

Inventory of Anthropogenic Mercury Emissions in the Northeast

**Prepared by
NESCAUM**

November 2005

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Executive Summary

This report was prepared by NESCAUM as a follow up to the NESCAUM 1998 Report, “Northeast States/Eastern Canadian Provinces Mercury Study, a Framework for Action”. While that document represented a comprehensive review of mercury in 1998, this report provides solely an update to the Northeast mercury emissions inventory. The work was pursued in part to assist the New England Governors and Eastern Canadian Premiers (NEG/ECP) in their effort to assess progress in meeting the goals of mercury emissions reduction that were set forth in their 1998 Mercury Action Plan. In addition, the inventory will be modeled to assess the relative contribution of specific in-region and out-of-region mercury sources to deposition in the northeast. Ultimately, these efforts provide information relating emission changes to deposition changes and the resulting change in mercury levels in fish, one of the critical public health rationales for limiting mercury emissions to the environment.

The refined inventory quantifies mercury emissions for combustion, manufacturing, and area sources in the Northeast. Total anthropogenic mercury emissions in the Northeast from these sources are estimated at 4,693 kilograms (kg) annually. This estimate compares to the 15,903 kg/year from the previous 1998 inventory, a decline of roughly 70 percent¹. The primary drivers behind this substantial decrease are Municipal Waste Combustors (MWCs), Medical Waste Incinerators (MWIs), Industrial, Commercial, and Institutional boilers (ICIs), and Electric Utility Boilers. The respective emission decreases for these categories are 86, 98, 76 and 56 percent. In addition, the closure of a single chlor-alkali plant in Maine contributed a nearly 3% emissions reduction.

In this version of the inventory, approximately 59 percent of the total emissions are derived from combustion sources, 14 percent from manufacturing sources, and the remaining 27 percent from area sources. As estimated here, the four source categories responsible for the largest percentage of Northeast mercury emissions are: MWCs (22 percent); electric utility boilers (19 percent); and residential heating (15 percent) and Sewage Sludge Incinerators (SSIs) (12 percent). Note that the percentage contribution to the current inventory and percent reductions from the previous inventory may vary considerably on a state by state basis.

The current inventory reveals the considerable progress that states in the northeast have made in recent years in limiting mercury emission to the environment. Based on these results, the 75% emissions reduction goal by 2010 set forth by the NEG/ECP is within reach. Targets of opportunity that remain include EGUs, which mostly remain uncontrolled, SSIs and MWCs. Despite the significant reductions realized to date in the northeast, the last category still contributes substantially to the overall emissions burden. Since state of the art controls, some going beyond US EPA requirements, are in place for MWCs in the northeast states, states must now redirect efforts to minimize or eliminate

¹ This direct comparison of total emissions is meant to be a rough guide. As detailed in the body of the report, several factors should be taken into account in the interpretation of the overall emission decreases in the region (e.g., new source categories, methodological changes). Further work is needed for a true “apples to apples” comparison of emission reductions.

the use of mercury in products and promote recycling and collection to prevent mercury from entering the waste stream.

Although regional efforts are important, taken alone they will not solve the environmental mercury problem in the northeast. A successful solution will require broader participation in the country as a whole. However, the efforts undertaken in this region serve as a guide to effective programs for the control of mercury emissions to the environment.

1. INTRODUCTION

1.1. Overview

The 1998 New England Governors and Eastern Canadian Premiers (NEG/ECP) Mercury Action Plan "...concluded that aggressive and concerted actions are needed to reduce potential health risks attributable to mercury exposures and to expand scientific information on mercury sources, controls and environmental impacts." The scientific underpinnings of this conclusion are detailed in the associated report: Northeast States and Eastern Canadian Provinces *Mercury Study: Framework for Action* (1998). Based on the current state of knowledge, the NEG/ECP agreed to a regional goal to virtually eliminate anthropogenic mercury emissions to the environment. An interim goal of a 50% reduction in mercury emissions by 2003 from the 1998 baseline was also established.

The 1998 baseline emissions inventory for Hg in the Northeast improved upon the emissions estimates developed by U.S. Environmental Protection Agency (EPA) for its Mercury Study Report to Congress (USEPA, 1996). These refinements were made based on facility-specific information collected by state air quality agencies, including stack test data, fuel use rates, air pollution control devices, and other operational parameters. The updated inventory reported herein relies on a similar approach to revise the most recent federal mercury inventory for the Northeast states. The latest regional inventory improvement represents a critical step toward evaluating emission impacts associated with mercury deposition in the region, designing effective control strategies, and enabling a comparison to the baseline to assess progress and provide a measure of the effectiveness of control efforts.

For this work, the Mercury Inventory Workgroup² began with version 3 of EPA's 1999 National Emissions Inventory (NEI) as this version was believed to represent the most comprehensive peer-reviewed inventory of Hg emissions currently available at that time. Updates (representative of 2002/03) to the NEI were performed to reflect the number of facilities currently operating in their state for each of the key source categories, the most recent information on activity levels for these facilities, and the most recent emissions estimates based on either direct emission measurements (i.e. stack test data) or most recent emission factors and activity data for the source category.³ The Workgroup also adopted the NEI area source inventory with few exceptions.⁴ For mobile

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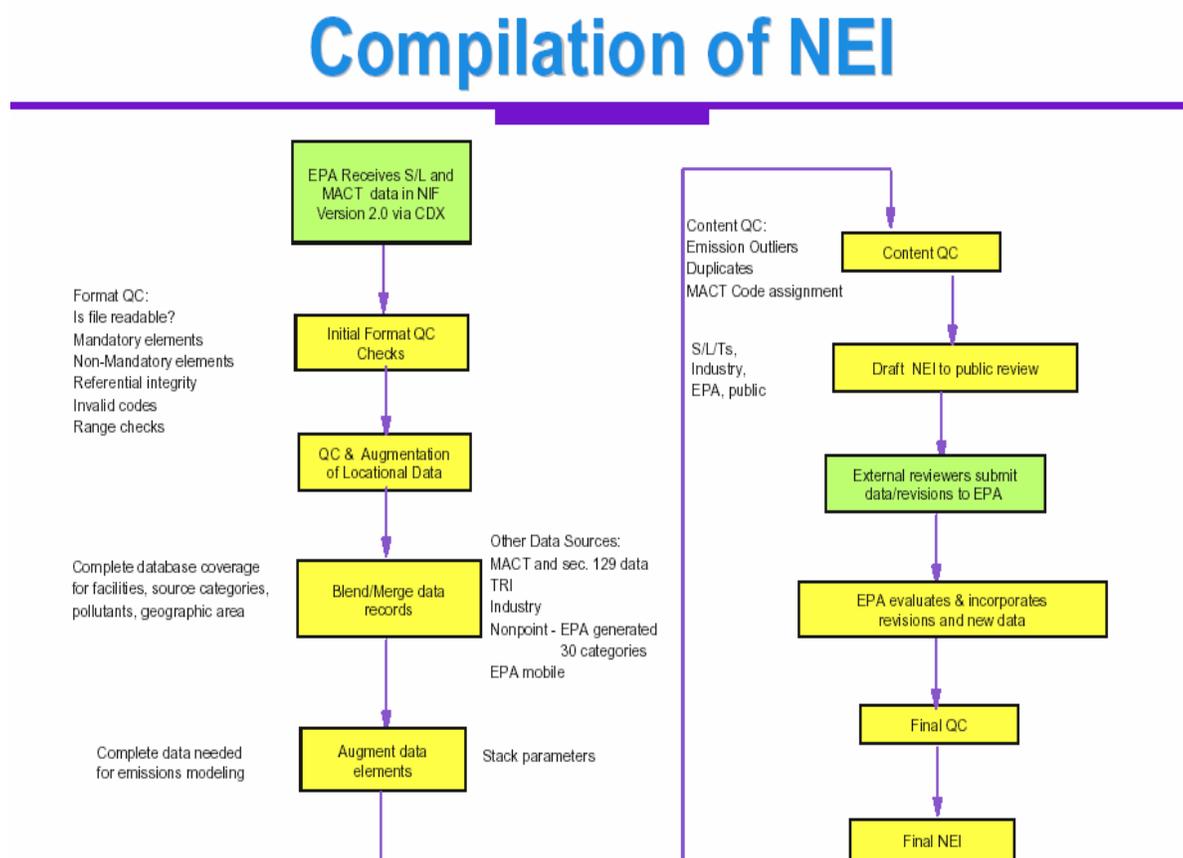
³ For consistency, the states used emission factors in USEPA's FIRE database.

