participants. The Home Thermometer Survey was done at eighteen (18) retail outlets.

Mercury-free thermometers were widely sold. All of the outlets (100%) sold mercury-free thermometers, a clear majority of locations sold both (72%) and some sold only mercury-free thermometers (28%). As a note, some pharmacies preferred selling only mercury-free thermometers forcing people to purchase them at the higher price. One could regard this situation an effort to promote mercury-free alternatives (see Tab. 5.1).

Mercury-free thermometers were much more expensive. The cost for a mercury-containing clinical thermometer ranged from 11 rubles to 25 rubles (avg. price 18 rubles). The cost for a mercury-free clinical thermometer range from 98 rubles to 1,710 rubles (avg. price 579 rubles).

Family doctors preferred mercury-free thermometers for family use. All family doctors interviewed (100%) preferred working with the mercury-free alternative. These doctors work with wealthy families and advise them to purchase mercury-free thermometers for family and/or individual use. These thermometers had attractive designs and were recognized as safer for the home because they did not contain mercury or as significant an amount of highly toxic chemicals. Families making use of a family doctor can afford the more expensive mercury-free thermometers.

The following benefits of high-end mercury-free electronic thermometers were mentioned by family doctors; improved safety, accuracy, fast response time to results, anti-allergenic cover, and an attractive design.

Tab. 5.1 Russian Household Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price (RUB)	11	25	98	1,710
Average	18 RUB		579 RUB	

5.1.2 Current status regarding availability and use of mercury-containing measuring devices in the health-care sector in Moscow, Volgograd, and Novorossiysk, Russia

5.1.2.1 Russian Clinical Sphygmomanometer Survey

Participants. The Clinical Sphygmomanometer Survey was done in twenty-eight (28) hospitals, fifty-eight (58) doctors' practices, and with five (5) family doctors in Moscow, Volgograd and Novorossiysk, Russia.

Hospitals and doctors' offices have adopted mercury-free blood pressure devices. All hospitals and doctors' practices (100%) used mercury-free (aneroid) blood pressure meters exclusively in their measurements.

Quality mercury-free blood pressure devices were easily obtained. There are no problems in the availability of mercury-free blood pressure meters. They could be purchased in all pharmacies and stores where medical equipment was sold anywhere in the country. So, no limitations existed on the availability of mercury-free blood pressure meters.

No medical professionals, hospitals or clinics used mercury-containing blood pressure meters. Mercury-free meters have been the standard since the 1980's. The professionals recognized advantages due to decreased weight, smaller size, and greater portability. Two types of mercury-free pressure meters are in use: mechanical and electronic. Mechanical blood pressure meters have been found to be more reliable. Both types of mercury-free meters were used not only in hospitals and clinics, but by family doctors and in the home.

No costs for training staff to use mercury-free devices were noted. According to all those interviewed, trainings have not been necessary. Since all received training in school, health care operations did not need to train staff.

Costs for mercury-free devices were affordable. The cost for a mercury-free blood pressure meter ranged from 321 rubles to 3,510 rubles, the mean value is 1,277 RUB.

5.1.3 Status of availability and cost of most common types of mercury-containing batteries on the market in Moscow, Volgograd, and Novorossiysk, Russia

Availability problems in acquiring D-cell and button batteries were not found.

Most "D" cell batteries offered on the market were labelled. Fourteen (14) different brands of D cells were found in retails shops, the majority of which (57%) were labelled mercury-free, the remainder (43%) had no label concerning mercury content on either the package or the battery. For the non-labelled batteries, internet statements on mercury content could be found for two (14%) of the non-labelled batteries: one was indicated to contain mercury, the other did not.

Labelled D-cell batteries tended to cost more. Price could have an influence on adoption since unlabeled batteries were less expensive to purchase than those labelled

mercury-free. Unlabeled batteries prices (25 RUB) started at about half the lowest price of a labelled battery (55 RUB). This price difference may have been an indicator of adopting new technology for battery manufacturing.

D-cell batteries were well labelled, including imports. Of the fourteen batteries, nine (64%) were labelled with an indication of mercury content (seven on the package/product and two in the internet). The vast majority (86%) were indicated to be imported. Most of these known imports (75%) indicated mercury content. The only battery indicating the presence of mercury was imported and originated in Belgium. This was also the most expensive battery on the market.

Button batteries were not labelled. Concerning the button cell LR 44, six (6) battery brands were found, but none (0%) were labelled. No additional information on the brands purchased could be found via the internet.

5.1.4 Status of the availability and use of mercury-containing skin-lightening products in Moscow, Volgograd and Novorossiysk, Russia

Participants. The Retail Cosmetic Survey was done in Moscow, Volgograd, and Novorossiysk, Russia. Interviews were held with thirty-five (35) users and twenty-five (25) merchants of skin-lightening creams and soaps, respectively.

5.1.4.1 Russian Consumer Cosmetic Survey

The consumer interviews were held with fifteen (15) academics (including college graduates, artists, monks and other persons with “brain power”), eight (8) craftsmen, five (5) merchants, five (5) farmers and two (2) unskilled labourers (see Tab. 5.2).

Consumers were unaware that mercury might be present in skin-lightening products. Of the consumers interviewed, most (86%) could not say if mercury was present in the skin-lightening products offered in Russia. The only consumers knowing that some skin lightening cosmetics can contain mercury were the merchants. Interestingly, all of the merchants were aware of this.

Consumers were aware that mercury was toxic. All of the interviewed people (100%) indicated they knew mercury was a toxic substance.

Consumers were unaware that mercury-free skin-lightening products were available. Paralleling the consumer awareness of mercury in skin-lightening products, most consumers (86%) did not know there were mercury-free alternatives.

All of the people surveyed who were aware of the potential presence of mercury in these products (100%) chose to purchase mercury-free options. All of these consumers were merchants. Very likely, they believe, but cannot confirm, that the products they sell do not contain mercury. Even better educated and higher income segments of the population that would be expected to recognize this issue indicated no knowledge about choosing an optional mercury-free product.

Labelling practices were felt to be insufficient to give consumers adequate information. Mercury was never mentioned anywhere on the packages. Consumer choices were identified to be based on price, brand name, and/or recommendations from merchants, friends and cosmetologists.

Consumers were generally unconcerned about the presence of mercury in skin-lightening products. Among people interviewed few expressed concern about mercury in skin-lightening products. Most wanted well-recognized brands and effective products, but did not care whether these products contained mercury or not. They were sure that well-known brands would never risk their reputation by including mercury or other harmful substances in their products. According to merchants, customer choice was based mostly on price.

Tab. 5.2 Russian Consumer Cosmetic Survey Responses

Response		Occupation				
Inquiry	***"yes" "no"***	***Academics (15)***	***Craftsmen (8)***	***Merchants (5)***	***Farmers (5)***	***Unskilled labourer (2)***
1) Consumers know that some skin lightening creams contain mercury	5	0	0	5	0	0
	30	15	8	0	5	2
2) Consumers are aware that mercury is a toxic substance	35	15	8	5	5	2
	0	0	0	0	0	0
3) Consumers know that mercury-free skin lightening products are available in town/region	5	0	0	5	0	0
	30	15	8	0	5	2
a.) If "YES" to 3): consumers using a mercury-free skin lightening product	5	0	0	5	0	0
	0	0	0	0	0	0
b.) If "YES" to 3): Did you deliberately decide to use a product without mercury?	5	0	0	5	0	0
	0	0	0	0	0	0

5.1.4.2 Russian Merchant Cosmetic Survey

Availability. Products were found in 25 shops. A total of eighteen (18) widely-available products were found in the shops. Of these, fourteen (14) products were used for the survey. Most originated from France (9), some from Germany (3), or some (2) domestically produced.

Merchants indicated mercury-free skin-lightening products were widely available in pharmacies, cosmetic clinics and stores. All merchants surveyed (100%) were convinced that the products they sold did not contain harmful ingredients. Mercury con-

tent was not mentioned anywhere on the packaging of any product surveyed. The absence of any mercury statement on the package was sufficient for them to believe that the products they sold were mercury-free.

Merchants were aware that mercury is a toxic substance and that skin-lightening products might contain mercury. All merchants interviewed (100%) knew that mercury is toxic. All knew that skin-lightening products might contain mercury.

Merchants believed the products they sold were safe for use. They all believed in brand name manufacturers and were sure that well-known manufacturers would not sell dangerous products. At the same time, all merchants (100%) declared that skin creams, even if they contained mercury or other toxic substances, would not lead to fatal results. They were also sure that products they sold were safe since no statements concerning mercury and toxicity were present on the packages.

Merchants believed they gave good advice when asked about making a purchasing choice. All merchants (100%) believed they sold only non-mercury skin lightening creams. They believed strongly that all products they sold were safe and did not contain toxic substances, including mercury. Their confidence was based on their belief in brands. This confidence was confirmed by the list of ingredients printed on the products.

Merchants felt the mercury-free alternatives gave superior results. All sellers interviewed stated that there were no problems with decreased durability, lower efficiency or content of other toxic substances with mercury-free skin-lightening creams.

Price was related to source country. The cost for skin-lightening cosmetic products ranged widely from a low of about 2 RUB/ml to a high of over 20 RUB/ml. French imports tended to cost the most. Price was not related to listed active ingredient(s) or the complexity of the ingredient listing nor was there a cost relationship related to synthetic versus natural products. On some of the products only active ingredients are listed, on some all ingredients are listed. In general, the product ingredients were relatively well-declared.

Labelling was not well-defined. All products were claimed by merchants to be mercury-free, but no labelling was present for consumers to verify this claim other than

listed ingredients. Only two of the offerings were submitted for analysis and neither of them was found to have detectable levels of mercury.

Mercury was not found in analyzed samples. Two skin-lightening producst were analyzed for mercury, but mercury was found (Tab. B.5).

5.1.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restoration in Moscow, Volgograd and Novorossiysk, Russia

Participants. The Dental Restoration Survey was done at twenty (20) dentistries in Moscow, Volgograd and Novorossiysk, Russia.

Patients who sought dental care could afford it. All dentists interviewed at privately-owned clinics in Moscow stated that only wealthy patients could afford to get a tooth restored at their clinic while dentists from state-owned clinics in Moscow and with the other dentists interviewed in Volgograd and Novorossiysk, most (60%) said the average person can afford this service.

Dentists used many mercury-free materials for restorations. It was identified that amalgam was banned from use in many countries in this region, including Russia. All dentists interviewed (100%) used various non-mercury materials for restoration including: plastic, cement, ceramic, and glass ionomer cement, either with photic cure or chemical cure.

Dentists used a wide variety of alternative materials (n = 6). All dentists surveyed used different types of plastic fillings and other fillings of chemical cure and photic cure. Half of the dentists employ also ceramic, cement and glass ionomer cement fillings. Cost varied with the service rendered and the dental practice.

Dentists were aware of the risks posed by mercury. All dentists interviewed (100%) indicated they understood mercury's threat to human health and the environment, although two (2) dentists thought mercury was not as dangerous as indicated/talked about.

5.2 Kyrgyzstan: Bishkek and Issyk-Ata (Chui Region)

Bishkek is the capital and the largest city of Kyrgyzstan. Bishkek is also the administrative centre of Chui Province which surrounds the city. Civic population was estimated at 1,250,000 in 2007. The economy of Kyrgyzstan was estimated at US$ 11.66 billion GDP PPP in 2001 [14]. The per capita PPP earnings were calculated at US$ 2,146.64 for that year. The city of Issyk-Ata is a popular health resort open year round, about 70 km from Bishkek at an altitude of 1,775 m. Issyk-Ata became a place of pilgrimage after the Silk Road era.

The Som (code: KGS) is the official currency of the Kyrgyz Republic in Central Asia. As of 14 April 2009, the exchange rate was 1 USD = 43.2109 KGS or 57.1646 KGS to 1 Euro[10].

5.2.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Bishkek and Issyk-Ata, Kyrgyzstan

5.2.1.1 Kyrgyz Clinical Use Thermometer Survey

Participants. The Clinical Thermometer Survey was done in 10 hospitals and medical centres (5 hospitals, 5 medical centres) in Bishkek and Issyk-Ata, Kyrgyzstan.

Mercury-free thermometers were not used at medical and hospital facilities. Mercury-containing clinical thermometers were used in all hospitals and in all medical centres. At present, mercury-free clinical thermometers were not used at any (0%) hospital or doctors practice.

The cost of mercury-free thermometers was greater than mercury-containing thermometers. The cost for a mercury-containing thermometer ranges from 15 Som to 42 Som (avg. = 35 Som). The cost for an electronic mercury-free thermometer is approximately 200 Som. Electronic thermometer prices are based on past purchasing experience since no facility currently owns a mercury-free thermometer.

[10] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

Staff could not evaluate alternative methods. Those surveyed had little experience with alternative thermometers. Therefore, no conclusive comparison could be made about efficacy due to the lack of sufficient experience with mercury-free thermometer use for measuring patients' body temperatures.

Mercury-free thermometer experience was limited. Electronic mercury-free thermometers were used at one medical centre previously. Those thermometers were found to be safer to handle, but within the course of time (~8 months) they lost accuracy. It is unknown what led to this outcome but could have been related to lack of experience and a failure to maintain or repair them. Due to this loss of accuracy, they were exchanged for mercury-containing thermometers. Mercury-free disposable thermometers were sent to one hospital under humanitarian aid but were rapidly used up. These two limited experiences, as related to the interviewer, were indicated to be generally good.

Mercury-containing thermometers pose safety issues. The biggest problem related to the usage of mercury-containing thermometers was the management of broken thermometers, which were often thrown out with medical wastes or placed in common waste containers.

As related by the surveyor, five (5) hospitals currently have 1,546 mercury-containing thermometers in use. In 3 doctors' practices, sixty (60) mercury-containing thermometers were in use. Staff of one hospital reported that 100 - 200 mercury-containing thermometers have to be changed per year due to breakages.

5.2.1.2 Kyrgyz Household Thermometer Survey

Participants. The survey was done in 11 retail shops (10 drugstores and 1 pharmaceutical storehouse) in Bishkek and Issyk-Ata, Kyrgyzstan (see Tab. 5.3).

Mercury-free thermometers were available for purchase in many outlets. Many locations sold mercury-free thermometers (45%); all (100%) of them sold mercury-containing thermometers; no locations (0%) offered only mercury-free thermometers.

Mercury free thermometers were not as affordable as mercury-containing thermometers. Mercury-free thermometer prices ranged from 3.5 to 5 times more than the

most expensive mercury containing thermometer. Indicating price was a barrier to adopting mercury-free thermometers, but availability was likely not.

Tab. 5.3 Kyrgyz Home Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price (Som)	25	50	180	250

5.2.2 Current status regarding availability and use of mercury-containing blood pressure measuring devices in the health-care sector for Bishkek and Issyk-Ata, Kyrgyzstan

5.2.2.1 Kyrgyz Clinical Sphygmomanometer Survey

Participants. The Clinical Sphygmomanometer Survey was done in five (5) hospitals and five (5) medical centres in Bishkek and Issyk-Ata, Kyrgyzstan.

Adoption of exclusive use of mercury-free blood pressure meters occurred about a decade ago. All (100%) of the hospitals and doctors' practices (n = 10) used only mercury-free clinical blood pressure meters and have been doing so for more than 10 years according to the surveyor.

Mercury-free blood pressure meters were widely used. Mercury-containing clinical blood pressure meters were used in none (0%) of surveyed hospitals and doctors' practices. All hospitals and doctors' practices (100%) used only mercury-free blood pressure meters. In the hospitals surveyed sixty (60) mercury-free clinical blood pressure meters were in use, and in four (4) doctors' practices 193 mercury-free clinical blood pressure meters were in use.

Mercury-free blood pressure devices were affordable and widely available for purchase, but the choices were very limited. Only mercury-free blood pressure meters were in use in the hospitals and medical practices. The cost for a mechanical

blood pressure meter, depending on manufacturer, ranged from 338 to 653 Som (when completed with a phonendoscope – 1,100 Som), the cost for electronic blood pressure meter ranges from 1,500 to 6,000 Som. The respondents at one medical centre recalled that in 1998 the cost for a mercury-containing blood pressure meter was about 150 Som.

Using mercury-free blood pressure devices posed no difficulties. The clinical staff did not experience any difficulties in handling and/or using various styles (mechanical and electronic) mercury-free blood pressure meters, they found them easy to use and safe for patients and clinical staff. However, some blood pressure meters broke frequently and could not be fixed. Mechanical clinical blood pressure meters with plastic cases were shown to get easily damaged beyond repair. Respondents indicated their life cycles ranged from 6 months to 2.5 years.

Training staff on their use did not incur extensive cost. In three (3) hospitals and medical centres the respondents indicated that no training was required for the clinical staff. In six (6) hospitals and doctors' practices the respondents indicated the necessity for induction training when putting new models into operation. The staff of one medical centre indicated that such training is being provided to students at medical educational institutions.

5.2.3 Status of availability and cost of most common types of mercury-containing batteries on the market in Bishkek and Issyk-Ata, Kyrgyzstan

Availability problems in acquiring D-cell and button batteries were not found.

Many D-cell batteries on the Kyrgyz market were labelled. For cylindrical D-cells, twenty-one (21) different brands were found and investigated. Ten (10) of these were labelled mercury-free (~50% of D-cells) on the packaging or the battery itself, two (2) were labelled containing mercury, and nine (9) were not labelled at all. For only one (1) of the non-labelled batteries, a statement was found in the internet (contains no mercury).

All of the major brands of batteries were found in the marketplace. In Bishkek and Issyk-Ata, one could find all major battery brands for sale in the D-cell size.

Prices for unlabeled D-cell batteries tended to be lower. Prices for labelled D-cell batteries tended to be higher (10 - 100 SOM per battery) than with unlabeled ones (5 - 40 SOM), especially at the lowest prices.

Button batteries are poorly labelled. For the second selected type of battery, the alkaline button cell LR 44 (1.5 V), nine (9) different brands were found. For these, the labelling was not as evident and fewer of the products were indicated to be mercury-free (22%).

Prices were very similar for button batteries. All prices for labelled and unlabeled button batteries were comparable.

Most batteries were imported. None of the batteries could be identified as being produced in Kyrgyzstan. The majority of them came from Korea and China with a few coming from EU countries and elsewhere. Two of the imports were identified as containing mercury by their packaging. Both of these came from China. Six could not be identified as to their manufacturing country.

5.2.4 Status of the availability and use of mercury-containing skin-lightening products in Bishkek and Issyk-Ata, Kyrgyzstan

Participants. The Cosmetic Survey was done in ten (10) retail outlets and four (4) local dealers, and two (2) market places in Bishkek and Issyk-Ata, Kyrgyzstan for the side of the merchants, and with twenty-five (25) persons using skin-lightening soaps.

5.2.4.1 Kyrgyz Consumer Cosmetic Survey

Participants. From the total number of consumers interviewed there were sixteen (16) academics (including college graduates, artists, monks and other persons with “brain power”), five (5) craftsmen, three (3) temporarily unemployed, and one (1) farmer. (See Tab. 5.4)

Consumers knew mercury-free products were available. Most persons asked (60%) had knowledge that mercury-free skin lightening products were available in their region, some answered that they “were not interested in it”, and one person said she “did not see any statement concerning that.” This lack of awareness was prevalent

among the lower income occupations and may have reflected educational status as well.

Consumers knew about the potential for mercury in products. More than half (60%) of the persons interviewed were aware of potential mercury content in creams. The majority of the respondents were academics indicating education may correlate with awareness.

Many Consumers were aware of the risk from mercury. Most (80%) of the consumers knew about mercury's toxicity. Here the knowledge was rather evenly distributed among the occupations surveyed.

Consumers chose mercury-free products to protect their health and safety. The majority of all persons (60%) bought mercury-free creams recognizing their safety. The majority of the academics understood this, but few of the others recognized this issue (see numbers in Tab. 5.4).

5.2.4.2 Kyrgyz Merchant Cosmetic Survey

Availability. Assortments of five (5) to eight (8) different skin lightening creams were found in the seven (7) shops surveyed in Bishkek and Issyk-Ata, Kyrgyzstan. The survey identified a total of sixteen (16) different creams.

Merchants were unaware of the mercury content of the skin products they sold. During the survey done at some market places the merchants answered they did not know anything about the ingredients of the skin lightening creams available for sale.

Merchants felt results of brand-name creams were superior and likely mercury-free. All interviewed merchants were sure that well-known, well-respected firms did not produce mercury-containing skin lightening products; therefore, they actively promoted these products to consumers as safe and mercury-free. Merchants reported a lack of complaints about the products.

