

# **US Status Report on Mercury Activities**

**US Environmental Protection Agency (EPA)**

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# **1 Status and Trends**

## **1.1 Emission Inventories**

### *National Toxics Inventory*

The 1990 amendments to the Clean Air Act (CAA) present a list of 188 Hazardous Air Pollutants (HAPs) of which mercury is one. The CAA requires the US Environmental Protection Agency (EPA) to identify HAP sources, quantify the emissions by source category, develop regulations for each source category, and assess the public health and environmental impacts after regulations are implemented. The various needs for air toxic data cover major, area, and mobile sources, and include estimates of emissions at the national, regional, county, and facility-specific levels, and even down to process-specific emission data for modelers.

In 1993, EPA began developing the National Toxics Inventory (NTI), a national repository of emission inventory data for HAPs. The 1996 NTI is a model-ready emissions inventory for use in dispersion and exposure modeling that not only can be used to predict ambient air concentrations and resultant risk to the American population, but will also be used to measure progress under the CAA in reducing HAP emissions.

The 1996 NTI has recently been compiled with estimates of the 188 HAPs. It will be used as the base year for comprehensive, facility-specific HAP emissions data and source-specific parameters. NTI contains estimates of emissions from major sources, area sources, and onroad and nonroad mobile sources. Subsequent NTIs will be created every three years.

### *Toxics Release Inventory*

In 1986, the US Congress enacted the Emergency Planning and Community Right-to-Know Act (EPCRA) and in 1990 passed the Pollution Prevention Act (PPA). Section 313 of EPCRA and section 6607 of PPA require certain industrial facilities to submit reports each year to EPA's Toxics Release Inventory (TRI) on the amounts of toxic chemicals released or managed as a waste. By providing communities with information on releases and waste management of toxic chemical from local facilities, TRI data enable them to work directly with those facilities to enhance environmental protection. A facility is required to report if it (1) has 10 or more full-time employees, (2) manufactures or processes over 25,000 pounds (11,338 kg) of the approximately 600 designated chemicals or 28 chemical categories specified in the regulations, or uses more than 10,000 pounds (4535 kg) of any designated chemical or category, and (3) is classified under certain industrial categories. Starting with the 1998 reporting year, this list of TRI industry categories has expanded beyond the manufacturing sector to include coal mining, metal mining, electricity generating, petroleum bulk storage, solvent recovery, chemical wholesale, and Resource Conservation and Recovery Act (RCRA) Subtitle C treatment, storage and disposal (TSD) facilities.

EPA has recently reduced the reporting threshold for mercury and mercury compounds to 10 pounds (4.5 kg) for the reporting year 2000. Therefore, TRI information reflecting the new threshold will be publicly available starting the summer of 2002.

The following table presents release and management information for mercury (CAS Number 7439-97-6) and mercury compounds from the 1997 Toxics Release Inventory, (publication: EPA 745-R-99-003; April 1999). TRI information is available for public access on the following two Internet addresses: Right-to-Know Network at <<http://www.rtk.net>>; and on the US EPA Internet server at <<http://www.epa.gov/tri>>.

<b>Toxics Release Inventory Data for Mercury and Mercury Compounds (kilograms)</b>				
	<b>1988</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>
<b>Total Air Emissions—on-site</b>				
Mercury	10,390	5,967	6,432	5,355
Mercury Compounds	1,078	1,432	1,323	1,191
<b>Surface Water Discharges—on-site</b>				
Mercury	634	87	212	175
Mercury Compounds	4	62	33	15
<b>Underground Injection—on-site</b>				
Mercury	0	0	0	0
Mercury Compounds	12	3	4	19
<b>Releases to Land—on-site</b>				
Mercury	6,023	461	244	3,575
Mercury Compounds	0	0	0	0
<b>Transfers Off-site to Disposal (off-site Releases)</b>				
Mercury	117,355	6,454	5,902	11,364
Mercury Compounds	8,127	93,939	13,353	11,570
<b>Total On- and Off-site Releases*</b>				
<b>Mercury</b>	<b>134,401</b>	<b>12,969</b>	<b>12,791</b>	<b>20,469</b>
<b>Mercury Compounds</b>	<b>9,221</b>	<b>95,435</b>	<b>14,713</b>	<b>12,796</b>
<b>Recycled</b>				
Mercury	NA	443,648	375,481	198,976
Mercury Compounds	NA	56,830	21,931	21,021
<b>Energy Recovery</b>				
Mercury	NA	0	0	0
Mercury Compounds	NA	28	19	0
<b>Treated</b>				
Mercury	NA	7,818	3,745	6,734
Mercury Compounds	NA	2,085	3,305	1,271
<b>Quantity Released On- and Off-site**</b>				
Mercury	NA	8,156	10,894	9,028
Mercury Compounds	NA	11,629	10,850	11,368
<b>Total Production-related Waste Managed</b>				
<b>Mercury</b>	<b>NA</b>	<b>459,622</b>	<b>390,120</b>	<b>214,738</b>
<b>Mercury Compounds</b>	<b>NA</b>	<b>70,572</b>	<b>36,104</b>	<b>33,659</b>

NA: not applicable (waste management data was not required to be reported for 1988 reporting year).

Notes: \* Reflects all on site releases and transfers off-site for disposal as reported in Section 6 of Form R

\*\* Limited to production-related releases as reported in Section 8.1 of Form R.

### *Mercury Inventory for Coal-fired Utility Boilers*

A mercury inventory for coal-fired utility boilers is being developed through collaborative efforts with the Department of Energy's Federal Energy Technology Center (DOE/FETC) and Electric Power Research Institute (EPRI), and the utility industry. This includes the recent Information Collection Request (ICR) for mercury concentrations in coal as issued by EPA for the utility industry that will have a tremendous impact on obtaining an accurate mercury inventory. Additionally, the ICR will gather information on stack emissions of mercury for a segment of the coal-fired electric utility industry. The new data will add to our understanding of mercury partitioning in flue gas from full-scale operations. This, in turn, will improve the reliability of emission modification factors and the efficacy of mercury emission control options. Having placed these matters in context of our current understanding of mercury emissions, the US coal-fired power generation industry's contribution to the global inventory can be more seriously debated as well as any considerations put forward to increase control levels beyond those currently realized with existing processes and equipment.

## **1.2 Ambient Monitoring**

### *Current Federal Ambient Mercury Monitoring Programs and Projects*

The Integrated Atmospheric Deposition Network (IADN) is a joint US and Canadian monitoring program that assesses atmospheric deposition of toxic substances into the Great Lakes. Mercury is one of the substances monitored. IADN has sampled atmospheric gas-phase and precipitation in the Great Lakes since 1991. IADN could be used as a template for international monitoring efforts such as those being undertaken by the CEC. The web site is <<http://www.epa.gov/glnpo/air/iadndocs.html>>.

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a nationwide network of precipitation monitoring sites to collect accurate and precise weekly data on the chemistry of precipitation for monitoring of geographical and temporal long-term trends. The network is a cooperative effort between many different groups, including the state Agricultural Experiment Stations, US Geological Survey, and US Department of Agriculture, EPA, and numerous other governmental and private entities. The Mercury Deposition Network (MDN), which is part of NADP, currently has over 35 sites and is proposing to add more. MDN was formed in 1995 to collect weekly samples of precipitation that are analyzed for total mercury. The objective of the MDN is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. The data will be used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors. Methylmercury can be monitored if desired by a site sponsor. Data are available via the MDN web page at <<http://nadp.sws.uiuc.edu/mdn/>>.

EPA has developed a mercury-monitoring network in New England to characterize mercury deposition to and flux from different ecological systems of the coastal marsh focusing on salt marsh grass and near shore sediments.

EPA has established a Regional Environmental Monitoring and Assessment Program (R-EMAP) project to assess trace elements on precipitation and aerosol samples. Back trajectory analysis and identifiable emission

signatures are used to estimate and apportion local, regional, and inter-regional sources. Other EPA R-EMAP projects include: a source receptor project that provides observational data on precipitation events from a number of municipal solid waste incinerators in a small geographic area for a 200-mile (320-kilometer) corridor in the Lower Merrimack Valley and Adjacent Coastal Areas of Michigan; an assessment of sediment contaminants, including mercury, in the Colorado, Rio Grande tidal, East Bay Bayou and Corpus Christi Bay estuarine watersheds; and an assessment of biological communities in wadeable streams in three east Texas ecoregions, including fish and benthic macroinvertebrates (see <<http://www.epa.gov/emap/html/remap.html>> for more information).

EPA is conducting an assessment of mercury in hypolimnetic lakebed sediments, fish, and piscivorous birds in Vermont and New Hampshire. The study will examine the concentration of methylmercury in surficial sediments at more than 100 randomly selected lakes in both of these states. Fish will be collected from a subset of the lakes to determine what correlations may exist between methylmercury in sediments and fish tissue. To demonstrate bioaccumulation of mercury, loons will be captured; blood and feather samples collected and abandoned eggs will be collected and sampled for mercury.

