



2011 Minerals Yearbook

MERCURY

MERCURY

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In 2011, no mines produced mercury as a principal product in the United States. The last domestic mine to produce mercury as its principal product, the McDermitt Mine in northern Nevada, closed in 1992. However, in 2011, mercury was produced as a byproduct of domestic gold-silver processing, mainly in Nevada, and may have been produced as a byproduct of processing other metals. Imported byproduct mercury was processed domestically, and the mercury was resold. Mercury was also produced from reclamation of mercury contained in fluorescent and compact fluorescent (CFL) lamps and a declining supply of mercury-containing automobile convenience switches, batteries, dental amalgam, electronic waste, medical devices, and thermostats. The chlorine-caustic soda industry was the leading domestic user of mercury for its mercury-cell plants, and some of that mercury was recycled in-plant. Data on domestic byproduct and recycled mercury production were not available.

Since 1927, the common unit for measuring and pricing mercury has been the “flask,” which was set to conform to the historical measuring system used at Almaden, Spain (Myers, 1951). One flask of mercury weighs 34.5 kilograms (kg), and 1 metric ton (t) of mercury contains approximately 29 flasks. The flask itself is a screw-top, welded-steel container that is approximately the size of a 2-liter bottle.

Legislation and Government Programs

In January, the U.S. Environmental Protection Agency (EPA) proposed regulatory changes to allow the use of nonmercury thermometers in petroleum refining, power generation, and testing for vehicle emissions. The National Institute of Standards and Technology (NIST), in collaboration with the EPA, announced on February 2, 2011, that it will no longer calibrate mercury-in-glass thermometers beginning on March 1, 2011 (U.S. Environmental Protection Agency, 2011d). In January 2012, the EPA issued a final rule to provide flexibility to the use of alternatives to mercury-containing thermometers in petroleum refining, power generation, and polychlorinated biphenyl (PCB) waste disposal, and the final rule will become effective on March 19, 2012 (U.S. Environmental Protection Agency, 2012).

In March, the EPA proposed the first-ever national standards for mercury, arsenic, and other toxic air pollutants from coal-fired powerplants; these standards represent one of the strongest health protections from air pollution since passage of the Clean Air Act in 1970. These standards would require powerplants to install widely available, proven pollution control technology. The proposed standards provide up to 4 years for facilities to meet the standards, and once fully implemented, would prevent 90% of the mercury in the coal from being released into the air. Additionally, these standards were expected to provide numerous health benefits as well as short- and long-

term construction and industry-related jobs (U.S. Environmental Protection Agency, 2011b).

Also in March, the EPA proposed amendments to the national emission standards for mercury releases from mercury cell chlorine-caustic soda plants. The first option required the elimination of mercury emissions and conversion to nonmercury technology, and the second option required improvements that would result in near-zero mercury emissions while still allowing the mercury cell to operate (U.S. Environmental Protection Agency, 2011c).

In December, the EPA proposed changes to the Clean Air Act Standards that would achieve extensive public health protection through reduction in toxic air pollutants, especially mercury, from boilers and incinerators. The proposed changes cut the cost of implementation and these new standards meet the requirements of the 1990 Clean Air Act Amendments (U.S. Environmental Protection Agency, 2011a).

In July 2009, the U.S. Food and Drug Administration (FDA) had classified mercury-containing dental amalgam as a moderate human health risk. However, in response to consumer petitions and letters, the FDA and an advisory panel decided to review the existing scientific evidence that resulted in the FDA’s earlier pronouncement that dental fillings containing mercury do not cause harm to patients. The review was scheduled for completion in early 2011 (Zajac, 2010); however, by the end of 2011, there had been no announcement.

A reconnaissance study by the U.S. Geological Survey (USGS) to determine mercury concentrations in fish from Whiskeytown Lake, Shasta County, CA, indicated that mercury concentrations in 17% of legal-catch-sized fish were above the human health baseline of 0.30 microgram per gram ($\mu\text{g/g}$) wet weight. These data will serve as a baseline for future studies (May and others, 2011, p. 1).

USGS research in the Great Lakes region indicated that mercury in annual tree litterfall from deciduous forests was equal to or exceeded the amounts of mercury deposited by annual precipitation. The airborne mercury was released from coal-fired powerplants, industrial boilers, cement manufacturing, and incinerators, and the mercury will eventually end up in fish and food webs (U.S. Geological Survey, 2011a).

