



Northeast States Succeed in Reducing Mercury and Continue to Address Ongoing Challenges

Prepared by Northeast Waste Management Officials' Association (NEWMOA) Staff with Assistance from the NEWMOA Mercury Workgroup & Interstate Mercury Education and Reduction Clearinghouse Committees

Since 2000, states in the Northeast have enacted major legislation to address mercury use in products and ultimately in solid and hazardous waste. This legislation includes bans and phase-outs on the sale of certain products, requirements for product labeling, and requirements for manufacturers to report on their use of mercury in products that are sold in the region. These laws affect a wide variety of products, including mercury thermometers, thermostats, switches and relays and products that contain these components, various measuring devices, linear and compact fluorescent bulbs, button batteries, and others.

In addition to these requirements, state environmental agencies have initiated mandatory and voluntary programs for collecting certain mercury-containing products at their end-of-life. Mercury-added products that have been targeted for collection and recycling include convenience light switches in cars; linear and compact fluorescent bulbs; fever thermometers; thermostats; dental amalgam in wastewater; and various measuring devices, such as dairy manometers and sphygmomanometers (i.e., blood pressure cuffs). Finally, state programs have also focused on eliminating or reducing the use of mercury and mercury-added products by various types of facilities, such as schools and hospitals, and removing the existing inventory of these products at those locations.

This paper presents a brief quantitative summary of the mercury reduced from the waste or wastewater stream as a result of these key initiatives in the Northeast, where data are available. Overall, the state programs collected and recycled approximately 7.5 tons of mercury through product collection and recycling

initiatives in the region from 2000 to 2006. The states' best estimate of the mercury that has been eliminated through restrictions on product sales in the region from 2000 to 2006 is approximately 14 tons. This is the first attempt by the states in the region to quantify the overall results of their regulations and programs, and this paper outlines the methods NEWMOA used to estimate these reductions and describes some of the associated uncertainties.

The reduction estimates presented here are conservative because, while state and local governments have initiated a number of programs to reduce and collect mercury, they have not been able to fully quantify the associated reductions in mercury from all of those efforts. Furthermore, the estimates of the impacts of the state phase-out requirements and product bans are conservative because the estimates are based on information from manufacturers of the products, and the states continue to find additional products that must be phased out and to identify product manufacturers that have not been reporting their mercury use as required by state laws. Also, if a company reported that it was at some point in the middle of a year that it stopped selling its product or eliminated the use of mercury in its products, NEWMOA used a conservative approach in estimating the reduction for that year.¹

Overview of Major Sources of Mercury in Waste

A recent report, titled *Mercury in Products in Massachusetts: Summary and Analysis of the Mercury-added Products Database, June 2006*, (available at

1. For example, if a company reported that it eliminated mercury use in products it was selling in the region as of June 2004, NEWMOA estimated the reductions associated with that change starting in 2005, rather than trying to make estimates or reductions for partial years.

<http://www.newmoa.org/prevention/mercury/imerc/FactSheets/index.cfm>) summarizes the major types of mercury-added products that are currently sold in the Northeast, and, hence, potentially enter the waste stream. The report identifies the following types of mercury-added products as the major categories sold in the United States as of 2001:

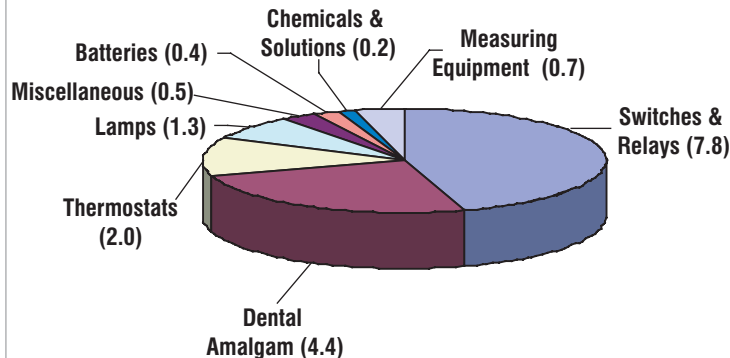
- switches and relays and the products that contain these components
- dental amalgam capsules
- thermostats
- lamps (i.e., fluorescent, high intensity discharge, mercury short arc, compact fluorescent, ultraviolet, mercury capillary)
- batteries (e.g., button cell and mercuric oxide)
- sphygmomanometers (blood pressure cuffs), manometers, barometers, psychrometers, and other measuring equipment
- fever, laboratory, and industrial thermometers
- chemicals and solutions (e.g., preservatives, mercury compounds, and elemental mercury)

