

# **Mercury in Products Phase-Down Strategy**

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## Great Lakes Mercury in Products Phase Down Strategy

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# Mercury in Products Phase-Down Strategy

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## **1. EXECUTIVE SUMMARY**

### **1.1 Origins and Scope of this Report**

This Mercury in Products Phase-Down Strategy was developed in response to the Great Lakes Regional Collaboration (GLRC) Strategy to Restore and Protect the Great Lakes. The GLRC Strategy calls for the development of a basin-wide mercury product stewardship strategy designed to phase out the use of mercury and provide for mercury waste management. The GLRC document identifies full phase-outs of mercury-added products by 2015, as possible, as an interim milestone for toxics reduction. The GLRC was convened by federal agencies, Great Lakes governors, Great Lakes mayors, Great Lakes tribes, and members of the Great Lakes States Congressional Delegation. Members of the Great Lakes Regional Collaboration include the Great Lakes Interagency Task Force, the Council of Great Lakes Governors, the Great Lakes and St. Lawrence Cities Initiative, the Great Lakes Native American Tribes, and the Great Lakes Congressional Task Force.

This Phase-Down Strategy is a project of the GLRC and seeks to complement and enhance the recommendations in the Quicksilver Caucus's Action Plan and Implementation Strategy for reducing mercury in the environment (see Appendix E). Implementation of this strategy is one important element in achieving virtual elimination of mercury inputs into the Great Lakes as envisioned in the Great Lakes Binational Toxics Strategy (see Appendix D). The GLRC endorses the recommendations of the Strategy as valid options for consideration by Great Lakes states, tribes, and municipalities. The GLRC does not expect each state, tribe or municipality to commit to implementation of all of the recommendations, but rather to consider implementation of those recommendations that are appropriate and feasible in its individual circumstances.

The Council of Great Lakes Governors and the Great Lakes and St. Lawrence Cities Initiative endorsed this initiative in a December 12, 2005, letter to President Bush: "The Great Lakes States, Cities and Tribes will develop a basin-wide mercury product stewardship strategy aimed at managing mercury wastes and reducing the use of mercury-containing products."

The team responsible for preparing this phase-down strategy is composed of representatives from the environmental agencies of each of the Great Lakes states, the Great Lakes Indian Fish and Wildlife Commission and the Chippewa Ottawa Resource Authority, the Great Lakes and St. Lawrence Cities Initiative, the Great Lakes Regional Pollution Prevention Roundtable, and U.S. EPA's Region 5 and Great Lakes National Program Office.

The goal of this phase-down strategy is to reduce the use of mercury-containing products and to minimize mercury releases caused by remaining uses of mercury-containing products in the Great Lakes region by 2015. States are encouraged to take the recommended actions as early as is practical, with implementation of mercury bans no later than 2015.

While coal-fired power plants represent the largest air emissions source of mercury, a significant fraction of mercury emissions comes from mercury-containing products, whether from melting steel scrap that is contaminated with mercury contained in switches and other devices used in autos, industrial equipment, and commercial and consumer appliances, or from incineration of municipal, hazardous, and medical waste that can include mercury-containing products such as lamps, batteries, thermometers, and thermostats. Additionally, mercury-based amalgam used in some dental fillings is one of the primary sources of mercury in wastewater.

Some states, tribes and cities in the Great Lakes basin have passed laws or have implemented programs to prevent pollution from mercury-containing products. This strategy seeks to build on those foundations to accomplish the 2015 phase-down goal. The strategy recommends a wide range of product-targeted policies for states to adopt, including sale bans and phase-outs, disposal regulations, public awareness and education programs, collection/end-of-life management for products, purchasing preferences, and labeling requirements. Some will require legislative action; others can be implemented by state, municipal or tribal agencies.

The Strategy Team recognizes that tribal governments have a variety of programs to address mercury use by various sectors and in various products on reservation. This strategy recommends that, where applicable and appropriate, tribes adopt the policies embodied by the strategy in implementing those programs. Where available, tribes should be eligible for funding to implement those programs.

The Strategy Team considered the many products and sectors that represent significant sources of mercury releases to the environment and selected five products and five sectors to analyze and address in this strategy. For each product and sector, the team developed recommendations for state responses.

### **1.2 Recommended actions, grouped by product or sector**

We recommend that each of the Great Lakes states implement the following actions. Where appropriate, cities and tribes should consider these recommendations as well.

#### **Dental amalgam**

- 5.1.3.1 Require dental offices that place or remove dental amalgam to use waste amalgam best-management-practices recommended by the American Dental Association, including the installation and maintenance of amalgam separators that meet the ISO 11143 standard. Separator installation should be universal among Great Lakes States not later than 01/01/2011, but may be required sooner if municipal or state policy warrant. Separator installation requirements should include provisions for dental office record keeping, reporting, oversight, and sewer use ordinance compliance integrated into municipal and state pretreatment programs. In addition to the installation and maintenance of amalgam separators, amalgam recycling may, in part, be accomplished in accordance with ANSI/ADA Specification No. 109.
- 5.1.3.2 Implement a program to promote inclusion of instruction in dental office amalgam best management practices, including proper use of amalgam separators, in training programs for dentists and dental assistants, with a particular focus on continuing education for practicing dentists.
- 5.1.3.3 Support a joint effort with the dental community to ensure removal of remaining bulk elemental mercury from dental offices in states that have not already implemented such programs.
- 5.1.3.4 Undertake a joint effort with the dental community to ensure that adequate options for safe disposal of dental waste are available throughout the state.
- 5.1.3.5 Require that dental insurance plans provided to the general public allow use of non-mercury restorative materials, with full cost coverage of most appropriate prescribed restoration material.
- 5.1.3.6. The states, either independently or with the appropriate dental association, should promote, and distribute literature for dental patients explaining alternative tooth restorative materials that are available for various dental treatments. The literature should be updated periodically as new restorative materials become available.

#### **Thermostats**

- 5.2.3.1 Implement statewide bans on sale and/or installation of mercury thermostats.
- 5.2.3.2 Mandate collection and proper management of mercury-containing thermostats at the end of the product's life.

- 5.2.3.3 Require manufactures or wholesalers to offer financial and/or non-financial incentives to motivate consumers and contractors to collect and return mercury thermostats for recycling.
- 5.2.3.4 Promote the use of ENERGY STAR qualified programmable thermostats (which are both mercury-free and energy-efficient).
- 5.2.3.5 Increase awareness of recycling options by encouraging do-it-yourselfers as well as HVAC building contractors to return thermostats to Thermostat Recycling Corporation (TRC) or other collection centers.
- 5.2.3.6 Include thermostat collection in household hazardous waste collections, potentially in partnership with TRC.
- 5.2.3.7 Encourage retailers to offer collection for household thermostats, either as part of a national program, if available, or in partnership with state programs.

### **Switches, Relays, and Measurement and Control Devices**

- 5.3.3.1 Implement legislation to phase out the sale and distribution of electrical switches and relays and measurement and control devices, including thermometers. The restriction should include mercury devices sold individually or as a product component, and should include a mechanism to allow for use of a mercury device when a suitable alternative is not available or when replacement components are needed for existing equipment. This sales restriction could be accomplished through the general ban on mercury-containing products recommended in section 7.1. States are encouraged to phase out mercury electrical switches and relays and measurement and control devices, including thermometers, as early as is practical and appropriate, but no later than 2015.
- 5.3.3.2 Develop product labeling requirements to promote proper management of products and product components that are exempted from the phase-out (see §7, Crosscutting Strategies).
- 5.3.3.3 Conduct outreach to users of equipment that contains mercury switches to notify them of proper end-of-life disposal and identify alternative mercury-free products.
- 5.3.3.4 Encourage national and international standard-setting bodies to establish standards that utilize non-mercury technology for measuring devices. Support the initiative by the Northeast states to work with ASTM to revise standards for non-mercury temperature measurement.
- 5.3.3.5 Provide dairy farms with information on cost-effective, non-mercury containing gauges, and on proper management options available for disposal of mercury manometers. Seek funding initiatives and collection system alternatives to assist dairy farmers in the removal of mercury manometers, including manometers no longer in use. Continue to include and promote the collection of dairy manometers and other mercury-containing devices in household hazardous waste (HHW) and “Clean Sweep” programs.

### **Lamps**

- 5.4.3.1 Require recycling of mercury-containing lamps by all generators (except households) regardless of whether the lamps are TCLP-compliant.
- 5.4.3.2 Work with household hazardous waste programs, utilities, retailers, manufacturers and others to provide collection programs for households and small businesses and others who need to dispose of small quantities of spent fluorescent bulbs, and work with these stakeholders to consider regulatory and programmatic options for increasing lamp recycling from households and small businesses.
- 5.4.3.3 Ban the sale of mercury lamps for which adequate energy-efficient, mercury-free alternatives are available, such as car headlights, while providing an exception for replacement parts
- 5.4.3.4 Require permits for the use of drum top crushers in order to ensure that only those that meet emissions requirements are used. States can do this by classifying crushing as treatment of hazardous or universal waste, or by regulating it under their state air quality standards.

## **Thermometers**

- 5.5.3.1 Ban sale and distribution of mercury fever thermometers except by prescription.
- 5.5.3.2 Support funding and provide guidance for local thermometer exchange programs.
- 5.5.3.3 Increase public awareness of the hazards of thermometer breakage and the appropriate cleanup techniques for household mercury spills through outreach mechanisms such as placing information brochures in doctors' offices and booths at the county fairs as a supplement to online information.

## **Schools**

- 6.1.3.1 Prohibit the purchase, use, and storage of elemental mercury, mercury compounds, and mercury-containing laboratory and medical equipment in schools.
- 6.1.3.2 Provide education/outreach regarding mercury spill management, health impacts, sources of exposure, handling, and disposal to school administrators, teachers, and students.
- 6.1.3.3 Provide education/outreach to college and university students majoring in education, particularly future science teachers.
- 6.1.3.4 Assist schools to eliminate mercury by
  - facilitating access to lower-cost management services, for instance by allowing schools free access to household hazardous waste collection programs,
  - providing technical assistance for clean-outs
  - advocating the proper disposal of worn or broken mercury-containing gauges, switches, and relays (e.g., boiler gauges, thermostats). If replaced, new devices such as switches and relays should be mercury-free, and
  - ensuring the availability of a collection program for schools to dispose of unwanted chemicals, including mercury and mercury-containing equipment.

## **Steel Manufacturing/Scrap Metal Melting Facilities, Scrap Yards**

Great Lakes states are already participating in the National Vehicle Mercury Switch Recovery Program. In some cases, this is done in coordination with existing state programs. Consistent with those efforts, we recommend that all states

- 6.2.3.1 Facilitate proper recycling of auto mercury switches, consistent with state and federal law and regulations, including RCRA regulations and forthcoming U.S. EPA air emissions standards for steel producers, and educate scrap recyclers about the need to remove mercury devices from autos and other equipment. State efforts should complement or incorporate the National Vehicle Mercury Switch Recovery Program, and should ensure that letters are sent to dismantlers about the need to recycle mercury switches and the advantages of participating in the national program.
- 6.2.3.2 Conduct outreach to steel mills and iron foundries designed to encourage participation in the National Vehicle Mercury Switch Recovery Program.

In addition, states should

- 6.2.3.3 Consider programs or legislation to ensure continued achievement of auto switch recycling goals after the expiration of the three-year implementation fund for providing incentives for switch removal under the National Vehicle Mercury Switch Recovery Program.
- 6.2.3.4 Consider laws requiring the removal and proper management of all mercury-containing components from vehicles, appliances and other products that are likely to end up in steel scrap. For example, states may use stormwater permit authority to regulate removal and management.

## **Heavy Industry**

6.3.3.1 Conduct outreach to heavy industry to promote mercury reduction projects, focusing on sectors within the state that use significant amounts of mercury.

6.3.3.2 Promote the development of industry mercury containing equipment phase-out plans. The plans should include

- purchasing policies that avoid mercury-containing devices where feasible and appropriate,
- internal inventories of mercury and mercury-containing devices, and
- measures to ensure proper disposal of these devices at end of life, including labeling of equipment that incorporates mercury-containing devices.

States could implement this recommendation in a variety of ways to address various industrial sectors and categories of facilities with state or local permits.

6.3.3.3 Work with wastewater treatment authorities to encourage large volume users of commodity chemicals to routinely obtain certificates of analysis for these chemicals and, in cases where mercury contamination is a problem, to procure lower-mercury chemicals.

## **Health Care**

6.4.3.1 Continue to implement and promote state Hospitals for a Healthy Environment (H2E) programs that include participation by hospitals, clinics, and nursing homes, and reward, recognize, or provide incentives to health care facilities that complete mercury reduction programs. Assist health care facilities in keeping mercury out of the environment by

- replacing mercury-containing products with mercury-free alternatives,
- adopting a mercury-free purchasing policy,
- maintaining proper mercury spill clean-up procedures,
- conducting an internal mercury audit, and
- establishing proper handling and disposal of mercury-containing materials.

6.4.3.2 Become H2E partners and develop programs that implement mercury reduction activities at state-operated facilities.

6.4.3.3 Seek to engage other health care facilities, such as independent medical research labs and veterinary care facilities, in mercury pollution prevention efforts, using existing work with hospitals as a model.

## **Households**

6.5.3.1 Educate the general public on mercury hazards and proper management. Much of the needed information is already available on the states' environmental agencies websites. States should consider additional forms of outreach – such as ads on public transportation vehicles, mailings with utility bills, notification by waste management and recycling companies, and flyers at doctors' offices – as the websites may only be read by those who already have an interest in the issue.

6.5.3.2 Ensure access to free collection of mercury and mercury-containing products for households. At a minimum, access should include periodic mercury collection opportunities for all citizens able to travel a reasonable distance, especially near major population centers.

6.5.3.3 Implement legislation to ban sale of mercury-added button cell batteries, including imported batteries, on a schedule consistent with the U.S. industry commitment to phase out mercury by 2011.

## **Crosscutting Strategies**

7.1.1 Adopt legislation that phases out the sale of mercury-added products no later than 2015, with exceptions for fluorescent lamps and dental amalgam and a mechanism to allow for use of a mercury device when a suitable alternative is not available. Manufacturers applying for exemptions should justify their exemption request and include a plan to collect and manage used mercury-added products through manufacturer take-back or by funding other private or public collection programs,

including accountability measures to ensure high rates of recovery for end of life products. Exemptions should be issued for a limited period (e.g., two years) and may be renewed for additional periods as long as the criteria are met.

- 7.2.1 Provide significant additional support, funding and staff for existing and new state and local mercury reduction activities, including
  - implementation, enforcement, monitoring, and measurement of mercury reduction and management laws and policies;
  - outreach and public education on the dangers of mercury and the availability of mercury-free products;
  - collection of mercury-containing products, including fluorescent lamps, from schools and households.
- 7.2.2 Consider targeting research and development funding toward mercury-free alternatives to products.
- 7.3.1 Implement and enforce mercury product labeling requirements. To avoid putting unnecessary burden on industry, we recommend that states implement such requirements consistent with the IMERC program.
- 7.4.1 Implement mercury product notification requirements in order to further improve data about mercury use in products. To avoid putting unnecessary burden on industry, we recommend that states implement such requirements consistent with the IMERC program.
- 7.4.2 Participate in national or regional clearinghouse efforts for coordination of mercury product stewardship initiatives, such as IMERC, P2Rx, GLRPPR, and the Toxics in Packaging Clearinghouse.
- 7.6.1 Continue providing education on proper disposal of mercury-containing products and continue providing collection programs at the local level that accept any type of mercury or mercury-containing product. Such collections may be funded by users through a small collection fee or by manufacturers through an extended producer responsibility approach.
- 7.6.2 Support extended producer responsibility approaches in the development of voluntary end-of-life management programs and consider mandatory manufacturer-funded take-back programs for mercury-containing products, where feasible and appropriate.
- 7.6.3 Design end-of-life management programs to ensure that product users are made aware of the program and its operating requirements; are motivated to participate via monetary or other incentives; and have convenient and easy access to collection services or sites. The programs should also include performance measures that contribute to program accountability, periodic evaluation of results and continuous improvement in collection rates.
- 7.7.1 Adopt state purchasing policies that ensure purchase of non-mercury products where appropriate—where such products are available and equivalent in performance, including energy efficiency, to the mercury alternative.
- 7.7.2 Adopt policies to ensure that mercury in state-owned facilities is managed properly at end-of-life.
- 7.8.1 Periodically check on what happens to mercury collected from within their boundaries. If it turns out that substantial quantities of mercury and mercury-containing devices are being sent overseas, they should adopt measures to discourage this practice.
- 7.10.1 Share their expertise on methods for mercury reduction.

### **Tracking Progress on Implementation**

- 8.1 We recommend that each of the Great Lakes state environmental agencies, Great Lakes Tribes (or tribal organizations), the Great Lakes and St. Lawrence Cities Initiative, and the U.S. Environmental Protection Agency appoint a representative to a workgroup tasked with tracking progress on implementation of the recommendations in this report and for sharing information about

implementation priorities and approaches. This workgroup should invite participation from Environment Canada and the Ontario Ministry of the Environment, and seek stakeholder input.

8.2 We further recommend that each of the Great Lakes state environmental agencies and Great Lakes Tribes (or Tribal organizations) and the Great Lakes and St. Lawrence Cities Initiative publicly identify its implementation priorities and the organizations responsible for achieving them.

## **2. GOAL**

Phase down the use of mercury-containing products and minimize mercury releases caused by remaining uses of mercury-containing products in the Great Lakes Region by 2015, or earlier where practical and appropriate.

## **3. BACKGROUND**

### **3.1 Origins and Scope of this Report**

This Mercury in Products Phase-Down Strategy was developed in response to the Great Lakes Regional Collaboration (GLRC) Strategy to Restore and Protect the Great Lakes.<sup>1</sup> The GLRC Strategy calls for the development of a basin-wide mercury product stewardship strategy designed to phase out the use of mercury and provide for mercury waste management. The GLRC document identifies full phase-outs of mercury-added products by 2015, as possible, as an interim milestone for toxics reduction. The GLRC was convened by federal agencies, Great Lakes governors, Great Lakes mayors, Great Lakes tribes, and members of the Great Lakes States Congressional Delegation. Members of the Great Lakes Regional Collaboration include the Great Lakes Interagency Task Force, the Council of Great Lakes Governors, the Great Lakes and St. Lawrence Cities Initiative, the Great Lakes Native American Tribes, and the Great Lakes Congressional Task Force.

This Phase-Down Strategy is a project of the GLRC and seeks to complement and enhance the recommendations in the Quicksilver Caucus's Action Plan and Implementation Strategy for reducing mercury in the environment (see Appendix E). Implementation of this strategy is one important element in achieving virtual elimination of mercury inputs into the Great Lakes as envisioned in the Great Lakes Binational Toxics Strategy (see Appendix D). The GLRC endorses the recommendations of the Strategy as valid options for consideration by Great Lakes states, tribes, and municipalities. The GLRC does not expect each state, tribe or municipality to commit to implementation of all of the recommendations, but rather to consider implementation of those recommendations that are appropriate and feasible in its individual circumstances.

The Council of Great Lakes Governors and the Great Lakes and St. Lawrence Cities Initiative endorsed this initiative in a December 12, 2005, letter to President Bush: "The Great Lakes States, Cities and Tribes will develop a basin-wide mercury product stewardship strategy aimed at managing mercury wastes and reducing the use of mercury-containing products."<sup>2</sup>

The team responsible for preparing this phase-down strategy is composed of representatives from the environmental agencies of each of the Great Lakes states, the Great Lakes Indian Fish and Wildlife Commission and the Chippewa Ottawa Resource Authority, the Great Lakes and St. Lawrence Cities Initiative, the Great Lakes Regional Pollution Prevention Roundtable, and U.S. EPA's Region 5 and Great Lakes National Program Office.

This report is not meant to be a comprehensive summary of actions needed to reduce mercury releases to the Great Lakes. It does not address emissions from power plants, commercial and industrial boilers, mining,

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<sup>1</sup> Great Lakes Regional Collaboration Strategy to Restore and Protect the Great Lakes. Dec. 12, 2005.  
[http://www.glrc.us/documents/strategy/GLRC\\_Strategy.pdf](http://www.glrc.us/documents/strategy/GLRC_Strategy.pdf)

<sup>2</sup> [http://www.cglg.org/projects/priorities/Letter\\_to\\_the\\_President\\_on-GLRC\\_12-12-05.pdf](http://www.cglg.org/projects/priorities/Letter_to_the_President_on-GLRC_12-12-05.pdf). See Appendix C.

cement production, chemical production, and other important sources of mercury to the Great Lakes. This report is limited to addressing mercury-containing products, which is just one important component of a broader effort to virtually eliminate mercury from the Great Lakes. Additionally, this report is not intended to provide complete information on the human and environmental health effects of mercury, as these are well-known and are fully documented elsewhere. Rather, this report presupposes these health effects and seeks to present prevention strategies.

### 3.2 Sources of Mercury

Mercury is a naturally occurring metallic element and a potent neurotoxin.<sup>3</sup> As a natural element in the earth's crust, mercury is released when raw materials such as fuels, metal ores, or limestone are heated. It is used extensively in many products and processes due to properties that enable it to conduct electricity, measure temperature and pressure, act as a pesticide and fungicide, and alloy with other metals. Many of the products we use in our everyday lives are made with mercury or contain a mercury component, including thermometers, thermostats, dental fillings, and fluorescent lights. Mercury is also released as an incidental byproduct of numerous processes. As the health effects of mercury have become known and as desirable alternatives to many mercury-containing products have been developed, many uses of mercury have been phased out or greatly reduced. As a result, overall mercury use has declined by more than 90 percent since the mid-1980s, driven largely by decreased use of mercury in products, as well as by decreased use of mercury in chemical manufacturing.

Scientists have determined that in many locations, including the Great Lakes, atmospheric deposition is the primary pathway by which mercury enters surface waters.<sup>4</sup> Mercury is released into the air through combustion, incineration, or manufacturing processes, or through natural processes, and is eventually deposited into surface water and onto the land. Globally, atmospheric mercury releases are divided roughly evenly among natural emissions, emissions resulting from current human activity, and volatilization of mercury released to the environment by human activities in the past.<sup>5</sup> Mercury deposition in the United States is caused increasingly by mercury emissions overseas, as domestic mercury emissions have decreased and mercury emissions in Asia and Africa have increased. Mercury emissions can travel long distances; while some emissions will deposit locally, some mercury emissions can remain in the atmosphere for six months or more, traveling around the globe. Mercury does not degrade, and it is not destroyed by combustion. In addition, it persists in the environment and bioaccumulates in the aquatic food chain.

Even small quantities of mercury in fish consumed by a pregnant woman can impair the neurological development of her fetus.<sup>6</sup> Young children are also vulnerable to mercury exposure, and it can create health risks for adults. In addition to exposure through eating contaminated fish, people can be poisoned by breathing mercury vapors. This can occur when mercury is spilled indoors; exposure to mercury vapor outdoors is not considered a significant risk in most circumstances.<sup>7</sup>

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<sup>3</sup> U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Research and Development. Mercury Study Report to Congress, Volume V: Health Effects of Mercury and Mercury Compounds; EPA-452/R-97-007 (December 1997).

<sup>4</sup> U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Research and Development. Mercury Study Report to Congress, Volume III: Fate and Transport of Mercury in the Environment; EPA-452/R-97-005 (December 1997), p. 3-1.

<sup>5</sup> Seigneur, C., K. Vijayaraghavan, K. Lohman, P. Karamchandani, and C. Scott. 2004. Global source attribution for mercury deposition in the United States. *Environmental Science & Technology* 38(2): 555–569.

<sup>6</sup> Water Quality Criterion for the Protection of Human Health: Methylmercury; EPA-823-R-01-001, EPA-823-R-01-001, U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, January 2001.

<sup>7</sup> U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Research and Development. Mercury Study Report to Congress, Volume VII: Characterization of Human Health and Wildlife Risks from Mercury Exposure

Use and disposal of mercury-containing products causes environmental releases of mercury, although this is not the largest source. Coal-fired power plants, representing the largest air emission source category in the United States, release mercury vapors as an incidental byproduct of metallic mercury in raw materials. The same is true of several of the other large source categories, such as industrial boilers and gold mines (see Table 1).

Table 1. U.S. sources of mercury emissions, 2002. Source: U.S. EPA, National Emissions Inventory, 2002.

Source Category	Tons of Mercury emitted
Utility coal boilers (coal-fired power plants)	50.4
Electric arc furnaces	10.6
Industrial/commercial/institutional boilers and process heaters	9.7
Hazardous waste incineration	7.4
Gold mining	6.5
Chlorine production (chlor-alkali plants)	5.4
Municipal waste combustion	4.2
Medical waste incineration	0.2
Other	24.2
<b>Total</b>	<b>118.6</b>

However, the second-biggest source category, electric arc furnaces, emits mercury by melting steel scrap that is contaminated with mercury contained in switches and other devices used in autos, industrial equipment, and commercial and consumer appliances. Incineration of municipal, hazardous, and medical waste is also a significant source of mercury emissions due to the disposal of mercury-containing products such as lamps, batteries, thermometers, and thermostats as wastes. While new products in many of these categories are either mercury-free or contain reduced quantities of mercury, many mercury-containing products, such as thermostats, switches, relays, and manometers, have long service lives. As a result, the older products that are being discarded often contain high levels of mercury. Emissions from incineration of municipal and medical waste have declined by more than 90 percent since 1990, when these two categories accounted for more than 100 tons of mercury emissions, as a result of decreased use of mercury in products such as batteries and thermometers, as well as the imposition of regulatory requirements to install mercury control devices on incinerators.

Moreover, the use of mercury-containing products causes additional mercury releases that do not rise to the top of the emissions inventory, or that may not be quantified at all, but which nonetheless are collectively significant. For instance, lamps, thermometers, and other products that contain elemental mercury sometimes break during use, or more frequently during waste collection and transport. Such breakage causes mercury releases because elemental mercury volatilizes at ambient temperatures. When mercury-containing wastes are disposed of in burn barrels, nearly all of the mercury is volatilized.

Also, mercury-containing dental amalgam is the leading source of mercury to sewage treatment plants, leading both to direct water discharges of mercury and mercury releases from sludge incineration and land application of sludge.<sup>8</sup>

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in the United States; EPA-452/R-97-009 (December 1997), p 5-2, and National Institutes of Health, Office of Research Facilities, Development and Operations, "Mercury Health Hazards" (website), <http://orf.od.nih.gov/Environmental+Protection/Mercury+Free/MercuryHealthHazards.htm>.

<sup>8</sup> A study by the Association of Metropolitan Sewerage Agencies (since renamed the Association of Clean Water Agencies) found that dental offices are the largest source of mercury to publicly owned treatment works, contributing more than 35% of mercury influent to the POTWs studied. AMSA. Mercury Source Control & Pollution Prevention Program Evaluation: Final Report. March 2002 (Amended July 2002).

In addition to environmental releases, mercury-containing products cause mercury spills in homes, schools, and workplaces. When such spills are not cleaned up properly, they can result in dangerous exposures to elemental mercury vapor. The risk is particularly high in poorly ventilated spaces.

Across the United States, 44 states – including all of the Great Lakes states – have issued fish consumption advisories for at least some of their water bodies due to mercury contamination. For example, in Minnesota, 94% of the lakes surveyed have mercury levels high enough to warrant fish consumption restrictions. In response to the prevalence of fish consumption advisories and the high level of anthropogenic releases, EPA and many states have taken steps to reduce mercury emissions and “virtually eliminate” the anthropogenic contribution to mercury levels in the Great Lakes, as challenged by the International Joint Commission.

### 3.3 Existing State Laws in the Great Lakes

Table 2. Existing state laws regarding mercury in the Great Lakes basin.<sup>9</sup>

An asterisk (\*) indicates a voluntary state program intended to accomplish the same result as the law in question.