EPA is studying air emissions and wastewater releases to the Everglades and to Devil's Lake, Wisconsin. The goals of this project include determining the relative contributions of mercury air emissions and wastewater from various sources; identify how much deposition comes from local and distant sources; and assessing how federal and state air and water programs can work together in reducing mercury contamination of water. This project will help states develop Total Maximum Daily Loads for waterbodies.

EPA is conducting a South Florida Mercury Monitoring Study to assist in defining the magnitude, extent and trend of mercury contamination in the Florida Everglades, as well as provide information for the initial phase of the ecological risk assessment. Extensive data collection will support the parameterizing of the South Florida Restoration Project models. The information will assist in developing a mathematical biogeochemical model of mercury cycling in the Everglades, in performing ecological risk assessments, in determining human health and ecological risks and in developing remediation or regulatory strategies.

Recent and continuing Florida Atmospheric Mercury Studies, being conducted by the EPA, focus on understanding reactive gaseous mercury and particulate mercury, building on the South Florida Mercury Monitoring Study and is coordinated with the Florida Department of Environmental Protection. Measurements of reactive mercury in the ambient atmosphere and its dry deposition, along with particulate-bound mercury, are critical to evaluating the sources and transport of mercury in the Everglades. Development of advanced models has begun for atmospheric transport and deposition of mercury to incorporate new information on species and forms of mercury and related gases. These models will be able to include south Florida's specific meteorology while representing processes, which can be generally applied to other areas.

The South Florida Ecosystem Assessment Project (Phase I) is a large-scale EPA monitoring and assessment program designed to measure current and changing conditions of ecological resources in South Florida using an integrated holistic approach. The ultimate goal of this program is to provide decision-makers with sound ecological data needed to improve environmental management decisions for the restoration of the Everglades ecosystem. This project addresses multiple issues that are thought to be critical to the restoration of the ecosystem and addresses the interactions among issues. These issues include mercury contamination, eutrophication, marsh habitat alteration, and hydroperiod modification. Phase II sampling has been completed and an assessment is scheduled for completion by the end of 2000. Time series monitoring will identify changes occurring since Phase I. Increased emphasis will be placed on vegetation, phosphorus and mercury assessment, providing data for input to various ecosystem models such as an Everglades mercury cycling

model. The Phase I technical report and database is located on the Region 4 web site <<http://www.epa.gov/region4/sesd/reports/epa904r98002.html>>.

EPA is monitoring and performing back-trajectory modeling to identify key external sources of mercury for sites in Barrow, Alaska, the Great Lakes, and Russia. The goals are to track mercury deposition levels and obtain modeling projections sufficient to identify transboundary, external sources of mercury deposition to the US that are important for mass balance analyses. Speciated mercury measurements will also provide for better understanding of a mercury depletion event during the Arctic Sunrise, which could result in enhanced bio-uptake.

As part of the US Arctic Monitoring and Assessment Program Initiative, the Alaska Native Cord Blood Monitoring Program is designed to monitor the levels of selected heavy metals (including mercury) and persistent organic pollutants (including PCB congeners) in umbilical cord blood and maternal blood of indigenous groups of the Arctic, with an initial focus on Alaska Native American populations. The program was developed in response to Alaska Native concerns about the effects on the health of mothers and infants of organic and heavy metal contaminants that are accumulating in subsistence food species in the circumpolar north. The objective of this project is to expand the present Alaska Native Cord Blood Monitoring Program to establish a sampling infrastructure that supports a statistically significant yearly number of maternal-infant blood samples and to expand the study to include other indigenous peoples that are representative of native populations in the Arctic.

The National Center for Health Statistics is preparing to conduct the fourth National Health and Nutrition Examination Survey (NHANES). This survey will document occurrences of elevated hair mercury levels in the US population. A sub-task looks at diverse groups with high intakes of mercury.

The National Oceanic and Atmospheric Administration's (NOAA) Air Resource Laboratory (ARL) is working cooperatively with the Great Lakes Environmental Research Laboratory (GLERL) and the Lake Champlain Research Consortium (LCRC) on conducting the Lake Champlain Air Quality Research Program. Mercury deposition has been measured at Lake Champlain since late 1992. Within the Lake Champlain Basin, an estimated 600 pounds (273 kg) of mercury falls annually. Recently, ambient particle and gas concentrations in air have also been measured as well as grab samples from the snow pack and from local stream water.

The Mussel Watch Project of NOAA's National Status and Trends Program includes measurements of ambient mercury concentrations around the coasts of the United States. This project measures mercury in bivalve mollusks every other year at about 250 sites in the US estuarine, coastal, and Great Lakes waters. It measures surficial sediment concentrations of mercury once every 5 to 10 years at the same sites. This measurement program was started in 1984 and is providing continuing information on the trends in ambient mercury levels in US coastal ecosystems. To complement this study, this year the EPA is initiating a national survey to determine chemical residues, including mercury, in fish.

## 1.2 Trends Data

### *Domestic Consumption*

Domestic Consumption of Mercury (Metric Tons)						
	1990	1992	1994	1996	1997	1998
Imports for Consumption	15	92	129	340	164	200
Country Origin of Import						N/A
-Canada				137	4	
-Kyrgyzstan				33	53	
-Russia				79	--	
-South Africa				--	32	
-Spain				68	19	
-Taiwan				--	36	
-United Kingdom				>1	17	
-Other				23	3	
Exports	311	977	316	45	134	150
Country Destination of Export						N/A
-Brazil				3	5	
-Canada				4	3	
-Germany				4	2	
-Hong Kong				<b>B</b>	97	
-Japan				13	<b>B</b>	
-Korea, Republic of				5	2	
-Mexico				3	7	
-United Kingdom				1	7	
-Other				12	11	
Industrial Consumption (reported)	720	621	483	372	346	400
Shipments from Government Stockpile excesses/National Defense Stockpile <sup>a</sup>	52	267	86	--	--	--
Price: average value, dollars/flask (1 flask = 34.5 kg) <sup>b</sup>						
- D.F.Goldsmith,	\$249	\$201	\$194	\$262		
- Free Market					\$160	\$180

Source: Robert G. Reese, Jr., US Geological Survey, *Minerals Yearbook*, 1997, Mineral Commodity Summary, 1999.

Notes:

a Shipments from the government stockpile were suspended in 1995.

b Price rounded to nearest dollar.

N/A Not available



*Use Patterns*

<b>US Industrial Consumption Of Refined Mercury, By Use<sup>a</sup></b> (metric tons)				
<b>Use Category</b>	<b>1995 Baseline</b>	<b>1996</b>	<b>1997</b>	<b>2006 Challenge Goal<sup>b</sup></b>
Chlorine and Caustic Soda Manufacture	154	136	160	-
Electric Lighting	30	29	29	-
Wiring Devices and Switches	84	49	57	-
Measuring and Control Instruments	43	41	24	-
Dental Equipment and Supplies	32	31	40	-
Other Uses <sup>c</sup>	93	86	36	-
<b>TOTAL</b>	<b>436</b>	<b>372</b>	<b>346</b>	<b>218</b>

a Use amounts are estimated. US Geological Survey, *Minerals Yearbook* for 1995, 1996, and 1997

b Challenge goal based on the Great Lakes Binational Toxics Strategy reduction challenge of a 50 percent reduction in the deliberate use of mercury by 2006; the 1995 use inventory total is used as the baseline to calculate the challenge goal because this was the most recent data that was used for the Great Lakes Binational Toxics Strategy

c Other Uses comprise unclassified uses and those uses from the three principal end-use categories for which the figures are withheld to protect company proprietary data or for which the volume of use is small

***Production Patterns***

<b>Mercury Production Statistics (metric tons)</b>						
	1990	1992	1994	1996	1997	1998
Number of US Gold Mines	9	9	7	6	5	N/A
Primary (US Mine) Production						
- Principal product <sup>a</sup>	448	—	—	—	—	—
- Byproduct from gold mines	114	64	W	W	W	W
World Mine:						
- Production				2,890	2,730	2,600 <sup>e</sup>
-Reserves						120,000
-Reserve base						240,000
Secondary Production						
- Industrial <sup>b</sup>	108	176	446	446	389	400 <sup>e</sup>
- Government <sup>c</sup>	193	103	—	—	—	—
Industry Stocks, year-end <sup>d</sup>	197	436	469	446	203	200 <sup>e</sup>

Source: Robert G. Reese, Jr., US Geological Survey, *Minerals Yearbook*, 1997, and Mineral Commodity Summary, 1999.

