Mexican Mercury Market Report

Jose Castro Díaz

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For more information:

Commission for Environmental Cooperation
393, rue St-Jacques ouest
Bureau 200
Montreal (Quebec) Canada H2Y 1N9
t 514.350.4300 *f* 514.350.4372
info@cec.org / www.cec.org

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From Mexico

David Alejandro de la Rosa Pérez
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National Environmental Research and Training Center **(*Centro Nacional de Investigación y Capacitación Ambiental*—Cenica, *Instituto Nacional de Ecología*—INE)**

Alfonso Flores Ramírez
General Director of Integral Management of Hazardous Materials and Activities,
Secretariat of Environment and Natural Resources **(*Gestión Integral de Materiales y Actividades Riesgosas, Secretaría de Medio Ambiente y Recursos Naturales*—Semarnat)**

From the United States

Jacqueline E. Mosby, MPH
Chief, Program Assessment and Outreach Branch
National Program Chemicals Division (7404T)
Office of Pollution Prevention and Toxics
US Environmental Protection Agency

Timothy Lehman
Office of Pollution Prevention and Toxics
Economics, Exposure and Technology Division (OPPT/EETD)
US Environmental Protection Agency

Ned T. Brooks
The Minnesota Pollution Control Agency

From the CEC

Luke J. Trip
Program Manager, Sound Management of Chemicals

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List of Acronyms

ANIQ	*Asociación Nacional de la Industria Química* (National Association of the Chemical Industry)
Camimex	*Cámara Minera de México* (Mexican Mining Association)
CASRN	Chemical Abstracts Service Registry Number
CEC	Commission for Environmental Cooperation
CMY	Canadian Minerals Yearbook
COA	*Cédula de Operación Anual* (Annual Certificate of Operation)
CRM	*Consejo de Recursos Minerales* (Council of Mineral Resources, now SGM)
EPA	Environmental Protection Agency (US)
INE	*Instituto Nacional de Ecología* (National Institute of Ecology)
INEGI	*Instituto Nacional de Estadística y Geografía* (National Institute of Statistics and Geography)
HS	Harmonized System
HTS	Harmonized Tariff Schedule
LAU	*Licencia Ambiental Unica* (Limited Environmental License)
LGEEPA	*Ley General del Equilibrio Ecológico y la Protección al Ambiente* (General Act of Ecological Balance and Environmental Protection)
LCSP	Lowell Center for Sustainable Production
MYB	Minerals Yearbook (US)
NAAEC	North American Agreement on Environmental Cooperation
NAFTA	North American Free Trade Agreement
NARAP	North American Regional Action Plan
Profepa	*Procuraduría Federal de Protección Ambiental* (Federal Attorney for Environmental Protection)
RCRA	Resource Conservation and Recovery Act (US)
RETC	*Registro de Emisiones y Transferencia de Contaminantes* (Pollutant Release and Transfer Register)
SGM	*Servicio Geológico Mexicano* (Mexican Geological Service)
SIAVI	*Sistema de Información Arancelaria vía Internet* (Tariff Information System via the Internet
SE	*Secretaría de Economía* (Secretariat of Economy)
Semarnat	*Secretaría de Medio Ambiente y Recursos Naturales* (Secretariat of Environment and Natural Resources)
SMOC	Sound Management of Chemicals (Initiative)
UNEP	United Nations Environment Programme
USGS	United States Geological Survey

NOTE:

Throughout this report most quantities of mercury are reported in metric tons; however, the author has sometimes employed kilograms when the quantities are small or occasionally in order to cite information exactly as it was found in the official sources of information consulted.

Organization of this Report

This Mexican mercury market report has six chapters and two annexes.

- **Chapter 1**, the Introduction, presents a brief overview of the current international context related to reducing and eliminating anthropogenic sources of mercury, as well as a background overview of mercury initiatives in North America. It also indicates the objective and scope of the report.

- **Chapter 2** describes the commodity-grade Mexican mercury market. It presents figures related to historic and recent primary and secondary mercury production, based on available sources of official information; presents data on imports and exports; and describes the mercury commerce with other countries.

- **Chapter 3** provides estimates of potential mercury supply in Mexico, taking into account the following sources: ancient mercury-containing tailings resulting from the precious-metals mining in the State of Zacatecas; the stocks possessed by mercury cell chlor-alkali plants; and abandoned mercury mines in the state of Querétaro and other locations in Mexico.

- **Chapter 4** describes the Mexican market in mercury compounds and mercury-containing products imported or manufactured in Mexico; includes information about retailers and consumers; and describes methodology and criteria for collection, selection and organization of information, based on other experiences in North America. When available, information on alternative, mercury-free products is presented. Information on mercury-containing products and other data on companies are organized by sectors and will be integrated with the Mexican database of mercury-containing products and (mercury-free) alternatives, based on an equivalent EPA project.

- **Chapter 5** presents findings and conclusions of the report.

- **Chapter 6** gives recommendations.

- **Annex 1** is a complementary work that analyzes available official information from the three countries on commodity-grade mercury production, imports/exports, and consumption (when available). Some findings on mercury commerce in North America and information gaps are presented.

- **Annex 2** offers more details on the organizations, agencies, companies and other entities from which the information in this report was compiled. Several website addresses are included.

Executive Summary

The purpose of this market report is to collect and analyze available information from Mexico in order to describe supply, demand, trade, market characteristics, and trends of elemental mercury and mercury-containing products in commerce. The report also identifies market actors, consumers, producers and institutions. Data on production, imports, exports, supply and demand are presented.

A contradiction in Mexico exists in that although regulations have been developed that limit mercury emissions to air and water and control disposal of wastes, this element has not been regulated as a good, and minimal governmental action has been taken to raise public awareness on risk reduction and exposure to mercury.

Based on available official data and recognizing that these data may have inaccuracies, this report provides the following information on commodity-grade mercury: during the period 2001–2007, Mexico produced secondary mercury in the amount of 81.25 metric tons; imported 193.46 metric tons; and exported 58.25 metric tons. Through a formula, total production plus imports minus exports, a result is reached of an apparent supply of 216.46 metric tons over this time period, for an annual average of 30.86 metric tons (see Table 2.5). Primary production also occurs, although on a small scale and unofficially, therefore not yet quantified.

An important global environmental issue is that during the last four years Mexican exports have increased, indicating that Mexico played a role as an intermediary country for commodity-grade mercury, importing it from developed countries and exporting it to Latin American countries. During this period, Mexican exports of mercury were as follows:

2005: 5.9 metric tons
2006: 8.1 metric tons
2007: 21.3 metric tons
2008: 58.5 metric tons
Total: 93.8 metric tons

These quantities represent a significant increase in exports over these four years. The main countries to which Mexico exported mercury were Peru, Colombia, Argentina, and Brazil.

During the same period (2005 to 2008), Mexico imported the following quantities of mercury from the United States:

2005: 26.2 metric tons
2006: 21.5 metric tons
2007: 4.0 metric tons
2008: 15.3 metric tons
Total: 67.0 metric tons

This progressive growth in import-export activity is possibly due to brokering activities and demand for mercury from artisanal gold mining in Latin American countries.

Potential mercury reserves in Mexico are estimated at approximately 26,892 metric tons, comprising of secondary production from ancient tailings (14,902 metric tons in the state of Zacatecas), primary mercury mines (11,750 metric tons in the state of Querétaro), and chlor-alkali stocks (240 metric tons in two plants). Secondary mercury reserves in Zacatecas especially are economically feasible for recovery due to the value of the silver amalgamated to the mercury. Ancient tailings exist in the state of San Luis Potosí and have not been quantified.

The above-mentioned estimation on Mexico's potential reserves of secondary and primary mercury and their extraction (technically, economically, and environmentally) feasibility needs further consideration, as this quantity represents around 10 times the global mercury demand (according to the *UNEP Summary of Supply, Trade and Demand Information on Mercury,* http://www.chem.unep.ch/MERCURY/Trade-information.htm). Taking this quantity into account, the recommendations section in Chapter 6 considers the advisability of conducting a more detailed study of these potential reserves.

Based on production statistics for mercury-containing products, imports-exports, and domestic goods, the following table presents an estimate of mercury consumption (metric tons) in Mexico during 2007.

Sectors and Products	**Nationally Produced Products***	**Imported Products***
Dental and health care		
• Amalgams	3.5	5.5
• Thermometers		2.4
• Sphygmomanometers	1.9	1.9
Electrical equipment, appliance and component manufacturing		
• Lighting and neon signals	1.0	0.5
• Batteries, relays and switches		12.5
Miscellaneous manufacturing		
• Fluxometers, manometers and thermostats		1.4
Computer and electronic product manufacturing		
• LCD displays, laptops, video cameras		0.1
Professional, scientific and technical services		
• Barometers, non-medical thermometers, psychrometers, etc.		1.6
Chemical synthesis and biopharmaceutical uses		
• Chlor-alkali process	5.0	
• Basic inorganic chemical production	9.1	
• Biopharmaceutical and laboratory uses	3.9	
• Net imports of unknown Hg compounds (40% of 122.8 metric tons)		48.7
Total Consumption, Sectors and Products	**24.4**	**74.6**
*Numbers correspond to mercury weight contained in the products.		

Thus, total mercury consumption in Mexico during 2007, comprising both nationally produced goods and imported ones, amounted to approximately 99.0 metric tons.

In the near term, the Mexican mercury market will be influenced by two new important factors that will also generate changes in the global mercury scenario. The first is that on 26 October 2006, the European Commission proposed legislation to ban all European Union exports of mercury from 2011. The other factor is the US Mercury Export Ban Act of 2008, which prohibits the transfer of elemental mercury by federal agencies, bans US export of elemental mercury, effective 1 January 2013, and requires the US Department of Energy to designate and manage an elemental mercury long-term facility, effective 1 January 2010.

Judging by these factors and considering that the US has been the main mercury supplier to Mexico, the prospective for the future may include activation of secondary mercury production, informal primary production, and fostering of mercury recycling facilities and the imports (legally or illegally) of mercury-spent products for recycling, depending on the local and international demand in the near future. For these reasons, a comprehensive environmental assessment should be considered.

The average apparent supply of commodity-grade mercury from 2000 to 2006 was approximately 37.4 metric tons. However, in 2007 and 2008, for first time, there were negative apparent supplies, amounting to -8.9 metric tons in 2007 and -34.7 metric tons in 2008 (see Table 2-5).

Among the 25 recommendations proposed in this report, it is important to consider these:

- Design a strategy that takes into consideration costs and technology for mercury-containing waste recycling, as well as legislative and economic factors;
- Develop a midterm study related to developing capacity for final retirement and storage of excess mercury that considers which entities (state or private company) could be allowed to store mercury; who should pay initial and ongoing costs of storage; what should be the technical standards for safe, long-term storage; what is the legal authority for the storage of the mercury; what legislative/regulatory changes may be needed; and
- An urgent, high-priority action that should be undertaken by the health authorities is to ban the sales of elemental mercury in drugstores. In Mexico, mercury for amalgams is sought for uses other than those in the oral care and health sector, such as neon sign workshops, traditional cures, jewelry, and other unknown uses.

Information gathered in this Mexican market study may be useful in helping to develop the best strategies for reducing the consumption and supply of this pollutant in Mexico.

In addition, this information could provide elements for the design and assessing of a final mercury retirement and confinement strategy, on a medium- and long-term basis.

Chapter 1: Introduction

Due to its unique physical and chemical properties and its identification as a persistent, bioaccumulative and toxic substance (PBT), mercury has raised concern in most countries for the last three decades. This concern has been expressed in strategies that comprise scientific research; legal framework development; programs for reducing mercury emissions; collection and recycling initiatives of mercury-containing products; and food consumption advisories related to intake of mercury. Outcomes from these strategies in many cases have been successful but, probably as a consequence, mercury as a commodity is available in considerable amounts on the global market and tends to be sold in developing countries, where it is used in artisanal gold mining or in non-essential applications.

Some of the important properties of mercury are its capacity for long-range atmospheric transport, due to its volatility and long lifespan (1/2 to 2 years); its capacity for bioaccumulation in aquatic food chains; and its capacity for transformation into more toxic compounds, such as methylmercury.

1.1 International Context

Globally, important initiatives have emerged related to reducing anthropogenic mercury emissions. Significant response is taking place, expressed in national, regional and international initiatives, protocols and plans. However, there is still a long way to go.

On 20 June 2001, representatives of several Swedish universities and various environmental organizations sent a letter[1] to the European Commissioner for the Environment, denouncing mercury production in the Almadén mines in Spain. The letter pointed out that about 85 percent of the mines' production was exported to developing countries. Emissions to the air during the production of mercury at this mine were estimated to be approximately one kilogram of mercury per hour, which resulted in more than four metric tons of mercury emitted to the air in 1995, when 1,500 metric tons of mercury were produced. Another important request by the academics was to analyze how the EU will handle the 12,000 metric tons of surplus mercury that will result when European mercury cell chlor-alkali factories change to a mercury-free process.

In 2005 it was reported that Almadén mercury production had ceased indefinitely (*Metal Bulletin* 2005a). On 28 January 2005, the Commission of the European Communities issued the *Community Strategy Concerning Mercury.* Action 5 of this strategy proposes that the export of the commodity mercury from the European Community be completely phased out by 2011.

The Commission's purpose for proposing the ban is to support global efforts to phase out primary production of mercury from mines (such as those in Almadén, Spain) and to prevent secondary supplies from re-entering the global market. At this time, the Strategy is still in proposal form, and it is not clear how global markets and policy-makers in other nations would respond to a ban on the export of mercury from the EC.

Mercury mining is still occurring in Algeria and Kyrgyzstan; China has also produced mercury in recent years and appears to have increased mining in response to recent high prices (*Metal Bulletin* 2004b). In Mexico, the Mexican Geological Service reports temporary mercury mining in Querétaro State (*Servicio Geológico Mexicano* 2007); the amount of mined mercury has not yet been quantified.

[1] Letter to European Communities Environment Commissioner, Margot Wallström, from Lars Hylander, Earth Sciences Centre, Uppsala University, 20 June 2001.

In 2001 the United Nations Environment Programme (UNEP) Governing Council (GC), through GC decision 21/5, decided to initiate a process to undertake a global assessment of mercury and its compounds. The *Global Mercury Assessment* (UNEP 2002) was presented to the 22nd session of the GC in 2003. Based on the key findings of the report, the GC concluded that there was sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment. The Council decided, through GC decision 22/4 V, that national, regional and global actions, both immediate and long-term, should be initiated as soon as possible, with the objective of identifying exposed populations and ecosystems, and reducing anthropogenic mercury releases that affect human health and the environment. In 2006 UNEP released its *Summary of Supply, Trade and Demand Information on Mercury* (UNEP 2006), which represents an initial effort to understand the mercury global market.

Estimates of the global mercury demand are about 3,000 to 3,900 metric tons for the year 2005, while the global supply estimated for the same year is approximately 3,000 to 3,800 metric tons, plus an additional supply of perhaps 11,000 metric tons that is due to technological changes and plant phase-out in the chlor-alkali sector (UNEP 2006). Use of mercury fluxes in developed countries may be decreasing but increasing in developing countries because of their increased use of mercury in gold mining.

There are two new and very important factors in the global mercury scenario: first, the *Community Strategy Concerning Mercury*, of the Commission of the European Communities (EC), which proposes that the export of commodity mercury from the European Community be completely phased out by 2011; and second, the United States' Mercury Export Ban Act of 2007, signed by President Bush on 14 October 2008, which prohibits the transfer of elemental mercury by federal agencies, bans US export of elemental mercury, effective 1 January 2013, and requires the Department of Energy to designate and manage an elemental mercury long-term facility, effective 1 January 2010.[2]

1.2 North American Context

In 1994, The North American Agreement on Environmental Cooperation (NAAEC) established the Commission for Environmental Cooperation (CEC), an international organization whose signatory partners are Canada, Mexico and the United States. The agreement complements the environmental provisions established in the North American Free Trade Agreement (NAFTA). The CEC's main objectives are to address regional environmental concerns; to help to prevent potential trade and environmental conflicts; and to promote the effective enforcement of environmental law.

In October 1995, the Council authorized Resolution 95-05 on the Sound Management of Chemicals (SMOC). The resolution established "a working group composed of two senior officials selected by each Party, whose duties pertain to the management of toxic substances and who shall work with the CEC to implement the decisions and commitments set out in this Resolution." The Resolution specifically called for the development of regional action plans for selected persistent and toxic substances as a first priority in the Parties' common desire to address national and regional concerns associated with the sound management of chemicals.[3]

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[2] More information is available at: http://www.glin.gov/view.action?glinID=71491.

[3] From 1966 to 1999, five task forces created by the SMOC Working Group have developed regional action plans on persistent, toxic and bioaccumulative substances: DDT; chlordane; PCBs; mercury; and dioxins, furans and hexachlorobenzene. A sixth task force was created in 2000 to develop the Monitoring and Assessment Action Plan.

By 1997, the SMOC Working Group recommended the creation of a North American Task Force on Mercury (the Task Force), consisting of members from industry, nongovernmental organizations, academia, indigenous peoples, and government, from the three countries. The Task Force had the primary responsibility for developing the North American Regional Action Plan (NARAP) on Mercury.

The NARAP provided a strategic framework for the three countries to execute actions aimed at reducing and eliminating anthropogenic mercury sources, through national implementation plans. One of the goals of the mercury NARAP is to promote initiatives on mercury management by:

- Investigating the best management options (according to official guidance and/or voluntary actions);
- Recognizing the need for stewardship and producer responsibility for product use and management, including on the part of suppliers, manufacturers, retailers, product users and the waste management community; and
- Strengthening citizen participation in the development and monitoring of sound mercury management programs.

Outside of the CEC's mercury NARAP work, the United States Environmental Protection Agency (US EPA) independently developed a global mercury market report that focused heavily on the United States' circumstances. The study, entitled *Mercury Market Background Report* (EPA 2005), assessed supply, demand, trends, and market characteristics of US and global mercury markets.

In reflecting on future reductions in the demand for mercury, the remaining quantities from the decommissioned chlor-alkali units, the increase of by-product mercury generated from different metals mining, and increasing quantities resulting from spent products collection programs and recycling programs, the US has considered the long-term storage of excess mercury. Some important questions and facts associated with this matter have emerged, such as:

- An interagency stakeholder panel for managing surpluses of domestic elemental, commodity-grade mercury was created in 2007. The panel will promote a discussion of the pros and cons of different options for managing non-federal mercury supplies
- Which entities (e.g., a state agency or private company) could be allowed to store mercury?
- Who should pay for costs of initial and ongoing storage?
- What should be the technical standards for safe, long-term storage and where should that storage be?
- What is the legal authority for storing mercury and who will have legal title to the stocks and be liable for their environmentally safe long-term storage?
- What legislative/regulatory changes may be needed from the environmental and marketing perspectives?

The US Government has two previous experiences in managing mercury stockpiles: 1) the Department of Defense (DOD) stockpiled 4,436 metric tons in aboveground storage in the 1950s and 1960s for use in the production of enriched lithium, a product used in the atomic weapons program, and 2) the Department of Energy (DOE) has approximately 1,206 metric tons of stored mercury, which the department decided in late 2006 to continue to store rather than sell. The stockpile is currently stored at DOE's National Nuclear Security Administration facility in Oak Ridge, Tennessee. DOE will continue this temporary storage arrangement while investigating options for alternative long-term storage. The annual storage costs of these stockpiles are about US$1 million (EPA 2007a).

A supplementary section on mercury import/export statistics for Canada, Mexico and the United States is included in Annex 1.

1.3 Objective and Scope

The objective of this Mexican mercury market report is to undertake an assessment of the status of mercury as a commodity and of its economic aspects. The report includes descriptions and assessments of production, supply, demand, trade, market characteristics, and trends of mercury in commerce in Mexico, and its uses in products and processes.

The scope of this report is to collect, review and gather background documentation; identify market actors (producers, suppliers and consumers), institutions and government agencies; perform data collection and analysis of mercury consumption and production in Mexico, specifically secondary production from "ancient" mine tailings in Zacatecas; as well as gather quantitative data on sales, imports, exports and quantities of mercury and mercury-containing products in the Mexican market.

An earlier report, *Preliminary Mercury Market Report for Mexico*, was made in 2007. The current report reflects the second phase of the project and focuses on further refining the collected background data and information into an updated new version. Any pertinent information on the manufacture of specific products and alternatives in Mexico will be incorporated into the Spanish version of the EPA's Mercury-added Products Database[4] for the development of a Mexican mercury-containing products and alternatives database.

Information gathered from this Mexican market study will be used to help strategize best approaches to reducing consumption of mercury and to the handling of the supply of mercury in Mexico. In addition, this information may provide elements that will enable decision makers to assess and design a final retirement and confinement strategy for mercury, for medium- and long-term.

[4] EPA/OPPT (US Environmental Protection Agency, Office of Pollution Prevention and Toxics) Draft EPA Mercury-containing Products and Alternative (mercury-free) Products Database, 2008.

Chapter 2: Commodity-Grade Mercury Market in Mexico

2.1 Mexican Context and Historical Overview

Two significant sources of mercury have been identified as an integral part of Mexican history. These sources also correspond with two different historic phases: the first as a Spanish colony, when *conquistadors* brought thousands of tons of mercury from the Almadén mine in Spain to be used to extract silver and gold; the second as a developing country, when global demand for mercury was considerable and there was a broad capacity in Mexico to produce this metal.

Silver, gold and mercury share an intertwined history. Significant sources of mercury were imported from the Almadén mine in Spain to extract the precious metals, using the amalgamation process in the mining activity. From about 1556 AD until 1710 AD, the Spanish Crown supplied mercury to its Mexican mines in Zacatecas, Guanajuato, San Luis Potosí, Pachuca, and elsewhere in Mexico. During this period (see Table 2.1), due to the high demand for mercury which exceeded the production capacity of Spanish mines (Almadén in Spain and Huancavelica in Peru), Spain resorted to supplementing its own exports of mercury with mercury acquired from the Idrija mine in Slovenia and from other places in Europe. Historical references often describe many additional problems related to mercury transportation from Spain, which had an impact on the trade and use of this metal, needed for silver extraction.

Table 2-1
Mercury Imports from Europe to New Spain (Mexico)
1556–1710

Information Source	Period	Imported Quantity	
		*Quintales**	Metric tons
Chaunu and Mantilla[a]	1556–1645	252,970	11,499
Archivo General de Indias[b]	1646–1650	11,528	524
Chaunu and Mantilla[a]	1651–1700	97,805	4,446
Archivo General de Indias[b]	1701–1710	29,154	1,325
Archivo General de Indias[b]	1572–1700	44,000 (from Peru)	2,000
Total		**435,457**	**19,794**

***** One metric ton is equal to 22 *quintales*.
[a] Chaunu and Mantilla (quoted in Lang, M.F., 1977, p. 353).
[b] *Archivo General de Indias* (quoted in Lang, M.F. 1977, p. 354).

Attempts were made at mercury extraction from Mexican mines as well; however, these attempts were not successful because the Spanish Crown, in order to have control over silver extraction and technological problems at the mines, did not allow efficient mercury production. For this reason, Spain imported the mercury used in Mexican silver mines from Peru. According to the *Archivo General de Indias*, the amount of these imports during 1572 to 1700 was 44,000 *quintales*, equivalent to 2,000 metric tons (Table 2-1, tabulated from Lang 1977).

Based on the information presented above, during the 154-year period (1556–1710), Mexico (New Spain) imported 19,794 metric tons of mercury, which represents an average of 128.5 metric tons annually.

Near the end of the eighteenth century, Mexican consumption of mercury used to extract silver exceeded 16,000 *quintales* (727 metric tons) annually and was probably more, given that miners, who charged in silver for the amount of mercury they used, tended to understate the quantities of mercury sold or consumed. Following the Mexican War of Independence of 1810, mining activity diminished and small entrepreneurs turned increasingly to lixiviation (a leachate process), which included use of cyanide, to extract gold, silver and mercury from tailings (CEC 1998). In fact, tailings from the colonial mining activity have been an important source of secondary mercury and silver production since the early 1940s in tailings reprocessing facilities (*plantas de beneficio*). San Luis Potosí is another state where significant colonial mining activity took place, but there is no official information on secondary mercury production.

The other important source of mercury in Mexico is the considerable reserves remaining in Mexican mines exploited during the post-revolutionary and industrialization periods (see Table 2-2).

Table 2-2
National Mercury Production, 1922–1967
(in metric tons)

Year	Production	Year	Production	Year	Production
1922	41.90	1938	293.68	1954	508.63
1923	44.75	1939	253.27	1955	1 030.11
1924	36.66	1940	401.71	1956	673.25
1925	38.72	1941	797.62	1957	726.30
1926	45.42	1942	1 116.87	1958	782.00
1927	81.11	1943	976.33	1959	566.00
1928	87.42	1944	795.10	1960	693.00
1929	82.63	1945	556.84	1961	628.71
1930	170.52	1946	402.01	1962	650.00
1931	251.37	1947	333.82	1963	593.00
1932	252.73	1948	164.66	1964	433.00
1933	154.39	1949	181.17	1965	662.00
1934	157.92	1950	117.31	1966	762.00
1935	216.39	1951	218.93	1967	497.00
1936	182.96	1952	301.03	**Total**	**18,531.76**
1937	170.16	1953	401.36		

Source: Sumarios Estadísticos de la Minería Mexicana, as quoted in *Comisión de Fomento Minero* 1968.

The annual average in mercury production during this 46-year period was 402.86 metric tons per year, with the peak years of 1942 and 1955 having production of 1,116.87 and 1,030.11 metric tons, respectively.

2.2 Current Situation in Mexico

2.2.1 Primary production

Based on information from the Mexican *Consejo de Recursos Minerales* (CRM—Council of Mineral Resources),[5] there has been no official primary mining of mercury reported in Mexico since 1994. The operations stopped due to decreasing mercury prices resulting from the decreasing demand for mercury. Mexico's economic statistics do not mention data on primary mercury production.

However, the *Servicio Geológico Mexicano* (SGM—Mexican Geological Service) reports that three mines may be producing mercury intermittently, but no data are available about production volumes. These mines are located in the municipality of Peña Miler in the state of Querétaro (*Servicio Geológico Mexicano* 2007). Despite the known existence of 86 potential mercury mining sites in eight states (Chihuahua, Durango, México, Guanajuato, Guerrero, Querétaro, San Luis Potosí and Zacatecas), there is no information reported by CRM/SGM related to the status of these sites. (For further discussion, see Chapter 3 and Table 3-2.) Unofficial mining in other Mexican states was not identified.