⁴ The data for industrial process categories were adopted from the 2002 Draft NEI for lamp breakage and general lab use. Landfills and IC engines were not included due to lack of data. Estimates are discussed in detail in the report.

source Hg emissions, the Workgroup intended to rely upon the most recent mobile source inventory that was used in the Clear Skies Act analysis (USEPA, 2003). However, EPA determined these estimates were incorrect, which led to their removal from the inventory. It should be noted that onroad and nonroad estimates were substantial (~10% of the current inventory) and would be a top five source category in the region.

Figure 1-1 presents an overview of the steps in compiling the NEI including the extensive review and augmentation by both the states and EPA.⁵ Documentation for the 1999 NEI can be obtained electronically on USEPA's website.⁶

Figure 1-1: Flow Chart describing NEI development methodology



1.2. Background

For the purposes of this inventory, anthropogenic sources of mercury emissions are categorized as “point” or “area” sources according to their size and dispersion characteristics. Point sources typically release emissions from a stack and are large enough to be associated with a specific geographic location. Examples of point sources

⁵ <http://www.epa.gov/ttn/chief/conference/ei11/qa/popepres.pdf> for more detail

⁶ <http://www.epa.gov/ttn/chief/net/1999inventory.html>

include municipal waste combustors and electric utility boilers. Point sources are further divided into two categories: combustion and manufacturing sources. Area sources are typically small but numerous, and are usually not associated with emissions from a “stack”. An example of an area source is mercury emissions resulting from fluorescent lamp breakage. With regard to hazardous air pollutants, point and area sources are also characterized according to the definition in the 1990 Clean Air Act Amendments whereby point sources are defined as sources that emit mercury above 10 tons per year (tpy) for a single hazardous air pollutant (HAP) or a combined 25 tpy for multiple HAPs.

Point Sources

- **Combustion:** municipal waste combustors; medical waste incinerators; sewage sludge incinerators; electric utility boilers; fossil fuel and wood-fired industrial/commercial/institutional boilers;⁷
- **Manufacturing:** cement manufacturing; secondary mercury production; petroleum refining; lime manufacturing; steel foundries; and miscellaneous industrial processes.

Area Sources

- Fossil fuel residential heating; fluorescent lamp breakage and recycling; laboratory use; dental use; and crematories;

1.3. Summary

Table 1-1 summarizes the refined inventory of mercury emissions for combustion, manufacturing, and area sources in the Northeast. Total anthropogenic mercury emissions in the Northeast from these sources are estimated at 4,693 kilograms annually. Approximately 59 percent of this total comes from combustion sources, 14 percent from manufacturing sources, and the remaining 27 percent from area sources. As estimated here, the four source categories responsible for the largest percentage of Northeast mercury emissions are: MWCs (22 percent); electric utility boilers (19 percent); and residential heating (15 percent) and SSIs (12 percent).

⁷ For the purposes of this inventory we are reporting both the point and area ICI boilers in the point source category.

Table 1-1:2002 Mercury Inventory for Northeast States

Mercury Source Categories	Emissions Estimate (kg/yr)	Percent of Inventory
Point Sources		
<i>Combustion Sources</i>		
Municipal Waste Combustors	1,012	21.6
Sewage Sludge Incinerators	543	11.6
Medical Waste Incinerators	15	0.3
ICI Boilers Total	329	7.0
Coal-Fired Boilers	47	1.0
Oil-Fired Boilers	245	5.2
Wood-Fired Boilers	29	0.6
Natural Gas- Fired Boilers	8	0.2
Electric Utility Boilers Total	875	18.7
Coal Fired	739	15.7
Oil Fired	129	2.8
Wood-Fired	7	0.2
Natural Gas Fired	.05	0.001
Total Combustion Sources	2,774	59.1
<i>Manufacturing Sources</i>		
Cement Manufacturing	239	5.1
Lime Manufacturing	4	0.1
Petroleum Refining	28	0.6
Steel Foundries	400	8.5
Misc. industrial processes	3	0.1
Total Manufacturing Sources	674	14.4
Total Point Sources	3448	73.5
Area Sources		
Residential Heating	715	15.2
Industrial Processes	530	11.3
Electric Lamp Breakage & Recycling	227	4.8
General Lab Use	58	1.2
Dental Preparation and Use	80	1.7
Crematories	165	3.5
Total Area Sources	1245	26.5
Area + Point Sources	4,693	100

Note: totals and percentages may not add exactly due to rounding.

2. INVENTORY DEVELOPMENT METHODOLOGY

2.1. Overview

Estimating emissions from a particular source category requires information on the number and types of facilities in the sector, applicable emission factor(s)⁸ and the activity level of each facility, or reported stack test data. The current Hg inventory relied upon the most recent inventory databases available. For the point source inventory, the two databases utilized in this effort were: (1) the update of Hg emissions conducted by the NEG/ECP Mercury Task Force Inventory Workgroup in 2002 to determine if the 50% reduction milestone in the NEG-ECP Mercury Action Plan was achieved⁹ and (2) the 1999 Hg National Emissions Inventory (NEI). The NEI is a peer-reviewed inventory, which relies on state input for updates. A more detailed description of this methodology may be found in the documentation for the 1999 NEI.

The area source emission estimates reported in this Hg inventory were taken in part from the draft 2002 NEI. Some adjustments were made to these estimates. For example, the emissions from fluorescent lamp breakage were adjusted to reflect a change in the emission factor and individual state data on recycling rate (Section 5.3). No emissions were available in this version of NEI for human cremation. State specific estimates were obtained from the Cremation Association of North America (US EPA's source of prior year estimates for this category). In general, US EPA county-level area source estimates are based on emission factors for each area source category and a per-capita allocation methodology. In addition, the mobile sources inventory was omitted here since EPA withdrew its original estimates that were based on potentially erroneous mercury emissions factors. Improved factors are under development, by USEPA.