Notes:

- W Withheld for confidentiality      N/A Not available
- a Comprises only mercury produced at McDermitt Mine, as reported in Placer Dome Inc. Annual and Form 10-K reports (US Securities and Exchange Commission); the mine was closed in November 1990
- b Secondary mercury production (e.g., recycling) involves processing scrapped mercury-containing products, and industrial waste and scrap
- c Secondary mercury shipped from US Department of Energy stocks
- d Stocks at consumers and dealers only; mine stocks withheld to avoid disclosing proprietary data
- e Estimated

## **2 Risk Management and Pollution Prevention**

### **2.1 National Policies**

#### ***EPA's Mercury Emission Reduction Goal***

As part of implementing the Government Performance Results Act, EPA has created an agency-wide Strategic Plan that lays out the agency's mission and ten broad goals that will serve as the framework for future action. (The 1997 Strategic Plan publication number is EPA/190-R-97-002; a revised Strategic Plan is to be released in October 2000.) The EPA's goal and objective that directly relate to mercury are discussed below.

- Goal: Reducing Global and Transboundary Environmental Risks
- Objective: By 2005, consistent with international obligations, the need for upward harmonization of regulatory systems, and expansion of toxics release reporting, reduce the risks to US human health and ecosystems from selected toxics (including pesticides) that circulate in the environment at global and regional scales. Results will include a 50 percent reduction of mercury emissions from 1990 levels in the US and the worldwide use of lead in gasoline will be below 1993 levels.

The actions of individual nations to control the adverse human health and environmental effects of certain toxics often are insufficient because of the long-range transport of such substances. In addition, the banning of toxics by one or more nations may merely result in the relocation of production, distribution and use of the substance to other regions, shifting but not reducing or eliminating overall risks to human health and the environment. Thus, it will take coordinated international action to reduce the risks posed by toxics globally, let alone in the US.

The objective represents a continuation of certain ongoing Agency efforts to reduce risks associated with selected toxic substances and an expansion of related new initiatives. Building on long-standing domestic programs, this work promotes the international cooperation essential to reducing risks at a global level. Over the life of the objective some work elements will shift from a focus on international policy development (e.g., treaty negotiation) to capacity building and the implementation of and compliance with formal treaty obligations.

#### ***Acceptable Human Health Risk Level***

The Agency for Toxic Substances and Disease Registry (ATSDR) endorses a minimum risk level for methylmercury exposure of 0.3 micrograms per kilogram of body weight per day. This is ATSDR's acceptable daily exposure level over a lifetime. EPA's reference dose is three times lower, at 0.1 micrograms per kilogram of body weight per day. The reference dose is an estimate of the maximum daily exposure level over a lifetime in which no appreciable risks are expected to occur. To help resolve the issue of acceptable levels of risk to methylmercury, the US Congress has directed the National Research Council's National Academy of Science to complete a report by mid- or later 2000.

## **2.2 International Protocols**

Through international initiatives like this North American Commission for Environmental Cooperation (CEC) Regional Action Plan on Mercury, the US is collaborating with other countries to better characterize and understand the international or transboundary nature of mercury sources, transport, deposition and fate. In addition, the US will continue to encourage other countries to undertake domestic mercury risk reduction measures, with a focus on pollution prevention approaches. This could involve working bilaterally on a government-to-government basis and multilaterally through international organizations. A brief description of each of the various international fora in which the US is addressing mercury is provided below.

On 7 April 1997, the United States and Canada signed the Great Lakes Binational Toxics Strategy. At the present time the EPA and Environment Canada are working with all industrial sectors that release mercury, states, tribes, environmental groups and the public, to help identify and undertake specific mercury reduction activities.

In February 1998, the US and other Parties to the UN Economic Commission for Europe's Convention on Long-range Transboundary Air Pollution (LRTAP) concluded negotiations on a legally binding protocol on mercury and other heavy metals. The protocol includes obligations to control mercury emissions from stationary sources and to establish and report mercury emissions inventories. It also contains obligatory and voluntary provisions regarding the use of mercury in products. The US signed the LRTAP Heavy Metals Protocol in June 1998, agreeing in principal to this international agreement; however, it is still under review and has not yet been ratified. The US is participating in UN ECE LRTAP working groups to resolve some of the uncertainties involving various mercury issues.

The Arctic Monitoring and Assessment Program (AMAP) collects information on pollution threats, detects changing conditions and emerging problems, and conducts risk reduction activities. AMAP is performing a study on mercury in the arctic atmosphere. The Protection of the Arctic Marine Environment (PAME) program is drafting a regional action plan for pollution from land-based sources which includes voluntary commitments by Arctic Council members on persistent organic pollutants (POPs) and heavy metals.

On 8 June 1998, the New England Governors/Eastern Canadian Premiers signed a resolution concerning mercury and its impacts on the environment. In addition, the Governors and Premiers adopted the Mercury Action Plan, which has as its regional goal "the virtual elimination of the discharge of anthropogenic mercury into the environment." The NEG/ECP has established a task force, which includes the New England states, the Eastern Canadian Provinces, to coordinate and implement the Mercury Action Plan. The action plan identifies 45 specific actions to reduce mercury emissions, including emission reduction targets from specific source categories, such as municipal waste combustors, medical waste incinerators, sludge incinerators, utility and non-utility boilers, industrial and area sources and source reduction and safe waste management of mercury.

## **2.3 National Legislation, Regulations, and Guidelines**

This section is not intended to provide an historical account of all laws or regulations regarding

mercury, but rather to provide summaries of the recently promulgated and proposed EPA regulations and criteria addressing the various emission and release sources of mercury.

**Municipal Waste Combustor Rule:**

In compliance with sections 111 and 129 of the Clean Air Act Amendments (CAA) of 1990, EPA has set performance standards and emission guidelines for new and existing municipal waste combustors (MWC) based on maximum achievable control technology (MACT) requirements and with emission limits for mercury. Available data indicates the control systems achieve over 90 percent mercury control. New MWCs must comply at start-up and existing MWCs must comply by December 2000.

**Medical Waste Incinerator Rule:**

In compliance with sections 111 and 129 of the CAA, EPA has set performance standards on emission guidelines for new and existing medical waste incinerators (MWI) based on maximum achievable control technology (MACT) requirements and with emission limits for mercury. Approximately 90 percent reduction in mercury emissions is expected when MWI regulations are fully implemented. New MWIs must comply at start up and existing MWIs must comply by September 2002.

**Industrial/Commercial Waste Incineration Rule:**

An Industrial/Commercial Waste Incineration Rule was proposed in November 1999. It will require performance standards for nine substances or mixtures, including mercury.

**Hazardous Waste Combustion Facilities Rule:**

In September 1999, EPA promulgated air emission standards for a number of chemicals, including mercury, being emitted from hazardous waste combustion facilities. When the rule is fully implemented, EPA estimates that mercury emissions from incinerators, cement kilns, and lightweight aggregate kilns that burn hazardous waste to be reduced from 6 metric tons/year to 2.3. These facilities burn a large majority of the hazardous waste that is combusted; however, additional hazardous waste is also burned in some industrial boilers and other industrial furnaces. The Agency is collecting data to proceed with regulations to control these facilities as well.

**Municipal Solid Waste Landfill Rule:**

EPA is required to promulgate emission standards for Municipal Solid Waste Landfills under section 112 (d) of the CAA. The rule will address emissions of the hazardous air pollutants (including mercury) listed in section 112 (b) of the CAA. Taking the maximum achievable control technology (MACT) approach, EPA will develop emission standards for this source category which consists of contiguous geographical space/facilities receiving household waste, and other types of RCRA Subtitle D waste, such as commercial solid waste, nonhazardous sludge, conditionally exempt small quantity generator waste and industrial solid waste. Proposed and final rules are scheduled for 30 May 2000 and 1 June 2001, respectively.

**Land Disposal Restriction Rule:**

Several of the existing Land Disposal Restriction (LDR) treatment standards for hazardous wastes containing high levels of mercury require either retorting or incineration, depending on whether organic constituents (or organo-mercurial compounds) are present in the waste. See EPA's Advanced Notice of Public Rulemaking on this subject, 64 FR 28949, 28 May 1999. EPA is scheduled to propose a rule to revise the 40 CFR Part 268 Land Disposal Restrictions treatment standards applicable to mercury-containing wastes by the end of 2000. The revisions under

consideration by the Agency will involve a comprehensive reevaluation of the treatment standards for mercury-containing wastes. EPA is reexamining the LDR mercury treatment standards because 1) the supply of recycled mercury has increased to where it exceeds the demand for mercury; 2) retorting may not be appropriate for certain wastes for which it is currently a required method of treatment (i.e., mixed waste, high-mercury subcategory); 3) there are concerns over emissions from incinerating mercury-containing wastes; and 4) the Agency wants to further investigate source reduction. In revising this rule, EPA is working with the Department of Energy to develop data on alternative treatment technologies for high-mercury wastes and on factors that effect the relative stability of treated forms of mercury under varying conditions.