USGS research showed that atmospheric deposition of mercury was about four times higher in lakes near several major U.S. cities compared with lakes in remote areas. This was the first study to quantify the relation between mercury fallout and distance from major urban centers—the study included lakes nearby and remote from Albany, NY, Boston, MA, Chicago, IL, Denver, CO, Minneapolis, MN, New Haven, CT, Portland, OR, Salt Lake City, UT, Tampa and Orlando, FL, and Montreal, Quebec, Canada. Coal-fired powerplants were the primary source of the mercury emissions, and these emissions traveled in the atmosphere (U.S. Geological Survey, 2011b).

Five contractors agreed to pay back part of the more than \$7 million in costs incurred by the EPA for removal of mercury-contaminated soil at the Port Refinery Superfund Site at Rye Brook, NY. More than 20 years ago, police responded to a complaint that a Rye Brook resident was illegally storing mercury; then, after significant contamination levels were measured, structures at the site were demolished and remediation was begun. At that time, clean-up costs were estimated to be \$4 million. There are five remaining defendants as well as more than 20 other responsible parties (Henry, 2011).

The National Defense Stockpile (NDS) held an inventory of 4,436 t of mercury at several sites in the United States. Mercury sales from the NDS were suspended in 1994 in response to environmental concerns. Following the completion of an environmental impact statement, the Defense Logistics Agency, DLA Strategic Materials selected Hawthorne Army Depot, Hawthorne, NV, for consolidated mercury storage. Hawthorne is a government-owned, contractor-operated facility, controlled by the U.S. Army Joint Munitions Command. In July 2010, the Nevada Division of Environmental Protection approved the transfer of the elemental mercury to the Hawthorne site. Shipments of mercury began in August 2010 and were completed in March 2011 (Defense Logistics Agency, Strategic Materials, 2011). The DOE has 1,329 t of mercury in storage facilities in Oak Ridge, TN.

Production

In 2011, byproduct mercury was produced at several precious metals mines in Nevada. Bethlehem Apparatus Co. Inc. (Bethlehem, PA) processed and refined mercury for resale. Data on the amount of byproduct mercury produced in the United States were not available. Mercury has not been mined as a principal product in the United States since 1992, when the McDermitt Mine, NV, closed.

Consumption

In 2011, the domestic consumption of mercury declined to less than 50 t (Bruce Lawrence, President, Bethlehem Apparatus, Inc., oral commun., December 6, 2011). In the past, domestic mercury consumption was broadly estimated to be about 50% for chlorine-caustic soda manufacture and 50% for other uses (Brooks and Matos, 2005, p. 3); however, closure of several chlorine-caustic soda plants may have shifted those estimates, and exact quantities are not available.

Global human health and environmental concerns about mercury have caused a decline in mercury purchases by the chlorine-caustic soda industry as well as an overall market shift in the chlorine-caustic soda industry from mercury cell technology toward nonmercury chlorine-caustic soda production technology. Since 1995, total annual mercury used by the industry has been reduced by 97%. In 1996, there were 14 operating mercury cell plants in the United States; however, at yearend 2011 only 4 mercury-cell facilities were in operation in the United States. In 2010, Olin Corp. (Augusta, GA) announced that its mercury cell chlorine-caustic soda plants in Augusta, GA, and in Charleston, TN, would close within 2 years. These are two of the four domestic plants still in operation that use

mercury to make chlorine (Wermers, 2010). Olin's mercury cell plant in Charleston, TN, will convert to membrane technology by the end of 2012 and its mercury cell plant in Augusta, GA, will be closed by yearend 2012 (de Guzman, 2011). The other mercury cell plants are in Ohio and West Virginia. As mercury-cell plants close around the world, that mercury, as well as mercury from remediation of the plant facilities and soil, will become available for recycling and sale.

Recycling

Mercury was reclaimed from end-of-service automobile convenience switches, CFLs, dental amalgam, fluorescent lamps, laboratory and medical devices, mercury contaminated waste, and thermostats in 2011. The voluntary National Vehicle Mercury Switch Recovery Program (NVMSRP) was started in 2006 by the EPA to stop toxic emissions of mercury when cars are scrapped and then melted to make new steel. Funding for the program was depleted in July 2009; however, payments will continue in States where they are required by law or that have a State-funded program. The goal of the NVMSRP is to collect 80% to 90% of the mercury switches by 2017 (U.S. Environmental Protection Agency, undated).