NESCAUM initiated the update by sending electronic copies of the final 2002 point source inventory for each state from the NEG-ECP Hg Task Force Inventory Workgroup, and the 1999 Hg NEI version 3. NESCAUM then organized a series of conference calls with the NESCAUM Hg inventory workgroup to discuss specific ways to revise the inventory. This process continued for area sources once the draft 2002 NEI became available. The following revisions to the inventory were made:

- Emission factors (EFs) reported in FIRE (Factor Information Retrieval) were used since they reflect the most recent EFs developed by USEPA.
- The Hg inventory for landfill emission estimates reported in the 1999 NEI was not included because the sites and emission estimates were based on a proprietary database that was not available to the states for verification.

⁸ An emission factor is the ratio of the mass of mercury emitted to a measured level of source activity and may be generated from emission or stack test data, mass balance techniques, or engineering judgment.

⁹ The Hg inventory workgroup conducted a limited revision of the inventory by estimating 2002-03 emissions based on reductions associated with controls that were applied since 1998, closures, and updated EGU emissions. Based on this analysis, over 50% of Hg emissions, primarily from incinerator controls and closures, were achieved.

- Similarly, the inventory did not include emission estimates from the 1999 NEI for Internal Combustion (IC) engines because the emission estimates were highly uncertain and inconsistent from state to state.
- Industrial, Commercial, and Institutional boiler (ICI) results from the 1999 NEI were adopted without any changes due to the lack of information about this source category. However, comparison of fuel consumption estimates for 1999 from the Energy Information Administration (EIA) for ICI boilers indicates the 1999 NEI inventory may substantially underestimate Hg emissions from this source category. This is discussed in more detail in Section 3.6.
- The Hg Inventory Workgroup identified the need for the development of emission factors for fuel combustion for residential heating and ICI boilers.

After review, each State submitted its inventory to NESCAUM for final compilation and analyses. Updates were evaluated and any information still missing (e.g., stack information, latitude and longitude, and SCC codes) was incorporated using default information from USEPA's 1999 National Emissions Inventory (NEI). In cases where latitudes and longitudes were not provided by the 1999 NEI, NESCAUM relied on Terra-server, an Internet based latitude-longitude locator program. This process used the street name or county name to identify the latitude-longitude in decimal degrees. When coordinates were provided in Universal Transverse Mercator-North American Datum 1983 (UTM NAD 83), the U.S. Army's Corpscon program was used to convert UTM coordinates into geographic decimal degrees.

2.2. Uncertainty in Emission Estimates

Each inventory source estimate was assigned an uncertainty level drawn from a four-category range (very high, high, medium, and low). The factors considered to estimate uncertainty included:

- generic emission factor usage (these may fail to capture differences in control efficiencies and activity levels for specific facilities)
- Use of outdated emission factors (may be derived from limited data not reflective of process changes over time)
- The age of test methods used in emissions determinations (older approaches may produce different emission estimates than those based on newer testing protocols)
- Representativeness of test data (some data may be of poor quality or may be based on a small sample of facilities that do not reflect the full range of variation in the source population being studied {e.g. residential fuel oil})
- Source characterization limits (trace levels of mercury emitted by some sources are near the minimum detection limits of the equipment used to measure these emissions)

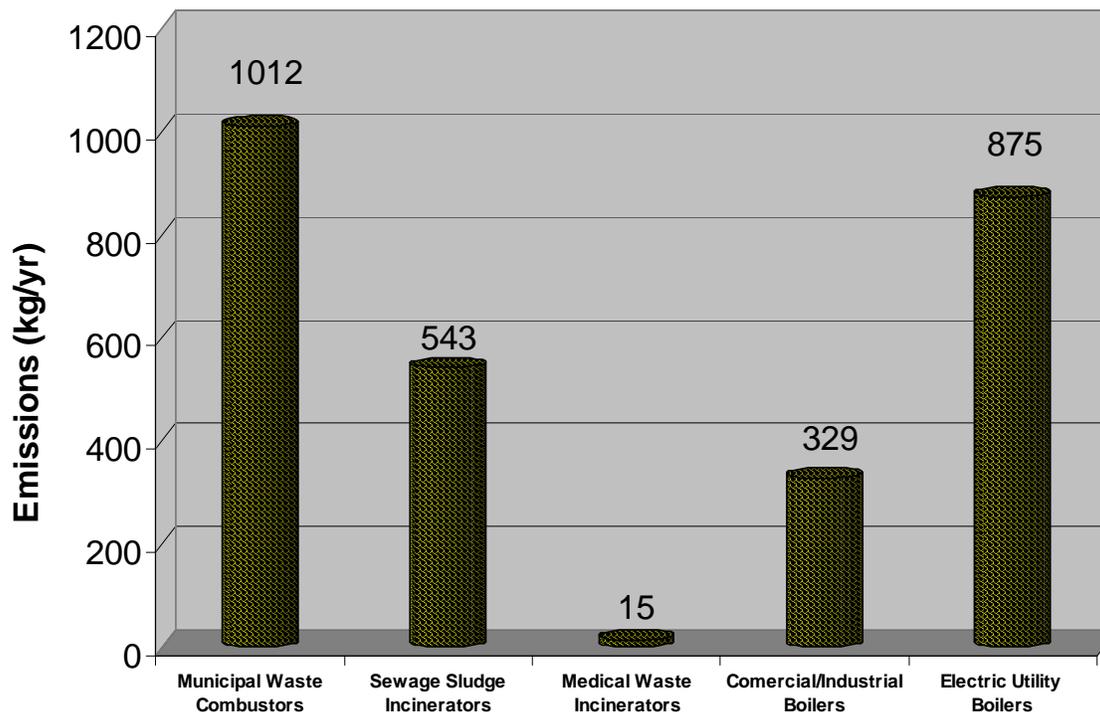
3. POINT SOURCES: COMBUSTION

3.1. Overview

During the combustion of mercury-containing fuels or waste products, mercury is emitted to the atmosphere in particulate and vapor forms with other exhaust gases. The combustion point source inventories described below include municipal waste combustors, medical waste incinerators, sewage sludge incinerators, electric utility boilers, and non-utility industrial/commercial/institutional boilers (ICIs) (Figure 3-1).

The 1998 recommendations in the NEG-ECP Hg Action Plan for MWCs called for a 0.028 mg/dscm (milligrams per dry standard cubic meter) mercury emission limit for facilities that have the capacity to burn 250 tons per day or more of municipal solid waste.¹⁰ Mercury emission limits for existing and new facilities under 250 tons/day were to be evaluated regarding the feasibility of adopting the 0.028 mg/dscm on a case-by-case basis. For Medical Waste Incinerators (MWIs), the adoption of a 0.055 mg/dscm emission limit was recommended. The region was to evaluate the feasibility of adopting this limit or lower for these facilities within three years. For both MWC and MWI, the action plan proposed that each facility perform at least annual emissions monitoring and stack testing.