**Mercury-containing Lamps Rule:**

EPA issued a final rule in March 1999 to add mercury-containing lamps to the Universal Waste Rule, which allows for expedited collection and handling of certain hazardous wastes.

**Chlorine Production Facilities Rule:**

EPA is developing a rule that would limit mercury emissions from plants that produce chlorine using the mercury cell method. The rule will include emissions limits based on maximum achievable control technology (MACT) and on management practices. Proposed and final rules are scheduled for November 2000 and November 2001, respectively.

**Revision of the Human Health Water Quality Criterion for Mercury:**

Under the Clean Water Act (CWA), EPA establishes water quality criteria that are used by states and tribes to establish enforceable water quality standards. The EPA is revising the human health criterion for mercury using new methodology. Factors affecting mercury include: (1) presenting an RfD (reference dose) range for noncarcinogens which is the maximum daily exposure level over a lifetime in which no appreciative risks are expected to occur; (2) using developmental effects in evaluating the toxicity of mercury; (3) revisions to the Fish consumption portion of the exposure estimate to reflect recreational and subsistence fishers; (4) use of bioaccumulation factors rather than bioconcentration factors when estimating uptake of contaminants into fish. The revised criterion is expected by December 2000.

**Analytical Measurement Revision to Support Water Quality Criterion:**

In parallel with the revision of the water quality criterion for mercury, EPA has revised its required analytical method by developing a rule that amends the guidelines establishing test procedures for the analysis of pollutants under the Clean Water Act by adding *Method 1631: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence*. Use of Method 1631 allows reliable measurement of mercury at the low levels associated with ambient water quality criteria and less, subject to sample contamination. The final rule was published in May 1999 (<<http://www.epa.gov/ostwater/methods/mercury1631.html>>).

**2.4 State Legislation, Regulations, and Guidelines**

Acknowledging that there is existing mercury legislation, regulations, and guidelines that have been enacted by numerous states to date, this section summarizes the state legislation on mercury that has been enacted in 1999. This information was compiled by the National Council of State Legislators and is current as of September 1999. Since January, there have been 35 pieces of mercury legislation

introduced in twelve states, with five having been signed into law. These five new laws are described below.

### **Connecticut**

CT H.B. 6625; INTRODUCED: 29 January 1999; LAST-ACTION: 29 June 1999; SUMMARY: Requires labeling of products containing mercury; bans sale of unlabeled products; requires development of waste management standards, waste reduction measures and recycling programs related to mercury-containing products.

### **Maine**

ME S.B. 716; INTRODUCED: 24 March 1999; LAST-ACTION: 11 June 1999; SUMMARY: (LD 2038) Suspends the law that prohibits the discharge of mercury in any concentration that increases the natural concentration in the receiving waters until 1 October 2001; prohibits anyone from increasing the discharge concentration between the effective date of the Act and that date; requires the Department of Environmental Protection to adopt rules establishing interim discharge limits; requires development of a statewide standard for mercury.

### **Montana**

MT H.B. 183; INTRODUCED: 24 December 1998; LAST-ACTION: 28 April 1999; SUMMARY: Revises the Open Cut Mining Act and the Metal Mine Reclamation laws; transfers the regulation of soil and peat mining to the Open Cut Mining Act; regulates phosphate mining under the Metal Mine Reclamation Laws; limits the use of mercury and ore-processing reagents and solvents by metal miners; clarifies dredge operation exemptions.

### **New Hampshire**

NH H.B. 340; INTRODUCED: 7 January 1999; LAST-ACTION: 28 MAY 1999; SUMMARY: Establishes a committee to study mercury source reduction and recycling issues

### **Vermont**

VT H.B. 158; INTRODUCED: 5 February 1999; LAST-ACTION: 1 JUNE 1999; SUMMARY: Relates to the procedure for reporting and prosecuting illegal dumping and littering violations; provides for penalties; relates to municipal regulations of public and private resource recovery and recycling facilities; requires imported and domestic bottled water sold in Vermont to meet state standards or their equivalent; adds bottled municipal water to provision requiring certain label information; regulates labeling of items containing mercury.

## **2.5 Voluntary Partnerships and Initiatives**

The following table provides examples of voluntary partnerships and initiatives that have recently occurred under the direction, or with the assistance of, federal, state, and community government levels, as well as within industry, and within special interest groups. This is not intended to be an exhaustive list of voluntary partnerships and initiatives that exist. The number of these types of activities is continually increasing as voluntary efforts gain acceptability as an effective mercury use and release reduction tool.

### *Federal Voluntary Partnerships and Initiatives*

Three northwest Indiana steel mills, Bethlehem Steel Burns Harbor, Ispat Inland Inc. Indiana Harbor Works, and US Steel Gary Works, signed a voluntary agreement with the Lake Michigan Forum, US Environmental Protection Agency (EPA), and the Indiana Department of Environmental Management (IDEM), on 15 September 1998, to reduce the use of mercury at their facilities. The mills intend to develop a clean sweep/pollution prevention initiative to inventory, recycle, and substitute to the greatest extent practicable mercury at their facilities.

EPA and the American Hospital Association (AHA) signed a memorandum of understanding, on 25 June 1998, committing them to work together to significantly cut hospital wastes by 2005. The agreement envisions the virtual elimination of mercury-containing hospital wastes and a one-third reduction in total hospital wastes by 2005. EPA and AHA intend to co-sponsor a series of national waste management seminars for hospitals. The agreement also covers: obtaining and reviewing industry information on pollution prevention efforts; developing model plans for cutting chemical wastes; and investigating pollution prevention opportunities for ethylene oxide and persistent, bioaccumulative, and toxic pollutants.

EPA Region 5 recently awarded a matching funds grant to the Ecology Center of Ann Arbor, to promote pollution prevention (P2) in the health care industry in partnership with the Michigan Hospital Association. The project will focus on mercury reduction in SE Michigan. The award was made through the Environmental Justice P2 Grant program competition.

The Chlorine Institute has provided to USEPA its first annual report detailing the chlor-alkali industry's progress towards meeting a voluntary commitment to reducing mercury use 50 percent by 2005. The report includes descriptions of activities undertaken to help identify reduction opportunities, and also provides data on preliminary reductions achieved in 1996 and 1997. The Chlorine Institute's report can be viewed at: <http://www.epa.gov/bns/bnsmerc.html>.

Olin Corp. has set a goal to eliminate discharges of mercury used to produce chlorine and caustic soda at its two chlor-alkali plants. The company will be involved in a research program designed to answer uncertainties about the quantity of mercury released from these plants. The research will be conducted by the Department of Energy's Oak Ridge National Laboratory, and the Universities of Tennessee and Michigan, and will be funded by Olin Corp., and EPA.

EPA's Green Lights Program is a voluntary initiative with state and local governments, and industry, that encourages use of high efficiency light fixtures and use of appropriate disposal/ recycling for mercury-containing lamps.

### *State Voluntary Partnerships and Initiatives*

Wisconsin Department of Natural Resources provided information encouraging mercury reduction to state hospitals and clinics in 1998. A booklet, "Mercury-Free: What's In It for Me," was included with the annual medical waste report that hospitals must complete for the state. This outreach effort was the result of interaction and cooperation between two different bureaus within DNR. While hospitals are not required to report on mercury reduction efforts underway, two chose to do so.



Wisconsin Department of Natural Resources is partnering with electric utilities through the Thermostat Recycling Corporation (TRC), community clean sweeps, household hazardous waste collection facilities, and other means to promote recycling and replacement of mercury-switch thermostats. Two of the state's six major utilities have included promotional materials with customer bills and/or on their web sites. TRC reports that, since November 1997, 932 thermostats have been collected; 69 recycling bins have been issued; and 9.7 pounds (4.4 kg) of mercury have been reclaimed.

Beginning in the fall of 1998, the Wisconsin Department of Natural Resources, the University of Wisconsin, and the University of Wisconsin Extension Program began replacing mercury-containing manometers to Wisconsin farmers in the Great Lakes basin. This program is funded by a grant from the US EPA Great Lakes National Program Office and is patterned after a similar program in Minnesota.

Indiana's Department of Environmental Management (IDEM) Mercury Awareness Program is a state and local partnership dedicated to investigating and identifying commercial uses of mercury, researching potential pollution prevention options, and developing and implementing outreach strategies for significant sources. In October 1998, IDEM initiated a statewide effort to collect and recycle household items containing mercury. The effort will be led by the Regional Household Hazardous Waste Task Force, a consortium of 35 southern Indiana solid waste management districts, and will involve other solid waste management districts and communities.