2.2.2 Production of mercury as a by-product

Only non-official information is available related to mercury production as a by-product. This is an important issue, considering that Mexico is a major producer of copper, silver, lead, zinc, and gold. These metals are often found together in various concentrations as reduced sulfur compounds, such as copper sulfide (CuS), lead sulfide (PbS), zinc sulfide (ZnS) and mercuric sulfide (HgS—cinnabar). Mercury is frequently associated with gold and it is found within the crystal structure of gold in many gold deposits. Mercury is considered an indicator metal for the presence of gold in the gold prospecting industry (*Acosta y Asociados* 2001).

Mercury has a low boiling point, relative to gold and silver. For this reason, mercury is typically evaporated during the initial refining of these metals. In the US, in cases where the mercury concentration in the ore is sufficiently high to make recovery economically attractive, mercury retort furnaces and condensers are used to evaporate and recover mercury from the ore. Another factor that encourages gold mine operators to remove the mercury from the gold ore during initial refining is the economic penalty imposed by gold refiners for gold/silver concentrate, known as "dore," that contains more than 1 000 milligrams (mg) of mercury per kilogram (kg) (*Acosta y Asociados* 2001).

Based on emissions data and on official data on production in 1999, Acosta estimated emissions from the gold-mining and refining sector at 11.27 metric tons, and from the ferrous and non-ferrous smelters sector at 1.89 metric tons, yearly (*Acosta y Asociados* 2001).

A letter from Semarnat (*Secretaría de Medio Ambiente y Recursos Naturales*—Secretariat of Environment and Natural Resources) was submitted on 16 November 2007 to the Mexican Mining Association (Camimex), requesting information related to the production of virgin mercury and to mercury production as a by-product of the mining of other minerals (primarily gold, silver, lead, zinc and copper). On 21 January 2008, Camimex sent a letter of response to Semarnat, stating that none of its members produces mercury or uses the amalgamation technique for recovery of precious metals. In regard to mercury-containing wastes, the Association claimed that in most of the recovery processes of precious metals, mercury is not generated as a waste, and that in regard to other processes (initial refining or smelting of these metals), some mercury-containing wastes are generated (sludge), due to the gas wash in the condensers, and that the resulting wastes are sent to controlled confinement.

[5] In 2005, the Council of Mineral Resources changed its name to the Mexican Geological Service (SGM).

Although it appears that mercury is not being produced as a by-product of mining in Mexico, the existence of an unknown number of small gold or silver mining operations in the states of Sonora, Chihuahua, Durango, Zacatecas, Querétaro and Guerrero make it advisable to conduct a specific study on this matter.

2.2.3 Secondary production

Since the early nineteen-forties of the 20th century, the most important source of secondary mercury production in Mexico has been tailings reprocessing facilities (*plantas de beneficio*) in the Zacatecas region. During the Spanish colonial period, the resulting tailings from the mercury amalgamation "patio" process were manually spread around the countryside over the existing soils and to depths varying from a few centimeters to several meters. Reprocessors or recyclers now collect this mineral-rich overburden and have been using the "Zacatecana" process for recovery of precious metals and mercury from these ancient tailings around this city and the municipalities of Guadalupe and Veta Grande. By leaching the soils with a thiosulfate-based chemical solution, the resulting pregnant liquor can be precipitated, using scrap copper wire as a catalyst. The precious metal containing sludge is retorted in a furnace and the precious metals collected. The mercury and water vapor are directed to a rudimentary cooling chamber, which allows both to condense. They then flow to a separation well where the mercury metal is scooped by hand into standard 76-pound (35-kg) mercury flasks. These flasks of mercury are sold on the national and international markets.

As a consequence of the current leaching technique, large post-processing tailings dumps located near the facilities rise to an elevation of about 10–15 meters above the surrounding land. The rudimentary technology for capturing the mercury vapors from the retort furnaces includes no control equipment for mercury vapor emissions from the furnace other than a simple condensation chamber consisting of four cement block walls and floor drains which direct the condensed mercury to a stilling well outside the walled area for collection. Mercury emissions from these *plantas de beneficio* are estimated to be 9.66 metric tons per year (*Acosta y Asociados* 2001).

Historic information on the beginnings of secondary production refers to the La Pimienta facility, located six kilometers west of Zacatecas City, as the first recycling plant, which initiated activities in 1941 and closed in 1977 (Perales-Rivas, no date).

Other mining operations sites where the mercury amalgamation "patio" process for silver extraction was implemented in Mexico during the Spanish colonial period are presented in Table 2-3. These tailings sites may be assessed in order to determine if secondary mercury production is taking place, or took place in past years, as well to determine their production potentiality and environmental context.

Table 2-3 Historic Tailings Sites in Mexico	
State	**Mining centers**
Chihuahua	Parral
Durango	Northern region
Estado de México	Temascaltepec, Tlapujahua, Zacualpan
Guerrero	Taxco
Guanajuato	Guanajuato City-La Valenciana
Hidalgo	Pachuca, Real de Monte
Jalisco	Guadalajara
San Luis Potosí	Real de Catorce, Charcas, San Luis Potosí City
Zacatecas	Fresnillo, Guadalcazar, Mazapil, Real de Angeles, Sombrerete, Zacatecas City
Source: Derived from Lang, M.F., 1977	

Information on secondary mercury production from tailings reprocessing facilities around Zacatecas City and El Pedernalillo reservoir reported 33.3 metric tons annually (see Table 2-4).

Table 2-4
Estimates of Annual Secondary Production in Zacatecas Tailings Reprocessing Plants (kg)

Facility name	Production period*	Average annual production**	Location
Jales de Zacatecas, formerly named La Piñuelita	1979–May 2001	**4,200** *(350 kg/month)*	Colonia Osiris, Guadalupe County, North La Zacatecana Lagoon
Beneficiadora de Jales de Zacatecas	1971–2000	**14,484** *(1,207 kg/month)*	Guadalupe County, Northeast La Zacatecana Lagoon
Jales del Centro	1995–2008	**8,400** *(700 kg/month)*	Tacoaleche road
Mercurio del Bordo	1971–2000	**6,216** *(518 kg/month)*	El Lampotal Community, Veta Grande County
Yearly average production of the four plants		**33,300**	

* *Source*: CEC 1998, and *Gobierno del Estado de Zacatecas* 2002.** Source*:* Profepa 1996.

A similar amount of secondary production (33.30 metric tons) was reported by Profepa for the years 1994–1995 in the Zacatecas City area (Profepa 1996).

Information in Table 2-4 enables us to estimate amounts of secondary production presented in Table 2-5 and in consequence to have more realistic data on the mercury supply in Mexico.

Secondary mercury production from these tailings depends largely on the market price of silver and on the weather, since abundant precipitation during the rainy season makes extraction of the metals more difficult. Reliable records on secondary production during the last 67 years are not available. Information from other sources, including from academic and local authorities, may help to provide estimates.

The importance of having an estimate of the secondary mercury production locally is that it allows us to gain a realistic view of the potential national mercury secondary supply. **Annex 3** is an attempt to present at least an initial calculation of estimated quantities of secondary production of mercury from ancient tailings, resulting from silver extraction in Zacatecas during the last 20 years, based on the available technical, historical, official and unofficial information.

Another source of information on mercury secondary production for Mexico is the United States Geological Survey (USGS), which estimates secondary production of mercury as averaging 15 metric tons yearly from 2000 to 2005 (*USGS Minerals Year Book*, Vol. III, Area Reports: International (years 2000–2005).

2.2.4 Imports, exports and apparent supply of mercury in Mexico

The objective of this section is to present an overview of the mercury market in Mexico by compiling official data on primary production, imports, and exports; and estimates of secondary production (as calculated in section 2.2.3, above).

Before presenting the information in Table 2-5, it is important to define the concept of *apparent supply*, in the context of this work. Apparent supply is a comprehensive concept of imprecise calculations. Theoretically, it can be derived by adding production (of primary, secondary and by-product mercury) plus imports minus exports. The apparent supply also comprises national consumption.

As well, the concept of apparent supply should include unknown or undeclared mercury reserves stored for one or more years by brokers or industrial facilities, and, in some cases, recovered mercury, generally imported into Mexico from products and closed chlor-alkali plants.

Officially, there has been no primary mercury production of mercury in Mexico since 1994, and neither is there accessible and reliable national information on informal primary production, on production of mercury as a by-product, or on mercury-containing waste recycling.

Data presented in this report regarding commodity-grade mercury imports/exports (Table 2-5) are mainly based on official trade statistics generated from procedure papers that all importers/exporters are required to submit to pay duties and taxes. In this revenue-generating area, official information sources may be reliable; however, this information has also been known to have a degree of inaccuracy, due to errors during the process of data management and publishing. For instance, inadvertent mistakes might be made, such as indicating units as kilograms instead of metric tons.

Other potential errors in processing information can result from accidental changes in figures during the transposing of information from printed to electronic format; or from the allocation of inaccurate commodity codes for products by agents or administrative personnel in customs offices during importation or exportation. These codes are listed in the Harmonized System (HS)[6]. For instance, the HS number (*fracción arancelaria*) for commodity-grade mercury is **28054001**.

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[6] The Harmonized System (HS), of tariff classification, is a common name; also, it is equivalent to the Harmonized Tariff Schedule (HTS) of the United States.

It is important to note that there are three other relevant HS numbers: **28520001**, *Inorganic mercury compounds, except amalgams*; **28520059**, *Any other organic or inorganic compounds, except amalgams*; and **28439099**, *Any other compound, amalgam.* It is possible that under these numbers, imports/exports of metallic mercury are being listed, along with unknown mercury compounds whose proportions of mercury are therefore also unknown. See Table 4-3 for all HS numbers corresponding to mercury and mercury-containing products.

Considering the potential concerns mentioned above, it may be necessary to implement auditing mechanisms to validate data among importer/exporter countries. The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, 2005, can play an important role in this matter, considering that mercury and its compounds (including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury) are listed in Annex III of this Convention and, in consequence, are subject to the Prior Informed Consent (PIC) procedure, which is a mechanism for formally obtaining and disseminating the decisions of importing Parties as to whether they wish to receive future shipments of Annex III chemicals, and for ensuring compliance with these decisions by exporting Parties (see: http://www.pic.int).

Data in Table 2-5 for the period 1985–2007 can be divided into two parts: the first covers primary production in Mexico from 1985 to 1994 (10 years) and the second the period when primary mercury production ceased, from 1995 to 2007 (13 years).

Mercury production (primary and secondary) during the first period, 1985 to 1994, averaged 306.7 metric tons per year, with 1989 and 1990 being peak production years, at 675.9 and 759.9 metric tons, respectively. This period was a time of significant global demand and important Mexican primary production capacity; while for the second period, 1995–2007, production (only secondary) averaged approximately 21.62 metric tons annually (see Table 2-5).

Analyzing import data for the 10-year period from 1985 to 1994 shows Mexico's average to have been approximately 45 metric tons per year, while for the 1995–2007 (13-year) period, imports averaged 21.15 metric tons per year.

Table 2-5
Apparent Supply of Mercury in Mexico, 1985–2008
(in metric tons)

	Year	Virgin mining[1]	Secondary production[3]	Imports	Exports	Apparent supply
Secondary production Yearly average: 20.68 metric tons	2008	NP	8.40	15.34[2]	58.48[2]	-34.74
	2007	NP	8.40	4.03[2]	21.36[2]	-8.92
	2006	NP	8.40	21.46[2]	8.14[2]	21.72
	2005	NP	8.40	26.21[2]	5.92[2]	28.70
	2004	NP	8.40	24.77[2]	0.66[2]	32.51
	2003	NP	8.40	21.09[2]	2.38[2]	27.11
	2002	NP	8.40	43.84[2]	4.39[2]	47.85
	2001	NP	30.85	52.06[2]	15.41[2]	67.50
	2000	NP	33.30	9.60[2]	6.22[2]	36.68
	1999	NP	33.30	26.38[2]	54.02[2]	5.66
	1998	NP	33.30	19.80[2]	0.24[2]	52.86
	1997	NP	33.30	8.21[2]	7.01[2]	34.49
	1996	NP	33.30	7.74[2]	4.00[2]	37.04
	1995	NP	33.30	9.87[2]	0.31[2]	42.85
Primary and secondary production Yearly average: 306.7 metric tons	1994	11.00	24.90	27.80[1]	0.30[1]	63.40
	1993	12.00	24.90	40.50[1]	0.30[1]	77.10
	1992	21.00	24.90	101.90[1]	1.90[1]	145.90
	1991	340.00	24.90	2.15[1]	0.30[1]	367.05
	1990	735.00	24.90	0.40[1]	23.20[1]	737.10
	1989	651.00	24.90	276.10[1]	91.00[1]	861.00
	1988	345.00	24.90	0.40[1]	142.00[1]	228.20
	1987	124.00	24.90	0[1]	121.00[1]	27.90
	1986	185.00	24.90	0[1]	154.00[1]	55.80
	1985	394.00	24.90	0.70[1]	92.00[1]	327.50
Total	**1985–2008**	**2,818.00**	**538.45**	**740.35**	**814.54**	**3,282.26**

[1] INEGI. 1999. *Anuarios Estadísticos de la Minería Mexicana 1998*. 1999 update. *Consejo de Recursos Minerales*, and the *Banco Nacional de Comercio Exterior*, SNC.

[2] *Source*: World Trade Atlas, Secretariat of Economy, consulted 28 November 2007 and 6 June 2008.

[3] Figures were estimated according to historic information from: *Gobierno de Zacatecas* 2002; CEC 1998; Profepa, Official Communication, 1996; and Ogura *et al*. 2003. Amounts are also estimated based on Table 2-4.

NP = No production.

During the same period, 1985–1994, Mexico's exports of mercury averaged 62.6 metric tons per year, while for the 1995–2007 (13-year) period, they averaged 10 metric tons per year.

It is important to note that temporary imports/exports from the maquiladora sector (see section 2.2.5, below) are not considered, a subject that should be investigated.

Mexico seems to have played an important role as an exporting country during the period 1985–1990. In regard to recent trends in the international mercury market, since 2005, Mexico has increased its exports, especially to developing countries, coinciding with the period when mercury prices started to increase dramatically. (See further discussion in section 2.2.5, below.)

The apparent average supply of mercury during the period 1985–1994 was 289.12 metric tons per year, while for the 1995–2007 (13-year) period, the average supply, including national consumption, had dropped to only 32.77 metric tons per year.

2.2.5 Mercury imports/exports, by country

Imports

Table 2-6 is derived from the Secretariat of Economy's World Trade Atlas database, and presents information on annual imports to Mexico, by country, from 1995 to 2008. (Additional information, with names of importer or exporter companies, are presented in Table 2-9).

Table 2-6
Mercury Imports to Mexico, by Country of Origin, 1995–2007 (in kilograms)

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Canada	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
China	0	2	0	0	0	0	7	0	0	0	0	0	0	0	9
Dominican Republic	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
EEC (other than named)	0	0	0	0	0	0	5,175	0	0	0	0	0	0	0	5,175
France	0	0	0	2	0	0	0	2	5	10	2	1	0	0	22
Germany	500	506	749	334	408	3	0	0	20	0	0	0	0	49	2,569
Great Britain	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Italy	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Japan	12	0	1	0	0	14	0	0	0	10	0	0	0	0	37
Netherlands	785	650	601	525	242	426	21,343	5,641	521	281	0	0	0	0	31,015
Russia	0	0	0	932	0	0	0	0	0	0	0	0	0	0	932
Spain	5,175	5	0	0	0	0	0	3,450	0	0	0	0	0	0	8,630
Taiwan	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4
United States	3,394	6,578	6,856	18,007	25,731	9,160	25,528	34,751	20,543	24,469	26,204	21,457	4, 034	15, 289	242,001
TOTAL	**9,870**	**7,741**	**8,207**	**19,800**	**26,382**	**9,604**	**52,057**	**43,844**	**21,089**	**24,770**	**26,206**	**21,458**	**4,034**	**15,338**	**290,400**

Source: World Trade Atlas, Secretariat of Economy, consulted 28 November 2007 and 6 June 2008.

From 1995 to 2008, Mexico imported 290,400 kg from 14 different countries, showing a significant increase since 1998. The majority of imports came from the United States: 83% (242,001 kg) of the total. Imports from the Netherlands were the second-highest amount: 10.7% (31,015 kg) of the total. Imports from all countries except the United States ceased in recent years, probably due to inventories in closed chlor-alkali plants and to the incremental increase in recycling activities in this country. Considering that Mexico has an adequate domestic supply and also a significant amount of imports, brokering activities are taking place. This may be the reason that three companies play both roles, as both importers and exporters (see Table 2-9).

Exports

Table 2-7

Mercury Exports from Mexico, by Receiving Country, 1995–2008 *(in kilograms)*

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Argentina	0	0	0	0	0	0	0	0	0	0	3,106	552	552	5,175	9,385
Bolivia	0	0	0	0	0	0	0	0	0	0	0	86	0	0	86
Brazil	0	4,002	0	0	0	90	0	0	0	0	0	3,105	5,175	2,070	14,442
Chile	0	0	0	0	172	0	0	0	2	0	0	2	0	0	176
Colombia	0	0	0	0	0	0	0	0	0	0	1,207	3,000	11,952	16,649	32,808
Costa Rica	0	0	0	0	0	0	0	0	0	14	0	0	0	0	14
Cuba	0	0	6,749	0	0	0	0	0	0	0	0	0	0	0	6,749
Dominican Republic	0	0	30	0	0	100	0	0	0	0	0	0	0	0	130
Ecuador	0	0	0	0	0	0	0	0	0	0	1,224	483	100	100	1,907
El Salvador	34	0	0	0	0	80	98	25	161	207	315	276	0	276	1,472
Guatemala	0	0	102	0	0	0	41	148	126	0	0	0	0	5	422
Haiti	0	0	0	0	0	0	0	0	0	0	0	0	20	0	20
Honduras	0	0	0	0	0	90	216	35	134	0	0	0	0	0	475
Nicaragua	276	0	0	242	0	0	0	0	0	0	64	517	898	1,215	3,212
Netherlands	0	0	0	1	0	932	45	106	0	0	0	0	0	0	1,084
Paraguay	0	0	0	0	0	0	0	0	0	0	0	108	0	10	118
Peru	0	0	0	0	0	0	0	250	0	0	0	0	2,650	32,876	35,776
Spain	0	0	0	0	53,325	0	0	0	0	0	0	0	0	0	53,325
United States	0	0	127	0	22	4,333	15,007	3,226	1,961	437	0	8	8	1	25,130
Uruguay	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100
Venezuela	0	0	0	0	500	595	0	600	0	0	0	0	0	0	1,695
Total	**310**	**4,002**	**7,013**	**243**	**54,019**	**6,220**	**15, 407**	**4,390**	**2,384**	**658**	**5,916**	**8,137**	**21,355**	**58,477**	**188,431**

Source: World Trade Atlas, Secretariat of Economy, consulted 28 November 2007 and 6 June 2008.

From 1995 to 2008, Mexico exported 188,431 kg to 21 different countries, with Spain receiving the largest quantity, 53,325 kg, due to an apparent one-time shipment of mercury in 1999, equal to 28.3% of total imports during this period. Peru was the second-largest recipient, with 35,776 kg (19%) of total Mexican exports during this period.

2.2.6 Mexican market trends

SIAVI (*Sistema de Información Arancelaria vía Internet*—Tariff Information System by Internet) information for 2008 provides an updated overview of recent trade trends in Tables 2-6 and 2-7. Imports of mercury into Mexico during this year were 15,338 kg (15,289 kg from the US and 49 kg from Germany), while exports amounted to 58,477 kg (to Latin American countries).[7]

As shown in Table 2-6, Mexico imported 290,400 kg of mercury during 1995–2007 (14-year period). The yearly average was 20,742 kg. The US provided 82.42% (242,001 kg) of the imports. Imports from the US during 2007 declined to 4,002 kg, but according to SIAVI statistics, increased to 15,289 kg in 2008 (see also Figure 2-1).

The country that exported the second-highest amount of mercury to Mexico was formerly the Netherlands; however, during 2005–2007, there were no imports from this country.

Table 2-7 shows that the yearly average of Mexican exports of mercury during 1995–2008 (14-year period) was 13,046 kg.

To summarize, during the period 1995–2008, Mexico imported approximately 290.40 metric tons and exported approximately 188.43 metric tons, making it a net mercury importer, by approximately 102 metric tons.

It is important to note that during the last four years (2005 to 2008), the trend in Mexican exports indicates that the country has been an intermediary, importing mercury from developed countries and exporting it to Latin American countries:

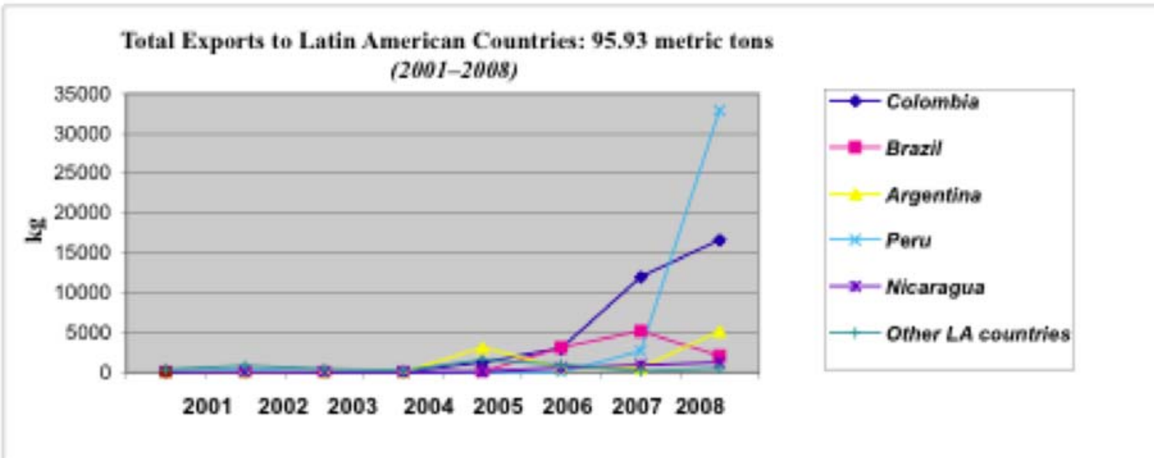
2005: 5.9 metric tons
2006: 8.1 metric tons
2007: 21.3 metric tons
2008: 58.5 metric tons

Total: 93.8 metric tons

These quantities represent an incremental increase in exports of 992% during these four years. The main countries to which Mexico exported mercury were Peru, Colombia, Argentina, and Brazil, mainly for artisanal mining uses (see Figure 2-1).

[7] Secretariat of Economy, http://www.economia-snci.gob.mx:8080/siaviWeb/siaviMain.jsp, consulted 10 March 2009.

Figure 2-1

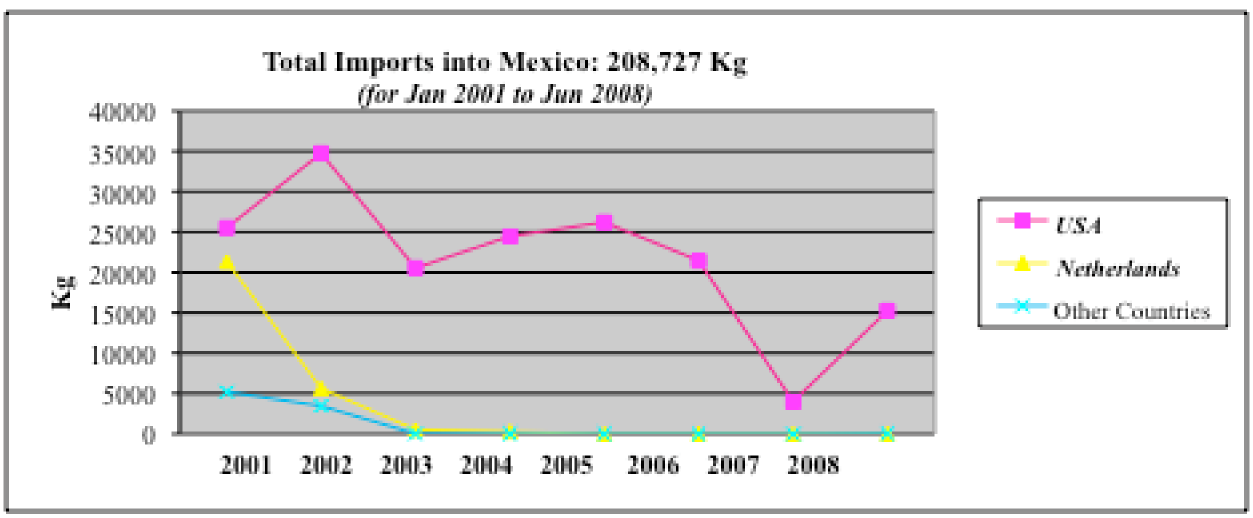


Source: World Trade Atlas, Secretariat of Economy, consulted 28 November 2007 and 6 June 2008.

During the same period (2005 to September 2008), Mexico imported mercury from the US as follows (Figure 2-2):

2005: 26.2 metric tons
2006: 21.5 metric tons
2007: 4.0 metric tons
2008: 15.3 metric tons
Total: 67.0 metric tons

Figure 2-2



Source: World Trade Atlas, Secretariat of Economy, consulted 28 November 2007 and 6 June 2008.

International mercury market prices (see Table 2-8) increased drastically during the period 2004–2005, following the serious supply shortage that developed in 2004. Since 2005, Mexico has increased its exports in response, especially to developing countries (UNEP 2006).

Table 2-8
Mercury prices, 1985–2007
(spot price for a 76-pound flask of mercury on the world market)

Year	**US dollars/flask** (one flask equals 76 pounds)	**US dollars/kg** (first column multiplied by 0.029008 flask/kg)
1985	310.96	9.02
1986	232.79	6.75
1987	295.50	8.57
1988	335.52	9.73
1989	287.72	8.34
1990	249.22	7.22
1991	122.42	3.55
1992	201.39	5.84
1993	187.00	5.42
1994	194.45	5.64
1995	247.39	7.17
1996	261.61	7.58
1997	159.52	4.62
1998	139.84	4.05
1999	140.00	4.06
2000	155.00	4.49
2001	155.00	4.49
2002	155.00	4.49
2003	170.00	4.93
2004	350.00	10.15
2005	750.00	21.75
2006	650.00	18.85
2007	550.00	15.95

Sources:
1985–2005: Robert G. Reece, Jr., Mercury, http://www.econstats.com/spot/Mercury.xls; United States Geological Survey, http://minerals.usgs.gov/minerals/pubs/commodity/mercury/.
2006-2007: William E. Brooks, US Geological Survey, Mineral Commodity Summaries, January 2008, (Salient Statistics—United States),
http://minerals.usgs.gov/minerals/pubs/commodity/mercury/mcs-2008-mercu.pdf.