The Energy Independence and Security Act of 2007 (Public Law 110–140) included a ban on the sale of incandescent bulbs by 2014 and added CFLs, which may contain 3 to 5 milligrams of mercury, to the list of recyclable products. Beginning in 2012, the Federal Government had planned to ban incandescent light bulbs, instead requiring that more energy-efficient CFLs be manufactured and sold. However, funding for enforcing the ban was eliminated, thereby creating a delay in enforcement and regulatory uncertainty (ABC News Inc., 2011).

Byproduct mercury from domestic and foreign sources and mercury reclaimed from end-of-service products were processed, or recycled, in the United States and then sold into the international metals market. No data were available on the amount of mercury processed from domestic sources, such as precious-metals processing, nor end-of-service products.

In 2011, the major companies that recycled mercury included AERC.com, Inc., Allentown, PA; Bethlehem Apparatus Co., Inc., Bethlehem, PA; Clean Harbors Environmental Services, Inc., Braintree, MA; D.F. Goldsmith Chemical and Metal Corp., Evanston, IL; Onyx Environmental Services, Lombard, IL; and WM Mercury Waste, Inc., Union Grove, WI. Benivia LLC (Atlanta, GA) maintained a list of companies whose role was mainly collection of mercury-containing materials that would ultimately be moved on to the larger companies for reclamation of the mercury (Benivia LLC, undated).

In 2011, Thermostat Recycling Corp. (TRC) (Rosslyn, VA) announced that it had collected 1.4 million thermostats that contained 6.6 t of mercury. Individual thermostats may contain 2.5 to 10 grams of mercury (Thermostat Recycling Corp., 2011).

In the United States, from 1997 to 2007, it was estimated that more than 500 million computers became obsolete and only 20% was collected and the metals recycled. As much as 180 t of mercury may be contained in the “e-waste” resulting from discarded and obsolete computers (Zhang, 2011).

Prices

The average domestic price of mercury was \$1,850 per flask in 2011. The mercury price quoted in Platts Metals Week began the year at \$1,950 per flask in January, saw minor fluctuations throughout the year, and ended at \$1,950 in December. Demand for mercury remained strong in the global market, particularly from small-scale gold mining regions such as Africa, Asia, the Far East, and South America. Mercury refining capacity in Europe was restricted owing to the EU export ban that took place in Europe, and some prices were close to \$3,500 per flask for the limited quantities that were available (Mining Journal, 2011).

The increase in the average price of gold for 2011, to approximately \$1,570 per troy ounce, resulted in an increase in the global demand for mercury destined for use in small-scale gold mining. For comparison, in 2000–03, the average price of gold was \$310 per troy ounce and the average price of mercury was \$140 per flask. The mercury price was also affected by a diminished supply of mercury from recycled mercury-containing products, fluctuations in imports of byproduct mercury, and fluctuations in production of domestic byproduct mercury.

Foreign Trade

In 2011, mercury imports totaled 110 t and exports totaled 132 t. Chile (90 t) and Ukraine (8 t) were the leading sources of imported mercury, which was produced as a byproduct of large-scale precious metals mining and an unknown source, respectively. Canada (96 t), Guyana (22 t), and Australia (10 t) were the principal export destinations for mercury in 2011. Mercury imports in 2011 were 63% less than those in 2010. Imports of mercury may vary from year to year, possibly owing to stockpiling of byproduct mercury produced at foreign precious metals smelters before shipment, or availability of mercury owing to closure of chlorine-caustic soda plants, or, more recently, shipment of mercury to non-U.S. destinations.

In 2011, a total of 34 t of amalgam was imported into the United States. Amalgam is defined as mercury with one or more metals and may include mercury-containing chlorine-caustic soda waste. Principal amalgam source countries were Germany (23 t), the United Kingdom (4 t), and Mexico (3 t). A total of 128 t of amalgam was exported from the United States, and principal destinations were Canada (29 t), Japan (19 t), and Austria (18 t).

World Review

In 2011, world mercury mine production was estimated to be 2,000 t. China (1,500 t) and Kyrgyzstan (250 t) were the world's leading producers of mercury while Chile (100 t) and Peru (35 t) were the leading producers of byproduct mercury. World production estimates have a high degree of uncertainty because most companies and countries may not report primary, byproduct, or secondary production data owing to environmental and health concerns. Quantities may appear erratic from year to year because of stockpiling of sufficient mercury for shipment.