Michigan's Mercury Pollution Prevention (M2P2) Task Force was convened in August 1994 and, since that time, has been active in numerous mercury pollution prevention efforts across Michigan. A few of the Task Force's efforts include:

- Michigan Department of Environmental Quality (MDEQ) has funded a household hazardous waste collection program in 22 counties across Michigan and approximately 200 pounds (91 kg) of mercury have been collected;
  - M2P2 Task Force's Automobile Subgroup identified 23 uses of mercury in automobiles; and
- Outreach materials describing mercury threats and disposal options have been distributed to science teachers.

In order to evaluate progress towards the zero discharge goal in the Lake Superior basin, baseline information is needed on indicators of releases of nine designated chemicals. The Minnesota Pollution Control Agency (MPCA) is working on two projects to 1) establish a baseline for five mercury indicators and 2) encourage the use of low mercury feedstock chemicals, such as caustic soda. MPCA is also working with a group of Minnesota stakeholders in the development of a comprehensive mercury reduction strategy. The stakeholders are involved through an advisory council that will provide recommendations to the state government on mercury reduction options. Teams of staff and stakeholders are working on reduction strategies and the criteria by which to rank them. The agency will use the council's advice as one source of information when considering a mercury reduction initiative. The MPCA may develop regulations or recommend legislation as a result.

### *Community Voluntary Partnerships and Initiatives*

Western Lake Superior Sanitary District (WLSSD) in cooperation with the Northeast District Dental Society has developed recycling procedures for materials containing amalgam particles. Amalgam contains mercury which, if disposed of in solid or medical waste or rinsed to the sewer, could be released to the environment. The first annual amalgam recycling report showed that approximately 522 pounds (237 kg) of waste material containing amalgam was collected for recycling. Eighty eight percent of dental practices responded to the survey conducted by the WLSSD. The Minnesota Dental Association also supports amalgam recycling.

Western Lake Superior Sanitary District (WLSSD), the largest wastewater treatment facility discharging to the Lake Superior watershed, is supporting the goal of zero discharge of persistent bioaccumulative toxics by developing a multimedia mercury zero discharge pilot project with hospitals, clinics, educational institutions, laboratories, and dental practices. WLSSD hopes this program will not only test the theory that prevention at the source is more cost-effective than end-of-pipe treatment, but also will also ultimately result in the virtual elimination of mercury discharges from these specific business types. In some instances reduced discharge through recycling, on-site treatment, or better management practices may be an interim goal.

With support from the Great Lakes Protection Fund, the Western Lake Superior Sanitary District (WLSSD) has conducted a Mercury Zero Discharge Project to identify and eliminate sources of mercury to its wastewater treatment plant. The results of the project have been compiled in a booklet titled *Blueprint for Mercury Elimination*. It was designed for use by other wastewater treatment plants in developing and implementing their own mercury reduction programs. It includes information on sources of mercury, successful reduction strategies and case studies, and suggestions for implementing a program. As a result of this project, WLSSD initiated or strengthened pollution prevention partnerships with industries, educational facilities, hospitals, and dentists in its service area and demonstrated that significant mercury reductions in municipal wastewater discharges can be achieved through cooperative partnerships with industry, public education, and disposal facilities.

Mercury releases to municipal sanitary sewer systems by hospitals, dental offices, schools, universities, laboratories, other facilities, and homes are largely unregulated. The Wisconsin Department of Natural Resources is working with seven communities to develop and implement mercury reduction programs targeted to these diverse wastewater sources. The programs are designed to educate the population about the impacts of and alternatives to mercury use, collect mercury and mercury products, and provide information about and/or coordinate transporting the mercury to a contractor for recycling.

The Pennsylvania Department of Environmental Protection Program (P3ERIE) is a voluntary pollution prevention program working with businesses, civic organizations, and educational institutions in the greater Erie community. Its mission is to build support for pollution prevention by developing and implementing a public education campaign and practical projects to reduce the amount of mercury and other persistent toxins that are used and released to the environment in the greater Erie community, especially the Lake Erie watershed. To date, P3ERIE has accomplished the following:

- collected 1,245 pounds (566 kg) of elemental mercury during a 1998 Earth Day event;
- worked to encourage northwest Pennsylvania's largest hospital, Hamot Medical Center, to become mercury-free; and
- implemented an active pollution prevention program for school laboratories

The Mercury Reduction Project for the Greater Milwaukee Area is a joint effort of the Pollution Prevention Partnership, Milwaukee Metropolitan Sewerage District, and Wisconsin Department of Natural Resources. The project has already produced a Mercury Source Sector Assessment Report to help identify important source sectors; to set priorities for developing cooperative mercury education, technical assistance, and collection programs; and to develop an effective mercury reduction program.

As part of the Lake Superior Alliance Sustainable Basin Project, the Central Upper Peninsula Sierra Club was awarded a grant to develop a Community Mercury Reduction Project. Through this grant, the Marquette Community Mercury Reduction Task Force was formed. The Task Force developed recommendations related to: sampling; public education; outreach; ordinances; small businesses; and its own continued efforts. In June 1998, the Marquette Area Wastewater Treatment Facility submitted a grant to EPA Region 5 requesting support to implement efforts of the Task Force to achieve a regional mercury mass balance, continue education and outreach, and implement community mercury reduction activities. The project is designed to be transferable to other communities in the Great Lakes Basin.

### *Nongovernmental Organization Voluntary Initiatives*

#### Industry

The amount of coal used by non-utility industry is being reduced through the further electrification of industry throughout the country. Efficient electrical use opportunities are matched and marketed to non-utility coal users to replace coal processes. For example, many efficient electric arc furnaces have replaced basic oxygen furnaces in steel manufacture. The industry estimates that a reduction of more than 15 tons (13,608 kg) of emitted mercury for commercial and industrial boilers has already resulted.

In response to a 1997 request by the state of Michigan to reduce storage and eliminate the need for mercury instruments that could be replaced cost-effectively with non-mercury instruments, Detroit Edison, Michigan's largest electric utility, employed just-in-time arrangements for instrumentation and mercury with a supplier. The project ended in December 1998. One ton (907 kg) less mercury is now stored at Detroit Edison facilities.

Consumers Energy Company, a Michigan electrical and gas energy and energy services company, began a Mercury Pollution Prevention Initiative in 1996. Mercury is contained in coal used in fuel and is used in plant equipment. The company took action to identify its mercury sources, estimate the total quantity of mercury use, review existing disposal practices, and investigate future management options and costs. The program has heightened awareness of mercury concerns in the company and presented options for use of non-mercury-containing equipment. It has also reduced the use of equipment containing mercury and associated stock inventory. In 1996, the program recorded a 231-pound (105 kg) reduction of elemental liquid mercury; in 1997, an additional reduction of 171 pounds (78 kg) was reported.

Niagara Mohawk Power Corporation, an investor-owned electric and gas utility providing energy to 1.5 million residential, commercial and industrial customers, is committed to the virtual elimination of the use of mercury in its service territory and has established a goal of replacing all mercury-containing gas regulators. The company reports that it has reduced the number of mercury-containing gas regulators from approximately 37,500 to approximately 600. The company also reports that it has achieved the US challenge

<p>for Binational Toxics Strategy for Level I substances and that these results surpass the 50 percent reduction target of the Binational Toxics Strategy in the deliberate use of mercury.</p>
<p>American Electric Power's (AEP) "Project Good Turn" encourages customers in Ohio, Indiana, and Michigan to turn in second, older working refrigerators and freezers for recycling CFCs and scrap metal, incinerating PCB capacitors, and safe disposal of mercury since 1987. AEP reports that it has already recycled more than 40,000 units containing a total of more than 1,000 pounds (454.5 kg) of PCBs and 80 pounds (36 kg) of mercury.</p>
<p>Wisconsin Electric's Fossil Operations staff began a resurvey of equipment in its power plants in May 1998. The term "resurvey" is used because the company initiated a purge of mercury-containing equipment at its power plants more than 10 years ago and by 1994, the purge was largely complete. A review of hazardous waste records from the early 1980s suggests that several thousand kilograms of mercury were collectively removed from these facilities.</p>
<p>In December 1997, Thermostat Recycling Corporation (TRC) launched a program to recycle mercury-switch thermostats in nine states. The TRC is a private corporation established by thermostat manufacturers, Honeywell, General Electric, and White-Rodgers. Under the program, heating and cooling contractors can drop off old mercury-switch thermostats at participating wholesalers. The wholesalers will collect the thermostats in protective bins provided by TRC and send them to TRC's recycling center where the switches will be removed and forwarded to a mercury recycler. TRC reports that it has processed 120 pounds (54.5 kg) of mercury in the program's first nine months, much of which comes from Great Lakes states. The TRC also announced plans to expand the program to 13 east-coast states and DC as soon as it obtains the necessary regulatory approvals.</p>
<p>The lighting industry has made significant investments in manufacturing process and new lamp designs to continue to drive down mercury content in lamps. These investments have reportedly reduced the average mercury content of a four-foot lamp from 48.2 mg in 1985 to 22.8 mg in 1994. The lamp industry expects to drive mercury content below 12 mg/lamp by the year 2000.</p>
<p>Consumers Energy Company launched the <i>Bottom Line Solutions</i> replacement lighting program for commercial and industrial customers in 1996. The program allows customers to increase their business lighting while reducing operating and future disposal costs. The new fixtures have efficient, low-mercury lights and non-PCB ballasts.</p>
<p>Bell Atlantic, a provider of telecommunication services, has instituted a project to collect all mercury relays and switches from old telecommunication equipment. The effort is ongoing with no expected end date. The collected electrical devices are sent to a mercury smelter that safely separates the mercury from the metal casings. On an annual basis, Bell Atlantic collects more than 50,000 pounds (23,000 kg) of switches and relays containing mercury.</p>
<p>Using environmentally conscious design and manufacturing principles, General Motors' Midsize &amp; Luxury Car Group (MLCG) facilities replaced mercury switches with ball-type switches used in underhood lamp activation in their 1998 Cadillac and Buick models. This change resulted in an estimated elimination of 1,500 pounds (682 kg) of mercury a year from underhood switches. It has been estimated that the mercury</p>