2.2.7 Mexican importers and exporters of commodity-grade mercury

Information on companies that import or export commodity-grade mercury, retrieved from SIAVI, is presented in Table 2-9. The results indicate that five companies imported 141.4 metric tons of mercury, while 10 companies exported 42.8 metric tons, during the period 2002–2007. The annual averages for this six-year period are 23.6 metric tons for imports and 7.1 metric tons for exports.

Unfortunately, SIAVI only gives information on the number and name of importer or exporter companies if there are more than three companies in the category or if a company imports or exports less than 80% of the total quantity under the product's HS number. Another limitation is that SIAVI does not give individual records on imported or exported quantities of products for each company.

Table 2-9
Commodity-grade mercury importer and exporter companies, 2002–2007

Importers (5)	Exporters (10)
Aldrett Hermanos, SA de CV	Aldrett Hermanos, SA de CV
Globe Chemicals, SA de CV	Globe Chemicals, SA de CV
Viarden, SA de CV	Viarden, SA de CV
Mallinckrodt Baker, SA de CV	Burner systems international de Juárez, SA de CV
Philips Mexicana	Maquiladora TCA de Juárez, SA de CV
	Mexicana de Cobre, SA de CV
	Omega Scientific, SA de CV
	Sigma Aldrich Química, SA de CV
	Sylvania Componentes Electrónicos SA
	Aleaciones Dentales Zeyco, SA de CV
Total imports, 2002–2007: **141.4** metric tons	*Total exports, 2002–2007:* **42.8** metric tons

Source: SIAVI, http://www.economia-snci.gob.mx:8080/siaviWeb/siaviMain.jsp, accessed 1 December 2007 and 13 June 2008.

Net imports (imports less exports) for the same six-year period were 98.6 metric tons, and the annual average for net imports was 16.4 metric tons.

Three companies are both importers and exporters: Globe Chemicals, SA de CV, dedicated to supplying raw materials for pharmaceuticals and laboratories; Viarden, SA de CV, dedicated to selling products for dentistry, included triple-distilled mercury; and Aldrett Hermanos, SA de CV, a mercury broker.

Table 2-9 shows two companies, Burner Systems International de Juárez, SA de CV, and Maquiladora TCA de Juárez, SA de CV, that are reported as commodity-grade mercury exporters. These companies are *maquiladoras*—cross-border plants allowed up to 100% foreign investment and entitled to special Customs treatment—and a detailed assessment should be performed to determine whether the imported mercury in the products they manufacture is reported when products are exported.

Mallinckrodt Baker, SA de CV, is a basic manufacturer that provides chemical products for the laboratory, biopharmaceutical, microelectronic and industrial markets; it has several distributor companies in Mexico.

Sigma-Aldrich is an international company that supplies raw materials and equipment to chemical, pharmaceutical and biopharmaceutical industries and to intermediaries. This enterprise distributes 100 different types of compounds and instruments that contain mercury (QuimiNet 2007).

2.2.8 Mercury uses and consumption in Mexico

According to the National Institute of Statistics and Geography (INEGI) 2004 Industrial Census, mercury consumption during 2003 was estimated at approximately 53.2 metric tons (see Table 2-10). This quantity is an important reference point in regard to the estimates of mercury consumption by sectors and products that will be presented in Table 5-2, although that information was calculated using other information sources.

Table 2-10
Mercury consumption, as reported by the 2004 Industrial Census*
(in kilograms)

Sector or activity class	Mercury produced in Mexico	Imported mercury	Total mercury consumption
Class 325180: Production of basic inorganic chemicals. Series number 4923 (includes chlor-alkali sector)	14,076	0	14,076
Class 335110: Lamps production and glass products. Series number 11658	18,000	0	18,000
Class 339111: Equipment and apparatus for medical, dental production and uses in laboratories. Series number 13815	10,344	9,750	20,094
Class 3399950: Neon lights production. Series number 14412	1,024	0	1,024
Total mercury consumption (year 2003)	**43,444**	**9,750**	**53,194**

Source: INEGI (National Institute of Statistics and Geography), http://www.inegi.gob.mx/est/contenidos/espanol/proyectos/censos/ce2004/cuadros/anematep03.xls.
* Information applies to the year 2003.

Mercury demand in measuring and control devices, lighting, electrical equipment, and dental applications behaves similarly in Mexico to the trends in other countries, where the movement is toward mercury-free alternatives. In the health sector, trends in Mexico to reduce the demand for mercury-containing products and amalgam use seem to be initiated by substitution programs. Other sectors, such as the paints, chemical products production sector should be better characterized to assess future demand trends.

Chapter 3: Potential Mercury Supply in Mexico

3.1 Zacatecas Ancient Tailings

Due to several centuries of silver-mining activities, two important silver and mercury reservoirs are to be found in the Zacatecas metropolitan area. These are the Pedernalillo Dam and reservoir, and a conglomeration of several sites around Zacatecas City, where ancient tailings were deposited. Thanks to the inefficiency of the colonial process for recovering precious metals, these tailings have retained high levels of precious metals and mercury, and they have been undergoing reprocessing for more than sixty years.

3.1.1 Non-processed tailings and probable mercury reserves in Zacatecas

Besides reprocessing activities in Zacatecas described in Chapter 2, section 2.2.3, during the last 24 years, estimated to be around 530 metric tons of mercury (see Table 2-5), another 14,902 metric tons from the approximately same historic tailings area can be reprocessed, according to theoretical estimates that should be better characterized (see Table 3-1 for details).

Table 3-1
Probable mercury reserves in tailings around Zacatecas City

Author	Metric tons	Observations
Ogura *et al*. 2003 (based on Lang 1977)	18,000	Estimation based on Hg imports average for the 1556–1710 period, assuming that imports were homogeneous for1550–1900.
Bakewell 1977	21,000	Estimation based on yearly average of 608 metric tons during 1630–1709, assuming that imports were homogeneous for 1550–1900.
Bakewell 1977	15,000	Estimation based on yearly average of 608 metric tons during 1565–1700, assuming that imports were homogeneous for1550–1900.
Bakewell 1977	14,000	Estimation based on Hg consumption during 1608–1698 of 3,730 metric tons, assuming that imports were homogeneous for 1550–1900.
Ogura *et al*. 2003 (based on Gonzalez 1944, Bakewell 1977, and Eissler 1891)	34,000	Estimation based on production during 1550–1900 in Zacatecas of 17,000 metric tons of silver using the amalgamation process, and on application to that whole time period of loss rate in 1595 of 2 kg of Hg per 1kg of silver produced.
Average	20,400	* This amount considers 2,350 metric tons, previously estimated at El Pedernalillo Dam (MINCO 2006) See section 3.1.2, below. ** The total of 19,870 metric tons does not take into consideration mercury losses as emissions during the amalgamation process and from tailings since the colonial period and from tailings from secondary production. Therefore, a more realistic calculation of the reserves would be 25% less than this amount, estimated at around 4,968 metric tons.
Secondary production (1985–2007)	-530	
Total	19,870*	
Hg losses (25%)**	**4,968 ****	
	14,902	

Source: Ogura *et al.* 2003.

In a review of the historic literature on silver production and mercury use in Mexico, Ogura *et al.* calculated that one-third of the total silver production of Mexico (and, in consequence, one-third of mercury use) between 1550 and 1900 took place in Zacatecas, and from that calculation they estimated the amount of dumped mercury from the mining activities in that region.

In Table 3-1, the difference between the total of 19,870 metric tons and the theoretical reserves of 14,902 metric tons (25% less) was estimated based on the following factors, which have not been investigated:

- Mercury air emissions during the years when the amalgamation process was in use;
- Mercury air emissions from tailings during more than 450 years;
- Secondary production from these tailings during the last 60 years, and emissions from that process; and
- An important tailings area has been covered by urban development, which precludes reprocessing activities.

3.1.2 El Pedernalillo Dam

In addition to the secondary mercury production from tailings recovery operations around Zacatecas City, as described in Chapter 2, a significant reservoir of mercury and silver is located at El Pedernalillo Dam, situated in the area known as La Zacatecana, where silver recovery operations have not occurred during recent decades, due to various political, legal and economic factors.

This historic mercury reservoir originated as a product of colonial mining operations in the Zacatecas area, which commenced in 1546 AD. The conquistador, Juan de Tolosa, established a military outpost at the foot of the Cerro de La Bufa, upon discovery that the hill contained a rich vein of silver. Within just four years of Tolosa's arrival, there were over 34 mines in this area and this number expanded to approximately 50 mines by the turn of the century.

According to Lacerda (as quoted in Barenco Inc. 2002), in Zacatecas from the mid-1500s until the 1880s, at least 70% of Mexican silver was produced via the patio process, developed by Bartolomé de Medina in 1554 and involving the use of raw mercury. Over 750 million ounces of silver and 5 million ounces of gold (Pan American Silver Corp. 1995) were produced this way. The patio process consists of mixing silver ore with a minimum of three reagents: mercury, salt and a "magistral" (generally copper sulfate).

This process created an estimated 13–40 million metric tons of amalgam tailings, which historically have graded as 100–125 grams per ton (g/t) silver, 0.5–1,0 g/t gold and 300–350 g/t mercury. The tailings deposited along the beds of rivers and streams and in ravines near the many mine sites located in the volcanic hills in the Zacatecas mining district have gradually spread down the slopes into the valleys, primarily via the streams and rivers (e.g., Arroyo de la Plata—Silver Creek). The trail of contaminated tailings deposits extends at least 18–30 kilometers (km) downstream from Zacatecas into the reservoir behind the El Pedernalillo Dam, which has gradually filled with sediment, sewage effluent from Zacatecas, and the transported mine tailings washed down by the Arroyo de la Plata.

The reservoir covers 120 hectares (ha) and has a surface area of 12 km by 2 km. Water depth in the lagoon varies with the amount of rain, and can range from essentially dry to over three meters. Wastewater is now diverted from the lagoon by a series of channels, but the water is still used for irrigating crops along a sloping upstream surface (Pan American Silver Corp. 1995).

There is also evidence and anecdotal information that suggests the tailings from the mine operations were so extensive that they were manually carried away from the extraction yard sites and used as coarse cover on local fields and land areas. Table 3-2 presents estimates of mercury reserves, based on information compiled by Nuñez-Monreal from studies on tailings contents inside the Pedernalillo reservoir.

In one of the studies cited by Nuñez (as quoted in Kilborn 1994), the amount of mercury in the tailings in El Pedernalillo is estimated to be 350 grams per metric ton (in addition to 85 grams silver and 0.4 grams gold per metric ton). The same study assumes that through the chemical leaching process, 60% of the silver in the tailings, 50% of the gold and 70% of the mercury can be recovered. Thus, an estimate of probable mercury reserves in the zone is approximately 2,500–3,000 metric tons. The CEC is considering launching a separate study to quantify potential mercury supply from the historic mining tailings in the Zacatecas region.

Table 3-2
Estimated mercury reserves at El Pedernalillo Dam, Zacatecas
(in metric tons)

Study	Volume of tailings (in kg)	Grams of Hg per metric ton	Total Hg estimated	Total Hg at 70% recovery rate
EH Stihlknecht, 1916	5,950,000	650	3,867.50	**2,707.25**
CE Wuench, 1931	9,100,000	346	3,148.60	**2,204.02**
Comisión de Fomento Minero 1981	4,210,290	500	2,105.15	**1,473.61**
Kilborn Engineering Pacific Ltd. 1994	9,100,000	350	3,185.00	**2,229.50**

Source: Nuñez-Monreal 2002.

Based on another study of the tailings content inside El Pedernalillo reservoir, estimates of mercury reserves are calculated at 2,349 metric tons (Minco 2006). This quantity is part of the 19,870 metric tons reported in Table 3-1.

These figures appear to be very significant, in both the local and the global context, and should be examined and verified.

3.2 Mercury Cell Chlor-alkali Plants

There are five chlor-alkali plants in Mexico, with a combined production of 447,000 tons of chlorine gas per year. Three of these plants are equipped with the mercury cathode technology to utilize the mercury cell production process, producing 147,000 tons of chlorine per year (*Acosta y Asociados* 2001).

According to Acosta and based on information provided to the *Instituto Nacional de Ecología* (INE—National Institute of Ecology) by the *Asociación Nacional de la Industria Química* (ANIQ—National Chemical Industry Association), in 2002 in Mexico there were three chlor-alkali plants with mercury cell technology, with a total of 120 cells (titanium anode type). Each cell contained 2,287 kg of mercury on average, resulting in an inventory of functioning mercury of about 274.44 metric tons.

Plants were operating in that year at over 90% of total production capacity and there were no plans to increase actual installed capacity. The estimate of mercury consumption for 1998 was 5.66 metric tons, equal to the yearly amount of mercury purchased by chlor-alkali plants reported by ANIQ (*Acosta y Asociados* 2001).

On 21 November 2007, Semarnat submitted a letter to ANIQ requiring an update of information from its member companies—requesting data on amounts of existing mercury stocks and consumption of mercury in these facilities, and information on other companies that consume mercury in their processes. This information had not arrived by the time of the writing this report.

On 29–31 March 2006, the Mercury Stewardship Workshop was held in Coatzacoalcos, Veracruz, sponsored by the World Chlorine Council (WCC1), ANIQ, the US Environmental Protection Agency (US EPA), and the United Nations Environment Programme (UNEP). One of the workshop objectives was to provide context for the discussions on and exchange of best available techniques (BATs) and best environmental practices (BEPs) for reducing mercury use and emissions.

During this workshop, staff of the corporation Mexichem presented details of the ongoing conversion from mercury-cell to membrane technology at the Santa Clara plant in the state of México, which was scheduled for completion in early 2007. This facility was constructed in 1957 and began operations in 1958. (More information is available online at: http://www.chem.unep.ch/mercury/Sector-Specific-Information/Chlor-alkali_sector(1).htm.)

On 7 July 2008, Semarnat sent an official letter from to Mexichem requiring information about the date when this plant started using mercury-free technology and about the management of mercury available due to this change in technique. The requested information had not arrived by the time of the writing this report.

An official letter was also sent on 7 July 2008, to the industrial group Cydsa, requiring information on operational mercury and mercury consumption amounts in the two facilities of the company Industria Química del Itsmo, SA, in the states of Veracruz and Nuevo León. The requested information had not arrived by the time of the writing this report.

To gauge mercury volumes in the absence of official information from these three plants undergoing technological change, a rough estimation can be made, based on the Acosta report, by extrapolating each plant's production capacity data with the mercury stock in the three plants (274.44 metric tons). Thus, as presented in Table 3-3, since the Mexichem plant contributed 12.25% of total chlorine production (147,000 metric tons) and the total mercury stock in the three plants is 274.44 metric tons, the mercury now available at that plant due to the change in technology is estimated to be around 33.62 metric tons (12.25% of 274.44 metric tons). Unfortunately, the information presented by Acosta is aggregated and does not provide details about how many mercury cells are in each plant. To this 33.62 metric tons in the Mexichem plant should probably be added an (unknown) amount of mercury reserves to cover mercury losses during the production process. As mentioned above, no official information was provided by Mexichem about the destiny of this available mercury.

Table 3-3 Mercury cell chlor-alkali plants in Mexico					
City and state	**Producer**	**Year built**	**Cell type**	**Chlorine production** (in metric tons)	**Percent of total chlorine production**
Santa Clara, México	Mexichem, SA de CV	1958	De Nora 14TGL, 14x3F merc Mathiesen E11 merc. ’66	18,000	12.25
Monterrey, Nuevo León	Industria Química del Itsmo, SA	1958	Mathiesen E8 merc	29,000	19.75
Coatzacoalcos, Veracruz	Industria Química del Itsmo, SA	1967	De Nora 18X4, 18H4’72 merc	100,000	68.00
			Total	147,000	100%
Source: Derived from Acosta y Asociados 2001.					

The above calculations result in an amount of mercury inventory in the two remaining chlor-alkali plants of approximately 240.82 metric tons (274.44 minus 33.62). The total mercury consumption in these two plants can be derived by calculating 87.75% of the known yearly consumption (5.66 metric tons) when all three plants were in operation, which gives 4.97 metric tons.

3.3 Mines in Querétaro, and Other Mercury Mines in Mexico

During the 1990s, the Council of Mineral Resources (CRM) produced a monograph for each of eight states, reporting 83 mercury mines. This information has not been updated and there is no official information about conditions of those mines, some of which are reputed to be active mines while others may be closed or abandoned.

In 2007, the Mexican Geological Service (*Servicio Geológico Mexicano*—SGM, the successor to CRM) published two studies in the series *Physical Inventories on Mineral Resources*, covering two counties (*municipos*): Peña Miler and Pinal de Amoles, in Querétaro State. The Peña Miler study (SGM 2007 b) reports 14 mercury mines, but does not give any estimation of potential reserves of mercury. The study on Pinal de Amoles (SGM 2007a) reports on seven mercury mines, and gives two estimates of mercury reserves: Mina La Guadalupana has potential mercury reserves of 2,250 metric tons, and Mina la Soledad has potential reserves of 9,500 metric tons. The two new studies report 21 mercury mines, seventeen of which are included in Table 3-4.

In short, to date there is a potential reserve of 11,750 metric tons of mercury in Querétaro. It is important to confirm that all of these mercury reserves are potentially recoverable.

Table 3-4
Mercury mines in Mexico

Name	Latitude	Longitude	Name	Latitude	Longitude
Chihuahua			***Querétaro (cont)***		
Luz Julieta	28°26’	107°05’	La Maravilla	20°55’	99°36’
Cerros Prietos	28°01’	105°21’	La Pequeña	20°54’	99°53’
Maijoma	28°56’	104°24’	La Barranca	20°53’	99°37’
San Miguel	28°18’	104°13’	La Lana	20°54’	99°37’
Nuevo Almadén	27°52’	108°30’	San Juan	20°50’	99°35’
Batopililias	27°53’	108°27’	***San Luís Potosí***		
Piloncillos	26°51’	104°09’	C. Tecolote	23°11’	100°56’
Durango			El Socorro	23°03’	100°54’
Angelita	24°42’	103°32’	Huancavélica	23°00’	100°57’
Berrendo	24°46’	103°22’	Los Morados	22°50’	100°40’
El Colorado	26°04’	105°42’	San Juan	22°47’	100°40’
El Cuarenta	26°11’	105°30’	El 18	22°46’	100°40’
Guadalupe	25°09’	104°32’	Soc. el Refugio	22°45’	100°36’
La Gaviota	24°42’	103°26’	M. La Trinidad	22°39’	100°29’
La Perla	24°47’	103°29’	El Picachito	22°38’	101°10’
La Roca	24°27’	103°43’	Arroyo El Barro	22°37’	100°44’
La Sirena	24°42’	103°27’	Santa Julia	22°50’	100°39’
Otinada	24°03’	105°01’	El Socorro	22°50’	100°39’
Pedernalillo	24°32’	103°35’	Los Caliches	22°52’	100°35’
Rodeo	25°11’	104°31’	La Vocadora	22°48’	100°33’
San Pedro	24°38’	103°58’	Lupe 1 y 2	22°47’	100°33’
Sonrisa	24°40’	103°41’	Las Narices	22°46’	100°35’
Tebicos	23°58’	105°27’	El Padre	22°36’	100°44’
Estado de México			Agua Nueva	22°36’	99°51’
Sn. José de Solís	nd	nd	***Zacatecas***		
Cruz del Sur	nd	nd	Carbonerillas	24°29’	101°24’
Guanajuato			El Duraznillo	24°25’	101°25’
Atarjea	21°16’	99°41’	Tanquecito	24°22’	101°39’
Guerrero			San Benito	24°18’	101°34’
La Hedionda	18°15’	100°30’	El Orégano	24°18’	101°32’
Las 3 Marías	18°39’	99°44’	Cortes	24°16’	101°32’
Vicente Guerrero	18°25’	99°38’	La Arracada	24°15’	101°27’
La Cruz o Marina	18°17’	99°20’	C. El Muerto	24°14’	101°28’
Querétaro			Buena Suerte	24°08’	101°55’
La Sonia	21°14’	99°44’	El Triunfo	23°51’	103°24’
La Liga	21°14’	99°44’	El Castro	23°36’	103°13’
Los Banquitos	21°10’	99°40’	El Cuervo	23°25’	103°39’
La Mora	21°08’	99°36’	Los Hornillos	23°31’	103°52’
La Tranca	21°06’	99°43’	Los Cuates	23°12’	102°44’
Morelos	21°05’	99°41’	Mezquitillos	23°10’	102°47’
Soyatal	21°05’	99°41’	Lucia	23°06’	102°20’
El Mono	21°04’	99°42’	Canoas	22°10’	101°52’
Cristo Rey	21°03’	99°42’	Majona	23°50’	101°40’
Todos Santos	21°02’	99°36’	Maravillas	23°21’	103°51’
San Cristóbal	20°57’	99°39’	**Total: 83 mercury mines**		
Las Calabacillas	20°57’	99°38’			

Source: Compiled from Consejo de Recursos Minerales, *Monografía Geológico Minera* de los Estados de: Chihuahua, 1994; Durango, 1993; Estado de México, 1996; Guanajuato, 1992, Guerrero, 1999; Querétaro, 1992; San Luis Potosí, 1992; 1994; Zacatecas, 1991. As quoted in CEC 2000b.

POTENTIAL MERCURY SUPPLY IN MEXICO
Summary

Theoretical reserves in Zacatecas tailings including calculated reserves at El Pedernalillo Dam, Zacatecas	14,902 metric tons
Chlor-alkali plants (two facilities)	240 metric tons
Mines in Querétaro State	11,750 metric tons
Total	**26,892 metric tons**

3.4 Product Recycling Perspectives in Mexico

Secondary mercury production from recycling discarded mercury-containing products is not occurring in Mexico due to a lack of interested companies; gaps in legislation; and the possible repercussions of a campaign about mercury releases due recycling activities, among other reasons.

An important initiative was organized in 2007 by the Center for Analysis and Action on Toxics and Its Alternatives (CAATA) and supported by the CEC, the Health Care Without Harm (HCWH) project, the Pediatric National Institute (INP), and the Federico Gómez Hospital for Children, among others. This strategic initiative is dedicated to eliminating the use of mercury in the health care sector.

Some mercury-containing waste has begun to be collected through a program initiative for thermometer replacement in ten Mexican hospitals. However, over the short term, there is no strategy in place related to the confinement of these wastes.

Discarding and maintenance of sphygmomanometers is generating another important source of elemental mercury, but in this case there is no confinement option because, according to Mexican rules, liquid hazardous waste must not be confined but should first undergo a solidification process.

It is expected that in the future the rising demand for mercury recycling will lead to an increase in recycling initiatives and greater investigation into safe mercury confinement.

Chapter 4: Mercury-containing Products Sold in the Mexican Market

This chapter is divided into five parts: Section 4.1 outlines the chapter's objectives, which are to identify and quantify mercury-containing products in Mexico; section 4.2 is dedicated to reviewing previous experience and criteria for setting mercury product prioritization; section 4.3 deals with the methodology for collecting and organizing information on products in Mexico; section 4.4 tries to identify as much as possible the companies that are importers/exporters of mercury compounds; and section 4.5 lists and describes the mercury-containing products in the Mexican market for which mercury-free alternatives are available.

4.1 Criteria to Identify and Quantify Mercury-containing Products and Categories

Identifying and reducing the use of mercury-containing products is a necessary step in preventing mercury releases to the environment and, in consequence, exposure of people and living organisms to mercury. Mercury releases may occur at many different points during the life cycle of a mercury-containing product, including manufacture, use, recycling and disposal.

For these reasons it is important to have as much of an overview as possible of mercury-containing products, including companies that manufacture, import or distribute them in the Mexican market and its sectors. In many cases, non-mercury alternatives exist for mercury-containing products, so it is also important to identify and recommend their use.

The objectives of this chapter are to identify and quantify mercury-containing products and categories, using the following criteria:

- Mercury-containing products manufactured in Mexico and quantity of mercury consumed by them;
- Estimate of mercury-containing products imported and exported;
- Mercury-containing products sold in Mexico;
- Identification of key manufacturers, distributors and end-users; and
- Identification of mercury-free alternatives, if available, and the suppliers of those alternatives.

4.2 Resources and Criteria for Setting Mercury Product Prioritization

During at least the last two decades, a significant number of initiatives have been promoted in Canada and the Unites States that focus on addressing mercury releases in order to reduce their impact on public and environmental health. These initiatives take the form of projects, actions and plans at the binational, federal, and state or provincial level.

A valuable resource for understanding the market for mercury-containing products in order to prevent mercury releases in Mexico is *An Investigation of Alternatives to Mercury Containing Products,* prepared for the Maine Department of Environmental Protection (DEP) as part of a comprehensive strategy to reduce the mercury content of products. To conduct this study, the Maine DEP commissioned the Lowell Center for Sustainable Production (LCSP), of the University of Massachusetts at Lowell (Lowell 2003).

The LCSP study included a review of the mercury product notification data submitted by manufacturers to the Interstate Mercury Education & Reduction Clearinghouse[8] (IMERC). The notification data included description of mercury-added components, number of components, amount of mercury per unit, amount of mercury in total domestic sales, and purpose of mercury in the product. At the time of the review, data had been submitted by seventy-six manufacturers, reporting 390 mercury-containing products. The LCSP study also included discussions with mercury product experts, discussions with manufacturers of mercury products, review of responses to a letter from the State of Maine on 1 May 2002, to mercury product manufacturers, a review of published mercury product studies, and reviews of pertinent data available on the Internet.

The LCSP reasoned that due to the fact that there are thousands of products that contain mercury, a prioritization effort was needed to determine a core set of products that could then undergo further detailed study.

The criteria for this prioritization included:

1. the amount of mercury contained within the product;
2. the total amount of mercury reported for all sales of the product;
3. the effect on the environment by the amount of mercury released in the product category;
4. product coverage by current regulation; and
5. the availability of non-mercury alternatives.