	IL	IN	MI	MN	NY	OH	PA	WI
Require dental amalgam separators		*Outreach through fact sheets		*	6NYCRR subpart 374-4			10
Thermostat sale ban	P.A. 095-0452	*Thermostat Reduction & Recycling Program	P.A. 492 of 2006		Ch. 676, Laws of 2005 <sup>11</sup>	ORC 3734.65, 2007		
Thermostat disposal ban		*Thermostat Reduction & Recycling Program		Stat 2001, §115A.932, 116.92	Ch. 145, Laws of 2004		25Pa.Code §261.5(b) Applies to CESQGs	13
Ban sale of mercury in switches and relays	P.A. 093-0964			12	Ch. 676, Laws of 2005			
Fever thermometer sale ban	P.A. 093-0165	Ind. Code 13-20-17.5,	P.A. 578 of 2002	Stat 2001, §115A.932, 116.92	Ch. 145, Laws of 2004	ORC 3734.63, 2007		13
Sale ban on mercury-added measuring devices (other than fever thermometers)	P.A. 095-0087		P.A. 578 of 2002 <sup>14</sup>	Stat 2001, §115A.932, 116.92	Ch. 676, Laws of 2005	ORC 3734.63, 2007 <sup>14</sup>		
Ban installation or sale of mercury manometers (dairy farms)				Stat 2001, §115A.932, 116.92 (installation)	Ch. 676, Laws of 2005 (sale)			
Limit quantity of mercury in vehicle components to 15 mg					Ch. 611, Laws of 2006			

<sup>9</sup> Information from Quicksilver Caucus “2005 Compendium of State Mercury Activities” and Status of Local, State and Federal Mercury Product Legislation and Laws: 2005-2006 Legislative Sessions [www.newmoa.org/prevention/mercury/modelleg.cfm](http://www.newmoa.org/prevention/mercury/modelleg.cfm).

<sup>10</sup> No statewide rule exists, but some municipalities in Wisconsin require separators.

<sup>11</sup> Prohibited from sale if a non-mercury alternative is available per New York State determination.

<sup>12</sup> Does not ban, but producer is responsible for keeping it out of the solid waste stream.

<sup>13</sup> Banned in various municipalities, but not statewide.

<sup>14</sup> Industrial/laboratory/scientific thermometers

	IL	IN	MI	MN	NY	OH	PA	WI
Lamp disposal ban		Universal Waste Rule 329IAC 3.1-16		Stat 2001, §115A.932, 116.92	Ch.145, Laws of 2004. <sup>15</sup>		25 Pa. Code §261.5(b) applies to CESQGs	Businesses not households, Universal Waste Rules
Regulate drum top crushers (Through haz waste rules or through air permits)	Haz Waste	Haz Waste 329IAC 3.1-15-23.1-16-2	Air permit	Haz Waste	Haz Waste	Haz Waste	Haz Waste	Haz Waste
Ban purchase or use of mercury in schools	P.A. 093-0964	IC 13-20-17.5-4	P.A 376 of 2000	16	Ch. 145, Laws of 2004	ORC 3734.62, 2007		
Require removal of mercury switches in scrap recycling or are implementing the NVMSRP	P.A. 094-0732	HB1110 leg. sess 2006	NVMSRP	HF 2602 & SF 1934 leg. sess 03	Ch. 180, Laws of 2006 & NVMSRP	NVMSRP and state incentives	NVMSRP and state incentives	NVMSRP and state incentives
Mandate labeling of mercury-containing products				session law 201, leg. sess 2006 <sup>17</sup>	Ch. 145, Laws of 2004			
Sales ban on mercury in novelty items (e.g. toys and apparel)	P.A. 93-165	IC 13-20-17.5-2		Stat 2001, §115A.932, 116.92	Ch. 145, Laws of 2004	ORC 3734.64, 2007		Ch. 100, Laws of 1993
Ban mercury sphygmomanometers		* through H2E	P.A. 493 of 2006, P.A. 494 of 2006 <sup>18</sup>		Ch. 676, Laws of 2005 <sup>11</sup>			
Restrictions on Batteries Containing Mercury		IC 13-20-17						
Restrictions on Sale of Mercury Commodities		IC 13-20-17.5-5						
Implement Public Education Program		IC 13-20-17.5-6						Ch. 283, most municipalities

#### 4. SELECTION OF PRODUCTS AND SECTORS

##### 4.1 Criteria for Selecting Products and Sectors

The Strategy Team carefully considered the many sectors and products that represent significant sources of mercury releases to the environment. The team developed and used the following evaluation criteria to determine which products and sectors would be addressed in this strategy:

- 1) Amount of mercury used and in use, in the product and its manufacture, or in the sector
- 2) Estimated mercury releases from the product or sector (use, manufacture, or disposal), with special attention to water discharges because of direct Great Lakes impact)
- 3) Whether there are commercially available substitutes (in the case of mercury-containing products)

<sup>15</sup> Small businesses (disposing of 15 or fewer non-hazardous bulbs per month) and households are exempt.

<sup>16</sup> Banned in Duluth, but not statewide.

<sup>17</sup> Only applies to fluorescent bulbs distributed by utilities.

<sup>18</sup> Also bans esophageal dilators, bougie tubes and gastrointestinal tubes

- 4) Whether there is potential for reduction through sector-focused action that would be missed by a product-focused approach
- 5) Whether there is unmet potential for reduction through action (in at least some of the Great Lakes states)
- 6) Potential for direct exposure to sensitive populations, such as children and women of childbearing age

#### **4.2 List of Priority Products and Sectors**

Using these criteria, the Strategy Team identified and ranked the top five products and five sectors for which to develop recommendations for action. The priority products are

- 1) Dental Amalgam,
- 2) Thermostats,
- 3) Switches, Relays, and Measurement and Control Devices
- 4) Lamps, and
- 5) Fever Thermometers.

The priority sectors are

- 1) Schools,
- 2) Steel Manufacturing and Processing,<sup>19</sup>
- 3) Manufacturing and Industry,
- 4) Health Care and Veterinary Health, and
- 5) Households.

#### **4.3 Structure of Product and Sector Strategy Sections**

For each mercury-containing product or related sector in this strategy, we present a brief overview of the issue, quantifying the human and environmental hazard posed by current use of this product. We then describe existing pollution prevention programs for this product, including federal, state, and local government policies as well as private actions and public/private partnerships. Finally, for each product we present a short list of recommended actions. Some states have already implemented some of these recommendations, but each state will find numerous opportunities for further mercury reduction among these suggestions. It is not expected that every state will be able to implement all of the recommendations immediately. States, tribes, and municipalities are encouraged to work toward as many of the recommendations as is feasible.

#### **4.4 Other Products and Sectors Containing Mercury**

In order to give due attention and provide careful recommendations on the highest priority products and sectors, the Strategy Team chose to focus on five products and five sectors in this initial strategy. Although we have omitted discussion of some other mercury products and sectors, the strategy also prescribes general crosscutting strategies that address *all* mercury products and sectors. Moreover, some of the products or sectors not treated individually are addressed as subsets of broader product or sector categories.

## **5. PRIORITY PRODUCTS**

### **5.1 Dental Amalgam**

#### **5.1.1 Background**

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<sup>19</sup> The main mercury-related concern with steel manufacturing is contamination of scrap metal by mercury-containing switches and other devices. Thus new switches are addressed in §5.3 on switches, relays, and control devices, and end-of-life recovery of switches is addressed in §6.2 on steel manufacturing.

### 5.1.1.1 Amount of Mercury Involved.

Dental amalgam contains approximately 50% mercury by weight, along with silver, copper, tin and other metals. Each amalgam filling contains about 327–982 mg of mercury, depending on the size.<sup>20</sup> 1999 statistics indicated that approximately 35.2 tons of mercury were used in amalgam fillings in the U.S. annually, an amount that likely has decreased somewhat in recent years.<sup>21</sup> Amalgam fillings are a commonly used treatment for dental cavities in posterior teeth due to their reasonable cost and reputation for durability. Alternatives to dental amalgam, such as ceramic composites, are increasingly popular, particularly in anterior teeth where the silver color of amalgam is undesirable. In addition to the partial switch to mercury-free alternatives for cosmetic reasons, there has been an overall decrease in dental cavities in school children and young adults.<sup>22</sup> As a result, the number of dental fillings in which amalgam was used declined by an estimated 38% in the 1980s and by an additional 25% in the 1990s, despite population growth.<sup>22,23</sup> When using dental amalgam, current standard practice is for dentists to use amalgam capsules. Standard practice a generation ago was for dentists to mix their own amalgam, using flasks of elemental mercury and bulk alloys of other metals. Pre-capsulated amalgam uses individually prescribed measured doses in direct proportion to the size of the specific restoration. This practice results in less spillage, less evaporation, and less excess material left over after each procedure, thereby reducing waste and the risk of mercury exposure to dental personnel.

### 5.1.1.2 Releases of Mercury

Mercury from dental amalgam reaches the environment through a variety of pathways, including water discharges to wastewater treatment systems from dental offices; land application, incineration or disposal of biosolids; disposal of excess mixed amalgam along with traces of amalgam contained in spent capsules; and air releases from crematories and dental offices. Releases also may occur from incineration or autoclaving of medical waste if dentists put scrap amalgam in medical waste bags. If mercury-bearing wastes, such as chair side traps and vacuum filters, are disposed with municipal trash that is incinerated, this would be an additional release to the air. Mercury from dentists is also found in the sediment in pipes and sewer systems and can be released when the pipes or sewers are serviced or changed.<sup>24</sup> Although there is considerable variability among research, some studies have shown dental offices to be the largest source of mercury discharge to most public sewerage systems.<sup>8</sup> Mercury can enter dental wastewater when new fillings are installed, repaired, or removed as a result of amalgam waste particles passing through office filtration systems and discharging into sewerage systems.<sup>20,25</sup> A study funded by the American Dental Association (ADA) estimated that dental offices discharge approximately 6.5 tons of mercury per year to sewage treatment systems nationwide, which represents half of the mercury entering such systems.<sup>21</sup>

Dental offices may switch vacuum systems to what are called “dry” or “turbine” systems that do not make use of a “vacuum filter” at the vacuum pump. These vacuum systems may cost more, but they use less water and electricity than “wet” or “liquid-ring” systems. Dry vacuum systems, however, would release more amalgam to the sewer system since they usually do not have a vacuum filter. (Virtually all vacuum systems still employ a “chair side trap”, a coarse filter at each chair.) Therefore, if dental offices do not install an amalgam

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<sup>20</sup> Water Environment Federation, “Controlling Dental Facility Discharges in Wastewater: How to Develop and Administer a Source Control Program,” 1999.

<sup>21</sup> Vandeven J, McGinnis SL. An Assessment of Mercury in the Form of Amalgam in Dental Wastewater in the United States. *Water, Air and Soil Pollution* 2005; 164:349-366. Online at <http://www.springerlink.com/content/1538222288239061/>

<sup>22</sup> CDC “Dental Amalgam Use and Benefits” Fact Sheet <http://www.cdc.gov/oralhealth/factsheets/amalgam.htm>

<sup>23</sup> Berthold, M. “Restoratives: Trend data shows shift in use of materials.” *Am. Dental Assoc. News* (2002), 33(11), 10-11.

<sup>24</sup> See ADA guidelines on Amalgam Accumulations in Dental Office Plumbing, [http://www.ada.org/prof/resources/positions/statements/amalgam\\_plumbing\\_guidelines.pdf](http://www.ada.org/prof/resources/positions/statements/amalgam_plumbing_guidelines.pdf)

<sup>25</sup> Kunkel, P; Cook, K; Mueller, P; York, B “The fate of mercury in dental amalgam” *Water Environment & Technology*, Vol. 8, no. 12, pp. 49-53. Dec 1996.

separator, and they switch to dry vacuum systems, then the overall quantity of amalgam discharged will increase.<sup>26</sup>

Human waste from individuals with amalgam fillings is another significant source of mercury to domestic wastewater, because mercury is gradually released into the body from fillings and subsequently excreted.<sup>27</sup> Mercury from amalgam is a concern because of its toxic effects at low concentration and potential to transform to even more toxic organic forms in the environment. Monomethyl mercury, the form of mercury that bioaccumulates in aquatic life, has been found in dental-unit wastewater at quantities greater than natural environmental samples (i.e. part per billion levels versus part per trillion levels).<sup>28</sup>

While dental amalgam contributes significant amounts of mercury to wastewater treatment plant influent, the amount of this mercury discharged as effluent from the treatment plant is uncertain. Overall, wastewater treatment plants have been found to achieve an average of 95 percent removal of mercury in influent.<sup>29</sup> The mercury removed by sewage treatment plants is incorporated into biosolids, or sludge. Approximately two-thirds of treatment plant biosolids in the United States are land-applied as a soil amendment, with most of the remainder incinerated or land filled. Dental amalgam contributes an estimated five metric tons of mercury to sewage sludge annually, of which an estimated one metric ton is released to the air, mostly via sludge incineration.<sup>30, 31</sup>

Dental amalgam is also responsible for mercury emissions in a variety of other ways. Most notably, cremation of human remains causes emissions to the atmosphere of the mercury contained in amalgam fillings and mercury is released to the atmosphere from dental office vacuum systems. Mercury releases to air from dental amalgam caused by all pathways together total an estimated 4.5 tons per year nationwide. Cremation accounts for approximately half of this amount, with most of the remainder divided between sludge disposal and dental office vacuum systems.<sup>30</sup>

## 5.1.2 Existing Programs/Policies

### 5.1.2.1 Pollution Prevention Outreach and Education Programs

Pollution prevention outreach and education programs can inform dentists of the environmental impact of dental amalgam discharges and of opportunities to minimize these discharges. For example, the production and distribution of a best management practices (BMP) manual informing dentists in the Western Lake Superior Sanitary District (WLSSD) service area about the proper disposal of mercury, amalgam, and other dental wastes aided in the reduction of mercury in wastewater discharge.<sup>32</sup> The BMP manual, which was developed through

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<sup>26</sup> Controlling Mercury in Wastewater Discharges from Dental Clinics, January 2006, National Association of Clean Water Agencies.

<sup>27</sup> Association of Metropolitan Sewerage Agencies, "Evaluation of Domestic Sources of Mercury," August 2000. Dental amalgam is responsible for an estimated one ton per year of mercury entering wastewater treatment systems through human waste.

<sup>28</sup> Stone, Mark, Mark E. Cohen, Lian Liang, and Patrick Pang. "Determination of methyl mercury in dental-unit wastewater." Dental Materials 19 (2003) 675-679.

<sup>29</sup> Vandeven J, McGinnis SL. An Assessment of Mercury in the Form of Amalgam in Dental Wastewater in the United States. Water, Air and Soil Pollution 2005; 164:349-366 and AMSA. Mercury Source Control & Pollution Prevention Program Evaluation: Final Report, March 2002 (Amended July 2002).

<sup>30</sup> A. Cain, S. Disch, C. Twaroski, J. Reindl, C. Case. Substance Flow Analysis of Mercury Intentionally Used in Products in the United States. Journal of Industrial Ecology, 11, No. 3, 2007, pp. 61-75

<sup>31</sup> The estimate of nearly one metric ton includes 339 kg of emissions from land-applied biosolids. Such emissions are extremely difficult to estimate; this estimate is based on the assumption that 10% of dental mercury in land-applied biosolids is emitted to air over time. Carpi, A., Lindberg, S.E. (1997) "The Sunlight Mediated Emission of Elemental Mercury from Soil Amended with Municipal Sewage Sludge," Environmental Science and Technology 31(7): 2085-2091.

<sup>32</sup> Great Lakes Protection Fund, Great Lakes Pollution Prevention Centre, and Western Lake Superior Sanitary District. "Blueprint for Mercury Elimination: Mercury Reduction Project Guidance for Wastewater Treatment Plants," January 2002.

collaboration between the WLSSD and Northeast District Dental Society, included recommendations such as capturing amalgam waste in chair-side traps as well as vacuum pump traps.

A variety of educational materials are available for dentists to help implement BMPs and to select amalgam separators. Such materials include the “Best Management Practices for Amalgam Waste” video, created by the Naval Institute for Dental and Biomedical Research in collaboration with the ADA. The ADA distributed this video to every active dentist in the Great Lakes region.<sup>33</sup> In addition, ADA has produced an educational brochure and poster for dental offices describing the ADA’s BMPs; articles on amalgam separators published in the *Journal of the American Dental Association*; and ADA guidelines on Amalgam Accumulations in Dental Office Plumbing.<sup>24</sup>

The ADA has also initiated and led a successful effort to develop a standard for storing and preparing amalgam waste for delivery to recyclers or their agents for recycling, along with requirements for the containers used for storing and/or shipping amalgam waste. This standard, known as ANSI/ADA Specification No. 109, was developed by a working committee that included EPA representatives, state wastewater officials, shipping companies, recyclers and representatives from ADA and state dental societies.

In addition, a variety of programs have been implemented to train dentists, dental assistants, and dental hygienists in management of dental amalgam waste. For instance, the Kansas Small Business Environmental Assistance Program has created a curriculum that is now used by schools that train dental assistants—“The Proper Place for Dental Waste: A Curriculum for Kansas Dental Schools.”<sup>34</sup> Moreover, under a 2002 Memorandum of Understanding, Environment Canada and the Canadian Dental Association have worked together to incorporate training on best management practices for dental amalgam waste into Canadian dental school curricula.<sup>35</sup> The Naval Institute for Dental and Biomedical Research provides online continuing education courses for dentists in management of mercury in dental unit wastewater and of solid waste issues for dental offices.<sup>36</sup> And the U.S. EPA Office of Solid Waste (OSW) is currently working with at least one dental school to incorporate dental amalgam waste BMPs into the curriculum for dental students, as well as incorporating them into continuing education programs to reach practicing dentists.<sup>37</sup>

### **5.1.2.2 Elemental Mercury Collection Programs**

Many dental offices have stocks of elemental mercury left over from the days when dentists typically mixed their own amalgam. These mercury stocks create a risk of spill or of improper disposal. State and local governments can implement elemental mercury collection programs to deal with the legacy of unwanted elemental mercury in dental offices, now that the use of amalgam capsules is standard practice. Successful instances of such programs include:

- 1) In 1996, a statewide bulk mercury dental collection in Michigan, which netted 1,400 pounds of elemental mercury from 400 dentists at 11 drop-off sites established throughout the state.
- 2) An April 2003 collection event by the Indiana Department of Environmental Management in collaboration with the Indiana Department of Health, the Indiana Dental Association, and the Indiana Solid Waste

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<sup>33</sup> American Dental Association September 2005 [http://www.ada.org/prof/resources/topics/amalgam\\_bmp.asp](http://www.ada.org/prof/resources/topics/amalgam_bmp.asp),  
Naval Institute for Dental and Biomedical Research <http://www.dentalmercury.com/relatedlinks.htm>

<sup>34</sup> <http://www.sbeap.org/ppi/dental.asp>

<sup>35</sup> Canadian Dental Association and Environment Canada, Memorandum of Understanding (MOU), February 18, 2002.  
<http://www.ec.gc.ca/MERCURY/DA/EN/da-damou.cfm>

<sup>36</sup> <http://www.dentalmercury.com/>

<sup>37</sup> Mark Stone, Project Manager, Mercury Management Program [Naval Dental Research Institute](http://www.navalresearchinstitute.org). March 2007.

Management Districts in which 241 pounds of elemental mercury was collected from more than 50 dentists.<sup>38</sup>

- 3) Several collection events in Erie County, New York, which collected 162 pounds of elemental mercury.<sup>39</sup>
- 4) A statewide program in Pennsylvania started as a six-month pilot in the eastern region of the state and fully implemented in January 2006, that is collecting approximately 1,062 pounds of elemental mercury identified by Pennsylvania dentists as being available for pickup. The collection program is a collaborative effort between the Pennsylvania Department of Environmental Protection (DEP) and the Pennsylvania Dental Association,<sup>40</sup> with DEP inspectors collecting the mercury in conjunction with X-ray inspections at dental facilities.

### **5.1.2.3 Voluntary Installation of Amalgam Separators and Implementation of Best Management Practices for Waste Disposal**

Preliminary data from a number of locations, including Duluth, Toronto, Milwaukee, Minneapolis and Gurnee, show amalgam separators to be effective in reducing mercury loadings to wastewater treatment plants, and therefore in decreasing the mercury content of sewage treatment plant biosolids. In most cases, the separators installed were of the lower cost particulate removal types, yet there was a substantial decrease in mercury loadings.<sup>37</sup>

In the Duluth, Minnesota area, the Western Lake Superior Sanitary District initiated a pilot program to collect and recycle mercury collected in chair-side traps after an audit discovered amalgam waste being disposed of in solid waste or medical waste containers. After this pilot project and prior to the development of a Minnesota statewide voluntary program (see next paragraph), WLSSD achieved nearly universal installation of amalgam separators at dental offices in Duluth through a voluntary program. In this case, WLSSD purchased amalgam separators for several dental offices utilizing funds provided through the settlement of an enforcement case with a large facility. The effectiveness of the program and amalgam separator installations was demonstrated by the decrease of mercury in wastewater discharge from 300 to 86 mg of mercury per dentist per day from one medical building populated with many dental practices.<sup>41</sup>

The Minnesota Dental Association and Metropolitan Council Environmental Services (the wastewater treatment authority for the Minneapolis-St. Paul metropolitan area) are collaborating on a voluntary dental office amalgam separator program. This program promotes the installation of approved amalgam separators that remove at least 99% of amalgam particles from dental office wastewater.<sup>42</sup> Newly listed separators, or modified models, must also be certified. By participating voluntarily, dentists avoid imposition of regulatory requirements to install separators.<sup>43</sup> In 2007, the program within the Minneapolis-St. Paul metropolitan area has shifted to a regulatory approach, formally requiring offices that have not installed a separator to obtain a discharge permit and meet a mercury limit. As of April 2007, over 98% of the 749 metropolitan area offices have installed an amalgam separator. The Minnesota Dental Association is promoting the voluntary program

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<sup>38</sup> NEWMOA Mercury Reduction Programs Database, Dental Mercury Program, Indiana Department of Environmental Management, <http://www.newmoa.org/prevention/mercury/programs/MercuryProgramList.cfm>

<sup>39</sup> NEWMOA Mercury Reduction Programs Database, "Mercury P2 Education," Erie County Dept. of Environment and Planning, <http://www.newmoa.org/prevention/mercury/programs/MercuryProgramList.cfm>

<sup>40</sup> Memorandum of Understanding By and Between the Pennsylvania Department of Environmental Protection and the Pennsylvania Dental Association, January 2006.

<sup>41</sup> Great Lakes Protection Fund, Great Lakes Pollution Prevention Centre, and Western Lake Superior Sanitary District. "Blueprint for Mercury Elimination: Mercury Reduction Project Guidance for Wastewater Treatment Plants," January 2002.

<sup>42</sup> Minnesota Dental Association and Metropolitan Council "Re: Amalgam Recovery" March 2003  
[http://www.mndental.org/client\\_files/documents/amalgam\\_recovery.pdf](http://www.mndental.org/client_files/documents/amalgam_recovery.pdf)

<sup>43</sup> Minnesota Dental Association Amalgam Recovery Program [http://www.mndental.org/professionals/amalgam\\_recovery/index.html](http://www.mndental.org/professionals/amalgam_recovery/index.html)

statewide, and reports that 76% of the 710 offices in out state Minnesota have also installed a separator.<sup>44</sup> Another voluntary amalgam separator installation and BMP program has taken place in Ohio through collaboration between the Ohio Dental Association and the Northeast Ohio Regional Sewer District.

The Canadian Council of Ministers of the Environment endorsed a “Canada-wide Standard (CWS) on Mercury for Dental Amalgam Waste” in 2001. The goal of the CWS is to reduce mercury release from dental amalgam waste discharges into the environment by 95% of 2000 baseline values by 2005.<sup>45</sup> The implementation of best management practices plus the installation of ISO 11143 certified separators, as recommended by the standard, enables Canadian dentists to contribute to reaching the goal. In order to show commitment to implementing the standard, the Canadian Dental Association and Environment Canada signed a Memorandum of Understanding in February of 2002.<sup>46</sup> Accountability is realized through the authority of the federal Minister of the Environment, who can exert his authority via the Canadian Environmental Protection Act of 1999 if necessary. Additionally, certain provinces and municipalities have regulations or bylaws in place to help enforce the standard.

#### **5.1.2.4 State-Mandated Installation of Amalgam Separators**

A New York State law passed in 2002 and effective in March of 2003 prohibits the use of non-encapsulated elemental mercury in dental offices and requires dentists to recycle any elemental mercury or dental amalgam waste generated in their offices in accordance with corresponding regulations. Regulations developed by the New York State Department of Environmental Conservation pursuant to this law became effective on May 12, 2006, and require dental facilities to install, properly operate, and maintain mercury amalgam separation and collection equipment compliant with ISO 11143 standards and capable of 99% removal efficiency.<sup>47</sup> Amalgam separators must be certified, except if installed in larger clinics.

Vermont has a similar requirement for installation of amalgam separators. In both states, exceptions are made for dental offices that do not place amalgam fillings, such as orthodontists, periodontists, endodontists, and maxillofacial surgeons.<sup>48</sup>

Local governments have used existing authority to require pretreatment of wastewater released to the treatment plant. For instance, the Milwaukee Metropolitan Sewerage District (MMSD) has implemented regulations mandating amalgam separator installation and implementation of Best Management Practices.<sup>49</sup>

#### **5.1.2.5 Regulating Discharge and Mercury Handling Practices**

States can require wastewater treatment plants to control dental mercury inputs if the treatment plants are not meeting discharge limits. In all of the Great Lakes states, sewage treatment plants are required to establish pollutant minimization programs (PMPs) if their effluent levels for certain pollutants, including

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<sup>44</sup> Peter Berglund, Metropolitan Council Environmental Services, personal communication, May 2, 2007.

<sup>45</sup> Canada-wide Standard (CWS) on Mercury for Dental Amalgam Waste <http://www.ec.gc.ca/MERCURY/DA/EN/c-w-s.cfm>

<sup>46</sup> Canadian Dental Association and Environment Canada’s Memorandum of Understanding  
<http://www.ec.gc.ca/MERCURY/DA/EN/da-damou.cfm>

<sup>47</sup> Pursuant to Environmental Conservation Law (ECL) Section 27-0926, as enacted by Chapter 506, Laws of 2002, the New York State Department of Environmental Conservation (NYSDEC) adopted new regulations, 6 NYCRR Subpart 374-4 - Standards for the Management of Elemental Mercury and Dental Amalgam Wastes at Dental Facilities.  
<http://www.dec.state.ny.us/website/dshm/redrecy/374regs.html>

<sup>48</sup> Vermont Department of Environmental Conservation “Environmental Best Management Practices Guidelines for Dental Offices”  
<http://www.anr.state.vt.us/dec/ead/mercury/dental/>

<sup>49</sup> Milwaukee Metropolitan Sewerage District Dentist Offices and Mercury  
[http://www.mmsd.com/rules/dentist\\_offices\\_and\\_mercury.cfm](http://www.mmsd.com/rules/dentist_offices_and_mercury.cfm) and [http://www.mmsd.com/news/news\\_detail.cfm?id=10](http://www.mmsd.com/news/news_detail.cfm?id=10)

mercury, exceed water quality standards.<sup>50</sup> The Great Lakes water quality criterion limits the amount of mercury in effluent from Publicly Owned Treatment Works (POTWs) to 1.3 ng/L,<sup>51</sup> and any POTW exceeding this limit would have to develop and implement a PMP aimed at reducing mercury inputs, including inputs from dentists.