contained in underhood and trunk lamp switches accounts for 87 percent of mercury usage in automotive applications. This amounts to 12.2 million mercury switches containing a total of 8.5 metric tons of mercury per year. MLCG has already eliminated all mercury switches in the trunk lamp activation and replaced these with trunk-ajar switches.

Chrysler Corporation has participated in discussions with the Michigan Mercury Pollution Prevention Task Force about mercury use within its facilities and products. The company had discovered in 1995 that mercury is used in underhood switches of certain models and has developed an approach to identify and remove these mercury switches.

Ford Motor Company reports that it has worked since 1995 to identify feasible alternatives for all mercury switches in all models worldwide and to introduce mercury-free designs in all identified applications as soon as practicable.

The Dow Chemical Company, in support of the Binational Toxics Strategy, has set a goal for the company to reduce air and water emissions of hexachlorobenzene and mercury compounds by 75 percent by 2005.

### *Special Interest*

Greenpeace Native Lands Campaign and the Indigenous Environmental Network are collaborating on several environmental issues. Together, they have produced an information sheet on mercury contamination, its sources and effects.

National Wildlife Federation (NWF) has promoted the reduction and virtual elimination of Binational Toxics Strategy substances for several years. NWF utilizes a broad range of activities and tools such as hosting workshops, convening special task forces, distributing action alerts and publishing reports and articles on timely topics to educate the public regarding important water quality issues. NWF is working with EPA and state officials to promote the establishment of total maximum daily loads (TMDL) for mercury in regional watersheds.

## **3 Remediation Activities**

### **3.1 Retirement and Management of Mercury Stocks**

The Department of Defense (DOD) has recently completed an Environmental Assessment on the sale of its currently managed mercury stockpile of approximately 9.7 million-pound (4,400 metric tons). Based on the National Environmental Policy Act and the results of this assessment, DOD will now prepare an Environmental Impact Statement (EIS) on the disposition of the stockpile. The EIS process is very comprehensive; therefore, a final EIS may take several years to complete. In the meantime, DOD has begun a complete review of the five facilities across the US currently storing its mercury, and is inspecting all the mercury-containing flasks to ensure proper and safe storage.

The Department of Energy (DOE) is storing approximately 132 metric tons of secondary mercury. DOE has identified 4.5 metric tons of mercury-contaminated wastes currently awaiting disposal as part of an ongoing inventory of such wastes. DOE's Mixed Waste Focus Area-Mercury Working Group, in conjunction with EPA, has initiated studies of the direct treatability and disposal of high mercury-inorganic subcategory wastes that contain radioactive materials resulting from nuclear weapons production. These treatability studies include the evaluation of technologies such as alternative oxidation technologies, stabilization using specialized amendments, amalgamation technologies, sulfur polymer cement stabilization, and mercury solubilization and removal.

The EPA and DOE are also currently investigating alternative treatment technologies for mercury-containing wastes other than retorting and incineration. For instance, an EPA study is evaluating stabilization and solidification as an alternative treatment method for mercury-containing wastes. Stabilization and solidification processes are effective in treating a variety of difficult-to-manage waste materials for reuse or disposal. The study is comprised of two primary areas: analysis of leaching mechanisms of a sulfide treatment sludge and determination of leaching stability, and verification of commercial stabilization and solidification treatment technologies for mercury-containing wastes. This study is in support of EPA's Office of Solid Waste's potential revision of the Land Disposal Restrictions. A final report is expected during 2000.

### **3.2 Contaminated Sites**

Under authority of the Comprehensive Environmental Response, Compensation, and Liability Act and its amendment, the Superfund Amendments and Reauthorization Act, EPA's Superfund Program locates, investigates and cleans up the worst hazardous waste sites throughout the United States. Superfund sites are selected through an assessment process called the Hazard Ranking System. Once a site is selected it is placed on the National Priorities List, which is a published list of hazardous waste sites that are eligible for extensive, long-term cleanup under the Superfund program. For each site on the National Priorities List, a detailed study is conducted to identify the cause and extent of contamination at the site, the possible threats to the environment and the people nearby, and options for cleaning up the site. EPA uses this information to develop and present a Proposed Plan for Long-term Cleanup to citizens and to local and state officials for comment. The Proposed Plan describes the various cleanup options under consideration and identifies the option EPA prefers. Once the public's concerns are addressed, EPA publishes a Record of Decision, which describes how the

Agency plans to clean up the site. As of February 1999, the Superfund Program has developed Record of Decisions for 1130 superfund sites. Of these sites, 258 have mercury listed as a contaminant of concern. If a contaminated site presents an immediate threat to human health or the environment, the Superfund program can take emergency actions in response to this threat without initiating the site listing process.

An example of a remediation activity that is addressing mercury contamination is an effort coordinated among six Federal agencies to restore the south Florida ecosystem. EPA through the Science Working Sub-group, participated in developing initial ecological and hydrological restoration, maintenance and protection plan. Mercury-related studies form a significant component of EPA's activities, including: (1) the construction of mercury models that reflect an expanded understanding of the biogeochemical processes controlling the transportation and transformation of mercury; (2) development of a geographic information system for the environmental parameters that may control the transport and transformation of mercury in south Florida; (3) the integration of microbial methylation/demethylation rates and abiotic geochemical transformation into a mass balance comparison of mercury sources using data from the R-EMAP South Florida Mercury Study and Florida Atmospheric Mercury Study (FAMS) data; and (4) ecological risk assessments and analyses of ecosystem protection options using and linking hydrologic and hydrodynamic sediment transport, contaminant transport and bioaccumulation models and air transport and deposition models. Project reports will discuss the enhancements in air, water, ecological, and process models to account for the south Florida ecosystem dynamics.

### **3.3 Technologies Development**

Considerable effort has gone into developing efficient, low-cost technologies for mercury emission reductions from utility plants. The goal for the Mercury Measurement and Control Program of the Department of Energy's Federal Energy Technology Center (DOE/FETC) has been to develop control strategies for reducing the current annual utility mercury emissions by 50 to 70 percent by 2005 and by 90 percent by 2010, at a cost of one-quarter to one-half of current estimates. DOE/FETC performed a detailed cost analysis of activated carbon injection under four different control scenarios for the EPA for Volume VIII, Appendix B of its "Mercury Study Report," presented to Congress in December 1997. DOE/FETC's cost estimates ranged from \$2.5 to \$6 billion annually to the US utility industry to control mercury at the 90 percent removal level indicated by the EPA in the mercury report (<<http://www.epa.gov/ttncaaa1/t3/reports/volume8.pdf>>).

Over the next three to five years, the EPA, the Department of Energy (DOE), the United States Geological Survey (USGS), and private sector organizations including the Electric Power Research Institute (EPRI), will work cooperatively to address combustion control research on determining the cost and effectiveness of options to reduce mercury releases from all types of coal-fired boiler configurations.

Studies will be conducted to identify, evaluate, and demonstrate innovative technological solutions, such as specialized sorbents, reagents and control equipment, which can cost-effectively reduce mercury emissions from combustion systems where standards have not been issued or where improved technologies would significantly reduce the costs to comply with existing regulations. The EPA also plans to conduct research to improve the devices used to measure mercury emissions from combustion sources. These devices are needed to support development of control options (need to

know mercury species) and to determine compliance with regulations. An example is the development of continuous emissions monitors, which are sensitive enough to measure total mercury and speciate mercury emissions even at very low concentrations. The results from this research will also be useful to international organizations and specific countries where combustion sources are a major emission source. The EPA will develop appropriate technology transfer documents summarizing research findings and provide technical support for any international demonstrations. The information in this paragraph was obtained from the draft Mercury Research Strategy of the EPA's Office of Research and Development (<<http://www.epa.gov/nceawww1/pdfs/mercstra.pdf>>). This is the proposed direction the EPA is going to take in technology development. However, these activities are subject to change.