Figure 3-1: 2002 Combustion Source Emissions in Kg per Year



¹⁰ It is important to note that the USEPA regulation, revised in 1997, had a Hg emission limit of 0.65 mg/dscm. Stack tests in New Jersey, which took the lead nationally in regulating MWC emissions, showed however that MWCs could achieve a more stringent emission limit. Thus, the 0.028 mg/dscm was adopted.

3.2. Municipal Waste Combustors

3.2.1. Background

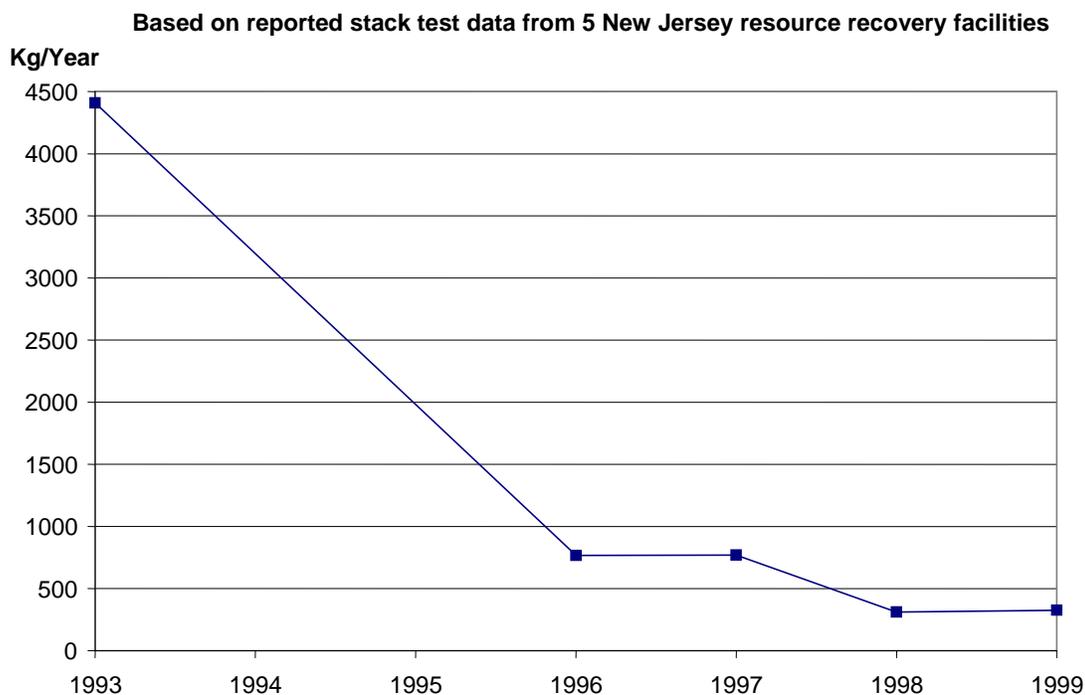
MWCs burn municipal solid waste in order to reduce waste volume and in some cases to recover energy. The material combusted at these facilities is composed primarily of household and other commercial, institutional, and industrial wastes and may include discarded mercury-containing products, such as batteries, electrical switches, fluorescent lights, paint residues, plastics, and electronic equipment. A detailed discussion of sources of mercury in solid waste streams is presented in Chapter VII of the 1998 Mercury Study (NESCAUM, 1998). Mercury-containing products discarded in landfills (as opposed to those being combusted in MWCs) may also result in mercury emissions to the atmosphere. However, the Hg inventory for landfill emission estimates reported in the 1999 NEI was not included because the sites and emission estimates were based on a proprietary database that was not available to the states for verification.

Mercury is emitted by MWCs when mercury in the solid waste is vaporized during combustion and vented through the exhaust stack. Pollution control technology can reduce mercury emissions from these combustors. Currently, more than 85 percent of the MWC plants in the U.S. use some kind of add-on device for the control of particulates and other pollutants. These controls range from electrostatic precipitators to acid gas controls, such as dry lime injection. New MWCs use a combination of controls plus activated carbon injection technology. Factors that enhance mercury control are: low temperature in the add-on pollution control system; the presence of effective mercury sorbent such as activated carbon; and the presence of carbon in fly ash, which enhances mercury sorption onto particulate matter and allows mercury to be captured by particulate control devices. See Appendix H of the Mercury Study (NESCAUM, 1998) and a follow-up NESCAUM report (NESCAUM, 2000) for a description of add-on pollution control options for reducing mercury emissions from combustion sources.

In 1994, New Jersey adopted regulations requiring each MWC to install mercury emission controls designed to reduce at least 80 percent of the stack emissions of mercury. Five out of six of the affected facilities in New Jersey chose to add carbon injection to comply with this rule. Based on quarterly stack tests at these five facilities, the use of carbon adsorption combined with existing fabric filter bag houses or electrostatic precipitators has resulted in an average mercury removal efficiency of 90-95 percent. The emission estimates for MWC operating in NJ in the 1998 report reflect the substantial emission reduction from this sector (Figure 3-2). The other states followed suit and required controls on all their MWC by 2002.

3.2.2. Emissions Estimate

There were 80 MWCs operating in the Northeast region at the time this emission inventory was compiled in 2002. Together they represent a substantial source category of anthropogenic mercury emissions in the region, contributing a total of 1,012 kg of mercury or approximately 22 percent of the overall annual inventory. The degree of uncertainty for emission estimates for MWCs is low. Emission estimates are based on frequent stack tests performed by the states.

Figure 3-2: Mercury Emissions from Municipal Waste Combustors

3.2.3. Methodology for Estimating Emissions

All eight states in the Northeast region provided emission estimates based on stack test data. Further discussions were held with all states during the Q-A process at NESCAUM to double-check all emission estimates and make any necessary changes in the inventory. MWC emission estimates are believed to be the most up to date and accurate of all the emission categories.

3.3. Medical Waste Incinerators (MWIs)

3.3.1. Background

MWIs burn infectious and non-infectious wastes generated in medical and veterinary facilities. Their primary function is to reduce the volume of waste and render it biologically innocuous. Mercury sources known to be in the medical waste stream include batteries, fluorescent lamps, thermometers, plastic pigments, antiseptics, diuretics, infectious waste bag pigments, and CAT (Computer Assisted Tomography) scan paper. Due to the presence of chlorinated plastic products in the waste stream, it is believed that much of the mercury emitted by these facilities is in the form of mercuric chloride (USEPA, 1996).

3.3.2. Emission Estimate

As of 2002, the fifteen commercial and on-site MWI units in the Northeast states were estimated to emit 15 kg of mercury annually, representing approximately 0.3 percent of the total inventory. This category experienced numerous facility closures (down from 111 in 1996) and medical waste incineration was consolidated to a small number of active facilities throughout the region.