Under these requirements, Wisconsin sewage treatment plants that do not meet water quality discharge standards for mercury must require dental offices to minimize the discharge of mercury to their sewerage system. WDNR recommends implementation of amalgam BMPs and installation of an amalgam separator as the preferred means for complying with sewer use ordinance limits on mercury discharges to the sanitary sewer. BMPs, including amalgam separator installation, need to be implemented within two years of submittal of the treatment plant mercury PMP plan to WDNR. The MMSD has required dental offices to install amalgam separators by February 2008, and other major Wisconsin municipalities must impose similar requirements over the next several years.<sup>52</sup>

#### **5.1.2.6 Removing Obstacles to Use of Alternative Dental Restorative Materials**

In the United States, federal, state and local governments have generally avoided restricting the use of dental amalgam, preferring to leave decisions about what materials should be used to dentists and patients. However, there have been some efforts to promote the use of non-mercury materials on a voluntary basis. Moreover, some agencies have considered policies to remove barriers to the choice of non-mercury materials. These barriers include inadequate dental insurance coverage for alternatives.

The Federal Indian Health Service has encouraged use of non-mercury restorative materials. Department of Health and Human Services Public Health Service Bemidji Area Indian Health Service Circular No. 02-01 on Mercury Use and Pollution Prevention Policy Issuance requests that acceptable alternatives to mercury or mercury-containing devices, items and reagents be purchased and utilized, including the use of non-mercury dental restorative materials instead of dental amalgam. However, the circular acknowledged that cost considerations may prohibit universal utilization of non-mercury restorative materials. It states that dental professionals must evaluate the cost effectiveness vs. health care provision issues. Within the Bemidji area, which includes Minnesota, Michigan, Wisconsin, Indiana and Illinois, there are 34 federally recognized tribes, five urban programs and 3 federal direct service units that provide comprehensive health services for approximately 93,000 Indian people.

In some cases, dental insurers will not approve reimbursement for the use of non-mercury dental fillings. When dental insurance does approve non-mercury fillings, it frequently will provide reimbursement only up to the cost of an amalgam filling if the mercury-free filling is more expensive. A bill introduced to the Vermont legislature attempts to make coverage for non-mercury fillings more available: it would require coverage for mercury-free dental fillings when insurance coverage for dental fillings is provided, and would require the state “to ensure that the state employees’ dental insurance contract provides coverage for non-mercury dental fillings at no greater expense than for mercury-containing dental fillings.”<sup>53</sup>

#### **5.1.3 Recommended Actions**

5.1.3.1 Require dental offices that place or remove dental amalgam to use waste amalgam best-management-practices recommended by the American Dental Association including the installation

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<sup>50</sup> Federal Court Issues Decision on Great Lakes Water Quality Initiative (GLI)

<http://www.vssp.com/CM/Environmental%20Alerts/environmental%20alerts104.asp>

<sup>51</sup> Wisconsin Municipal Mercury Pollutant Minimization Program <http://dnr.wi.gov/org/caer/cea/mercury/potw.htm>

<sup>52</sup> Wisconsin Mercury in Wastewater Rule <http://www.dnr.state.wi.us/org/water/wm/ww/mercury/mercury.htm>

<sup>53</sup> Vermont H638, introduced 2005-2006 legislative session.

and maintenance of amalgam separators that meet the ISO 11143 standard. Separator installation should be universal among Great Lakes States not later than 01/01/2011, but may be required sooner if municipal or state policy warrant. Separator installation requirements should include provisions for dental office record keeping, reporting, oversight, and sewer use ordinance compliance integrated into municipal and state pretreatment programs. In addition to the installation and maintenance of amalgam separators, amalgam recycling may, in part, be accomplished in accordance with ANSI/ADA Specification No. 109.

- 5.1.3.2 Implement a program in cooperation with state or local dental associations to promote inclusion of instruction in dental office amalgam best management practices, including proper use of amalgam separators, in training programs for dentists and dental assistants, with a particular focus on continuing education for practicing dentists.
- 5.1.3.3 Support a joint effort with the dental community to ensure removal of remaining bulk elemental mercury from dental offices in states that have not already implemented such programs.
- 5.1.3.4 Undertake a joint effort with the dental community to ensure that adequate options for safe disposal of dental waste are available throughout the state.
- 5.1.3.5 Require that dental insurance plans allow for the use of non-mercury restorative materials, with full cost coverage of the most appropriate prescribed restoration material.
- 5.1.3.6. The states, either independently or with the appropriate dental association, should promote, and distribute literature for dental patients explaining alternative tooth restorative materials that are available for various dental treatments. The literature should be updated periodically as new restorative materials become available.

## 5.2 Thermostats<sup>54</sup>

### 5.2.1 Background

#### 5.2.1.1 Amount of Mercury Involved

Although the amount of mercury used in thermostats is declining and major manufacturers have ceased to produce mercury thermostats as the market shifts toward electronic thermostats, mercury thermostats are still manufactured and sold. Thermostat manufacturers reported selling thermostats containing more than 14 tons of mercury in 2004.<sup>55</sup> Of the three manufacturers that accounted for most of this mercury—Honeywell, General Electric, and White-Rogers—one, Honeywell, has stopped making mercury thermostats since 2004. Data is not available for more recent years, but this amount has been reduced substantially. However, since mercury thermostats are long-lived products, there will continue to be significant discards of mercury-containing thermostats, despite the recent trend in thermostat sales. New building construction and replacement of old thermostats each account for roughly half of mechanical thermostat sales,<sup>56</sup> so not all of the new thermostats sold correspond to old ones being discarded. Still, between 2 and 3 million mercury thermostats are retired per

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<sup>54</sup> This report will only consider thermostats designed for heating and cooling systems for buildings, not those for vehicles or appliances.

<sup>55</sup> Adam Wienert, IMERC Coordinator, Northeast Waste Management Officials Association, “Recent Trends in Mercury Use in Products: Summary of the IMERC Database.” Presentation to the Great Lakes Binational Toxics Strategy Mercury Workgroup, December 12, 2007. <http://www.epa.gov/bns/reports/stakedec2007/mercury/Wienert12-2007.pdf>

<sup>56</sup> Frost and Sullivan, North American HVAC Thermostat Markets, 2003, pp. 3-5, 3-19, quoted in Product Stewardship Institute’s Thermostat Stewardship Initiative Background Research Summary of 2004. (link to MS Word version of this document online at <http://productstewardship.us/displayPage.php?pageid=173>)

year nationwide,<sup>57</sup> and at approximately 3 grams of mercury per thermostat, this corresponds to between 6.6 and 10 tons of mercury from thermostats being discarded in the United States annually.

In 1994, an EPA study determined that about 90% of the 70 million residential thermostats in use in the United States at the time, or about 63 million units, used mercury.<sup>58</sup> This percentage has been decreasing as mercury-free programmable electronic thermostats gain a wider share of the market, but because of the long product life of thermostats and because mercury ones are still regularly being sold and installed, a significant number of mercury thermostats remain in use. In its comments on the first draft of the *Global Mercury Assessment* report prepared by the United Nations Environment Programme, the United States estimated that there are 230 tons of mercury in its current domestic mercury thermostat inventory, i.e. currently in use or in stock for sale.<sup>55</sup>

The U.S. government's ENERGY STAR program and many states in the Great Lakes region recommend programmable thermostats, which can save energy since users can preset them to run HVAC systems at lower levels when buildings will be unoccupied (e.g. residences during the day; office buildings at night). All programmable thermostats are electronic and do not contain mercury. The decreasing cost of digital programmable thermostats and the potential energy savings associated with them are leading more people to replace their mercury thermostats with digital, increasing the need for proper disposal outlets for mercury thermostats.

### **5.2.1.2 Releases of Mercury**

Because the glass vial of mercury in a thermostat is completely enclosed within a metal or plastic case, there are rarely problems with accidental direct exposure while the thermostat is in use. Rather, the mercury is typically released when a thermostat is discarded with household or construction and demolition waste. The glass vial can break en route to the disposal facility or in a landfill and from there the mercury can leach into groundwater or diffuse into the air. In a trash incinerator, the mercury will volatilize into the atmosphere. Alternatively, if a thermostat is left in a building that is demolished, it will likely break and release the mercury. According to U.S. EPA's 2002 estimates, each year about 6-8 tons of mercury from discarded thermostats ends up in solid waste facilities and 1-2 tons are released into the air.<sup>55</sup>

## **5.2.2 Existing Programs**

### **5.2.2.1 Product Phase-Out**

#### **5.2.2.1.1 Sale Ban**

Some states have banned the sale of mercury thermostats by regulating retailers and wholesalers. In Oregon, installation of mercury thermostats in homes and commercial establishments is prohibited.<sup>59</sup> Recently, California made it illegal to sell thermostats that contain mercury,<sup>60</sup> as did Michigan,<sup>61</sup> Maine,<sup>62</sup> Connecticut,<sup>63</sup> Rhode Island<sup>63</sup> and Massachusetts.<sup>64</sup> New York prohibits the sale and distribution of mercury-containing

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<sup>57</sup> Obenauf, Patrick, and Steven Skavroneck. "Milwaukee Mercury Source Sector Assessment for the Greater Milwaukee Area", Prepared jointly by: The Pollution Prevention Partnership and the Milwaukee Metropolitan Sewerage District September 1997.

<sup>58</sup> Mercury Usage and Alternatives in the Electrical and Electronics Industries EPA 600 SR-94/047 May 1994. Available at <http://nepis.epa.gov>

<sup>59</sup> Oregon State Law ORL 455.355.

<sup>60</sup> California Assembly Bill 1369, session 2003-2004

<sup>61</sup> P.A. 492 of 2006.

<sup>62</sup> Public Laws of Maine, CHAPTER 620 H.P. 1501 - L.D. 2004. Online at [janus.state.me.us/legis/ros/lom/LOM120th/4Pub601-650/Pub601-650-19.htm](http://janus.state.me.us/legis/ros/lom/LOM120th/4Pub601-650/Pub601-650-19.htm)

<sup>63</sup> Tom Metzner, Connecticut Department of Environmental Protection, March 2007.

<sup>64</sup> Chapter 190 of the Acts of 2006, online at <http://www.mass.gov/legis/laws/seslaw06/sl060190.htm>

thermostats, except to the blind or visually impaired, after January 1, 2008, if a non-mercury alternative is available.<sup>65</sup> Ohio also prohibits the sale and distribution of mercury-containing thermostats, except to the blind or visually impaired, after April 6, 2008.<sup>66</sup> Numerous other states are considering similar bills.<sup>67</sup>

**5.2.2.1.2. Voluntary Product Phase-Out**

Honeywell, which previously was the largest producer of mercury thermostats, joined U.S. EPA's National Partnership for Environmental Priorities (NPEP). The company no longer manufactures mercury switches for thermostats. In October, 2006, Honeywell was the recipient of the NPEP award for ending its manufacturing of mercury switches.

**5.2.2.2 Collection Program**

In 1998, the three largest thermostat manufacturers (Honeywell, General Electric, and White-Rodgers) established the Thermostat Recycling Corporation (TRC). Under this program, TRC provides HVAC contractors (heating, ventilation, and air conditioning) with a collection bin for a one-time \$25 fee. The contractors can return discarded mercury thermostats to participating wholesalers. The wholesalers ship them at TRC expense to a Honeywell facility to be disassembled. The mercury components are then sent to a commercial mercury retort. Other than the fee for the collection bin, TRC pays all the costs of shipping and recycling.

This collection method was chosen because the majority of discarded thermostats are removed by HVAC contractors, and wholesalers were determined to be a sufficiently centralized location for maximal efficiency of collection. Individual homeowners and others are permitted to use the wholesalers' drop boxes, but the program is not marketed toward them and is almost exclusively used by contractors.

The TRC program initially served 9 states and has now officially spread to all the lower 48 states, although in some areas participation rates are zero or close to zero. The following table shows TRC's collection results nationwide<sup>68</sup>:

Table 3. TRC nationwide collection results, 1998-2006

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Lbs of Hg	163	237	256	402	530	626	729.43	819.91	1082.5	4846
Thermostats	15,270	27,780	31,611	48,215	61,487	64,957	80,094	87,899	113,658	530,971

While the numbers show a marked increase over time, overall collection rates are low. Some may be discarded via household hazardous waste (HHW) programs, but based on statistics from Connecticut, where an estimated 21,796 thermostats were discarded and only 148 were collected by the Department of Environmental Protection's HHW program, this method of disposal accounts for less than 1%.<sup>69</sup> It seems probable, therefore, that almost all discarded mercury thermostats are thrown away with construction and demolition waste or in the ordinary household trash. Using the estimate of 2 million mercury thermostats discarded annually, even the most recent year's results only indicate that about 6% of mercury thermostats are reclaimed through the TRC program, and that there are still more than 1.8 million mercury thermostats being retired annually through other disposal methods.

<sup>65</sup> Ch. 676, Laws of 2005

<sup>66</sup> ORC 3734.65, 2007

<sup>67</sup> A state-by-state searchable list is available at <http://www.epa.gov/epaoswer/hazwaste/mercury/laws.htm>

<sup>68</sup> Data for this and the following table is self-reported by TRC and is available online at <http://www.nema.org/gov/ehs/trc/upload/TRC%2006%20YEAR%20END%20SUMMARY.xls>.

<sup>69</sup> Review of the Thermostat Recycling Corporation Activities in the Northeast. By the Northeast Waste Management Officials' Association (NEWMOA) November 2001. [www.newmoa.org/prevention/mercury/trcreport.pdf](http://www.newmoa.org/prevention/mercury/trcreport.pdf)

Most of the Great Lakes states have been served by TRC since its inception and have among the highest numbers in the country for quantities collected. Still, they only collect a small percentage of discards. The eight Great Lakes states are home to 28% of the U.S. population.<sup>70</sup> Assuming that thermostats are discarded at roughly the same rate per capita nationwide, at least 560,000 mercury thermostats are discarded each year in these states, while about 51,000 are collected by TRC. Although this capture rate of approximately 9% is higher than the national average, it still leaves the vast majority of mercury thermostats in the trash.

Table 4. TRC results: Number of thermostats collected in Great Lakes states

	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Illinois	471	1,872	2,080	3,635	2,148	3,009	3,128	3,597	4,596	24,536
Indiana	639	2,701	3,429	4,490	3,689	5,851	4,340	5,763	6,080	36,982
Michigan	498	831	1,060	1,701	2,320	2,289	2,969	2,573	3,528	17,769
Minnesota	7,107	8,739	7,170	10,237	15,394	8,486	9,832	8,512	11,660	87,137
New York			2,083	1,334	1,041	1,829	2,473	2,211	3,915	14,886
Ohio	930	2,124	2,257	3,390	3,453	3,961	4,348	5,146	6,841	32,450
Pennsylvania			278	1,632	2,346	2,575	4,609	5,065	7,019	23,524
Wisconsin	2,057	3,489	3,312	4,825	6,800	5,086	7,373	6,660	7,708	47,310
<b>Total GL</b>	11,702	19,756	21,669	31,244	37,191	33,086	39,072	39,527	51,347	284,594

A blank indicates that TRC did not operate in that state during that year.

The Clean Air Foundation, located in Ontario, Canada, operates the “Switch the Stat” program, an initiative that helps encourage the installation of energy efficient programmable thermostats and responsibly recovers older, mercury-containing thermostats. Between April 2006, when the voluntary pilot program began, and December 18, 2007 the “Switch the Stat” mercury thermostat collection program has collected 9,591 switches from HVAC contractors/wholesalers. This represents the safe recovery of 52.8 pounds (24 kg) of mercury.

#### 5.2.2.2.1 Incentives

In order to boost participation, some wholesalers have offered incentives to contractors who turn in thermostats. In Hennepin County, Minnesota, and Pinellas County, Florida, various wholesalers offered \$2 toward the purchase of an electronic thermostat for each returned mercury thermostat.<sup>71</sup> Error! Bookmark not defined. These two counties had the highest return rates nationwide as measured by NEWMOA’s 2001 report, and the two states of Minnesota and Florida had the highest collection rates of any state participating in 2000-2001 – more than twice as many thermostats as any other state.<sup>68</sup> Under a Maine law, TRC provides a \$5 payment for every mercury thermostat brought to a state-approved collection site.

The Product Stewardship Institute (PSI), a coalition of representatives from state and local environmental agencies, initiated an experimental incentive project with the TRC that lasted through the end of 2006. A \$50,000 U.S. EPA grant supported a collaborative effort by PSI, TRC, the Indiana Department of Environmental Management, the Oregon Department of Environmental Quality, and Portland General Electric to run pilot projects in Indiana and Oregon. These incentive projects give a mail-in coupon for a rebate on the purchase of a new ENERGY STAR programmable (mercury-free) thermostat in exchange for each mercury thermostat recycled through TRC.<sup>72</sup>

<sup>70</sup> U.S. Census 2005.

<sup>71</sup> Review of the Thermostat Recycling Corporation Activities in the Northeast by the Northeast Waste Management Officials Association (NEWMOA) November 2001. [www.newmoa.org/prevention/mercury/trcreport.pdf](http://www.newmoa.org/prevention/mercury/trcreport.pdf)

<sup>72</sup> More pilot project information available at <http://productstewardship.us/displayPage.php?pageid=239>

In Indiana, the TRC companies underwrote the \$3 rebates, so the coupons were only usable for thermostats manufactured by those companies. Portland General Electric funded Oregon's \$4 rebates, and any ENERGY STAR thermostat was eligible for the rebate, regardless of manufacturer.

The final report for this project, "Mercury Thermostat Recycling: Effect of Financial Incentive for HVAC Contractors in Two State Pilots"<sup>73</sup>, was released on November 12, 2007. In Oregon, the pilot recovered 4587 thermostats, an increase of 124% from 2005, and exceeded its performance goal of recovering 4000 thermostats. In Indiana, the pilot recovered 6080 thermostats, an increase of 6% from 2005, compared to a performance goal of 9000 thermostats. There were similar increases in the numbers of participating wholesalers in each state. In the first six months of 2007, after the incentives were discontinued, collections in both states fell back close to levels seen in 2005 prior to the pilot.

The report reaches seven conclusions about incentives in general and the specific incentive system used in this pilot project. For the full text of each conclusion, as well as recommendations for further research, see pages 17 to 2- of the full report. These conclusions have important implications for every type of program designed to recover mercury and mercury-containing products at end of life from households and businesses.

1. A financial incentive can result in increased collection of thermostats. It can be an effective motivational tool to increase mercury thermostat recycling for those contractors requiring additional motivation. The effectiveness of this tool will depend on the amount and logistics of the incentive provided, how long it is offered, and whether its availability is effectively communicated to contractors.
2. Not all contractors will need an incentive to participate. There appear to be at least two classes of HVAC contractors – those who will participate without an incentive because it is the "right thing to do" (e.g., environmental sensitivity) and those that need other motivation to be convinced to recycle.
3. The increase in thermostat collection was much higher in Oregon than in Indiana. Factors contributing to this differential in performance include the relative maturity of the Indiana program, fewer thermostat brands eligible for the rebate in Indiana, and the lower amount of the rebate in Indiana. Another contributing factor was the greater level of education and outreach conducted in Oregon as compared to Indiana, including the temporary use of a dedicated intern in Oregon who made personal contact with wholesalers and contractors.
4. The administrative costs of operating this pilot were very high, although these costs can be substantially reduced by simplifying the administration of the incentive, by not verifying Energy Star purchases, and by using staff billed at a rate commensurate with the tasks involved.
5. Other incentive mechanisms are likely to be simpler, more effective, less costly, and more widely accepted than the rebate off an Energy Star purchase. This conclusion is based on data such as the small number of contractors who took advantage of the pilot incentive in both states, the small number of coupons that were redeemed, and contractor survey results that indicated a preference for at least two other incentives. This conclusion is also based on the inherent complexity of the rebate mechanism that was designed, and the resulting cost of administering the pilot.
6. Education and outreach should be a strong component of all thermostat recycling programs. These programs should be conducted collaboratively among thermostat manufacturers,

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<sup>73</sup> Mercury Thermostat Recycling: Effect of Financial Incentive For HVAC Contractors in Two State Pilot  
<http://productstewardship.us/displaycommon.cfm?an=1&subarticlenbr=102>

retailers, government agencies, environmental groups, and other stakeholders. However, one significant barrier demonstrated in other Product Stewardship Institute/Thermostat Recycling Corporation (PSI/TRC) thermostat pilot projects is the limited ability by most state and local government agencies to undertake aggressive education and outreach activities, due to lack of funding and staff resources.

7. Prior to this pilot, PSI had attributed low contractor participation in the TRC program to three significant factors – lack of awareness of the program, an inadequate number of convenient collection locations, and insufficient motivation. This pilot demonstrates that the most successful results will be achieved by addressing all three factors.

#### **5.2.2.2 Outreach and Promotion of TRC**

In order to raise awareness of the hazards of improper disposal of mercury thermostats, some states have developed outreach programs aimed at homeowners, builders, and HVAC contractors. While recycling rates are low nationwide, TRC results are markedly higher for the states that have made outreach efforts, including Minnesota, Florida, Indiana, and Wisconsin.<sup>68</sup>

The Wisconsin Department of Natural Resources, with the help of an EPA Great Lakes National Program Office (GLNPO) grant,<sup>74</sup> developed print and internet versions of a fact sheet to promote residential recycling of mercury-containing thermostats.<sup>75</sup> It also implemented a pledge program within Wisconsin to recognize HVAC contractors and wholesalers who recycle mercury-containing thermostats and encourage use of non-mercury thermostats, and maintains a list of these contractors and wholesalers on its website.<sup>76</sup> In 2002, the New York State Department of Environmental Conservation sent an informational letter to approximately 800 HVAC contractors across the state and to the municipal recycling coordinators as well. The letter noted that it is illegal for businesses to dispose of thermostats in construction and demolition debris or with the regular trash and suggested participation in the TRC program. It also identified the roughly 30 HVAC wholesalers in New York State that were participating in the TRC program.

#### **State Outreach to Wholesalers**

In order to further promote TRC's collection program, PSI is working with state officials and U.S. EPA to contact wholesale chains to encourage them to participate.<sup>77</sup> Washington State, supported in part by an EPA grant, spent \$75,000 on thermostat-related outreach over 2005<sup>78</sup> and collected 3,260 thermostats,<sup>68</sup> translating to a cost of \$23 per thermostat. Florida sent out letters to its largest wholesalers, but had received no response four months later.<sup>78</sup> In Minnesota, the Pollution Control Agency called wholesalers and obtained a positive response, according to the PSI's report.<sup>78</sup> Minnesota's collection rate decreased from 2004 to 2005 by 13%, however.<sup>68</sup> In 2002, New York State also prepared and distributed letters to all New York State HVAC wholesalers to inform them of the TRC collection programs and to encourage their participation. Collection results increased for two years following that effort.

#### **Providing Contractor Collection Bins**

PSI is also seeking to make participation easier for large contractors by eliminating the step of delivering old thermostats to a wholesaler, allowing contractors to ship thermostats directly to TRC. In Wisconsin in 2005, the Department of Energy Administration provided funding for 200 bins to be provided free of charge to

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<sup>74</sup> Pollution Solutions II: Continuing to Promote Pollution Prevention in the Great Lakes Basin. EPA publication 905-R-05-004, September 2005.

<sup>75</sup> View the fact sheet online at [http://dnr.wi.gov/org/aw/wm/publications/hazard/co\\_110.pdf](http://dnr.wi.gov/org/aw/wm/publications/hazard/co_110.pdf)

<sup>76</sup> Available at <http://www.dnr.state.wi.us/org/caer/cea/mercury/thermostat/businesses/index.htm>

<sup>77</sup> Wholesaler Outreach project description at <http://www.productstewardship.us/displayPage.php?pageid=237>

<sup>78</sup> PSI Summary [http://www.productstewardship.us/supportingdocs/Hg\\_ExpansionSummary1.16.06.doc](http://www.productstewardship.us/supportingdocs/Hg_ExpansionSummary1.16.06.doc)

contractors. As of January 2006, 80 bins had been requested.<sup>78</sup> Collection results in 2005 did not show any improvement due to this initiative: 6,660 thermostats were collected, a 10% decrease from the previous year.<sup>68</sup> But in 2006, Wisconsin's collection rates reached an all-time high of 7,708, potentially as a result of this initiative for contractors.

### **Collection through Household Hazardous Waste programs**

HHW programs in Illinois, Minnesota, Wisconsin, Washington and Florida conducted pilot programs with TRC to allow homeowners and other non-professionals to drop off old thermostats at HHW sites for TRC recycling.<sup>79</sup> From May through December 2006, 72 permanent facilities, 111 mobile facilities and 14 one-time events collected 3,007 discarded mercury thermostats containing 22 pounds of mercury.

The program is now being expanded: any HHW program in the United States can participate by requesting a collection bin from TRC for a one-time fee of \$25. TRC covers all subsequent costs, including transportation, disassembly and recycling of the thermostats.

The major concern with the pilot program was the high rate of improper materials returned. 37% of bins returned through the pilot program contained items other than intact mercury thermostats; typically mercury thermometers and other mercury-containing products or broken or disassembled thermostats. Since TRC's operation relies on thermostats being regulated as universal rather than hazardous waste, improper materials cause safety concerns and legal issues. Therefore, TRC is communicating strongly to its new HHW partners the importance of shipping back intact thermostats only.

#### **5.2.2.3 Disposal Legislation**

Some states are addressing the problem of improper disposal by regulating the disposal of mercury-containing products, including thermostats. California,<sup>80</sup> Minnesota,<sup>81</sup> and New York<sup>82</sup> prohibit the disposal of mercury-containing thermostats with solid waste. They must either be recycled or disposed of with other hazardous waste.

Maine's laws prohibit disposal of mercury-containing products in ordinary solid waste facilities<sup>83</sup> and require wholesalers to operate a take-back program with incentives for contractors to return thermostats.<sup>84</sup> Wholesalers can either participate in an existing program such as TRC or simply collect the thermostats themselves provided that they dispose of them in accordance with certain restrictions.

### **5.2.3 Recommended Actions**

- 5.2.3.1 Implement statewide bans on sale and/or installation of mercury thermostats. This sales restriction could be accomplished through the general ban on mercury-containing products recommended in section 7.1. States are encouraged to phase out mercury thermostats as early as is practical and appropriate, but no later than 2015.
- 5.2.3.2 Mandate collection and proper management of mercury-containing thermostats at the end of the product's life through TRC or other programs.

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<sup>79</sup> Product Stewardship Institute, Thermostat Collection at HHW Facilities, Final Report, March 27, 2007.

<sup>80</sup> California Assembly Bill 1369, session 2003-2004

<sup>81</sup> Minnesota Statute 115, 116. See <http://ros.leg.mn/stats/115A/932.html>

<sup>82</sup> Senate Bill S04469, session 2005-2006. Online at <http://assembly.state.ny.us/leg/?bn=S04469&sh=t>

<sup>83</sup> Title 38, section 1663. Online at <http://janus.state.me.us/legis/statutes/38/title38ch16-Bsec0.html>

<sup>84</sup> [http://www.mainelegislature.org/legis/bills\\_121st/billtexts/LD190102-1.asp](http://www.mainelegislature.org/legis/bills_121st/billtexts/LD190102-1.asp)

- 5.2.3.3 Taking into account the results of the PSI pilot incentive project, require manufactures or wholesalers to offer financial and/or non-financial incentives to motivate consumers and contractors to collect and return mercury thermostats for recycling.
- 5.2.3.4 Promote the use of ENERGY STAR qualified programmable thermostats (which are both mercury-free and energy-efficient).
- 5.2.3.5 Increase awareness of recycling options by encouraging do-it-yourselfers as well as HVAC building contractors to return thermostats to Thermostat Recycling Corporation (TRC) or other collection centers.
- 5.2.3.6 Include thermostat collection in household hazardous waste collections, potentially in partnership with TRC.
- 5.2.3.7 Encourage retailers to offer collection for household thermostats, either as part of a national program, if available, or in partnership with state programs.

## 5.3 Switches, Relays, and Measurement and Control Devices

### 5.3.1 Background

A large variety of switches, relays, and measurement and control devices contain mercury. There is risk of direct exposure when these devices break during use and mercury volatilizes in a home or workplace. Some types of barometers are particularly subject to spills, since they must be periodically refilled with mercury, creating a potential for accidents. Moreover, mercury from these devices enters the environment when they are disposed of, particularly if the device is incorporated into a piece of equipment that is recycled to make new iron or steel (see Steel Sector §6.2).