Products and components were reviewed as part of the prioritization process. Components are typically sold to original equipment manufacturers to be incorporated within a product. For example, the mercury tilt switch is a component that is incorporated in automobiles, vending machines, cranes, wheelchairs, and numerous other products. Subject to the above criteria, the priority products selected for further detailed study included sphygmomanometers, gastrointestinal tubes, manometers, non-medical thermometers, barometers, hygrometers, psychrometers, hydrometers, flow meters, pyrometers, and thermostats (industrial and manufacturing only). The priority components selected for further detailed study included float switches, tilt switches, pressure switches, temperature switches, displacement relays, wetted reed relays, mercury contact relays, and flame sensors.

After the priority products and components were selected, detailed research and analysis was then conducted. The findings from this research include:

- descriptions of how the mercury product/component operates;
- typical applications of the mercury product/component;
- non-mercury alternatives available;
- cost range for the mercury product/component and non-mercury alternatives;
- advantages and disadvantages of the mercury products/components and their non-mercury alternatives;
- manufacturer information for no-mercury alternatives; and
- summary of findings for each mercury product/component.

In general, cost-competitive non-mercury alternatives were identified that meet the functionality requirements for most priority mercury products. Therefore, these products would be viable targets for mercury reduction efforts.

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[8] Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont.

For the following components there were cost-competitive non-mercury alternatives available for new products and applications: flame sensors, float switches, tilt switches, temperature switches, and pressure switches. However, for new relay products or applications, non-mercury relays can cover most but not all combinations of design parameters.

Certain retrofit situations for mercury switches and relays exist where the non-mercury alternative is not cost-competitive. Efforts to reduce the sale of mercury switches and relays for retrofitting existing products or applications should take this into consideration.

There are many options for substituting non-mercury alternatives for mercury-containing products and components. However, many alternatives are not simple drop-in substitutions. Although a non-mercury alternative may ultimately achieve the same desired functionality, such as providing an accurate measure of blood pressure or sensing a flame, there are often design considerations or different techniques or practices that must be first learned and communicated (LCSP 2003).

Another important study is *Trends in mercury use in products* (NEWMOA/IMERC 2008), which focuses mainly on instruments and is a very important reference for product demand by category. According to this study, mercury consumption by category in US is reported as follows:

- Switches, relays, and dental amalgam capsules accounted for approximately 70% of the total mercury use in 2001 and 2004 for the US;
- In 2001, approximately 60 tons of mercury was sold in switches and relays, which declined to approximately 51 tons in 2004;
- Approximately 30 tons of mercury was sold in dental amalgam in 2001 and 2004, with no substantial change in the two reporting years;
- Approximately 15.5 tons and 15 tons of mercury were sold in thermostats in the US in 2001 and 2004, respectively;
- In 2001, lamp manufacturers sold approximately 10.7 tons of mercury in mercury-added light bulbs. This decreased by 0.6 tons in 2004, representing a 6% decrease; and
- Measuring devices, such as barometers, manometers, and sphygmomanometers, contained the largest amounts of mercury in individual products, and these products accounted for 4.5% of the total in 2001 and 4% of the total in 2004.

In addition to this study, another important and complementary source of information that could help to develop criteria for prioritization of mercury-containing products in Mexico is the *Summary of Supply, Trade and Demand Information on Mercury* (UNEP 2006), in which mercury uses and consumption are ranked according to demand. Information from this study is reproduced in Table 4-1.

According to UNEP (Table 4-1), the main demand for mercury on the global level is from artisanal and small-scale gold mining. Mexico appears to play an important role here—not as a consumer but as a supplier through its mercury exports to countries where mercury is probably used in artisanal gold mining. This matter should be the subject of a separate, regional study.

Another area of major concern is the increasing use of mercury in the production of vinyl chloride monomer (VCM), as a mercuric chloride catalyst when the process uses an acetylene hydrocarbon feedstock. This is of special concern in China, where significant quantities are used (estimated to be several hundred metric tons) and it is not yet clear where much of the mercury goes as the catalyst is depleted (UNEP 2006). This matter should be studied in order to determine if Mexico imports mercuric chloride or produces it itself to use in the production of VCM, or exports mercury or mercuric chloride for that purpose. From July 2007 to June 2008, Mexico imported approximately 173 metric tons of unknown mercury compounds and exported around 51.2 metric tons, for a total of about 122.8 metric tons in net imports (see section 4.4, below).

Table 4-1
Global mercury demand by sector (2005), and reduction scenarios (2015)

Global mercury demand, by sector (in metric tons)	Present (2005)	"Status quo" scenario (2015)	"Focused Hg reduction" scenario (2015)
1. Small-scale/artisanal gold mining	650–1,000	650	400
2. Vinyl chloride monomer (VCM) production using the acetylene process and a mercury catalyst	600–800	1,000	1,000
3. Chlor-alkali production	450–550	350	250
4. Batteries	300–600	200	100
5. Dental use	240–300	270	230
6. Measuring and control devices*	150–350	125	100
7. Lighting	100–150	125	100
8. Electrical and electronic devices	150–350	110	90
9. Other (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.)	30–60	40	30
Total	**2,670–4,160**	**2,870**	**2,300**

Note: "Demand" may also be termed "gross consumption," and is here defined as total annual throughput of mercury for each of these sectors. In each of these sectors some mercury recycling takes place, involving the recovery of mercury from products or wastes. Therefore, "net consumption" of mercury in any of these sectors may be significantly lower than "gross consumption." Further details and uncertainties are described in the full UNEP report, Sections 5.1, 5.2 and 5.3.
*Probably includes devices used in the health sector.
Source: Adapted from UNEP 2006, p. 7 (Table 2).

In regard to mercury use in chlorine production, in Mexico one of the three chlor-alkali plants that use the mercury cell process is in the final phase of change to a mercury-free process. Information (not updated) on the mercury consumption of the other two plants puts it at approximately 4.9 metric tons (see Chapter 3, section 3.2).

It is difficult to characterize the battery sector in Mexico, since information on battery imports and exports lumps batteries containing mercury in with those that do not. The latter type is not produced in Mexico.

Similarly, it is difficult to tell how much mercury is used in dental amalgams in Mexico, since the dentistry supply is actually included in a single sector covering paints, laboratory, pharmaceutical, and cultural/traditional uses (such as neon signs and fireworks, among others).

The sixth sector in the UNEP table covers measuring and control devices. If these devices include those used in health care, it is an important to know which hospitals have become mercury-free under the program just started in Mexico in 2007, and which facilities still use mercury-containing alternatives. Use of these devises for specific scientific purposes is difficult to determine.

The last three sectors in the table cover lighting, electrical and electronic devices, and “other” (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.), which includes products responsible for mercury emissions that are not controlled under Mexican legislation.

Further guidance in establishing criteria for selecting priority products for this study could be taken from the *Mercury Market Background Report* (EPA 2005), which determined mercury uses and consumption in the US by percentage, as follows:

- chlor-alkali process, 10%;
- switches and relays, 38%;
- measuring devices, 25%;
- dental amalgams, 13%;
- lighting, 8%; and
- other, 6%.

According to this report, switches, relays and measuring devices comprise 58% of total mercury consumption in the United States.

The guidance on products and classification from LCSP, UNEP and US EPA can be used to help determine a ranking for mercury products and components in Mexico using the following criteria:

- amount of mercury contained within a product;
- total amount of mercury reported for all product sales;
- affect on the environment of the total amount of mercury released in the product category; and
- availability of non-mercury alternatives.

Then, from the information provided by the those three quoted sources and using the classification of the Mexican mercury market found in Table 4-2, below, products and product sectors can be assessed as high-, medium- or low-priority, according to their mercury risk.

4.3 Methodology for Collecting and Organizing Information on Products

During the first phase of this study, in 2007, a registry of 138 companies was compiled by consulting commercial information sources and Yellow Pages. In this second phase, in 2008, the information collected in 2007 was revised and complementary searches of other sources were performed. As information was retrieved from different commercial WebPages, occasionally company names were duplicated. Information related to type or model of products in some cases was not available, nor were the quantities of mercury contained in each one. A questionnaire was designed for collecting information not otherwise found through electronic commercial sources and an initial mailing was sent to 25 suppliers and companies for filling out. Unfortunately, none replied, probably because there was no legal obligation to do so.

Other key objectives of this study are the organization and classification of the information collected and determining the means to retrieve and disseminate it, which could be implemented by developing a database similar to the EPA Mercury Products and Alternatives Database. This database could be adapted to the Mexican context by taking account of market similarities and differences between the two countries, cultural differences, the legal frameworks, and institutional support.

The EPA Mercury Products and Alternatives Database divides information into 16 product or component sectors. This study recommends that the Mexican counterpart initially consider a smaller number of sectors, with the understanding that the list will grow and undergo changes in classification as the needs particular to Mexico become clearer. In this way, the basic structure of the database would remain the same while accommodating national differences such as in mercury products available in Mexico but not sold in the US market, or in divisions of control over mercury content (e.g., dental amalgams and other uses of mercury in the health sector—see Table 4-2, below).

Thus, the information obtained has been classified initially into six main sectors categories:

1. Amalgams and Mercury Uses in the Health Sector—which includes thermometers and sphygmomanometers (not considered by EPA);
2. Chemical Manufacturing and Biopharmaceutical (not considered by EPA);
3. Computer and Electronic Product Manufacturing;
4. Electrical Equipment, Appliance and Component Manufacturing;
5. Miscellaneous Manufacturing; and
6. Professional, Scientific and Technical Services.

The differences in sector classification do not change the objectives of the two databases to identify, quantify and assess the uses of mercury-containing products, which remain the necessary steps in preventing mercury releases to the environment and, in consequence, limiting exposure of people and living organisms to mercury.

Other criteria for collecting information relate to priorities, considering the potential for mercury releases, depending on its quantity in products, or when the potential risks from possible releases are not known. These priorities can be ranked as:

- **High Priority** products are those that can have important mercury releases because they contain significant quantities of mercury either as an element or as a compound, or they are used in significant quantities even though they contain rather small amounts of mercury. Another criterion in determining that a substance should be considered as high priority is when its environmental impacts or paths have not been characterized but are considered important.

- **Medium Priority** products are those whose mercury content or their volume of use is not considered important given its possible amount of releases.

- **Low Priority** products are those whose possible releases are estimated as being less than those of the two categories described above.

Table 4-2 Products and sectors classification for the Mexican mercury market			
Product or component	**Product priority ***	**Identified suppliers ****	**Sector category**
Triple-distilled mercury, and health-care uses	H	3	Amalgams and Mercury Uses in the Health Sector
Mercuric oxide Mercuric chloride Mercurous chloride (mercury I chloride, calomel) Mercury nitrate Mercuric nitrate Tridistillated mercury Mercury sulfate Other substances	H H H H H H H M	14	Chemical Manufacturing and Biopharmaceutical
LCD displays	M		Computer and Electronic Product Manufacturing
Mercury batteries Mercury displacement relays Mercury tilt switches Mercury connectors Mercury lamps Mercury bulbs Mercury light systems for copier machines	M H H H L H M	3	Electrical Equipment, Appliance and Component Manufacturing
Components in electronics	M		Electronics and Appliances Stores
Not determined	L		Fabricated Metal Product Manufacturing
Not determined	L		Furniture and Home Furnishing Stores
Hg-containing parts	M		Machinery Manufacturing
Manometers	M		Miscellaneous Manufacturing
Hg-containing parts	M		Motor Vehicle and Parts Dealers
Not determined	M		Nonmetallic Mineral Product Manufacturing
Not determined	M		Plastic and Rubber Products Manufacturing
Not determined	M		Printing and Related Support Activities
Barometers Flow meters Non-medical thermometers	L L H		Professional, Scientific and Technical Services
Not determined	M		Transportation Equipment Manufacturing
Not determined	H		Wholesale Trade, Durable Goods
Not determined	H		Wholesale Trade, Nondurable Goods
Not determined	H		Mercury Cultural Uses
Total		**20**	
* Product priority level: H = high, M = medium, L = low. ** A questionnaire was submitted to these identified suppliers, but no response was obtained.			

Finally, it was decided that in this second phase only data from top manufacturers and large importer/exporters or important retailers should be included in the database; it is important to note that there is a significant number of small companies which were not considered.

4.4 Imports and Exports of Mercury Compounds

The import and export of mercury compounds is a broad sector and one in which it is difficult to acquire much data because the sources of information do not specify the Chemical Abstracts Service Registry Numbers (CASRN) or the names of imported and exported mercury compounds. As a consequence, is difficult to quantify the mercury content of these imported or exported compounds.

Information found at SIAVI and in the Secretariat of Economy's World Trade Atlas is classified under the Harmonized System (HS); numbers and their corresponding descriptions are presented in Table 4-3. The limitations of SIAVI are that it gives information on the numbers and names of importer or exporter companies but only when there are more than three companies that deal in a specific category; it does not provide names of companies that import or export 80% or more than the volume reported in any HS; and it does not present individual records on imported or exported quantities of products for each company, but instead the information is aggregated.

Table 4-3
Harmonized System (HS) codes for mercury and mercury-containing products

HS number	Description of mercury and mercury compounds
28054001	Liquid mercury
28520001	Inorganic mercury compounds, except amalgams
28520099	Any other organic or inorganic compounds, except amalgams
28439099	Any other compounds, amalgams
29309039	Ethylmercurithiosalicylic acid sodium salt (thimerosal), and similar compounds
29310002	Phenylmercuric acetate, and other organic/inorganic compounds

Source: Derived from SIAVI, in searches performed 2 December 2007 and 28 August 2008.

According to a search of the SIAVI database performed in August 2008 for the HS number 28520001—*Inorganic mercury compounds, except amalgams*—during the period of July 2007 to June 2008, Mexico imported 42.98 metric tons of these mercury compounds from eight different countries. The main exporter countries to Mexico were the United States, with 37.03 metric tons, and Germany, with 5.9 metric tons. Mexican exports were 25.3 metric tons, to three different countries, principally the Philippines, which received 20 metric tons. SIAVI does not present information on importer or exporter companies in this category, which means that no more than three companies were responsible for these amounts. Nor does SIAVI give information on what kind of inorganic mercury compounds are imported or exported.

A search of the SIAVI database in August 2008 for the HS number 28520099—*Any other organic or inorganic compounds, except amalgams*—for the same time period revealed that Mexico imported 129.9 metric tons of these mercury compounds from six different countries, the main one being the United States, with 102.9 metric tons. Mexican exports were 25.9 metric tons, to six different countries, the main one being Switzerland, with 24.3 metric tons. SIAVI does not present information on importer or exporter companies in this category, which means that no more than three companies were responsible for these amounts. Nor does SIAVI give information on what kind of organic or inorganic mercury compounds are imported or exported.

To summarize, imports/exports of non-specified organic and inorganic mercury compounds during July 2007 to June 2008 were 173 metric tons in imports and 51.2 metric tons in exports, for a total of 121.8 metric tons of net imports of unknown mercury compounds during that period. No company names were provided by SIAVI.

One specified mercury compound reported by SIAVI is ethylmercurithiosalicylic acid sodium salt (thimerosal). A search performed 2 December 2007 for the HS number 29309039, corresponding to this compound, indicates that it was imported in quantities totaling 563 kg during the years 2002–2007 (see Table 4-4). Thimerosal contains about 50% mercury by weight and is used as an antibacterial, antifungal agent in vaccines and ophthalmologic products.

Table 4-4
Ethylmercurithiosalicylic acid sodium salt (thimerosal) imports, 2002–2007 (in kilograms)

Harmonized System (HS) number	Description	Year					
		2002 Apr–Dec	2003	2004	2005	2006	2007 Jan–June
29309039	Ethylmercurithiosalicylic acid sodium salt (thimerosal) and similar compounds	40	131	135	76	131	32
Total							**563 kilograms**

Source: SIAVI, in search performed in 2 December 2007.

Unfortunately, the category for HS number 29309039, corresponding to thimerosal, which was created in 2002, changed in 2007 and now covers more compounds, including non-mercury compounds. This category now covers 2-(dietilamino)-etanotiol and its salts, substances that were formerly listed separately under HS numbers 29309072 and 28520003**.**

No other significant quantitative and specific information related to mercury compounds was retrieved from SIAVI. Further discussion on this sector is found below in section 4.5.2, on the chemical manufacturing and biopharmaceutical sector.

4.5 Mercury-containing Products and Sectors

Compared with the official information on import/export of commodity-grade mercury, information available from SIAVI and from the Secretariat of Economy's World Trade Atlas on mercury-containing products is usually much less accurate and less readily available. Also, these information sources group information on products by type and do not consider whether products are mercury-containing or non-mercury-containing.

A typical example of this occurs in the battery sector, where four tariff numbers were eliminated and replaced with one number, resulting in a more generic grouping of products. For this reason, when a query for information on mercury batteries is submitted, the results show a large quantity of batteries imported—however, not all are mercury-containing. Similar inaccuracy occurs with other products, such as lamps, thermometers or switches, which are grouped together with other kinds of non-mercury-containing products.

Confidentiality and the use of different information sources make it difficult to adopt a standard methodology for deciding the criteria for estimating mercury quantities used or contained in each sector or group of products. For example, data on the sphygmomanometer sector was compiled from information from the health sector instead of from that available at SIAVI. In the case of mercury compounds, information from both commercial sources and SIAVI were used.

4.5.1 Dental and health care sectors and their alternatives

a) Amalgams and their alternatives

Dental amalgams use an alloy that typically contains 50% mercury, 25% silver, and 25% of other metallic elements such as tin and/or copper; they have been used for more than one hundred years by dentists for teeth fillings. In Mexico, dentists prepare amalgams on-site by using bulk liquid mercury and metallic powders. Mercury for amalgam use is also available on the market in pre-dosed amalgam capsules of different sizes, the contents of which can vary from >0.1 gram to 1gram of mercury.

In a search of SIAVI performed in August 2008 for the HS number 28439099—*Any other compound, amalgams*—for the time period July 2007 to June 2008, it was found that Mexico imported a total of 12.5 metric tons of these compounds, the two main exporting countries being the US, with 8.4 metric tons, and Argentina, with 1.9 metric tons. Mexican exports to other countries for this period were a total of 1.4 metric tons, the US being the main importer, with 1.1 metric tons. To summarize, Mexico has been a net amalgam importer, by approximately 11.1 metric tons.

SIAVI provides names for 5 exporting and 16 importing companies, as follows.

Exporting companies: AS Catalizadores Ambientales; Etal Baker; Etal; Minerales y Productos Industriales; and Sicor de México.

Importing companies: Arj de Yucatán; AS Catalizadores Ambientales; Asofarma de México; Dentsply México; Johnson Matthey de México; Joskes de México; Laboratorios Columbia; Laboratorios Gayz; Laboratorios Pisa; Lemery; Morac México; Philips Mexicana; Productos Roche; Raychem Juárez; Sicor de México; and Sigma Aldrich Quimica.[9]

The information does not specify if the total amount refers only to mercury or includes other amalgam components like silver or tin.

A complicating factor is that commodity-grade, triple-distilled mercury for use in dentistry is also sold in pharmacies or in other stores that sell dental products. In Mexico, besides being used in the oral health care sector, mercury in amalgams is put to other uses, such as in neon sign workshops, traditional cures in botanical stores, jewelry, fireworks, and other industrial uses. For these reasons, it is difficult to determine the real mercury consumption in the dental amalgams sector and, in consequence, in other sectors such as chemical manufacturing and biopharmaceutical applications. (For supply companies and retailers, see Annex 2: Cosmos Online and Quiminet.)

[9] Source:
http://www.economia-snci.gob.mx:8080/siaviWeb/siaviMain.jsp.

To refine and compare the information found on mercury consumption in the amalgams sector, other calculations can be made, based on statistics from the National Center for Epidemiologic Surveillance and Disease Control (Cenavece), as shown in Table 4-5, below. It is estimated that on average, 13,457,492 dental amalgam fillings were installed annually over the period 2000–2006. The corresponding yearly average in mercury use is about 9,016 metric tons (see Table 4-5).

Calculations in Table 4-5 are estimations based on a mercury content of 50% of 1.34 grams per capsulated amalgam dose, or 0.67 grams. The other 0.67 grams includes silver, tin and copper (WRPPN Dental P2 Project 2005). Cenavece does not specify the proportion of capsulated amalgam use compared to the traditional mortar-and-pestle mixing method, which does not use pre-measured, capsulated amalgam and thus generates more waste and, in consequence, more mercury consumption. On the other hand, data from Cenavece do not specify whether the reported cases reflect amalgam restoration or other kinds of treatments. Also, private dentistry is not covered in Table 4-5.

Table 4-5
Estimated mercury consumption from dental amalgams
(in kilograms, calculated at 0.67 grams per restoration *)

Year	Estimated no. amalgam fillings**	kg
2000	11,172,892	7,485
2001	11,371,235	7,618
2002	12,511,087	8,382
2003	13,408,576	8,983
2004	14,433,367	9,670
2005	17,703,234	11,861
2006	13,602,055	9,113
Total	13,457,492	**63,112**
Annual average		**9,016**

* WRPPN Dental P2 Project 2005. Dental amalgam use.
** Cenavece (Centro Nacional de Vigilancia Epidemiológica y Control de Enfermedades) 2006. *Informe de rendición de cuentas de la Administración 2000–2006.*
http://www.cenave.gob.mx/archivos/informeetapa3.pdf
http://www.wrppn.org/dental/pages/pdf/Amalgam_Use%2001.pdf

Estimating consumption of mercury in amalgams, from available sources of information

Estimation of annual consumption, based on Cenavece, for 2000–2006: **9.0 metric tons**.

Estimation of consumption, based on SIAVI data on net imports of amalgams during July 2007–June 2008 (11,087 kg) and calculating that 50% of this amount is mercury: **5.5 metric tons**.

Taking into consideration the limitations of the SIAVI data, it would thus be reasonable to accept the Cenavece estimate of the quantity of mercury consumption from amalgams in Mexico: **9.0 metric tons**—of which **5.5 metric tons** are net Hg imports, and **3.5 metric tons** are nationally produced Hg.

Alternatives to amalgams exist in Mexico; however, discussion and debates among dentists about the benefits of mercury amalgams and the other non-mercury-containing materials are ongoing.

b) Thermometers and their alternatives

Description**:** mercury fever thermometers are used to measure temperature as the mercury level inside the glass rises and falls with the temperature (NEWMOA/IMERC 2008). The content of each thermometer can vary from >0.6 gram to 1 gram of mercury.

The Mexican Government is the main buyer of fever thermometers, which are listed in the "Basic List of Medications and Supplies" authorized for the health sector, classified under this list numbers 060.879.0150 and 060.879.0143, for oral and rectal types. The private health sector uses both mercury and digital thermometers.

SIAVI data on HS number 90251199, covering direct reading liquid thermometers and others, show that Mexico's apparent consumption for the period 2002–2007 was about 20 million thermometers (a yearly average of 3.7 million—see Table 4-6, below). It is likely that these data include other types, like non-medical thermometers. The main country to which Mexico exported thermometers during that period was the United States (10,814,937 units or 99.75% of total Mexican exports).

Information from another category, HS number 90251101, which covers glass thermometers either filled with mercury or empty (just the glass), was not considered since this HS number probably includes thermometers without mercury, such as those containing a mixture of gallium, indium, and tin or another type of liquid.

According to the INEGI 2004 Industrial Census, only 64,937 thermometers were produced in Mexico in 2003.

The main countries exporting thermometers to Mexico were China, with 29,874,822 units (88.25%), and the US, with 2,861,229 (8.45%). Other countries accounted for 1,115,544 units (3.30%). Thus, total imports into Mexico were 33,851,595.

Table 4-6 Thermometer imports/exports (in units)							
Year	**2002** **Apr–Dec**	**2003**	**2004**	**2005**	**2006**	**2007**	**Total**
Imports	4,141,077	5,908,154	5,798,757	6,201,528	5,435,603	6,366,476	33,851,595
Exports	3,583,439	1,955,477	3,191,607	1,053,803	552,830	505,225	10,842,381
Net imports	557,638	3,952,677	2,607,150	5,147,725	4,882,773	5,861,251	23,009,214
Source: World Trade Atlas, consulted December 2007, and SIAVI, consulted October 2008.							

SIAVI reports 5 exporting companies and 85 importing companies.

Estimating consumption of mercury in thermometers, from available sources of information

Average net importation of mercury thermometers in Mexico for the 2002–2007 period is **3,834,869** units (see Table 4-6). Based on a mercury content of 0.61 grams per unit,* mercury consumption can be calculated as approximately 2.3 metric tons plus the quantity of mercury contained in thermometers produced in Mexico (64,937 x 0.61 grams = 40 kg), for a total of approximately **2.4 metric tons**.

* See: http://www.newmoa.org/prevention/topichub/index.cfm?page=subsection&hub_id=101&subsec_id=1.

In 2007, Mexico initiated a pilot program to substitute digital thermometers in two hospitals, and it is expected that in 2008 this program will be expanded to 10 more hospitals.

Consumption: In the health sector data on these products are aggregated, due to the difficulty in separating the different kinds. There are 32 companies listed as selling "thermometers," including Fisher Scientific de México, SA, and its subsidiary Casa Rosas.

In addition, two Mexican thermometer-manufacturing companies were identified: BDF de México, SA de CV, and LeRoy. An important chain of stores (Chedraui) sells mercury thermometers made in Mexico.

Mercury-free alternatives are available on the Mexican Market. The cost ratio for mercury-free thermometers to digital thermometers available in Mexico is about five or six to one, but they may nonetheless be a cost-effective alternative in the meantime, when breakage of mercury thermometers and the cost of waste disposal are taken into account.

c) Sphygmomanometers and their alternatives

A sphygmomanometer is a type of manometer that is used to measure blood pressure. Mercury in a glass column rises as a cuff wrapped around the patient's arm is inflated with air. As the air is slowly released, pressure readings in milligrams of mercury are made when blood starts to pulse through the artery and when the pressure in the artery exceeds the pressure in the cuff (NEWMOA/IMERC 2008). The content of each sphygmomanometer can vary from 50 to 140 grams of mercury.

The available official information on sphygmomanometers does not specify if the reported numbers of (imported or exported) units are mercury-containing, or mercury-free alternatives.

According to SIAVI (under HS number 90189003), from July 2007 to June 2008 Mexico imported 429,401 and exported 2,619,662 sphygmomanometers, leaving a negative balance of -2,190,261 units, which is not a reasonable result. It is likely that either Mexico has seen considerable maquiladora activity in the manufacture of sphygmomanometers, or the SIAVI information is not accurate and should not be considered.

According to the INEGI 2004 Census, 30,604 sphygmomanometers were produced in Mexico in 2003. This information source, also does not specify if the units produced are mercury-containing or non-mercury-containing alternatives.