Tab. 5.4 Kyrgyz Consumer Cosmetic Survey Responses

Response		**Occupation**			
Inquiry	***"yes" "no"***	***Academics (16)***	***Craftsmen (5)***	***Farmer (1)***	***Unemployed (3)***
1) Consumers know that some skin lightening products contain mercury	15	12	2	0	1
	10	4	3	1	2
2) Consumers are aware that mercury is a toxic substance	20	15	3	0	2
	5	1	2	1	1
3) Consumers know that mercury-free skin lightening products are available in town/region	15	12	3	0	0
	10	4	2	1	3
a.) If "YES" to 3): Consumers use a mercury-free skin lightening product	15	12	3	0	0
	0	0	0	0	0
b.) If "YES" to 3): Consumers deliberately decide to use a product without mercury	15	12	3	0	0
	0	0	0	0	0

Merchants were aware mercury is toxic. Interviews with merchants regarding skin lightening cream showed that all respondents (100%) were aware of the danger of mercury. Some conflict is noted here as merchants indicated a lack of awareness about mercury content, but knew of the danger from mercury.

Not all available skin lightening creams had labelling information about their active ingredients. Vegetable-based active ingredients were mainly listed as compounds of the creams in the market places of Bishkek and the Chui Region

No skin lightening products were found to have statements regarding mercury on the package. Alongside well-respected brand-name skin-lightening products were unknown products of Chinese origin (1 - 2 per shop) without statements of ingredients. Other products came from e.g. Poland, Russia, Bulgaria, and Israel. Two of the (poorly

declared) offerings were submitted for analysis, neither of them had detectable levels of mercury.

A look at price relationships found a couple of the highest-priced, imported products commanded the highest prices. Prices for most products were under 2.00 SOM per ml except for a few imported products that demanded up to 76.00 SOM per ml. No clear relationship could be concluded from price. Chemical analysis found no mercury in two product samples (Tab. B.6).

5.2.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restorations in Bishkek and Issyk-Ata, Kyrgyzstan

Participants. The Survey was done in ten (10) dentistries in Bishkek and Issyk-Ata, Kyrgyzstan. Out of these, four (4) dentistries were private, and six (6) dentistries were state-owned.

Dentists stated mercury-free dental materials were the only tooth restoration materials used. None of the dentists (0%) in Kyrgyzstan were indicated to use mercury amalgam as a tooth restoration material, and in ten (10) dentistries out of ten (10) surveyed dentistries, no dentists used it.

Patients could afford mercury-free tooth restorations. According to some dentists, only those earning low to no income would not be able to afford a tooth restoration in the state-owned dentistries, the rest indicate everyone can afford this service. In private-owned dentistries only the average to wealthy people of Kyrgyzstan can afford a tooth filling.

Dentists indicated mercury-free materials were available to patients. It was identified that amalgam was banned from use in many countries in this region, including Kyrgyzstan. According to the survey data no dentistry has been using mercury amalgam as a tooth filling for more than 15 years. At the interview, the Chief Dentist of the Kyrgyzstan Republic noted that currently, the use of amalgam as a restorative material had been dropped from dental school curricula.

Dentists offered many mercury-free alternative materials for tooth restorations (n = 7). In all ten (10) dentistries surveyed, the dentists used many materials including cement, composite materials (light-hardened and chemo-hardened), evicrol, metacril-based polymeric materials, glass ionomer cement, and silidont.

Cost for tooth filling depends on the material and technology used. Restorative materials of cement (50 Som), silidont (69 Som), and evicrol (95 Som) were less-costly and more accessible to low-income patients. The highest price found was in private dental practices for light-cured composite – 1,800 Som. But other dentists offered similar light-cure composite fillings for 600 Som. These costs likely reflected expenditures for specific dental equipment, staff training, and mercury-free materials.

The preferred alternative material was light-cured composite material. In most instances (90%), patients did not ask for alternatives other than what was offered by their dentist as a filling material.

Dentists understood the health and environment risk posed by mercury and by the use of mercury amalgam. None of the dentists (0%) thought mercury was less dangerous than believed or spoken about.

6 Latin America

6.1 Brazil, Curitiba City

For 2001, Brazil had a Gross Domestic Product (GDP PPP) of US$ 2.030 Trillion and a per capita PPP of US$ 10,214.39 [14]. Curitiba City had over a US$ 17 billion GDP and ranks as the fourth largest in Brazil [16]. The GDP for the city is R$ 29,821,203,000 (2005) with a per capita average income of R$ 16,964 (2005). Research was undertaken in Curitiba City, located in Southeastern state of Parana. With a population approximately 1.8 million people, Curitiba City is the capitol of Parana and Brazil's 7th largest city.

The real (sign: R$; code: BRL) is the present-day currency of Brazil. The exchange rate as of 14 April 2009 was 2.1665 BRL to 1.00 USD or 2.8868 BRL to 1 Euro[11].

6.1.1 Current status on availability and use of mercury-containing fever thermometers for clinical and home use in Brazil

6.1.1.1 Brazilian Clinical Thermometer Survey

Participants. The Clinical Thermometer Survey included health care professionals at six (6) hospitals and three (3) doctors' offices in Curitiba City, Parana, Brazil.

Of the professionals surveyed, most (78%) had mercury-free thermometers in use.

Health care professionals indicated that mercury-free thermometers were not only available, but preferred. Of the health care professionals, the vast majority (88%) either saw no difference or preferred mercury-free thermometers because of either the technology improvements or the improved safety issues. Only one (1) person favoured mercury-containing thermometers because of cost-related issues including reduced likelihood of theft.

[11] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

Health care professionals in Brazil indicated that while slightly more expensive to purchase, mercury-free thermometers delivered accurate results and provide superior performance. From the majority that preferred mercury-free thermometers, most (57%) indicated their preference was based on features that signal after reaching a peak temperature; reduction in the need for specific positioning to get an accurate measurement; shorter time necessary to get a measurement; and breakage resistance. According to health care professionals, the average cost for a mercury-containing clinical thermometer R$ 7.50, while a mercury-free clinical thermometer average price was R$ 24.00.

Health care professionals strongly preferred mercury-free thermometers on safety issues. Reasons for this claim included the elimination of potential for mercury contamination of patients and facilities, and threats to patients and others posed by broken glass and mercury following any breakage.

6.1.1.2 Brazilian Household Thermometer Survey

Participants. The retail thermometer survey was done in eight (8) retail outlets in Curitiba City, Parana, Brazil.

Mercury-free options were readily available. In the vast majority (88%) of the shops surveyed, mercury-free thermometers were offered on the shelves. All of them offered mercury-containing thermometers.

Prices were higher for mercury-free options in all stores surveyed. Prices in most outlets were about double for selecting a mercury-free option compared to the mercury-containing ones. On average the mercury containing thermometer ranged from R$ 4.00 to R$ 6.15 mercury free options ranged from R$ 9.80 to R$ 17.95 (see Tab. 6.1).

Tab. 6.1 Brazilian Household Thermometer Price Survey

Type of thermometer	Mercury-containing		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price (BRL)	R$ 4.00	R$ 6.15	R$ 9.80	R$ 17.95
Average	R$ 5.56		R$ 13.88	

6.1.2 Current Brazilian status on availability and use of mercury-containing measuring devices in the health-care sector

6.1.2.1 Brazilian Clinical Sphygmomanometer Survey

Participants. The Clinical Sphygmomanometer Survey was undertaken in six (6) hospitals and three (3) doctors' offices in Curitiba City, Parana, Brazil. Most hospitals (5) and some doctors' offices (1) used mercury-free blood pressure meters. A few chose exclusive use of one or the other.

Health care staff has begun adopting mercury-free blood pressure meters and generally consider them accurate, user-friendly, more portable, and safer. From the hospitals and doctors' offices using mercury-free aneroid pressure meters, some doctors stated they were more reliable because of greater precision and accuracy, but many could not differentiate between the two types regarding accuracy, precision, or ease of use. Some liked the reduced risk of from breakage and preferred to work with the digital aneroid alternative because the smaller size made them more practical. Only one professional thought the mercury devices were more reliable due to their perception of greater precision.

When comparing mercury-free products, some performance was rated superior to others. Of interest here is the use of an aneroid "monitor" meter at one hospital. This was a different device from the smaller, portable, digital meters generally supplied for use. These portable meters were deemed unreliable due to inaccuracies. The respondent found the "monitor" meter was more reliable than the portable meters. As a result, this hospital made a comparison test using the same patient with their mercury-containing meter, a mercury-free "monitor" meter and a mercury-free "portable" meter.

The results showed that the portable meter gave different readings from the other two which gave the same reading. Consequently the hospital staff now prefers using the aneroid “monitor” meter due to its increased accuracy.

Costs for blood pressure meters were relatively comparable. Mercury-free meters ran from R$ 100 to R$ 175 while mercury-containing ones ran from R$ 50 to R$ 150.

6.1.3 Status of availability and use of most common types of mercury-containing batteries on the Brazilian market

D-cell battery products offerings were limited but well-labelled. Most retail outlets in Curitiba commonly sell D-cell batteries: supermarkets, toy stores, electronic stores, bargain stores, drugstores, gift stores, etc. Only a limited number of brands were available even with the large number of outlets selling these products.

Sources of batteries were varied. Production was varied with some domestic offerings alongside products from China, USA and the Philippines.

D-cell batteries were found to be well-marked. Most (83%) D-cell products were found to include information on their package that they do not contain mercury. Costs for most D-cell products ranged from R$ 1.80 to R$ 7.64 per battery.

Those offerings without labelling had the lowest prices and came from China while the most expensive were imported from the USA.

Button batteries were not as well-marked. Only one product (20%) found had any information and that was indicative of mercury’s presence.

For button cells, price was inversely related to mercury content. Button cell product prices increased as the knowledge of mercury increased with offerings labelled as containing mercury costing more than other non-labelled offerings. Only one (20%) button cell product was indicated to be mercury free.

A recent effort at passage of a National Environmental Council (CONAMA) resolution was undertaken to minimize any content of cadmium or mercury in batteries [17]. The new CONAMA restriction would minimize the amounts of cadmium and mercury al-

lowed in any battery sold in Brazilian markets. Of the products found, most (83%) were indicative of compliance with the new CONAMA restrictions with language ranging from “Formulated without cadmium or mercury” to “No mercury added.”

6.1.4 Status of the availability and use of mercury-containing skin-lightening products on the Brazilian market

6.1.4.1 Brazilian Consumer Cosmetic Survey

Participants. Twenty-six (26) persons using skin lightening soaps were interviewed in Curitiba City, Parana, Brazil. These respondents included five (5) academics (including college graduates, artists, monks and other persons with “brain power”), one (1) entrepreneur, two (2) governmental officers, two (2) housewives and sixteen (16) unskilled labourers. The responses from Brazil reflected more wage-earners that were outside of the middle to upper income demographic (see Tab. 6.2).

Brazilian government restrictions limit mercury in products. In Brazil, consumers require notification of mercury in products under National Health Surveillance Agency (ANVISA) requirements [18]. This government agency prohibits uses of substances or drugs in products they list for requiring consumer notification. ANVISA is considered a well-respected source of information.

Mercury was not well-known as an ingredient in cosmetics. Skin-lightening product users, in general, including the most-educated/highest income earners, were not well-educated on the potential for mercury’s presence (19% awareness) in cosmetics nor did most (73%) seek mercury-free when shopping for those products. Of those who knew mercury-free products were offered, most (86%) chose mercury-free products for their safety.

Consumers were aware of mercury’s threat. These same consumers, except for some of the least educated, were well-aware (69%) that mercury is toxic.

Tab. 6.2 Brazilian Consumer Cosmetic Survey Responses

Response		**Occupation**				
Inquiry	***"yes"*** / ***"no"***	***Academic (5)***	***Merchant (1)***	***Gov't officer (2)***	***Housewife (2)***	***Unskilled labourer (16)***
1) Consumers know some skin lightening soaps contain mercury	5	2	0	1	0	2
	21	3	1	1	2	14
2) Consumers aware that mercury is toxic	18	5	1	2	2	8
	8	0	0	0	0	8
3) Consumers know mercury-free skin lightening products are locally available	7	2	1	1	0	3
	19	3	0	1	2	13
a.) If "YES" to 3): Consumers use a mercury-free skin lightening product	6	2	1	1	0	2
	1	0	0	0	0	1
b.) If "YES" to 3):Consumers deliberately decide to use a product without mercury	2	1	0	1	0	0
	5	1	1	0	0	3

6.1.4.2 Brazilian Merchant Cosmetic Survey

Availability. Products were found in nine (9) shops. A total of eleven (11) widely-available products were identified. Of these, most (55%) products were produced domestically. Others included imports from France or gave no indications of origin.

Participants. The Consumer Cosmetic Survey results made nine (9) inquiries with merchants about skin-lightening cosmetics.

Merchants found clear information about the active ingredients, but not mercury, in various creams and soaps on all packages sold. None of the packages stated direct information about mercury, but according to the merchants interviewed, they did not sell mercury-containing products (77%). The rest stated that they did not know how to obtain this information.

Most merchants could not compare results, but said there were no complaints about the products they sold. In the efforts at assessing the mercury v. mercury-free

comparison on perceived quality and duration of results, ease of use, and affordability; most merchants (77%) felt they had no basis for such a comparison. As a result, they could not make a comparison because they lacked any experience or response from consumers about the efficacy of mercury-containing creams. All merchants (100%) did not mention any complaints about the products they sold.

All products were indicated to have active ingredient labelling. Products identified indicated their active ingredients and content, but failed to indicate if mercury was present. Some indications of the fact they sold no mercury-containing products may indicate the ANVISA declaration was a good substitute for mercury labelling. Only one merchant mentioned the ANVISA system as his guide for mercury-free products.

No product with mercury. In no product mercury could be found at a detectible level (Tab. B.7).

Cost for products ranged widely. Prices varied from a low of R$ 0.24 per gram to a high of R$ 3.63 per gram with imported products demanding the highest prices.

6.1.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restoration in Brazil

Participation. A total of eight (8) dentistries participated in the Dental Survey.

Dentists used mercury-free restorations with a clear majority using mercury-free filling materials exclusively. All dentists interviewed (100%) used resin composites as their main restorative material, with only one dentist employing ceramic materials, Vidrion® and Vitremer®. Most (75%) used only mercury-free restorative materials.

Even though all dentists offered mercury-free tooth restoration options to their patients, most indicated only middle and upper-class people could afford tooth fillings at all. The rest felt the vast majority could afford dental services in that office since discounts and payment options were offered. A few said their prices also vary in accordance with the financial status of patients, and the amount of restoration needed.

According to the dentists responding, the price difference to patients for using resin compounds ranged from R$ 30 to R$ 80 (avg. = R$ 55) over the price of amalgam. The

majority chose to avoid stating specific prices due to their office system for varying price as a function of the restoration's size and the patient's ability to pay. Rather, the variation was indicated in terms of percentage.

The average cost of resin costs was higher than amalgam. Some dentists indicated their price difference at about 33% more for mercury-free over amalgam while others indicated it was only about 20%. Most affirmed that the resin cost might go as high as 40 – 50% over that of amalgam. Ceramic options were indicated at only 10% more than amalgam.

Material cost was the major influence on price differences. Many dentists stated that resin filling wear less and were easier to alter, if needed. While the amalgam filling was the least expensive option, it required preparation of more material and additional preparation time that raised costs. One (1) dentist indicated equipment needed for resin restorations was more expensive than that used for amalgam restorations. All dentists stated that their training for non-mercury restorations was given in dental college so did not influence costs of alternative fillings other than the increased material costs.

Suppliers have a different take on what causes price differences. Two suppliers of resin equipment and material were queried about resin material and equipment costs. Both said that the equipment for resin (photopolymerizer) is in average around R$ 600 and comparable in price to the mercury amalgam mixer used for preparing mercury fillings. One stated resin and mercury amalgam materials were comparable in price, what was believed to cause the price variation was that resin's aesthetic appeal. Also said that when resin was first introduced training courses were very expensive, but now, it is a widely employed, common technique; making it difficult to distinguish the price difference in terms of material, equipment or training.

Most dentists indicated their patients normally request mercury-free materials. Some dentists affirmed their patients request mercury fillings due to their lack of awareness about mercury risks, but if/when informed, chose otherwise.

All dentists were aware that mercury posed risks to human health and the environment. None of them thought mercury was not as dangerous as indicated/talked about and all dentists have heard about health risks due to mercury.

6.2 Mexican Cities

Mexico City, Mexico State (for clinical thermometers, blood pressure meters, dentistry, households clinical/fever thermometers, creams and batteries); Chihuahua City, Chihuahua State; Texcoco City, Mexico State; Iguala City, Guerrero State and Coatzacoalcos City, Veracruz State (for clinical thermometers and blood pressure meters in the health care systems and dentistry)

Overall, Mexico had a US$ 1.578 trillion economy according to the 2001 estimate of PPP GDP. Per capita income was estimated at US$ 14,189 [14].

Mexico City incorporates 40 adjacent municipalities of Mexico State and 1 municipality of the state of Hidalgo, according to the most recent definition agreed upon by the federal and state governments. Greater Mexico City has a population exceeding 22 million people, making it the largest metropolitan area in the western hemisphere and the second largest in the world by population. With a PPP GDP of US$ 315 billion in 2005, the city's GDP per capita is US$ 22,696, the highest of any city in Latin America.

Chihuahua City is the state capital of the Mexican state of Chihuahua. Its population of about 748,500 works predominantly in light industry in the form of maquiladoras (industrial cities of mainly foreign companies) as it borders the southern USA.

Texcoco City is officially known as Texcoco de Mora, also commonly referred to as "Texcoco". The city stands at about 2,250 meters above sea level. Originally founded on the eastern bank of the Lake Texcoco, the city now sits well within the boundaries of Greater Mexico City. In the census of 2005 Texcoco de Mora had a population of 99,260 people and Texcoco municipality had a population of 209,308. The municipality has an area of 161.66 sq miles and includes numerous smaller communities besides Texcoco de Mora.

Iguala City, Guerroro State had a 2005 census population of 110,390 sitting on 218.96 sq mi. The city is the third-largest community in the state of Guerroro, after Acapulco and Chilpancingo.

Coatzacoalcos City is a major port city in the southern part of the Mexican state of Veracruz. The 2005 census population of 234,174 made it the third-largest city in the state

after Veracruz and Xalapa, but first in metropolitan population. The municipality covers a surface area of 181.916 sq mi and reported a population of 280,263 persons.

The peso (sign: $; code: MXN) is the currency of Mexico. As of 14 April 2009, its exchange rate was 13.1134 MXN to 1 US$ or 17.3745 MXN to 1 Euro[12].

6.2.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Mexico

6.2.1.1 Mexican Clinical Thermometer Survey

Participants. Clinical Thermometers Survey was done in ten (10) hospitals and four (4) doctors' practices in Mexico City, Chihuahua, Iguala, and Coatzacoalcos.

Mercury-free thermometers were present in many locations. Most hospitals (60%) and doctors' offices (75%) had mercury-free thermometers

Almost half of health care professionals interviewed preferred working with the mercury-free alternatives. Health care professionals listed the elimination of mercury, near-zero risk of any problems due to breakage, ease of use, faster response time, durability, equal or better reliability, and their modern technology as reasons they preferred mercury-free thermometers. Also noted was the digital readout was quick and exact, much faster than getting readings with mercury thermometers.

Once trained on use, even professionals accustomed to using mercury devices were convinced readings from both options were just as accurate. Of note here, in the three (3) hospitals where training was needed, some (mainly senior staff) nurses and doctors did not believe that digital thermometers were as precise and then compared readings using both. After a short period, they were convinced non-mercury digital alternatives were as accurate and dependable as the mercury-containing option and provided other benefits as well.

[12] http://www.oanda.com/convert/classic conversion rates determined on April 14, 2009 from website, website last visited April 14, 2009

Not only was training helpful, it was also widely understood that digital options needed some extra maintenance (including regular battery checks and replacement) and some additional care (such as avoiding putting them into extreme temperatures for sterilization).

When comparing prices, mercury thermometers were cheaper to buy; but according to some, in the long-term they were a more expensive option. But when hospitals realized how many mercury thermometers get broken each month (or year), minds were changed and the purchase of more expensive digitals were found to actually save money. For example, at the Children's National Health Institute, an inventory found 4,700 glass mercury thermometers were broken each year.

In many cases, health care professionals often had no choice in their daily rounds – mercury thermometers were the equipment they received for use. Those who indicated a preference for mercury thermometer usually did so because of their affiliation with hospitals that based purchasing decisions solely on cost and therefore used only mercury fever thermometers. Public Health Hospitals only purchase mercury thermometers.

The cost for a mercury-containing clinical thermometer range from 10 to 50 pesos (avg. = 15 MXN). The cost for a mercury-free clinical thermometer ranged from 50 to 490 pesos (avg. = 80 MXN). No problems exist with the commercial availability of mercury-free clinical thermometers. Many options were readily available on the market - digital, forehead strip thermometers, infra red, etc.).