Mercury has been used in significant quantities in electrical switches and relays since the 1960s, and for more than 100 years in various measurement devices. Mercury use in switches and relays peaked in the late 1980s, and in measurement devices in the 1950s through 1970s.<sup>85</sup> Mercury continues to be used in new devices in significant quantities, especially in relays.<sup>86</sup> As a result, there are large inventories of mercury-containing equipment in use in U.S. industry, institutions, and residences. According to a study by the U.S. Geological Survey, there were approximately 2,670 metric tons of mercury in wiring devices and switches in use in the United States in 1996, and an estimated 331 metric tons in measurement devices. While these amounts have likely decreased in the last 10 years as the result of decreased production of new mercury-containing devices, stockpiles are drawn down very slowly because of the long service life of many of these products, especially electrical devices. U.S. EPA estimates that 50% of electrical switches remain in service for 50 years or more, and that only 10% are discarded within 10 years.<sup>87</sup>

<sup>85</sup> Jasinski, S.M. *The Materials Flow of Mercury in the United States*. U.S. Geological Survey. Information Circular 9412 (1994).

<sup>86</sup> USGS tracked mercury use in the category “wiring devices and switches” through 1997, when 57 metric tons (mt) of mercury were used, down from the peak of 84 mt in 1995. See U.S. Geological Survey, *Minerals Yearbook*, 1995 and 1997, available at: <http://minerals.usgs.gov/minerals/pubs/commodity/mercury/>. Since 1997, trends in mercury use for this category are unclear, but substantial uses remain. The Northeast Waste Management Officials Organization (NEWMOA) estimates that roughly 50 mt of mercury were used in switch and relay components sold in the United States in 2001. Relays accounted for approximately 30 mt (60%) of this amount. This figure excludes thermostats, which NEWMOA estimates accounted for more than 13 mt of use in 2001, and switches and relays used in cooking appliances, which accounted for 3.5 mt of use in 2001. See NEWMOA. Fact Sheet: Mercury Use in Switches & Relays. Nov 2005. Available at [www.newmoa.org/prevention/mercury/imerc/FactSheets/switches.doc](http://www.newmoa.org/prevention/mercury/imerc/FactSheets/switches.doc). Since 2001, mercury use for auto switches has ended and mercury use for thermostats has decreased, but there is little indication of significant changes in other uses of switches and relays.

<sup>87</sup> Sznopce, J.L., and T. G. Goonan. *The Materials Flow of Mercury in the Economies of the United States and the World*. USGS Circular 1197 (2000).

Table 5 lists products in the switch, relay, and measurement and control device category that can contain mercury. Related products that are sometimes grouped with this category, including thermostats, auto switches, and fever thermometers, are discussed elsewhere in this strategy.

Table 5. Switches, relays, and measurement and control devices that can contain mercury

Switches	Relays	Measurement & Control Devices
chest freezers	computer devices	barometers
Washing machines	level indicators	hygrometers/psychrometers
gas ranges	industrial welding equipment	flow meters
gas hot-water heaters	steam generators	hydrometers
sump and bilge pumps	transformers	manometers
space heaters	street and parking area lighting	pyrometers
dishwashers	railroad and traffic signals	non-fever thermometers
gas furnaces	drying ovens	sphygmomanometers

For a list of additional devices that contain mercury, see the Great Lakes Regional Pollution Prevention Roundtable/ Illinois Waste Management & Research Center fact sheet at [http://www.glrppr.org/docs/mercury\\_in\\_industry.htm](http://www.glrppr.org/docs/mercury_in_industry.htm).

In many cases, new products such as chest freezers, washing machines and space heaters are no longer being made with mercury switches, the older models are still in service. Although a few measuring devices are no longer being produced using mercury (e.g., flow meters, pyrometers), several mercury-containing measurement devices continue to be manufactured, including mercury barometers, hygrometers/psychrometers, manometers, non-fever thermometers, and sphygmomanometers. The quantity of mercury in measuring devices varies. For instance, mercury manometers used on dairy farms can contain up to 340 grams of mercury; the mercury content of sphygmomanometers varies from 20 to 60 grams.<sup>88</sup>

For each type of measuring device, mercury-free alternatives are available that are at least as accurate as products containing mercury. However, in the case of non-fever thermometers, mercury is still considered to be the standard for temperature-sensing devices.<sup>89</sup> The use of mercury sphygmomanometers has significantly decreased in hospitals and clinics across the country as a result of regulation (particularly in the northeastern states) and cooperative voluntary agreements such as the 1998 memorandum of understanding between the American Hospital Association and the U.S. EPA, as well as award recognition and outreach contributions from groups like Hospitals for a Healthy Environment and Health Care Without Harm.<sup>90</sup>

Many household appliances or “white goods” contain mercury switches and thermocouples to open or close electrical circuits. For instance, mercury has been used in heat sensors for pilot lights in gas ranges, in tilt switches to turn on lights in chest freezers, and in switches to detect a lid opening or severely out-of-balance washing machine. Most household appliances are no longer manufactured using mercury or must be labeled if they incorporate a mercury-containing device (labeling of mercury-added consumer products is a regulatory requirement in some states).<sup>91</sup> As mentioned above, these appliances are collected for their scrap metal value,

<sup>88</sup> Environment Canada. 2004. Source of Mercury – Mercury-containing Products. Available at: <http://www.ec.gc.ca/MERCURY/SM/EN/sm-mcp.cfm?SELECT=SM>.

<sup>89</sup> Galligan, C., Morose, G., and J. Giordani. 2003. An Investigation of Alternatives to Mercury Containing Products. Prepared for the Maine Department of Environmental Protection by the Lowell Center for Sustainable Production.

<sup>90</sup> Health Care Without Harm. Available at <http://www.noharm.org/details.cfm?type=document&ID=1114>.

<sup>91</sup> Vermont Agency of Natural Resources. 2002. Household Appliance Mercury Switch Removal Manual. Available at <http://www.anr.state.vt.us/dec/ead/mercury/PDF/appman.pdf>. Accessed September 2006. For details on Vermont’s mercury-added products labeling law, see [www.anr.state.vt.us/dec/ead/mercury/manreq/index.htm](http://www.anr.state.vt.us/dec/ead/mercury/manreq/index.htm).

and mercury may be released to the environment when the appliances are recycled or disposed of. To avoid the release of mercury, mercury-containing components can be removed and properly managed prior to recycling of the appliance. The identification and removal of mercury-containing devices from household appliances can take as little as one minute for some appliances and up to twenty minutes for others.

Mercury relays (also called mercury contactors) are used in a variety of industrial and commercial electric heating, lighting, switching, and control applications. Mercury relays are manufactured for use in plastic extruders (injection molding), vacuum forming, steam generators, boilers, street and parking area lighting, emergency lighting, tungsten lamps, drying ovens, ultraviolet curing, temperature control, flashers, railroad and traffic signals, computer devices, automated equipment, and other commercial applications. Mercury is often found in relays located in distribution boxes in buildings for applications such as regulating stair lights. A number of types of machinery and equipment can contain mercury, including level indicators in skylifts and mobile ladders, industrial welding equipment, forestry machinery, gas-operated relays in transformers, and manufacturing machinery.

Mercury-free relays are available that can exceed the performance of typical mercury relays. At the time they were introduced, mercury relays had advantages over electromechanical and solid state relays and some industrial users are therefore reluctant to change. Mercury relays have proven durable in adverse conditions of temperature, dust, and moisture and offer compact size, low contact resistance, rapid on-off cycling capability, low coil power requirements, and quiet action. At present, however, many industry experts believe solid state relays can outperform mercury relays in terms of cycling capacity and quiet action, and there are very few applications where mercury relays are preferable.<sup>63</sup>

### **5.3.2 Existing Programs/Policies**

There are many approaches for eliminating mercury use in switches, relays and measurement and control devices and for encouraging proper product disposal or recycling. These approaches include restrictions on the sale of such products, outreach to sectors that utilize mercury-containing products, state and municipal government purchasing policies, labeling requirements, and improved opportunities for households and small businesses to recycle mercury-containing products and components. These latter three approaches are addressed in the crosscutting strategies section. Here we address restrictions on sale and sector outreach.

#### **5.3.2.1 Restrictions on Sale**

Several states have restricted the sale of broad categories of mercury-containing products, including mercury switches and relays. Others have restricted numerous categories of mercury-containing switches, relays, and measurement and control devices. These restrictions typically include exemptions for products designated under a federal regulatory requirement, replacement devices for existing equipment, and circumstances where an adequate mercury-free device is not available.

For instance, in Illinois, the sale or distribution of mercury electrical switches and relays is prohibited, beginning July 1, 2007. The Illinois law includes mercury switches and relays sold individually or as a product component. The law excludes switches and relays used in medical diagnostic equipment regulated under the Food, Drug and Cosmetic Act; at electric generating facilities; in thermostats to sense and control room temperature; or required under federal law or federal contract specifications. Also excluded are replacement switches and relays for a product in use prior to July 1, 2007, if the larger product is used in manufacturing, or the switch or relay is not physically separate from other components in the larger product. Manufacturers may apply for an exemption to this rule, if they can show that there is a “convenient and widely available” system in place for properly collecting and disposing of the device at the end of its useful life, and if they can show that continued sale of the device would provide benefits to the environment, public health, or public safety, in

comparison with the alternatives.<sup>92</sup> Manufacturers have applied for exemptions for eight different products, including replacement sensors in anti-lock brakes, wetted relays in power contact output modules, gas supply oven safety valves and tilt switches for liquid level control.

In New York State, the sale or distribution of most categories of mercury measuring devices, switches, and relays will be prohibited by 2008.<sup>93</sup> The prohibition includes mercury switches and relays sold individually or as a product component. However, the prohibition does not extend to mercury-added products if the use of such product is a federal requirement; to the replacement of mercury-added products that are a component of larger products in use prior to the regulation; or to the resale of mercury-added consumer products manufactured prior to the regulation. The law also requires the New York State Department of Environmental Conservation to issue written findings in 2008, and subsequently in response to written request, regarding mercury sphygmomanometers, mercury wetted reed relays, mercury flame sensors, non-fever mercury thermometers and mercury thermostats, except for mercury thermostats used by a visually impaired person. These findings shall determine whether non-mercury alternatives are comparable in price to, are as effective in performance as, and are as accurate and precise as the mercury devices. Upon finding that non-mercury alternatives are comparable, sale and distribution of the mercury device would be prohibited.

Minnesota specifically bans the sale, installation, or repair of mercury manometers for use on dairy farms, and requires that mercury manometers on dairy farms be removed from use. Minnesota and Michigan law also prohibits the sale or distribution of mercury thermometers used in industrial applications, with some exceptions.<sup>94</sup>

### **5.3.2.2 Sector-Based Outreach**

A number of programs are underway to work with industrial sectors that use mercury containing electrical and measurement devices. Other sections of this report address efforts to work with schools, scrap yards, manufacturing industry generally, health care and veterinary facilities, and households.

Additional programs can be tailored based on the mercury-using industries that are important in particular states or municipalities. For instance, some Great Lakes states have many dairy farms that use mercury manometers to measure vacuum changes in milking systems. These measurement devices contain up to one pound of mercury per unit. Many dairy farms have switched to non-mercury alternatives, but many still have their old mercury manometers.

The Wisconsin Department of Natural Resources (WDNR) operates a recycling program for mercury manometers used in milking houses.<sup>95</sup> The program offers financial incentives to encourage the replacement of old mercury manometers with alternative digital manometers or other mercury-free gauges at end-of-life. Farmers receive a \$200 rebate when a mercury manometer is replaced with a digital manometer. Replacement is typically performed by a farmer's regular dairy equipment service provider to assure that the mercury is safely handled and that the new gauge is accurately installed. Mercury manometers can be recycled at Agriculture Clean Sweeps. WDNR will also pay a service provider \$100 to find and remove obsolete mercury manometers that are left behind when a dairy farm goes out of business or a farmer stops milking cows. As of May 1, 2004, more than 525 manometers, which equates to approximately 405 pounds of mercury, had been collected and

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<sup>92</sup> See <http://www.epa.state.il.us/mercury/mercury-illinois.html>.

<sup>93</sup> For mercury hydrometers and manometers, the provisions take effect January 1, 2007. For mercury switches and relays, the provisions take effect January 1, 2008. See <http://www.dec.state.ny.us/website/dshm/redrecy/chap145.html> (Section 27-2107).

<sup>94</sup> See <http://www.revisor.leg.state.mn.us/stats/116/92.html> and Michigan law section 324.17202

<sup>95</sup> See <http://www.dnr.state.wi.us/org/caer/cea/mercury/program.htm#Dairy>.

recycled. An estimated 100 mercury manometers still remain on Wisconsin dairy farms, though not all Wisconsin dairy farmers are eligible for the reimbursement program.

New York also allows dairy farmers to manage unwanted mercury-containing dairy manometers in its Clean Sweep collection program for unused or outdated pesticides. Unfortunately, no funding is provided to pay for replacement devices, but some farmers have taken advantage of this free collection program and have phased out the use of mercury-containing manometers.

Minnesota provided funding for removal and replacement of dairy barn manometers through the Agriculture Department's dairy inspectors. These inspectors visit dairy farms regularly, and under Minnesota's program, also removed mercury-containing devices from former dairy barns where manometers were still installed.<sup>96</sup>

A dairy farm mercury manometer exchange program was piloted in Michigan in 1998 and expanded statewide in 2000. The exchange program was co-sponsored by the Michigan Department of Agriculture (MDA) and the MDEQ. It offered dairy farmers up to \$250 credit toward the cost of replacing mercury manometers with mercury-free vacuum gauges. In all, the project replaced 131 mercury manometers and collected 158 pounds of liquid elemental mercury.<sup>97</sup>

### **5.3.3 Recommended Actions**

- 5.3.3.1 Implement legislation to phase out the sale and distribution of electrical switches and relays and measurement and control devices, including thermometers. The restriction should include mercury devices sold individually or as a product component, and should include a mechanism to allow for use of a mercury device when a suitable alternative is not available or when replacement components are needed for existing equipment. This sales restriction could be accomplished through the general ban on mercury-containing products recommended in section 7.1. States are encouraged to phase out mercury electrical switches and relays and measurement and control devices, including thermometers, as early as is practical and appropriate, but no later than 2015.
- 5.3.3.2 Develop product labeling requirements to promote proper management of products and product components that are exempted from the phase-out (see §7, Crosscutting Strategies).
- 5.3.3.3 Conduct outreach to users of equipment that contains mercury switches to notify them of proper end-of-life disposal and identify alternative mercury-free products.
- 5.3.3.4 Encourage national and international standard-setting bodies to establish standards that utilize non-mercury technology for measuring devices. Support the initiative by the Northeast states to work with ASTM to revise standards for non-mercury temperature measurement.
- 5.3.3.5 Provide dairy farms with information on cost-effective, non-mercury containing gauges, and on proper management options available for disposal of mercury manometers. Seek funding initiatives and collection system alternatives to assist dairy farmers in the removal of mercury manometers, including manometers no longer in use. Continue to include and promote the collection of dairy manometers and other mercury-containing devices in household hazardous waste (HHW) and "Clean Sweep" programs.

## **5.4 Lamps**

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<sup>96</sup> John Gilkeson, Minnesota Office of Environmental Assistance, December, 2006.

<sup>97</sup> Steve Kratzer, Michigan Department of Environmental Quality. December, 2006.

## 5.4.1 Background

### 5.4.1.1. Amount of Mercury Involved

Many types of light bulbs contain mercury, from the 4-foot-long fluorescent lights often used in office buildings to specialized lamps used for high-tech applications such as curing ultraviolet inks and coatings used in manufacturing and commercial printing. This section focuses on the most widely used types of mercury-containing lamps: the familiar tube-shaped fluorescent bulbs and the newer compact fluorescent light (CFL) bulbs that the EPA's ENERGY STAR program recommends as an energy-efficient substitute for standard incandescent bulbs.<sup>98</sup>

Use of these fluorescent lamps is recommended by U.S. EPA and the Department of Energy and many states despite their mercury content. The energy efficiency and long life of fluorescent lamps reduces demand for burning of fossil fuels and hence reduces emissions of mercury and other pollutants from power plants. Mercury-free, energy-efficient lighting technologies will likely replace mercury in the decades to come and are already used in some applications. But at present, mercury-containing fluorescent bulbs are the economically and environmentally preferred option for many general lighting applications. Decreasing the amount of mercury used in lamps and increasing recycling rates can minimize mercury releases from fluorescent lamps.

The quantity of mercury contained in bulbs varies greatly among categories of lamps, and within these categories there is also variation among manufacturers. CFLs contain small quantities, typically less than 5 mg of mercury. The long fluorescent bulbs usually contain more mercury than CFLs do. A study of lamps sold in 2004 found that 88% contained more than 5 mg, 40% contained more than 10 mg, and 12.5% contained more than 50 mg of mercury.<sup>99</sup> Most of the lamp sector's mercury is accounted for by the long fluorescent bulbs. In 2004, for example, fluorescent tubes containing more than 12,000 pounds of mercury were sold in the United States, along with CFLs containing more than 650 pounds.<sup>100</sup> Sales of CFLs have significantly increased in the last year, and will continue to increase as more consumers buy CFLs.

The quantity of mercury in lamps has been decreasing over the past decades: technological developments made possible a 60% reduction between 1996 and 2006 in the average amount of mercury per lamp. The number of fluorescent lamps in use increased, however, so total mercury use has decreased in this sector by only 30%.<sup>101</sup>

Annually in the United States, about 670 million fluorescent lamps are discarded, of which approximately 150 million are recycled.<sup>102</sup> Nationwide in 2003, for example, about 23% of fluorescent lamps were recycled.<sup>103</sup> The remaining 77% were either landfilled or incinerated.

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<sup>98</sup> The light bulb manufacturing industry typically refers to individual bulbs as "lamps," and the words "lamp" and "bulb" will be used interchangeably throughout this document.

<sup>99</sup> Statistics from bulbs sold in 2004. Northeast Waste Management Officials' Association fact sheet "Mercury Use in Lighting" p. 12. online at [newmoa.org/prevention/mercury/imerc/factsheets/lighting.pdf](http://newmoa.org/prevention/mercury/imerc/factsheets/lighting.pdf)

<sup>100</sup> Ibid, p. 10. (<http://newmoa.org/prevention/mercury/imerc/factsheets/lighting.pdf>) These numbers are self-reported by lamp manufacturers, so these statistics may underreport the actual number if not all companies participate in the reporting program.

<sup>101</sup> Thomas Goonan, U.S. Geological Survey, abstract of presentation for the August 2006 International Mercury Conference in Madison, WI. (abstract online at [www.usgs.gov/newsroom/article.asp?ID=1535](http://www.usgs.gov/newsroom/article.asp?ID=1535))

<sup>102</sup> The business sector recycles about 27% of its discarded lamps; the residential sector only about 2%. Paul Abernathy, President, Association of Lighting and Mercury Recyclers, written commun., 2004. qtd. in USGS 1196-U Mercury Recycling in the United States in 2000. William E. Brooks and Grecia R. Matos published 2005. Online at [http://pubs.usgs.gov/circ/c1196u/Circ\\_1196\\_U.pdf](http://pubs.usgs.gov/circ/c1196u/Circ_1196_U.pdf)

<sup>103</sup> [http://www.nema.org/lamprecycle/docs/ALMR\\_capacity\\_statement.pdf](http://www.nema.org/lamprecycle/docs/ALMR_capacity_statement.pdf)

The amount of mercury in discarded lamps should be decreasing in parallel with the declining mercury content of lamps, with a lag time of a year or more between sale and disposal. The National Electrical Manufacturers Association (NEMA) estimates that in 2003 seven tons of mercury was contained in lamps sold in the United States, down from 23.6 tons in 1990, 17 tons in 1994, 13 tons in 1999, and nine tons in 2001.<sup>104</sup> However, if the use of compact fluorescent lamps in place of incandescents increases, the quantity of mercury disposed will rise if recycling rates do not increase.

#### **5.4.1.2 Mercury Releases**

Since each fluorescent bulb contains only a small amount of mercury (much less than a fever thermometer or household thermostat), and since bulbs are rarely handled while in use, exposure due to accidental breakage of a single bulb while in use is not usually a major concern. However, breakage of multiple bulbs can occur when lamps are stored and transported.

End-of-life disposal is the larger source of environmental release; burned-out bulbs that are thrown in the trash are likely to break in or en route to a landfill. One study found that under ordinary ambient temperature conditions, an estimated 17-40% of the mercury contained in a broken lamp evaporates into the atmosphere within two weeks.<sup>105, 106</sup>

If lamps are incinerated rather than landfilled, a higher percentage of the mercury vapor will be released from the lamps. The vapor that is not captured by a control device escapes into the atmosphere and eventually falls back to earth with rain or as a particulate and enters lakes and streams. Nationwide, fluorescent lamps account for an estimated 2-4 tons of mercury air releases annually, according to a 2004 study, with a larger amount going into landfills.<sup>105</sup> Air releases will decline as recycling rates improve and as the mercury content of disposed lamps declines.

### **5.4.2 Existing Programs and Policies**

#### **5.4.2.1 Disposal Regulations**

Under the Resource Conservation and Recovery Act (RCRA), generators may assume that their discarded mercury-containing lamps are hazardous waste and manage them accordingly. Alternatively, generators can test their mercury-containing lamps using the Toxicity Characteristic Leaching Procedure (TCLP) to simulate how much mercury might leach out under typical landfill conditions. RCRA allows for lamps that test less than a threshold value of 0.2 mg/liter of mercury emitted to be disposed of as solid waste and hence either landfilled or incinerated. Lamps that fail the TCLP test or that are not tested must be managed as either hazardous waste or universal waste, depending on the state laws.<sup>107</sup>

But federal regulations allow significant numbers of lamps to be disposed of as solid waste. For instance, RCRA allows universal or hazardous waste lamps that come from households or conditionally exempt small quantity generators to be disposed of in the ordinary municipal solid waste stream. The household

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<sup>104</sup> NEMA, *Fluorescent and other Mercury-Containing Lamps and the Environment: Mercury Use, Environmental Benefits, Disposal Requirements*, March 2005 (online at <http://www.nema.org/gov/ehs/committees/lamps/upload/Lamp%20Brochure%20Final%203%2005.DOC>).

<sup>105</sup> Michael Aucott, Michael McLinden, and Michael Winka. *Release of Mercury from Broken Fluorescent Bulbs*. February, 2004 (online at <http://www.state.nj.us/dep/dsr/research/mercury-bulbs.pdf>)

<sup>106</sup> Michael Aucott, NJ DEP, qtd. in *Pollution Prevention and Management Strategies for Mercury in the New York/New Jersey Harbor*. By Allison L. C. de Cerreño, Marta Panero, and Susan Boehme. May 14, 2002 by the New York Academy of Sciences.

<sup>107</sup> Universal waste and hazardous waste both require the same end treatment, but regulations on documentation and transport and collection of universal waste are less stringent in order to facilitate and encourage proper treatment. *Hazardous Waste Management System; Modification of the Hazardous Waste Program; Hazardous Waste Lamps*. Federal Register, vol. 64 no. 128. July 6, 1999. Ibid, pp. 36466-36490.

exemption applies to multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas as well as to single-family homes. Conditionally exempt small quantity generators (CESQGs) are businesses or institutions that generate less than 100 kilograms of nonacute hazardous waste in a month and never accumulate more than 1,000 kilograms at a time.

Moreover, mercury-containing lamps that pass the TCLP can be thrown in the trash regardless of generator status. Unfortunately, lamps that pass the TCLP test may still release significant mercury vapor to the air and cumulatively may release significant quantities of mercury to landfill leachate.

Therefore, many states have established rules and/or regulations stricter than RCRA. For instance, Minnesota prohibits the disposal of mercury-containing lamps into solid waste regardless of source, even from households.<sup>108</sup> California, Connecticut, Florida, Maine, Massachusetts, New York, Ohio, Pennsylvania, Rhode Island and Vermont require CESQGs (but not households) to recycle hazardous waste lamps. And some states, including *Minnesota*<sup>108</sup> and *New York*,<sup>109</sup> prohibit disposal of all lamps that contain mercury, regardless of whether the lamps pass the TCLP test.

#### **5.4.2.2 State-mandated Labeling**

In order to improve compliance with disposal regulations, Minnesota<sup>108</sup> and several other states have required wholesalers and distributors of mercury-containing lamps to include flyers describing the applicable rules, packaged with the lamps they sell or attached to invoices. As a result of state requirements, manufacturers have started labeling all the fluorescent lamps they sell nationwide with disposal information.<sup>110</sup> These labels or flyers typically include information on recycling options as well as the applicable laws.

#### **5.4.2.3 State-mandated Recycling Targets**

Massachusetts requires its lamp manufacturers to distribute disposal information with the lamps they sell in order to help meet recycling targets. The state has established yearly goals for increasing rates of recycling participation: 30% by the end of 2008, 40% in 2009, 50% in 2010, and 70% each year following 2010. Recycling rates are to be measured based on the quantity of lamps available for recycling, using a method to be established by the state's environmental department. If the goal is not met in any given year, the lamp manufacturers are required to contribute funding up to \$1 million to the state to be used for municipal recycling programs. The share of the funding each company must contribute is determined by its market share and by the effectiveness of its disposal information distribution program.<sup>111</sup>

#### **5.4.2.4 Educational Outreach**

The Association of Lighting and Mercury Recyclers (ALMR), NEMA, and the Solid Waste Association of North America (SWANA) are working with an EPA grant to increase the fluorescent lamp recycling rate through outreach and education. Their collaboration has resulted in an educational CD and brochures aimed at people who handle spent lighting material or manage recycling and disposal decisions.<sup>112</sup> These are distributed via the ALMR and NEMA websites as well as direct mailings and handouts at seminars.<sup>113</sup> Their goal is to increase the fluorescent lamp recycling rate to 40% nationwide by 2006, and 80% by 2009. According to an

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<sup>108</sup> Minnesota Waste Management Act (available online at [www.moea.state.mn.us/berc/WMA-hg-01.pdf](http://www.moea.state.mn.us/berc/WMA-hg-01.pdf))

<sup>109</sup> Households and small businesses that dispose of no more than 15 lamps monthly are exempt from this requirement. Under New York's rules, small businesses are not the same as CESQGs: they are defined as being independently owned and operated and having 100 or fewer employees. Chapter 145, Laws of 2004, Mercury-Added Consumer Products Law  
<http://www.dec.state.ny.us/website/dshm/redrecy/chap145.html>

<sup>110</sup> [http://www.ewire.com/display.cfm/Wire\\_ID/1468](http://www.ewire.com/display.cfm/Wire_ID/1468), <http://www.epa.gov/region5/air/mercury/meetings/December03/bleasby.pdf>

<sup>111</sup> Chapter 190 of the Acts of 2006 <http://www.mass.gov/legis/laws/seslaw06/sl060190.htm>

<sup>112</sup> <http://www.epa.gov/region5/air/mercury/meetings/December03/buscher.pdf>

<sup>113</sup> ALMR, personal communication with Jessica Winter, October 12, 2006.

ALMR representative, response has been “overwhelmingly good,” but current recycling statistics are not available.

#### **5.4.2.5 Providing Recycling Options**

In Vermont, a collection program was established in July 2005 by a partnership between the state Department of Environmental Conservation and True Value hardware stores to take back spent fluorescent lamps from consumers for recycling.<sup>114</sup> It has since expanded to include Ace hardware stores as well so that now 63 stores in the state provide lamp recycling to small volume generators.<sup>115</sup> A number of electrical wholesalers in Connecticut and throughout the Northeast also provide recycling of lamps from commercial customers. Without this type of program, the only alternative to the trash for most households would be household hazardous waste collections, and most consumers would choose not to keep waste around for such a long period of time in between collections.<sup>116</sup>

#### **5.4.2.6 Limiting Use of Mercury in Lamps**

##### **Voluntary**

Member companies of the National Electrical Manufacturers Association have voluntarily agreed to limit the use of mercury in CFLs to 5 or 6 mg, depending on the wattage. This commitment took effect April 15, 2007.<sup>117</sup> Ten companies have made this pledge so far, including some of the nation’s largest lighting manufacturers.