Two important alternatives to mercury sphygmomanometers are available on the market: aneroid (mechanical dial) sphygmomanometers and low-end, professional electronic blood pressure monitors that are considered direct replacements for mercury sphygmomanometers. There are other non-mercury blood pressure monitors available as well, including home monitors, ambulatory blood pressure monitors, and high-end, vital signs monitors, but these are generally not considered direct replacements for mercury sphygmomanometers (LCSP 2003).

Because of the misleading nature, as mentioned above, of the information on sphygmomanometers, estimates need to use different method of calculation.

The Status of Mercury in Mexico (CEC 2000b) established a ratio of four hospital beds to one mercury sphygmomanometer in use and 0.5 units per every medical office. Based on this, Table 4-7 presents estimates of the use of these devices.

Another important consideration for estimating mercury consumption in sphygmo-manometers is that they need cleaning and checking at least every six months in hospital use and every 12 months in general use (Beevers 2007), due to dirt and mercury oxidation.

Table 4-7
Calculating use of mercury sphygmomanometers
(through hospital beds and medical offices)

Hospital beds*							
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Public	75,303	76,201	75,627	77,705	78,519	75,364	80,066
Private	38,437	39,479	40,140	40,214	41,992	41,737	42,744
Total	**75,303**	**115,680**	**115,767**	**117,919**	**120,511**	**117,101**	**122,810**
Yearly average of hospital beds in Mexico for 2001–2007 period is **112,156**. Calculating 1 unit per every 4 beds, yearly average of sphygmomanometers use equals **28,039** units.							
Medical offices*							
Public	51,598	52,488	52,532	54,113	54,528	54,765	57,338
Private	10,093	11,149	11,772	11,699	12,096	12,648	13,130
Total	**61,691**	**63,637**	**64,304**	**65,812**	**66,624**	**67,413**	**70,468**
average of medical offices in Mexico for 2001–2007 period is 65,707 Calculating 0,5 unit per every office, yearly average of sphygmomanometers use equals **32,854** units.							
Total mercury sphygmomanometers used: **60,893**							

***Based on *Sistema Nacional de Información en Salud* (Sinais), available at http://sinais.salud.gob.mx/descargas/xls/infra_numeralia_rf.xls.

Estimating mercury consumption of sphygmomanometers, from available sources of information

The amount of mercury in an individual sphygmomanometer is about 50–140 grams.* The annual average of mercury consumption for sphygmomanometers during 2001–2007 can be estimated by taking an average of 95 grams per unit, multiplied by 60,893 units, which equals 5.78 metric tons. Considering that the product lasts five years, and presuming that only 20 percent of the beds and medical offices might need the product each year, then one-fifth of these 5.78 metric tons correspond to the yearly consumption (purchase or replacement) of sphygmomanometers, equal to 1.16 metric tons overall (5.78 metric tons x 20 percent).

Considering that all sphygmomanometers in hospitals need to be cleaned two times a year, and this operation consumes 30 percent of the average mercury contents (95 grams), this would give an estimate of around 30 grams of mercury for each time per the unit is cleaned, or 60 grams per unit per year, which equals 1.40 metric tons for all hospitals (60 grams x 28,039 units in hospitals).

Considering that sphygmomanometers in medical offices need to be cleaned once a year, and this operation consumes 30 percent of the average mercury contents (95 grams), or approximately 30 grams of mercury per estimated units which equals 30 grams per unit a year which equals .98 metric tons. (30 grams x 32,854 units in medical offices).

From the amounts calculated above, an estimate of total mercury consumption in this sector can be derived as follows:

Sphygmomanometers, annual demand		1.16 metric tons
Sphygmomanometers, maintenance in hospitals		1.68 metric tons
Sphygmomanometers, maintenance in medical offices		0.98 metric tons
	Total	**3.82 metric tons**

* See: http://www.newmoa.org/prevention/mercury/imerc/FactSheets/measuring_devices.cfm.

Non mercury-containing alternatives: as mentioned before, in the Mexican market, two alternatives to mercury are available for clinical blood pressure measurement. They are aneroid (mechanical dial) sphygmomanometers and low-end professional electronic blood pressure monitors. Unfortunately, it is not possible to calculate the increasing use of mercury-free alternatives versus mercury sphygmomanometers.

One consideration is that mercury sphygmomanometers are very durable instruments; significant quantities of them are still used in hospitals. Mexico just began (in 2007) two pilot substitution programs for thermometers under the Health Care Without Harm program. It is expected that for the medium-term, the use of mercury-free sphygmomanometers will actually increase. In fact, replacement programs have just started in a few hospitals since 2007 and evaluation of costs and efficiency of available mercury-free alternatives in Mexico is only beginning.

4.5.2 Chemical manufacturing and biopharmaceutical sector

This sector includes industrial production of mercury compounds and elemental mercury for use in laboratories (academic, health, and industrial), as well as mercury used in the biopharmaceutical industry.

According to the 2004 Industrial Census, during 2003 (see section 2.2.8, above) the basic inorganic chemicals manufacturing sector in Mexico consumed around 14 metric tons of commodity-grade mercury. According to SIAVI data, during the second semester of 2007 and first semester of 2008, net imports (imports minus exports) of mercury compounds were estimated at 122.8 metric tons (see section 4.4, above). This quantity comprises at least 40% mercury, considering the high atomic weight of this element and the wide range of mercury contained in the different compounds. For example, mercuric iodide is about 44.14% mercury while mercuric oxide is 92.61%. For estimating the overall content of mercury in mercury compounds (produced, imported or exported) in the Mexican market, a lower factor of 40% will be considered.

Commercial information sources for the chemical sector provide data on several mercury compounds supplied to the Mexican market, which are analyzed throughout this section. Technical information on mercury formulations, preparations and their major uses, as well as their main consumers and

producers, was obtained from the Hazardous Substances Data Bank (HSDB),[10] which compiles a comprehensive, peer-reviewed compendium of toxicology data for about 5,000 chemicals, and provides a comprehensive profile for each substance included in this databank. (For more information, see:
http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB.)

Information from HSDB on mercury uses may help to identify if types of usages of mercury compounds formerly found in developed countries are still occurring in Mexico. It is important to develop a more specific study on uses of these compounds in the Mexican context (for example, in homemade biocides, remedies, or cultural uses). The significant quantities of unknown mercury compounds in net imports, as mentioned previously, make this an important sector to assess from an environmental perspective.

The descriptions below of formulation and major uses of each mercury compound are quoted almost verbatim from the sources cited.

a) Mercuric chloride

CASRN:[*] 7487-94-7

Formulations/Preparations:

- Wettable powder (mixture with mercurous chloride); dust (mixture with mercurous chloride and malachite green).[11]

Major uses:

- Preserving wood and anatomical specimens; embalming; browning and etching steel and iron; intensifier in photography; white reserve in fabric printing; tanning leather; depolarizer for dry batteries; electroplating aluminum; mordant for rabbit and beaver furs; manufacture of ink for mercurography; reagent in analytical chemistry; manufacture of other Hg compounds; for freeing gold from lead; in magic photograms; staining wood and vegetable ivory pink; in medication: topical antiseptic, disinfectant; in medications (vet): caustic, antiseptic, disinfectant.[12]
- Solutions used as dip for bulbs and tubers, including seed potatoes, on greenhouse beds for earthworm control, and on fire blight cankers of quince trees. Also used as repellent to ants, roaches, and termites. Insecticide, fungicide (former).[13]
- Used in dry battery cases. Agent in removal of mercury from zinc by-product gases.[14]
- Used in the past century as a disinfectant. And as medication and veterinary medication.[15]
- Until about 1980, mercuric chloride was used extensively as a catalyst for the preparation of

[10] HSDB presents a full description for each substance that covers almost all aspects, such as formula, commercial names, environmental paths etc.

[*] Chemical Abstracts Service Registry Number.

[11] Worthing, CR (ed.). *Pesticide manual.* 6th ed. Worcestershire, England: British Crop Protection Council (l979), p. 333.

[12] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals.* Whitehouse Station, NJ: Merck and Co., Inc. (1996), p. 1003.

[13] *Farm Chemicals Handbook 87.* Willoughby, Ohio: Meister Publishing Co. (1987), p. C-70.

[14] Ashford, RD. *Ashford's Dictionary of Industrial Chemicals.* London, England: Wavelength Publications Ltd. (1994), p. 560.

[15] World Health Organization (WHO). *Environ Health Criteria: Mercury* (1976), p. 29.

vinyl chloride from acetylene. Since the early 1980s, vinyl chloride and vinyl acetate have been prepared from ethylene instead of acetylene, and the use of mercuric chloride as a catalyst has practically disappeared.[16]

- Not registered for current use in the US.[17]

Companies:

According to Cosmos (a website compendium of industries and products, at http://www.cosmos.com.mx) and QuimiNet (another industrial resource website, at http://www.quiminet.com), in Mexico, eighteen companies supply mercuric chloride:
Aslo Reactivos; Central de Drogas (Cedrosa); Grupo Químico Amillan; Jalmek Cientifica; Macame; Mallincrodt; Materiales y Abastos Especializados, SA de CV (Maesa); OPTA 2000, SA de CV; Productos Quimicos Monterrey; Proquisa; Quantyka; Quimica Tech; Quimik; Grupo Minero Rago; Sealab; Sigma Aldrich Quimica, SA de CV; Tecsiquim; United Phosphorus de México.

b) Mercury nitrate (mercuric nitrate)

CASRN: 10045-94-0

Formulations/Preparations:

- 97% min. assay /available.[18]

Major uses:

- Manufacture of felt; mercury fulminate; destroying *Phylloxera.*[19]
- In bronzing; in the inside of field glasses.[20]
- Analytical reagent; preparation of mercuric nitrate standard solution.[21]
- Nitration of aromatic organic compounds.[22]
- Formerly widely used in manufacture of fur felt hats.[23]
- Used in organic synthesis as the starting material and for the formulation of a great many other mercuric products.[24]
- Determination of chloride ion.[25]

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[16] *Kirk-Othmer Encyclopedia of Chemical Technology*. 4th ed. Volume 1. New York, NY: John Wiley and Sons (1991–Present), p. V16 (96) 232.
[17] Environmental Protection Agency/Office of Pesticide Program's Chemical Ingredients Database on Mercuric Chloride (7487-94-7).
[18] Fluka. Catalog 14, *Chemicals and Biochemicals* (1984), p. 622.
[19] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals*. Whitehouse Station, NJ: Merck and Co., Inc. (1996), p. 1004.
[20] Browning, E. *Toxicity of Industrial Metals.* 2nd ed. New York: Appleton-Century-Crofts (1969), p. 227.
[21] Association of Official Analytical Chemists. *Official Methods of Analysis.* 10th ed. and supplements. Washington, DC: Association of Official Analytical Chemists (1965). New editions through 13th ed. plus supplements (1982), pp. 12/276, 16.170.
[22] Lewis, RJ, Sr. (ed.). *Hawley's Condensed Chemical* Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 712.
[23] American Conference of Governmental Industrial Hygienists, Inc. *Documentation of the Threshold Limit Values*. 4th ed. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, Inc. 1(980), p. 254.
[24] *Kirk-Othmer Encyclopedia of Chemical Technology*. 4th ed. Volume 1. New York, NY: John Wiley and Sons (1991–Present), p. V16 (95) 233.
[25] *Ibid*., at V4 (92) 554.

Companies:

According to Cosmos and QuimiNet, fourteen companies in Mexico supply mercury nitrate: Análisis y Servicios Integrales; Arequim; Aslo Reactivos; Flash Chemicals; Jalmek Científica; Laboratorios y Teconologia México, SA; Macame; Materiales y Abastos Especializados, SA de CV (Maesa); Mallinckrodt; Productos Quimicos Monterrey; Prolab de México; Proquisa; Quantika; Tecsiquim.

c) Mercuric oxide

CASRN: 21908-53-2

Formulations/Preparations:

- Santar/ thixotropic paste, containing 3% mercury as mercuric oxide **(**former use).[26]
- Grades of purity: red: technical, reagent, purified; yellow: technical, NF, reagent.[27]
- Grade: Technical, paint, ACS reagent (Red); Grade: CP, technical, NF (yellow).[28]
- Contains 99–99,5% HgO.[29]

Major uses:

- Yellow mercuric oxide: for determining zinc or hydrogen cyanide; detecting acetic acid in formic acid, CO in gas mixtures.[30]
- Red mercuric oxide: in marine bottom paints, diluting pigments for painting on porcelain; with graphite as depolarizer in dry batteries; in Kjeldahl nitrogen determination; as reagent for citric acid, thiophene, glucose, aldehyde, urea, acetone; as reagent and catalyst in organic reactions.[31]
- Fungicide: as paste for wound sealing and canker treatment of fruit trees and rubber trees. Not to be used for sealing graft wounds or for treating pruning cuts in the first year after cutting.
- Yellow mercuric oxide:[32] Largely restricted to seed protectants. Useful as fruit and foliage spray (former use).[33]
- Used as a fixative in selenium determination.[34]
- Chem[ical] int[ermediary] for mercury salts, e.g., Millon's Base.[35]
- Chem[ical] int[ermediary]for organic mercurials via mercuric acetate; pigment and glass

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[26] *Farm Chemicals Handbook 87.* Willoughby, Ohio: Meister Publishing Co. (1987), p. C-273.

[27] Weiss, G.; *Hazardous Chemicals Handbook*. Park Ridge, NJ: Noyes Data Corporation (1986), p. 656.

[28] Lewis, RJ, Sr (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 717.

[29] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals.* Whitehouse Station, NJ: Merck and Co., Inc., 1996, p. 1004.

[30] *Ibid*., at 100.

[31] *Ibid*., at 1004.

[32] *Farm Chemicals Handbook 2000*. Wiloughby, OH: Meister Pub. Co. (2000), p. C 411.

[33] *Kirk-Othmer Encyclopedia of Chemical Technology*. 4th ed. Volume 1. New York, NY: John Wiley and Sons (1991–Present), p. V18 (96) 317.

[34] Association of Official Analytical Chemists. *Official Methods of Analysis.* 10th ed. and supplements. Washington, DC: Association of Official Analytical Chemists (1965). New editions through 13th ed. plus supplements (1982), pp. 13/410–25.310.

[35] *Kirk-Othmer Encyclopedia of Chemical Technology*. 4th ed. Volume 1. New York, NY: John Wiley and Sons (1991–Present), p. V16 (95) 224.

modifier; Chem[ical] int[ermediary]for chlorine monoxide; fungicide; preservative in cosmetics; analytical reagent, e.g., for hydrogen in the atmosphere; medication (vet) and medication.[36]

- Cathode material of dry cell batteries, e.g., zinc-mercury, cadmium mercury, indium-bismuth-mercury.[37]
- Component of antifouling paints (former use).[38]
- Mercury compounds may be used in batteries (mercuric oxide), pigments (imported to the United States), catalysts, explosives (mercury fulminate), laboratory-based research, and in some pharmaceutical applications (ammoniated mercury and merbromin).[39]
- Not registered for current use in the US.

Companies:

According to Cosmos and QuimiNet, nineteen companies in Mexico supply mercuric oxide: American Chemet Corporation; Arequim, SA de CV; Aslo Reactivos, SA de CV; Botica Nueva; Central de Drogas (Cedros); Universal de Industrias, SA de CV; Farbe; Fisher Scientific de México, SA de CV; Grupo Minero Rago; Grupo Químico Amillan; Herschi Trading; Jalmek; Karal, SA; Laboratorios y Tecnologia de México; Macame y Cia, SA de CV; Productos Crystal, SA de CV; Productos Quimicos Monterrey; Prolab de México; Quantyka and Tecsiquim.

d) Mercury sulfate

CASRN: 7783-35-9

Formulations/Preparations:

- 100%.[40]

Major uses:

- Electrolyte for primary batteries; with sodium chloride; for extracting gold and silver from roasted pyrites; as reagent for wine coloring, barbital, and cysteine.[41]
- Reagent for preparation of calomel and corrosive sublimate, catalyst in the conversion of acetylene to acetaldehyde.[42]
- Used in analytical chemistry to bind chloride ions in the determination of the chemical oxygen demand (COD) of wastewater; as a catalyst in the production of acetaldehyde depolarizer in galvanic elements.[43]

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[36] *Ibid*.
[37] *Ibid*.
[38] Gerhartz, W. (exec. ed.). *Ullmann's Encyclopedia of Industrial Chemistry*. 5th ed. Vol A1: Deerfield Beach, FL: VCH Publishers (1985 to Present), p. VA16 (90) 287.
[39] *Kirk-Othmer Encyclopedia of Chemical Technolog*y. 4th ed. Volume 1. New York, NY: John Wiley and Sons (1991 to Present), pp. V16 (95) 212–28.
[40] Weiss, G.; *Hazardous Chemicals Handbook*. Park Ridge, NJ: Noyes Data Corporation (1986), p. 657.
[41] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals*. Whitehouse Station, NJ: Merck and Co., Inc. (1996), p. 1005.
[42] Lewis, RJ, Sr (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 713.
[43] Gerhartz, W. (exec. ed.). *Ullmann's Encyclopedia of Industrial Chemistry*. 5th ed. Vol A1: Deerfield Beach, FL: VCH Publishers (1985 to Present), p. VA16 (90) 290.

Companies:

According to Cosmos and QuimiNet, fourteen companies in Mexico supply mercury sulfate:
Análisis y Servicios Integrales; Distribuidora de Productos Químicos Hidalgo; Fábrica de Sulfato El Aguila, SA de CV; Flash Chemicals; Jalmek Científica, SA de CV; Aslo Reactivos, SA de CV; Macame y Cia., SA de CV; Productos Quimicos Monterrey; Mallinckrodt: Materiales y Abastos Especializados, SA de CV Maesa; Quimica Alcano, SA de CV; Quimik; Sehyex; and VWR International, SA de RL de CV.

e) Mercuric iodide

CASRN: 7774-29-0

Formulations/Preparations.

- Grades: technical, reagent.[44]

Major Uses:

- In analytical chemistry, for preparation of Nessler's reagent (alkaline mercuric potassium iodide solution).[45]
- Photography, to intensify the details.[46]
- Treatment of skin disease. Preparation of high quality photodetectors.[47]
- For mercuric iodide (USEPA/OPP PC Code: 052003) there are 0 labels that match. SRP (Scientific Review Panel): Not registered for current use in the US.

Companies:

According to Cosmos and QuimiNet, nineteen companies in Mexico supply mercury iodide:
Análisis y Servicios Integrales; Aslo Reactivos, SA de CV; Central de Drogas (Cedrosa); Farbe; Fisher Scientific de México, SA; Flash Chemicals; Jalmek Científica, SA de CV; Laboratorios y Tecnología México, SA de CV; Macame y Cía., SA de CV; Materiales y Abastos Especializados, SA de CV (Maesa); Mallinckrodt; Metalúrgica Lazcano, SA de CV; Productos Químicos Monterrey, SA de CV; Prolab de México; Proquisa; Quimik; Sigma-Aldrich Química, SA de CV; Tecsiquim, SA de CV (TSQ); and VWR International, SA de RL de CV.

f) Mercuric acetate

CASRN: 1600-27-7

Formulations/Preparations:

- Grades of purity: CP–99+%.[48]

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[44] Lewis, RJ, Sr. (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 711.
[45] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals*. Whitehouse Station, NJ: Merck and Co., Inc. (1996), p. 1004.
[46] *Kirk-Othmer Encyclopedia of Chemical Technology*. 4th ed. Volume 1. New York, NY: John Wiley and Sons (1991–Present), p. V18 (96) 953.
[47] *Ibid*., at V16 (95) 233.
[48] US Coast Guard, Department of Transportation. *CHRIS—Hazardous Chemical Data*. Volume II. Washington, DC: US Government Printing Office (1984–5).

Major uses:

- Chemical intermediary for phenylmercuric acetate, a fungicide. For the absorption of ethylene.[49]
- Catalyst in organic synthesis, pharmaceuticals.[50]
- Used for the synthesis of organomercury compounds, as a catalyst in organic polymerization reactions, and as a reagent in analytical chemistry.[51]
- Chemical synthesis of 1-(2,6-dihydroxyphenyl)-1-alkanones and benzophenone.[52]
- For mercuric acetate (USEPA/OPP PC Code: 052104) there are 0 labels that match. (Scientific Review Panel) SRP: Not registered for current use in the US.

Companies:

According to Cosmos and QuimiNet, ten companies in Mexico supply mercuric acetate: Ampex Chemicals; Aslo Reactivos; Jalmek; Macame y Cía., SA de CV; Mallinckrodt; Productos Químicos Monterrey; Quimik; Sigma Aldrich; Tecsiquim, SA de CV; and VWR Internacional, SA de RL de CV.

g) Mercuric bromide

CASRN: 7789-47-1

Formulations/Preparations:

- 98% minimum assay available.[53]

Major uses:

- In preparation of medicines.[54]
- Convert inorganic mercury to methylmercury. Mercuric salts.[55]
- Used as a reagent for arsenic and antimony, as an intermediate in the production of bromine-containing organomercury compounds, and as a catalyst in organic synthesis. The melt is used as a nonaqueous solvent.[56]

[49] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals*. Whitehouse Station, NJ: Merck and Co., Inc. (1996), p. 1003.
[50] Lewis, RJ, Sr (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 710.
[51] Gerhartz, W. (exec. ed.). *Ullmann's Encyclopedia of Industrial Chemistry*. 5th ed. Vol. A1. Deerfield Beach, FL: VCH Publishers (1985 to Present), p. VA16 (90) 289.
[52] Ashford, RD. *Ashford's Dictionary of Industrial Chemicals*. London, England: Wavelength Publications Ltd. (1994), p. 1220.
[53] Fluka. Catalog 14. *Chemicals and Biochemicals* (1984), p. 621.
[54] Lewis, RJ, Sr. (ed.). *Hawley's Condensed Chemical* Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997).
[55] Gilman, AG, TW Rall, AS Nies, and P Taylor (eds.). *Goodman and Gilman's The Pharmacological Basis of Therapeutics*. 8th ed. New York, NY: Pergamon Press (1990), p. 1599.
[56] Gerhartz, W. (exec. ed.). *Ullmann's Encyclopedia of Industrial Chemistry*. 5th ed. Vol. A1. Deerfield Beach, FL: VCH Publishers (1985 to Present), p. VA16 (90) 288.

Companies:

According to Cosmos and QuimiNet, four companies in Mexico supply mercuric bromide: Ampex Chemicals; Distribuidora de los Ríos; Macame; and Productos Químicos Monterrey, SA.

h) Mercuric thiocyanate (mercuric sulfocyanide)

CASRN: 592-85-8

Major uses:

- In manufacture of pharaoh's serpents (fireworks); intensifier in photography.[57]
- Used as a reagent for chloride analysis of water.[58]
- Pyrotechnics.[59]

Companies:

According to Cosmos and QuimiNet, six companies in Mexico supply mercuric thiocyanate: Ampex Chemicals; Metalúrgica Lazcano, SA de CV; Fisher Scientific; Jalmek Cientifica; Macame; Proquisa; and Quimik.

i) Mercuric cyanide

CASRN: 592-04-1

Formulations/Preparations:

- Grades of purity: Reagent.[60]
- Grades: Technical.[61]
- The commercial salt of mercury oxycyanide is often a mix of the oxycyanide (1/3) and mercury cyanide (2/3).[62]

Major uses:

- In germicidal soaps; manufacturing cyanogen gas; in photography.[63]
- Has been used as a topical antiseptic (vet).[64]

[57] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals*. Whitehouse Station, NJ: Merck and Co., Inc. (1996), p. 1005.
[58] NIOSH. Current Awareness Listing (1985).
[59] Lewis, RJ, Sr. (ed.). *Hawley's Condensed Chemical* Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 713.
[60] US Coast Guard, Department of Transportation. *CHRIS—Hazardous Chemical Data*. Volume II. Washington, DC: US Government Printing Office (1984–5).
[61] Lewis, RJ, Sr (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 711.
[62] Gosselin, R.E., R.P. Smith, H.C. Hodge. *Clinical Toxicology of Commercial Products*. 5th ed. Baltimore: Williams and Wilkins (1984), p. II-114.
[63] Lewis, RJ, Sr. (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 711.
[64] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals.* Whitehouse Station, NJ: Merck and Co., Inc., 1996, p. 1003.

Companies:

According to Cosmos and QuimiNet, four companies in Mexico supply mercury cyanide: Arequim; Galvanoquimica; Grupo Pochteca; and Macame.

j) Mercury, elemental

CASRN: 7439-97-6

Major uses:

- In barometers, thermometers, hydrometers, pyrometers; in mercury arc lamps producing ultraviolet rays, in switches, fluorescent lamps; in mercury boilers; synthesis of all mercury salts, mirrors; catalyst in oxidation of org compounds; extracting gold and silver from ores; electric rectifiers; making mercury fulminate; for Millon's reagent; as cathode in electrolysis, electroanalysis.[65]
- Component of batteries (e.g., zinc-carbon and mercury cells), industrial and control instruments (e.g., meters), and amalgams (e.g., for dental preparations); agent in manufacture of wire and switching devices (e.g., oscillators); cathode in electrolytic synthesis of chlorine and caustic soda; catalyst for urethane and epoxy resins; laboratory reagent; lubricant (e.g., in turbines).
- Metallic mercury (quicksilver) has been employed in India to fumigate and protect grain in closed containers from insect infestation.[66]
- Used in agricultural chemicals /discontinued use/, antifouling paints, (Scientific Review Panel) /SRP: as a wet chemistry method.[67]
- Medication, medication (veterinary) Used as a neutron absorber in nuclear power plants.[68]

Companies:

The most important company in terms of volume is Grupo Minero Rago, which supplies the elemental mercury industry. This company is a certified mercury distiller.

The elemental mercury sector and the amalgam sector are not well differentiated (as market segments), due to the fact, as mentioned before, that the amalgam sector also provides mercury to other industries. Information on the mercury market is presented in Chapter 2, above.

Estimating mercury consumption in the chemical manufacturing and biopharmaceutical sector from available sources of information

During July 2007 to June 2008, nonspecified organic and inorganic mercury compounds were imported in the amount of 173 metric tons, and exported in the amount of 51.2 metric tons, for a total of net imports of unknown mercury compounds of approximately **121.8 metric tons**. No company names were recorded by SIAVI (see section 4.4, above). Therefore,

[65] *Ibid*., at 1006.

[66] *Farm Chemicals Handbook 2000*. Wiloughby, OH: Meister Pub. Co. (2000), p. C 251.