The DOE/FETC Program Research and Development Announcement's (PRDA) "Advanced Emissions Control Technology Program" (or Mega PRDA) and associated projects, represent the largest mercury control development program for the coal-fired utility industry in the United States and in the world. The following six Phase II research and development projects are 2–3-year efforts to further investigate and develop fine particulate and mercury control technologies and concepts. This research is focusing on developing potential technologies for mercury emission reduction from utility plants and is aimed at either the addition of some type of sorbent technology to adsorb the mercury, improving the mercury capture effectiveness of existing pollution control technology, or using new technology for mercury control.

***Mercury Control Technology Research for Coal Combustion***

ABB Power Plant Laboratories and ADA Technologies, Inc. are investigating novel improvements to ultra high efficiency electrostatic precipitators (ESPs) for more efficient collection of particles—less than 2.5 μm in size—and the trace toxic metals associated with these particles. Phase I tested flue gas cooling using moisture or heat exchangers. This option captured more than 90 percent of the mercury found upstream of the ESP. Phase II will test carbon particle injection, with the added moisture, in a pilot-scale facility drawing flue gas from a full-sized utility burning a variety of coals.

ADA Technologies, Inc., together with CONSOL, Public Service Gas & Electric, and Burns and McDonnell, are developing a process with highly efficient mercury removal and recovery, and sorbent regeneration and reuse, which has been termed "Mercur-RE." This process uses gold, or other precious metals, as the sorbent to capture mercury in its various chemical forms at ordinary flue gas temperatures and to desorb the Hg from the gold in order to recover the mercury as a useful byproduct.

Physical Sciences, Inc. is conducting a fundamental investigation to predict the distribution and fate of mercury, arsenic, chromium, and their various chemical forms, from a variety of combustion conditions. Knowing the form, or forms, is important in understanding the potential risks—because chemicals can be more toxic in some forms than in others—and to develop strategies to capture specific trace elements.

Public Service Company of Colorado, together with ADA Technologies, Inc. and EPRI, are demonstrating mercury removal with a pilot-scale technology to inject carbon, or other solid chemical capturing materials, as part of a coal-fired utility air pollution control device (APCD), such as an electrostatic precipitator (ESP) or fabric filter (FF). The investigators are conducting engineering and economic studies to look at how the technology fits in different utility configurations. Phase II will take the most promising technologies to increasing size scales from the small pilot-scale to near full-scale designs, with the goal of demonstrating them



commercially.

Radian International LLC, and its team members, EPRI, and Meserole Consulting, are investigating the conversion of elemental mercury to a more soluble form to remove more than 95 percent of it with Wet Flue Gas Desulfurization systems.

The University of North Dakota, Energy and Environmental Research Center (UNDEERC) is investigating a highly reliable advanced hybrid particulate collector that can provide more than a 99.99 percent collection efficiency rate for all particle sizes and will be applicable for use with all US coals and cost-competitive with existing technologies. The UNDEERC is teamed with W.L. Gore and Associates, Inc. and Allied Environmental Technologies Company. The concept is based on integrating ESP principles and FF technology to create particulate control devices that will be as much as 75 percent smaller than similar conventional devices.

In addition to the above efforts, DOE issued a call for proposals (20 March 2000, see <http://www.fetc.doe.gov/>) for cost-cutting mercury-control methods applicable to coal-based power plants, which will require contractor and industrial cost sharing. There are many engineering and technical issues that need to be addressed before mercury control can be successfully implemented in the utility industry and before any regulatory decisions on mercury can be made based upon sound science. As DOE's public release states: "The effectiveness of existing flue gas emission controls in removing mercury can vary considerably from plant to plant, or even from boiler to boiler. With today's technologies, mercury removal can range from essentially no control to as high as 90 percent."

## 4 Research Activities

EPA's Office of Research and Development is in the final stages of finalizing its *Mercury Research Strategy* (<<http://www.epa.gov/ncea/mercstra.htm>>), which was reviewed by an external peer panel in December 1999. *The Mercury Research Strategy* identifies and prioritizes the research needed to assess and manage risks from mercury. Its research activities address the most pressing mercury research needs of the Agency, many of which have been identified in the *Mercury Study Report to Congress* and *EPA's Mercury Action Plan*. The strategy considers all sources and release routes of mercury to form a "multimedia" research approach. The strategy can be categorized along basic research themes that address near-term regulatory efforts, as well as longer term research concerns. The research themes are as follows:

- Hazards of mercury/methylmercury to human health
- Ecological effects of mercury/methylmercury
- Modeling and monitoring of environmental media for mercury
- Human and wildlife exposures to methylmercury through the aquatic foodweb
- Control technologies for combustion sources of mercury
- Controls for noncombustion sources of mercury (chlor-alkali industry, waste disposal and recycling, other sectors, contaminated sediments and soils, and mining)
- International issues and transboundary distribution of mercury/methylmercury
- Risk communications on mercury/methylmercury

### 4.1 Current EPA Mercury Research Activities

EPA's Science To Achieve Results (STAR) grants program is supporting fundamental research on the complex chemical and physical transformations and movement of mercury through the environment. Nine grants totaling approximately seven million dollars have been awarded in order to improve EPA's ability to trace mercury from its entrance into the ecosystem through its biogeochemical cycling to the concentration of methylmercury in fish tissue. A better understanding of the movement of mercury in the environment is expected to promote the development of risk management strategies based on sound science. Titles of the nine grants are as follows: (1) Watershed Influences on Transport, Fate and Bioavailability of Mercury in Lake Superior; (2) Methylmercury Sources to Lakes in Forested Watersheds: Has Enhanced Methylation Increased Mercury in Fish Relative to Atmospheric Deposition; (3) Response of Methylmercury Production and Accumulation to Changes in Mercury Loading: A Whole-Ecosystem Mercury Addition Study; (4) Mercury: Transport and Fate through a Watershed; (5) Chemical and Biological Control of Mercury Cycling in Upland, Wetland and Lake Ecosystems in the Northeastern US; (6) Processes Controlling the Chemical/ Isotopic Speciation and Distribution of Mercury from Contaminated Mine Site; (7) Microbiological and Physicochemical Aspects of Mercury Cycling in the Coastal/ Estuarine Waters of Long Island Sound and Its River-Seawater Mixing Zones; (8) Understanding the Role of Sulfur in the Production and Fate of Methylmercury in Watersheds; (9) The Redox Cycle of Mercury in Natural Waters.

The Mercury Total Maximum Daily Load (TMDL) Air Deposition Pilot project involves developing a TMDL for a water body that receives mercury contributions from air sources. Atmospheric deposition is identified by states as a major contributor to use impairments. The goals of the pilot project are to evaluate both technical and legal tools for developing a TMDL for mercury from air deposition. Specifically, the pilot will examine whether and how existing air and water modeling tools can be combined to develop a TMDL. In addition, the project will analyze how the Clean Air Act, the Clean Water Act, and state and local authorities can be used jointly to address air emissions. The results are intended to provide tools that states and regions can use in developing TMDLs for mercury from air sources

The Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) software (v. 2.0) provides an integrated Geographic Information System (GIS) and modeling tool for state watershed analysts. The BASINS software package is being upgraded to allow users to include air deposition as a nonpoint source and to include a continental US data coverage of modeled mercury deposition rates. The combination of data and system functionality will permit state TMDL analysts to determine the air deposition contribution to current waterbody mercury loads for waters listed in CWA section 303(d) and to predict the impact of recent air emission reduction rules on future waterbody mercury loads. The latest generation of the Office of Research and Development's air quality models is being revised to include the most recent atmospheric, terrestrial and aquatic transport and fate information on mercury.

Section 112 (m) of the CAA of 1990 requires EPA to prepare and submit to Congress every two years a study of health and environmental impacts of atmospheric deposition to the Great Lakes, Chesapeake Bay, and Lake Champlain. The first and second reports of the series *Great Waters Report to Congress* contains information on the deposition of pollutants, current actions to control the release of these pollutants, recommendations for the additional research and actions to further reduce air deposition. Mercury is one of the 15 Great Waters pollutants of concern.