##### **Mandatory**

The Canadian Council of Ministers of the Environment issued a requirement in 2001 for manufacturers collectively to reduce average mercury content in lamps by 70% by 2005 and 80% by 2010 from a 1990 baseline number of 43 mg.<sup>118</sup> In 2004, they reported that they had exceeded their goal: there had been a 73% reduction to an average of 11.4 mg.

#### **5.4.2.7 Product Bans**

Although in most cases fluorescent lights’ energy efficiency advantage justifies their use of small amounts of mercury, in some applications the energy savings do not justify the use of mercury. For instance, some car headlights contain mercury, which is emitted when the headlights break. The small amount of energy that is conserved would not have been drawn primarily from power plants but instead from the car battery. Therefore, non-mercury headlights are preferable for use in vehicles.

In New York State, Chapter 611 of the Laws of 2006 will stipulate that, starting with motor vehicle model year 2011, motor vehicles sold in New York State cannot contain any mercury-added component, including switches, sensors, lights and navigational systems among others. The “mercury-added component” within this statute is defined as a component containing more than 15 mg of mercury. Therefore, not all mercury-added components in motor vehicles are subject to the ban. Also, components that are subject to the current ban may become exempt as progress is made in developing products with lower mercury content.

There are high-efficiency alternatives to mercury-containing fluorescent lights that are not suitable for home and commercial use because of their poor color rendering, but that would be satisfactory for other uses

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<sup>114</sup> [http://www.newmoa.org/prevention/newsletters/15\\_2/Vol15\\_2.htm#vt-dec-update5](http://www.newmoa.org/prevention/newsletters/15_2/Vol15_2.htm#vt-dec-update5)

<sup>115</sup> [http://www.newmoa.org/prevention/newsletters/16\\_2/Vol16\\_2.htm#vt-dec-update2](http://www.newmoa.org/prevention/newsletters/16_2/Vol16_2.htm#vt-dec-update2)

<sup>116</sup> U.S. EPA provides information about lamp recycling opportunities and links to information about state and local lamp recycling programs at <http://www.epa.gov/epaoswer/hazwaste/id/univwast/lamps/index.htm>

<sup>117</sup> <http://www.nema.org/media/pr/20070313a.cfm>

<sup>118</sup> [http://www.ccme.ca/ourwork/pollution.html?category\\_id=120](http://www.ccme.ca/ourwork/pollution.html?category_id=120)

such as lighting parking lots at night. Indiana considered a bill in 2003 that would have prohibited the sale or installation of mercury vapor lamps for outdoor use and also would have required all such lamps in use at the time to be removed.<sup>119</sup> This bill never became law, however.

#### 5.4.2.8 Regulating Drum Top Crushers

Lamp recycling necessitates shipping the spent lamps from the collection site to the recycler, which can be costly. In order to consolidate the bulky bulbs, some companies use a drum top crusher. This device fits directly on the top of a 55-gallon drum and crushes the fluorescent lamps into the drum below. It reduces the volume by almost an order of magnitude, so it represents a cost savings for companies handling large quantities of lamps. It is designed to contain the mercury vapors, but an EPA study<sup>120</sup> found that there are some situations in which mercury vapor concentrations in the vicinity of a drum top crusher can exceed health standards, so it presents a potential exposure risk for the operator and for anyone else using the same ventilation system. The researchers found that three of the four models of drum top crushers they tested were satisfactory for human health when properly assembled and operated, but that even these devices leaked under some conditions, either when improperly sealed and assembled or after extended use when the filters became saturated. *Mercury vapor concentrations also failed to meet safety standards during the switching operation when the drum top crusher is moved onto a new drum and the full drum is sealed for transport.* Testing on a fourth commercially available model was discontinued because it repeatedly failed to meet health and safety standards.

Because of these concerns, some states are choosing to regulate the use of drum top crushers. Michigan requires air emissions permits for bulb crushers.<sup>121</sup> Additionally, lamps that are crushed can no longer be managed as universal waste but are subject to the stricter requirements for hazardous waste.<sup>122</sup> Indiana, New York, Ohio, Pennsylvania, and Wisconsin regulate drum top crushers via their waste management rules. In these states, crushing mercury-containing lamps is considered treatment of hazardous waste and requires permitting and compliance with emissions and reporting regulations.<sup>123</sup> Under some circumstances, the same is true in Minnesota.<sup>124</sup> In Illinois, drum top crushers do not require permits and can be used if certain safety and notification procedures are followed.<sup>125</sup>

#### 5.4.3. Recommended Actions

- 5.4.3.1 Require recycling of mercury-containing lamps by all generators (except households) regardless of whether the lamps are TCLP-compliant.
- 5.4.3.2 Work with household hazardous waste programs, utilities, retailers, manufacturers and others to provide collection programs for households and small businesses and others who need to dispose of small quantities of spent fluorescent bulbs, and work with these stakeholders to consider regulatory and programmatic options for increasing lamp recycling from households and small businesses.
- 5.4.3.3 Ban the sale of mercury lamps for which adequate energy-efficient, mercury-free alternatives are available, such as car headlights. States considering a sales ban should consider whether or not it should apply to replacement parts for mercury-containing products currently in use.

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<sup>119</sup> <http://www.in.gov/legislative/bills/2003/IN/IN1839.1.html>

<sup>120</sup> <http://www.epa.gov/epaoswer/hazwaste/id/univwast/drumtop/drum-top.pdf>

<sup>121</sup> Steven Kratzer, Michigan Dept. of Environmental Quality, October 25, 2006.

<sup>122</sup> <http://www.deq.state.mi.us/documents/deq-ead-tas-univwaste.pdf>

<sup>123</sup> Indiana: <http://www.in.gov/idem/programs/land/hazwaste/guidance/universalwasterule.pdf>

New York: <http://www.dec.state.ny.us/website/dshm/hzwstman/bulbs2.htm>

Ohio: [http://www.epa.state.oh.us/dhwm/pdf/Universal\\_Waste\\_Rules\\_for\\_Handlers\\_of\\_Lamps.pdf](http://www.epa.state.oh.us/dhwm/pdf/Universal_Waste_Rules_for_Handlers_of_Lamps.pdf)

Pennsylvania: <http://www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1242&Q=462311>

Wisconsin: <http://dnr.wi.gov/org/aw/wm/publications/hazard/BulbrecyclingWA195-03.pdf>

<sup>124</sup> <http://www.pca.state.mn.us/programs/lsi/solutions-spring01.pdf>

<sup>125</sup> <http://www.epa.state.il.us/land/fluorescent-lamps/>

5.4.3.4 Require permits for the use of drum top crushers in order to ensure that only those that meet emissions requirements are used. States can do this by classifying crushing as treatment of hazardous or universal waste, or by regulating it under their state air quality standards.

## 5.5 Mercury Fever Thermometers

### 5.5.1 Background

#### 5.5.1.1 Amount of Mercury Involved

Although mercury fever thermometers contain only a small quantity of mercury (roughly 1 gram in each), they present an environmental and health concern because their use is widespread. Many hospitals and health care organizations used to freely distribute mercury-containing thermometers to patients before non-mercury alternatives were available. By the mid-1990's, approximately 17 tons of mercury from discarded fever thermometers was introduced into the United States solid waste stream each year, and much of this ended up being volatilized into the atmosphere in incinerators.<sup>126</sup> As recently as 2002, in New England alone, at least one and a half tons of mercury was sold to consumers in fever thermometers.<sup>127</sup> Since then, nearly all retailers have substituted mercury thermometers with non-mercury alternatives for sale to consumers, and hospitals have phased out mercury thermometers as well. But while new fever thermometers do not represent a significant source of mercury pollution to the Great Lakes region, there are many old mercury thermometers still in use in households throughout the region.

The risk of accidental exposure from mercury thermometers is particularly high in comparison to other mercury-containing household products (such as thermostats) because of the easily breakable glass and the portability of the device. They are one of the most common sources of mercury exposure reported to emergency spill and poison control hotlines.<sup>128</sup> Moreover, children and pregnant women, the segments of the population most susceptible to mercury poisoning, regularly use thermometers. First line responders such as poison control centers and public health departments need to take extra precautionary measures for spills occurring in areas frequented by sensitive populations.

#### 5.5.1.2 Releases of Mercury

Mercury-containing fever thermometers can easily be broken when they are shaken down before use or when they fall out of a cluttered medicine cabinet onto a sink or floor. In these cases, the quantity of mercury released is small, and if the cleanup is accomplished properly, it does not pose a major threat to humans or the environment.<sup>129</sup> But even small spills can create dangerously high exposures to mercury vapor if they are not cleaned up properly. Few people are familiar with the correct methods for cleaning up a mercury spill. As a result, a number of problems can occur:

- The mercury from a broken thermometer can be rinsed down the drain and increase the mercury influent to the local wastewater treatment plant. Additionally, mercury in a bathroom sink is likely to settle in the J-trap of the plumbing system. This endangers the inhabitants of the house because it can then evaporate over a prolonged period of time into the small, usually windowless room, resulting in concentrated vapors and an inhalation hazard.

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<sup>126</sup> U.S. Environmental Protection Agency, 1996, Mercury Study Report to Congress, Science Advisory Board Review Draft, Vol. 2, p. 4-19, p. ES-3.

<sup>127</sup> Quantities self-reported by manufacturers to IMERC [Interstate Mercury Education & Reduction Clearinghouse] [http://www.newmoa.org/prevention/mercury/imerc/FactSheets/measuring\\_devices.cfm](http://www.newmoa.org/prevention/mercury/imerc/FactSheets/measuring_devices.cfm)

<sup>128</sup> Peter Pettit, New York State Department of Environmental Conservation. 2006.

<sup>129</sup> Mercury: Emergency Spill and Release Facts. U.S. EPA 540-K-97-004

- Vacuuming up spilled mercury disperses it into the air and contaminates the vacuum cleaner so that it could continue to disperse mercury every time it is used.
- When thermometers are thrown into household trash, a portion of the mercury can volatilize en route to final disposal or be released from an incinerator or landfill into the atmosphere or water table.

## **5.5.2 Existing state or local programs or policies**

### **5.5.2.1 Product Bans**

Some of the Great Lakes states have taken legislative action concerning mercury fever thermometers. In Illinois it is illegal to manufacture or sell them, and Indiana, Michigan, Minnesota, New York and Ohio also prohibit their sale.<sup>130</sup> Local ordinances ban the sale of mercury thermometers in parts of Wisconsin as well.<sup>131</sup>

### **5.5.2.2 Voluntary Phase-Out**

In addition, many of the large pharmacy chains and other retailers have already agreed to a voluntary moratorium on the sale of mercury thermometers.<sup>132</sup> For the most part, consumers are being offered alternatives to traditional mercury thermometers, such as digital (with recyclable mercury batteries), liquid crystal, and gallium thermometers. These alternatives are within the same price range as mercury thermometers. While one of these environmentally safer options would most likely be chosen for the purchase of a new thermometer, an individual who has a 20-year-old mercury thermometer in perfect working condition is unlikely to decide to discard it and purchase a replacement.

### **5.5.2.3 Thermometer Exchanges (Collection for safe disposal)**

Many local agencies have coordinated collection programs to try to encourage the public to get rid of mercury thermometers. In some cases, these are one-time events: for one day, an organization will manage a collection site where individuals can drop off their mercury thermometers for safe management. Often, such events will promote participation by offering an exchange, such as a free or discounted digital thermometer for those who bring in their mercury ones. The collected thermometers are usually transported to a recycling facility so that the mercury can be reused in other applications to help reduce the need for mining of virgin mercury. One-time events like this have occurred all over the country, including within the Great Lakes states. For example, the Michigan Department of Environmental Quality, with funding from the U.S. EPA's Great Lakes National Program Office, helps local hospitals, municipalities, schools, health departments and businesses to host thermometer exchange events. To date, 81 such events have taken place in Michigan capturing 40,000 mercury-containing devices and nearly 1,000 pounds of liquid elemental mercury.<sup>133</sup> Health Care Without Harm has prepared a brochure of advice on how to coordinate such a program.<sup>134</sup> In addition, unwanted mercury-containing thermometers can generally be managed through household hazardous waste collection programs (see Households §6.5).

### **5.5.2.4. Awareness/education initiatives**

Many state health departments and environmental protection agencies have online advice on the management of mercury thermometers and cleaning up spills from broken thermometers. Indiana's Department

<sup>130</sup> The sale bans provide some exceptions to avoid conflict with doctor prescriptions and federal requirements.

Illinois: Public Act 93-165. July 2004.

Indiana: Indiana Code 13-20-17.5. July 2003.

Michigan: Natural Resources and Environmental Protection Act 451 section 324.17202. January 2003.

Minnesota: Minnesota Statutes 116.92. 2001.

New York: Environmental Conservation Law Article 27, Title 2107.

<sup>131</sup> Dane County, WI Code of Ordinances Chapter 34. Racine, WI Municipal Code, Article XXVIII Section 66, passed March 2001.

<sup>132</sup> Health Care Without Harm's January 2003 list of "mercury-free" pharmacies <http://www.noharm.org/us/mercury/mercuryFree>

<sup>133</sup> MDEQ "Draft" Mercury Strategy, September 2006

<sup>134</sup> The brochure is available at [http://www.noharm.org/library/docs/How\\_to\\_Plan\\_and\\_Hold\\_a\\_Mercury\\_Thermometer\\_\\_3.pdf](http://www.noharm.org/library/docs/How_to_Plan_and_Hold_a_Mercury_Thermometer__3.pdf)

of Environmental Management has a clear and user-friendly guide to cleanup,<sup>135</sup> as does the U. S. EPA.<sup>136</sup> All of the Great Lakes states have telephone hotlines that people can call to obtain answers to questions and guidance on cleaning up mercury spills. However, the general public may not be fully aware of this information.

### **5.5.3. Recommended Actions**

5.5.3.1 Ban sale and distribution of mercury fever thermometers except by prescription. This sales restriction could be accomplished through the general ban on mercury-containing products recommended in section 7.1. States are encouraged to phase out mercury fever thermometers as early as is practical and appropriate, but no later than 2015.

5.5.3.2 Support funding and provide guidance for local thermometer exchange programs.

5.5.3.3 Increase public awareness of the hazards of thermometer breakage and the appropriate cleanup techniques for household mercury spills through outreach mechanisms such as placing information brochures in doctors' offices and booths at the county fairs as a supplement to online information.

## **6. PRIORITY SECTORS**

### **6.1 Schools**

#### **6.1.1 Background**

Schools may contain large amounts of mercury; both in equipment used in school buildings and in chemical supply storerooms for science class. While schools do not constitute one of the largest sources of mercury to the environment, they are places where children can be exposed to the hazards of mercury vapor when spills occur.

Products in school buildings containing mercury include mercury switches, mercury vapor lamps, and fluorescent light bulbs. Classrooms and facilities may have mercury-containing thermostats, thermometers, barometers, and silent wall switches. Other items sometimes found in schools that contain mercury include button cell batteries and old microwave ovens.

Science classrooms may contain jars of elemental mercury as well as mercury in Charles' law tubes, J tubes, diffusion demonstration apparatus, density demonstrations, sphygmomanometers, mercury compounds such as mercurous nitrate, mercuric nitrate, mercuric oxide, and solutions containing mercury such as Million's solution and Hayem diluting fluid. Other mercury products that may be found on school property include old latex paint produced before 1992, flooring material for gymnasiums produced by 3M Corporation from the 1970's,<sup>137</sup> and pesticides produced before 1994.<sup>138</sup>

Students, teachers, and other school employees have been exposed to hazardous mercury vapor because of spills. Spill incident reports from state and federal agencies indicate that mercury spills occur regularly in schools. Most high schools and middle schools have had one or more mercury spills involving elemental mercury, thermometers, sphygmomanometers, or barometers.

In addition to the risk of direct human exposure, mercury spills can close schools and cost thousands or even millions of dollars to decontaminate school facilities, buses, and homes exposed to the spilled mercury.

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<sup>135</sup> [http://www.in.gov/idem/your\\_environment/mercury/catalog/spill.pdf](http://www.in.gov/idem/your_environment/mercury/catalog/spill.pdf)

<sup>136</sup> <http://www.epa.gov/epaoswer/hazwaste/mercury/faq/spills.htm>

<sup>137</sup> Peter Pettit, NY DEC, Dec. 12, 2006. Personal commun.

<sup>138</sup> UW-Extension, 2003. Mercury in Schools. Last revised: October 10, 2003. Accessed: August 2006.

<http://www.mercuryinschools.uwex.edu/schools/where.htm>.

Equipment and any nonporous surfaces that come in contact with mercury need to be thoroughly decontaminated. Porous materials such as wood floors, clothing, and carpeting that are contaminated have to be replaced and disposed of as hazardous materials. Indoor air levels have to be monitored to ensure that mercury vapors have cleared.<sup>138</sup>

Using mercury-free equipment can eliminate mercury spills. Mercury-free thermometers, including red alcohol and digital thermometers, are generally sufficiently accurate and readily available. For all current instructional applications, safe, mercury-free alternatives are available.

If mercury is used in experiments, it is possible to use other chemicals to illustrate the same chemistry principles, or microscale experiments can be performed to reduce the amount of materials necessary and eliminate the need to store large quantities of mercury.

In addition, mercury-catalyzed polyurethane flooring has been used in schools within the Great Lakes states primarily for athletic floors, but also for cafeterias, kitchens, and other flooring. This may be an indoor air quality issue during its continued use and a demolition and disposal concern when removed. Michigan, Minnesota and Ohio have done Health Consultations on this issue.

### 6.1.2 Magnitude of the Problem

There are approximately 37,354 school buildings in the Great Lakes states, as shown in Table 6. These figures include public and private elementary, junior high, and high schools. The figures in Table 6 do not include colleges and universities, which are expected to contain more mercury than primary and secondary schools.<sup>139</sup>

Table 6. Number of School Buildings and estimated remaining mercury in schools in the Great Lakes States, Pre-K through Grade 12<sup>140</sup>

State	Number of School Buildings	Estimated Mercury Remaining (lbs)
Illinois	6,916	15,907
Indiana	2,860	6,578
Michigan	5,728	0 <sup>141</sup>
Minnesota	2,263	4,000 <sup>142</sup>
New York	7,498	16,891 <sup>143</sup>

<sup>139</sup> C. Hubbard, Minnesota Pollution Control Agency. October 2006. Personal commun.

<sup>140</sup> Sources: Illinois State Board of Education website [www.isbe.state.il.us/research/htmls/directories.htm](http://www.isbe.state.il.us/research/htmls/directories.htm).

Indiana Department of Education website <http://www.doe.state.in.us/asap/welcome.html>.

Michigan Center for Educational Performance and Information website [http://www.michigan.gov/cepi/0,1607,7-113-986\\_10485-74163--,00.html](http://www.michigan.gov/cepi/0,1607,7-113-986_10485-74163--,00.html).

Minnesota Department of Education website

[education.state.mn.us/mde/Data/Data\\_Downloads/School\\_and\\_District/Contact\\_Information/index.html](http://education.state.mn.us/mde/Data/Data_Downloads/School_and_District/Contact_Information/index.html)

New York State Education Department website <http://www.nysed.gov/admin/bedsdata.html>.

Ohio Department of Education website <http://www.ode.state.oh.us/GD/Templates/Pages/ODE/ODEDefaultPage.aspx?page=1>.

Pennsylvania Department of Education website

<http://www.pde.state.pa.us/k12/cwp/view.asp?a=165&Q=46056&k12Nav=|810|&k12Nav=|1141|810|>.

Wisconsin Department of Public Instruction website <http://dpi.wi.gov/schldist.html>.

<sup>141</sup> Michigan schools were reported to have removed mercury-containing instruments from their facilities two years in advance of the statutory deadline of December 31, 2004, set by Michigan Public Act 376 of 2000. See [http://www.michigan.gov/deq/1,1607,7-135-3585\\_4127\\_4175-11693--,00.html](http://www.michigan.gov/deq/1,1607,7-135-3585_4127_4175-11693--,00.html). While the amount of mercury collected at a collection event in May 2006 suggests that additional mercury remains in Michigan schools, a good estimate of the amount remaining is not available.

<sup>142</sup> The Minnesota Pollution Control Agency estimates that 4,000 pounds of mercury remains in 1,842 public and private middle schools and high schools in Minnesota. See <http://www.pca.state.mn.us/programs/mercury-free/goals.html>.

<sup>143</sup> The NY Department of Environmental Conservation (NY DEC) conducted pilot programs to remove mercury from 154 schools in Albany and Rochester. Knight, D., NY DEC. Personal communication, October 2006.

Ohio	4,670	10,741
Pennsylvania	4,861	11,180
Wisconsin	2,558	5,867 <sup>144</sup>
<b>TOTAL</b>	<b>37,354</b>	<b>71,164</b>

Note: These figures do not include colleges and universities.

The amount of mercury contained in school buildings in the Great Lakes states is uncertain. While some schools have been involved in programs to remove mercury or have conducted inventories of the amount of mercury contained in the school, many schools have made no effort to identify or remove elemental mercury or mercury-containing items.

Schools in Michigan were reported to have removed elemental mercury and mercury-containing instruments as required by Michigan law. However, a collection event for schools near Grand Rapids, Michigan, held on May 13, 2006, collected 333 items containing mercury and 66 pounds of elemental mercury; 44 schools participated in the event. The amount of mercury collected suggests that more mercury remains in Michigan schools.

New York has also statutorily prohibited schools from purchasing or using elemental mercury and has begun a program to educate and assist schools in removing mercury. The other Great Lakes states have likewise begun to assist schools in removing mercury. Where available, estimates of the amount of mercury remaining in schools are listed in Table 6. Where no state estimates are available, the estimated amount of mercury remaining was calculated using the number of school buildings in a state and an average 2.3 pounds of mercury per school.<sup>145</sup> The latter estimates do not account for schools that have conducted school cleanout programs to remove mercury.

### 6.1.2 Existing Programs/Policies

Various approaches have been used to identify and reduce mercury in schools. A few such approaches are discussed below, along with examples of implementation of each approach.

#### 6.1.2.1 Prohibiting Mercury in Schools

Some states have enacted legislation to ban the use of mercury and mercury products in schools. As of 2005, Michigan law has prohibited purchase, use, and storage of mercury in elementary and secondary schools. This prohibition applies to free-flowing elemental mercury and mercury-containing instruments such as thermometers and barometers. It requires schools not only to avoid purchase of mercury, but also to remove mercury and mercury-containing devices purchased in the past. It allows use of the lowest mercury content instrument in circumstances where “no reasonably acceptable mercury-free alternative exists.”<sup>146</sup>

Similarly, as of September 2004 a New York State law bans primary and secondary schools from purchasing or using elemental mercury. The law bans the purchase of a number of mercury devices statewide as well.<sup>147</sup> Elemental mercury, mercury products, and spill cleanup materials contaminated with mercury are classified as hazardous or universal wastes.<sup>148</sup> In Illinois, the purchase or acceptance of bulk mercury, mercury-containing compounds and mercury-containing instructional equipment for use in primary or secondary

<sup>144</sup> Seven schools in Wisconsin have verified that they have virtually eliminated mercury, as part of Wisconsin’s Green & Healthy Schools Program.

<sup>145</sup> Estimate obtained through collections from some elementary and middle schools, primarily high schools, and a few colleges and universities. C. Hubbard, Minnesota Pollution Control Agency. October 2006. Personal commun.

<sup>146</sup> Michigan Public Act 376 of 2000.

<sup>147</sup> New York Laws, Chapter 145, <http://www.dec.state.ny.us/website/dshm/redrecy/chap145.html>

<sup>148</sup> See <http://www.health.state.ny.us/nysdoh/enviro/hsees/mercury/index.htm#brochures>.

classrooms has been prohibited since July 1, 2005. An exemption is provided for mercury-containing measuring devices used as teaching aids, if no adequate mercury-free alternative exists.<sup>149</sup> Unlike Michigan, Illinois and New York have not required removal of existing mercury devices from schools.

Municipalities may also adopt local ordinances that ban mercury from schools. For example, in Duluth, Minnesota, no public or private school offering kindergarten, elementary, junior high school, or high school classes is permitted to purchase bulk elemental mercury or mercury compounds for use in classrooms.<sup>150</sup>

### 6.1.2.2 Mercury Pledge Program

The Indiana Department of Environmental Management's (IDEM) mercury pledge program asks schools to sign a simple pledge by which they agree to work toward mercury-free goals.<sup>151</sup> Participants in IDEM's Mercury Awareness Program pledge to:

- Inventory buildings for mercury-containing items
- Purchase mercury-free substitutes where possible (except fluorescent lamps)
- Implement a phase-out plan for mercury-containing devices (except fluorescent lamps)
- Turn in mercury and mercury-containing items for recycling

The Mercury Free Zone,<sup>152</sup> implemented by the Minnesota Pollution Control Agency (MPCA), is another mercury pledge program, which uses a mercury-sniffing dog to promote mercury reduction and find unknown sources of mercury at schools in Minnesota.<sup>153</sup> MPCA also supplies schools with mercury-free equipment, such as alcohol thermometers and digital pyrometers, free of charge. As of March 1, 2006, 600 schools had signed Minnesota's mercury-free pledge, 207 schools had been assessed, and 1,162 pounds of elemental mercury had been removed from Minnesota schools.<sup>154</sup>

### 6.1.2.3 Bounty Program

A bounty program helps offset the costs of switching to mercury-free alternatives by providing a bounty for each thermometer (and sometimes barometers and sphygmomanometers) that allows the purchase of new equipment. For a limited time, the Milwaukee and Superior sewage treatment plants in Wisconsin offered the following rewards to schools for turning in their mercury-containing equipment:<sup>155</sup>

- Thermometers – \$5
- Blood Pressure Gauge – \$20
- Barometers – \$50

Bounty programs have proven to be effective in motivating schools in some communities to exchange their mercury devices. Milwaukee's collection, conducted in 2000, netted over 300 pounds of mercury from 32 schools. Superior's program, conducted in 2001 in 10 counties surrounding Lake Superior, collected over 150 pounds of mercury from 35 schools. In early 2003, Appleton, DePere, Green Bay, Heart of the Valley MSD, Neenah-Menasha MSD, and Grand Chute Menasha West conducted a collection modeled after Milwaukee's

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<sup>149</sup> See <http://www.epa.state.il.us/mercury/mercury-illinois.html>.

<sup>150</sup> See <http://www.newrules.org/environment/duluth.html>.

<sup>151</sup> See <http://www.in.gov/icpr/webfile/formsdiv/50411.pdf>.

<sup>152</sup> See <http://www.pca.state.mn.us/programs/mercury-free/index.html>.

<sup>153</sup> UW-Extension, 2003. Mercury in Schools. Last revised: October 10, 2003. Accessed: August 2006.  
<http://www.mercuryinschools.uwex.edu/schools/where.htm>.

<sup>154</sup> Based on estimates of the amount of mercury contained in each piece of equipment. See  
<http://www.pca.state.mn.us/programs/mercury-free/goals.html>.

<sup>155</sup> The Milwaukee and Superior bounty programs were funded through grants from the Wisconsin Department of Natural Resources and U.S. EPA. See [http://mercuryinschools.uwex.edu/act/collect\\_pgm.htm](http://mercuryinschools.uwex.edu/act/collect_pgm.htm).

and Superior's successful bounty collections. Eleven schools participated and 70 pounds of mercury were collected and recycled.<sup>156</sup>

#### **6.1.2.4 Chemical Cleanout**

In a chemical cleanout project, schools are provided technical assistance with inventorying and cleaning out all unwanted, unlabeled, or unknown hazardous laboratory chemicals, including mercury and mercury compounds. The project may also involve teacher training in proper laboratory chemical management and the development of lab chemical management plans to minimize future risks. EPA has provided funding to the ten EPA regions to support Schools Chemical Cleanout Campaign (SC3) programs.<sup>157</sup> Each region identifies schools in need of assistance and develops school cleanout programs. In EPA Region 5, the SC3 funds were designated to assist an under-served area with school chemical cleanouts. Within the designated area, schools were given the option to participate in a one-time disposal of expired and used lab chemicals and to participate in a voluntary audit of their lab.