[67] Budavari, S. (ed.). *The Merck Index—An Encyclopedia of Chemicals, Drugs, and Biologicals.* Whitehouse Station, NJ: Merck and Co., Inc., 1996, p. 1006.

[68] Lewis, RJ, Sr. (ed.). *Hawley's Condensed Chemical Dictionary*. 13th ed. New York, NY: John Wiley & Sons, Inc. (1997), p. 715.

calculating a mercury content in these nonspecified compounds of 40% results in a conservative estimate of **48.72** metric tons for net imports of elemental mercury.

From this and the amounts calculated in the sections above, an estimate of total mercury consumption in the chemical manufacturing and biopharmaceutical sector can be derived:

Net imports of Hg compounds	48.72 metric tons
Chlor-alkali industry	4.97 metric tons
Biopharmaceuticals and labs	3.92 metric tons
Basic inorganic chemical	9.12 metric tons
Total	**66.73 metric tons**

4.5.3 Professional, scientific and technical services sector

This sector covers instruments for scientific and professional use, such as barometers, non-medical thermometers, and psychrometers/hygrometers. It is difficult to quantify the mercury uses in this sector because these kinds of instruments are used by a well-defined but dispersed sector of consumers and it is not easy to determine the annual consumption status of this market.

Fortunately, a valuable resource is found in the *Interstate Mercury Education & Reduction Clearinghouse (IMERC) Fact Sheet* series, which provides information such as descriptions of all kinds of mercury devices and instruments and their uses, and products' mercury content and their mercury-free alternatives.

The descriptions of instruments and their mercury-free alternatives below are presented almost verbatim from the information sources cited.

a) Barometers

Description: Barometers are used to measure atmospheric pressure. The barometer is a long, cylindrical tube filled with mercury. The mercury is displaced by the atmospheric pressure. When the mercury level rises in a barometer it indicates increasing air pressure; when the mercury level is decreasing it indicates decreasing air pressure (LCSP 2003). The amount of mercury in each apparatus is around 400–620 grams (NEWMOA/IMERC 2008).

Alternatives: The aneroid barometer is more compact and consists of an evacuated metal diaphragm linked mechanically to an indicating needle. As atmospheric pressure increases or decreases, the diaphragm compresses or expands, causing the indicating needle to show the change in pressure. The digital barometer contains a sensor with electrical properties (resistance or capacitance) that change as the atmospheric pressure changes. These sensors are considered to be just as accurate as a traditional or an aneroid barometer. Additional electronic circuitry converts the sensor output into a digital display. There is also a device called a water barometer that is similar to a traditional mercury barometer. Changes in air pressure cause the water to rise and fall in the spout. Low water level indicates high pressure and fair weather. The water level rises as the air pressure falls (LCSP 2003).

According to SIAVI, from July 2007 to June 2008, net imports (imports minus exports) under HS number 9025 8099, which covers 10 similar types of instruments, including barometers, amounted to 1,452,501 units.

Calculation of the total mercury consumption in this sector must consider that the total quantity of units includes ten types of instruments—including barometers, of which there are four types (mercury, aneroid, eco-celli liquid-gas silicon, and digital)—involving five types of technology, and that the rate of obsolescence of mercury barometers means their use is reduced to about one fifth. Thus, by assuming that each mercury barometer contains an average of 400 grams of mercury, the total mercury consumed is approximately **581 kg**. (1,452,501÷10 instrument types ÷ 5 technology types ÷ 4 kinds of barometers ÷ 5 years to obsolescence × 400 g).

According to Cosmos, eight companies supply barometers in Mexico:
El Crisol, SA de CV; Suministros para Laboratorio, SA de CV; Laboratorios y Tecnología México, SA de CV; PCA Instrumentación Analítica; WWR Internacional; Coinlab; Industrial Torres Marmex; and Filtramex.

b) Non-medical thermometers

Description: Non-medical thermometers are used for various industrial, laboratory, and commercial applications, including food preparation, freezers, laboratory refrigerators, and testing. The protocol for certain lab requirements and food preparation codes requires that the thermometers be of a high quality (LCSP 2003). The amount of mercury in different types of thermometers ranges from 0.5 to 54 grams (NEWMOA/IMERC 2008).

Non mercury-containing alternatives: the colored-liquid-in-glass thermometer (also called a "liquid thermometer") is the most common replacement for the mercury thermometer. Its appearance and structure are similar to those of the mercury-in-glass thermometer as it consists of a cylindrical tube containing a liquid that expands and contracts with increasing and decreasing temperature. The liquids used in such glass thermometers include common organic liquids such as alcohol, kerosene, and citrus extract–based solvents, which are dyed blue, red or green. Some manufacturers offer liquid thermometers described as non-toxic or environmentally friendly. Digital, bi-metal or infrared thermometers are also alternatives to mercury thermometers and are used in many of the same applications (LCSP 2003).

Consumption: The list of 32 companies that sell thermometers includes Fisher Scientific de México, SA, and its subsidiary Casa Rosas.

According to SIAVI, from July 2007 to June 2008 net imports (imports minus exports) under HS number 90258099, which includes 10 types of measuring devices and instruments, including non-medical thermometers, were 1,452,501 units.

Taking into consideration that this quantity includes ten types of instruments, including non-medical thermometers, and five types of thermometers (liquid, digital, bi-metal, infrared and mercury) and calculating each mercury thermometer to have an average of 25 grams of mercury results in total mercury consumption of approximately **726 kg** (1,452,501÷10 thermometer types ÷ 5 technology types × 25 g).

c) Psychrometers/Hygrometers

Description: A hygrometer is an instrument used to measure the moisture content of air or any gas. The most common type of hygrometer is the "dry and wetbulb psychrometer." The psychrometer is best described as two mercury thermometers, one with a wetted base, and one with a dry base. The water from the wet base evaporates and absorbs heat, causing the thermometer reading to drop. Using a calculation table, the reading from the dry thermometer and the reading drop from the wet thermometer are used to determine the relative humidity.

The sling psychrometer is also used to determine relative humidity and is reliably measured by both digital and alcohol-type psychrometers. The sling psychrometer is basically a thermometer encased in a swiveling mechanism that is swung around rapidly to record an accurate reading for relative humidity.

Psychrometers function in the same way as hygrometers; however, the names differ according to the applications for which they are used. For example, the hygrometer is used to monitor the moisture in the storage area for cigar tobacco used by manufacturers and cigar aficionados.

Atmospheric scientists and weather enthusiasts use the psychrometer to monitor outdoor humidity and moisture content (LCSP 2003). The amount of mercury in different types of these apparatus ranges from 5 to 6 grams (NEWMOA/IMERC 2008).

Alternatives: Spirit-filled thermometers can be used in psychrometers instead of the mercury thermometers and provide equally accurate results. Another alternative is the digital hygrometer, which uses electronic sensors and a digital program to measure the humidity of the air. Both the digital hygrometer and spirit-filled hygrometer are relatively inexpensive, readily available, and currently in use (LCSP 2003).

Consumption: According to SIAVI, from July 2007 to June 2008, net imports (imports minus exports) under HS number 9025 8099, which includes 10 types of measuring devices and instruments, including non-medical thermometers, were 1,452,501 units.

Taking into consideration that this quantity includes ten types of instruments, including psychrometers and three types of hygrometer (digital, spirit-filled, and mercury-containing), and calculating that each unit has an average of 6 grams of mercury, the total mercury consumption is approximately **290 kg**. (1,452,501÷10 instrument types ÷ 3 technology types × 6 g)

Summary of mercury use in the professional, scientific and technical services sector

Barometers	581 kg
Non-medical thermometers	726 kg
Psychrometers/Hygrometers	290 kg
Total	**1,597 kg**

4.5.4 Electrical Equipment, Appliance and Component Manufacturing Sector

This sector includes batteries switches, mercury displacement relays, mercury tilt switches, and mercury connectors.

Because technological changes have been displacing unknown quantities of mercury-containing appliances, is difficult to establish the numbers of mercury-free and mercury- containing uses, imports, and discarded quantities of these electrical products. Therefore, it would be advisable to implement a management plan and launch a public awareness program on risks, for the collection and recycling of spent products and their substitution with mercury-free alternatives.

Some of the descriptions in the sections below are taken almost verbatim from the information sources cited.

a) Mercury batteries

Button cell batteries that contain mercury in small proportion include zinc-air batteries, silver oxide batteries, and alkaline manganese dioxide batteries. Gas can form in all of these batteries due to the corrosion of zinc, which liberates hydrogen gas. Build-up of hydrogen gas can cause the batteries to leak, limiting the ability of the battery to function. Because mercury suppresses this zinc corrosion, it is added to button cell batteries (NEWMOA/IMERC 2008). The amount of mercury contents in these types of batteries is less than 100 milligrams (LCSP 2003).

In mercuric oxide batteries, mercury is used as an electrode and accounts for up to 40 percent of the battery's weight. Previously used in hearing aids, button-cell mercuric oxide batteries were banned in 1996 and are now used only for military and medical equipment where stable current and long service life are required (NEWMOA/IMERC 2008).

According to SIAVI, from July 2007 to June 2008, net imports (imports minus exports) under HS number 85063001, corresponding to mercuric oxide batteries, totaled 197,475 kg. The mercury content in this kind of product ranges from 33% to 40%, resulting in a total weight in mercury consumption that seems to be extremely high—between 65 and 99 metric tons.

It could be that a mistake in reporting, which is common, has occurred and thus the above information is not correct. If the total weight of mercury batteries, which have an average weight of around three grams, was misrepresented as being in kilograms when it was in fact in grams, and an average mercury content per unit is assumed as 40% by weight, the resulting total mercury consumption would be approximately **237 kg**.

It is essential that steps be taken to require more information on these batteries be recorded at Customs, such as size and type, so that it can be relayed to SIAVI—especially since this type of product is supposedly banned.

As mentioned above in Chapter 3, information generated from SIAVI may have significant levels of inaccuracy due to changes and reassignment of code numbers in the Harmonized System (HS). There was a reduction in HS numbers in 2002 and the statistical data of similar products previously listed separately were lumped together.

The mercury content of other types of batteries (such as alkaline, zinc-carbon, and silver oxide) needs to be analyzed and the percentage by weight regulated according to the minimum for mercury in batteries as stipulated in the Aarhus Protocol on Heavy Metals (1998) Annex VI, Product Control Measures, Item 5, which states:

> *Each Party shall, no later than five years, or ten years for countries with economies in transition that state their intention to adopt a ten-year period in a declaration to be deposited with their instrument of ratification, acceptance, approval or accession, after the date of entry into force of this Protocol, achieve concentration levels which do not exceed:*
>
> *(a) 0.05 per cent of mercury by weight in alkaline manganese batteries for prolonged use in extreme conditions (e.g., temperature below 0ºC or above 50ºC, exposed to shocks); and*
>
> *(b) 0.025 per cent of mercury by weight in all other alkaline manganese batteries.* [See CEC 2000, Annex 2.]

According to SIAVI data, 14 exporter companies and 53 importer companies were reported. There are no domestic manufacturers of alkaline, zinc-carbon or mercury batteries in Mexico.

b) Relays

A relay is an electrically controlled device that opens or closes electrical contacts to effect the operation of other devices in the same or another electrical circuit. Relays are often used to switch large current loads by supplying relatively small currents to a control circuit. There are two general families of relays: electro-mechanical and semiconductor. Electro-mechanical relays include mercury displacement relays, and mercury contact relays. There are other kinds of relays that are non-mercury-containing and electro-mechanical, such as the dry-reed relay. Semiconductor relays include solid-state relays and silicon-controlled rectifiers (LCSP 2003).

A relay is a versatile component used to meet the needs of hundreds of varied products and applications. A relay can be incorporated into a product (e.g., copiers, heaters, commercial aircraft, lighting controls conveyors, telecommunications, computers, injection molding machines, kilns, laboratory test instruments, etc.) or can be purchased as a component to be used in a customer-specific application (e.g., petrochemical processing) The amount of mercury in different types of these apparatus ranges from 0.1 to more than 1 gram (LCSP 2003).

Non-mercury-containing alternatives include the following:

1. Dry magnetic reed relays
2. Other electro-mechanical relays
3. Solid-state relays
4. Silicon-controlled rectifiers
5. Hybrids (electromechanical and solid-state)

According to SIAVI, during July 2007 to June 2008 total net imports (imports minus exports) of relays were 284,515 kg (see Table 4-8, below). This quantity includes eight kinds of relays—five mercury-free—totaling 177.5 metric tons (62.5%), and three that are mercury-containing, totaling 107 metric tons (37.5%).

Table 4-8 Net imports of mercury relays		
HS number	**Description**	**Total weight (kg)**
53359014	Automatic relays, 60 A	46,668
85359022	Other relays	7,369
85364111	Auxiliary multiple contact relays, 60 A, 60 V (automatic and manually operated)	114,058
85364905	Auxiliary multiple contact relays, 60 A, 480 V (automatic and manually operated)	116,150
	Total	**284,515**
Source: SIAVI, consulted 15 October 2008.		

The weight of relays depends on their components: mercury displacement relays have a heavy case, while mercury-wetted reed relays are made from lighter materials, including glass. This makes it difficult to establish the proportion of mercury by weight or an average content in these 107 metric tons.

One factor that can help to determine this is that the most commonly used relays are the heaviest—the type used as a part of the mechanism that turns city lights on and off—and the type in the high-voltage (480 V) lines in industrial facilities. The proportion of mercury in these relays is about 10 percent by weight. Thus, a fair estimate of total mercury consumption in the relay group is **10.7 metric tons**.

The main country from which Mexico imported relays was the US.

c) Switches

Switches are devices that open or close an electrical circuit, or a liquid or gas valve. Mercury-added switches are used in myriad consumer, commercial, and industrial applications, including space heaters, ovens, air handling units, security systems, leveling devices, pumps, and on/off switches. The amount of mercury contents in these different types of switches ranges from 0.1 to 70 grams (NEWMOA/IMERC 2008).

The switch sector has approximately twenty different mercury-free types of models and five types of mercury-containing models, as described below.

Mercury-float switches

Description: A mercury-float switch is typically located in buoyant float housing and is actuated based upon the rising and falling liquid levels. The mercury-float switch contains a small tube with electrical contacts at one end of the tube. As the tube lifts, the mercury collects at the lower end, providing a conductive path to complete the circuit. When the switch is tilted back the circuit is broken. The mercury-float switch operates in a similar fashion to the mercury-tilt switch. The mercury content reported by manufacturers to IMERC for float switches was in the range of greater than 1 gram/switch (LCSP 2003).

Non-mercury-containing alternatives:
1. Mechanical float switch
2. Magnetic dry-reed switch
3. Optical float switch
4. Conductivity float switch
5. Metallic ball switch
6. Sonic/ultrasonic float switch
7. Pressure transmitter float switch
8. Gallium indium alloy switch
9. Thermal float switch
10. Capacitance-level float switch

Mercury-tilt switches

Description: Mercury-tilt switches are small tubes with electrical contacts at one end of the tube. As the tube lifts, the mercury collects at the lower end, providing a conductive path to complete the circuit. When the switch is tilted back the circuit is broken. The mercury content reported by manufacturers to IMERC for tilt switches ranged from 0.4 to
71 grams/switch (LCSP 2003).

Non-mercury-containing alternatives:
1. Metallic ball tilt switch
2. Electrolytic tilt switch
3. Potentiometers
4. Mechanical tilt switch
5. Solid-state tilt switch
6. Capacitive tilt switch

According to the Cosmos website, six companies supply tilt switches.

Mercury pressure switches

Description: The mercury pressure switch typically uses a piston, diaphragm, or bellows acting as the pressure sensor to actuate the mercury switch.

The mercury content reported to IMERC by manufacturers for pressure switches was greater than 1 gram/switch.

Non-mercury-containing alternatives:
1. Mechanical pressure switches
2. Solid-state pressure switches

Mercury temperature switches

Description: The temperature switch employs a temperature-responsive sensor, which is coupled to the mechanical means of actuating a mercury switch. The temperature-responsive sensor is typically either a thermocouple, resistance temperature detector (RTD), or gas-actuated bourdon tube. The mercury content reported by manufacturers to IMERC for temperature switches was more than 1 gram/switch (LCSP 2003).

Non-mercury-containing alternatives:
1. Mechanical temperature switches
2. Solid-state temperature switches

Automotive switches

The sources of information consulted did not provide specific information related to switches or other mercury devices used in automobiles.

Since this is a specific market, there are two possible future actions that can be implemented. One is to find how many and which parts containing mercury are being sold in the new-car parts sales market.

The other very important action is in the context of dismantling scrap cars. Considerable numbers of used cars have been entering Mexican territory (and many more will, thanks to NAFTA), and when they no longer operate they remain in Mexico and are sold as scrap metal.

There is no active automobile mercury switch removal program in place in Mexico.

According to SIAVI, there are about 12 HS numbers covering different types of switches, one of which applies to mercury tilt switches (HS number 85365006). During July 2007 to June 2008, there were net imports (imports minus exports) of 78.34 metric tons in this category. Calculating an average proportion of mercury content of about 2 percent, the resulting total mercury consumption for this group of products is approximately **1.56 metric tons.**

d) Mercury lamps

Mercury is used in a wide variety of light bulbs, in both indoor and outdoor applications, from fluorescent tubes to neon signs. Fluorescent and other mercury-added lamps are increasingly popular, as they are more energy efficient and typically last longer than incandescent lamps. Mercury is an essential element in how these bulbs generate light (LCSP 2003). The individual mercury content in different types of lamps ranges from 3 milligrams to 50 milligrams (mg).

The main mercury fluorescent lamps manufacturers in Mexico are General Electric, Osram, and Philips. These companies manufacture, import and export lamps. According to SIAVI, from July 2007 to June 2008, net imports (imports minus exports) of mercury lamps were around 74 million units of different types of lamps (see Table 4-9, below).

Table 4-9 Net imports of mercury-containing lamps, July 2007–June 2008				
HS number	**Description**	**Net Imports Jul-07 to Jun-08 (units)**	**Hg Content* (mg)**	**Total (kg)**
85393101	Tube fluorescent lamps, type "O" or "U" Hot cathode Main exporters: China and US	2,717,709	6	16.30
85393201	High-pressure mercury- or sodium-vapor lamps Metallic halogen lamps Main exporters: US and China	1,006,477	48	48.31
85393202	Mercury- or sodium-vapor lamps Metallic halogen lamps Main exporter: US	450,834	48	21.64
85393203	Low-pressure mercury- or sodium-vapor lamps Metallic halogen lamps Main exporter: USA	210,801	8	1.68
85393299	Other kinds: Mercury- or sodium-vapor lamps Metallic halogen lamps Main exporters: China and Belgium	595,774	10	5.95
85393903	Other kinds: Tube fluorescent lamps, type "O" or "U" Main exporter: China	11,068,953	6	66.41
85393905	Other kinds: Neon lamps Main exporters: China and USA	17,273,210	3	51.82
85393999	Other kinds: Discharge lamps and tubes, except ultraviolet rays Main exporter: China	40,696,999	6	244.18
	Total	**74,020,757**		**456.29**

Source: SIAVI, consulted 24 0ctober 2008.
*Derived from Mercurio en Sistemas de Iluminación, and Osram.

Non–mercury-containing alternatives: Due their efficiency and low energy consumption, mercury-added lamps will remain on the market for several years; other technologies, such as LED (light emitting diodes), which are more expensive than mercury lamps, will eventually share the market because of their efficiency.

The most significant countries exporting lamps to Mexico are China and the US, while the main countries to which Mexico exports are the US, Guatemala, Cuba and El Salvador.

e) Neon signs

Neon signs use the same basic technology as linear fluorescent lamps, with the difference that they are not manufactured in an industrial scale due to the fact that their manufacture depends on the size, shape and diameter required, according to different projects generally developed for advertising purposes. The individual mercury content in different shapes of lamps may range from 0.5 grams to 5 grams, depending on quality control and size.

According to the 2003 Industrial Census, mercury consumption in this sector was approximately **1.024 metric tons**. Neon signs are manufactured in Mexico in artisanal shops and mercury is not used carefully. It is usual for the mercury used in small businesses to be purchased from pharmacies. According to the Yellow Pages for Mexico City, there are 97 companies and workshops engaged in this activity.

Non–mercury-containing alternatives: trends in this sector suggest a reduction in mercury consumption, due to the increase in mercury prices and to changes of fashion in publicity.

Summary of
electrical equipment, appliance and component manufacturing sector

Mercury batteries	0.237 metric tons
Mercury relays	10.700 metric tons
Mercury switches	1.560 metric tons
Mercury lamps	0.456 metric tons
Neon signals	1.02 metric tons
Approx. Total	**14 metric tons**

4.5.5 Miscellaneous manufacturing sector

Because technological changes have caused displacement of unknown quantities of instruments and equipment, it is difficult to estimate the quantities of mercury used or contained this sector.

Descriptions of the mercury products and alternatives below are reproduced almost verbatim from the information sources cited.

a) Mercury flow meters

Description: Flow meters are used in many areas for measuring the flow of gas, water, air, or steam. They are used in water treatment plants, sewage plants, power stations, and other industrial applications (LCSP 2003). The individual mercury content in flow meters ranges from 3 milligrams to 0.5 g to more than 1 gram. Manufacturers contacted stated that they did not use mercury in the fabrication of new flow meters. However, older flow meters still in use or stockpiled contain mercury.

Non–mercury-containing alternatives: some industrial operations may still have mercury flow meters in use; however, research indicates that new flow meters are manufactured without mercury.

Non-mercury flow meters include digital and ball-actuated flow meters (LCSP 2003, and IMERC Fact Sheet[69]).

According to Cosmos, QuimiNet, and Buscador Industrial, more than 50 companies supply flow meters.

b) Manometers

Description: Manometers are used to measure air, gas, and water pressure. The mercury in manometers responds to air pressure in a precise way that can be calibrated on a scale. Manometers are used in laboratories, the dairy industry milking process, and for calibrating outboard motors and motorcycle carburetors. Manometers are also used by HVAC contractors for testing, balancing, and servicing equipment (LCSP 2003). The mercury content in manometers ranges from 6 grams to 75 grams.

Alternatives: The three alternatives to a mercury manometer include the needle/bourdon gauge, the aneroid manometer, and the digital manometer. The needle/bourdon gauge operates under a vacuum with a needle indicator as a method to measure pressure. The aneroid manometer operates in a similar fashion to the needle/bourdon gauge. The digital manometer uses a digital, computer-programmed memory and gauges to measure the pressure (LCSP 2003).

Consumption: According to SIAVI, from July 2007 to June 2008, net imports (imports minus exports) of products under HS numbers 90262002 and 90262006, which cover 7 types of measuring devices, including manometers, were a total of 13,263,909 units.

Since this quantity includes seven types of instruments, including manometers, and there are four kinds of manometer, three of which are non-mercury-containing (the needle/bourdon gauge, the aneroid manometer, and the digital manometer), and taking into consideration obsolescence and the lesser demand for mercury manometers, the amount of mercury is calculated using a factor of one half. Thus, with an average weight per unit calculated at 6 grams, the total mercury consumption in this product group is approximately **1.421** metric tons (13,263,909 ÷ 7 kinds of instruments ÷ 4 types of manometers ÷ 2 lesser demand × 6 g)

The main exporter countries to Mexico are the US, China and Germany.

According to the Cosmos website, seven companies supply mercury manometers, and two of them manufacture and assemble manometers.

c) Thermostats

Description: Industrial thermostats provide temperature control in manufacturing and industrial settings. The mercury thermostat uses a mercury switch to activate the heating/cooling device. The mercury in the switch is part of an electric current relay which relies on an electric current to activate and deactivate the heating/cooling device when the mercury in the switch is tipped (LCSP 2003). The mercury content in thermostats ranges from 1 grams to 3 grams (NEWMOA/IMERC 2008).

Non mercury-containing alternatives: Digital electronic thermostats available for industrial type workloads and temperature control use a simple resistor called a thermistor to measure temperature by measuring changes in electrical resistance caused by fluctuations in temperature. The microcontroller in a digital thermostat can measure the resistance and convert that number to a temperature reading (LCSP

[69] See: http://www.newmoa.org/prevention/mercury/imerc/factsheets/measuring_devices.pdf.

2003). According to the sources of information and dealers consulted, digital thermostats are not sold in Mexico.

d) Hydrometers

Description: A hydrometer is an instrument used to measure the specific gravity of a liquid—the ratio of the density of the liquid to the density of water. Hydrometers are often used in cooking, especially in beer brewing and wine making. They are typically made of glass and consist of a cylindrical stem and weighted bulb, which makes the device float upright in the liquid solution. Historically, elemental mercury was used in hydrometers as a weight. The amount of mercury was small—often less than one gram, depending on the size of the instrument. Non-mercury hydrometers that use lead ballast for the weight are now used.[70]

Alternatives: An alternative to the mercury hydrometer is the spirit-filled hydrometer. These come customized to suit individual applications. The manufacturer should be consulted, in order that the most appropriate hydrometer for the use can be chosen.

Summary of mercury consumption in the miscellaneous manufacturing sector

Flow meters, thermostats and hydrometers	(not many in use or no data)
Manometers	1.4 metric tons
Total	**1.4 metric tons**

4.5.6 Computer and electronic product manufacturing sector

Since mercury consumption is growing, due to the expansion of applications in the electronic sector, especially the use of mercury lamps in liquid crystal displays and of other specialty lamps, it is important to dedicate resources to undertake a study which would describe these mercury uses and consumption in the Mexican electronic industry. Table 4-10 presents what is currently known about these products.

[70] For more information, see http://www.newmoa.org/prevention/mercury/projects/legacy/measdev.cfm#h.

Table 4-10 Mercury in electronics				
Product	**Component**	**Hg content per unit**	**Number of units (net imports)**	**Hg consumption (kg)**
LCD Displays* ≤14 inches HS 85285101	Fluorescent light bulb	2.5 mg	69,361	0.173
LCD Displays * 14 inches HS 85285199	Light bulb fluorescent	3.0 mg	2,395,620	7.18
Laptops* HS 94713001	Lamp for LCD	2.5 mg	2,490,646	6.23
Video Cameras*		2.5 mg	22,975,195	57.44
Video Cameras**	LCD display	2.5 mg	362,578	0.906
Laptop computers**	Lamp for LCD	2.5 mg	1,632,557	4.08
Total				**76.01**
Sources: *SIAVI, consulted 15 October 2008; ** INEGI, Economic Census 2004.				