6.2.1.2 Mexican Retail Thermometer Survey

Participants. Eleven (11) shops/market places/local dealers in Mexico City were surveyed for the availability and price of fever thermometers for home use.

All outlets (100%) offered mercury free thermometers for sale. Most locations (91%) sold both styles of thermometer, with one selling only mercury-free thermometers.

Prices were very different. The prices for alternative thermometers ranged from 2 – 18 times the price of mercury-containing ones. For lower income levels, price would be a barrier to adoption (see Tab. 6.3).

Tab. 6.3 Mexican Household Thermometer Market Analysis

Type of thermometer	Mercury		Mercury-free	
	Least expensive product	Most expensive product	Least expensive product	Most expensive product
Price (MXN)	$9.20	$22.00	$43.70	$169.40
Average	$15.60		$106.60	

6.2.2 Current status regarding availability and use of mercury-containing measuring devices in the health-care sector in Mexico

6.2.2.1 Mexican Clinical Sphygmomanometer Survey

Participants. The Clinical Sphygmomanometer Surveys were taken in ten (10) hospitals and four (4) doctors' practices in Mexico City, Chihuahua, Texcoco, Iguala City and Coatzacoalcos. Mercury-containing blood pressure meters were used in most hospitals and doctors' practices. Mercury-free blood pressure meters were used in just as many hospitals but fewer doctors' practices. Mercury-free blood pressure meters were used exclusively in only a few of the hospitals and doctors' practices.

Many hospitals and doctors' practices preferred working with the mercury-free alternative. Most (57%) found the mercury-free aneroid sphygmomanometers were easier to use, safer (no mercury risk from breakage), equally precise, equally reliable, and more mobile. These hospitals have chosen to sign a voluntarily mercury phase out commitment with Health Care Without Harm.

Accuracy is enhanced by regular maintenance. Ongoing efforts to convince senior staff about the precision of the mercury-free devices included indications that maintaining calibration merely required regular confirmation and adjustment, if necessary. It was noted by one physician that the digitals lost accuracy more frequently because of

his location (tropical, seaside Gulf of Mexico location) and that more frequent calibration was warranted.

To use mercury-free devices, additional training was needed at additional cost to the hospitals while doctors indicated training was not a burden. In order to institute the use of the aneroid devices, three hours of training for each staff shift (one training was estimated to run 500 MXN) was needed. Private consultancy indicated their staff did not need this training. It was noted that this training was given to students currently studying medicine.

Prices for mercury-free and mercury-containing devices overlapped. Mercury-containing devices range from 300 to 500 pesos (400 MXN average). The cost for an aneroid meter ranged from 150 to 700 pesos (1,500 MXN for the floor standing model, average cost = 300 MXN).

Minor, unidentified problems were noted on availability. Most people said there are no problems or had no opinion or evidence of issues related to availability. Some (15%) health care professionals indicated problems existed with the availability of mercury-free options but could not be more specific about the problems.

6.2.3 Status of availability and use of most common types of mercury-containing batteries on the Mexican market

Batteries were easily found in the markets surveyed in Mexico City.

75% of the D-cell batteries packages found (6 out of 8) were labelled mercury-free. An internet statement found indicated one additional battery was mercury-free. The major brands reported correspond with about 90% of the Mexican battery market. Batteries originated from either USA (63%) or Asian manufacturers. Those products that gave clear labelling had little price difference from those without labelling.

Button batteries were not as well labelled. Of the five button batteries obtained, most (60%) had no statement regarding mercury, the rest was labelled to be mercury-free.

6.2.4 Status of the availability and use of mercury-containing skin-lightening products in Mexico

6.2.4.1 Mexican Consumer Cosmetic Survey

Participants. Cosmetic Surveys were done in five outlets in Mexico City with merchants and were held with twenty-two (22) interviewees using skin lightening soaps/creams. Included were six (6) academics (including college graduates, artists, monks and other persons with "brain power"), one (1) craftsman, four (4) merchants, four (4) housewives and (7) seven labourers (see Tab. 6.4).

Consumers had no clear understanding about mercury in cosmetic products. The majority (82%) of respondents indicated a lack of awareness about mercury as a potential product ingredient.

Consumers using these products were generally aware mercury is toxic. Over half of the consumers surveyed (55%) indicated they understood mercury is toxic. None of these same respondents (0%) knew mercury-free skin creams were available.

Consumers did not choose mercury-free products deliberately. None of the persons (0%) surveyed decided to choose their products based on the potential for mercury in them. Persons who knew mercury-containing skin lightening products were once available in the town/region say they are no longer available.

The key influence on selection was price. People generally prefer a good price for their favourite but would change brands depending on price. When found in small stores or drugstores where variety is limited, some widely-sold brands had higher prices. Staining or uneven coloration was the main reason people used these products while others chose it because of their desire to lighten their overall complexion. Obtaining the desired results was the critical aspect when choosing products.

Tab. 6.4 Mexican Consumer Cosmetic Survey Results

Response		Occupation				
Inquiry	***"yes"*** / ***"no"***	***Aca-demic (6)***	***Crafts-man (1)***	***Merchant (4)***	***House-wife (4)***	***Unskilled labourer (7)***
1) Consumers know that some skin lightening soaps contain mercury	4	2	0	1	0	1
	18	4	1	3	4	6
2) Consumers are aware that mercury is a toxic sub-stance	12	4	0	2	3	3
	10	2	1	2	1	4
3) Consumers knowing that mercury-free skin lightening products are available in town/region	0	0	0	0	0	0
	22	6	1	4	4	7
a.) If "YES" to 3): Consum-ers use a mercury-free skin lightening product	0	0	0	0	0	0
b.) If "YES" to 3):Consumers deliberately decide to use a product without mer-cury	0	0	0	0	0	0

6.2.4.2 Mexican Merchant Cosmetic Survey

Availability. Fourteen (14) products were identified from seven (7) shops in Mexico City. Most (79%) were well labelled with the remainder having content listed inside the package but not where consumers could access it prior to purchase. None (0%) of them indicated mercury content or had mercury indicated as an ingredient.

All merchants stated they knew the contents of the products they sold and none contained anything toxic. All of the merchants (100%) indicated they had knowledge about the content of the products offered for sale in their shops.

Most merchants were unaware that mercury was toxic. Over half (57%) lacked knowledge that mercury was toxic. Of those that did know, most (67%) were unaware of mercury's potential presence in cosmetics.

All products sold were indicated to be non-toxic. All of the merchants indicated the products they sold were non-toxic. All of the shops indicated the products offered were mercury-free.

None of the merchants stated that the mercury-free creams were more difficult to get. One (1) merchant stated, that the mercury-containing creams are more difficult to get.

No strong difference in results was indicated. As far as results, none reported any difference in product performance. Three (3) merchants said this strongly depends on the brand of the soap. The most common skin lightening creams used in Mexico contain pearl shell powder. Merchants believe that all skin lightening creams sold are mercury-free. However, when asked, most (six of seven) merchants were unaware that mercury is a toxic substance.

Skin-lightening creams and soaps produced in Mexico must have a registry/permit through the Ministry of Health (Secretaría de Salud). Of the products identified only three (3) did not have an active contents declaration on their outer label and did not have the Ministry of Health seal. Clear information was available to consumers via labelling in almost products. Almost all merchants were unaware if skin lightening creams containing mercury and/or mercury-free creams were sold in their shops.

In many products mercury was found. Of the seven products analyzed, four were found to have mercury in detectable quantities. One product had a very high mercury content of about 1325 ppm mercury (Tab. B.8). All of these products were domestically produced. No clear relationship on price was indicated with one of the mercury-containing products reflecting one of the lowest prices. No relationship was indicated regarding labelling as some of the better declared products contained mercury.

Most products were produced domestically. The product containing the highest mercury level was also produced in Mexico, but stated to be a German formulation.

Prices for products varied widely. Prices for products varied from a low of 0.13 MXN per gram to a high of over 10 MXN per gram. No relationship was seen with price.

6.2.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restoration in Mexico

Participants. Twenty (20) dentists were interviewed in five (5) cities including Mexico City, Chihuahua, Texcoco, Iguala, and Coatzacoalcos. According to the respondents, in general, most urban residents cannot afford private dental care. Instead, a Public Health System is available to give the poor in rural and urban areas access to care. Almost all dentists (90%) use mercury, only two (2) dentists interviewed do not use amalgam. For alternatives to amalgam, dentists use resins, chromium, porcelain, and silver. The majority of the restorations placed involve the use of resins.

Charges for restoration placements vary not only between offices, but within an office and for the same materials. For example, one private dentist charges 450 Mexican pesos for amalgam, 700 MXN for resin and 2,200 MXN for porcelain. In the Public Health System hospitals, the lowest rate was 19 MXN for amalgam and 22 MXN for resin. Others answering said the difference can run from between 100 and 600 MXN for resin depending on the quality of the material and extent of the work necessary.

Dentists indicated the additional cost of equipment was incorporated into the higher prices for their placement. Some dentist said the cost of the other filling material can be 15 to 25% of the total cost but did not provide figures, other costs for placing alternative materials including special halogen lamps and protective lenses needed for placing resin materials.

Most dentists offered options on materials used with prices varying accordingly. Some dentists preferred amalgam because of its durability when used on larger surface areas. Some dentists in the public system said amalgam was the only available option when the government provided the supplies. In most cases, patients asked for

alternatives, but when presented the difference in price, chose amalgam. In some cases, the more expensive materials were chosen, mostly for aesthetic reasons.

With a rare exception, every dentist said they knew of mercury's health and environmental risks, but these were not well understood. While not indicated throughout the surveys, dentists indicated they understood mercury's toxicity. Results were highly variable and not always accurate. In addition, holistic concerns about mercury were not always understood.

For example, one (1) dentist said when properly used, mercury is not a danger. Other dentists said risks only exist if exposure is at high doses. Another doctor said he knew of a Mexican expert study indicating minimal risks from mercury amalgam that equated 50 amalgam fillings as the level initiating any risk.

At hospitals under voluntarily agreements to phase-out mercury, it was recommended that if amalgam must be used, it only be used in the pre-encapsulated form and with proper management of all residues. None of the dentists indicated awareness on mercury's persistence and only one (1) said anything about bioaccumulation.

7 Synopsis

7.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in communities surveyed

Eliminating mercury-containing clinical thermometer use was poorest in Kyrgyzstan (100% of all outlets surveyed used only mercury-containing thermometers), China (88% exclusive use) and India (70% exclusive use); while Russia (44%), Kenya (43%), Mexico (36%) and Brazil (21%) saw improvements over these; and Senegal (7%) indicated it had the best efforts underway. In most countries, clinical adoption of mercury-free thermometers was poorer than that indicated by the mercury-free marketplace offerings for home use (21% of outlets offered only mercury-containing thermometers), even though medical professionals indicated preferences for this technology. Much of this was indicated to be due to budgeting restrictions in the health care sector.

Preferences for mercury-free thermometers by some health care professionals (22%) were seen in all countries' health care sectors due to their safety, ease of use, flexibility, response time, and durability. Senegalese (50% preferred mercury-free thermometers), Brazilian (44%) and Mexican (43%) physicians showed the most desire for use while Kenya (29%) and Chinese (38%) were also supportive. Indian (not indicated), Kyrgyz (not indicated) and Russian (5%) physicians showed the least concern for eliminating these products from their private practices, hospitals and clinics.

In addition to cost, some problems associated with using mercury-free options included accuracy, reliability and availability. Most health care professionals responding negatively about mercury-free thermometers were quick to point out accuracy as an issue for them (noted from Senegal, China, Russia and Mexico). This issue can be created due to the quality of the non-mercury thermometer. Physicians in half of the countries indicated reliability issues. This may also have been an artefact of quality or it could have originated from poor or non-existent maintenance of electronic thermometers. Disinfection of newer materials and the need for alternative methods was also indicated to create issues related to adoption (Russia). Availability was indicated to be a big problem in Kyrgyzstan but not elsewhere.

Clinical thermometer prices varied widely in the areas surveyed. Most surveys found prices ranged from being similar in price to 120 times more for non-mercury options when compared to mercury-containing thermometers. The highest price differences for low-end offerings were seen in Kyrgyzstan and Kenya (where the lowest cost mercury-free thermometer was about 5 times more expensive than for the lowest priced mercury thermometer).

Home thermometers ranged from having similar pricing for both the lowest priced mercury-free and mercury-containing thermometers to 160 times greater for the highest priced mercury free option compared to the lowest priced option.

In many countries, stores carried mercury-free options (80%) while hospitals and clinics maintained their mercury thermometer use (53%). Health care professionals indicated barriers to clinical adoption to be generally related to budgeting issues outside of the physicians' control.

7.2 Current status regarding availability and use of mercury-containing blood-pressure measuring devices in the health-care sector of communities surveyed

This had the clearest differentiation in response by region. Both Eastern European countries, Russia and Kyrgyzstan – 0% exclusive mercury device use/100% exclusive non-mercury devices regionally, had eliminated the use of mercury-containing devices in doctors' offices and hospitals over a decade before, according to the surveyors. The two Latin American countries (Brazil and Mexico GRULAC region – 18% exclusive Hg use/26% non-mercury) have made strong efforts to address their use. Some efforts were indicated to be underway in Africa (Kenya and Senegal African Region 20% and 5%), but the two Asian countries showed the lowest level to date for eliminating mercury-containing devices and adopting non-mercury devices exclusively (India and China Asia-Pacific Region – 61% and 5%).

Preferences for mercury-free devices were seen by health care professionals due to their convenience, ease of use, safety and improved readability issues. The majority of professionals surveyed indicated preference for mercury-free products in Senegal (57%), Mexico (57%) and China (75%). Less support was seen in Kenya (17%), India (25%) and Brazil (10%). Medical schools were tending to train and use mercury-free devices in not only Russia and Kyrgyzstan, but also Latin American and African re-

gions, while no indication of this training in schools was made in Asian countries. This, even though no country indicated costs for training were excessive or burdensome. This training eliminated those additional costs for adopting this technology. Mercury-containing device prices were not well understood but pointed out to be much costlier in China. In Senegal, costs were reported as lower for mercury-free options, while health care professionals indicated the costs were higher. Strong perceptions about mercury-containing devices and their perceived “superior” performance were seen in those countries where efforts to replace these products was lacking (China, India, Senegal and Kenya).

7.3 Status of availability and use of most common types of potentially mercury-containing batteries on the market in communities surveyed

The best indicator on mercury-free batteries was the labelling of those products. For D-cell batteries labelling was much better than for button cell varieties. India (0% labelled mercury-free) and Kenya (0% labelled mercury-free) displayed the least point-of-sale information to consumers about their purchases. China (100%), Brazil (83%), and Senegal (54%) led the way on informing consumers about their purchases. In some cases (27%) additional information was available via the internet, but information made available here fails to give consumers information when they most need it – when making decisions regarding purchases.

A large difference was seen between D-cell and button batteries. Button batteries were not as well indicated, only 27% had a statement on mercury, this increased to 57% when internet research was added. Kyrgyzstan (14%), India (0%) and Russia (0%) had the lowest reported indications. Senegal was also 0%, but only had one battery present in the button-cell survey.

For D-cells, 72% had statements, while internet research increased this to 89%. When internet research was added, Kyrgyzstan (31%) and Senegal (23%) had the most D-cell batteries purchased without information available.

Price and importation were not significant factors related to the mercury-free battery market. For most markets the price was the same or similar for both marked and unmarked products, while in one instance price was greater for mercury-containing button cell batteries. Labelling was not seen relating to either importation or domestic production.

7.4 Status of the availability and use of mercury-containing skin-lightening products in communities surveyed

Retailer knowledge and consumer use of cosmetic skin-lightening products was similar in all markets. Surveys in Russia, India and Senegal indicated mercury-free product adoption was lowest in these countries. Responses indicated linkages between mercury awareness and use in half (Kenya, India, Russia, Kyrgyzstan) but not all (Senegal, China, Brazil, Mexico) markets. Awareness and use of mercury-free products tended to trend following education and income. Kenyan and Chinese merchants (not necessarily in cosmetic sales) also tended to choose mercury-free products for their use.

Kenya, Mexico, and Brazil, had instituted labelling systems to inform the public about limits of mercury in skin-lightening products while Russia had banned their sale. Many merchants indicated mercury-containing products were available (Kenya, China, Kyrgyzstan, Russia and Mexico) and some even stated these were relatively easy to get, although many said this was not legal (Kyrgyzstan, Russia, Brazil and Mexico).

Awareness varied among countries. Both consumers and merchants surveyed in Kenya were very aware of the potential for (83%) and concerns about (100%) mercury in skin-lightening products while China (53%/87% potential and concerns respectively) and Kyrgyzstan (60%/80%) showed high awareness in both categories; Brazil (19%/69%) and Mexico (18%/55%) showed less knowledge or concern about mercury in these products but awareness about mercury's toxicity. Russian (9%/64%) responses indicated overall knowledge about mercury, but not with regard to skin-lightening products. While India (8%/24%) and Senegal (0%/3%), showed the lowest overall awareness.

Laboratory analysis showed countries with labelling systems still had issues related to mercury content in the products sold there. Mercury was detected in products sent for testing from India, Kenya, but contents were below the limit of quantification (0.07 ppm). Mercury likely was present as a contaminant from other ingredients. In Mexico, products containing 0.8 ppm were found, in one skin lightening cream a mercury content of 1325 ppm was analyzed. It is unknown if any of these products carried government approvals/verifications.

Price differences regarding mercury content were not found. Relationships to cost were mostly related to source of imports with French imports tending to cost more in Brazil,

China, and Russia while African imports from Ivory Coast and other neighbouring countries were more expensive in Senegal.

No consumer or merchant claims were widely expressed about problems associated with using mercury-free skin-lightening products (as seen with thermometers and sphygmomanometers). Although the most common negative relationship indicated mercury-free products were less effective.

Some preference was also indicated for natural or herbal products as these were felt to give consumers another layer of safety from potential chemical exposure problems associated with using these products. All markets had such offerings, but there was no clear movement by consumers or merchants to pursue or promote their use.

Labelling of products varied from extensive and complete listing for all ingredients, to minimal with only active ingredients listed, to having nothing at all. Product trade secrets that limit disclosure of the actual ingredients may have affected the listings and identification of active ingredients. Active ingredients listed included chemical preparations and natural extracts.

7.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restoration in communities surveyed

The dental market was seen to be somewhat regionally influenced. Both Eastern European countries (Kyrgyzstan and Russia) had banned amalgam from use in dentistry as early as the mid-1980's according to reports from the surveyors. All countries had dentists who offered mercury-free alternatives to their patients. But not all dentists offered this service. While Kenya, India and Mexico had dentists surveyed who still offered only amalgam as a restorative material to their patients. When those who used amalgam were analyzed, the numbers showed a little different story (Kenya 100%, Mexico 90%, Senegal 86%, India 70%, Brazil 25%, and China 21%).

While consumer inquiry about mercury-free options was identified by all dentists (100%) affordability was estimated to be outside of some patients budgets. Cost as a prohibition to getting mercury-free restorations was indicated beyond a portion of the populations seeking restorations by dentists as: Brazil 88%; Kenya 33%; China 90%; Senegal 0% and India 0%. Prices to patients were indicated to be: Kenya

1,000 –1,400 KES; Senegal 5,000 – 20,000 XOF; China 20 – 200 RMB; India 200 – 2,000 RUP; Brazil 30 – 80 BRL; and Mexico 100 – 600 MXN.

Contradictions were seen in amalgam as a problem compared to mercury. All dentists, except one in Mexico, felt that mercury was as toxic as indicated. However, in China, many dentists (53%) did not feel that amalgam was as much of a problem as indicated. Other countries where dentists indicated some lack of concern about amalgam use were Mexico (95%), Russia (90%) and India (90%).

Dentists in Kenya, Senegal, China, India, Brazil and Mexico indicated the mercury-free materials were more expensive to acquire and required more time to place, increasing costs to patients (from 10 – 100%). The other major difference between amalgam and mercury-free materials, in addition to cost, was indicated as durability.

8 City of Braunschweig, as an example from Germany

Braunschweig, a city in Northern Germany with a population of about 250 thousand people is used to describe exemplarily the situation for a city in an industrialized country of Western Europe.

Germany has an area of 357.000 km² and a population of about 82.33 million people. Germany's gross domestic product personal purchasing parity (GDP PPP) economy was estimated in 2001 at US$ 2,863 billion [14], with a per capita PPP income of US$ 34,775. Germany is one of the founding members of the European Union and introduced the Euro (€) as national currency in January 2002. As of April 14, 2009, the exchange rate was 1 € = 1.39736 USD or 1 USD = 0.71564 €.