Illinois EPA's Greening Schools Program<sup>158</sup> includes school chemical cleanouts, educational workshops and on-site assistance. The chemical cleanouts are made available to schools that participate in workshops that educate teachers about chemical management procedures and safer alternatives to using hazardous materials in science and art classes. Mercury-containing waste that is generated from educational activities is eligible for the chemical cleanouts. For example, mercuric oxide and mercury-containing barometers are accepted; fluorescent light bulbs are not. The wastes are recycled or disposed (if recycling is not an option). Chemical cleanouts have occurred at over 525 primary and secondary schools in Illinois. More than 122 drums of bulk mercury and mercury-containing devices have been collected. Over 800 science teachers have participated in 34 educational workshops. State funds are used to support the school chemical cleanouts. Both state and federal funds are used to educate schools on the hazards of mercury and the availability of mercury-free alternatives. The Illinois Waste Management and Research Center is collaborating with IEPA on this project.

Other states also assist with recycling mercury and mercury-containing devices once they have been inventoried and collected from school buildings. For example, as part of Minnesota's Mercury Free Zone pledge program, MPCA staff work with schools to ensure that collected mercury is properly recycled (e.g., through local collection programs or solid waste authorities).<sup>159</sup> Bowling Green State University and the Ohio Environmental Protection Agency operate an Elemental Mercury Collection Program that offers free collection of uncontaminated mercury to academic institutions, including schools in any state.<sup>160</sup>

#### **6.1.2.5 Outreach/Education**

Outreach and education efforts provide information for school administrators, faculty, staff, local health jurisdictions, and parent groups on the hazards of mercury in schools and ways to reduce potential impacts on children's health, avoid chemical liabilities, develop planning tools, and establish collection programs for mercury. The Great Lakes Regional Pollution Prevention Roundtable (GLRPPR) hosts a Mercury in Schools topic hub at <http://glrppr.org/hubs/toc.cfm?hub=501>. This is an online primer on the topic of mercury in schools that provides detailed descriptions of where mercury is found or used in schools and discusses effects of mercury in schools justifying action for change. It also provides summaries and links to resource materials as well as contact information for expert assistance and advice.<sup>161</sup>

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<sup>156</sup> WDNR Mercury Reduction Program. See <http://dnr.wi.gov/org/caer/cea/mercury/program.htm>.

<sup>157</sup> See <http://www.epa.gov/epaoswer/osw/conserveschools/index.htm>.

<sup>158</sup> See <http://www.greeningschools.org/>.

<sup>159</sup> See <http://www.pca.state.mn.us/publications/p-p2s4-01.pdf>.

<sup>160</sup> See <http://www.bgsu.edu/offices/envhs/page18364.html>.

<sup>161</sup> The Mercury in Schools topic hub is a resource funded by U.S. EPA Office of Pollution Prevention.

The University of Wisconsin Extension's Solid and Hazardous Waste Education Center developed a mercury in schools education and outreach program.<sup>162</sup> Key project activities included:

- 1) creating and maintaining a clearinghouse (at <http://www.mercuryinschools.uwex.edu>) for information related to reducing mercury usage, increasing mercury recycling and improving mercury management in schools, and educating students and teachers about eliminating mercury;
- 2) conducting workshops for educators and agency staff using a mercury curriculum package; and
- 3) offering online classes on mercury. Funding for the project was provided through a grant from U.S. EPA.

The New York State Department of Health, in partnership with the New York State Department of Environmental Conservation and New York State Department of Education, has prepared a packet of nine brochures to help school personnel identify mercury sources and reduce or remove the risk of a mercury spill. This program was developed under a program funded by the U.S. EPA. The brochures are available at <http://www.health.state.ny.us/nysdoh/envIRON/hsees/mercury/>.

The New York DEC has conducted workshops throughout New York State to promote mercury awareness in schools. A pilot project funded by U.S. EPA to remove mercury from schools in the Rochester City and Albany County school districts was recently completed. Information on these mercury cleanouts will be posted on the DEC's website for New York schools interested in initiating mercury cleanouts to reference.

The Michigan Department of Environmental Quality developed a step-by-step guide to assist Michigan schools in phasing out mercury, in accordance with Michigan law. The eight-page document (available at <http://www.deq.state.mi.us/documents/deq-ead-p2-mercury-mercinschools.pdf>) presents nine steps to becoming a mercury-free school. Although mercury is not prohibited in Ohio schools, Ohio EPA provides guidance for school teachers that discuss ways to reduce, manage (spills), and dispose of mercury and mercury-containing devices. Ohio's guidance document is available at [www.epa.state.oh.us/ocapp/p2/mercury\\_pbt/schoolt1.pdf](http://www.epa.state.oh.us/ocapp/p2/mercury_pbt/schoolt1.pdf).

The Minnesota Pollution Control Agency (MPCA) is currently reviewing the use of mercury-catalyzed polyurethane flooring in schools and management and disposal guidance relative to this flooring. They currently recommend ventilation be maintained before and during the use of these spaces to reduce potential exposures and are evaluating their management and disposal guidance to provide environmentally protective standards so schools know in advance about cost and logistics of removal and disposal.

The Pennsylvania Department of Environmental Protection (PA DEP) has been implementing a voluntary mercury pick-up program for schools, nonprofit organizations, and private citizens since 1997.<sup>163</sup> PADEP, in conjunction with the Pennsylvania Department of Education, provided notification of the availability of this free program to all school district administration officials and science teachers. Schools may contact PA DEP's emergency response staff, who are the personnel authorized to pick up elemental mercury and mercury-containing products from school buildings and deliver them to a designated Pennsylvania mercury recycler for disposition. PADEP has an agreement with the mercury recycler to take these materials from schools, nonprofit organizations, and private citizens at no charge. The program has been working well, and to date, approximately 15,250 pounds of mercury has been collected from these entities.

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<sup>162</sup> See <http://www.mercuryinschools.uwex.edu/project/index.htm>.

<sup>163</sup> PA DEP's Standard Operating Procedures for Acceptance, Collection, Transport, Storage and Disposition of Elemental Mercury is available at <http://164.156.71.80/VWRQ.asp?docid=2087d8407c0e0000000008f0000008f&context=2&backlink=WXOD.aspx%3ffs%3d2087d8407c0e00008000008200000082%26ft%3d1>.

### 6.1.2.6 Tools

Additional tools are available to assist schools in mercury reduction efforts. For example, NEWMOA has developed a mercury assessment checklist to assist in identifying and locating mercury-containing products and equipment in schools.<sup>164</sup> EPA has developed a software tool to help school districts establish and manage comprehensive school facility self-assessment programs; the *Healthy School Environments Assessment Tool* (HealthySEAT) contains a fully integrated environmental health and safety checklist and is designed to be easily customized to reflect state and local requirements and policies.<sup>165</sup>

In addition to the brochures developed by New York State, another useful tool that can assist schools in identifying mercury-containing items and alternatives that can be used to replace them is a fact sheet prepared by Illinois EPA. The fact sheet (available at <http://www.epa.state.il.us/p2/green-schools/mercury-free-alternatives-for-schools.pdf>) lists mercury-containing items that may be found in schools and mercury-free alternatives.

### 6.1.3 Recommended Actions

- 6.1.3.1 Prohibit the purchase, use, and storage of elemental mercury, mercury compounds, and mercury-containing laboratory and medical equipment in schools.
- 6.1.3.2 Provide education/outreach regarding mercury spill management, health impacts, sources of exposure, handling, and disposal to school administrators, teachers, and students.
- 6.1.3.3 Provide education/outreach to college and university students majoring in education, particularly future science teachers.
- 6.1.3.4 Assist schools to eliminate mercury by
  - facilitating access to lower-cost management services, for instance by allowing schools free access to household hazardous waste collection programs,
  - providing technical assistance to identify potential mercury containing products, elemental mercury and other mercury containing items, such as mercury-catalyzed polyurethane flooring, to assist in clean-outs and proper removal of items identified,
  - advocating the proper disposal of worn or broken mercury-containing gauges, switches, and relays (e.g., boiler gauges, thermostats). If replaced, new devices such as switches and relays should be mercury-free, and
  - ensuring the availability of a collection program for schools to dispose of unwanted chemicals, including mercury and mercury-containing equipment.

## 6.2 Steel Manufacturing/Scrap Metal Melting Facilities, Scrap Yards

### 6.2.1 Background

Various types of mercury switches and measurement and control devices are contained in iron and steel equipment, notably automobiles, commercial appliances, and a wide array of industrial equipment. When this equipment is scrapped without removal of the mercury-containing devices, mercury emissions can occur at various stages. Scrapped equipment is often shredded, causing some breakage of these devices and resulting in mercury emissions from the shredder. Shredded and crushed equipment is fed into a steelmaking furnace, leading to emissions of most of the mercury input. U.S. EPA estimates that in 2002, 10.7 tons of mercury was emitted from electric arc furnaces, where most steel scrap is melted. This sector is the second-largest source of

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<sup>164</sup> See <http://www.newmoa.org/prevention/mercury/schools/checklist.cfm>.

<sup>165</sup> See <http://www.epa.gov/schools/healthyseat/index.html>.

mercury emissions in the United States after power plants.<sup>166</sup> Nearly all of this mercury comes from mercury-containing devices contained in scrap; electric arc furnaces do not have other significant mercury inputs.

While steel furnaces do not have mercury emissions control equipment, particulate control devices at these facilities capture a small percentage of mercury. However, the steel furnace flue dust from the particulate control devices is typically sent to facilities that recover zinc and other metals. This recovery process uses high heat that may volatilize the remaining mercury.<sup>167</sup>

Automobiles are the main contributors in the contamination of scrap metal with mercury. Prior to 1997, autos sold annually in the United States contained an estimated 10 tons of mercury, primarily in convenience light switches, and to a lesser extent in switches used in anti-lock braking systems. These switches were gradually phased out between 1997 and the end of model year 2002. Model year 2003 and newer autos still contain some mercury, though in much smaller quantities, in some high intensity discharge (HID) headlamps, entertainment systems, and back-lit panel displays. As of 2004, autos still in service were thought to contain approximately more than 100 tons of mercury, of which approximately nine tons ended up in scrap each year.<sup>168</sup> The amount of mercury in scrapped vehicles is thought to have peaked sometime between 2000 and 2005. This amount will decline gradually, provided no further mercury-containing components are used in future vehicles. It is expected to reach minimal levels by approximately 2018, when most vehicles built prior to 2003 are likely to have been scrapped.

Other types of equipment with mercury-containing devices are also melted as scrap in steel furnaces. Examples include:

- Chest freezers built prior to 2002 that contain mercury tilt switches to activate a light;
- Gas ranges that contain mercury flame sensors (those manufactured in 2001 alone contain an estimated 1,300 pounds of mercury); and
- Various commercial appliances (for instance, commercial ovens sold in 2001 contain more than three tons of mercury in electrical relays).<sup>169</sup>

## 6.2.2 Existing programs and policies

A variety of federal and state programs are in existence or under development to address mercury contamination from auto mercury switches. These programs include:

### 6.2.2.1 Prohibiting mercury in new vehicles

Several states have laws that prohibit the use of mercury switches in new vehicles. In addition, U.S. EPA has proposed a rule that would prohibit nationally the manufacture, import, or processing of mercury for use in convenience light switches, anti-lock braking system (ABS) sensors, and active ride control sensors in motor vehicles, without a 90-day notice period allowing U.S. EPA to prohibit or limit the use.<sup>170</sup>

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<sup>166</sup> According to U.S. EPA's National Toxics Inventory. See <http://www.epa.gov/region5/mercury/progress06.pdf>

<sup>167</sup> EPA's 2003 Toxics Release Inventory contains mercury emissions reports from three facilities that process electric arc furnace flue dust: Inmetco International Metals, in Ellwood City, Pennsylvania, which reported 1900 pounds of mercury air emissions, and Horsehead Resource Development, with a facility in Chicago, IL that emitted 210 pounds of mercury, and a Palmerton, Pennsylvania facility that emitted 220 pounds.

<sup>168</sup> Clean Car Campaign. Mercury in Vehicles Update: Automotive Mercury Releases to the Environment Reach Record Levels, 2004. [http://www.cleancarcampaign.org/Mercury\\_April\\_2004.pdf](http://www.cleancarcampaign.org/Mercury_April_2004.pdf)

<sup>169</sup> NEWMOA, Mercury-Added Product Fact Sheet: Mercury Use In Gas & Electric Cooking Ranges And Other Cooking Equipment, September 2004 (online at [http://www.newmoa.org/prevention/mercury/imerc/FactSheets/factsheet\\_ranges.cfm](http://www.newmoa.org/prevention/mercury/imerc/FactSheets/factsheet_ranges.cfm)).

<sup>170</sup> 71 FR 39035 (July 11, 2006).

### **6.2.2.2 The National Vehicle Mercury Switch Recovery Program (NVMSRP)**

This program was established by an August 2006 agreement among U.S. vehicle manufacturers, steelmakers, vehicle dismantlers, auto shredders, brokers, the environmental community, state representatives and U.S. EPA. Under this nationwide program, vehicle manufacturers must provide auto dismantlers with information and supplies for mercury switch removal, collect and transport switches to retorters for proper recycling or disposal, assume liability for the switches once collected, establish a database to track switch recovery by program participants, and disburse incentive payments to eligible participants. To carry out these responsibilities, automakers have formed the non-profit organization End of Life Vehicle Solutions (ELVS). ELVS has eleven members, BMW, DaimlerChrysler, Ford, General Motors, International Truck, Mack Truck, Mitsubishi, Nissan, Subaru, Volkswagen, and Volvo Trucks. Toyota used mercury-containing ABS sensors and is not a member of ELVS.

Dismantlers will recover mercury switches from model year 2002 and older vehicles and submit them to the program. Steelmakers will encourage their suppliers to participate in the program, and will match a \$2 million donation from vehicle manufacturers, establishing a three-year, \$4 million implementation fund that will be used to provide incentives for switch removal to auto dismantlers.

For further information on the NVMSRP and the responsibilities being carried out by ELVS, please refer to <http://www.epa.gov/mercury/switch.htm> and <http://www.elvsolutions.org>, respectively.

### **6.2.2.3 Air emissions regulation for steel industry**

Major source iron and steel foundries must comply with U.S. EPA air emissions regulations that require foundries to use auto scrap only from suppliers that have procedures in place to ensure removal of mercury-containing switches. U.S. EPA is also developing emissions regulations for electric arc furnaces (where most auto scrap is melted) and minor source iron and steel foundries.

### **6.2.2.4 Legal requirements for mercury switch removal**

Several states have laws requiring auto dismantlers to remove mercury switches prior to crushing automobiles. Some states also require auto manufacturers to pay for collection and recycling of the switches and to provide a payment to dismantlers for each switch removed. These state requirements supersede the voluntary national program described above, though ELVS operates in a similar manner in all of the mandated states except for Maine, which currently has a unique switch collection system.

As examples of these state laws, Illinois requires vehicle manufacturers to set up a recycling program for mercury vehicle switches and sets recovery goals for the program: 35% for July 1, 2006 through June 30, 2007; 50% for July 1, 2007 through June 30, 2008; 70% for each subsequent year through 2011. If these program goals are not met, mercury switch removal becomes mandatory for auto recyclers, and a \$2 payment to auto recyclers for each switch recovered becomes mandatory for auto manufacturers.<sup>171</sup> In New York, a new law, Chapter 180, Laws of 2006, requires removal of mercury switches prior to crushing or shredding end-of-life vehicles and requires auto dismantlers to report annually.<sup>172</sup> In Minnesota, Minn. Stat. § 116.92, subd. 4(c) requires auto dismantlers to make a good faith effort to remove mercury switches prior to crushing (effective 8/1/95).

### **6.2.2.5 Use of stormwater permit authority**

Wisconsin and New York both use stormwater permit requirements to promote mercury switch removal by auto dismantlers. In Wisconsin, most auto dismantlers are members of a cooperative compliance program (CCP) that exempts participants from chemical monitoring requirements if they follow the requirements of the CCP. These requirements include best management practices that incorporate removal of mercury-containing

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<sup>171</sup> Illinois Public Act 094-0732.

<sup>172</sup> New York Laws of 2006, Chapter 180, <http://www.dec.state.ny.us/website/dshm/redrecy/chap180.html>.

switches from end-of-life vehicles.<sup>173</sup> In New York, before Chapter 180 was adopted, a program was started in the western part of the state to add requirements to stormwater permits for auto shredders. The permits stated that the shredder operators could only accept scrap from suppliers that have removed mercury switches. Therefore, auto recycling facilities were required to remove the mercury switches before scrap was sent to the shredder. The collected mercury switches were then shipped in a plastic/cardboard box mailer as Conditionally Exempt Small Quantity Generator waste to a local county hazardous waste collection center that had agreed to accept them. Now, under the Chapter 180 requirements, New York State recommends that all auto dismantlers participate in the National Vehicle Mercury Switch Recovery Program discussed earlier.

#### **6.2.2.6 Outreach to auto dismantlers and scrap dealers**

All the Great Lakes states have programs that conduct outreach to auto recyclers and scrap dealers to inform them of the environmental problems created by mercury switches and to explain how to remove and recycle the switches. Some states have worked to provide mechanisms for storing the recovered switches and shipping them for recycling within state and federal law. The Universal Waste Rule has been expanded to include auto switches and any device that contains liquid mercury, helping to minimize paperwork burdens on dismantlers and scrap dealers who remove mercury devices. Presentations at conferences of auto dismantlers' organizations have also been useful in passing along relevant information. Under the NVMSRP, ELVS is taking the lead in distributing this information to auto dismantlers, with the assistance of states, the steel industry, and others.

The Clean Air Foundation, located in Ontario, Canada, operates the "Switch Out" program, an initiative that responsibly recovers mercury-containing automobile switches. Between 2001, when the voluntary pilot program began, and December 18, 2007 the "Switch Out" program has collected 183,792 switches from automotive recyclers. This represents the safe recovery of 343.2 pounds (156 kg) of mercury.

In addition to programs addressing auto switches, some state and local governments have programs to prevent other types of mercury-containing products from ending up in steel scrap. Such programs include the following:

#### **6.2.2.7 White goods recycling programs**

Some local governments are including mercury switch removal in their white goods (large appliances) recycling programs. These efforts focus on removal of mercury from chest freezers and gas ranges, and also include mercury removal from pre-1972 washing machines, gas dryers, pool heaters, air conditioners and HVAC systems, commercial gas hot water heaters larger than 100 gallons, space heaters, sump pumps, and bilge pumps. The Association of Municipal Recycling Coordinators of Ontario has produced a guide on removal of mercury switches in municipal white goods recycling programs,<sup>174</sup> and California has produced guidance for appliance recyclers that explains the need for removing mercury switches and how to do it.<sup>175</sup>

Some states, including Illinois, Minnesota and New York, make it illegal to dispose of or recycle a major appliance that contains a mercury switch without first removing the switch. States have devised ways of funding collection programs. For example, in North Carolina, an advance disposal fee is charged when an

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<sup>173</sup> See Storm Water Discharge Permits and the Cooperative Compliance Program (CCP) for Auto Recyclers and Scrap and Waste Recyclers (online at <http://www.dnr.state.wi.us/org/caer/cea/assistance/scrap/stormwater/>)

<sup>174</sup> AMRC, How to Add Mercury Switch & Sensor Removal to a Municipal White Goods Program, 2002. <http://www.saskwastereduction.ca/metal/mercury-white-goods.pdf>

<sup>175</sup> California Environmental Protection Agency, Department of Toxic Substances Control, Self-Training Manual for Removing Mercury Switches from Major Appliances: A Guide for Appliance Recyclers, June 2004. [http://www.dtsc.ca.gov/HazardousWaste/Mercury/upload/HWMP\\_POL\\_Guidance\\_Mercury\\_Appliances.pdf](http://www.dtsc.ca.gov/HazardousWaste/Mercury/upload/HWMP_POL_Guidance_Mercury_Appliances.pdf)

appliance is purchased and the funds are distributed to North Carolina Counties to fund recycling programs for white goods, which are accepted at no charge at county white goods recycling facilities. Landfill disposal of white goods is prohibited in the State of North Carolina.<sup>176</sup> In La Porte County, Indiana, a small fee is charged (\$2.00 for smaller appliances, \$5.00 for larger appliances) to help offset the costs of white goods collection days.<sup>177</sup>

#### **6.2.2.8 Outreach to scrap recyclers**

In conducting outreach to scrap recyclers on mercury switch removal, some states, including Wisconsin, also incorporate education about mercury in other types of equipment that can end up in scrap.

**6.2.2.9 Programs and legislation to limit continuing uses of mercury devices that might end up in steel scrap** (see §5.3 on switches, relays and measurement and control devices).

**6.2.2.10 Programs to improve end-of-life management of mercury-containing devices used in manufacturing equipment** (see §6.3 on manufacturing industry).

#### **6.2.2.11 Outreach to contractors providing chlorofluorocarbons removal**

Some companies specialize in removal of CFCs from appliances prior to shredding or crushing. As these companies are made aware of various states' mercury switch removal requirements, they can help educate the processors. These companies may also consider expanding their services to include mercury switch removal. New York State has already begun discussions with CFC removal companies to provide information to processors of old appliances about mercury switch removal and crushing and shredding restrictions.

### **6.2.3 Recommended Actions**

Great Lakes states are already participating in the National Vehicle Mercury Switch Recovery Program. In some cases, this is done in coordination with existing state programs. Consistent with those efforts, we recommend that all states

6.2.3.1 Facilitate proper recycling of auto mercury switches, consistent with state and federal law and regulations, including RCRA regulations and forthcoming U.S. EPA air emissions standards for steel producers, and educate scrap recyclers about the need to remove mercury devices from autos and other equipment. State efforts should complement or incorporate the National Vehicle Mercury Switch Recovery Program, and should ensure that letters are sent to dismantlers about the need to recycle mercury switches and the advantages of participating in the national program.

6.2.3.2 Conduct outreach to steel mills and iron foundries designed to encourage participation in the National Vehicle Mercury Switch Recovery Program.

In addition, states should

6.2.3.3 Consider initiatives to ensure continued achievement of auto switch recycling goals after the expiration of the three-year implementation fund for providing incentives for switch removal under the National Vehicle Mercury Switch Recovery Program.

6.2.3.4 Consider measures to assure the removal and proper management of all mercury-containing components from vehicles, appliances and other products that are likely to end up in steel scrap. For example, states may use stormwater permit authority to regulate removal and management.

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<sup>176</sup> See <http://www.fac.unc.edu/WasteReduction/Recyclables/whitegoods.asp>.

<sup>177</sup> See [http://www.solidwastedistrict.com/programs/tires\\_whitegoods.html](http://www.solidwastedistrict.com/programs/tires_whitegoods.html).

## **6.3 Heavy Industry**

### **6.3.1 Background**

#### **6.3.1.1 Amount of Mercury Involved**

No reliable data exist to determine how much mercury is contained in devices used by heavy industry, as opposed to residences, office buildings, and non-manufacturing businesses and institutions such as hospitals and farms. However, it is clear that a large percentage of the mercury used in switches, relays and measurement and control devices is used in manufacturing, utilities, shipping, and other heavy industry. Mercury switches and relays are incorporated into a variety of industrial equipment, including manufacturing machinery, furnaces, injection molding equipment, drying ovens, and industrial welding equipment. Manufacturers use mercury-containing industrial thermometers, as well as a variety of thermostats and manometers to control temperature and pressure within manufacturing processes. In addition to mercury-containing devices, some industries use significant volumes of chemicals, such as sodium hydroxide or sulfuric acid that may be contaminated with mercury.

#### **6.3.1.2 Releases of Mercury**

When mercury-containing products break during use, they can release mercury, posing potential risks to workers. Mercury-containing products that are incorporated into manufacturing equipment are not likely to break during use; however, at end-of-life, manufacturing equipment is likely to be recycled for its iron and steel content, increasing the likelihood that mercury contained in this equipment will be released from steel production furnaces. Mercury that contaminates feedstock chemicals used by industry can be discharged directly to water or to sewage treatment plants.

### 6.3.2 Existing Programs and Policies

Mandated recycling and restrictions on use of mercury-containing products are covered in other sections. This section focuses on programs that work with industry to reduce purchases and use of mercury-containing equipment and to dispose of mercury-containing equipment properly.

#### 6.3.2.1 Conducting Internal Audits

In 1998, three Northwest Indiana steel mills signed a voluntary agreement with the Lake Michigan Forum, Indiana Department of Environmental Management, and U.S. EPA to initiate a mercury pollution prevention initiative. The initial goal of the project was to achieve a 33% reduction in mercury usage in two years, a further 33% reduction in five years, and a total 90% reduction in ten years. Under this agreement, the steel mills-- International Steel Group (ISG) Burns Harbor LLC, Ispat Inland Indiana Harbor Works, and United States Steel Gary Works-- conducted inventories of mercury in materials and equipment, purchased and in use. The companies collectively found approximately 4,600 pounds of mercury at the three facilities, of which an estimated 64% was in equipment and devices and 28% in liquid mercury stored on site (for the purpose of refilling mercury-containing equipment). The companies removed more than 80% of their total mercury by the end of 2003.<sup>178</sup> In addition, the companies collaborated with the Delta Institute to produce a guide to mercury reduction at other industrial facilities that wish to conduct similar programs.<sup>179</sup>

The city of Superior, WI, together with the Western Lake Superior Sanitary District and Northwest Wisconsin Regional Planning Commission's Northwest Clean Sweeps, are promoting mercury reduction projects in the shipping industry of the Lake Superior basin, using a grant from the Great Lakes National Program Office. The city is offering free, tailored technical assistance to companies (focusing on the shipping industry) to do mercury inventories, develop mercury management policies, and to recycle unwanted mercury.<sup>180</sup>

Many gas and electric utilities have also implemented programs to remove mercury devices from service. Power plants in Michigan conducted such programs in response to the 1996 recommendations of the Michigan Mercury Pollution Prevention (M2P2) Task Force.<sup>181</sup> As a result of M2P2 recommendations, two of Michigan's largest utilities, Detroit Edison and Consumers Energy, identified sources of elemental mercury used within their operations, including customer gas regulators, thermostats, thermometers, manometers, barometers, switches, relays, timers, and gauges in various meters and bulk mercury in bottles. After the initial inventories were concluded, these companies committed to phasing out the use of mercury over time as equipment was being retired. Thus far, Detroit Edison has reported elimination of 2,745 pounds of mercury sources, while Consumers Energy has eliminated 1,488 pounds or approximately 60% of the original 1996 inventory of 2,464 pounds of mercury from their facilities. Additionally on their own initiative, the Lansing Board of Water and Light (LBWL) eliminated more than 450 pounds of mercury from their facilities between the years 2000 and 2005.<sup>182</sup>

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<sup>178</sup> International Steel Group, Burns Harbor, Indiana; Ispat Inland, East Chicago, Indiana; U.S. Steel, Gary, Indiana. Mercury Agreement Reduction Program, January 2004. <http://www.epa.gov/region5/mercury/nwindianareport3-17-04.pdf>

<sup>179</sup> Inland Ispat Indiana Harbor Works, Bethlehem Steel Burns Harbor Division, United States Steel Gary Works, The Delta Institute, and Lake Michigan Forum. A Guide to Mercury Reduction in Industrial and Commercial Settings. July 2001. <http://www.delta-institute.org/publications/Steel-Hg-Report-0627011.pdf>

<sup>180</sup> Superior Public Works Department, Wastewater Division. Semi-Annual Report: Basinwide Mercury Reduction Initiative with Shipping Focus. Project Number GL2005-104. June 6, 2006.