Chapter 5: Findings and conclusions

5.1 Current Trends in Supply and Demand in the Mexican Mercury Market

The findings of chapters 1–4 on the current trends in demand and supply in the Mexican mercury market can be summarized as follows:

- During the nineteen-eighties (from 1985–1989), Mexico was a net exporter of approximately 323 metric tons of mercury (exports, 600, minus imports, 277).
- During the nineteen-nineties (1990–1999), Mexico turned into a net importer of approximately 153.5 metric tons (imports, 244.8, minus exports, 91.3).
- In 1994, primary production ceased in Mexico due to the low prices of mercury.
- During the period 2000–2007, Mexico was a net importer of approximately 138.5 metric tons (imports, 203, minus exports, 64.5).
- The average apparent supply of mercury from 2000 to 2006 was approximately 37.4 metric tons.
- However, in 2007, for first time, the apparent supply of mercury was negative, in the amount of -8.9 metric tons, and in 2008, the apparent supply was of -34.7 metric tons (see Table 2-5).
- A possible explanation for this negative apparent supply is that from 2005 to 2007, Mexican exports to Latin American countries increased by a factor of 360%, and according to data from 2008 released in March 2009, this further increased to 992% of the 2005 exports.
- This trend would seem to indicate that Mexico played a role as an intermediary country that imports mercury from developed countries (mainly the US) and exports it to developing countries.

5.2 Current and Future Trends on the International Scene

The Community Strategy Concerning Mercury, of the Commission of the European Communities (EC), proposes that the export of commodity mercury from the European Community be completely phased out by 2011. The Mercury Export Ban Act of 2007, signed by President Bush on 14 October 2008, prohibits the transfer of elemental mercury by US federal agencies, bans US export of elemental mercury, effective 1 January 2013, and requires the Department of Energy to designate and manage an elemental mercury long-term facility, effective 1 January 2010.[71]

Taking this into consideration along with the fact that the US is the main country from which Mexico imported mercury, the prospective of the Mexican mercury market may be anticipated to have the following characteristics:

- Secondary silver-mercury production from ancient tailings activities in Zacatecas will continue, due to international mercury demand and silver and gold prices;
- Primary production activities, which are now taking place as an informal activity and are not officially reported, will probably increase;

[71] For more information, see: http://www.glin.gov/view.action?glinID=71491.

- The EC and US bans on mercury exports will motivate infrastructure development in Mexico for recycling mercury-containing end-of-life products;
- In view of these bans, Mexico may consider capacity building related to recycling facilities, investment, and clean technology, and some changes to its legislation; and
- Mercury imports into Mexico during 2009 could be high, due to the planned US export ban.

5.3 Countries that Import the Greatest Quantities of Mercury from Mexico

Mexico exported 5.9 metric tons of mercury in 2005, 8.2 in 2006 and 21.3 in 2007—a 360% increase over these three years (see Table 5-1, below); then a drastic change in 2008 increased Mexican exports by 992% from 2005 to 2008. Peru is the main country to which Mexico exports mercury, followed by Colombia, Brazil and Argentina.

Table 5-1
Main countries to which Mexico exports mercury
(metric tons)

Country	2005	2006	2007	2008	Total
Peru	0	0	2.65	32.88	35.53
Colombia	1.21	3.00	11.95	16.65	32.81
Brazil	0	3.11	5.18	2.07	10.36
Argentina	3.11	0.55	0.55	5.18	9.39

Derived from Table 2-7

5.4 Estimation of Mercury Consumption in Mexico, by Sector

Using results of calculations Chapter 4, Table 5-2 summarizes information on mercury consumption in processes and products, classified by sector.

Because it was necessary to gauge the quality of available information (official, technical, and commercial) when calculating the mercury uses and consumption, it was then also important to not overestimate some sectors. Unfortunately, the electrical sector (especially switches and relays) may have a greater degree of inaccuracy than others in the products sectors, due to the amount of information that was aggregated. The professional, scientific and technical services sector needs to undergo more assessment. In both sectors, it is important to develop a collection program, considering that many units of these products are still in use.

The priority of each sector depends on its impact on the environment: the amount of mercury released at the end of the product's life; the amount of mercury a product contains; the total amount of mercury reported for all product sales; and the availability of non-mercury alternatives. If a product meets three of these four criteria, its priority is high.

Table 5-2
Mercury consumption in Mexico, by sector
(in metric tons)

Sector	National Produced Products	Imported products	Total	Priority
Product sectors				
Dental and health care			**15.2**	
• Amalgams	3.5	5.5		H
• Thermometers		2.4		H
• Sphygmomanometers	1.9	1.9		H
Electrical equipment, appliance and component Manufacturing			**14.0**	
• Lighting, national production		0.5		M
• Neon signals	1.0			H
• Batteries, relays and switches		12.5		H
Miscellaneous manufacturing			**1.4**	
• Fluxometers, manometers and thermostats		1.4		H
Computer and electronic product manufacturing			**0.1**	
• LCD displays, laptops, video cameras		0.1		M
Professional, scientific and technical services			**1.6**	
• Barometers, non-medical thermometers, psychrometers/hygrometers		1.6		M
Total Product Sectors	**6.4**	**25.9**	**32.3**	
Process Sectors				
Chemical manufacturing and biopharmaceutical			**66.7**	
• Chlor-alkali	5.0			M
• Basic inorganic chemical production	9.1			H
• Uses in biopharmaceuticals and laboratories	3.9			M
• Net imports of unknown mercury compounds (40% of 121.8 metric tons)		48.7		H
Total, Process Sectors	**18.0**	**48.7**	**66.7**	
Total Consumption, Products and Process Sectors	**24.4**	**74.6**	**99.0**	

5.5 Products and Processes that Consume the Greatest Volumes of Mercury

1. *Chemical manufacturing and biopharmaceutical sector*
The highest amount of mercury consumption is found in this sector (see Table 5-2, above). In the cases of basic inorganic chemical production, with consumption of 9.12 metric tons, and net imports of unknown mercury compounds, in the amount of 48.7 metric tons, the priority of these segments is rated high not only because of the volume of mercury consumed but also because of the unknown life cycle and environmental paths of these compounds.

The uses of mercury in the biopharmaceuticals and laboratories segment, with consumption of approximately 3.9 metric tons, includes a significant number of mercury compounds used in research and academic laboratories. Unfortunately, the information available on mercury imports/exports and production does not distinguish the amounts in this segment from mercury sales in other sectors, like neon signs and cultural uses.

The chemical manufacturing and biopharmaceutical sector represents a priority area for assessing the possible impacts and environmental pathways of processes and produced substances.

In the chlor-alkali segment, annual mercury consumption has been reduced by approximately 12.25% (from 5.66 to 4.97 metric tons) due to the fact that one of the three plants changed its technology to a mercury-free process.

2. *Dental and health care sector*
This sector has the second-highest consumption, approximately 15.2 metric tons. Mercury consumption in this sector will be reduced in the future, due to the fact that Mexico just started in 2007 a program for the elimination of mercury-containing apparatus in hospitals. The challenges this program faces include gaps in the technology, in the number of facilities dedicated to collecting and recycling thermometers and sphygmomanometers, and in the requirement of current Mexican regulation that generated liquid mercury has to be solidified before disposal. For these reasons, the priority for action on these products is high.

The problem in controlling the mercury used in dental amalgams is that the substance is sold in many pharmacies and dental products stores, leading to non-essential uses of mercury and, in consequence, unnecessary mercury emissions.

3. *Electrical equipment, appliance and component manufacturing sector*
This sector takes third place, with mercury consumption reported to be around 14 metric tons. This amount is surely underestimated, however, due to gaps in information—especially as related to switches and relays, which may be in considerably greater quantity than reported.

For this reason and the absence of collection and recycling programs, and mainly because of the unknown quantities of mercury generated when these products are discarded (presumably relatively high, considering the content of mercury in each unit), this is a high-priority sector. Another element of uncertainty and significance is the existence of considerable numbers of hoarded units of these electric products.

4. *Professional, scientific and technical services sector*
This sector is fourth in significance, with consumption of mercury products estimated at approximately 1.6 metric tons. The prospective on this sector seems to be that consumption of mercury-containing products will be reduced, due to the availability of new, mercury-free technology.

5. *Miscellaneous manufacturing sector*

Mercury consumption in this fifth-priority sector is estimated at approximately 1.4 metric tons. As with the electrical equipment, appliance and component manufacturing sector, there is an absence of sources of adequate information and of collection and recycling programs.

6. *Computer and electronic products manufacturing sector*

The sixth place is held by a sector that is difficult to characterize in relation to mercury consumption because most of its products are imported and there are information gaps. The estimated mercury consumption is approximately 73 kilograms. It is important to note that this sector generates other toxic substances, and for this reason risk management and public awareness actions should be undertaken.

Chapter 6: Recommendations

6.1 Recommendations on Mercury Production and on the Management of Mercury Reserves, Depending on Current and Future Trends

Recommendation 1: Design a study to determine if informal primary mercury production is occurring in Mexico.
Recommendation 2: Design an assessment that improves on what was possible for this report on secondary mercury production from tailings in Zacatecas to determine its economic-environmental feasibility. Also, it would be important to determine if there are other silver-mining towns in San Luis Potosí, Hidalgo, and Guanajuato with the potential for tailings operations.
Recommendation 3: Perform a brief assessment to determine the impact on the global market if those sources of supply become available.
Recommendation 4: It is necessary to compile and assess information related to mercury production as a by-product, and the significant mercury emissions from metal extraction processes from copper, zinc or gold deposits.
Recommendation 5: As Mexico has not yet developed recycling capacity, it is important to start assessing this issue from both the legal and environmental perspective.
Recommendation 6: Develop a midterm study related to developing capacity for final retirement and storage of excess mercury which considers: the entities (state or private company) permitted to store mercury; the party(ies) responsible for paying costs of temporary and long-term storage; the technical standards needed for safe long-term storage; the legal authority for such storage; and the legislative/regulatory changes that may be needed.

6.2 Recommendation on Mexican Exports to Other Countries

Recommendation 7: Consider improving the implementation of the Rotterdam Convention on the Prior Informed Consent Procedure (PIC) for Certain Hazardous Chemicals and Pesticides in International Trade with Latin American countries and other signatories. PIC is a mechanism for formally obtaining and disseminating the decisions of importing Parties as to whether they wish to receive future shipments of those chemicals listed in Annex III of the Convention, and for ensuring compliance with these decisions by exporting Parties. Mercury and some of its compounds are listed chemicals. Implementing the Rotterdam Convention will help at least to manage environmental risk and also to validate information generated by customs authorities.

6.3 Recommendations on Alternative Products and End-of-life Management and Disposal

The Chemical Manufacturing and Biopharmaceutical Sector
Recommendation 8: The chemical manufacturing and biopharmaceutical sector, which generates a significant tonnage of mercury, really needs to be studied more for greater precision in the amounts consumed, and to have more knowledge about the disposal of these products and their impacts on human health and the environment.
The Annual Certificate of Operation (COA) required of industrial facilities could be an important tool in following-up and evaluating new information on mercury consumption and emissions in industries that reported during 2005, 2006, and future years. As this information is confidential, the Federal Attorney for Environmental Protection (Profepa) must analyze it to assess the possibility of ongoing mercury pollution.

It is important to determine where it is possible to make process substitutions for mercury or implement best available technologies (BATs) and best environmental practices (BEPs) in this sector.
Dental and Health Care Sector **Recommendation 9**: (for *Secretaría de Salud*) Consider a short/middle term mandatory project to eliminate mercury-containing apparatus from hospitals and also an amalgam collection program. **Recommendation 10**: (for *Secretaría de Salud*) A high-priority action that should urgently be taken by the health authorities is to ban the sales of elemental mercury in drugstores. In Mexico, mercury for amalgams is sought for uses other than those in the oral care and health sector. Such other uses include neon sign workshops, traditional cures, and jewelry making. A contradictory situation concerning mercury exists in Mexico, in that there are regulations that limit mercury emissions to air and water and that control wastes but this pollutant has not been regulated as a commodity, and no governmental public awareness strategy on reducing risks and incidents of exposure to mercury has been devised.
Electrical Equipment, Appliance and Component Manufacturing Sector ***Recommendation 11:*** In the electrical equipment, appliance and component manufacturing sector, urgent action is needed in the area of medium-size and large relays, which are used in significant numbers and then usually sent to secondary recycling foundries when they are discarded. This should be more fully researched and risk management and public awareness programs begun. Similar actions should be considered for switches, discarded manometers, and in general for all mercury-containing products that can be replaced with mercury-free alternatives. These actions could be extended to miscellaneous manufacturing, and the professional, scientific and technical activities included in the electronics sector. It is important to note that this sector generates other toxic substances, making risk management and public awareness actions especially important. Other sectors of society—including manufacturers and retailers of mercury-containing products, academic institutions, governmental entities, and NGOs—can play important roles in supporting these initiatives. **Recommendation 12**: Considering that annual mercury consumption in the chlor-alkali segment has been reduced by approximately 12.25% (from 5.66 to 4.97 metric tons), the two plants still using a mercury-based process should participate in collection and recycling programs in order to recycle the mercury. **Recommendation 13**: It may be necessary to devise a strategy in conjunction with customs authorities for developing a quick method to analyze mercury levels in batteries. **Recommendation 14**: A specific partnership initiative should be developed in the context of Border 2012 related to the removal of mercury switches by recyclers of imported used cars. An initial action can be to contact US-Mexico representatives of Border 2012. **Recommendation 15:** Use information generated from the Mercury Market Report related to mercury-containing products and processes to begin a *Use and Substitute Analysis*, which would identify the alternatives for those products, their costs, etc. This analysis could assist the Mexican government in prioritizing consumption reduction initiatives for mercury. **Recommendation 16**: Design a mercury management plan together with other sectors of society—including manufacturers and retailers of mercury-containing products, academic institutions, governmental entities, and NGOs—that can play an important role in supporting these initiatives. **Recommendation 17**: Initiate a pilot project in hospitals; this project can be related to plan a collection program for thermometers and sphygmomanometers, and end of life management of the resulting waste for their temporary storage or recycling.

6.4 Recommendations for Improving Information Sources and Public Awareness

Recommendation 18: An initial program should be jointly organized by the US Customs Administration and the Mexican Secretariat of Economy for the purpose of refining and validating data on imports/exports of mercury and mercury-containing products reported by SIAVI. Imported and exported quantities of mercury and mercury-containing products from both countries should be validated and analyzed by the importing and exporting countries.

Recommendation 19: Considering *maquiladoras*, where certain companies are allowed to import mercury as a raw material and export it as mercury-containing products with special dispensation from the customs authorities, an investigation of the control and reporting mechanisms related to these temporary imports/exports should be considered. It would also be useful to compare the data generated by Mexican authorities to those of the other countries' respective customs authorities.

Recommendation 20: Mechanisms should be implemented that can validate statistics generated on imports and exports by customs authorities related to content of mercury and other persistent bioaccumulative and toxic substances. This could be undertaken under the North American Regional Action Plan (NARAP) on mercury. An alternative would be to implement and improve mechanisms already in place, such as the Rotterdam Convention, to compile and organize information related to mercury fluxes due to import/export activities. This will help validate and improve information sources that already exist in Mexico, like SIAVI; also, generated information can help identify elements for better risk assessment of these toxic substances.

Recommendation 21: Provide information to the public on mercury toxicity, since it is not mentioned on labels of commercial products and in advertising for mercury-containing products.

Recommendation 22: Work with industry and commerce to improve cooperation on providing information on mercury use and supplies.

Recommendation 23: Implement a public awareness campaign, ideally undertaken by the environment secretariat (Semarnat), the health secretariat (*Secretaría de Salud*), the Customs Administration, industry, Caname, and the mercury-containing products suppliers. An initial meeting could be organized by Semarnat, attended by representatives of the above-mentioned stakeholders and other key participants.

Recommendation 24: Design and print pamphlets, catalogs and commercial information to promote mercury-free alternative products.

Recommendation 25: Develop a national mercury plan, based on actions proposed and undertaken in the context of the second phase of the North American Regional Action Plan (NARAP) on mercury, jointly developed by Canada, Mexico and the United States, as follows:

1. Management of atmospheric emissions of mercury;
2. Mercury management in processes, operations and products;
3. Mercury waste management approaches;
4. Research, monitoring, modeling, assessment and inventories;
5. Communication activities; and
6. Implementation and compliance.
7.

Annex 1: Mercury Importation and Exportation Statistics for Canada, Mexico and the United States

An important issue to be considered in addressing mercury challenges locally, regionally and globally is understanding the flow of commercial elemental mercury. Annex 1 is dedicated to collecting, analyzing and evaluating available information related to the elemental mercury trade in North America, in order to provide insights into how this market works.

Information on international trade of mercury as a commodity can be found in two different kinds of national sources: one is trade statistics of commodities, generally processed by customs authorities, and the other is official institutions dedicated to developing inventories and profiles of mineral resources.

International sources of information include organizations like the United Nations Environment Programme (UNEP), which in 2006 released a pertinent document entitled *Summary of Supply, Trade and Demand Information on Mercury*. UNEP has collected and processed data obtained from national and regional sources of trade information or from questionnaires submitted to countries and returned.

Brief descriptions of the most important national and international sources of information consulted for the writing of this Annex and the preceding chapters are presented in Annex 2.

a) Criteria for Selecting Information, and Gaps, Limitations and Inconsistencies

Table A-1 assembles available official information for elemental mercury from the North American commodities market in order to track commerce in mercury within the three countries. It is important to recognize that in some cases this information is not completely reliable; however, it represents a reasonable starting point for future discussions, considering the difficulty in determining reliable data for each country on mercury imports/exports, secondary production, supply, and consumption.

In order to understand mercury flow within North America it is important to clarify and define two key concepts referred to in this report: **apparent consumption** and **apparent supply**.

Apparent consumption refers to national consumption, including mercury used in dentistry and the health sector, domestic demand in industrial and manufacturing activities, and any other uses.

Data on apparent consumption are not available yet, probably due to the absence of a legal framework for reporting mercury uses. In some cases, data on national consumption are scarcely presented for Canada and the United States, in their respective minerals yearbooks. In the case of Mexico, industrial facilities are required by law to submit information related to listed substances, in an Annual Certificate of Operation (*Cédula de Operación Anual*—COA), to Semarnat. Mercury is on this list, but information is confidential and does not cover informal sectors or small facilities.

Apparent supply is a more comprehensive concept. It can theoretically be derived by adding national production (primary, secondary or as by-product) plus imports minus exports minus national consumption. The concept of apparent supply also includes reserves stored for one or more years by brokers and, in some cases, those associated with recycling activities of mercury-containing waste and with the closure of chlor-alkali plants in other countries.

Primary mercury is not officially produced in any of the three countries; however, in the case of Mexico, there is no reliable information available on informal primary production. Secondary mercury production from ancient tailings containing silver and mercury can be calculated or derived (see Tables

2-4 and 2-5). For the US and Canada, by-product production and secondary production from mercury-containing waste recycling occurs.

The available official information on imports and exports, as previously explained in this report, is a good starting point but should be validated.

Another cause of inaccuracy in the data is the significant but unknown number of brokerage operations that have taken place between the US and Mexico for more than thirty-five years.

An information gap in the sources for Mexico and the US occurs in relation to the movement of mercury through the temporary imports of the *maquiladora*, where mercury is reported when it comes into Mexico but not reported when it leaves as a mercury-containing product. More research is necessary to evaluate these differences.

The data on mercury commerce (imports/exports) in North America, presented in Table A-1, are mainly based on each country's national official sources, and are usually retrieved and processed from statistical customs information systems, since that information is generated nationally and is likely to be more accurate than information compiled by the previously mentioned international entities.

Also, information generated from each of the three countries' mineral sectors was considered as a complement and as a good frame of reference. These sources also provide scarce data on mercury secondary or by-product production and consumption that are presented in Tables 2-5 and A-1.

The three countries' commerce statistics are historically compiled by using the harmonized commodity description and coding system known as the Harmonized Tariff Schedule (HTS) in the US, or by using the Harmonized System (HS) in Canada and Mexico, which is an international commodity classification scheme developed under the auspices of the Customs Cooperation Council. This code was extended to ten digits for imports to serve as the basis for Customs tariffs and international trade statistics. For export purposes, the international, six-digit "root" was extended to eight digits.

HS is logically structured by economic activity or component material. For example, animals and animal products are found in one section; machinery and mechanical appliances, which are grouped by function, are found in another. The HS code for elemental mercury is 2805 4000.

Table A-1
North American Mercury Apparent Supply (1997–2007)
(in kilograms)

Year	Country	Production (as by-product, and secondary)	Imports[1]	Exports[1]	Apparent supply
2007	Canada	0	*11,075	*18,823	-7,748[6]
	Mexico	8,400[5]	4,034	21,355	-8,921[6]
	USA	0	67,080	84,642	-17,562[6]
2006	Canada	0	*11,101	*7,892	3,209[6]
	Mexico	8,400[5]	21,458	8,137	21,721[6]
	USA	0	94,245	390,457	-296,212[6]
2005	Canada	0	10,029	12,875	-2,846[3]
	Mexico	8,400[5]	26,206	5,916	28,690[6]
	USA	0	212,106	318,632	-106,526[6]
2004	Canada	0	7,285	2,344	4,941[6]
	Mexico	8,400[5]	24,770	658	32,512[6]
	USA	0	92,159	278,631	-186,472[6]
2003	Canada	0	8,391	6,420	1,971[3]
	Mexico	8,400[5]	21,089	2,384	27,105[6]
	USA	0	45,602	287,357	-241,755[6]
2002	Canada	0	8,347	11,254	-2,907[3]
	Mexico	8,400[5]	43,844	4,390	47,854[6]
	USA	97,000	209,608	324,033	-17,425[6]
2001	Canada	0	7,420	8,045	-625[3]
	Mexico	30,850[5]	52,057	15,407	67,500[6]
	USA	0	99,333	109,494	-10,161[6]
2000	Canada	0	11,709	4,108	7,601[6]
	Mexico	33,300[5]	9,604	6,220	36,684[6]
	USA	0	135,695	221,984	-86,289[2]
1999	Canada	0	9,434	1,778	7,656[3]
	Mexico	33,300[5]	26,382	54,019	5,663[6]
	USA	0	61,599	203,230	-141,631[2]
1998	Canada	0	11,389	8,037	3,352[3]
	Mexico	33,300[5]	19,800	243	52,857[6]
	USA	0	128,344	63,155	65,189[2]
1997	Canada	0	7,125	4,264	2,861[6]
	Mexico	33,300[5]	8,207	7,013	34,494[6]
	USA	389,000	163,535	133,774	418,761[2]
Total		**750,450**	**1,670,062**	**2,626,728**	**-256,459**

[1] Import/export information was obtained from:
for Canada, the Canadian Customs Tariff, Canada Border Services Agency;
for Mexico, the Secretariat of Economy, World Trade Atlas, consulted 28 November 2007 and 5 June 2008; and
for the US, the United States International Trade Commission (USITC), consulted 28 May 2008.
[2] Information obtained from USGS *Minerals Yearbook* (respective years).
[3] Information obtained from the *Canadian Minerals Yearbook* (respective years).
[4] Information obtained from: Preliminary Atmospheric Emissions Inventory of Mercury in Mexico. Prepared for: CEC.
[5] Information obtained from USGS *Minerals Yearbook*, Vol. III, *Area Reports: International*.
[6] Numbers derived by adding production plus imports minus exports, in cases when no official information was available.
[*] Information obtained from United Nations Commodity Trade Statistics Database, consulted 29 May 08.

Another important reason for compiling the information as based on the HS system is that each country's mineral sectors also use this information for compiling or validating their statistics. Information generated by the minerals sectors is sometimes in a different format from that generated by the customs sectors: the first in rounded quantities of metric tons, the latter in kilograms.

It is also important to consider that during the data compilation process, problems and inconsistencies related to quality control were detected, which probably originated during the generation and organization procedures—for example, when transposing information from printed to electronic format, or potentially when agents or administrative personnel in customs offices mistakenly allocate a wrong HS number.

International sources were used only to compare obtained data or in order to detect possible inconsistencies in national information sources, and in certain cases to cover information gaps in national sources.

Information presented for Canada related to imports/exports was obtained from the *Canadian Minerals Yearbook* (CMY—available online at http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/cmy-amc-eng.htm) (1998–2005), and from the Customs Tariff of the Canada Border Services Agency (online at http://www.cbsa-asfc.gc.ca/trade-commerce/tariff-tarif/menu-eng.html). Both sources of information present the same information, with insignificant differences. Data for 2006–2007 was not available from the CMY, and so information for these years was obtained from the United Nations Commodity Trade Statistics Database, consulted on 29 May 2008.

For the US, information related to mercury imports/exports from the United States International Trade Commission (USITC) Interactive Tariff and Trade Database (available online at http://dataweb.usitc.gov/) is similar to that from the USGS *Minerals Yearbook* (MYB—available online at http://minerals.usgs.gov/minerals/pubs/myb.html) except for imports in years 2000, 2004 and 2007. In exports corresponding to years 1999, 2000, 2002 and 2004, significant differences were observed. For this reason, in Table A-1 the information for the US was taken from the USITC, in order to be consistent with Canadian and Mexican information from Customs sources.

It should be noted that there is a significant information gap in mercury use and mercury production (as this kind of information is accessible for only a few years). For this reason, the amounts in the respective columns of Table A-1 were derived, when not available from official sources.

b) Findings

According to the data in Table A-1, the North American mercury market during the eleven-year period 1997–2007 presented the following characteristics:

Imports/exports in North America

During the 1997–2007 (eleven-year) period, Canada and Mexico have been net importers of mercury from different countries in the world, with amounts of 17 465 kg and 131 452 kg, respectively. Meanwhile, the US has been a net exporter (to different world countries), with an amount of 1 106 083 kg (see Table A-2). This pattern of fewer imports than exports could be because a considerable portion of US trade in mercury is not driven just by domestic use or production, but from significant activity of mercury waste recyclers and distillers or brokers for subsequent sale to other markets.

Table A-2 Net imports/exports worldwide for North American countries (1997–2007) (in kilograms)				
Country	**Imports**	**Exports**	**Net Imports**	**Net Exports**
Canada	103,305	85,840	**17,465**	
Mexico	257,451	125,499	**131,452**	
US	1,309,306	2,415,389		**1,106,083**
Total	**1,670,062**	**2,626,728**		
Source: Derived from Table A-1.				

Mexico-US trade

According to Mexico's SIAVI (see Table 2-6), elemental mercury exports from the US to Mexico amount to 216,740 kg, for the period 1997–2007. This represents 8.25% of the total of 2,626,728 kg (total exports from the US to different world countries—see Table A-2—based on USITC). Meanwhile, according to information from the USGS *Minerals Yearbook* for the same period, mercury exports from the US to Mexico total approximately 215,000 kg, which is about same amount (see: http://minerals.usgs.gov/minerals/pubs/commodity/mercury).