Manufacturers or their representatives submit information on these products to the states through the Interstate Mercury Education Reduction Clearinghouse (IMERC)² in compliance with laws in the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. In 2001, a few of these states began requiring companies that manufacture, distribute, or import mercury-added products to report certain information on these products. A searchable database of the product information submitted by the manufacturers since 2001 is available at <http://www.newmoa.org/prevention/mercury/imerc/notification/>.

According to the June 2006 Massachusetts report, a total of 122 tons of mercury were sold in the above products in the United States in 2001 by original equipment manufacturers.³ The largest total amounts of mercury were sold in switches and relays and dental amalgam capsules. These product categories accounted for 70 percent of the total amount of mercury that was sold in products in the U.S. in 2001, or approximately 86 tons. Switches and relays are components in a wide

FIGURE 1

Mercury (tons) in Products Sold in the Northeast in 2001



Using a simple, population-based method⁴, the estimated amount of mercury sold in products in the Northeast in 2001 was approximately 17.3 tons. Figure 1 presents a breakdown by product category of the total estimated amount of mercury sold in the eight NEWMOA-member states.

variety of larger products, including but not limited to electric and gas meters; motor vehicles; commercial and residential electric and gas ranges; boilers; heating, ventilation, and air conditioning (HVAC) equipment; pumps; hospital beds; circuit boards; manufacturing equipment; and fire control units.

Figure 1 presents a summary of the available data from manufacturers and distributors for mercury use in products sold in the Northeast in 2001 only. As such, the information provides a snapshot in time of the amount and distribution of mercury sold recently in products in the U.S. and in the Northeast. This presentation does not provide information on mercury-added products that were sold prior to 2001 that are still in use or in storage and can potentially enter the waste stream. Historical uses of mercury in products include use in old barometers, various antiques, numerous types of industrial equipment that contain mercury switches and relays, convenience light switches in many models of cars sold before 2003, alkaline batteries (made before 1999), old models of freezers that contained mercury light switches, old flow meters at sewage treatment plants, and such novelty items as games and jewelry.

2. IMERC is a program of the Northeast Waste Management Officials' Association (NEWMOA). In 2001 the NEWMOA member states launched IMERC to provide 1) ongoing technical and programmatic assistance to states that have enacted mercury education and reduction legislation, and 2) a single point of contact for industry and the public for information on mercury-added products and member states' mercury education and reduction programs. Since 2003, non-NEWMOA member states have joined IMERC, including Washington, Illinois, California, Minnesota, and North Carolina.

3. Data reported by the manufacturers of final products are not included because of the possibility of double counting the same mercury. For example, a mercury-added product, such as a switch, could be reported by the original equipment manufacturer (OEM), a gas range manufacturer that purchases the switch and installs it in the range, and a distributor that sells the range in at least one of the IMERC states.

4. By applying the percentage of U.S. residents living in the eight NEWMOA-member states to the total quantity of mercury sold by product, a rough estimate can be made on the amount of mercury sold in these products in the Northeast in 2001. According to 2005 Census data, approximately 14.2 percent of U.S. residents live in the Northeast states.

Figure 1 likely underestimates the amount of mercury sold in products in the Northeast in 2001. The information presently available may not represent the entire universe of mercury-added products because IMERC continually discovers uses of mercury that were previously unreported. IMERC constantly identifies companies that manufacture mercury-added products sold in the Northeast and should be providing notification but have not yet done so.

Potential Mercury Releases during Waste Management

When mercury-containing products, such as switches and thermostats, are disposed of as municipal solid waste, mercury can enter the environment through multiple pathways, including vaporization into the air and leaching into soil and water. The mercury in these products is usually in the liquid (elemental) form, and is often contained in breakable glass housings within the product. During solid waste handling and management, the products can break and release the stored mercury. The liquid mercury can evaporate, emitting vapors at various stages of the solid waste management process, including during transportation and at transfer stations on the way to a landfill or other waste management facilities (e.g., from collection containers and transport vehicles); from the working face, or active portion of the landfill; and during waste handling operations. If the solid waste is destined for a municipal solid waste (MSW) incinerator or resource recovery facility, the mercury can be released during incineration. The states and EPA have implemented regulations to substantially control these emissions, but recent estimates demonstrate that MSW incinerators are still the largest source of mercury emissions in the Northeast (NESCAUM 2005).