<sup>181</sup> For example, see Consumers Energy Company, Mercury Pollution Prevention: A Plan for the Management of Mercury Usage and Emissions and Report of Mercury Reduction Progress, March 1999 Update, <http://www.epa.gov/bns/mercury/consumersenergy99.html>

<sup>182</sup> Michigan Mercury Electric Utilities Workgroup Report, June 20, 2005. <http://www.deq.state.mi.us/documents/deq-aqd-air-aqe-mercury-report.pdf>

Minnesota law required the commissioner of the Pollution Control Agency to “solicit, by July 1, 1999, voluntary reduction agreements from sources that emit more than 50 pounds of mercury per year.”<sup>183</sup> While the law did not specify the content of these reduction agreements, in practice, many companies, including power plants, chose to implement internal audits of mercury-containing devices and to focus reduction efforts on devices and wastes generated by devices.<sup>184</sup>

### **6.3.2.2 Using Low-mercury Feedstock**

Many industries have also been successful in reducing mercury discharges by obtaining supplies of feedstock chemicals such as sodium hydroxide and sulfuric acid that are low in mercury. Such chemicals can have greatly varying levels of mercury contamination, depending on the supplier. For example, in the 1990s, the Western Lake Superior Sanitary District identified significant spikes in the mercury concentration of effluent from Potlatch Corporation’s pulp and paper mill in Cloquet, Minnesota. An assessment revealed that the culprit was Potlatch’s use of sulfuric acid containing 10,000 ppb mercury. After the facility switched to an alternative source of sulfuric acid, its effluent mercury concentrations dropped by 98%.<sup>185</sup>

### **6.3.3 Recommended actions**

6.3.3.1 Conduct outreach to heavy industry to promote mercury reduction projects, focusing on sectors within the state that use significant amounts of mercury.

6.3.3.2 Promote the development of industry mercury containing equipment phase-out plans. The plans should include

- purchasing policies that avoid mercury-containing devices where feasible and appropriate,
- internal inventories of mercury and mercury-containing devices, and
- measures to ensure proper disposal of these devices at end of life, including labeling of equipment that incorporates mercury-containing devices.

States could implement this recommendation in a variety of ways to address various industrial sectors and categories of facilities with state or local permits.

6.3.3.3 Work with wastewater treatment authorities to encourage large volume users of commodity chemicals to routinely obtain certificates of analysis for these chemicals and, in cases where mercury contamination is a problem, to procure lower-mercury chemicals.

## **6.4 Health Care and Veterinary Medicine**

### **6.4.1 Background**

#### **6.4.1.1 Amount of mercury involved**

Many instruments that are regularly used in medical institutions contain mercury, such as blood pressure monitors, thermometers, and a variety of specialized medical devices.<sup>186</sup> More than 20 different medical products contain mercury. Mercury is an ingredient in some proprietary formulas used to manufacture medical supplies. Non-medical products that contain mercury may also be present in health care facilities, including

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<sup>183</sup> Minnesota Laws, Section 1196.

<sup>184</sup> For example, see Great River Energy, Voluntary Mercury Reduction Agreement, January 30, 2001, [http://www.greatriverenergy.com/environment/\\_images/mercury\\_agreement.pdf](http://www.greatriverenergy.com/environment/_images/mercury_agreement.pdf). Great River Energy removed more than 660 pounds of mercury from its facilities, starting in 1990.

<sup>185</sup> Western Lake Superior Sanitary District. Blueprint for Mercury Elimination: Mercury Reduction Project Guidance for Wastewater Treatment Plants. Revised January 2002, p. 19. <http://www.wlssd.com/publications/Blueprint%20for%20mercury/Revised%20Blueprint%20for%20Mercury.pdf>

<sup>186</sup> Mercury devices, fever thermometers, thermostats, and dental amalgam are discussed in separate sections of this strategy.

fluorescent and high-intensity lamps, batteries, thermostats, and cleaning solutions. Mercury and mercury-containing products may be found in patient areas, labs, surgery rooms, clinical areas (e.g., x-rays), pharmacies (e.g., in medicines), housekeeping departments, kitchens, maintenance areas, and storage rooms. Broken or obsolete equipment has been identified as the primary source of mercury waste at many hospitals and clinics.<sup>187</sup> Veterinary care facilities use many mercury-containing devices similar or identical to those used in medical care facilities.

A survey conducted by the American Hospitals Association (AHA) in 2005 found that 97.3% of hospitals responding to the survey indicated that they were aware of the mercury issue and had taken steps to address the problem in their facility. Nearly 60% of hospital survey respondents had implemented a mercury management policy. According to the AHA, hospitals are removing mercury-containing medical devices from their facilities and are eliminating mercury beyond clinical devices, such as in pharmaceuticals and cleaning products. It has been estimated that hospitals contain 92.6 grams of mercury per bed prior to elimination efforts.<sup>188</sup>

Medical waste incinerators, which dispose of mercury-containing wastes from the health care sector, were once a significant source of anthropogenic mercury emissions in the United States – 49.7 tons in 1990. However, changes in hospital purchasing practices and a reduction in the quantity of medical waste incinerated have reduced the quantity of mercury going to medical waste incinerators so that in 2002, annual mercury emissions from medical waste incinerators were estimated between 0.2 and 0.3 tons, representing about 0.2% of national mercury emissions.<sup>188</sup>

#### **6.4.1.2 Releases of Mercury**

Mercury is released to the environment through the incineration of mercury-containing materials that have been placed in infectious waste containers at health care facilities. Mercury may also be released from health care wastes that are disposed in a landfill, and medical care facilities may emit small amounts of mercury through accidental spills and releases. Accidental breakages and spills of mercury in health care facilities can be an exposure liability and can necessitate costly cleanup procedures.

### **6.4.2 Existing Programs**

#### **6.4.2.1 Emission Regulations**

U.S. EPA's 1995 medical waste incinerator maximum achievable control technology (MACT) rule limits emissions from medical waste incinerators. The MACT forced the closure of over 6,000 medical waste incinerators since 1988 and, together with reductions in the mercury content of products used in hospitals, has resulted in a 99.6% reduction in mercury emissions.<sup>188</sup> Wastewater discharges from health care facilities are subject to regulations by local sewer authorities, which are in turn regulated by the Clean Water Act.<sup>189</sup> Facilities that discharge directly to streams or rivers are subject to U.S. EPA's national discharge standards, which include quantitative limitations for specific pollutants and require a permit from a state agency or U.S. EPA.<sup>190</sup>

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<sup>187</sup> Topic Hub™ for Mercury-Health Care. Available at <http://www.glrpr.org/hubs/toc.cfm?hub=502&subsec=7&nav=7>. Accessed October 2006.

<sup>188</sup> Hospitals for a Healthy Environment. 2005. Making Medicine Mercury Free: A 2005 Report on the Status of Virtual Mercury Elimination in the Health Care Sector. Available at <http://www.h2e-online.org/pubs/mercuryreport.pdf>. Accessed December 2006.

<sup>189</sup> Title 40 CFR Part 403--General Pretreatment Regulations [http://www.access.gpo.gov/nara/cfr/waisidx\\_03/40cfr403\\_03.html](http://www.access.gpo.gov/nara/cfr/waisidx_03/40cfr403_03.html)

<sup>190</sup> Healthcare Environmental Resource Center. [www.hercenter.org/regsandstandards/cwa.cfm#wastewater](http://www.hercenter.org/regsandstandards/cwa.cfm#wastewater) Accessed January 2007.

### 6.4.2.2 Product Bans

Mandated recycling and restrictions on the use of mercury-containing products are covered in other sections of this strategy. This section focuses on programs that work with health care facilities to reduce purchases and use of mercury-containing equipment, and to manage mercury-containing materials properly.

### 6.4.2.3 Voluntary Programs

In 1998, U.S. EPA and the AHA signed a Memorandum of Understanding (MOU) that launched Hospitals for a Healthy Environment (H2E), an initiative that addresses mercury pollution from the health care sector. The MOU called for the virtual elimination of mercury waste from the nation's health care facilities, as well as reduction in total hospital waste and education efforts for pollution prevention and toxics minimization.<sup>191</sup>

Furthermore, it is H2E's position that, "It is also important that as mercury-containing items are removed from service in the U.S. that these devices not be simply exported elsewhere, shifting the burden of mercury pollution to a global level and creating further problems rather than real solutions. ...[M]ercury pollution must be addressed as a global issue. While H2E's efforts are based in the U.S., H2E strongly discourages the export of mercury containing items and waste, as these actions simply shift the burden of mercury pollution to other countries rather than providing real solutions. In conjunction with this stance, H2E supports efforts to develop a national mercury disposition plan to ensure that mercury removed from health care facilities does not find its way back into the marketplace, either in the U.S. or globally."<sup>192</sup>

In 2006, H2E became an independent, non-profit organization. The H2E organization continues to provide assistance to states with the development of state H2E programs, which typically involve a partnership between a state agency and the state hospital association.

All of the Great Lakes states have H2E programs. For example, Ohio's Mercury Challenge Program is a cooperative effort between Ohio EPA and the Ohio Hospital Association (OHA) to virtually eliminate mercury from hospitals statewide. The program is a voluntary agreement initiated by an MOU signed by Ohio EPA and OHA in 1999.<sup>193</sup>

In addition, H2E recognizes "Partners" who promote the H2E organization and implement waste reduction activities at their own facilities. Government agencies can apply to be partners in support of the goal of forming "a sustainable network that will provide a forum for discussion and networking to support hospitals in a specific city, state or region in making continuous progress toward achieving H2E's goals of mercury elimination, waste reduction and hazardous chemical minimization, as well as other pollution prevention initiatives." State partners must make a number of commitments:

- "Commitment of sufficient staff resources to adequately support your organization's contribution to development, implementation and ongoing support of the program
- A multiyear commitment, as appropriate to support your stated goals
- Support for formation of a state or regional committee for an H2E "Chapter"
- Organization of an introductory event for state/metro health care facilities
- Establishing and facilitating network conference calls and/or regular meetings."<sup>194</sup>

<sup>191</sup> Hospitals for a Healthy Environment website <http://www.h2e-online.org/>.

<sup>192</sup> "MAKING MEDICINE MERCURY FREE - A 2005 Report on the Status of Virtual Mercury Elimination in the Health Care Sector" Hospitals for a Healthy Environment. <http://www.h2e-online.org/pubs/mercuryreport.pdf>

<sup>193</sup> Mercury Challenge Program. See <http://www.epa.state.oh.us/opp/hospital.html>.

<sup>194</sup> <http://www.h2e-online.org/champions/overview.htm#smc>

In the Great Lakes Region, the Indiana Department of Environmental Management, the Minnesota Technical Assistance Program, the New York State Energy Research and Development Authority, the Ohio Hospital Association and Ohio Nurses Association, the Pennsylvania Department of Environmental Protection, the Wisconsin Department of Natural Resources and U.S. EPA Regions 3 and 5 are all H2E partners. H2E has a number of other types of partners, in addition to health care providers and government agencies. These partners include group purchasing organizations (GPOs), health care professional or trade associations, vendors, manufacturers, consultants, other service providers, and member-based or community-based organizations working with health care facilities.

States support the H2E program in a variety of ways. Wisconsin's Mercury Reduction Program provides consultation and workshops to educate hospital personnel (including doctors, nurses, environmental and safety coordinators, and equipment purchasers) about the issue of mercury and the need for alternatives.<sup>195</sup> WDNR also holds thermometer exchanges for hospital staff and clients. A Mercury Reduction Program for Illinois Hospitals, sponsored by the Illinois EPA and the Illinois Waste Management and Research Center, has conducted waste reduction assessments at 22 hospitals in Illinois.<sup>196</sup>

In New York, the Erie County Office of Pollution Prevention conducted a technical assistance mercury pollution prevention (P2) implementation project for the health care industry. Three hospitals, representative of the large systems operating in the county, have participated in the project with the intention of extending the initiative to remaining hospitals using the methodologies developed through the pilot studies. The program included outreach to employees and department managers, and facility inventories were used to identify the type, amount, and location of mercury in use and storage. Data from the inventories were evaluated to determine future project goals and direction. Site visits were used to verify inventory results, as well as identify additional P2 and solid waste reduction opportunities. Recommendations were documented in detailed reports for each hospital. Efforts are underway to quantify mercury reductions, track progress in implementing the recommendations, and conduct additional employee outreach.<sup>197</sup>

Regionally, U.S. EPA Region 2 (which encompasses New York) implemented an Integrated Strategy for the Health Care Sector. The strategy consists of compliance assistance (seminars, presentations and meetings, development and distribution of compliance assistance tools), compliance incentives (especially the use of audit agreements in which health care facilities voluntarily conduct a self-audit and disclose all violations to EPA), compliance monitoring, and enforcement. A key component of these activities is mercury reduction.<sup>198</sup>

#### **6.4.2.4 Purchasing Policies**

Purchasing policies provide another mechanism for phasing out mercury from health care facilities. Adopting a mercury-free purchasing policy commits a health care facility to discontinue the purchase of new mercury-containing equipment where other non-hazardous alternatives are available and, where possible, eliminate or reduce the use of mercury and mercury compounds in processes and procedures.

#### **6.4.2.5 Take-Back Programs**

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<sup>195</sup> See <http://www.dnr.state.wi.us/org/caer/cea/mercury/program.htm#Medical> and

<http://www.newmoa.org/prevention/mercury/programs/Details.cfm?ID=103&GoBack=-1>.

<sup>196</sup> See <http://www.newmoa.org/prevention/mercury/programs/Details.cfm?ID=54&GoBack=-1>.

<sup>197</sup> See <http://www.newmoa.org/prevention/mercury/programs/Details.cfm?ID=219&GoBack=-1>.

<sup>198</sup> See <http://www.epa.gov/region02/mercury/projects.htm>.

Many manufacturers have begun to offer mercury take-back programs for mercury-containing medical devices. For example, Welch Allyn ended its production of mercury sphygmomanometers and took back 10,000 mercury devices in 2004, removing about 1 ton of mercury from the health care sector.<sup>188</sup>

#### **6.4.2.6 Information Campaigns**

Many resources are available that provide guidance to the health care sector in reducing mercury in products and waste streams.<sup>199</sup>

#### **6.4.2.7 Collection Programs**

Bowling Green State University and the Ohio EPA operate an Elemental Mercury Collection Program that offers free collection of uncontaminated mercury to any entity, including hospitals and health care facilities.<sup>200</sup>

#### **6.4.2.8 Tools**

*Mercury Use Reduction & Waste Prevention in Medical Facilities* is an interactive environmental education software program developed jointly by Purdue University and U.S. EPA to provide information on the proper handling and disposal of mercury wastes produced by medical facilities.<sup>201</sup>

Purdue University provides a virtual health care facility on the Internet that identifies typical sources of mercury contained in specific rooms of a medical institution. This facilitates identification of pollution prevention opportunities associated with hospital operations.<sup>202</sup>

### **6.4.3 Recommended Actions**

6.4.3.1 Continue to implement and promote state Hospitals for a Healthy Environment (H2E) programs that include participation by hospitals, clinics, and nursing homes, and reward, recognize, or provide incentives to health care facilities that complete mercury reduction programs. Assist health care facilities in keeping mercury out of the environment by

- replacing mercury-containing products with mercury-free alternatives,
- adopting a mercury-free purchasing policy,
- maintaining proper mercury spill clean-up procedures,
- conducting an internal mercury audit, and
- establishing proper handling and disposal of mercury-containing materials.

6.4.3.2 Become H2E partners and develop programs that implement mercury reduction activities at state-operated facilities.

6.4.3.3 Seek to engage other health care facilities, such as independent medical research labs and veterinary care facilities, in mercury pollution prevention efforts, using existing work with hospitals as a model.

## **6.5 Households**

### **6.5.1 Background**

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<sup>199</sup> For example, see resources listed at <http://www.glrppr.org/contacts/gltopicub.cfm?sectorid=43#15> and <http://www.epa.gov/glnpo/toxteam/potwp2.htm#I12>.

<sup>200</sup> See <http://www.bgsu.edu/offices/envhs/page18364.html>, and for a fuller description of this program, see the Households section (6.5).

<sup>201</sup> Mercury in Medical Facilities. Available at [http://www.epa.gov/seahome/mercury\\_disclaim.html](http://www.epa.gov/seahome/mercury_disclaim.html).

<sup>202</sup> See <http://www.purdue.edu/dp/envirosoft/mercury/src/hospital.htm>.

### **6.5.1.1 Amount of Mercury Involved**

Numerous common products in households contain mercury, including thermometers;\* thermostats;\* fluorescent lamps;\* switches\* in appliances (including clothing irons, chest freezers and washing machines); blood pressure gauges; older paints and pesticides; batteries; and some toys and clothing (such as flashing lights in shoes). Mercury-free or reduced-mercury versions of all of these products are currently on the market, although mercury continues to be used in new fluorescent lamps and thermostats. While many of the mercury-containing versions of these products are being phased out, many households still have older versions of these products that contain larger quantities of mercury, either still in use or simply stored away. Some households also have elemental mercury as part of a science kit or from some other source.

In addition, many consumer products such as hearing aids, watches and toys contain mercury-added button cell batteries. While the amount of mercury in each button cell battery is small, the total amount used is significant because of the large and growing number of button cells used in the United States. The Maine Department of Environmental Protection estimates that button cell batteries sold annually in the United States, either separately or in products, contain between three and five tons of mercury. Approximately half of these batteries were imported.<sup>203</sup> U.S. battery manufacturers have voluntarily committed to eliminate mercury use in button cell batteries sold after July 1, 2011.

### **6.5.1.2 Releases of Mercury**

The mercury in households poses several different risks. With elemental mercury and breakable items such as thermometers or sphygmomanometers there is a risk of human exposure to mercury vapors (see Thermometers, §5.5).

With items such as switches, thermostats and batteries where the mercury is securely enclosed, there is a low risk of direct exposure in the home. Rather, the concern arises when these items are discarded or during demolition or renovation projects. Households are typically not subject to the more stringent hazardous waste disposal requirements that govern other generators of mercury-containing waste. In most states, households are permitted to dispose of mercury-containing items with the regular solid waste stream. Even where there are stricter regulations on disposal of particular products, such as mercury-containing lamps in Minnesota, enforcement is usually focused on large-scale generators of dangerous waste, and residents frequently discard these items with the regular solid waste. See the sections on Thermostats (§5.2), Steel Manufacturing (§6.2), and Lamps (§5.4) for information on environmental releases from household products and appliances in the solid waste stream.

Use of mercury in batteries causes additional mercury releases overseas. Button cell batteries are a major consumer of mercury in China, with an estimated 109 tons of mercury used in such batteries annually, primarily in button cells. The trend in battery mercury use in China is downward, with a reduction of 76 percent since 1999.<sup>204</sup> Disposal of batteries in countries that do not have emissions controls on waste incinerators could lead to significant emissions.

### **6.5.2 Existing Programs**

Sale restrictions may be in the form of sales bans or product phase-outs.

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\* these products are addressed in greater detail in other sections of this document

<sup>203</sup> Maine Department of Environmental Protection. Mercury Use in Button Batteries. A Report to the Joint Standing Committee on Natural Resources, 122nd Maine Legislature. March 2005.

<sup>204</sup> Natural Resources Defense Council and Chemical Registration Center of China's State Environmental Protection Administration. China Mercury Production, and Mercury Use In China's PVC And Battery Manufacturing Sectors (August 2006).

### 6.5.2.1 Product Bans

The sale of mercury-containing versions of some household products has been banned in some states (e.g. see §5.5 Thermometers and §5.3 Switches, Relays and Measurement and Control Devices). In New York and other states, the law bans the sale of mercury-added consumer products such as thermometers and novelties.

One of the most important success stories of mercury reduction in the last 20 years has been the removal of mercury from most batteries. In the early 1980s, battery manufacturers used more than 1000 tons of mercury annually, an amount that fell dramatically in the late 1980s as industry began to remove mercury from batteries sold nationwide in response to laws passed in several states.<sup>205</sup> In 1996, the federal Mercury-Containing Battery Management Act prohibited the use of intentionally-introduced mercury in most categories of battery, with a notable exception for button cell batteries. Button cells were allowed to contain 25 mg of mercury each; U.S. manufacturers actually use approximately 8 mg and the most common type of button cell battery, the zinc air cell, typically contains 8 mg mercury. Current mercury use in batteries is estimated at three to five tons annually.

The mercury in button cell batteries performs an important function—it suppresses the buildup of gasses within the battery that can lead to leakage or rupture. Fortunately, battery manufacturers have recently developed alternative means of preventing this gas buildup, thereby allowing them to eliminate mercury use in button cells. U.S. manufacturers have voluntarily committed to eliminating mercury use in button cells by 2011.

However, this voluntary commitment will not prevent imports of mercury-added button cell batteries. As a result, the state of Maine has prohibited the sale of mercury-added button cell batteries, beginning in 2011. If additional jurisdictions follow suit, it could have a significant impact on the battery market, potentially leading to the cessation of mercury use in batteries worldwide.

### 6.5.2.2 Voluntary Phase-Outs and Phase-Downs

The use of mercury has been phased out voluntarily by manufacturers of some products (see §5.2 Thermostats, §5.5 Thermometers and §6.5.2.1 Button Cell Batteries); in others, technological improvements have made it possible to use reduced quantities of mercury (see §5.4 Lamps). For example, the mercury content of batteries has been decreased to 1% of its previous level. After 1994, the use of mercury in L.A. Lights™ shoes was discontinued. The use of mercury in latex paints was voluntarily discontinued in 1990 for indoor paints and 1991 for outdoor paints.<sup>206</sup>

### 6.5.2.3 Information Campaigns

Many states have initiated mercury hazard awareness programs for the public that focus on advising people on where they might find mercury in their homes and what they should do to protect themselves and the environment. All the Great Lakes states' environmental agencies have web pages to disseminate this information.

For example, the Ohio EPA has created a fact sheet “Mercury in the Household” to advise residents on many aspects of the mercury issue. It lists household products that may contain mercury, advises how to clean up a mercury spill, describes other sources of mercury to the environment such as coal power, and identifies

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<sup>205</sup> John L. Sznopce and Thomas G. Goonan. The Materials Flow of Mercury in the Economies of the United States and the World. U.S. Geological Survey Circular 1197, 2000.

<sup>206</sup> Great Lakes Binational Toxics Strategy. Wisconsin Mercury SourceBook: A Guide to Help Your Community Identify and Reduce Releases of Elemental Mercury. <http://www.epa.gov/glnpo/bnsdocs/hgsbook/house.pdf>

sources of mercury poisoning to humans, such as eating fish from contaminated waters. This fact sheet is available online at [http://www.epa.state.oh.us/ocapp/p2/mercury\\_pbt/mercur.pdf](http://www.epa.state.oh.us/ocapp/p2/mercury_pbt/mercur.pdf).

The Ohio Department of Natural Resources also has a brief fact sheet on “Household items that may contain mercury” (online at <http://www.ohiodnr.com/recycling/awareness/facts/factsheets/mercury1.htm>). It provides web links and phone numbers for disposal options and spill clean-up advice.

Indiana’s Mercury Awareness Program educates individuals about environmental and safety issues relating to mercury, about the presence of mercury in products, and about opportunities for proper disposal of mercury-containing household items. The state Department of Environmental Management publishes a household spill cleanup guidance sheet [http://www.in.gov/idem/your\\_environment/mercury/catalog/spill.pdf](http://www.in.gov/idem/your_environment/mercury/catalog/spill.pdf) and a household checklist for mercury-containing products [http://www.in.gov/idem/your\\_environment/mercury/catalog/search.pdf](http://www.in.gov/idem/your_environment/mercury/catalog/search.pdf).

#### **6.5.2.4 Disposal Bans**

New York State and Minnesota both ban the disposal to trash of mercury-containing products from all generators, including households. In New York State, the ban does not apply to fluorescent bulbs.

#### **6.5.2.5. Collection Programs**

Although mercury use has been phased out or greatly reduced in new consumer products, households contain old products with higher quantities of mercury, necessitating safe disposal methods.

#### **Ongoing Mercury Collections**

Bowling Green State University (Ohio) runs an ongoing mercury collection program in cooperation with Ohio EPA district offices and some city environmental offices and waste management companies. They accept mercury from households as well as from schools and other non-profit organizations. In order to minimize the risk of a mercury spill in a vehicle, trained program representatives come to pick up elemental mercury or mercury-containing products from homes. They store it safely and then send it to be recycled. This service is free to households.<sup>207</sup>

As part of the Mercury Awareness Program, Indiana’s Department of Environmental Management provides free mercury recycling to all households in Indiana. Schools can also use this recycling service but must pay 25% of the cost. Over 5,600 pounds of elemental mercury and mercury-containing devices were collected from Indiana households between 1998 and 2004.

#### **Mercury Collection Events**

The Michigan Department of Environmental Quality financially supported the collection of mercury and mercury-containing devices at 15 sites throughout Michigan under the Groundwater Stewardship ‘Clean Sweep’ Program. Between 2003 and 2006 they collected 87,538 mercury-containing devices and captured 2,741 pounds of elemental mercury.<sup>208</sup>

#### **Household Hazardous Waste Collections**

All eight Great Lakes states have Household Hazardous Waste (HHW) collection programs that accept elemental mercury and mercury-containing items.

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<sup>207</sup> Program website at <http://www.bgsu.edu/offices/envhs/page18364.html>

<sup>208</sup> Steve Kratzer, MI DEQ. Dec. 12, 2006.

For instance, in Indiana, each solid waste management district has a permanent drop-off site for HHW. There are 73 solid waste districts in the state, each serving one or more counties. Some districts have mobile units that serve as collection sites to make drop-off more convenient for residents spread over a large geographic area.

Many household hazardous waste collections in Michigan accept mercury.

Ohio has nine drop-off sites that are open year-round either monthly, weekly, or daily. In addition, local solid waste management districts organize special one-time collection events. In 2006 there were 55 such events.

In Fiscal Year 2005-2006 Pennsylvania had three permanent drop-off sites (pickup can sometimes be arranged as well) and held 51 additional one-day collection events. Pennsylvania's emergency response program, which operates out of the agency's six regional offices, also collects elemental mercury from the public on an as-requested basis.

Nine permanent HHW facilities operate year-round in New York State. Some facilities will accept HHW once per month, while others will accept waste daily or on weekends. Additionally, many municipalities hold one- or two-day HHW collection events; usually about 70-75 such events occur each year in New York State. The New York State DEC provides 50% funding to municipalities that conduct HHW collection events or establish permanent facilities. Over the past several years, the DEC has requested these municipalities to specifically promote the fact that mercury-containing items are accepted. In 2006, at least 1,714 pounds of mercury-containing devices/waste and 413 pounds of liquid mercury were collected during these events. While not all communities are required to conduct such programs, they are encouraged to establish them.

### **Button Cell Battery Collection**

States and municipalities have chosen not to implement button cell battery collection and recycling efforts. Cost-effectiveness is a consideration, because of the small amount of mercury in each button cell. NEMA has pointed out that collection and storage of button cell batteries could create a safety hazard, with potential short circuits and fires if the batteries are mixed with flammable materials. Moreover, according to NEMA, the Director of the National Capital Poison Control Center opposes button cell collection because of the potential it creates for increasing accidental ingestion of button cells.<sup>209</sup> For these reasons, this Strategy does not recommend development of button cell battery collection programs.

#### **6.5.3. Recommended Actions**

6.5.3.1 Educate the general public on mercury hazards and proper management. Much of the needed information is already available on the states' environmental agencies websites. States should consider additional forms of outreach – such as ads on public transportation vehicles, mailings with utility bills, notification by waste management and recycling companies, and flyers at doctors' offices – as the websites may only be read by those who already have an interest in the issue.