3.3.3. Methodology for Estimating Emissions

The 2002 inventory for MWIs is based on stack test data. In the case of source closures, sources were either omitted from the inventory or the facility was reported with zero emissions indicating that the facility had closed. Since only a small number of sources and stack tests were done by the states, the degree of uncertainty for MWIs emissions is medium (as compared to the frequency of tests for MWCs, whose emission estimate uncertainty were rated low).

3.4. Sewage Sludge Incinerators (SSIs)

3.4.1. Background

SSIs are primarily used in the U.S. during the final stage of the municipal sewage treatment process. The mercury in sewage sludge originates from mercury-contaminated wastewater that is discharged from household, commercial, and industrial sources. Wastewater is usually treated at a wastewater treatment plant, and then the residue is either incinerated in an incinerator or placed in a landfill.

3.4.2. Emission Estimate

The 50 sewage sludge incinerators operating in the region in 2002 contributed an estimated 543 kg of mercury annually, representing approximately 12 percent of the total mercury emission inventory in the Northeast.¹¹ This category contributes substantially (fourth largest source category) to the anthropogenic mercury burden in the region for 2002.

3.4.3. Methodology for Estimating Emissions

The 2002 inventory for SSIs is based on stack test data. In the case of source closures, sources were either omitted from the inventory or the facility was reported with zero emissions indicating that the facility had closed. This category has a medium degree of emission estimate uncertainty.

3.5. Electric Utility Boilers

3.5.1. Background

Utility boilers are large units used to generate electricity. They can be fired by coal, oil, natural gas, or a combination of these fuels. Trace amounts of mercury in boiler

¹¹ The reduction in SSI emissions from the previous inventory in 1998 is due to a significant number of closures in New York and New Jersey. Other states in the region experienced small increases in emissions

fuels are the primary source of mercury emissions. Because the combustion process occurs at temperatures around 2000° Fahrenheit, most of the mercury released from utility boilers is vaporized and exhausted as a gas, though a small fraction is in particulate form.

3.5.2. Emission Estimate

Total mercury emissions from electric utility boilers operating in the Northeast are estimated at 875 kg annually, or approximately 19 percent of the regional total. Electric utility boilers are currently the second largest source for anthropogenic mercury emissions in the region but dominate emissions nationwide. Of the 875 kg of mercury emitted by electric utilities, coal-fired boilers contributed 739 kg with oil-fired boilers contributing 129 kg annually. The remaining 7 kg can be attributed to wood and natural gas-fired boilers. As shown in Table 3-1 below, coal-fired boilers emit the vast majority of this total and constitute approximately 16 percent of the total Northeast inventory.

Table 3-1: Mercury Emissions from Utility Boilers in the Northeast

Emission Source	Emissions in kg/year	Percent of Total Northeast Inventory
Coal-fired utility boilers	739	15.7%
Oil-fired utility boilers	129	2.8%
Wood-fired boilers	7	0.2%
Gas-fired utility boilers	0.05	<0.001%
Total	875	18.7%

3.5.3. Methodology for Estimating Emissions

All emission estimates in the current inventory were initially provided by the states in the Northeast region. Emissions were reported according to each plant and stack based on emission factors from the 1999 USEPA Information Collection Request (ICR) and fuel consumption data from 2003. Given the considerable focus on coal fired utility boilers, extensive contact between NESCAUM and states in the region was established to provide the most accurate possible estimates. In some cases the original estimates were updated according to information from state contacts.

3.6. Industrial/Commercial/Institutional Boilers (ICIs)

3.6.1. Background

Industrial, commercial, and institutional (ICI) boilers are primarily used for process heating, electrical or mechanical power generation, and/or space heating. Industrial boilers are used in all major industrial sectors including paper, chemical, food, and petroleum industries. It is estimated that the heat input capacity for these boilers is typically between 10 and 250 MMBtu/hr; however, larger industrial boilers are in operation and are similar to electric utility boilers (EPA, 1997).

ICI boilers burn coal, oil, natural gas, wood, or a combination of these as fuels. As with electric utility boilers, the trace levels of mercury in these fuels vaporize during combustion and are vented to the atmosphere through the stack. The rate of mercury emissions is directly related to the type of fuel used; coal-fired boilers emit the highest amounts of mercury followed by oil and then gas. Commercial and Industrial boilers are generally smaller than the industrial units, with heat input capacities generally below 10 MMBtu/hr. These boilers supply the steam and hot water for space heating in such facilities as retail trade, office buildings, hotels, restaurants, hospitals, schools, museums, government buildings, and airports.

Industries that generate wood and wood waste as by-products often dispose of it by burning it in on-site boilers. Typically, the wood waste is burned in the form of sawdust and shavings chips in spreader stoker or suspension-fired boilers, and energy is generated at the same time. Wood-fired boilers are generally equipped with particulate matter control devices. Of the most commonly used particulate matter control devices for wood-fired boilers, only wet scrubbers, electrostatic precipitators (ESPs), and fabric filters (FF) have the potential to reduce mercury emissions.

USEPA emission factor estimates were used to estimate emissions from ICI boilers. Data on coal consumption by ICI boilers for individual facilities were provided by state agencies. The effects of coal washing were not considered because, according to the USEPA, coal for ICI boilers is generally bought on the spot market and is not washed.

Improvements in emission factor estimates are important to consider when using inventory data for the purposes of determining trends. In the Northeast states' inventory, adjustments were made to the baseline inventory only in cases where emission factor(s) estimates were improved since the mid-1990s when the baseline inventory was conducted. These adjustments occurred primarily in estimating Hg emissions from fossil-fuel combustion sources, particularly electric utility boilers and ICI boilers.

For oil-fired commercial/industrial boilers, mercury emission factors of 2.9 to 3.0 kg/10¹⁵ J were assumed depending on the type of fuel burned. These values are roughly consistent with the most recent estimates of mercury content for distillate oil published by USEPA (1997). However, they are much higher (by approximately one order of magnitude) than the value that was assumed for the mercury content of oil burned in utility boilers. Residual oil, which is heavier and less refined oil, is more commonly used in utility boilers. According to USEPA's latest published emission factors, mercury emissions from residual oil are approximately 13 times lower than mercury emissions from distillate oil.¹² As a result, emissions estimates for oil-fired commercial, industrial, and residential boilers — which are more likely to burn distillate oil — are significantly higher, relative to the amount of oil consumed, than emissions estimates for oil-fired

¹² According to USEPA's most recent report on "Locating and Estimating Air Emissions from Sources of Mercury and Mercury Compounds" (USEPA, 1997), emissions factors for residual (#6) oil and distillate (#2) oil are 0.20 and 2.7 kg/10¹⁵ J, respectively. A possible explanation for this difference may be that mercury volatilizes during the distillation process so that little of it is left behind in the residual oil. However, it is important to note that these estimates are based on limited data and are therefore uncertain. The estimates for distillate oil, in particular, are based on a single data point representing the average mercury content of oils obtained from only three sites. The emission factor for residual oil is based on a considerably larger number of data points. This is clearly an area where additional data are needed.

utility boilers. It is important to note that current estimates for oil-fired boilers, and especially for boilers using distillate oil, are based on very limited data.