European Union.—The European Union (EU) Regulation EC 1102/2008 became effective on March 15 and banned the export of mercury and imposed a storage obligation on mercury. The regulation makes it possible to permanently store mercury in underground salt mines or hard rock formations with the same level of safety. Euro Chlor (Brussels, Belgium), representing the European chlorine-caustic soda industry, indicated that it is important to have criteria for permanent storage of end-of-life mercury under the Landfill Directive (1999/31/EC) and continues to look into other permanent disposal solutions, including stabilizing mercury with sulfur. Euro Chlor continues to implement a voluntary agreement on phasing out mercury cell technology by 2020 (Euro Chlor, undated).

The number of plants and the mercury cell-based production capacity continued to decrease worldwide—the number of mercury cell plants decreased to 57 from 91 from 2002 to 2010, and the mercury cell-based chlorine production capacity decreased from 9.1 million metric tons (Mt) to 5.5 Mt during the same time period (Euro Chlor, 2011).

Chile.—In 2011, Chile exported 90 t of byproduct mercury to the United States, a decrease from 176 t in 2010. The mercury was produced as a byproduct from Chile's copper-gold mines.

China.—In 2011, China was the world's leading producer of mercury. Production decreased to 1,500 t in 2011 from 1,600 t in 2010 in accordance with a plan released by the China Nonferrous Metals Industry Association that indicated that China would restrain production of 10 nonferrous metals, including mercury, to less than 41 Mt by 2015 (Metal-Pages, 2010).

Colombia.—Colombia was one of the world's leading users of mercury for small-scale gold (silver-platinum) mining. Approximately 150 t of mercury may be released to the environment from small-scale gold mining in Antioquia, Colombia. From 15,000 to 30,000 small-scale gold miners in Antioquia alone produce 26 t of gold, or 63% of Colombia's total gold production of 41.5 t of gold by using mercury to recover the gold from alluvial sources (Viega, 2010).

Peru.—In 2011, only 1 t of byproduct mercury, compared with 102 t in 2010, from Peru's large-scale gold-silver mines was shipped to the United States. The mining companies that produced byproduct mercury voluntarily sent their mercury to Germany for stabilization with sulfur, as artificial cinnabar, and storage in salt mines so as not to participate in, or contribute to the use of mercury for small-scale gold mining in Peru and elsewhere (DELA GmbH, 2011).

Philippines.—In 2008, the Government of the Philippines announced the shift from incandescent bulbs to energy-efficient CFLs by January 2010, the first country in Asia to do so. In 2011, through a grant with the Asian Development Bank, the Philippine Government began the Philippine Energy Efficient Project (PEEP), which included retrofitting 40 government office buildings with efficient lighting and procuring 13 million CFLs for distribution in order to reduce peak power demand. Studies indicated that US\$90 million would be saved through the use of CFLs. However, end-of-life CFLs are thrown into municipal waste, which is then hauled to a garbage transfer station in Manila, and informal recyclers forage through the waste to find the CFLs in order to salvage the glass and

end-caps. This releases mercury into the immediate surroundings and exposes the recyclers, their families, and community to mercury emissions (United Nations Environmental Programme, 2011).

Outlook

Global mercury use continued to decline with the exception of mercury used in the CFL industry and in small-scale gold mining. If gold prices continue to rise, these increased prices are likely to cause increased demand for mercury in the small-scale gold mining industry. Rising gold prices may also result in increased artisanal mercury production, reopening of abandoned mercury mines to provide mercury for small-scale gold mining, and increased recycling of mercury-containing tailings. The increase in gold prices may also stimulate gold exploration, resulting in the opening of new large-scale mines, which, in turn, would result in continued byproduct mercury production from processing of precious metals ores. Worldwide mercury prices have risen, in part, because of the 2011 European Union mercury ban and the upcoming ban on mercury exports from the United States in 2013.

Gallium alloys may provide nontoxic substitutes for mercury in a wide variety of applications that include electrical switches, liquid mirror telescopes, pumps, and sensors. Gallium can be alloyed with a variety of metals that include silver, gold, lead, cesium, and tin. Specifically, galinstan, an alloy of gallium, indium, and tin, is liquid at room temperatures and, owing to the low toxicity of its component metals, is a replacement for mercury. Owing to its higher reflectivity and lower density than mercury, galinstan is being considered as a replacement for mercury in liquid mirror telescopes for astronomy. Mercury-containing dental amalgam, which is less aesthetically pleasing, has declined in use, replaced by ceramic material with a more natural appearance. Closure of mercury cell chlorine-caustic soda production facilities worldwide, owing to pressure from international environmental and health organizations, was expected to result in release of large quantities of mercury for disposal, recycling, or storage.