For all surveyed products it was tried to visit and study at different places as possible (e.g. different sizes of shops, high priced and budget-priced market places, discounter and specialty stores, old and young doctors, doctors employing different kind of techniques) to get a preferably sophisticated and comprehensive result. Due to the limited number of locations and individuals visited, figures and percentages should be regarded as local spotlights that are not necessarily representative. Therefore numbers and percentages are mostly abandoned.

8.1 Current status regarding availability and use of mercury-containing fever thermometers for clinical and home use in Braunschweig

8.1.1 Clinical Thermometer Survey

Participants. For the clinical thermometer survey health care professionals in three (3) hospitals and three (3) doctors' practices were interviewed. In order to find persons who still have experiences with mercury-containing thermometers, doctors' practices with doctors above the age of 60 were looked for.

Staff in all hospitals uses only mercury-free thermometers. In two doctors' practices that are managed by senior doctors (age of 62 and 67), also mercury-containing thermometers are still used besides digital (mercury-free) thermometers. In one practice the doctor and his staff is working with the mercury-containing thermometers. In

the other practice only the doctor himself uses mercury-containing thermometers because he would be well versed in utilizing them. But this doctor does not allow his staff to work with mercury-containing thermometers. The mercury-containing thermometers in these doctors' practices are leftovers from the past. New mercury-containing thermometers are not being obtained.

Experience with mercury-free thermometers is very good. Younger staff has no experience with mercury-containing thermometers anymore. But the older health care professionals stated, that mercury-free thermometers are very easy to handle, that the measurement is faster and their usage is safer than with mercury-containing thermometers. Mercury-free thermometers are similarly exact and reliable than the mercury-containing ones, but only when the battery is not too weak. Therefore the battery should be changed every six months.

All medical staff prefers working with mercury-free thermometers especially because of the absence of hazard due to mercury. Another reason is the faster measurement with the digital thermometers. This minimizes the danger, that patients bite the thermometer with their teeth. Those senior doctors who have always worked with mercury-containing thermometers and expressed to be experienced in handling them did not express any preference.

There are no problems with the accuracy and reliability of mercury-free thermometers as stated very often in other surveyed countries. Frequent battery replacement seems to be an issue for high reliability and accuracy of digital thermometers. Doctors in Braunschweig stated, that as long as mercury-free thermometers are running with a strong battery, they would be very reliable. There is no experience in Germany that the mercury-free option is less reliable for old people or people with high blood pressure because there is no correlation between temperature and blood pressure.

Costs for mercury-free thermometers are quite low but still higher than for mercury containing equipment. Only for hospitals a statement concerning the costs of used thermometers could be obtained. Here a mercury-free thermometer cost 1.61 €. A specialty shop for medical equipment (supplier for hospitals) also stated 1.60 € for simple mercury-free thermometers, but only half (0.80 €) for mercury-containing thermometers.

Mercury-free containing thermometers are everywhere available, Mercury-containing thermometers are on request still available for hospitals. None of the interviewed hospitals and doctors' practices still buys mercury-containing thermometers. Therefore they have mostly no idea if mercury-containing thermometers are still available. The rest has the opinion that only remainders are sold. A specialty shop for medical equipment does not have them in stock, but is able to re-order them on request[13].

8.1.2 Household Thermometer Survey

Participants. The Home Thermometer Survey was done at eleven retail outlets and pharmacies, respectively. These market places were three big specialty electronic shops, two drugstores, one department store and five pharmacies.

In all places only mercury-free thermometers were sold. 50% did not know, since how long their retail outlet does not sell mercury-containing thermometers any more. The other half of the staff in the shops stated that they never sold mercury-containing thermometers or that they do not sell them for at least 3 years. One pharmacy sold mercury-containing thermometers on request. But the staff of that pharmacy declared that since end of 2008 no thermometers with mercury were available any more.

Simple Mercury-free thermometers are quite cheap. The cheapest simple mercury-free thermometer in the different stores cost between 2 and 10 €, special thermometers like Ear-thermometers cost up to 50 €. The absolute price of a normal thermometer is so low in comparison with average income that the premium to be paid for mercury-free devices is not significant and does not represent a barrier towards the use of the mercury-free alternative. In 2008/early 2009 there was a nationwide campaign by pharmacies, during which customers could bring in their old mercury-containing thermometers and buy new mercury-free devices at a discounted price. But staff in visited pharmacies did not take part at the campaign and did not know about it either.

[13] It might be noted that since April 2009 bringing mercury-containing fever thermometers and other measuring devices onto the market is prohibited by EU law (2007/51/EC). Exceptions exist for health care and scientific purposes.

8.2 Current status regarding availability and use of blood pressure meters in the health-care sector in Braunschweig

Participants. For the survey on blood pressure meters health care professionals in two (2) hospitals and three (3) doctors' practices were interviewed. In order to find persons who still have experiences with mercury-containing blood pressure meters, doctors' practices with doctors above the age of 60 were looked for.

Medical professionals in all hospitals and almost all doctors' practices use only mercury-free blood pressure meters. In general mercury-containing blood pressure devices were substituted a long time ago as even the elderly staff in the hospitals has never worked with them. Only one senior doctor (62 years old) was found still using also mercury-containing blood pressure meters. The mercury-containing blood pressure meters in this doctors' practice are leftovers from a long time ago. He still works with them because they are very accurate if regularly gauged. No new mercury-containing blood pressure meters are bought.

Experience with mercury-free blood pressure meters is very good. Only three respondents could compare the mercury-free with the mercury-containing device due to missing experience of the other persons with the mercury-containing option. For these people measurements with mercury-free blood pressure meters are comparable in accurateness, reliability and quickness. They feel both devices as safe.

Only little training is necessary to get familiar with mercury-free blood pressure meters. Only a short instruction for the handling of the devices has to be done. For mercury-free blood pressure meters this is less than for mercury-containing devices.

Mercury-containing blood pressure meters are not stocked any more. In pharmacies mercury-containing blood pressure meters are not offered any more. Staff in a specialty shop for medical equipment (supplier for hospitals) said they could provide the customer with a mercury-containing blood pressure meter on request, but nobody would order it nowadays. Therefore the price is unknown. Medical staff could not tell the prices for mercury-free blood pressure meters, because new ones are not very often ordered. High quality mercury-free blood pressure meters in pharmacies cost 30 – 60 €.

8.3 Status of availability and cost of most common types of batteries on the market in Braunschweig

Participants. The survey on D-cell batteries and button cells (type LR 44) covered six (6) retail shops (3 big specialty electronic shops, 2 drugstores (offered no button cells), 1 department store).

No mercury-containing cylindrical batteries were sold in Braunschweig. Every shop sold about three different kinds of D-cells. In total nine (9) different batteries were found. Most of them (8) were produced in the European Union, one (1) in Switzerland. On the batteries or their packaging of one third (3 brands) a statement was given, that the certain battery contains no mercury. Six (6) had no statement, but for two (2) of them, an information could be found in the internet that they would be mercury-free. One shop assistant told us, that some years ago the information about mercury absence was given on the batteries. But nowadays, there would be no statement any more on the batteries, because it would be clear that they are mercury-free. Indeed, since 2001 it is prohibited to sell cylindrical batteries with more than 0.0005 weight% mercury in Germany (BattV § 13). The same regulation is also valid for the European Union (regulated by EU Directive 2006/66/EG). Therefore the adoption of mercury-free cylindrical batteries for all EU countries is completed.

The prices for the batteries in the surveyed shops were between 0.8 € and 3 € for one battery.

All button cells found were labelled. This is not surprising as the EU Directive 2006/66/EG allows selling of button cells containing up to 2 weight%, but regulates that all batteries containing more than 0.0005% mercury have to be labelled. Therefore manufacturer producing button cells with less than 0.0005% mercury are labelling their batteries as mercury-free.

Mercury-containing button cells cost about half of mercury-free button cells. Among 5 button cells of type LR 44, three (3) were labelled as being mercury-free. The two (2) button cells labelled as mercury-containing were only found in one discount specialty shop. These two showed also the cheapest prices with 1.23 € and 1.32 € per button cell. In this shop mercury-free button cells were not available. Upon request the shop manager showed to be unaware that mercury-free batteries were on the market. After being informed that these cost about twice as much, he stressed that such a pre-

mium would be unacceptable to their customers. The mercury-free button cells cost between 2.00 € and 2.99 € per battery. Mercury-free batteries were imported from Japan and China, mercury-containing button cells were produced in China and Germany.

8.4 Status of the availability and cost of mercury-containing skin-lightening products in Braunschweig

Participants. The Retail Cosmetic Survey was only done in three (3) shops, because no more shops selling skin-lightening products could be found in Braunschweig besides pharmacies. These three shops are managed by immigrants with most of their customers being immigrants also. In pharmacies no mercury-containing skin-lightening products are sold, because they are prohibited by the German regulation on cosmetics[14]. (Products, whose application and effect are restricted by the skin only, are referred to as cosmetics[15]). Therefore pharmacies were not properly surveyed, but some information about the products available was gathered.

Availability. In these three shops, the choice of skin-lightening products was quite different. In one shop only one cream (lotion) was available, in the second shop five soaps were offered. The third shop stocked 19 different skin-lightening products (soaps as well as creams and lotions, respectively). The choice of products obviously reflected the customers' background as being mostly either of African (or French) or Asian origin. In pharmacies only skin-lightening products with herbal active ingredients (e.g. kojic acid, watercress essence (nasturtium officinale) are available over the counter. In prescribed skin-lightening creams hydrochinone and cortisone are used as active ingredients.

Merchants were mostly not aware of mercury as being a toxic substance and that skin-lightening products might contain mercury. In two of the shops (not the pharmacies), merchants did not know anything about mercury. In the third shop one merchant knew, that it is a heavy metal. None of the sellers knew that mercury was frequently used as an active ingredient in the past and could still be a component in the products they offer. No one of the merchants knew whether they sell products with or without mercury.

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[14] In accordance with EU Directive 76/768/EEC mercury is not allowed as an ingredient or contamination except in eye cosmetics with a limit of 0.007 weight% [19].

[15] German Medicines Law (Arzneimittelgesetz §1 (3), 2) [20]

All skin-lightening products have an ingredients list on their wrapping. Most products were well declared. For soaps mostly only 3 – 4 substances were listed. But at least one active ingredient is always stated, giving the impression that active ingredients are always specified. Active ingredients more often mentioned are hydrochinone, kojic acid, bearberry extract, lemon extract or citronellol, niacinamid and alpha hydroxic acids.

For one soap mercury is listed as active ingredient. Very demonstrative (red and bold) it is stated on the package, that the soap (Mekako) contained 2% of mercury iodide (corresponding to 0.88% of mercury). However, a chemical analysis showed only minor levels of mercury (< 1ppm). This soap was produced in Dubai and additionally labelled "NEW". The fact, that a soap with a demonstrative declaration of 2% mercury iodide was found in a shop within such a small random sample, shows that the active ingredient mercury is still a selling point[16]. A statement that a certain product contains no mercury was never observed.

All the products sold in the shops are purchased from European importers. According to the sellers the availability of the products would be the same as long as the brand exists.

Obviously merchants do not know the active ingredients, which could be in their products. Therefore merchants do not know anything about efficiency of mercury-containing or mercury-free products or certain active ingredients. Merchants met in the shops do not really advise their customers. One seller said they were mainly selling food: Cosmetics were only a small part of their assortment and they have no idea about these products. The next seller was afraid to get problems and just told that her product were a good one. And the last seller with the highest selection of products said, the customers normally knew, which brands they wanted to buy. If customers asked her, she recommended good brands. But she was never asked about mercury so far.

Price of the products is neither related to source country nor to the listed active ingredients. The cost for skin-lightening products ranged widely from a low of about 1.85 €/100g to a high of 8.00 €/100g for soaps and from a low of 2.00 €/100ml to a high

[16] This is not the only finding of mercury in skin lightening cosmetics. As stated in the "Braunschweiger Zeitung" (Braunschweig newspaper) on November, 25th, 2009, also in Rheinland-Pfalz (a federal state of Germany) mercury was found in a skin lightening cream called "Shirley Medicated Cream".

of 25.00 €/100ml for creams and lotions, respectively. Because far the most products were produced in France, no relationship of the cost related to source of the product can be analyzed. Herbal Products sold in the pharmacies were much more expensive (about 15 – 25 €/100 g), but these products should only be applied on face and décolleté or rather only on pigmentation and liver spots.

8.5 Status of availability and use of dental amalgam and mercury-free alternatives for dental restoration in Braunschweig

Participants. The Dental Restoration Survey was done at four (4) dentistries in Germany. In order to get a comprehensive view by the small number of places that could be interviewed, it was actively sought for dentists applying different filling materials (especially amalgam and alternative material) for a different price. Therefore three (3) dentists using no amalgam and one (1) dentist using amalgam in their practice were selected. To get a more reliable answer on the question which percentage of dentists still employs amalgam fillings, twenty-five (25) dentists were additionally queried on this.

Nearly all patients can afford a basic tooth filling. A basic tooth filling is paid by the health insurance without additional costs for the patient. A health insurance is obligatory for all inhabitants of Germany. This basic filling material is mercury-amalgam or different cements (phosphate cement, zinc oxide eugenol cement, glass ionomer cement), and also composites (plastics) for the front teeth.

Three of the four interviewed dentists do not use mercury amalgam for different reasons. The reason for that given by the dentists are on the one hand health protection of the patient (release of mercury, interaction with other metals) and of their own (release of mercury gas during dental works). On the other hand, dentists stated that the patients do not want mercury amalgam anymore because of the metal mercury and preference for tooth-coloured materials. The one dentist who still applies mercury amalgam does this only rarely, if the patient does not want any other material and cannot afford another material, respectively.

Ten (10) of the 25 dentists (= 40%) interviewed on the usage of amalgam do not employ it nowadays. Most of them do not use it since 5 to 10 years or since opening of their practice. Of the fifteen (15) dentists still employing amalgam, only four (16%) use it as a standard material. The remaining 44% (11 dentists) said they would use it only rarely.

Additionally to the above stated basic filling materials different composites and compomers are used. These fillings are available for patients who are willing to pay a premium. The extra costs for the patients are for compomers about 15 € – 35 € per filling, for composites about 20 € – 80 € depending on the size of the filling and on the dentist. One of the selected dentists offers a cheap compomer material for no additional cost for the patient as an alternative standard filling because he does not want to use mercury. The filling material most often employed are composites. For inlays gold and ceramics are used.

Working with all alternative filling materials is part of educational standard training in Germany. An extra investment of about 1,000 to 1,500 € is required for lamps (polymerization) and provision of different tooth-colours etc. As working with alternative filling materials is generally accepted and widespread, the necessary investments already belong to the standard equipment of every dentistry. According to an estimation of a dentist the factually arising costs for an alternative filling are about 100 € more than for an average filling.

Most of the dentists argue that the best alternative fillings were as good as mercury amalgam fillings or even better. Even on the chewing surface the best alternative fillings are at least comparable to mercury amalgam.

New patients ask only rarely for alternative materials. According to the estimation of one dentist there was a good portion who does not care at all and another good portion of patients expect mercury-free dental care without further asking.

There are safety precautions when working with mercury amalgam. For every dental practice a mercury separator is obligatory and the mercury waste has to be disposed of as hazardous waste. It has to be cared for adequate ventilation at the time it is worked with mercury. And eventually a cofferdam is to be used (kind of protecting cover over the tooth) when an amalgam filling is bored out.

Dentists are aware of mercury as a toxic element. But partly they also said that the mercury amalgam would be more dangerous for the dentist than the patient and that the hysterics about mercury amalgam were not justified.

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APPENDIX A. Survey Documents

A.1 Clinical Thermometers

-> Please interview different hospitals and doctors' practices

- Are mercury-containing clinical thermometers used in the hospital or doctors' practice?
- Are mercury-free clinical thermometers also in use?
- If mercury-free clinical thermometers are used:
  - How is the experience with these thermometers (e.g. usability, reliability, safety) compared to the conventional mercury-containing thermometers?
  - Does the clinical staff preferably work with the mercury-containing or mercury-free alternative? Why?
- How much are the costs for a mercury-containing and a mercury-free clinical thermometer? (specify the prices in national currency)
- Are there any problems with the availability of mercury-free clinical thermometers?

A.2 Blood Pressure Meters in the health care system

-> Please interview different hospitals and doctors' practices

- Are mercury-containing blood pressure meters used in the hospital or doctors' practice?
- Are mercury-free blood pressure meters also in use?
- If mercury-free blood pressure meters are used:
  - How is the experience with these instruments (e.g. usability, reliability, safety) compared to the conventional mercury-containing blood pressure meters?
  - Does the clinical staff preferably work with the mercury-containing or mercury-free alternative? Why?
  - Has any training been necessary for the staff in order to work with the mercury-free blood pressure meters? Optional question, if the interviewed person knows about financial affairs: If yes, did any costs arise for the hospital respectively doctors' practice? How much (specify the costs in national currency)?
- How much are the costs for a mercury-containing and a mercury-free blood pressure meter (specify the prices in national currency)?
- Are there any problems with the availability of mercury-free blood pressure meters?

A.3 Thermometers used in Households

-> Please go to local dealers / shop owners or other places where you can buy thermometers

– ask for the costs of mercury-containing and mercury-free thermometers. Please specify the prices in national currency (in each case for a cheap and an expensive product (comparable in functionality)) for

Clinical (Fever) thermometer	**Mercury-containing**		**Mercury-free**	
	cheapest product in the shop	most expensive product in the shop	cheapest product in the shop	most expensive product in the shop
Price in national currency				

A.4 Skin Lightening Creams

(If application of skin-lightening soaps is rather unusual in your country/region but skin-lightening creams are much more common, please interview about creams and also buy creams)

-> Please interview local dealers/ shop owners (5 to 10) as well as consumers (approximately 25) and maybe practitioners in the health care-sector.

In case of consumers: Information about educational background:

Please note profession of interviewed persons. (The professions shall be grouped later into the categories “academics” (including artists, monks and other persons with “brain power”), “craftsmen”, “sellers”, “farmers” and “day-labourer”):

Questions to consumers who use skin-lightening products (especially soaps):

- Do you know that some skin lightening soaps contain mercury?
- Are you aware that mercury is a toxic substance?
- Do you know whether mercury-free skin-lightening soaps are available in your town/region?
- If yes:
  - How is the availability of mercury-containing and mercury-free skin lightening soaps (do you have to buy them in different places, or is one type of skin lightening soap only in special places to get, or is one type often sold out)?
  - Do you use a mercury-containing or a mercury-free skin-lightening product?
  - Did you decide deliberately to buy a cream/soap with or without mercury? If yes, why?

Question to sellers:

- Are there information about active ingredients of the different soaps? (e.g. on the packaging)
- Are there also mercury-free skin lightening soaps? (Active ingredients are hydroquinone (quinol), nonane dioic acid, potassium azelaoyl diglycinate, arctostaphylos uva-ursi (bearberry leaves essence), arbutin, nasturtium officinale (watercress essence), kojic acid (list maybe not exhaustive))
- Do you know whether you sell skin lightening soaps containing mercury and/or mercury-free soaps?
- If the seller knows about which skin lightening soaps contain mercury and which ones do not or if the active ingredient is stated on the packaging (than please ask all sellers about the well declared products):
  - Is the mercury-containing or the mercury-free alternative more difficult to get? (If yes, which one?)
  - Are there any problems with the mercury-free alternative (e.g. lower durability, lower efficiency or containing other toxic substances)?
  - If a mercury-free skin lightening soap is available, why is the mercury-containing product still used?
  - What is the proportion of sold mercury-containing in relation to mercury-free skin lightening soaps?
  - Is the seller aware that mercury is a toxic substance?

Please make a list of all available skin-lightening soaps (brand, producer/ importer, active content) as far as this information is available from the packaging or dealer's information and buy 5 to 10 different brands of the product. (You need to buy the different products (brands) only once, even if they are available in several shops, markets etc. Please do not buy products on which is clearly indicated on the package that they do not contain mercury.)

Brand name of **skin lightening soaps**	Price per package	Package size (volume or weight)	Producer/Importer	Active content (if known)	Statement concerning mercury on package? (no statement; no mercury; with mercury)

A.5 Batteries

Types of batteries to be considered:

1. Cylindrical battery, size “D” (diameter ~ 32.3 – 34.5 mm, height ~59.5 – 61.5 mm), 1.5 V

2. Button Cell, Model number LR44 (diameter ~11.6 mm, height ~5.4 mm), 1.5 V

Please go to different places and buy 5 – 10 battery packages of the two specified battery types for posting to GRS, Germany. (You need to buy the different products (brands) only once, even if they are available in several shops, markets etc. Please buy only batteries on which is not clearly indicated on the package that they do not contain mercury. In case of the cylindrical batteries please buy preferably batteries which have a paperboard covering (at least non-magnetic) or which are labelled as "Carbon-Battery", "Carbon-Zinc" or "Zinc-Manganese"-Battery.)