3.6.2. Emission Estimate

ICIs are estimated to emit approximately 329 kg or 7 percent of the total inventory in 2002. Of this total, oil-fired boilers attributed the majority of emissions at approximately 245 kg. Due to inconsistencies involving this category, the level of emissions estimate uncertainty is very high.

3.6.3. Methodology for Estimating Emissions

During NESCAUM's review process for ICI boilers it became apparent that the emissions appeared to be underestimated. The current inventory is largely based on the NEI and contacts with EPA concluded that the NEI underestimated the number of ICI sources. It is believed that the missing ICI sources have been included in the area sources category because most large ICI boilers have been reported under point sources.

NESCAUM tried several approaches to estimate ICI emissions more accurately including emission comparisons to the Energy Information Administration (EIA) and EPA's 1999 National Emissions Inventory (NEI). We attempted to modify emissions for ICIs to be consistent with each comparison approach but each method was inconsistent with the other and ultimately the original emission estimates provided by the states were used for the 2002 inventory. See Appendix A for further discussion.

4. POINT SOURCES: MANUFACTURING

4.1. Overview

Manufacturing sources include those that use mercury directly and those that generate mercury as a by-product and emit an estimated 481 kg of mercury per year in the Northeast. Together, all manufacturing sources included in this inventory account for approximately nine percent of the 2003 regional inventory. This section discusses the following manufacturing sources: secondary mercury production; cement manufacturing; mercury compounds production; lime manufacturing; petroleum refining; steel foundries; and miscellaneous industrial processes. Table 4-1 summarizes the mercury emissions from all manufacturing sources included in this report and the results are displayed in Figure 4-1.

Table 4-1: Mercury Emissions from Manufacturing Sources in the Northeast¹³

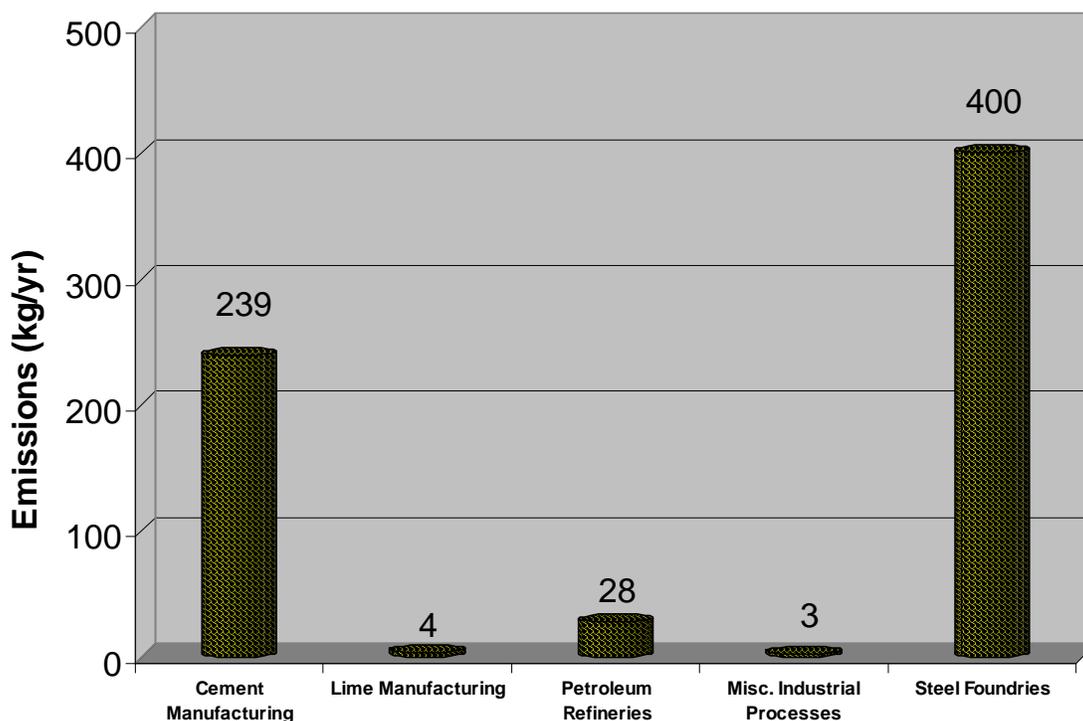
Manufacturing Source	Emissions in kg/year	Percent of Total Northeast Inventory
Chlor-alkali Production	0	0
Secondary Mercury Production	0	0
Cement Manufacturing	239	5.1
Mercury Compounds Production	0	0
Lime Manufacturing	4	0.1
Petroleum Refining	28	0.6
Steel Foundries	400	8.5
Misc. Industrial Processes	3	0.1
Total	674	14.4

4.2. Secondary Mercury Production

4.2.1. Background

Secondary mercury production or mercury recycling involves taking mercury-containing products that have been scrapped, industrial waste, and scrap mercury, and then processing the mercury so that it can be used again. Major sources of recycled mercury include dental amalgams, scrap mercury from instrument and electrical manufacturers, phosphor from discarded fluorescent lamps, waste and sludge from research facilities and electrolytic refining plants, and mercury-containing batteries (USEPA, 1993).

¹³ Categories listed with zero emissions are included here for comparison to the previous inventory. The only operating chlor-alkali plant in use during the previous inventory has been discontinued. During the last inventory this single source emitted 460 kg and was approximately 3 percent of the total mercury emissions. The previous inventory consisted of only one secondary mercury production plant, now closed, which was estimated to release 319 kg per year or two percent of the overall inventory for 1998. Similarly, the 1998 inventory included two plants that have since closed that emitted 18 kg per year representing less than one percent of the total Northeast inventory.

Figure 4-1: 2002 Combustion Source Emissions (Kg per Year)

4.2.2. Emission Estimate

There are no active secondary mercury production plants currently in the Northeast region at the time of this inventory. The previous inventory consisted of only one secondary mercury production plant, now closed, in New York which was estimated to release 319 kg per year or two percent of the overall inventory for 1998. This category had a low degree of emission uncertainty.

4.2.3. Methodology for Estimating Emissions

The estimate of emissions from the facility in New York State is based on a 1996 stack test.

4.3. Cement Manufacturing

4.3.1. Background

Mercury emissions primarily occur at the kiln and during the preheating/ pre-calcinating steps in the cement manufacturing process, where fossil fuels (mostly coal) are burned. Small quantities of mercury may also be emitted as particulate matter from fugitive emissions sources in the process.

4.3.2. Emission Estimate

There are currently four active cement manufacturing plants in the region, all in New York.¹⁴ Together, they are estimated to release an estimated 239 kg of mercury per year or approximately 5 percent of the total inventory.

4.3.3. Methodology for Estimating Emissions

For three facilities, NY DEC based the Hg emission estimates on the 2000 Toxic Release Inventory (TRI) data provided by the facilities. The fourth and largest facility conducted recent stack tests to determine its emissions. This category has a medium degree of emission estimate uncertainty.

4.4. Mercury Compound Production

4.4.1. Background

Common mercury compounds include mercuric chloride, mercuric oxide, and phenylmercuric acetate. The production processes for these compounds may result in emissions of mercury vapor and particulate mercury compounds at a number of points, including in reactors, dryers, filters, grinders, and in transfer operations.