According to SIAVI, Mexico has been a net mercury importer from the US, of 191,589 kg, during the same period (see Tables 2-5 and 2-6). According to SIAVI, the US imported mercury from Mexico in the amount of 25,129 kg for the period, 1997–2007. This represents 20% of the 125,742 kg in total Mexican exports to different world countries.

It should be mentioned that the USGS *Minerals Yearbook* reports zero imports from Mexico to the US during the same period (see: http://minerals.usgs.gov/minerals/pubs/commodity/mercury).

A discrepancy between the SIAVI and USITC databases is that USITC reports that only one kilogram of mercury was imported from Mexico during the 1997–2007 period[72] (see: http://dataweb.usitc.gov).

Canada-USA trade

According to the USGS *Minerals Yearbook*, elemental mercury exports from the US to Canada amount to 63,000 kg for the period 1997–2007, which represents 2.4% of the total of 2,626,728 kg (total exports from the US to different world countries).

According to the USGS *Minerals Yearbook*, elemental mercury exports from Canada to the US amount to 85,000 kg for the period 1997–2007, which represents 68% of 125,499 kg in total Canadian exports to different world countries.

Canada has been a net mercury importer, by 22,000 kg, from the US during the same period.

[72] There is another important quantitative difference between customs information from US and Mexican databases: import data for the US are not consistent with export data from Mexican sources.

Canada-Mexico trade

According to the Secretariat of Economy's World Trade Atlas, Mexico imported one kilogram from Canada in 2002, and no Mexican exports to Canada are reported.

More-detailed information on Mexican production and imports/exports is presented in Tables 2-5 to 2-8.

Primary production

In regard to primary production in North America, according to information from the respective official mineral sectors, Canada has not produced mercury since 1975, the US since 1992, and Mexico since 1995.

Secondary production and by-product production

Official information on each country's mercury production (secondary or as by-product) for period 1997–2007 is scarce.

For the US, the USGS MYB reported production during two years: 1997, with 389,000 kg, and 2002, with 97,000 kg.

For Canada, the CMY does not report any production for 1997–2007.

Secondary production of mercury from silver reprocessing activities from ancient tailings in Mexico during the period 1985–2007 was approximately 530 metric tons. In regard to primary production, official information reports Mexican production at 2,818 metric tons for the period 1984–1994 (see Table 2-5).

The MYB (Vol. III, international information) reports mercury secondary production in Mexico of 15 metric tons for each of the years during the period 1997–2005 (see: http://minerals.usgs.gov/minerals/pubs/commodity/mercury).

Mercury uses and consumption data

Official information generated by the mineral sectors of Canada and the US on mercury consumption or mercury uses do not cover all years. For the US, available data were found just for 1997–2000. For Canada, available data were found for the years 1998, 1999, 2001, 2002, 2003 and 2005. These data are presented in Table A-1, in the Apparent Supply column (considering consumption as part of supply). For years when no data on mercury use or consumption were available, the amounts were derived as apparent supply, which is calculated as secondary, by-product or primary production plus imports minus exports and consumption. Data for Mexico were calculated using the same formula. These data also were included in Table A-1. Theoretically, then, two different kinds of calculations can be done, as follows:

Calculation A:

Official information (when available) on mercury uses or consumption, and estimations of missing data as apparent supply (secondary, by-product or primary production plus imports minus exports).

Years 1997–2007	**Three countries**	**Production** (as by-product or secondary)	**Imports**	**Exports**	**Apparent supply** (including officially reported uses) (in kg)
Total		750,450	1,670,062	2,626,728	**-256,459**

Calculation B:

Uses the apparent supply formula for all years.

Years 1997–2007	**Three countries**	**Production:** (as by-product or secondary)	**Imports**	**Exports**	**Apparent supply** (in kg)
Total		750,450	1,670,062	2,626,728	**-206,216**

The difference between calculations A and B equals 50.24 metric tons. In both cases Apparent Supply is negative by more than two hundred metric tons. This can be interpreted as being due to the following:

- gaps of information related to production (mainly secondary and as by-product);
- gaps of information in or under-registry of mercury imports;
- reduction in mercury consumption in North America;
- North America being an important exporting region, with an average of 29 metric tons annually during 1997–2007, with the US the main exporter country (see Tables A-1 and A-2);
- North America having reduced its consumption, and increased its exports, resulting in the US having a negative apparent supply during 1999–2007, and Canada and Mexico having a negative apparent supply in 2007;
- over-estimation of exports; and/or
- the possibility that if export and import data are accurate, then an important amount of production has not been reported.

If global data from UNEP on mercury supply is considered for 2005, estimated at 2,670–4,140 kg (UNEP 2006, see also Table 4-1), the three North American countries exported 337.42 metric tons during this year, which represents approximately 10% of the global supply.

Annex 2: Descriptions of Information Sources Consulted

Some of the descriptions below have been taken almost verbatim from the sources cited.

Information sources consulted for Chapters 2, 3 and 4, and Annex 1

- ***Sistema de Información Arancelaria Vía Internet*** (SIAVI—Tariff Information System Via Internet). This database is located on the *Secretaría de Economía* (Secretariat of Economy) website; it provides national statistics on imports and exports. Data presented are mainly based on trade statistics, which are generated from information that every importer or exporter is required to report in order to obtain a permit to import or export and to pay duties or taxes. Information is compiled by the Bank of Mexico (*Banco de Mexico*) and covers imports and exports for the last five years. This database also gives names of importer and exporter companies when the number in a category does not exceed three.

  Information can be retrieved through the Harmonized System (HS) number or through a search for a word that is in the goods' name. SIAVI covers information for the last seven-year period, by month or by year. Information retrieved is displayed in US dollars and in the units of quantity in which goods are imported or exported, which in the case of mercury is kilograms. Also, information on the names of the importer and exporter companies can be obtained. The database is available online at: http://www.economia-snci.gob.mx.

  Historic information on periods of more than one year can be requested at the World Trade Atlas, online at: http://www.bancomext.com/Bancomext/index.jsp.

- ***Servicio Geológico Mexicano*** (SGM—Mexican Geological Service). The mandate of this agency is to generate and provide geological scientific knowledge for territorial planning and better and sustainable use of natural resources. It also provides scientific and technological support for economic and social development and planning, in regard to environmental care. A similar mandate was held by its predecessor, the Council of Mineral Resources (*Consejo de Recursos Minerales*—CRM), which in 2005 turned into the SGM.

  Among the significant number of information sources generated by both agencies (CRM and SGM) is the *Statistical Yearbook of Mexican Mining* (*Anuarios Estadísticos de la Minería Mexicana*). Published since 1968 to date, this yearly compendium contains statistical data on produced materials and minerals. According to the *Anuarios*, there has been no official virgin mercury mining reported in Mexico since 1994.

  Another important source of information is the Physical Inventories (of mineral) Resources by County (*Inventarios Físicos de los Recursos de Municipios*). These inventories report probable reserves of the mineral resources within the studied area, including mercury.

- ***Instituto Nacional de Estadistica y Geografia*** (INEGI—National Institute of Statistics and Geography). This is the official department that compiles, distils and processes national statistics on economic, social and geographic information. Also, this institute is in charge of conducting censuses, such as on population or on industry, among others. Online at: http://www.inegi.org.mx/inegi/default.aspx.

- **Cosmos Online**. This website provides yellow pages for various industrial sectors in Mexico, such as the chemicals industry, laboratories, food, and pharmaceuticals, among others. It contains more than 200,000 entries of registered products and suppliers and comprises information on 2,600 suppliers in the chemicals industry. Online at: http://www.cosmos.com.mx.

- **QuimiNet**. This website is an information service that covers a wide number of industrial sectors in Latin America, such as plastics, pharmaceuticals, food, paints, petrochemical, mining, and others. It also offers technical and scientific information on substances and processes. Online at: http://www.quiminet.com.

- **Caname** (*Camara Nacional de Manufacturas Electricas*—National Association of Electric Manufacturers). This organization represents 114 companies established in Mexico and dedicated to producing, importing and exporting, and supplying electric parts for the industrial and household sectors. A search (done by product) on switches and relays displays 23 companies. Online at: http://www.caname.org.mx.

- **Buscador Industrial**. This website is an important source of information for all industrial sectors. It is an important tool for localizing products and establishing contact with suppliers of parts for equipment, machinery and raw materials. Online at: http://www.rim.com.mx/buscador/.

Further information sources consulted for Chapter 4

- ***Fact Sheet* series of the Interstate Mercury Education & Reduction Clearinghouse** (IMERC). This important source of information provides descriptions of all kinds of mercury devices and instruments, their uses, and the way they are constructed; data on the mercury contained in products; and mercury-free alternatives. Online at: http://www.newmoa.org/prevention/mercury/projects/legacy/.

Further information sources consulted for Annex 1

- **Canadian International Merchandise Trade database**. This is accessible through the Statistics Canada website. Statistics Canada is a legislated and centralized agency that produces and provides national statistics on a wide number of economic, geographical and social subjects, like censuses, maps, tourism, etc.

  Imports/exports commodity data are available through the internationally comparable 6–8 digits of the Harmonized System (HS) of tariff classification, which is equivalent to the Harmonized Tariff Schedule (HTS) of the United States. Industry data are also accessible by using the Standard Industrial Classification (SIC) codes and the North American Industry Classification System (NAICS).

  A search for commodities in the Canadian International Merchandise Trade database can be performed by using the 6- to 8-digit HS numbers. Searches can be obtained by selecting and downloading commodity trade data in "txt," "dif," "cdf," "slk" or "html" formats. Retrieval costs can be paid by credit card. Online at: http://www.statcan.ca/trade/scripts/trade_search.cgi.

- **Industry Canada website**. The main limitation of this source of information is that it only provides economic data in quantities of money. Information in weight or in other kinds of quantitative units is not provided. The website is found at: http://www.ic.gc.ca/epic/site/tdo-dcd.nsf.

- ***Canadian Minerals Yearbook***. This information source has been published since 1944 by the Minerals and Metals Sector (MMS) of Natural Resources Canada. MMS undertakes a comprehensive review of developments in the minerals industry and publishes the results as the *Canadian Minerals Yearbook* (MYB). Available online at no cost at: http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/cmy-amc-eng.htm.

  In its Statistical Report section, the MYB reports imports/exports, and production of minerals (information on mercury is included for almost every year). In regard to secondary mercury production, the information in most cases is confidential. Also, the MYB includes a section with more-detailed profiles for a significant number of minerals, where information on use and production (primary or secondary) has been available for some years. As well, additional information on other mercury compounds is presented. Data in the MYB on imports/exports of mercury is the same, with only insignificant differences, as those obtained at the Canadian International Merchandise Trade database.

- **United States International Trade Commission** (USITC). The USITC Interactive Tariff and Trade Dataweb is an online database that provides public and free-of-charge information on US imports/exports statistics and US tariffs, along with other information on importers and exporters. The Dataweb responds to user-defined queries by integrating international trade statistics with complex tariff and customs treatment. International trade data are available for years 1989 to present, by month, quarter, year, or year-to-date, and can be retrieved in different types of classification systems, including the Harmonized Tariff Schedule (HTS), the Standard International Trade Classification (SITC), or the North American Industry Classification System (NAICS). Dataweb is found at: http://dataweb.usitc.gov/.

- **United States Geological Survey** (USGS). According to the review of the USGS Mineral Resources Program (MRP) by the National Research Council in 2003, there were four federal roles identified in mineral science and engineering: an unbiased national source of science and information, basic research on mineral resources, advisory, and international (undertaking or supporting international activities that are in the national interest).

  Among a significant number of information sources, the USGS produces the *Minerals Yearbook* (MYB), which is an annual publication that reviews the mineral and material industries of the US and foreign countries. The *Yearbook* contains statistical data on materials and minerals and includes information on economic and technical trends and development. It has chapters on approximately 90 commodities and over 175 countries in its Volume III, International Area Reports. The MYB also provides information on the status of the US mercury stockpiles. (Also available at the USGS website are the *Mineral Commodities Summaries*, a collection which presents complementary information on minerals, including mercury.)

  This yearly publication has been published since 1932. More information on the USGS and the *Minerals Yearbook* can be found online at:
  http://minerals.usgs.gov/minerals/pubs/myb.html.

- **United Nations Commodity Trade Statistics Database** (Comtrade). Comtrade is a database maintained by the United Nations Statistics Division (UNSD) that compiles and stores annual international trade statistics involving trade between over 160 partner countries, detailed by commodity and partner countries. Data are processed into a standard format with consistent coding and valuation. All values are converted into US dollars, using exchange rates supplied by the countries or derived from monthly market rates and volume of trade. Trade quantities (generally weight or number of items) are provided by the reporting country and, if possible, converted into metric units. For many countries the data coverage starts as far back as 1962 and goes up to the most recent completed year (UNEP 2006).

  Comprehensive statistics concerning the commercial trade of elemental mercury among UN member states are publicly available through Comtrade, which compiles detailed import and export statistics reported by Customs and other government authorities. More information available at: http://unstats.un.org/unsd/comtrade/.

- ***Summary of Supply, Trade and Demand Information on Mercury.*** One objective of this UNEP report was to analyze the comprehensive UN Comtrade data on the trade and transfers of mercury throughout the world, and to publish these data in such a manner as to enhance the international community's understanding of the flow of mercury through the global economy and society.

  Besides Comtrade data, the UNEP *Summary* draws on information from other reports and sources, such as: information submitted by governments; publicly available databases; and papers, reports and publications containing national trade data, etc. As available, peer-reviewed papers and reports have been used in support of this document. However, the number of papers on mercury supply, trade and demand that have appeared in scientific journals is rather limited in comparison to the number of papers addressing many other issues related to mercury (UNEP 2006).

  Among the information sources consulted by UNEP in the *Summary* is the Statistical Office of the European Communities (Eurostat), which is responsible for harmonizing European Community legislation in the field of statistics on the trading in goods and ensuring that the legislation is applied correctly. The statistics provided to Eurostat are therefore based on precise legal texts, directly applicable in the member states of the European Union. An important limitation of the Eurostat data is that they are concerned only with trade relating to European Union member states (UNEP 2006).

  Another important information source consulted by the UNEP *Summary* is the Trade Analysis and Information System (TrAInS), a database maintained by the United Nations Conference on Trade and Development (UNCTAD). TrAInS is a comprehensive computerized information system based on the HS (Harmonized System) of tariffs, covering tariff, para-tariff and non-tariff measures, as well as import flows by origin, for more than 140 countries. In addition, the Inter-American Development Bank, the secretariats of the Organization of American States (OAS), the Latin American Integration Association (Aladi), the Caribbean Community (Caricom), and the Central American Secretariat for Economic Integration (SIECA) have jointly signed a memorandum of understanding with UNCTAD for the establishment of a sub-system TrAInS for the Americas (UNEP 2006).

Annex 3: Estimation of Secondary mercury Production in the Zacatecas City Tailings Area

In a study on the chemical changes of mercury and its mass balance during the leaching process of tailings in one of the reprocessing plants in the Zacatecas area, Ogura *et al,* 2003, estimated that one metric ton of soil placed in the extraction pond freed 121 grams (g) of mercury, while 48 grams of mercury remained in the soil. Therefore, the recovery rate from the leaching process was 71.60%, yielding a total amount of mercury per metric ton of tailings of 169 parts per million (ppm).

Ogura *et al.* assumed the following:

The four facilities lixiviated 4,800,000 cubic meters (m^3) of the surface soil in the last 20 years; since it was observed that the processed soil had a density of 1.6 g per milliliter (g mL^{-1}), the result was 7,680,000 metric tons (t) of processed tailings.

Assuming that the mercury (Hg) content and the efficiency of lixiviation were the same as in the plant studied, 7,680,000 t × 121 g t^{-1} Hg (freed in the extraction ponds) = 929.28 t Hg extracted by the four facilities and 360.96 t Hg remaining in the abandoned soil.

After the leaching process, lixiviates go into another process called cementation, for recovering the mercury and silver as an amalgam, where Ogura *et al.* estimated a recovery efficiency percentage of 78% (0.78). Thus the four facilities produced 929.28 t × 0.78, which equals approximately 724.83 t of Hg. Over 20 years the result is a yearly average of 36.24 metric tons (derived from Ogura *et al.* 2003).

The estimation method of Ogura *et al.* seems reasonable in relation to the mercury content of the tailings around Zacatecas City, where studies by other researchers reflect a similar average Hg content in those tailings (152.86 ppm) to that of Ogura *et al.,* 168 ppm (see Table A-3).

In respect to the recovery rate of mercury from tailings from the leaching process, Nuñez-Monreal found a similar rate by analyzing tailings before and after leaching in another plant. There he calculated mercury concentrations of 88.1 ppm in non-processed tailings and 24.1 ppm in tailings after being processed, which represent an efficiency of 72.65% (Nuñez-Monreal 2002), closely correlated with the estimate of Ogura *et al.* of 71.60%.

Mercury levels in Zacatecas tailings depend also on the site from which they are obtained; some sites have more silver and mercury than others. Levels also depend on the analytical techniques used to obtain them (see Table A-3).

Table A-3 Analysis of mercury content in tailings around Zacatecas City area				
Author or laboratory	**Sampling place**	**Reported Hg values found before processing (ppm)**	**Reported Hg values found after processing (ppm)**	**Analytical method**
Ogura *et al*. 2003	nd	168	48.00	Cold Vapor Atomic Absorption (CVAA)
Environmental Management Unit Laboratory, National Autonomous University of Mexico (UNAM) 2004 *	La Purísima	198.35	nd	Cold Vapor Atomic Absorption Spectrophotometry (CVAAS) Method: Total Hg EPA SW 846: 7471A
	El Vivero	90.78	nd	
Flett Research Ltd., Winnipeg, Canada 2003 *	La Purísima	290.00	nd	Cold Vapor Atomic Absorption Spectrophotometry Method: Total Hg EPA SW 846: 7471A
	El Vivero	110.00	nd	
Nuñez-Monreal, Academic Unit of Chemical Sciences, Autonomous University of Zacatecas	Tailings from one of the recycling plants	88.10	24.10	nd
	Superficial soil in other of the recycling plants	123.80	11.30	
Average Hg content, PPM (grams per metric ton)		**152.86**		

***** *Comparative analysis for agricultural soils polluted with arsenic, lead and mercury, in Mexico. Presented at the Division of Environmental Chemistry American Chemical Society, Anaheim, CA, 28 March–1 April 2004.*
nd: Not determined.

The estimate by Ogura *et al.* of 36.24 metric tons of secondary mercury produced annually during the twenty past years represents a good starting point. However, the amount may be a slight overestimate, considering that:

- Besides mercury losses that occur during the leaching process and the cementation process (which amalgamates silver and mercury), loss also occurs during a third process to separate silver and mercury by sending this amalgam-containing sludge into a retort in order to distil mercury and separate the silver, resulting in around 10% of the mercury being released to air. Therefore, an estimate of 80 to 85 grams of secondary mercury produced from each metric ton of tailings would be more realistic.

- Ogura *et al.* supposed that the four facilities had been working full-time for all these 20 years, but in fact this was not the case. Some facilities closed temporarily or definitively during this time, due to rainy seasons that made working conditions difficult, low silver prices during some periods, or audits by the environmental authority. In fact, in their quoted work, Ogura *et al.* mention that one of the plants (Mercurio del Bordo) closed in 2000, yet this fact is not considered in their calculations.

- Ogura *et al.* credited each facility with five extraction ponds; however, other information shows that a least one facility has seven extraction ponds.

These 36.24 metric tons for secondary production can be complemented and compared by considering other available information related to secondary mercury production, generated by other official sources (see Table 2-4 in Chapter 4).

Bibliography

Acosta y Asociados. 2001. *Preliminary Atmospheric Emissions Inventory of Mercury in Mexico. Final Report.* Prepared for: Commission for Environmental Cooperation.

Barenco Inc. 2002. *Feasibility Study to Explore Potential Environmental Contamination in the Vicinity of Mining Operations—Zacatecas, Mexico.* Study prepared for CEC. Montreal, Canada.

Beevers, D. Garreth; Gregory Y. H. Lip, and Eoin O'Brien. 2007. *ABCs of Hypertension, 5th Ed*. Blackwell Publishing.

Brooks, N. 1999. *La Situación del mercurio en México y opciones para la gestión ambiental de desechos.* Instituto Nacional de Ecología.

Cenavece (Centro Nacional de Vigilancia Epidemiológica y Control de Enfermedades). 2006. *Informe de rendición de cuentas de la Administración 2000–2006.* Secretaría de la Función Pública (SFP) http://www.cenave.gob.mx/archivos/informe.htm.

CEC (Commission for Environmental Cooperation).1998a. Evaluación de la exposición a mercurio en una comunidad de Zacatecas, México. CEC Contrato 98.03.01 SMOC.

CEC. 1998b. *Summary Report, Mercury Assessment Workshop, Zacatecas, Mexico, 25–27 February 1998*. Montreal, Quebec: CEC.

CEC. 2000a. *North American Regional Action Plan on Mercury, Phase II*. Montreal, Quebec: CEC.

CEC. 2000b. *Status of Mercury in Mexico.* Montreal, Quebec: CEC.

Comisión de Fomento Minero. 1968. *Sumarios Estadísticos de la Minería Mexicana.* Mercurio.

EPA (US Environmental Protection Agency). 2005. *Mercury Market Background Repor*t. May 2005.

EPA. 2007 a. *Background Paper for Stakeholder Panel to Address Options for Managing U.S. Non-Federal Supplies of Commodity-Grade Mercury*. 14 March 2007.

EPA. 2007 b. *Mercury Storage Cost Estimates, final report*. 6 November 2007. Office of Pollution Prevention and Toxics and Office of Solid Waste and Emergency Response.

EPA. 2008. Draft EPA Mercury-Containing Products and Alternatives (mercury-free) Products Database. Office of Pollution Prevention and Toxics, 2008.

Gobierno del Estado de Zacatecas. 2002. *Plan de Acción de la Presa la Zacatecana para la Contención de Metales Pesados*. Municipio de Guadalupe, Zacatecas. Ciudad de Zacatecas.

Hogue, Cheryl. 2008. *Chemical and Engineering News*. October 6, Vol. 86, Number 40, p. 11.

Hylander, Lars. 2001. Letter to European Environmental Commissioner, Margot Wallström, from Centre for Metal Biology and Evolutionary Biology Centre, Uppsala University. 20 June 2001.

INEGI. 1999. *Anuarios Estadísticos de la Minería Mexicana 1998*. 1999 update. Consejo de Recursos Minerales, and Banco Nacional de Comercio Exterior, SNC.

INEGI. 2004. *2004 Industrial Census*.

Kilborn Engineering Pacific Ltd. 1994. *Proyecto Jales de la Laguna Zacatecana*. Project No 8648-17, Reporte de la Propiedad. Pan American Minerals Corp. November 1994.

Lang, Mervin F. 1977. *El Monopolio Estatal del Mercurio en el México Colonial (1550–1710)*. México. Fondo de Cultura Económica.

LCSP (Lowell Center for Sustainable Production). 2003. *An Investigation of Alternatives to Mercury-Containing Products.* Prepared for the Maine Department of Environmental Protection. University of Massachusetts: Lowell. Available at: http://www.maine.gov/dep/mercury/lcspfinal.pdf.

Maxson, Peter. 2006. Taking Stock: Mercury Supply, Demand and Trade. International Mercury Conference: How to Reduce Mercury Supply and Demand. Brussels, 26–27 October 2006. http://ec.europa.eu/environment/chemicals/mercury/pdf/conf/maxson.pdf.

Metal Bulletin. 2004a. Spanish Mercury Producer Restarts But Tightness Remains. London, 28 January 2004.

Metal Bulletin. 2004b. Mercury Rises to Almost $500 per Flask on Tight Supply. London, 1 September 2004.

Minco. 2006. Description of the Laguna Zacatecana Silver Tailings Project, available at: http://www.mincoplc.com/newsReleases/2006/lagunaSilverProjectUpdate010206.pdf

NEWMOA/IMERC (Northeast Waste Management Officials' Association/Interstate Mercury Education and Reduction Clearinghouse). 2008. *Trends in Mercury Use in Products: Summary of the Interstate Mercury Education & Reduction Clearinghouse (IMERC) Mercury-added Products Database*. June 2008. Available at:
http://www.newmoa.org/prevention/mercury/imerc/pubs/reports.cfm.

Nuñez-Monreal, J E. 2002. Metales pesados en la Zacatecana. *In* Gobierno del Estado de Zacatecas. 2002. Plan de acción de la Presa la Zacatecana para la contención de metales pesados; Municipio de Guadalupe, Zacatecas. Ciudad de Zacatecas, p. 36–41.

Ogura, Tetsuya; Ramirez-Ortiz, Jorge; *et al*. 2003. Zacatecas (Mexico) companies extract Hg from surface soil contaminated by ancient mining industries. *Water, Air, and Soil Pollution* 148: 167–177.

Pan American Silver Corp. 1995. Overview of the Zacatecana Project. Zacatecas. Plata Panamericana.

Perales-Rivas, FJ. No date. Información sobre el mercurio de la Zacatecana. Servicios de Salud de Zacatecas.

Profepa. 1996. Official communication from Mr. Jorge D. Rodriguera to Dra Cristina Cortinas, National Institute of Ecology. 6 August 1996.

QuimiNet. 2007. http://www.quiminet.com.

Servicio Geológico Mexicano (SGM). 2006. *Panorama minero del Estado de Querétaro*. December 2006.

Servicio Geológico Mexicano. 2007a. Inventario físico de los recursos del Municipio Peña Miler, Qurétaro. September 2007. Fideicomiso de Fomento Minero. México.

Servicio Geológico Mexicano. 2007b. Inventario físico de los recursos del Municipio Pinal de Amoles, Qurétaro. September 2007. Fedeicomiso de Fomento Minero. México.

UNEP (United Nations Environment Programme). 2002. Chemicals. Global Mercury Assessment. Geneva.

UNEP (United Nations Environment Programme). 2005. Chemicals. Toolkit for the Identification and Quantification of Mercury Releases. Geneva.

UNEP (United Nations Environment Programme). 2006. Chemicals. Summary of supply, trade and demand information on mercury. Geneva.

WRPPN Dental P2 Project. 2005. Dental amalgam use. Online at: http://www.wrppn.org/dental/pages/pdf/Amalgam_Use%2001.pdf.