Additionally make a list of 10 more brands available (in total) of the two types of batteries (10 for cylindrical cells and 10 for button cells).

1.) Cylindrical Battery, size “D” (diameter ~32.3 – 34.5 mm, height ~59.5 – 61.5 mm), 1.5 V

Brand name of **cylindrical cell**	Producer/ Importer	Price per package	Number of batteries per package	Statement concerning mercury on package? (no statement; no mercury; with mercury)	Battery bought ?

2.) Button Cell, Model number LR44 (diameter 11.6 mm, height 5.4 mm), 1.5V

Brand name of **button cell**	Producer/ Importer	Price per package	Number of batteries per package	Statement concerning mercury on package? (no statement; no mercury; with mercury)	Battery bought ?

A.6 Use of mercury in dentistry

-> Please interview dentists

- Which people in the country come to his dentistry and can afford a tooth filling (all people, most people, the average person, only the rich people)?
- Does the dentist use mercury amalgam as a tooth filling?
- Does the dentist also use other materials as a tooth filling (name of material or type of filling)?
- If yes:
  - What else does the dentist use?
  - What is the main filling type used?
  - What is the price difference for the patient?
  - How much are the costs to offer other filling materials (cost in general for equipment, training and costs for the particular filling: material and time)?
- If only mercury amalgam is used as a tooth filling: Why does the dentist not offer other tooth filling materials?
- Do Patients ask for other filling materials than the standard material?
- Is the dentist aware of the risks posed by mercury to human health and the environment?

APPENDIX B. Mercury contents in analyzed skin lightening products

B.1 Analytical procedure

Products were collected and sent in their original packaging to GRS, Braunschweig, Germany for chemical analysis. Samples (normally 1.0 to 1.5 g) of the products were taken and 7 ml of hydrochloric acid and 3 ml of hydrogen peroxide were added and the the samples solubilised in a closed vessel by pressure digestion in a microwave oven (MLS 1200 from “Mikrowellen Labor Systeme”, Leutkirch, Germany). After completion of the reaction samples were taken, diluted and analysed with ICP-MS (Inductively Coupled Plasma – Mass Spektrometry) after calibration with certified mercury solution standards (adjusted to the matrix). Two runs of analysis were done. Samples with a that were found to have higher concentration than 0.02 mg/kg were tested again in a second run to confirm the results (solubilisation and analysis). In both runs the limit of detection (content differing from zero) was 0.02 mg/kg (ppm), the limit of quantification 0.07 mg/kg (ppm).

B.2 Samples

All products were bought in the indicated countries between November 2008 and January 2009. Product name, producer and country of origin were taken from the information found on the products’ packaging.

Tab. B.1 Analysed mercury content of cosmetic products obtained in Kenya

Product name	Producer country of production	Concentration of Mercury [ppm]
Skin success	Palmer's United Kingdom	<0.07
Cocoa butter formula soap	Palmer's United Kingdom	<0.07
Ross beauty soap	Charafeddine industrial lab. Lebanon	<0.07
Clean and clear	Johnson and Johnson South Africa	<0.07
Johnson's healthy skin	Johnson and Johnson South Africa	<0.07
Pimplex Medicated Soap	Roc Cosmetics Kenya	<0.07
Ambi. Skin Care, Complexion clean-sing bar	Johnson and Johnson South Africa	<0.07
Fair and Lovely fairness cream	Dubai, Manufacturer not given	<0.07)[1]
Pimplex Medicated Cream	Roc Cosmetics Kenya	<0.07)[1]
Ambi. Skin Care Puff Cream	Johnson &Johnson South Africa	<0.07
Emami Fair and handsome	Herbo Foundation, Licensed user of Emami, India	<0.07
Mekako	Nish Cosmetics England	<0.07

)[1] Mercury could be detected but not quantified

Tab. B.2 Analysed mercury content of cosmetic products obtained in Senegal

Product name	Producer country of production	Concentration of Mercury [ppm]
+ HT 26 Cleansing soap	Laboratories HT 26 France	<0.07
Fair and White Savon gommant	Laboratory Derma France	<0.07
Civic	H Cosmetiques CI MN au Mali	<0.07
Clair and white Carrot	Clair and White Suisse	<0.07
Sure White	Picos-ci Ivory coast	<0.07
Vit fee	Rodis Ivory coast	<0.07
L'Abidjanaise	H Cosmetiques Ivory Coast	<0.07
Skin white	M.A.C. Paris France	<0.07
Charms	RODIS Ivory Coast	<0.07
Clair Liss	SIVOP	<0.07
All Clair	Grey de Kooroon Ivory Coast	<0.07
H 20 Jours	H Cosmetiques Ivory Coast	<0.07
Clairissime Savon gommant éclair-cissant	SKYROS international France	<0.07
Méti'cée	RODIS Ivory Coast	<0.07
X-White Plus	CHOC DIFFUSION France	<0.07

Tab. B.3 Analysed mercury content of cosmetic products obtained in India

Product name	Producer country of production	Concentration of Mercury [ppm]
Ponds White Beauty	Hindustan Uniliver	<0.07)[1]
Revlon Touch And Glow	Revlon	<0.07
L'Oreal White Perfect	L'Oreal India	<0.07
Jovees Fairness Cream	JR Herbal Care	<0.07
Emami Fair And Hand-some	Herbo Foundation, Licensed user of Emami, India	<0.07
Elder Fair One Man	Elder Health Care India	<0.07
Fair & Lovely Mens Active	Hindustan Uniliver	<0.07
Elder Fair One	Elder Pharmaceuticals	<0.07
Emami Natu-rally Fair	Herbo Foundation, Licensed user of Emami, India	<0.07
Emami Fair And Ageless	Herbo Foundation, Licensed user of Emami, India	<0.07
Fair & Lovely	Hindustan Uniliver	<0.07
Natural Fairever	Cavin Kare	<0.07
Garnier Skin Naturals Light	L'Oreal India	<0.07
Melalite 15	Mepromax Lifesciences	<0.07
Godrej Fair Glow soap	Godrej	<0.07

)[1] Mercury could be detected but not quantified

Tab. B.4 Analysed mercury content of cosmetic products obtained in China

Product name	Producer country of production	Concentration of Mercury [ppm]
SINOWAY HERB Beauty Whitening Emulsion	Shanghai Sinoway Herbs Cosmetics China	<0.07
Maxam	Shanghai Jahwa Unit China	<0.07
Dabao	Beijing Dabao Cosmetics China	<0.07
Danzi	France Danzi China	<0.07
Sewame	Zhongshan Jiadanting Cosmetics China	<0.07
Cathy	Guangdong Arche Cosmetics	<0.07

Tab. B.5 Analysed mercury content of cosmetic products obtained in Russia

Product name	Producer country of production	Concentration of Mercury [ppm]
Skin lightening jel	Kosmoteros	<0.07
Melanostop	Kosmoteros	<0.07

Tab. B.6 Analysed mercury content of cosmetic products obtained in Kyrgyzstan

Product name	Producer country of production	Concentration of Mercury [ppm]
WHITENESS	Shantou Jinyahong Fine Chemical China	<0.07
Sheep Placenta Cream	Shantou Jinyahong Fine Chemical China	<0.07

Tab. B.7 Analysed mercury content of cosmetic products obtained in Brazil

Product name	Producer country of production	Concentration of Mercury [ppm]
Clariderm	Laboratorios STIEFEL Ltda, Brazil	<0.07
Clariskin	Kley Hertz S.A. Industria e Comercio, Brazil	<0.07
Melani-D	La Roche-Posay, France	<0.07
Klassis	IGEFARMA Laboratorios S.A., Brazil	<0.07
Muriel (Kit Lotion and Cream)	Muriel do Brasil Ind., Brazil	Lotion: <0.07 Cream: <0.07
Uniform Skin (day)	Nivea Visage	<0.07
Uniform Skin (night)	Nivea Visage	<0.07
Bi-White Advanced	Vichy	<0.07

Tab. B.8 Analysed mercury content of cosmetic products obtained in Mexico

Product name	Producer country of production	Concentration of Mercury [ppm]
Aclarado total	Grisi Mexico	<0.07)[1]
Blanca Piel (cream)	Ida Richtter Mexico	1325 (cream) (= 0.1 wt.%)
Jabón de manzanilla	Ida Richtter Mexico	0.80
Xhivanni	Itande	< 0.07)[1]
Crema Blanqueadora	Vita Natura	< 0.07
Crema Tepezcohuite	No data	<0.07
Concha nacar	No data	<0.07

)[1] Mercury could be detected but not quantified

10 Figures

11 Tables

EU draft negotiation position for the preparation of a global legally binding instrument on mercury for the second session of the Intergovernmental Negotiating Committee (INC2); 24 to 28 January 2011, Chiba, Japan

Contaminated Sites

WPIEI Chemicals (Mercury) 17 November 2010
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Explanatory note

The purpose of this draft paper is to find a European position on how to handle the item of mercury contaminated sites within a global mercury treaty.

The draft paper consists of the following parts:

1. Background
2. UNEP Governing Council Decision 25/5: INC Mandate
3. EU legislation and Strategies
4. Previous EU positions and statements
5. Positions of other countries at INC-1 and other for a
6. Rationale
7. Proposed EU position

Management of Mercury Contaminated Sites

Elements for an EU position

1. Background

Recent studies (COWI, 2008[1]; Concorde, 2010[2]; UNEP 2009[3]) show the existence of many sites in the world with historic or ongoing industrial activities that due to these activities are heavily contaminated with mercury, including former sites of chlor-alkali production and vinyl chloride production, former mercury mines and sites of production or use of mercury-containing products (e.g. mirrors, pesticide, wood impregnation, hat making). COWI (2008) estimated that approximately 11,000-20,000 tonnes of mercury are present in soils of contaminated sites in the EU. At least 15,000 tonnes of mercury were estimated to be present in EECA countries (excluding EU member states, CONCORDE, 2010). A UNEP (2009) report identified more than 2000 potentially mercury contaminated sites worldwide, but much more are to be expected especially because of small scale mining activities.

Mercury contaminated sites are a source of mercury releases to air, soil, water and sediments that may lead to transboundary contamination of the environment[4]. According to UNEP (2009) about 150-300 metric tonnes of mercury are released annually to the global mercury budget from identified mercury contaminated sites. Therefore, it might be argued that addressing mercury contaminated sites is not only of national but of global importance and should be an element in an overarching strategy to protect human health and the environment.

2. UNEP Governing Council Decision 25/5: INC Mandate

The Governing Council of UNEP in its 25th session agreed 'that the intergovernmental negotiating committee is to develop a comprehensive and suitable approach to mercury, including provisions

(f) to address mercury-containing waste and remediation of contaminated sites

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1 COWI (2008) Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society

2 CONCORDE (2010) Excess mercury supply in Eastern Europe and Central Asia, 2010-2050

3 UNEP (2009) Executive summary of the report on the extent of contaminated sites. UNEP/GC.25/INF/28

4 Ebinghaus, R.; Turner, R. R.; de Lacerda, L. D.; Vasiliev, O.; Salomons, W. (1999) Mercury contaminated sites. Characterization, risk assessment and remediation. Springer, Berlin

3. EU legislation and Strategies

Based on its Thematic Strategy for Soil Protection[5] the European Commission has proposed a Soil Framework Directive. Central elements related to remediation were to establish national inventories of contaminated sites and to trigger the development of national remediation strategies. Until now (October 2010), no agreement on a framework Directive has been found.
With regard to historic mining sites, Directive 2006/21/EC requires Member States to draw up an inventory of closed, including abandoned, mining waste facilities by 1 May 2012.

Directive 2004/35/EC on environmental liability with regard to the prevention and remediation of environmental damage establishes a common framework for liability with a view to prevent and remediate damage to animals, plants, natural habitats and water resources, and damage affecting the land. Based on the 'polluter-pays' principle the competent national authorities require the operator (the potential polluter) to take the necessary preventive or, where environmental damage was caused after April 2007, take the necessary restorative measures.
In the Review of the Community Strategy Concerning Mercury (BIO/GRS 2010)[6] the following potential actions were identified for a revised Strategy:

- develop and recommend criteria for assessing the risk of mercury contaminated sites;
- improve and share expertise in identifying assessing, managing and remediating mercury contaminated sites (e.g. through Framework Programmes or other suitable programmes).

Due to the lack of common EU legislation on contaminated sites (except some provisions for the extractive industry and regulations on environmental liability), regulations on the management of contaminated sites mainly fall under national competence.

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[5] Commission of the European Communities (2006) Thematic Strategy for Soil Protection COM(2006)231. eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0231:FIN:EN:PDF

[6] BIO/ GRS (2010) Review of the Community Strategy Concerning Mercury. In Print.

4. Previous EU positions and statements

Council Conclusion 2008

In preparation of the 25th session of the UNEP GC, the Council adopted on 4 December 2008 additional conclusions, considering that a multilateral environmental agreement would be the most appropriate instrument for mercury control. The conclusions also emphasize that such an agreement should consider the whole life cycle of mercury and affirm its support for a structure of the agreement that could include actions to

– address remediation of existing contaminated sites;

EU statement at INC-1

'Within the EU there is experience with the management and remediation of mercury-contaminated sites resulting from abandoned mining activities or former industrial processes. We have found that prevention and the inter-linkages between waste, storage and contaminated sites have to be considered as a whole to ensure sound environmental management. Along with the Asian Development Bank and others, the EU has been supporting a project to establish a global inventory of polluted places concentrating particularly on developing countries.'

5. Positions of other countries at INC-1 and other fora

At INC-1 representatives of many developing countries said that technical and financial assistance was needed, in particular in respect to the remediation of contaminated sites. They presented examples of specific situations in their countries; of solutions being contemplated or implemented, including nationwide assessment, control and prevention systems; and of the assistance that they required. Some representatives highlighted the enormous costs associated with the remediation of contaminated sites and suggested that remediation should be undertaken domestically rather than under a global agreement.

At the UNEP Partnership Advisory Committee in September 2010 several African, Asian and European countries highlighted the problems with mercury contaminated sites and proposed to address this issue in the framework of the Global Mercury Partnership.

6. Rationale

The UNEP Governing Council decision 25/5 and the EU Council Conclusion of 2008 clearly identified existing mercury contaminated sites as one issue to be addressed by the INC.

Measures to avoid future contamination by phasing out the use of mercury in products and processes would be a priority action that should be addressed by the INC. However, such a proposal alone would not be an adequate answer to the risk posed by already *existing* contaminated sites and would not be in line with the decisions and conclusions mentioned above. Countries should be encouraged to identify, characterize, manage and remediate mercury contaminated sites in order to minimize the mercury releases from these sites. From an environmental point of view more ambitious obligations would be preferable (e.g. obligation to remediate contaminated sites), but would not be feasible for most countries taking into account the financial implications. Management and especially remediation of mercury contaminated sites can be very costly (up to many tens of million EUR per site). Any obligation for remediation would certainly be answered by demands for adequate funding which would exceed even the most optimistic estimates for the future financial mechanisms by orders of magnitude. Therefore, the Mercury Convention should concentrate on measures and provisions that could reasonably be implemented by Parties even with limited national and global funding. Such measures could include: information exchange, capacity building and conceptual support in developing management strategies but no measures that would actually implement management strategies.

7. Proposed EU position

Statement

The EU fully acknowledges the risk to human health and the environment that is being posed by the large number of mercury contaminated sited in many areas of the world. Mercury from contaminated sites may be mobilized in particulate and gaseous form so that mercury contaminated sites act as point emission sources that may lead to local, regional and global exposure. Therefore, the EU considers it necessary to address mercury contaminated sites in an adequate manner. Avoidance of future contamination by phasing out the use of mercury in products and processes and minimization of releases to soil and water should be considered as priority. There is, however, a need to address existing contamination as well. The EU is fully aware of the fact that remediation of mercury contaminated sites may pose considerable

challenges to affected countries, challenges that may go beyond the capabilities of the future Mercury Convention.

The approach chosen by the Stockholm Convention regarding sites contaminated with POP chemicals could be taken as an example. Parties shall endeavour to develop appropriate strategies for identifying sites contaminated by mercury. If remediation of those sites is undertaken it shall be performed in an environmentally sound manner and, if possible, on the basis of the 'polluter pays' principle.

Within the European Union there is considerable experience with the management and remediation of mercury contaminated sites among authorities, industry and research institutions. The EU is ready to share this experience and supports proposals to include information exchange and capacity building as necessary measures to assist other countries in addressing mercury contaminated sites.

Based on these considerations and taking into account the special needs of developing countries expressed at INC-1 and at this meeting, the EU would like to propose to include the following principles and provisions for further consideration:

<u>Proposed elements</u>

Parties shall take appropriate measures to

- Enhance the capacity of countries in addressing mercury contaminated sites by
    - development of guidance material and exchange of information on the identification, characterization and risk assessment of potentially mercury contaminated sites;
    - management and environmentally sound remediation of mercury contaminated sites;
    - capacity building for experts, particularly from developing countries and countries with economies in transition;
    - assisting developing countries and countries with economies in transition in developing management and remediation strategies.

Parties shall also

- Endeavour to develop appropriate strategies to identify and inventory mercury contaminated sites; if remediation of those sites is undertaken, it shall be performed in an environmentally sound manner*;*
- support research and development targeting contaminated sites and their remediation.

Definition

If needed, the EU could propose to agree on a definition of mercury contaminated sites:

> ‘Mercury contaminated sites’ means sites, which have such elevated mercury concentrations caused by human activities that they pose, taking into account the land use, all relevant contaminant pathways and the extent of exposure, a significant risk to human health or to the environment.

Additional remarks

These proposed elements shall apply to all countries.

When enhancing the capacity of countries in addressing mercury contaminated sites, it should be taken into account that site contamination with mercury usually comes along with other hazardous substances.

The benefit of the management of mercury contaminated sites will mainly be on the local level.

The level of progress can be drawn from the numbers and the ratio of mercury contaminated sites, which have been identified, which have been risk assessed and which have been remediated.

Evaluation of possible approaches to address mercury added products in the mercury treaty

1 Use of elemental mercury and mercury compounds in products and processes – current situation

Elemental mercury and mercury compounds have been in widespread use for more than 2000 years. Due to its unique chemical and physical properties mercury found numerous applications in many sectors. A study of the Nordic Council (Norden, 2007) identified about 70 uses. Another exhaustive list with a detailed discussion on the availability of alternatives is included in the report by COWI (2008).

2 Possible approaches to address uses of Elemental mercury and mercury compounds in products and processes

Principally there are two approaches to address products and process:

1. General ban on the use of mercury and mercury compounds in products and processes but definition of exemptions (time-limited or unlimited, general or for certain countries). This is the approach of Sweden. Similar policies are in place in Denmark, Norway and the Netherland. (The exceptions constitute a 'negative list')
2. Generally allow the use of mercury and mercury compounds in products and processes (not explicitly but de facto), but identify uses that are banned (These uses would constitute a 'positive list'). The list of banned uses may include some exemptions. This is the current approach of EU and US legislation.

3 General ban

The first approach has been implemented in Sweden. In 2008, it decided to ban all uses of elemental mercury and mercury compounds (KEMI 2008). There is a rather short list of mostly time-limited exemptions (Tab. 3). It includes

- Analytical purposes
- Research and development
- Dental amalgam
- Some very specific applications
    - Thermometers for flash-point determination according to Directive 67/548/EEC
    - Welding wheels and metallic mercury for refilling these for welding
    - Wildlife-tracking devices for research purposes

- Electric and electronic medical equipment and surveillance and control instruments covered by product categories 8-9 in Appendix 1 to Ordinance (2005:209) on producer responsibility for electric and electronic devices. The current negotiations in the European Union may limit this exemption
- Other exemptions in exceptional cases according to specific criteria upon application from an individual applicant.
- Uses where harmonised European Community (EC) legislation applies, such as electric and electronic equipment and batteries, are also exempted from the Swedish ban.

A similar list may be found in Danish legislation (Tab. 4).

Advantages

- As most applications are now prohibited, the short list of exemptions clearly identifies remaining uses and helps focussing efforts to phase them out.
- There are now loopholes. Unidentified applications are covered. Essential uses were identified before the general ban was enacted and were addressed.
- The legislation is rather short as few exemptions remain. The list of exemptions will be reduced every time an exemption expires
- The

3.1 Challenges

There is need to have a detailed understanding on the feasibility of phasing out specific mercury uses. In Sweden, such an understanding was produced in the course of several studies that investigated the status all major uses of mercury in Sweden (KEMI 2004). About one year after entering into force the performance and possible challenges of implementing the general ban were examined (KEMI, 2010). It could be shown that the Swedish general ban was effective and with very few exemptions mercury added products could be entirely replaced by alternatives. On a global basis it might not be entirely known where elemental mercury and mercury compounds are still in use and to what extent their use could be replaced. For example, the use of mercury compounds as catalysts in industrial processes is often regarded as a national Chinese issue, whereas few people know about its use in India and Russia. As a consequence, the potential impact of a ban may not be entirely clear.