6.5.3.2 Ensure access to free collection of mercury and mercury-containing products for households. At a minimum, access should include periodic mercury collection opportunities for all citizens able to travel a reasonable distance, especially near major population centers.

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<sup>209</sup>National Electrical Manufacturers Association. Button Cell Battery Collection: Why It Does Not Make Sense. January 2003.

6.5.3.3 Implement legislation to ban sale of mercury-added button cell batteries, including imported batteries, on a schedule consistent with the U.S. industry commitment to phase out mercury by 2011.

## **7.0 CROSSCUTTING STRATEGIES TO ADDRESS ALL PRODUCTS AND SECTORS**

### **7.1 Generic Phase Out and Exemptions**

Certain states have adopted laws, phasing out and/or banning the sale of selected mercury-added products. These laws have focused on key product categories where mercury has been intentionally added in relatively large amounts, such as thermostats, as well as switches and relays and the products that contain these components. The purpose of state product bans and phase out requirements is to eliminate non-essential uses of mercury in consumer, household and commercial products. The phase out requirements will typically allow for a manufacturer to apply for and obtain a written exemption if they want to continue to sell their product in the applicable states.

Because the state product bans or phase outs often only apply to selected mercury-added products, it is possible for new mercury-added products to be introduced into the marketplace. For example, mercury has been introduced into blue-tinted automobile headlamps and wheel balancing systems for certain motor vehicles in the past few years. While states should be commended for taking a leadership role in regulating mercury use in selected products, a more comprehensive regulatory approach would ensure that manufacturers develop new products that avoid the need for mercury entirely, in addition to systematically evaluating all of their existing product lines to identify opportunities for eliminating mercury use, even where it is used in smaller amounts. Several states, including Connecticut, Rhode Island, Maine and Louisiana, have recently enacted generic laws that would phase out the sale of nearly all mercury-added products within a certain period of time (with exemptions).

NEWMOA has developed model legislation that requires phasing out mercury over a six year period, beginning with fabricated products with more than 1 gram of mercury and formulated products with more than 250 ppm mercury within two years, falling to 100 mg and 50 ppm, respectively, in four years and 10 mg or 10 ppm, respectively, in six years. Under the NEWMOA model legislation, fluorescent lamps are exempt from the above limits on total mercury content and instead are subject to a limit of no more than 10 mg within eight years. The NEWMOA model legislation also contains provisions for a manufacturer to obtain exemptions from the phase out requirements if a system exists for the proper end-of-life management of the product and if the manufacturer can show that:

- i. use of the product is beneficial to the environment or protective of public health or protective of public safety, and
- ii. there is no technically feasible alternative to use of mercury in the product; and
- iii. there is no comparable non-mercury-added product available at reasonable cost.

### **Recommended Actions**

7.1.1 We recommend that each of the Great Lakes states adopt legislation that phases out the sale of all mercury-added products, regardless of mercury content or concentration, no later than 2015.

Fluorescent lamps and dental amalgam should be exempt from the phase-out. These products are addressed in other sections of this report.

States should adopt a mechanism to allow for use of a mercury device when a suitable alternative is not available, for instance if mercury replacement components are needed for existing equipment, when

a mercury device is a necessary component in rebuilt equipment meant for resale, when use of mercury in the product is required to meet federal or state health and safety rules, or when use of the mercury-added product is beneficial to the environment or protective of public health and safety compared to a non-mercury alternative.

Manufacturers applying for exemptions should justify their exemption request and include a plan to collect and manage used mercury-added products through manufacturer take-back or by funding other private or public collection programs, including accountability measures to ensure high rates of recovery for end of life products. Exemptions should be issued for a limited period (e.g., two years) and may be renewed for additional periods as long as the criteria are met.

## **7.2 Funding**

Successful implementation of the recommendations in this report will require the Great Lakes states to continue to devote resources towards mercury-reduction programs, and to increase support, where possible. In particular, it will be important to continue to fund outreach efforts and mercury-collection programs.

In addition, states may have the ability to provide monetary incentives to manufacturers for the development of environmentally preferable products. For example, the New York State Energy Research and Development Authority (NYSERDA) developed a program that provides funding to retailer and manufacturer partners to promote ENERGY STAR<sup>®</sup> and energy efficient products such as compact fluorescent light bulbs. This concept could be expanded to provide funding to develop, manufacture and promote mercury-free alternatives to certain products.

While many of the Great Lakes states now require the phase-out of specific mercury-containing products, some allow these products to continue to be sold if alternatives are not available. By targeting research and development funds toward the development of mercury-free alternatives, states could hasten the ultimate phase-out of mercury-containing products; increase manufacturing capacity to offset any manufacturing loss related to the cessation of production of mercury products; and reduce mercury use and the need for disposal of mercury-containing products at the end of their useful life. States' Economic Development Agencies could be approached to further develop this concept if such programs are not already in existence.

## **Recommended Actions**

7.2.1 Provide significant additional support, funding and staff for existing and new state and local mercury reduction activities, including

- implementation, enforcement monitoring, and measurement of mercury reduction and management laws and policies;
- outreach and public education on the dangers of mercury and the availability of mercury-free products;
- collection of mercury-containing products, including fluorescent lamps, from schools and households.

7.2.2 In addition, we recommend that states consider targeting research and development funding toward mercury-free alternatives to products.

## **7.3 Product Labeling**

Numerous states, including Minnesota and New York, prohibit the sale of any mercury-containing product unless the product has a label stating that it contains mercury and providing information about how to dispose of it. Model legislation developed by NEWMOA requires labeling of “mercury-added” products, meaning products to which mercury has been deliberately added and excluding products that contain trace amounts of contaminant mercury. The labeling laws generally specify the wording, size, and visibility of the

label. The laws apply both to mercury products sold separately and to products that contain a mercury-added component. These laws do not apply to mercury-added pharmaceuticals approved by the U.S. Food and Drug Administration.<sup>210</sup>

Most of the states that have mercury product labeling laws are members of the Interstate Mercury Education and Reduction Clearinghouse (IMERC). IMERC provides a single point of contact for manufacturers and promotes consistency in state labeling standards, helping to avoid undue burdens on manufacturers or distributors who might otherwise be required to provide different labels for products sold in different states.

Product labeling laws help consumers make informed choices about purchases, potentially promoting non-mercury alternatives. In addition, the labels identify good disposal practices and inform consumers of the need to dispose of mercury-containing products safely.

### **Recommended Actions**

7.3.1 We recommend that each of the Great Lakes states implement and enforce mercury product labeling requirements. To avoid putting unnecessary burden on industry, we recommend that states implement such requirements consistent with the IMERC program.

### **7.4 Notification Requirements**

Numerous states, including New York, have mercury product notification laws that require manufacturers, distributors and sellers of mercury-added products to notify the state of the quantity of mercury contained in the products that they sell. Such requirements improve public knowledge about which products contain significant amounts of mercury. This knowledge helps policy-makers set priorities for mercury reduction programs and helps recycling industry managers target their outreach.

IMERC is the contact point for manufacturers to comply with state notification requirements of member states. IMERC provides notification forms and coordinates a multi-state review group that compiles the information and makes it available to the public. The data provided goes into a Mercury Products Database.<sup>211</sup>

### **Recommended Actions**

7.4.1 We recommend that each of the Great Lakes states implement mercury product notification requirements in order to further improve data about mercury use in products. To avoid putting unnecessary burden on industry, we recommend that states implement such requirements consistent with the IMERC program.

7.4.2 We also recommend that states participate in national or regional clearinghouse efforts for coordination of mercury product stewardship initiatives, such as IMERC, P2Rx, GLRPPR, and the Toxics in Packaging Clearinghouse.

### **7.5 Public Outreach**

Existing outreach efforts have proven that informing manufacturers, purchasers and waste stream management officials of the problems and issues involved with mercury products can start to change their attitudes and practices. This is directly shown by the adoption of the various mandatory and voluntary programs started across the region and the country.

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<sup>210</sup> <http://www.newmoa.org/prevention/mercury/imerc/labelinginfo.cfm>

<sup>211</sup> See <http://www.newmoa.org/prevention/mercury/imerc/notification/index.cfm>

Regarding mercury and mercury products, states need to continue to inform people of the environmental and health impacts, purchasing preferences, collection and management efforts and concerns, and many other issues related to mercury product management. It can be effective to time mercury information campaigns to coincide with events like the opening of fishing season, since fish consumption is understood by the public to be a major route of mercury exposure for humans. A Great Lakes Mercury Awareness Day or Week could be created as part of a public awareness campaign.

Many of the Great Lakes states already participate in IMERC, which identifies education as one of the major duties of the Clearinghouse. In addition to developing and distributing specific information on various mercury issues, a more comprehensive educational campaign is needed. The impacts of mercury on human health and the environment need to be made known to all levels of government, industry, and the general public so that we continue to decrease the use and manufacturing of mercury products and promote the proper management of existing mercury-containing products.

### **7.6 End-of-Life Product Management, Product Stewardship and Producer Responsibility**

There is a substantial installed base of mercury-containing equipment in businesses, manufacturing facilities, and households across the Great Lakes Basin and the United States. The need for end-of-life management of this equipment and products (including collection of bulk mercury) cuts across several product and sector categories, including: dental: thermostats; switches; relays; measurement and control devices; lamps thermometers; schools; steel/scrap metal; health care; and households.

Traditionally in the U.S., producers are typically responsible for managing the environmental impact of their products during the production stage. Consumers and municipalities are generally held responsible for the environmental impact of using the mercury-containing product and managing it at the end of its useful life, whether that is disposal, reuse or recycling. In some instances, state government has provided assistance to municipalities in collecting these products through household hazardous waste collection events, chemical cleanouts or targeted product exchanges (see sections 5.4.2.5, 5.5.2.3, 6.1.2.3, 6.1.2.4 and 6.5.2.5). As another example, Bowling Green University in Ohio works with state and local organizations to facilitate free removal of uncontaminated elemental mercury for recycling. This service not only includes Ohio, but also extends to locations in Indiana, Michigan, Pennsylvania, West Virginia, Kentucky, Tennessee, Wisconsin, and as far away as Georgia, Texas and Nebraska.

Given the limited resources of local and state government, another end-of-life management approach is extended producer responsibility: making producers responsible for environmental impacts of products throughout their life cycles. The advantages of this approach are that it can lead to the involvement of producers in financing programs to properly manage wastes generated by products, and that it creates incentives for producers to design and market products that minimize end-of-life environmental impacts.<sup>212</sup> Under product stewardship approaches, other parties such as distributors, purchasers, end users, and waste management organizations have stewardship responsibilities as well, but producer responsibility extends even after the producer sells the product.

Several states, including Minnesota, have manufacturer take-back requirements for thermostats. Maine requires wholesalers to take back thermostats. In other states where these requirements do not exist, thermostat manufacturers have voluntarily employed an extended producer responsibility approach by taking responsibility for collection of mercury-containing thermostats (see Thermostats, §5.2). Auto makers, as a participant in the

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<sup>212</sup> Bette K. Fishbein, "The EPR Policy Challenge for the United States." In Extended Producer Responsibility: A Materials Policy for the 21st Century. June 2000. Available at <http://informinc.org/eprpolicy.php>.

National Vehicle Mercury Switch Recovery Program, are voluntarily employing an extended producer responsibility approach to automotive mercury switches through the End-of-Life Vehicle Solutions Corporation, which pays for collection and recycling of mercury switches removed by auto recyclers. Some state laws require auto makers to manage these collection programs, and in some cases to compensate auto recyclers for each switch removed (see Steel, §6.2).

In addition, Minnesota law creates producer responsibility requirements for manufacturers of mercury-containing displacement relays. Under the law, a displacement relay manufacturer “is responsible for the costs of collecting and managing its displacement relays to ensure that the relays do not become part of the solid waste stream” and must “provide incentives for, and sufficient information to, purchasers and consumers of the relay to ensure that the relay does not become part of the waste stream. A manufacturer that has complied with this subdivision is not liable for improper disposal by purchasers or consumers of its relays.”<sup>213</sup>

Massachusetts’s law requires all manufacturers of mercury-containing products to create and file with the state a “convenient and accessible collection plan for mercury-added products at the end-of-life, including a system for the direct return of the mercury-added product to the manufacturer or a collection and recycling plan... using new or existing collection systems.” Unless a state-approved collection plan exists for a given mercury product and is implemented by the manufacturers, it is unlawful to sell that product in Massachusetts.

In order for end-of-life management programs to be successful in preventing improper disposal and release of mercury when it is no longer wanted, it is very important that these programs include several components that address awareness, participation, performance and accountability.

First, outreach and education is necessary so that households and businesses know why mercury is a problem, and know which items contain mercury and what should be done with them.

Second, there must be collection and management systems that are visible and easily accessible to the household or business with the mercury item. A cost incurred at this point is a barrier to accessibility and a financial disincentive. End of life management costs should be prepaid in some manner by those in the best position to do so, e.g., by the manufacturer or by the retailer or user at time of sale or purchase.

Third, there must be motivation to manage the items properly. Motivation and incentives can be, for example, financial, non-financial, positive, or negative. Different individuals and businesses react in different ways to different types of motivation and incentives. While we operate in a society that is driven in large part by laws, markets, and civic/moral responsibilities, there are many businesses and individuals who may not be motivated by one or even all such factors. Therefore there must be multiple incentives and they should be used equitably across society so that no one receives unfair or favorable treatment.

Fourth, all of the parties involved in end of life programs must be responsible and accountable for their contribution to the program and accountable for program success. Programs must be regularly evaluated and improved.

These principles and essential program elements have been recognized by ECOS in their resolutions related to the national auto mercury switch recovery program. ECOS Resolution 04-7 communicated these principles to stakeholders in advance of negotiations to establish a national vehicle mercury switch recovery

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<sup>213</sup> Minn. Statute §116.92, cited in <http://www.pca.state.mn.us/oea/publications/wma-mercury.pdf>

program. The principles have been restated in ECOS Resolution 06-7 endorsing the National Vehicle Mercury Switch Recovery Program Memorandum of Understanding.

### **Recommended Actions**

7.6.1 We recommend that states continue providing education on proper disposal of mercury-containing products and continue providing collection programs at the local level that accept any type of mercury or mercury-containing product. Such collections may be funded by users through a small collection fee or by manufacturers through an extended producer responsibility approach.

7.6.2 We recommend that states support extended producer responsibility approaches in the development of voluntary end-of-life management programs and consider mandatory manufacturer-funded take-back programs for mercury-containing products, where feasible and appropriate.

7.6.3 We recommend that end-of-life management programs be designed to ensure that product users are made aware of the program and its operating requirements; are motivated to participate via monetary or other incentives; and have convenient and easy access to collection services or sites. The programs should also include performance measures that contribute to program accountability, periodic evaluation of results and continuous improvement in collection rates.

### **7.7 Government Purchasing, Disposal, and Maintenance**

Governments at all levels use mercury-containing products in facilities (thermostats, fluorescent lamps, switches, medical equipment) and vehicles (auto switches, back lighting and potentially head lamps). Governments can implement a variety of policies to minimize unnecessary uses of mercury and to ensure proper management of mercury-containing devices when in use and at end-of-life. State and local governments can include mercury disclosure requirements in bids and then purchase low- or no-mercury items based on the information provided in those disclosures.

Many state governments have “green” purchasing policies to help avoid purchase of environmentally damaging products and to improve energy efficiency. Guidance for Michigan’s Environmentally Preferred Purchasing program identifies categories of equipment that often contains mercury, and provides the following instruction: “Talk to manufacturers or suppliers about equipment that contains minimal to no mercury... compared to other equipment. This can help reduce disposal costs or procedures need[ed] to dispose of products or equipment containing mercury.”<sup>214</sup>

New York State recently passed Chapter 611, Laws of 2006, which added language to the State’s Finance law to “grant a preference and give priority to the purchase of vehicles which are mercury-free taking into consideration competition, price, availability and performance.”

A Commonwealth of Massachusetts bid specification for computers, peripherals, and services states that “it is desirable that Bidders demonstrate that computer equipment does not contain some or all of the following toxic/hazardous constituents: ...Mercury in the background lighting system, batteries and other electronic components.”<sup>215</sup>

The Federal Government’s Environmentally Preferable Purchasing Program provides a wealth of information about environmentally preferable purchasing, including information about products and examples

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<sup>214</sup> Michigan Department of Environmental Quality, “The Green Industry Guide to Environmental Purchasing.” January 2006. [www.deq.state.mi.us/documents/deq-ess-p2-turf-purchasingguide.pdf](http://www.deq.state.mi.us/documents/deq-ess-p2-turf-purchasingguide.pdf)

<sup>215</sup> <http://www.epa.gov/epp/pubs/electronics/electronics3.htm>

of contract language that can be used to ensure that environmentally preferable products are used by contractors providing goods and services to government agencies.<sup>216</sup>

In addition to purchasing policies, states and tribes can adopt policies to ensure proper management of existing mercury in facilities. For instance, a 1999 Indiana Executive Order on “Greening the Government” requires state facilities to conduct “mercury assessments.”<sup>217</sup>

### **Recommended Actions**

7.7.1 States should adopt purchasing policies that ensure purchase of non-mercury products where appropriate —where such products are available and equivalent in performance, including energy efficiency, to the mercury alternative. States should also adopt policies to ensure that mercury in state-owned facilities is managed properly at end-of-life.

## **7.8 International Transfers of Mercury in Equipment and Devices**

Some obsolete mercury containing equipment is transferred through resale or donation to other organizations or exported to developing countries. This is particularly a concern related to health care equipment. We have addressed this specific issue in section 6.4 Health Care.

### **Recommended Actions**

7.8.1 States should periodically check on what happens to the mercury collected from within their boundaries. If it turns out that substantial quantities of mercury and mercury-containing devices are being sold for reuse in circumstances that raise concerns about whether the equipment will be properly managed during use and disposal, states should adopt measures to discourage this practice.

## **7.9 Trash Disposal Bans**

Many Great Lakes states have banned trash disposal for mercury-containing items (see Table 2. Existing state laws regarding mercury in the Great Lakes basin.) In some states, this ban extends to all mercury-added products; in others, specific products, such as thermostats, are banned from the trash. In some states, this ban applies only to businesses and other large-scale solid waste sources, while in several states, the ban applies to households and smaller generators as well.

## **7.10 Coordination Among States; Collaboration With Canadian Provinces**

States can maximize the impact of all the actions recommended above if they coordinate their mercury reduction initiatives and avoid unnecessary duplication of effort. For example, states can share brochures and web pages and other public outreach materials with one another and with Canadian provinces, tribes and municipalities. States and provinces can advise one another on methods for product collection events or on innovative pollution prevention partnerships with industry. And they can coordinate to provide consistent rules and requirements for industry in the areas of product labeling, notification, and disposal. Such collaboration can take place via the Great Lakes Regional Pollution Prevention Roundtable, IMERC, the Quicksilver Caucus, and the Great Lakes Binational Toxics Strategy’s (GLBTS) mercury workgroup.

### **Recommended Actions**

7.10.1 States, cities, tribes, and provinces should share their expertise on methods for mercury reduction.

## **8.0 Tracking Progress on Implementation**

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<sup>216</sup> <http://www.epa.gov/epp/>

<sup>217</sup> State of Indiana, Executive Department, Executive Order 99-07, Greening the Government. Available at <http://www.newdream.org/procure/policy/indiana.pdf>

An ongoing system of governance and organization for follow-up on this strategy would facilitate the successful implementation of this strategy. A workgroup – perhaps including many of the drafters of this document – should be formed to periodically evaluate progress. States, tribes (or tribal organizations such as CORA or GLIFWC) and cities could appoint representatives to this group. In addition, Environment Canada and the Ontario Ministry of the Environment could be invited to participate, helping promote information sharing on successful mercury reduction approaches across the Great Lakes region. Input from stakeholders, including U.S. and Canadian industry and environmental groups, should be sought.

The proposed group could meet twice per year, at least initially. At workgroup meetings, state, tribal, and municipal representatives could discuss with one another the progress being made in mercury reduction in their areas. Additionally, the group could compile a progress report biennially (every two years) for submission to the Council of Great Lakes Governors. This report will be made available to regional, national, and international audiences. It will identify individual states' (and, where available, tribes' and cities') successful implementations of this strategy's recommendations and may also include other progress relative to mercury reduction. The biennial report will provide organizational structure for this project through 2015.

## 8.1 Track Progress on Implementation of Recommendations

*8.1.1 We recommend that each of the Great Lakes States environmental agencies Great Lakes Tribes (or tribal organizations), the Great Lakes and St. Lawrence Cities Initiative and the U.S. Environmental Protection Agency appoint a representative to a workgroup tasked with tracking progress on implementation of the recommendations in this report and for sharing information about implementation priorities and approaches. This workgroup should invite participation from Environment Canada and the Ontario Ministry of the Environment, and seek stakeholder input.*

## 8.2 Identify Implementation Priorities

*8.2.1 We further recommend that each of the Great Lakes state environmental agencies and Great Lakes Tribes (or Tribal organizations) and the Great Lakes and St. Lawrence Cities Initiative publicly identify its implementation priorities and the organizations responsible for achieving them.*

## APPENDICES

### Appendix A – Great Lakes Regional Collaboration

The Great Lakes are a unique and extraordinary natural resource providing drinking water, food, recreation, employment, and transportation to more than 35 million Americans. But the Great Lakes suffer from many serious environmental challenges. Since 1970, much has been done in attempts to restore and protect the lakes. Although there has been significant progress, the work of cleaning up the lakes and preventing further problems has not always been coordinated.

Learning that the protection of the Great Lakes was in need of better coordination, in May 2004, President Bush created a cabinet-level interagency task force and called for a “regional collaboration of national significance.” As a result, the federal Great Lakes Interagency Task Force, the Council of Great Lakes Governors, the Great Lakes Cities Initiative, Great Lakes tribes and the Great Lakes Congressional Task Force convened a group now known as the Great Lakes Regional Collaboration (GLRC). The Collaboration includes the EPA-led Federal Interagency Task Force, the Great Lakes states, local communities, tribes, non-governmental organizations and other interests in the Great Lakes region. While the Collaboration is a U.S. effort, its members do everything possible to synchronize its efforts with those of our Canadian partners.

The Collaboration created a strategy to restore the Great Lakes basin, which was released on December 12, 2005. Subsequently, Issue Area Strategy Teams were created and charged with developing detailed recommendations on how to accomplish the goals of the strategy. Eight Issue Area Strategy Teams include:

- Aquatic invasive species
- Habitat conservation and species management
- Near-shore waters and coastal areas (Coastal health)
- Areas of concern
- Non-point sources
- Toxic pollutants
- Sound information base and representative indicators
- Sustainability

The teams were made up of subject-matter experts from many diverse backgrounds: more than 1,500 people from all levels of government and nongovernmental organizations worked on the issues identified as crucial to the health of the Great Lakes ecosystem. The teams were the working bodies responsible for drafting action items and recommendations to address the eight issues.

In addition, the teams have addressed the following overarching considerations and topics:

- Human health impacts and priorities
- Tribal interests and perspectives
- Research and monitoring

On July 7, 2005, the GLRC released its draft strategy document for public view and comment. The Strategy included detailed recommendations addressing the eight Issue Areas.

### Appendix B – page 47 of the GLRC Strategy: Toxic Pollutant Strategy

#### I. Problem Statement

While certain persistent toxic substances (PTS) have been significantly reduced in the Great Lakes Basin Ecosystem over the past 30 years, they continue to be present at levels that pose threats to human and wildlife health, warrant fish consumption advisories in all five lakes, and disrupt a way of life for many in the basin, particularly the ways of life and cultures of tribal communities.

PTS releases from contaminated bottom sediments, various industrial processes, and non-point sources, loadings from atmospheric deposition, contaminated groundwater, and continuous cycling of PTS within the Great Lakes themselves, all contribute to this ongoing problem. More recently, researchers have documented the presence of additional chemicals of emerging concern that may also pose threats to the Great Lakes. Characteristics of these substances, such as sources, releases, fate, transport, persistence, bioaccumulation, and toxicity, must be better understood.

## **II. Goals and Milestones**

To establish and maintain the chemical integrity of the Great Lakes Basin Ecosystem, as called for in the Great Lakes Water Quality Agreement, this Strategy sets forth the following goals:

Goal 1: Virtually eliminate the discharge of any or all persistent toxic substances (PTS) to the Great Lakes basin ecosystem.

Goal 2: Significantly reduce exposure to persistent toxic chemicals from historically contaminated sources through source reduction and other exposure reduction methods.

Goal 3: Reduce environmental levels of toxic chemicals to the point that all restrictions on the consumption of Great Lakes fish can be lifted.

Goal 4: Protect the health and integrity of wildlife populations and habitat from adverse chemical and biological effects associated with the release of PTS.

Interim Milestones, Goals 1-4:

By 2008, collect 1 million pounds waste pesticides per year.

By 2010, 50% reduction in basin-wide household garbage burning.

By 2010, commence significant reductions in mercury emissions from coal-fired power plants.

By 2015, full phase-outs of intentionally added mercury bearing products, as possible.

By 2025, full phase-out of all PCB equipment in the basin.

By 2025, significantly reduce PTS inputs from international sources.

### **Appendix C – Council of Great Lakes Governors’ Letter to President Bush Dec. 12, 2005**

[http://www.cglg.org/projects/priorities/Letter\\_to\\_the\\_President\\_on-GLRC\\_12-12-05.pdf](http://www.cglg.org/projects/priorities/Letter_to_the_President_on-GLRC_12-12-05.pdf)

### **Appendix D – Binational Toxics Strategy**

The Great Lakes Binational Toxics Strategy is an agreement between Canada and the United States for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes Basin. The Strategy (<http://www.epa.gov/glnpo/p2/bns.html>) provides a framework for actions to reduce or eliminate persistent toxic substances resulting from human activity, especially those which bioaccumulate from the Great Lakes Basin, so as to protect and ensure the health and integrity of the Great Lakes ecosystem. The Strategy was signed by Canada and the United States on April 7, 1997. Recognizing the long-term nature of virtual elimination, the Strategy provides the framework for actions to achieve quantifiable reduction “challenges” in the timeframe 1997 to 2006 for specific toxic substances. The challenge for mercury in the United States was to reduce atmospheric mercury releases and mercury use 50% by 2006.

The goal of virtual elimination will be achieved through a variety of programs and actions, but the primary emphasis will be on pollution prevention. This Mercury in Products Phase-Down Strategy is one program that carries out this goal.

From the beginning, U.S. EPA and Environment Canada have involved state, provincial, tribal, industrial, environmental and other interested parties, recognizing that the governments alone cannot achieve the goal of virtual elimination – all parts of society must cooperate to ensure success. In implementing the Strategy, the two countries will continue to build this vital partnership. The Strategy reaffirms the two countries' commitment to the sound management of chemicals, as stated in *Agenda 21: A Global Action Plan for the 21st Century* and adopted at the 1992 United Nations Conference on Environment and Development.

#### **Appendix E – Environmental Council of the States (ECOS) Quicksilver Caucus**

The Quicksilver Caucus was formed in May 2001 by a coalition of State environmental association leaders to collaboratively develop holistic approaches for reducing mercury in the environment. Caucus members who share mercury-related technical and policy information include the Environmental Council of the States (ECOS), the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), the Association of State and Territorial Air Pollution Program Administrators (STAPPA), the Association of Local Air Pollution Control Officials (ALAPCO), the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), the Association of State Drinking Water Administrators (ASDWA) and the National Pollution Prevention Roundtable (NPPR).

Action Plan with Implementation Strategy:

[http://www.ecos.org/files/2513\\_file\\_2007\\_08\\_Action\\_Plan\\_DEC\\_06.pdf](http://www.ecos.org/files/2513_file_2007_08_Action_Plan_DEC_06.pdf)

White Paper on Mercury-Containing Products:

[www.ecos.org/files/2479\\_file\\_Mercury\\_Added\\_Product\\_White\\_Paper\\_formatted\\_final.pdf](http://www.ecos.org/files/2479_file_Mercury_Added_Product_White_Paper_formatted_final.pdf)