EPA and other researchers have shown that substantial amounts of mercury are released while waste loads are in transit to a landfill or incinerator, and during waste handling activities, such as dumping, distributing, and compacting (Southworth et al. 2005, Lindberg 1999a, 1999b). Studies also show that broken fluorescent bulbs and thermometers in dumpsters can continue to act as sources of mercury releases for days or weeks (Aucott 2003, Lindberg 1999b). Fluorescent bulbs contain mercury in both a vapor and powder form, and the powder form can continue to emit mercury for weeks after the bulbs break in the waste load.

Landfills can also be a source of organic mercury, a more toxic form of the element. Once mercury-containing wastes are buried, some of the inorganic mercury in

the landfill can be converted by bacteria into the organic form. Organic mercury can be released into the atmosphere from landfills in the same way that inorganic mercury is released. Researchers have measured one organic mercury compound, dimethyl mercury, in gas destined for landfill venting at levels 1,000 times higher than what has been measured in open air (Lindberg 2001). Organic mercury is primarily a local pollution concern because it generally deposits quickly after being emitted.

Mercury can also be released from landfill gas vents when the methane gas produced at landfills is collected and either burned or vented to the atmosphere. Flaring or burning landfill gas, before emitting it to the atmosphere, breaks down organic forms of mercury, but many landfills do not use flaring. Flaring does not break down inorganic mercury.

Mercury can also leach from landfills into groundwater. Available data show that mercury in groundwater near older, unlined landfills can exceed drinking water standards, but mercury is less likely to leach into groundwater from landfills that are lined and use leachate collection systems. Depending on how the leachate is treated, however, mercury collected in leachate systems may reenter the environment.

Dental amalgam wastes can enter the waste stream as both a solid waste and as suspended or dissolved particles in wastewater. Most of the states in the Northeast now require dental clinics to install amalgam separators to separate the mercury from their wastewater discharges. States and EPA are urging dental clinics to properly store and recycle the solid amalgam waste and to keep this material separate from municipal solid waste.

Mercury contained in certain formulated products, such as preservatives, reagents, and compounds, can also enter the environment if poured down the drain and discharged to a wastewater treatment facility.

While all of these pathways for mercury releases to the environment from products can be important in local areas, there are no overall estimates available for these releases in the Northeast. However, the Northeast states have taken a number of precautionary steps to prevent these releases, because mercury persists and bioaccumulates in the environment. Studies have shown that in total the various sources of mercury from products can be significant contributors to the overall mercury emissions to the environment in the region (NESCAUM 2005).

Impacts of Restrictions on the Sale of Mercury-Added Products in the Northeast

State environmental agencies in the Northeast have begun to quantify mercury reductions resulting from mercury product manufacturers complying with the states' mercury product reporting (often called notification) and product sales restrictions and requirements. This evaluation includes an estimate of the total mercury reductions reported to the states through IMERC by manufacturers discontinuing mercury product lines or ending the sale of products in one or more of the Northeast states. The majority of these are manufacturers of mercury-added switches and relays or products that contain these components.

Estimated Reductions Due to Reported Product Discontinuations

In the Northeast, as shown in Table 1, the total estimated mercury reduction from 2000 to 2006 due to the discontinuation of mercury-added product lines by manufacturers is approximately 11.6 tons. Note that

TABLE 1 AMOUNT OF MERCURY DISCONTINUED IN THE NORTHEAST BY MANUFACTURERS, 2000-2006*

YEAR	TOTAL AMOUNT OF MERCURY DISCONTINUED (POUNDS)
2002	1,785
2003	3,254
2004	5,554
2005	6,110
2006	6,542
Total	23,245 lbs. or ~ 11.6 tons