4 Selected ban on specified products or groups of products and processes

The EU addressed mercury added products and processes in a number of often independent directives

- **Cosmetics**: Cosmetics Directive (2008/42/EC): it is not permitted to place cosmetic products on the market if they contain mercury or mercury compounds.

However, the Directive contains exemptions signifying that phenyl mercury salts and thiomersal are permitted in eye make-up and products for removing eye make-up with a maximum mercury content of 0.007 per cent

- **Measuring devices**: Directive 2007/51/EC: Prohibition to put on the market mercury containing measuring devices (with exceptions). A proposal for an extended ban has been prepared by ECHA under REACH.
- **Electrical equipment**: Directive 2002/95/EC (RoHS) prohibits the use of mercury in electrical equipment, limits mercury contents in lamps, both with exemptions.
- **Batteries**: Directive 2006/66/EC (batteries)/ Regulation 1907/2006 (REACH) – prohibits use of mercury in batteries. Exemption for button cell batteries (2 % Hg allowed) and
- **Biocide**: Regulation 1907/2006 (REACH) prohibits the use of mercury as a biocide in some applications
- **Processes**: Use in processes: not addressed. Voluntary commitment from EuroChlor to close or convert all mercury cell chlor alkali plants by 2020, except for specialities. Not covered are mercury cell plants that do not produce alkali

The report by COWI (2008) investigated the remaining uses and found that many of them could be replaced in short time.

4.1 Advantages

A sector-wise and product based approach allows to stepwise extend a phase-out of mercury added products. Also in Sweden, before the general ban a product specific approach was chosen.

4.2 Challenges

The uses of mercury are numerous. Making a legislation for every product is a cumbersome and ineffective exercise. Within a global treaty with its often slow processes and the need for consensus, the stepwise extension of a list of banned uses may need a very long time. The approach also opens loopholes. Products that decision makers are not aware of (like mercury in polyurethane), not considered priority or that are new won't find their way on the negative list or only after a long delay.

Mercury consumption figures presented in the report by COWI (2011) show that EU legislation currently addresses approximately 10% of the EU mercury consumption. Another 40% is covered by the voluntary agreement of the chlor-alkali industry to phase out mercury cells by 2020. The remaining 50% of mercury used in the EU (130-270 t/year in 2007) is not subject to restrictions; this mainly includes dental amalgam (90-110 t/year), porosimetry (10-100 t/year) and chemicals (28-59 t/year). These sectors are characterised by widespread use and largely unidentified fate of used mercury added products.

5 How a negative list of exemptions could look like

The following table lists applications of elemental mercury and mercury compounds that may need an exemption on the national or global level. Exemptions may have different types:

- General exemption applicable to all parties
- National exemptions, applicable to those parties that have notified the Secretariat about continued need in their country
- Unlimited exemptions for applications where alternatives are physically impossible or not to be expected in the near future
- Exemptions that require a re-evaluation after some time: Alternatives are available, but further information is necessary to judge whether their application is feasible for all parties.
- Limited exemptions that allow for an interim period where mercury added products could be gradually phased out.

Tab. 1: Example for a list of allowed uses

Allowed Use	Type of Exemption
Analysis, measurement, research and development	
Analytical purposes: mercury analysis	unlimited
Analytical purposes: mercury compounds in other analytical procedures	Unlimited, re-evaluation after X
Measuring devices	National Exemption after notification/ General exemption for calibration purposes Electrodes: unlimited
Research and development	Unlimited
Medical and cosmetic applications	
Dental amalgam	National Exemption after notification
Vaccines	Unlimited, re-evaluation after X
Electronic and electrical equipment	
Batteries	Exemption until X?/ National Exemption after notification
Lamps	Unlimited for mercury content below X Laboratory uses: unlimited

Electronic parts (e.g. switches, relays)	National Exemption after notification
Processes	
VCM production	National Exemption after notification
Mercury cell chlor-alkali production	Exemption until 2020
Other mercury cell processes	National Exemption after notification
Artisanal small scale mining	National Exemption after notification
Other processes (e.g. polyurethane, acetaldehyde, vinyl acetate)	National Exemption after notification
Other	
Applications relevant for national security/ military	Unlimited?
Cultural, religious uses	National Exemption after notification
Specific applications like restoration of artwork	National Exemption after notification

Other general exemptions may have to be included in the list, if current exemptions in EU legislation should be fully reflected, e.g. mercury in cosmetics. A different approach would be to follow the

In many cases, such EU exemptions were considered by opening the possibility of national exemptions after notification (similar to the approach in the Stockholm Convention).

6 How a positive list of banned used could look like

A list of prohibited uses could have different levels of detailedness. It could

- prohibit the use of elemental mercury and mercury compounds for entire sectors, e.g. measuring devices or biocides and then define exemptions, or
- could pick very specific uses like ‘substances and constituents of preparations intended to prevent the fouling by micro-organisms, plants or animals of the hulls of boats’ (REACH) and therefore, avoid the definition of exemptions

An extensive use of bans for entire sectors would coincide with the general ban approach.

The following list represents a combination of current EU legislation and uses from the NORDEN list that are most probably of no relevance within the EU or could be easily replaced by alternatives. It is no exhaustive list and not all by EU legislation explicitly prohibited uses of mercury are listed in the table. It should be noted that there are numerous measuring devices that are currently not addressed by EU legislation.

Tab. 2: Example for a list of banned uses

Prohibited uses	Exemption
Analysis, measurement, control research and development	
Measuring devices (Specified list), e.g. - fever thermometers - other measuring devices intended for sale to the general public	Calibration purposes, Research and development Porosimetry?
Vacuum pumps	
Medical and cosmetic applications	
Cosmetics	List of exemptions (e.g. eye make-up and eye make-up remover EU Cosmetics Directive)
Medical applications	Dental amalgam, vaccines
Biocides	
Use of mercury compounds as biocides	in Vaccines
Electronic and electrical equipment	
Batteries	Button cells with a mercury content below X
In Electrical and Electronic equipment	List of exemptions (4 in RoHS), e.g. Lamps with a mercury content below X Laboratory atomic absorption spectrometry Lamps Infra-red light detection semiconductors Neutron source in synchrotron light establishments

	Lighthouses?
Processes	
Mercury cell chlor alkali production after 2020	
Other mercury cell processes	National Exemption after notification
Artisanal small scale mining	National Exemption after notification
Other processes e.g. polyurethane, acetal-dehyde, vinyl acetate)	National Exemption after notification
Other	
Pigment (vermilion)	For restoration of art
Other Browning and etching steel Gilding Certain colour photograph paper types Recoil softeners in rifles Mercury fulminate, Hg(ONC)2, used as detonators for explosives, in ammunition and in fireworks Executive toys	

Bans do not apply for applications relevant for national security/ military.

Tab. 3 Exemptions from the Swedish general ban (KEMI 2010)

General exemptions from the Swedish total ban (KIFS 2009:2)

1. Mercury for use in certain areas	**May be placed on the Swedish market until**	**May be used until**
Analytical chemicals		
1. Mercury compounds for mercury analyses and for the development of analytical methods for mercury	No limit	No limit
2. Mercury compounds for analyses according to international standards in the area of pharmaceuticals.	2014-12-31	2015-12-31
3. Mercury compounds for analyses of COD and in ampoules for COD analysis.	31 December 2011	31 December 2012
4. Mercury compounds for analyses as well as research and development in medical diagnostics.	31 December 2011	31 December 2012
5. Mercury compounds for other analyses than those covered by 1-4.	31 December 2011	31 December 2012
Research and development		
6. Mercury compounds for research and development in industry and the university system.	31 December 2011	31 December 2012
7. Thiomersal for disinfecting equipment used in transfusion and dialysis.	31 December 2011	31 December 2012
Dental amalgam		
8. Dental amalgam for emission measurements at crematoria.	No limit	No limit
9. Mercury for manufacturing dental amalgam intended for use according to point 10.	31 December 2011	31 December 2011
10. Dental amalgam for the following uses and provided the following conditions are met: Dental amalgam may only be used on adult patients in hospital dental clinics (or similar functions) if a. specific medical reasons apply, b. other methods of treatment do not provide sufficient protection, judged on an individual basis, and c. the clinic is specially equipped for the use of dental amalgam from an environmental perspective.	31 December 2011	2012-06-30
2. Products containing mercury for use in specific sectors	**May be placed on the Swedish market until**	**May be placed on the Swedish market as spare part for specified use until**
Measuring devices		
1. Thermometers for flash-point determination according to Directive 67/548/EEC.*	31 December 2013	31 December 2013
Seam welding		
2. Welding wheels and metallic mercury for refilling these for welding – straight profiles – curved profiles		 31 December 2013 31 December 2017
Tracking devices		
3. Wildlife-tracking devices for research purposes	31 December 2010	31 December 2010
Medical devices, surveillance and control instruments		
4. Electric and electronic medical equipment and surveillance and control instruments covered by product categories 8-9 in Appendix 1 to Ordinance (2005:209) on producer responsibility for electric and electronic devices. The current negotiations in the European Union may limit this exemption.	No limit	No limit

*Note: The test methods contained in Annex V to Directive 67/548/EEC have been incorporated into Council Regulation (EC) No 440/2008 (the Test Methods Regulation)

Tab. 4 Exemptions from the import, export and sale ban in Denmark (Danish MOE, 2010)

List of mercury-containing products for which import, sale and export are permitted - irrespective of the prohibition laid down in section 1 of the Order

1. Dental products for filling permanent molar teeth, where the filling is worn

2. Mercury-wetted film switches and relays which meet EN 119000, for specified applications in businesses:
- data and telecommunication
- process control
- PLC remote control of energy supply
- electrical test systems

3. Thermometers for special applications:
- calibration of other thermometers
- analysis equipment

4. Special light sources:
- discharge lamps, including energy-saving bulbs
- for analysis operations
- for graphic operations

5. Flash units for safety installations on railway lines

6. Manometers for calibration of other pressure gauges

7. Barometers for calibration of other barometers

8. Electrodes for special applications:
- polarographic analysis
- potentiometric analysis
- calomel reference

9. Mercury-containing chemicals for special applications:
- raw materials for analysis reagents
- analysis reagents
- standards
- preservation of starch for laboratory use
- isotope dilution testing
- catalysts

10. Products for research, including odontological research

11. Products for teaching

12. Products for vital applications in aircraft

13. Products for the repair of existing mercury-containing equipment

7 References

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Analysis of potential loopholes and Inconsistencies among suggested elements of the mercury treaty

Introduction

This paper discusses potential loopholes and inconsistencies among UNEP's 'Elements paper' INC.2/3 and the EU CRP. CRPs from other delegations are not covered. The aim of this paper is to provide some background information on topical areas where the Hg convention may fail to address the whole lifecycle of mercury. The paper also highlights some points, where EU positions will likely not find agreement among all delegations at INC-3. Suggestions for alternative formulations for provisions are given at several occasions.

(2) Definitions

(d) "Mercury" means elemental mercury (Hg(0)) or mixtures of elemental mercury with other substances, including alloys of mercury, with a mercury concentration of at least 95 per cent by weight;

This definition effectively limits the scope oft he convention to elemental mercury and certain mercury compounds. Such a restriction may also be found in the EU mercury export ban but there, it addresses trade.

Such a restriction is not appropriate when dealing with releases and emissions. Often, the exact nature of mercury in effluents or emitted gases is unknown, variable or simple not defined at all (e.g. mercury adsorbed on particulate matter). But independent of its nature, all releases of mercury add to the global pool and pose a risk to human health.

Therefore, regulations on emission sources typically address all chemicals forms of a pollutant. The Heavy Metal Protocol to the UNECE LRTAP Convention says:

Limit values for heavy metals include the solid, gaseous and vapour form of the metal and its compounds, expressed as the metal. (Annex V. 1.3)

As a consequence of the current definition of 'mercury' in the elements paper, the Hg convention would not address the industrial releases of methyl mercury that lead to the Minamata catastrophe. Throughout the text, it must be checked, where 'mercury', 'elemental mercury' and 'mercury compounds' are appropriate.

➔ Therefore, in the Hg Convention, the term 'mercury' should be used with care. It is suggested to re-define mercury as:

(d) "Mercury" means any chemical form of the chemical element mercury, including elemental mercury, mercury alloys and mercury compounds be they in solid, liquid, gaseous, or dissolved state.

➔ Later in the text certain provisions may be restricted by referring to a list of mercury compounds

(e) "Mercury and mercury compounds" means the substances listed in Annex B;

Again, this definition is too restrictive to be used in general. It may be deleted or replaced by a definition of 'mercury compounds'

➔ **(d) "Mercury compounds" means any chemical substance of defined chemical composition that contains the element mercury as one component including mercury alloys ('amalgams').**
➔ Later in the text certain provisions (e.g. on trade) may be restricted by referring to a list of mercury compounds

In CRP.4 the term 'commodity' is used. A definition may be necessary since its meaning is not that clear:

➔ 'Mercury commodities' means elemental mercury or mercury compounds that are intended to be sold, distributed in commerce, used or exported.

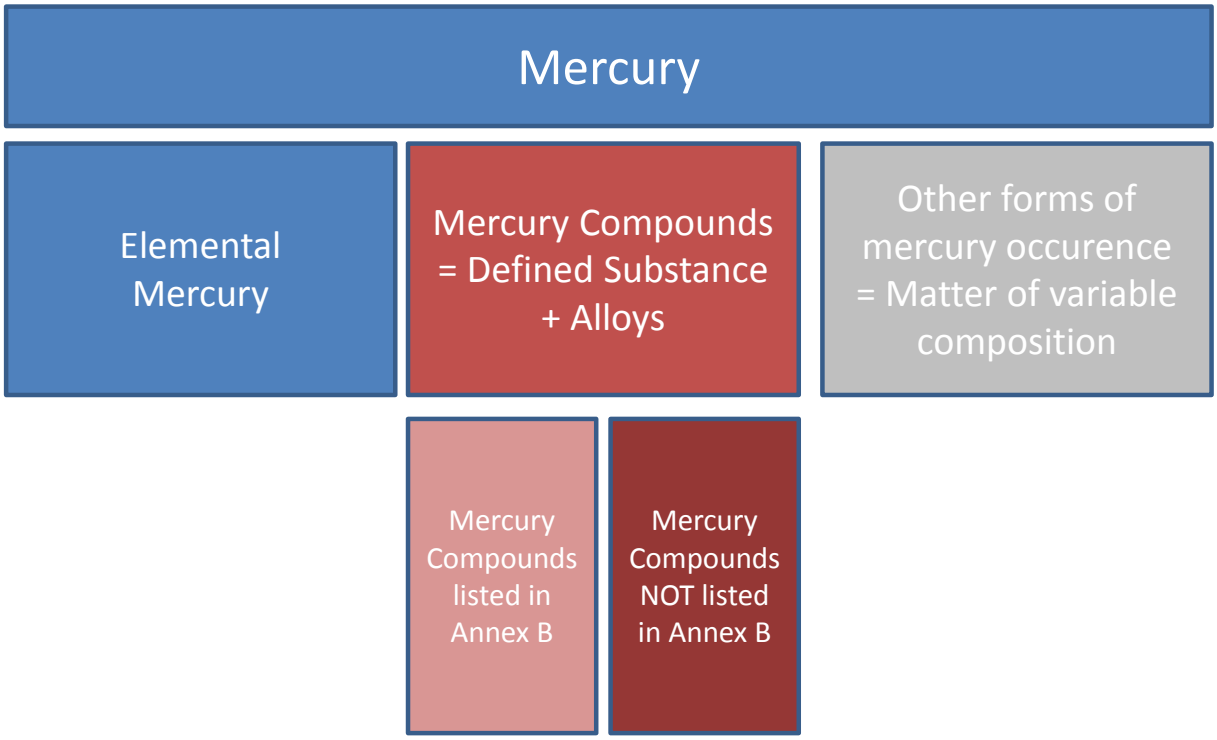


Figure 1: Suggested terminological system of mercury, elemental mercury and mercury compounds

(3) Mercury supply sources

CRP.4 (EU)

1. Each Party with primary mining within its territory shall:

(a) Eliminate primary mercury mining by the date of entry into force of this Convention for it;

And

2. Each Party shall not allow any new primary mercury mining activity on its territory.

This provision mainly affects Kyrgyzstan and China. There are probably some other countries where primary mercury mining is conducted to some minor extent. While Kyrgyzstan may be willing to stop its mercury mining activities (or forced to due to a dwindling profitability of its last remaining mine), China will not, as primary mining is an essential element of the national VCM production strategy (see 'VCM production'):

- The current Chinese mercury demand may be in the order of 1,400 - 1,800 t (Concorde 2009). VCM production is the single largest consumer (about 800 t may be more)
- The largest part of the demand is met by supply from Chinese mercury mines (around 1,100 t). Without this supply source, China and Chinese VCM production in large would entirely depend on imports.

Therefore, flexibility is needed to respond to the Chinese situation (delegations from India, Russia and Iran possibly do not know about their Hg based VCM plants)

- ➔ Be prepared to accept a formulation that allows supply from primary mining for the sole purpose of meeting domestic demand (for allowed uses), but requesting periodic national reports on the national supply/ demand situation
- ➔ Explicitly prohibit export of mercury from primary mercury mining
- ➔ Request countries with primary mercury mining to reduce reliance on this source by increasing recovery of mercury from other sources (e.g. nonferrous metal production)

3. Each Party shall:

(a) Not allow the sale, distribution in commerce, export or use of mercury obtained from supply sources listed in Annex A after any phase-out date specified therein;

It may have been overlooked that Annex A now covers perhaps 95-99% of global mercury supply. As there is a steady, accepted demand for mercury, some supply will have to be accepted as well. Unfortunately there is no consent about the amount of accepted demand, and there is no way to make a reliable prediction about accepted demand in the next 10, 20 or more years. Countries like India and China will likely not agree to any

phase-out dates for the sectors listed in Annex A. Perhaps they will agree for phase-out dates for some sectors that are of less relevance for them (e.g. chlor-alkali). The EU, on the other hand will likely not agree to define phase-out dates for sectors that form an essential part of EU mercury supply (e.g. recycling of waste)[1]. If, as intended by some speakers, phase-out dates were set for all sectors the global supply would tend to zero and products like energy saving bulbs, dental amalgam or lab chemicals for mercury analysis could not be produced any more. Annex A in its current construction is not flexible enough to respond on unknown future demand for mercury.

- ➔ Start with definitions of phase-out dates for those sectors that do not form an essential part of current global supply. Do not define a date for recycling activities.
- ➔ Introduce a mechanism that leads to a periodic assessment of the global supply/demand relation and subsequent addition of phase-out dates

CRP.4 does not use 'primary mining' and 'primary mercury mining' in a consistent way. In future revisions both terms should be clearly distinguishes or 'primary mining' not used at all as it covers mining of other non-mercury resources as well.

4.Each Party shall:

(b)Ensure that all mercury and mercury compounds from supply sources listed in Annex A that are intended to be sold, distributed in commerce, used or exported for the purposes of a use allowed to the Party under this Convention pursuant to paragraph 3(c) are stored in an environmentally sound manner in accordance with Article 4 prior to such sale, distribution, use or export;

It makes little sense to restrict environmentally sound storage to (commodity) elemental mercury and mercury compounds from certain sources. Elemental mercury and mercury compounds are toxic substances independent of the label on the container or the history of its production.

- ➔ It is suggested to make the provision more general by changing it to
  Ensure that all mercury and mercury compounds ~~from supply sources listed in Annex A~~ that are intended to be sold, distributed in commerce, used or exported for the purposes of a use allowed to the Party under this Convention pursuant to paragraph 3(c) are stored in an environmentally sound manner in accordance with Article 4 prior to such sale, distribution, use or export

Annex A: Source of supply of mercury and mercury compounds

The proposal covers nearly all important sources of mercury supply. It omits recovery of mercury from contaminated soil or mining waste (such as tailings), which is a very important source or potential source of mercury for many countries (e.g. Eastern Europe, Latin America). It has also been discussed to specify which industries are cov-

[1] The recent review oft he EU mercury strategy showed that the EU needs either imports or recycling as a source of supply to meet its domestic demand for energy saving lamps and dental amalgam.

ered by ‘Non-ferrous metals production facilities’. Instead of creating loopholes by excluding a long row of plants, a definition of Non-ferrous metals production may be introduced

- ➔ include recovery of mercury from contaminated soil or mining waste (such as tailings) in Annex A
- ➔ Define non-ferrous metal production as ‘Industrial process that produces metals other than iron and steel’ . Such metals include but are not restricted to gold, silver, copper, zinc, lead, mercury, manganese, antimony.