4.4.2. Emission Estimate

There were no active mercury compound production plants at the time of the 2002 inventory. The former inventory consisted of two plants in New Jersey that emitted 18 kg per year and were less than 1 percent of the total Northeast inventory. They have since been closed.

4.4.3. Methodology for Estimating Emissions

The emissions estimate for this source category represents the facility operator's best engineering judgment. This category has a low degree of emission uncertainty.

4.5. Lime Manufacturing

4.5.1. Background

The leading industrial uses for lime include steelmaking, pulp and paper manufacturing, water purification, soil stabilization, and flue gas desulfurization (Miller, 1993). Calcinating, which involves burning calcium carbonate at a high temperature, is the process through which most of the mercury is released during the manufacturing process. Most of the mercury is released as vapor kiln exhaust. Mercury that exists as an impurity in the processed stone can also be released in vapor form during calcination.

¹⁴ Maine and New York had the only active cement manufacturing plants during the previous inventory in 1998. Maine has one active cement manufacturing plant, but due to controls, mercury emissions from the facility are minimal.

4.5.2. Emission Estimate

There were four lime manufacturing facilities in the Northeast region; two in New Hampshire and one each in Massachusetts and New York. They are estimated to release 4 kg per year or approximately one tenth of 1 percent of the overall inventory.

4.5.3. Methodology for Estimating Emissions

According to USEPA's Emission Factor and Inventory Group (EFIG), the estimated mercury emission factor for lime manufacturing is 5.5×10^{-2} g of mercury per megagram of lime produced.¹⁵ An emission factor for lime manufacturing was estimated using a mass balance approach based on information about mercury content in limestone from 5 operating lime kilns in Wisconsin in 1983 (Miller, 1993). Assuming uniform emissions for each ton of lime produced, the plant emitted 5.53×10^{-5} kg of mercury per ton of lime output. Lime manufacturing has a high degree of emission uncertainty.

4.6. Petroleum Refining

4.6.1. Background

Petroleum refining is a new category added to the inventory in 2002. It was not included in the previous inventory due to a lack of information and uncertainties with emission factors and the mercury contained in crude oil.

4.6.2. Emission Estimate

New Jersey was the only state in the Northeast region to report mercury emissions for petroleum refining, as it alone has refineries. Mercury emissions were estimated to be approximately 28 kg per year or 0.6 percent of the total inventory.

4.6.3. Methodology for Estimating Emissions

The NJ DEP used the 1997 throughput of New Jersey refineries (in pounds) by crude oil origin or description and mean Hg concentration by crude oil origin or description from sampling and testing program carried out by NJ refineries using laboratories of Frontier Geosciences, Inc., and Cebam Analytical, Inc. (Holmes, Michael J., Miller, Stanley J., and Nyberg, Carolyn M. 2002).

4.7. Steel Foundries

4.7.1. Background

Steel foundries manufacture steel castings products, as well as the processing, salvaging, and recycling metals from automobiles. Automobiles are a major source of mercury emissions by means of their switches used for light bulbs, light relays, the anti-lock braking system, and gas pressure gauges. The mercury in these switches is released into the air when they are crushed and/or smelted in the scrap yard. Maine DEP estimates that there are currently 45 metric tons of mercury switches in the current auto fleet of 200 million autos with the potential to remove ~6 to 7 metric tons annually.

¹⁵ 1 megagram is equal to 1,000,000 grams

The auto industry has been decreasing the use of mercury in switches since 1995, therefore the main concern lies within older model autos (Maine Department of Environmental Protection, 2004). The opportunity to recover switches decreases every year as older autos are scrapped before switch removal takes place.

4.7.2. Emission Estimate

There were a total of eight steel foundries reported in the Northeast region during 2002. Several New Jersey sources were estimated to emit 383 kg per year and a single New York facility was estimated to emit 17 kg annually. They account for 400 kg per year or ~9 percent of the total point and area source inventory for the Northeast. This category is the largest source of anthropogenic mercury in the manufacturing sector.

This category is included in the inventory given the significant amount of emissions from a small number of sources; however it is incomplete because not all states in the region provided emissions estimates on these types of facilities. Connecticut does not have steel foundries, so has no emissions from this category; this may be true of the other New England states.

4.7.3. Methodology for Estimating Emissions

All reported emissions are based on state estimates according to stack testing. With the significant amount of mercury emitted from steel foundries a more complete inventory is needed in the Northeast, therefore this category has a very high degree of emission uncertainty.

4.8. Miscellaneous Industrial Processes

4.8.1. Background

This is a new category created for the 2002 Northeast inventory due to an abundant amount of manufacturing sources that could not be categorized under preceding categories. These sources only consisted of one to two sources per category or were unclear as to the manufacturing process. Furthermore, the mercury emissions for these categories were so low that it was unnecessary to create a separate category.

Miscellaneous industrial process sources include boat/airplane production, missile production, wood building products, hydrochloric acid, miscellaneous metal manufacturing, ceramics manufacturing, surface coating, printing, coating, dyeing of fabrics and among other processes in the manufacturing sector.

4.8.2. Emission Estimate

Miscellaneous industrial processes are estimated to emit 3 kg or approximately one tenth of one percent of the entire 2002 Northeast inventory.

4.8.3. Methodology for Estimating Emissions

All miscellaneous source emissions estimates were submitted by the states to NESCAUM for the 2002 inventory summary. This is a wide-ranging category and has a high degree of emission uncertainty.

5. AREA SOURCES

5.1. Overview

Area sources are estimated to emit 1,245 kg per year for the 2002 inventory. This accounts for approximately 27 percent of the total point and area source anthropogenic mercury emission estimates. NESCAUM relied on USEPA's final version 3 of the 1999 NEI and its 2002 draft NEI for area source mercury emission data, in addition to some state specific information. The NEI is based on a national analysis of area source emissions including: residential heating, electric lamp breakage, lamp recycling, general lab use, dental preparation and use, and crematoria. Area source mercury emissions represent county totals for each category per state. Emission estimates for crematoria were allocated differently depending upon whether any specific information on their precise location in a particular state was available. A more detailed discussion of each area source category is presented in each subsection. Please refer to Chapter VII (NESCAUM, 1998) for more detailed background information on these products and processes.

It should be noted that some sources reported as area sources could be tracked as point sources. USEPA provides a set of guidelines to determine what should be included as a major point-source in the NEI. The guidelines state that major sources are those stationary sources that have the potential to emit 10 tons per year or more of one HAP; or have the potential to emit 25 tons per year or more of any combination of HAPs.¹⁶ Sources below these thresholds may still be classified as point sources, although often they are reported as area sources.

5.2. Residential Boilers

5.2.1. Background

Residential boilers are used for heating homes and apartment buildings. As with other boilers, they can burn either coal, gas, or oil. The majority of fuel used is distillate #2 oil. Coal contributes approximately one percent of the residential-boilers fuel use.