* Table presents the estimated quantities of mercury in products that manufacturers reported they stopped making or selling in the region. The amounts are based on the quantities of total mercury reported by manufacturers reporting through the IMERC notification process. Mercury reductions were assumed to start the year after the phase-out was reported, unless the phase-out was reported to have occurred in January or February. The totals for companies phasing out only in Connecticut (or Maine and Rhode Island) were multiplied by the percent of U.S. population living in the state. For Connecticut, the percent used was 1.2%. For Maine, Rhode Island, and Connecticut combined, the percent used was 2%. 2001 totals were used when available. 2004 totals were used for companies that did not have 2001 totals or reported phasing-out during or after 2004. The table assumes that the reductions that occurred in one year continue to occur during each subsequent year, and that these reductions are, therefore, cumulative over the five-year period.

this analysis assumes that an amount of mercury discontinued in a given year is cumulative. That is, if 1,785 pounds of mercury was no longer used by a switch manufacturer starting in 2002, it was assumed that 1,785 pounds of mercury was no longer used or sold by the manufacturer each year from 2003 through 2006.

Estimated Reductions Due to State Product Sales Restrictions

The Northeast states have also estimated mercury reductions associated with products that are subject to state restrictions on sales that went into effect in 2004. The first effective date for these restrictions was July 2004 in Connecticut. Additional states have enacted similar restrictions (often called product phase-outs or bans) since that time, including Maine, Massachusetts, New York, Rhode Island, and Vermont. (For a summary of the effective dates for the laws enacted by these states, go to <http://www.newmoa.org/prevention/mercury/imerc/phaseoutinfo.cfm>) Many of the restrictions or phase-outs on the sale of certain types of mercury-added products by the states in the Northeast took effect after December 2006. These restrictions generally allow for manufacturers to apply for an exemption, and the states have been ruling on exemption applications since 2004. The mercury reduction estimates presented in Table 2 were calculated by summing the total amounts of mercury sold by manufacturers of products subject to sales restrictions in the region, minus the total amounts of mercury reported by manufacturers who have received an approval on their application for an exemption from the phase-outs. NEWMOA pro-rated these reductions for each state that has enacted the product restrictions based on their effective date. As shown, NEWMOA estimates that the total annual mercury reduction associated with the implementation of state restrictions on the sale of products in the region through 2006 is approximately 5,368 pounds or 2.7 tons.

Impacts of Northeast State Actions to Address Releases of Mercury through Collection of Mercury-Added Products

This section presents a summary of the quantitative information available from the state environmental agencies in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont to estimate the mercury in targeted products that were collected and recycled from 2000 to 2006. The analysis focuses on the following mercury collection and recycling initiatives:

**TABLE 2
PROJECTED TOTAL MERCURY REDUCTION (2004-2006) RESULTING FROM NORTHEAST STATE
RESTRICTIONS ON THE SALE OF MERCURY-ADDED PRODUCTS (LISTED BY EFFECTIVE DATE)**

MERCURY PRODUCT	STATE	EFFECTIVE DATE	MERCURY ELIMINATED* (POUNDS)
All Thermometers	Connecticut	July 2004	97
	Rhode Island	January 2006	12
	Maine	July 2006	7
Mercury Thermostats	Connecticut	July 2004	868
	Maine	January 2006	129
	Rhode Island	January 2006	107
	Vermont	July 2006	31
Barometers	Connecticut	July 2004	10
	New York	January 2006	23
	Rhode Island	January 2006	1
	Maine	July 2006	0.8
Sphygmomanometers	Connecticut	July 2004	129
	Rhode Island	January 2006	16
Hygrometers and Psychrometers	Connecticut	July 2004	1
	New York	January 2006	2
	Rhode Island	January 2006	0.1
	Maine	July 2006	0.07
Hydrometers	Maine	July 2006	0.02
Manometers	Connecticut	July 2004	58
	Rhode Island	January 2006	7
	Maine	July 2006	4
Switches & Relays	Connecticut	July 2004	3,228
	Rhode Island	January 2006	397
	Maine	July 2006	240
TOTAL			5,368 LBS. OR 2.68 TONS

**Obtained by multiplying the percent of U.S. population living in the state by the total amount of mercury reported as sold in the United States in 2001. For states with a July 2006 effective date, total estimated pounds were divided in half. For states with a July 2004 effective date, total estimated pounds were multiplied by 2.5.*