(4) Environmentally sound storage [of commodities and products]

CRP.5 (EU)

As the provisions in article 4 speak of ‘manage mercury and the mercury compounds considered as commodity’ the title should be adjusted, e.g.

- ➔ Environmentally sound management of mercury commodities [and mercury added products]

In article 4 the term ‘commodity’ appears for the first time. While elemental mercury is often considered ‘commodity’ in the sense of basic raw material intended for (international) trade or use (like gold, steel, copper, platinum), the term is seldom used for mercury compounds. It may be advisable to add a definition like

- ➔ ‘Mercury commodities’ means elemental mercury or mercury compounds that are intended to be sold, distributed in commerce, used or exported.

1.Each Party shall manage mercury and the mercury compounds listed in Annex B considered as commodity in accordance with the requirements on environmentally sound storage adopted, updated or revised by the Conference of the Parties pursuant to this article.

There is no need to restrict the provisions for environmentally sound management to a small list of mercury compounds. As all mercury compounds are classified as hazardous, reference to Annex B may be deleted. Moreover, the elements paper lacks provision for mercury added products. Article 4 might be the right place to include them.

- ➔ Each Party shall manage mercury commodities [and mercury added products] ~~mercury, and the mercury compounds listed in Annex B considered as commodity~~ in accordance with the requirements on environmentally sound storage adopted, updated or revised by the Conference of the Parties pursuant to this article.

2.The Conference of the Parties shall at its first meeting adopt, in the form of an additional Annex, requirements on the environmentally sound storage of commodity mercury and mercury compounds listed in Annex B. The ultimate objective of the requirements shall be that all mercury from the supply sources listed

in Annex A intended for concrete allowable uses shall be stored in an environmentally sound manner. In considering the requirements, the Conference of the Parties shall ensure their consistency with the requirements referred to in article 12 and take into account the factors listed in Part II of Annex B.

The intention of the EU proposal was clear: elemental mercury and mercury compounds that are not intended for allowable uses should be considered waste. The problem is that mercury, being present in some metal ore, has no imprinted purpose or intended use. It still has no purpose when it is extracted from that ore or during the metal production process... Nevertheless, even without such a purpose, it has to be stored in an ESM. An intended use manifests only when a potential user decided to use it.

➔ In order to avoid a 'storage loophole' article should address all types of commodities, independent of their source and destination. At a different place it must be clearly defined that mercury or mercury compounds are either waste or commodity and nothing in between.

2.The Conference of the Parties shall at its first meeting adopt, in the form of an additional Annex, requirements on the environmentally sound storage of mercury commodities ~~commodity mercury and mercury compounds listed in Annex B~~. The ultimate objective of the requirements shall be that all mercury commodities ~~mercury from the supply sources listed in Annex A intended for concrete allowable uses~~ shall be ~~stored~~ managed in an environmentally sound manner. In considering the requirements, the Conference of the Parties shall ensure their consistency with the requirements referred to in article 12 and take into account the factors listed in Part II of Annex B.

Annex B: Mercury compounds subject to international trade and environmentally sound storage measures

As discussed above, restriction regarding environmentally sound storage may not be appropriate. Reference to 'storage' could be deleted

➔ Annex B: Mercury and mercury compounds subject to international trade ~~and environmentally sound storage measures~~

Elemental mercury is no compound

➔ Elemental mercury should be deleted from the list

Part II: Development of requirements on environmentally sound storage

In developing the requirements under paragraph 2 of Article 4 on the environmentally sound storage of mercury and mercury compounds considered as commodity, the Conference shall take into account, among other things:

(a)Relevant provisions of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal and guidelines developed thereunder;

Since Annex B in the EU proposal deals with commodities, reference to the Basel Convention sound a little bit odd. The Basel Convention does not deal with commodities. Strictly speaking, there are no relevant provisions and applying waste related provisions to the general issue of hazardous substance management may not be an appropriate approach.

➔ Delete reference to the Basel Convention.

(d)The geographic, social and economic factors that may affect Parties' ability to achieve environmentally sound storage of mercury, taking particular account of the capacities and needs of developing-country Parties and Parties with economies in transition.

As article 4 deals with the management of mercury commodities this should be reflected here as well:

(d)The geographic, social and economic factors that may affect Parties' ability to achieve environmentally sound storage of mercury commodities [and mercury added products], taking particular account of the capacities and needs of developing-country Parties and Parties with economies in transition.

(7) Mercury-added products

Each Party shall not allow:

(a) The manufacture, distribution in commerce or sale of mercury-added products listed in Annex C, except in accordance with an allowable-use exemption listed in that annex for which the Party is registered as provided in Article 14;

Currently the list of not allowed products is rather small and not very detailed. For all entries in Annex C, almost all countries may have to apply for exemptions. That's a cumbersome procedure that unnecessarily overloads governments and the future convention's secretariat with work. For INC-3 a new Annex C should be prepared that already lists not allowed products in detail. This list may get long but allows concentrating on those products where country specific exemptions are really needed. It should be stressed that a short list of not allowed uses would open a wide range of loopholes. For example, the current proposal does not address use of mercury compounds in cosmetics, pesticides or toys.

➔ Prepare a detailed, comprehensive list of not allowed uses for Annex C

In addition, if the EU would like to follow the 'General Ban + Exemptions' approach (like in the Norwegian CRP.1), a detailed list of generally allowed uses should be prepared. It should be stressed again that a the General Ban approach

➔ Prepare a detailed list of allowed uses for Annex C

(8) Manufacturing processes in which mercury is used

CRP.8 (EU)

1. Each Party shall not allow the use of mercury or mercury compounds in the manufacturing processes listed in Annex D except in accordance with an allowable-use exemption listed in that annex for which the Party is registered as provided in Article 14.

The allowable use exemption is generally intended to be time restricted. Taking into account the current list of processes (Mercury cell chlor-alkali production, Vinyl chloride monomer production using catalysts consisting of mercury compounds) such a regulation would affect the following countries:

Chlor-alkali: approximately 46 countries (UNEP(DTIE)/Hg/INC.2/17)

VCM: China, India, Russia, Iran, possibly other countries as well

As conversion of chlor-alkali plants is costly it may only be feasible for globally operating companies or in the course of already planned expansion of production capacity. While some countries will likely manage to phase out mercury cell based chlor alkali production, smaller companies in other countries may not have the capital to do so. Therefore, it might be expected that there will be resistance from some developing countries.

The situation is more serious for VCM production. On order to get more independent on oil and olefin imports, companies are encouraged to increase coal based chemical production. Due to the low price of domestic coal, VCM production that is using the domestic coal-carbide-acetylene-vinyl chloride route is cost competitive to the imported ethylene – ethylene dichloride – vinyl chloride route. The majority of newly built VCM plants are based on the acetylene route. For China, the national cost advantage for coal based VCM production may be in the order of 0.9 billion USD per annum. It is not very likely that China will agree to a treaty that forces their industry to loose annual profits in such an order of magnitude. Moreover, since coal based VCM production is still expanding setting a phase-out date is not realistic. It is probably more useful to increase research in alternative chemical approaches like alternative catalysts or alternative routes from coal to vinyl chloride. The latter is the more promising one. There are already demonstration plants for the production of ethylene from coal, thus avoiding the synthesis of acetylene and allowing pursuing the next steps on the ethylene dichloride route.

- ➔ Request countries that produce VCM using mercury catalysts to develop and pursue a national research and development plan. The aim of this plan is to develop alternative catalysts and alternative synthesis routes that do not use mercury.

‘Mercury’ is imprecise

- ➔ ‘Mercury’ should be replaced by ‘elemental mercury’ in accordance to the terminology

Annex D

Manufacturing processes in which mercury is used

Part I

Manufacturing process	*Allowable-use exemption*
1. Chlor-alkali production	
2. Vinyl chloride monomer production	

The heading is not entirely correct. The list does in Annex does not contain processes but industry sectors. Not all chlor-alkali plants use mercury. It would be better if the table listed the correct and precise processes

Manufacturing process	*Allowable-use exemption*
1. Mercury cell chlor-alkali production	
2. Vinyl chloride monomer production using catalysts consisting of mercury compounds	

➔

Annex D in its current form contains only chlor-alkali and VCM production. There are a lot of other processes that also use mercury like:

- Polyurethane production using catalysts consisting of mercury compounds
- Mercury cell based alkylate/ alcoholate production

Currently, there is no consent to include these processes. But there are other processes that are most probably no longer in use in the EU because they are outdated and infamous for the pollution potential:

- Wood tanning using mercury compounds
- Acetaldehyde production using catalysts consisting of mercury compounds
- Vinyl acetate production using catalysts consisting of mercury compounds
- Production of the cube (1-amino anthrachinone) colours /pigments using catalysts consisting of mercury compounds
- Production of mirrors using elemental mercury and mercury alloys
- Gilding/ silvering using elemental mercury and mercury alloys

(10) Atmospheric emissions

CRP.9 (EU)

Annex E

Atmospheric emissions

Part I: Source categories

1.Coal-fired power plants and industrial boilers.

2.Non-ferrous metals production facilities.

3.Waste incineration facilities.

4.Cement production factories

5.Iron and steel manufacturing facilities.

This list is rather short and concentrates on thermal processes where mercury is an impurity in a feedstock (like coal, ore, waste, lime). It does not cover important source categories like chlor alkali production and VCM production, nor gas and oil production. It has also been discussed to specify which industries are covered by 'Non-ferrous metals production facilities'. Instead of creating loopholes by excluding a long row of plants, a definition of Non-ferrous metals production may be introduced

- ➔ Add 'chlor alkali production and VCM production' to the list.
- ➔ Add 'natural gas and oil production'
- ➔ Define non-ferrous metal production as 'Industrial process that produces metals other than iron and steel'. Such metals include but are not restricted to gold, silver, copper, zinc, lead, mercury, manganese, antimony.

(11) Releases to water and land

Annex F

Sources of mercury releases to water and land

1.Facilities that manufacture mercury-added products.

2.Facilities that use mercury in the manufacturing processes listed in Annex D.

3.Facilities for mercury recovery, recycling, and reprocessing and facilities where mercury is produced as a by-product of non-ferrous metals mining and smelting, as listed in Annex A.

4.Artisanal and small-scale gold mining.

5.Facilities for the disposal of mercury-containing wastes.

6.Sites contaminated by mercury and mercury compounds.

Point 3 is unclear as it implies that only those processes should be covered where mercury is produced as a by-product. There are many plants where mercury simply is

left in some waste and dumped near the production site, without mercury being produced as a ’by-product’. Natural gas may contain significant amounts of mercury. If not sent for recovery and disposal it is often dumped near the site.

- ➔ Split point 3 in two parts:
  3.Facilities for mercury recovery, recycling, and reprocessing
  3 bis. Metal mining and production
- ➔ ‘Add: Facilities that produce natural gas’

Use of mercury in processes

1 Purpose of this document

This document shall inform about the use of elemental mercury and mercury compounds in industrial and artisanal processes and options for its substitution. The following processes are covered

1. Vinyl chloride monomer production using mercury catalysts
2. Use of mercury catalysts in polyurethane production
3. Use of elemental mercury in chlor-alkali-production
4. Use of elemental mercury in alcoholate production

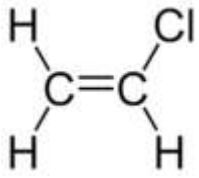
2 Vinyl chloride monomer production using mercury catalysts

2.1 Summary

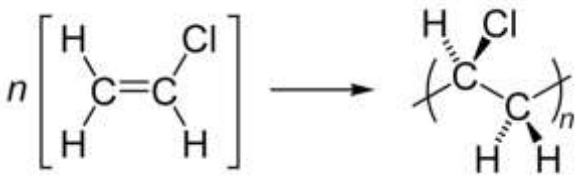
In some chemical plants, mercury(II) chloride ($HgCl_2$) is used as a catalyst to enhance the reaction of acetylene (C2H2) with hydrochloride (HCl) to vinyl chloride monomer (VCM). Vinyl chloride in turn is the basis to produce polyvinylchloride (PVC), an important plastic material. The annual consumption of mercury(II) chloride for the VCM process is estimated to be around 1000 t, the single largest consuming industrial sector. Mercury catalysts allow the production of PVC on the basis of coal which under certain national economic circumstances represents a significant economic advantage (in the order of 500 million USD per year) above crude oil based PVC production.

2.2 Structure and use of vinyl chloride

Vinyl chloride (H_2C-CHCl, IPUAC name chloroethene, old name: chloroethylene) is an important (toxic) industrial chemical. Structurally, it is based on ethene (common name: ethylene) with one hydrogen atom substituted for chlorine:



Vinyl chloride (monomer) is an intermediate. It is mainly used to produced polyvinylchloride (PVC, IUPAC: Poly(chloroethanediyl)), a thermoplastic polymer, by polymerization:



At much smaller quantities VCM is also used to make various copolymers with vinyl stearate, vinyl acetates and other chemicals (Nexant 2007).

2.3 Economical significance and mercury consumption

In 2009, about 32.3 million tons PVC were produced worldwide. The global production capacity represent 48 million tons per year (Deloitte 2010). PVC production is expected to rise up to 55.2 million tons by 2020 (Business Wire 2011). China is the biggest producer of PVC (37% of world production capacity, but only 26% of global production, Deloitte 2010). In Europe, prices for PVC were around 1000 EUR per ton in 2010 (CMAI 2010, Deloitte 2010), in South-East Asia around 730 EUR per ton (Deloitte 2010). Consequently the global market value of PVC is around 30 billion EUR. The annual mercury consumption in 2005 was in the order of 715-825 tons (UNEP 2008), but may have been higher in the following years to an increase of production capacity in China.

2.4 Synthesis of VCM

2.4.1 Acetylene based

Acetylene based production of VCM follows the following synthesis route:
Coal – Carbide – Acetylene - VCM

1. Carbide:Lime + Coal + Energy-> Calciumcarbide + Carbon Monoxide
   $CaCO_3 + 4C \rightarrow CaC_2 + 3CO$

2. Acetylene:Carbide + Water → Acetylene + Calcium hydroxide
   $CaC_2 + 2H_2O \rightarrow C_2H_2 + 2\ Ca(OH)_2$

3. Vinyl Chloride:Acetylene + Hydrochloride → Vinyl chloride
   $C_2H_2 + HCl \rightarrow H_2C=CHCl$(Catalyst: $HgCl_2$)

Alternatively, acetylene may be produced from methane by pyrolysis: $CH_4 \rightarrow C_2H_2 + 3\ H_2$.

2.5 Alternative approaches

- Substitution of PVC by other polymers
- Replacement of the acetylene process by other synthesis routes
- Replacement of the mercury catalyst by other catalysts

2.5.1 Substitution of PVC by other polymers

PVC may be substituted by high density polyethylene (HDPE) in many applications. However, at high prices for crude oil, HDPE is more expensive than PVC. Moreover, PVC is often needed to consume chlorine from the chlor-alkali production as demand for caustic soda is the driver for chlor-alkali production and not the demand for chlorine (Fryer 2006).

2.5.2 Replacement of the acetylene process by other synthesis routes: Ethylene based production

On a global scale the acetylene based production is more common. It starts with crude oil as the feedstock:

Crude oil – ethylene - 1,2-dichloroethane (EDC) - VCM

1. Ethylene:Cracking of lighter hydrocarbons at high temperatures
   e.g. $CH_3CH_3 \rightarrow 2\ CH_3\bullet$
   $CH_3\bullet + CH_3CH_3 \rightarrow CH_4 + CH_3CH_2\bullet$
   $CH_3CH_2\bullet \rightarrow CH_2{=}CH_2 + H\bullet$
2. EDC:a) Direct chlorination: Ethylene + chlorine → EDC
   $CH_2{=}CH_2 + Cl_2 \rightarrow ClCH_2CH_2Cl$

   b) Oxychlorination: Ethylene + Hydrochloride + Oxygen → EDC
   $CH_2{=}CH_2 + 2\ HCl + ½\ O_2 \rightarrow ClCH_2CH_2Cl + H_2O$
3. VCM:Thermal cracking at 500°C: EDC → vinyl chloride + hydrogen chloride
   $ClCH_2CH_2Cl \rightarrow CH_2{=}CHCl + HCl$

Since in China there is a lack of domestically produced ethylene or EDC and the production costs for the acetylene based route are much smaller, a production based on crude oil will likely not find broad acceptance. Recent developments in coal technology opened a way to produce ethylene from coal (with methanol as an intermediate) instead (ICB 2010)

2.5.3 Replacement of the mercury catalyst by other catalysts

For the production of VCM mercury chloride ($HgCl_2$) on activated coal is used (Rossberg et al. 2006). Other metal compounds are added to reduce the volatilization of $HgCl_2$.

A number of alternative catalysts have been described in the literature, mainly based on palladium and platinum compounds. According to a report by ETH Zürich (Sutter 2009, based on Rossberg et al. 2006) these proved less effective and didn't gain economic relevance. However, the article refers to literature and patents from the 1970ies, when the acetylene process was still of relevance for the European industry. Later developments may have produced more effective catalysts.

2.6 Economical significance and mercury consumption

Whether or not acetylene based VCM production holds a cost advantage over ethylene based VCM production depends on the relative costs of its feedstocks: coal and crude oil as well as energy costs. It has been calculated that crude oil prices must be as low as 35 USD per barrel to compete with carbide based VCM production in East China and be as low as 25 USD per barrel to compete with carbide based production in Northwest China. At price of 40 USD per barrel, China would have a 100 USD per ton advantage over PVC produced based on ethylene (Fryer 2006). At an annual production of 5.8 million tons this would mean savings in the order of 500 million USD. Higher coal and energy prices outside China has made acetylene based VCM production non competitive for a long time.

In 2008 it has been reported that due to strongly increased domestic coal prices acetylene based PVC production has become more expensive:

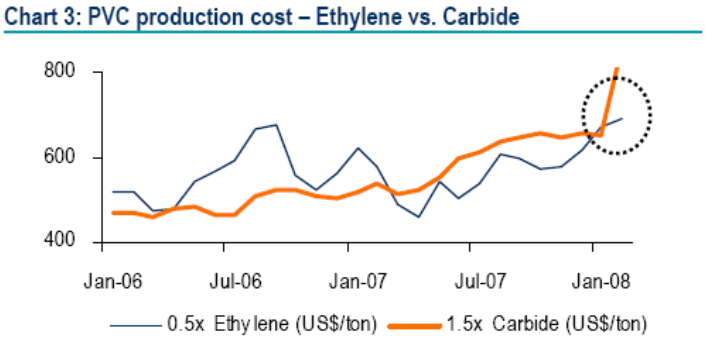


Figure 1: Development of PVC production costs in China from 2006 to 2008 (Merryl Lynch 2008)

The current situation (2011) is unknown, but it is obvious that there could be quite significant fluctuations in the near future that could make acetylene based VCM and PVC production non competitive or even uneconomic.

2.6.1 Mercury consumption and supply

According to an internet source, for the production of 1 ton VCM about 1.2 kg mercury catalyst is consumed. With a Chinese production of 5.8 million ton VCM in 2009 that

would result in 6960 ton of catalyst and 566 t mercury. For 2012, a production of 10 million ton is expected that would result in a consumption of 1056 tons.

At the temperature of the process (100 – 250 °C) mercury chloride slowly evaporates. A loss of mercury into several product and waste streams cannot be avoided (Rossberg et al. 2006). Supply of mercury becomes a limiting factor for the Chinese industry as output from domestic primary mining is expected to decrease.

The Chinese government has published a plan to reduce the consumption of mercury in the VCM sector by better recycling of depleted catalysts and better recovery of mercury from different waste streams. By 2012 the industry consumption shall be reduced by 25% and emissions by 50% (CCR 2010).

2.7 Countries with acetylene based VCM production

2.7.1 China

In China, about 80% of the VCM production capacity (16 million tons) is based on the acetylene process. Due to a low utilization ratio (44%) the actual production was only 7.700 t. (Deloitte 2010, data for 2009). In the recent years the number of plants (81 in 2007) and the total capacity has more than tripled and most of the increase account for acetylene based processes (Nexant 2007).

2.7.2 Russia

There are four plants with a total VCM production capacity of about 166.000 tons (UNEP 2010)

2.7.3 Iran

According to information by the Iranian government, six plants in the country are producing vinyl chloride monomer using mercury catalysts (Iran DOE 2007), although it may also be possible that this is the total number of VCM plants in Iran regardless of the technology used.