Section 112(n)(1)(A) of the CAA requires EPA to regulate hazardous air pollutants (HAP) emissions from electric utilities, if the EPA finds such regulation to be appropriate and necessary. In order to address current uncertainties about mercury emissions, EPA is collecting high quality emissions data about coal-fired electric generating plants to support a regulatory determination. The Agency will require all coal-fired power plants generating more than 25MW to provide the results of analysis to determine the mercury content of the coal they are burning. In addition, some plants will be required to perform stack testing for quantity and species of mercury emissions. The information will allow EPA to calculate the amount and species of mercury emitted by each coal-fired plant larger than 25MW.

The Urban Air Toxics Strategy, required by CAA sections 112(c)(3), 112(k), and 202(l), addresses health impacts from air toxics in urban areas. The strategy includes a draft list of 33 hazardous air pollutants (including mercury compounds) judged to pose the greatest potential threat to public health in the largest number of urban areas

EPA is conducting a mass balance study of several critical pollutants in Lake Michigan, including mercury. Through the Lake Michigan Enhanced Monitoring Program, a sound scientific base of information will be obtained to guide future toxic reduction efforts. The Lake mass balance will be coupled with an atmospheric mass balance and will include other models for simulating lake hydrodynamics, particulate transport and eutrophication processes to obtain relative loading from water and air sources.

EPA has entered into a cooperative agreement with the National Academy of Science (NAS) for a review of health research on mercury. NAS will focus particularly on research that has been conducted since completion of EPA's *Mercury Study Report to Congress*. The study results will include a recommendation concerning an appropriate reference dose level. The study is scheduled to be completed during 2000.

## 4.2 Current US Geological Survey Mercury Research Activities

The National Mercury Project (NMP) is a USGS Toxic Substances Program effort that is focused on identifying and providing information toward critical information gaps concerning mercury contamination of aquatic ecosystems. In particular, the NMP seeks to provide information at the regional to national scale on mercury contamination, controls of mercury methylation, and bioaccumulation of mercury. In addition, a planned component of the NMP is to perform wildlife toxicology studies of at risk species, such as fish consuming birds. In the summer of 1998 the NMP coordinated and executed a national-scale synoptic sampling study, where by water, sediment and game fish were collected at 108 sites nationally. The purpose of this study was to provide a national context for assessing how widespread mercury contamination of aquatic ecosystem is across the United States (including Alaska and Hawaii), and what controls mercury methylation and bioaccumulation at the national scale.

The objective of the Aquatic Cycling of Mercury in the Everglades (ACME) Project is to conduct intensive, process-oriented research that focuses on the primary mercury cycling pathways in the Everglades, and which can be synthesized by a “model” for restoration and predictive purposes. The ACME project is a USGS-led, multi-agency effort that is intended to provide a holistic view of the mercury problem in the south Florida environment. In particular, the project aims to provide information on the major biogeochemical processes and rates affecting the transport, transformations and fate of mercury.

Enriched mercury deposits occur in several areas of the United States where mercury itself has been mined, or where mercury was used for gold extraction purposes. Drainage from these areas is of environmental concern because of the likelihood of high levels of mercury transport and methylation enhancement from generally high sulfate levels. The purpose of this ongoing study is to assess the characteristics of mercury cycling in these enriched mercury zones, and to provide information on the environmental risk they pose.

For the past twenty years the USGS has been collecting data on mercury in coal bed samples from across the United States. To date, more than 7,000 samples have been tested. The USGS is also assembling a database on mercury content of coals in other major coal-burning countries. This information will be useful for estimating past and future global mercury emissions from coal combustion.

## 4.3 Collaborative Research

The Fate of Mercury in the Lake Superior Basin Proposal was initiated by the US Department of Energy Federal Energy Technology Center, the US Environmental Protection Agency, EPRI, and Ontario Hydro. The objectives are to increase the understanding of mercury loadings (local and regional transport and deposition) to the lake from coal-fired power plants ( $\text{Hg}^{2+}$  and  $\text{Hg}^0$ ) along with ongoing research on mercury methylation and bioaccumulation of mercury in fish in the Great Lakes Region. A team of leading experts in the fields of mercury measurement, transport, deposition, methylation rate, and bioaccumulation has been assembled to plan and conduct the research. The team includes the University of North Dakota Energy and Environmental Research Center (UNDEERC), the University of Michigan Air Quality Laboratory, the Michigan Department of Environmental Quality, the Academy of Natural Sciences, the Wisconsin Department of Natural Resources, Roy F. Weston, Inc., CONSOL INC, and Frontier Geosciences. Three of the four coal-fired power plant mercury emissions sources have been characterized (two in the United States and two in Canada), with funding pending from the EPA to conduct local and regional impact studies on mercury transport and deposition of a fourth power plant in the Lake Superior Basin.

## 5 Future Mercury Program Directions

EPA is developing a strategy to address persistent, bioaccumulative, and toxic (PBT) pollutants. Traditionally, PBT substances have been addressed by using single-statute approaches. However, the challenges that remain in dealing with PBT pollutants require EPA to work cooperatively across each media-specific Office (i.e., air, water, land) in order to address the multimedia issues associated with priority PBT substances.

There are four key elements to EPA's PBT Strategy. They are: (1) developing and implementing national action plans for priority PBT pollutants with the goal of reducing risks; (2) screening and selecting more priority PBT pollutants for action; (3) preventing the introduction of new PBT pollutants into commerce; and (4) measuring progress by linking activities to environmental results.

The recommendations in *EPA's Draft Action Plan for Mercury* are examples of how the Agency can work cooperatively across media programs to address PBT pollutants that move from land, to air, water and sediment. As a first step, EPA has analyzed current regulations, initiatives, and programs, which manage and control mercury, and has identified a set of cost-effective options to move toward achieving further reductions. The cross-agency work group that developed this Action Plan is continuing to look for opportunities to address mercury through a more integrated multimedia approach. The Agency proposes to take the following actions, in consultation with other federal agencies, and with the involvement of states, tribes and other stakeholders:

- Control emissions from air point sources. EPA has taken several important steps to reduce the levels of mercury and other pollutants, including reducing emissions from municipal waste combustors and medical waste incinerators. These actions, once fully implemented, will reduce mercury emissions caused by human activities by 50 percent from 1990 levels. Several other regulations that will limit mercury emission are under development, as well. Actions to reduce emissions of carbon dioxide to control climate change will also have a significant co-benefit in reduced mercury emissions. Additional work is being done in EPA's Total Maximum Daily Load (TDML) program to evaluate the linkage of air emissions to water quality impacts, to help determine appropriate geographically targeted reduction actions. In addition, EPA intends to gather high quality emissions data on coal-fired electric generating plants to address current uncertainties about mercury emissions and support a regulatory action.
- Seek reductions in uses of mercury and improve information and citizens' right-to-know. These use-reduction measures will reduce the levels of mercury in waste streams as well as the danger of accidental releases. Generally, EPA will look to voluntary rather than regulatory approaches to reduce mercury use. Additionally, EPA is considering changing the reporting requirements for mercury under the Toxic Release Inventory (TRI), which could result in additional reporting of mercury releases.
- Revise water quality criteria and improve measurement of mercury in water. EPA will revise its water quality human health criterion for mercury and publish new analytical methods for measuring mercury levels in water.
- Develop an environmentally acceptable disposal method for mercury wastes designated as hazardous wastes. Currently, EPA requires that hazardous wastes containing high levels of mercury be treated to recover the elemental mercury from the waste. This requirement may no longer be the preferred approach in all cases since the demand for mercury has been reduced to the point where the supply of recovered mercury exceeds it. Also, there are air emissions of mercury associated with the recovery

process. Therefore, EPA is evaluating alternative treatment technologies that would permanently stabilize mercury wastes to allow their disposal in hazardous waste landfills.

- Seek reduction in exposure to highly exposed populations. Because of the long time before reductions in releases will be reflected in lower fish-tissue levels, EPA will continue public information and outreach programs, including continued support and strengthening of the states' and tribes' fish advisory programs.
- Decrease further environmental contamination from illegal use/disposal of mercury through focused compliance monitoring and enforcement of mercury restrictions and requirements. Focus compliance assistance and outreach, monitoring and/or enforcement on sectors/sources that are significant contributors of mercury loadings to the environment. Where enforcement actions are warranted, use Supplemental Environmental Projects (SEPs) to encourage pollution prevention activities or mitigate damage. Expand compliance and enforcement activities for direct and indirect dischargers of mercury to surface waters.
- Continue international efforts to reduce mercury releases. The global circulation of mercury requires concerted efforts by all countries to solve the mercury problem in any one country
- Perform and support further research on all aspects of the mercury problem. A research strategy is being developed that will permit targeting of federal and other research on the most important data gaps.
- Support regional, state, tribal and local actions to reduce mercury. State, tribal and local governments play a key role in achieving mercury reductions. EPA will support state and local efforts through funding, information sharing, and coordination. For example, EPA will expand outreach to publicly owned treatment works about preventing mercury pollution in sewage discharges.