- Mercury and mercury-added product removal from K-12 schools
- Collection of mercury-containing auto switches
- Bulk elemental mercury collected from dental offices and dentists that have installed dental amalgam separators
- Collection and recycling of mercury thermostats
- Collection and recycling of mercury and mercury products from hospitals
- Collection and recycling of mercury dairy manometers and plumbing gauges

- Collection of mercury by household hazardous waste programs
- Collection and recycling of mercury fever thermometers

Table 3 summarizes the achievements in mercury collection and recycling in the Northeast. The results in the table are considered a conservative estimate because some of the Northeast states have collected mercury products and bulk mercury, but have not tracked the amounts. For example, many states' household hazardous waste programs are not required to report the

TABLE 3 MERCURY COLLECTION & RECYCLING FOR THE NORTHEAST STATES, 2000 - 2006		
MERCURY COLLECTION ACTIVITY	MERCURY COLLECTED & RECYCLED (POUNDS)	COMMENTS
Mercury Removal from Schools	4,696*	456 schools
Auto Switches Collected & Recycled**	267.5	120,973 switches
Bulk Mercury Collected & Recycled from Dental Offices	2,151	2,151 pounds of bulk elemental mercury was collected from dental offices (in the past dentists used to mix amalgam on-site and many older dental clinics, therefore, had leftover containers of bulk mercury); 6,406 dentists in New England have installed separators*** (represents an estimated 80 percent of dentists in New England)
Thermostats Recycled	458****	41,764 thermostats
Hospitals Reducing Mercury	761	Ten hospitals received Hospitals for a Healthy Environment mercury reduction awards for reducing an estimated 530 pounds of mercury*****; 825 sphygmomanometers collected from MA & VT hospitals & 61 pounds of bulk collected from MA hospitals
Dairy Manometers Collected	140	140 dairy manometers
Household Hazardous Waste Collection	6,092	
Plumbing Gauges	74	
Maple Sugar Thermometers	0.7	
Fever Thermometers Collected	352	213,322 thermometers
TOTAL COLLECTED IN NORTHEAST STATES = 14,992 OR 7.5 TONS		
<p>* Does not include all mercury equipment collected; some states reported pounds of liquid mercury only while others estimated amount of mercury collected from equipment in addition to liquid mercury</p> <p>** Assumes 1 gram of mercury per switch</p> <p>***It is not possible to estimate the amount of mercury that has been eliminated from wastewater by the installation of amalgam separators in the region, but studies have shown substantial declines in mercury in wastewater treatment sludge at facilities following the installation of amalgam separators.</p> <p>****Assumes thermostats contain 5 grams of mercury based on data from TRC</p> <p>*****Source: Hospitals for a Healthy Environment (H2E)'s Making Medicine Mercury Free Award. More than ten hospitals have eliminated mercury in New England; however, only ten applied for the H2E Award. 530 pounds is based on an estimate derived by H2E of 95.2 grams of mercury/acute care bed removed.</p>		

amounts of mercury or mercury in products collected during their collection events. Similarly, many states have not collected data on the number of dairy manometers or fever thermometers collected, although the majority of states have focused on collecting and recycling these items. States have also been actively promoting the collection and recycling of fluorescent lamps, but have no estimate of the amount of mercury that these efforts have helped to recycle. The sources of the data in Table 3 are:

- Annual reports prepared by the New England Governors' Conference Mercury Task Force for the past five years.
- Written communications with key officials in each state environmental agency.
- Reports provided by the Thermostat Recycling Corporation.
- Reports submitted to the Massachusetts Department of Environmental Protection (MA

DEP) by NEWMOA and individual municipal waste combustors that operate mercury source separation programs.

- Hospitals for a Healthy Environment Program.

From the analysis of the data available from 2000–2006, Table 3 shows that the state environmental programs collected and recycled approximately 7.5 tons of mercury through various initiatives in the Northeast. In addition, 14 tons of mercury have been eliminated through restrictions on product sales in the region during the same period.

Although this is a first attempt by the states in the region to quantify the overall results of their regulations and programs, the results of the data analysis presented in this paper demonstrate that key mercury reduction initiatives in the Northeast are having a positive impact on the amount of mercury in the waste and wastewater streams of the region. As IMERC continues to gather and analyze data from product notifications for 2004, the information will provide an even more precise view of the environmental benefits resulting from state mercury collection programs and mercury-added product legislation.

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