2.7.4 India

At least one plant in India is still producing VCM from acetylene (carbide based) using a mercury catalysts. The capacity of the plant has been expanded only recently to 70.000 tons per year (DSCL 2009). It has been reported that the process uses mercury chloride as a catalyst (Indian Ministry of Science and Technology, 1991)

2.7.5 Uzbekistan

According to Uzbek reports (UzInfoInvest year unknown, Uzbekistan Daily 2010), at least one plant in Uzbekistan is producing (or expected to produce in 2011) VCM from acetylene . The source of acetylene is pyrolysis of methane (CH_4). Although there is no information about the catalyst in the hydrochlorination process, it may be assumed that it is mercury chloride.

2.7.6 Slovenia

In 2009 it was reported that one VCM plant that was based on the acetylene technology was active in Slovenia (Anscombe 2009).

2.7.7 Other countries

In a UNEP report VCM plants in Croatia (2), Macedonia (2) and Turkey (1) were identified which, at least in the past were producing VCM on the basis of acetylene (UNEP 2010). No information was available whether these plants are still in operation.

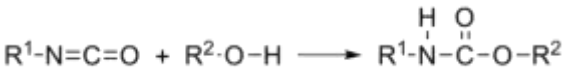
3 Use of mercury compounds in the production of polyurethane

3.1 Summary

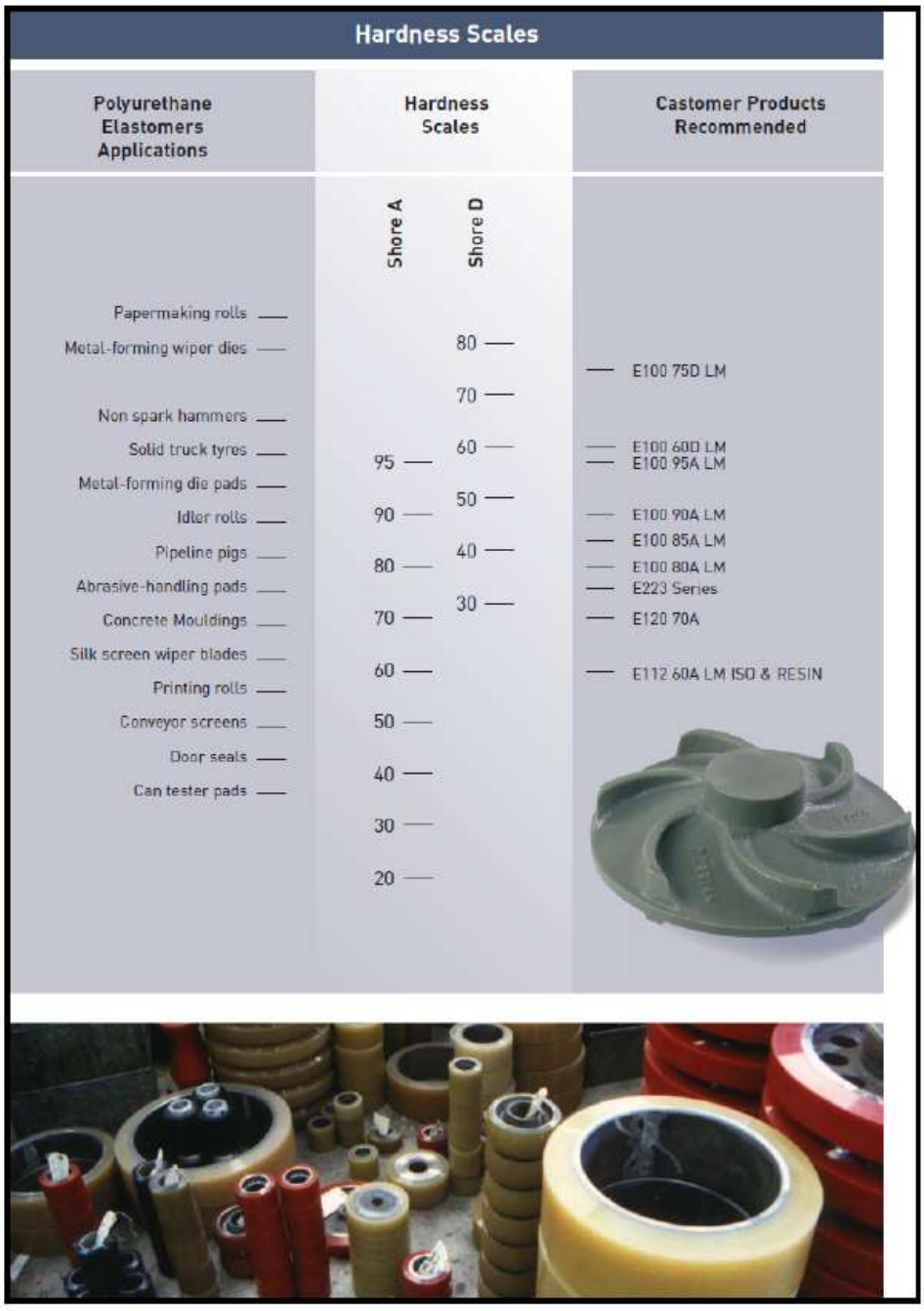
Mercury catalysts often containing phenylmercuric neodecanoate are used to produce some types of polyurethane elastomers. These are used or have been used until recently for special technological purposes including flooring materials. Due to the specifics of the production process the catalyst remains in the final product, from which it could be releases during use or disposal. The annual global consumption of Hg catalysts for polyurethane production is estimated to be in the order of 300 to 500 t.

3.2 Structure and use of polyurethane

Polyurethanes (PU or PUR) are made from an organic isocyanates (-N=C=O) and alcohols (-O-H). A producer may choose from many different combinations of isocyanates and alcohols and reaction conditions so that the products cover a broad range of properties that could be used for a large number of applications.



For some PU types (elastomers) mercury compounds are used to initiate and catalyse the reaction, but in difference from other chemical processes the catalyst remains in the product at concentrations up to 1 weight-%. Due to their specific properties, these elastomers find applications in marine and electronic technology, shoe soles, rollers, seals, shock absorption, prototyping, encapsulation purposes. During their use or disposal, mercury is released due to disintegration or abrasion (COWI 2008). At least until the 1980ies mercury containing polyurethanes were used for the production of flooring, e.g. in gyms. There are several cases reported where mercury from old flooring is continuously released into the atmosphere of gyms, posing a permanent risk of exposition to users of such buildings (Bush and Herbrandson 2009). Mercury catalysts often contain the compound phenylmercuric neodecanoate, but other compounds are reported as well (COWI 2008).



Source: Baxenden (2008)

Figure 2: Suggested PU systems for typical applications (Baxenden in COWI 2008,)

3.3 Economical significance and mercury consumption

It was estimated that about 300 to 500 t of mercury catalysts containing about 100 t are used for PU production worldwide. The total amount of PU produced by Hg catalysts may be in the order of 55,000 to 65,000 t (COWI 2008). The value of these products is unknown.

3.4 Alternative approaches

- Replacement of Hg catalysts by Hg free catalysts

For many PU elastomers, mercury free catalysts are already in the market at competitive prices. However, there may be certain applications where there is still no proper replacement for Hg catalysts. Currently, it is not possible to draw a detailed picture on the entire market, but it has been assumed that for most products and applications alternatives are available or could be made available within a few years (COWI 2008). It should be noted that the Swedish general ban also covers the use of mercury catalyst in PU production, although it is not known whether this is relevant for the Swedish chemical industry. Mercury free catalysts may be based on titanium, tin, lead or zirconium.

4 Use of elemental mercury in chlor-alkali-production

4.1 Summary

Elemental mercury is used in mercury cell chlor-alkali plants to produce chlorine gas and sodium hydroxide. In the process mercury acts as an electrode and separator. The sector still consumes about 450 to 550 t mercury annually and has been responsible for considerable mercury releases to air and soil, although improved housekeeping measures have reduced the releases significantly. Since the 1980ies mercury cell chlor-alkali plants have been more and more replaced by plants that use the cheaper membrane technology.

4.2 Technology

Chlorine (Cl_2) and sodium hydroxide (caustic soda, NaOH) are very important chemicals that are needed for many technological and chemical processes. Both chemicals are produced by electrolysis of an aqueous solution of sodium chloride (based on the naturally occurring mineral halite):

Anodic (oxidation) reaction: $2Cl^- \rightarrow Cl_2 + 2\ e^-$

Cathodic (reduction) reaction: $2Na+ + 2\ e^- \rightarrow 2Na$ (in Hg)

In the mercury-cell technology, mercury is used as the cathode. Sodium that is developed by the reduction dissolves in mercury to form an amalgam. In a separate chamber this amalgam is decomposed by addition of water. The reaction produces a solution of sodium hydroxide and hydrogen gas:

$2Na$ (in Hg) $+ 2\ H_2O \rightarrow 2\ NaOH + H^2\uparrow$

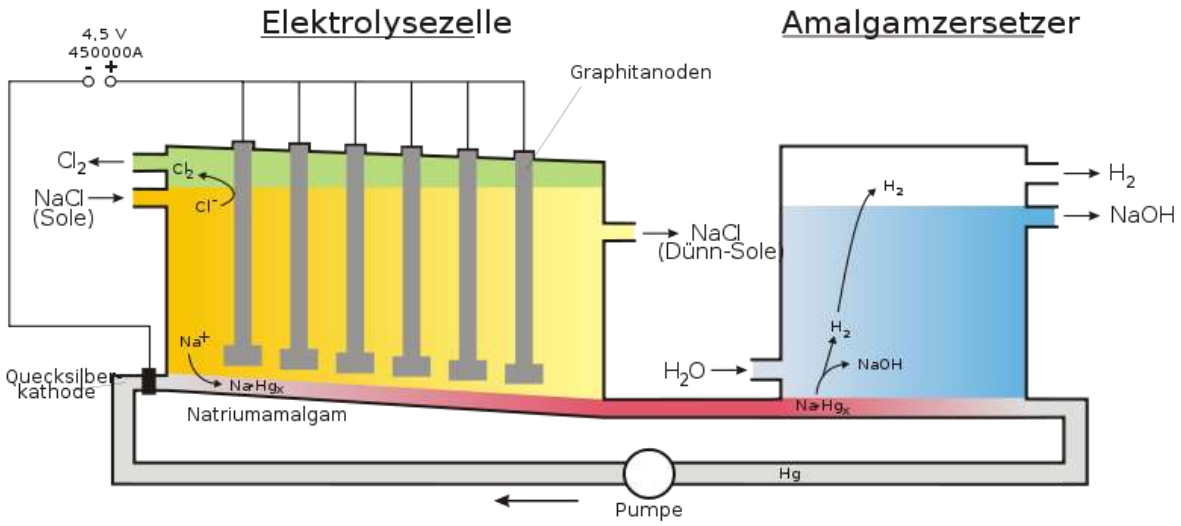


Figure 3: Diagram of a mercury cell fort the production of chlorine and caustic soda (Quelle: MarkusZi, Wikipedia, Public Domain)

A very illustrative animation may be found here (Eurochlor).

In the process mercury acts as an electrode (cathode) but at the same time separates the two half-cells of the electrolytic cell. This is important in order to keep sodium hydroxide/ hydrogen and chloride separated which could react with each other to form unwanted by-products.

Working as an electrode, mercury is not intended to be part of the reactions. However, due to its vapour pressure, aqueous solubility and reaction mercury with chlorine or trace amounts of oxygen it may be found in minor concentrations in all products as well as in specific waste types. That is one reason why mercury cells 'consume' mercury and mercury cell chlor-alkali plants are sources of mercury releases to the atmosphere, water and soil. Other reasons are bad management of mercury within the plant, leaks and technical defects. Good housekeeping measures helped to significantly reduce mercury releases from European plants.

4.3 Economical significance and mercury consumption

Although the number of plants is decreasing swiftly, mercury cell chlor-alkali plants are still responsible for about 5.6 million ton chlorine production capacity (World Chlorine Council 2010), about 10% of the global capacity of about 55 million tons (World Chlorine Council 2011). The annual consumption of mercury in the sector is estimated to be in the order of 450 to 550 tons. Part of the mercury goes to wastes that are recycled within the plants so that the net demand may be smaller (UNEP 2008). Currently about 100 plants in 44 countries use the mercury technology. About one half of these plants is expected to be closed down or converted during the next years, mainly in Europe, USA and India (UNEP Global Mercury Partnership Chlor-Alkali Area 2010).

4.4 Alternatives

Since the 1980ies mercury-cell chlor alkali plants are no longer built since the membrane technology (see picture below) offers the same product at a lower energy consumption (-30%, Krupp-Uhde 2001). Because of this many mercury-cell chlor alkali plants have already been converted to other technologies or closed (Concorde 2006). In the membrane technology the two half-cells are separated by a membrane that is permeable only for sodium but not for chloride. The investment costs for a conversion are rather high (in the order over several tens of million EUR per plant), which are an obstacle for many plant operators.

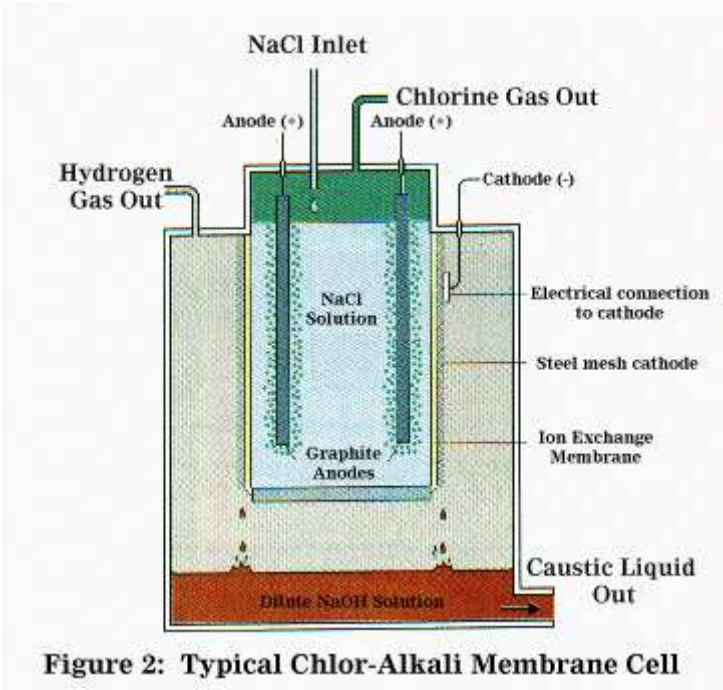


Figure 4: Membrane technology (source: cheresources.com)

Another approach is the diaphragm technology, which has been for many years the most preferred technology worldwide. Here the half-cells are separated by a porous material. Historically this has been asbestos, but nowadays materials like polyethylene are used. Production of caustic soda with the diaphragm technology consumes even more energy than with mercury cells so that diaphragm plants are more and more replaces by membrane plants (Krupp-Uhde 2001).

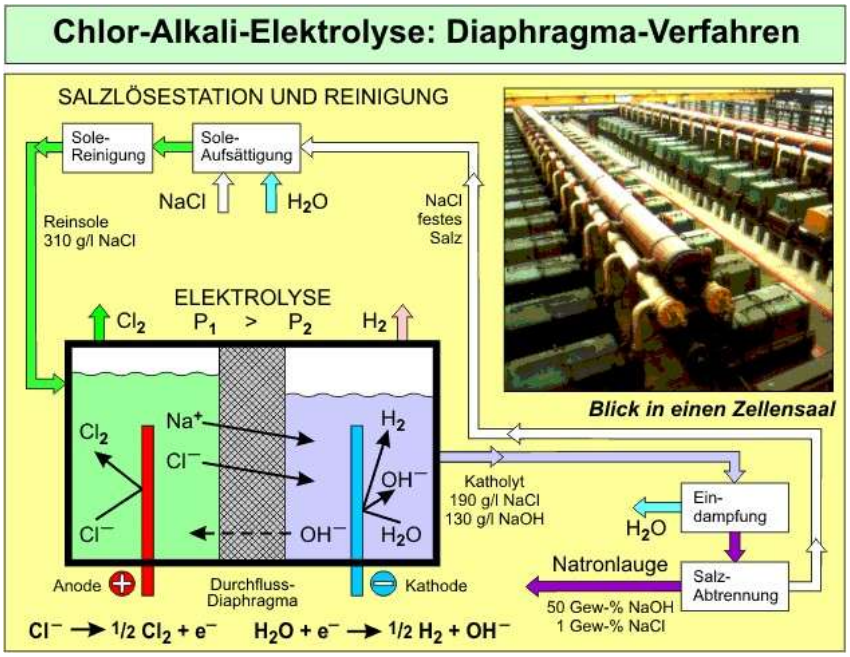


Figure 5: Principle processes in the diaphragm technology (Source: GDCH Dortmund/ VCI)

5 Use of elemental mercury in alcoholate production

5.1 Summary

Alcoholates (also called alkylates or alkoxides) are are group of chemicals whose most prominent use is the production of biodiesel. Three general synthesis routes exist. One of them uses the amalgam technology that uses the same type of mercury cells as in chlor-alkali production.

5.2 Technology, structure and use of alcoholates

Alcoholates (alkylates, alkoxides) are made from alcohols - hydrocarbons with a hydroxide group:

$C_xH_{x+1}OH$

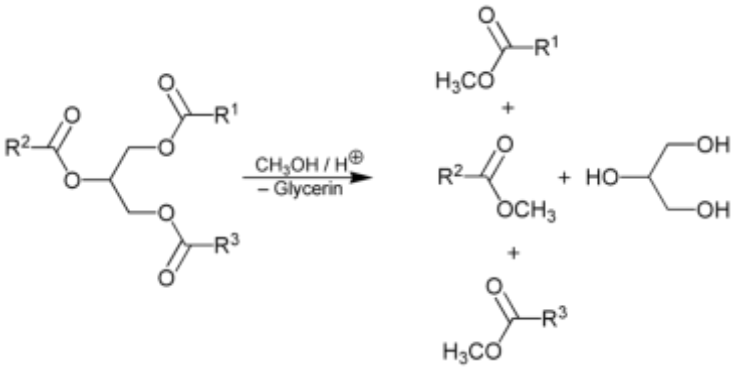
Abstraction of a proton (H+) leads to alcoholates:

$C_xH_{x+1}OH \rightarrow C_xH_{x+1}O^- + H^+$

An important alcoholate is sodium methanolate (sodium methylate, sodium mtehoxide):

$H_3C\text{-}O^- {}^+Na$

Sodium methanolate is mainly used in the production of biodiesel, where it plays an important role as a catalyst in the transesterification of vegetal or animal fats with methanol.



The purpose of this reaction is the transformation of viscous oils and fats into liquids of low viscosity that can easily replace diesel in ordinary engines. Around 15-17 kg of sodium methylate solution is needed to produce 1 tonne of biodiesel (Sodium Methylate's Importers Consortium 2010). An important example is the transesterification of oil rapeseed oil methyl ester (Rapsölmethylester). Other applications include the production of agrochemicals, pharmaceuticals and polymers (Nandini 2010).

In Europe sodium methylate is produced only by two German companies

- Evonik (Lülsdorf near Cologne)
- BASF (Ludwigshafen)

Both employ the mercury-cell technology. The design of the plants is very similar to those of the chlor-alkali production. The most important difference is that the intermediate sodium amalgam is not mixed with water but with methanol:

$2Na(Hg) + 2\ CH_3OH \rightarrow H_3C\text{-}O^-\ ^+Na + H_2$

Worldwide, there are no other plants that use this process.

5.3 Economical significance and mercury consumption

According to industry information, more than 100.000 tons of sodium methylate are produced every year in Europe by the two above mentioned plants (Sodium Methylate's Importers Consortium 2010). The amount of mercury in these plants and their annual consumption is unknown. These plants are not covered by the voluntary agreement of the European chlorine industry to phase-out the mercury-cell technology in chlor-alkali production by 2020.

5.4 Alternatives

Sodium methylate as well as other alcoholates may also be produced by reaction alkali metal with alcohols:

$2Na + 2\ CH_3OH \rightarrow H_3C\text{-}O^{-}\ ^{+}Na + H_2$

Sodium metal is produced from an electrolysis of liquid sodium chloride. Outside Europe this is the only process employed, although its costs are about 20% higher. Another possibility is a balance reaction of sodium carbonate with methanol:

$Na_2CO_3 + CH_3OH \rightarrow H_3C\text{-}O^{-}\ ^{+}Na + H_2O + CO_2$

The same companies that operate the mercury-cell plants in Germany are building mercury-free plants outside Europe (Sodium Methylate's Importers Consortium 2010).

Other products produced by the mercury cell technologyAccording to industry information (VCI , no year) the mercury cell technology is also used for the production of a number of other chemicals. These include:

- Sodium dithionite (1 plant in Germany, 1 in USA). Annual production using mercury cells: about 12% of 600.000 t.
- Alkali metals (sodium and potassium): one plant in Germany
- Potassium hydroxide or high purity: 6 plants in 4 countries (including Belgium, Germany, France)

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