Recycled mercury from mercury cell chlorine-caustic soda plants, byproduct mercury recovered from domestic and foreign precious metals operations, and mercury contained in the NDS are expected to be more than adequate to meet domestic needs.

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TABLE 1
SALIENT MERCURY STATISTICS¹

(Metric tons unless otherwise specified)

	2007	2008	2009	2010	2011	
United States:						
Secondary production, industrial	NA	NA	NA	NA	NA	
Imports for consumption	67	155	206	294	110	
Exports	84	732	753	459	132	
Industry stocks, yearend: ²	18	24	30	NA	NA	
Chloralkali	16	20	27	NA	NA	
Other	2	4	3	NA	NA	
Industrial consumption	31	NA	NA	NA	NA	
Price, average, free market ³	dollars per flask	530	600	610	1,076	1,850
World, mine production	1,200	1,820	1,960	2,250	2,010 ^c	

^cEstimated. NA Not available.

¹Data are rounded to no more than three significant digits, except prices.

²Stocks at consumer and dealers only.

³Source: Platts Metals Week.

TABLE 2
U.S. IMPORTS AND EXPORTS OF MERCURY, BY COUNTRY¹

Country	2010		2011	
	Quantity, gross weight (metric tons)	Value (thousands)	Quantity, gross weight (metric tons)	Value (thousands)
Imports:				
Canada	4	\$17	7	\$34
Chile	176	389	90	224
Germany	11	779	3	183
Peru	102	102	1	8
Ukraine	--	--	8	306
Other	1	4	(2)	22
Total	294	1,290	110	777
Exports:				
Australia	31	515	10	195
Canada	3	36	96	1,050
Guyana	16	326	22	687
India	14	229	--	--
Netherlands	295	4,080	(2)	7
Peru	38	818	--	--
Vietnam	36	615	2	81
Other	24 ^r	207 ^r	2	30
Total	459	6,830	132	2,050

^rRevised. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 3
U.S. IMPORTS AND EXPORTS OF AMALGAMS¹ OF PRECIOUS METALS,
WHETHER OR NOT CHEMICALLY DEFINED, BY COUNTRY²

Country	2010		2011	
	Quantity, gross weight (metric tons)	Value (thousands)	Quantity, gross weight (metric tons)	Value (thousands)
Imports:				
Argentina	2	\$23,100	1	\$17,600
Bolivia	9	14,400	--	--
Germany	4	7,110 ^r	23	10,100
Mexico	2	4,810 ^r	3	4,790
United Kingdom	4	13,600 ^r	4	10,500
Other	3 ^r	6,690 ^r	3	24,300
Total	23	69,800 ^r	34	67,300
Exports:				
Austria	--	--	18	51
Canada	32	7,700	29	11,100
China	12	39,200	1	10,400
Denmark	21	69	--	--
France	1	8,890	1	10,600
Germany	18	14,800	4	2,470
Hong Kong	3	495	(3)	472
India	13	54,600	12	61,500
Japan	2	3,120	19	3,680
Korea, Republic of	2	14,300	2	26,400
Mexico	19	4,170	12	56,900
Netherlands	13	8,260	13	32,700
Peru	29	120	(3)	160
Singapore	4	7,240	1	1,820
Taiwan	7	17,700	4	52,800
Thailand	7	60,600	4	39,300
United Kingdom	5	9,440	4	10,400
Other	15	22,800	4	20,100
Total	203	274,000	128	341,000

^rRevised. -- Zero.

¹An alloy of mercury with one or more other metals.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 4
MERCURY: WORLD MINE PRODUCTION, BY COUNTRY^{1,2,3}

(Metric tons)

Country	2007	2008	2009	2010	2011 ^e
Chile ⁴	NA	NA	88	176	100
China ^c	800	1,300	1,400	1,600	1,500
Finland	20	20	15	15	15
Kyrgyzstan ^c	250	250	250	250	250
Mexico ^c	8	21	21	21	21
Morocco ^c	10	10	10	10	8
Peru, exports ⁴	34 ^e	136	92	102	35
Russia ^c	50	50	50	50	50
Spain	NA	NA	NA	NA	NA
Tajikistan ^c	30	30	30	30	30
United States ⁴	NA	NA	NA	NA	NA
Total	1,200	1,820	1,960	2,250	2,010

^eEstimated. NA Not available.

¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through April 20, 2011.

³Canada is thought to produce byproduct mercury, but information on its production is inadequate to make reliable estimates.

⁴Byproduct mercury.