5.2.2. Emission Estimate

Residential boilers are categorized as area sources in the 2002 inventory. They emit 715 kg of mercury per year or approximately 15 percent of the total inventory. This category is the third largest source for anthropogenic mercury emissions in the Northeast region.

5.2.3. Methodology for Estimating Emissions

USEPA provided its 2002 area sources preliminary inventory to NESCAUM for the inventory summary. Residential boilers were filtered out of the inventory according to state by using the pollutant code for mercury. Once these sources were separated from

¹⁶ Information provided by USEPA's 1999 Point Source NEI Documentation; section 3.0

the entire 2002 inventory the SCC code was used to extract all residential boilers and their fuel types, coal and oil. Oil accounted for most of the residential boiler inventory. The emissions were based on consumption levels by fuel type for the year 2000 as provided by the Energy Information Administration (EIA).

Mercury emission estimates for oil combustion in residential boilers were based on the emission factors cited above for oil use in commercial and industrial boilers. Residential boilers were assumed to lack emission control devices. Oil consumption in residential boilers was estimated on a state-by-state basis. The resulting emissions estimate is considered highly uncertain for reasons similar to those described for oil-fired utility and non-utility boilers (i.e. emission factors based on test data from a limited sample of boilers).

5.3. Fluorescent Lamp Breakage¹⁷ and Recycling

5.3.1. Background

In the draft 2002 NEI, USEPA estimates that 79 percent of discarded lamps go to landfills and 21 percent go to recycling plants.

5.3.2. Emission Estimate

Mercury emissions from fluorescent lamp breakage and lamp recycling in the region are estimated to be 227 kg/yr, which represents approximately 5 percent of the total estimated inventory for emissions in the Northeast. Electric lamp *recycling* emissions are estimated to be less than 0.001 percent of the overall inventory.

5.3.3. Methodology for Estimating Emissions

In 2002, national estimates of lamp disposal were 660 million lamps. On average, each lamp was estimated to contain ~12 mg of mercury, reflecting a 50% decrease from lamps discarded in the late 1990s.. Population was used as a surrogate to apportion the national totals to each state. To calculate state-level mercury emissions from fluorescent lamp breakage, it was assumed that 79% of the total lamps discarded were sent to landfills and 21% were recycled¹⁸. Of all the lamps discarded, this inventory assumes that 25% of the mercury contained in the lamps is released into the atmosphere based on a study by the NJDEP (Aucott *et al.*, 2003). In contrast, EPA's NEI assumed that 6.6% of the Hg in lamps is released. This category's emissions are based largely on the New Jersey DEP study and have a high degree of uncertainty.

¹⁷ Mercury is also present in certain high-intensity, specialty lamps. However, the quantities of mercury involved are relatively small compared to fluorescent lamps. Lamp breakage so dominates the emissions that these two categories were combined in this inventory.

¹⁸ Vermont and Maine supplied state specific recycling rates of 65%. Lack of information for other state specific waste management programs may impact the accuracy of these emissions estimates.

5.4. General Laboratory Use

5.4.1. Background

Mercury is found in laboratory instruments, and is used in experiments as a catalyst.

5.4.2. Emission Estimate

The draft 2002 emission inventory estimates that approximately 58 kg of mercury are emitted in the Northeast from laboratory use each year. This represents just over 1 percent of the total regional inventory.

5.4.3. Methodology for Estimating Emissions

The USEPA assumes an emission factor of 40 kg of mercury emitted for each metric ton of mercury used in laboratories, which is documented in US EPA's 1997 Mercury Study Report to Congress, Volume II: An Inventory of Anthropogenic Mercury Emissions in the United States. National scale mercury use in laboratories was estimated by the US Geological Survey and reported in the draft 2002 NEI. This category has a high degree of emission uncertainty.

5.5. Crematories

5.5.1. Background

Most of the mercury emitted from crematories is released due to the incineration of amalgam tooth fillings. Given the useful life of these fillings (reflecting dental work ~10 years prior to death) and the trends in amalgam usage in general, emissions from this category may be expected to decline in the future.

5.5.2. Emission Estimate

Mercury emissions from crematories in the Northeast were estimated to total approximately 165 kg/yr. This estimate represents approximately 3.5 percent of the total point and area source emissions in the region's estimated overall inventory.

5.5.3. Methodology for Estimating Emissions

Mercury estimates are based on a California Air Resources Board emission factor of 4.8E-02 lbs mercury per ton body charged, where the average body weight is estimated at 150 pounds (equivalent to 1.63 g/body)¹⁹. Other available literature suggests average mercury emissions of 2.9 grams per cremation, with a range of 0.8 to 5.6 grams (Mills, 1990; Basu and Wilson, 1991; Skare, 1995; Kunzler and Andree, 1991; Nieschmidt, A., and N. Kim, 1997). The number of cremations per state was based on 2002 statistics from the Cremation Association of North America²⁰.

¹⁹ Maine and Connecticut reported slightly different emission factors (within ~10%). For the purposes of this regional inventory, a consistent factor was applied.

²⁰ New Jersey provided its own estimates which differed from CANA. Massachusetts, Maine and Vermont also provided their own estimates, but these were nearly identical to those reported by CANA.

Given the wide range of reported mercury emission factors from crematoria, this category has a high degree of emission uncertainty.

5.6. Dental Preparation and Use

5.6.1. Background

Mercury is used in amalgams for fillings. Initiatives in the northeast have moved forward with requiring amalgam separators in dentist offices to reduce emissions from this source category. In addition, community improvements in dental hygiene and composite fillings have led to a decline in mercury use by dentists.

5.6.2. Emission Estimate

Emissions from dental preparations and use are estimated to total 80 kg per year for 2002, representing slightly less than 2 percent of annual emissions.

5.6.3. Methodology for Estimating Emissions

States provided estimates based on the number of dental establishments and information regarding amalgam usage. The emission factor used accounts only for mercury emissions from spills and scrap during preparation and use.

5.7. Paint Sources

5.7.1. Background

Several mercury compounds have been used as biocides to control microbial growth in interior and exterior paint (USEPA, 1997).²¹ In May of 1991, the registrants voluntarily canceled all registrations for mercury biocides used in paints, and the use of mercury was banned in the manufacturing of paints. However, the phasing out of mercury in paint did not restrict the sale of existing paint inventories or subsequent use by the public. The emission estimate in the national inventory accounts for “off-gassing” over a 7-year period to reflect the fact that pre-regulation paints continue to emit mercury vapors after application. USEPA banned the use of mercury in interior paint in 1990 and in exterior paint in 1991. Under these laws, existing stocks of interior latex paint could continue to be sold until July 1991.²²

The 7-year duration of “off-gassing” of mercury at the time of the 1998 inventory which was actually data from 1996, explains why there are emission estimates for that inventory year. However, the 2002 inventory shows zero emissions from paint sources. Assuming that latex paint has a shelf life of 2 to 5 years, the optimum year latex paint being sold still containing mercury is 1996, and with “off-gassing” mercury emissions would continue until 2003. Perhaps, one explanation for why there are zero mercury emissions for the current inventory in 2002 is that stores did not hold paint on the shelf for the paint’s entire shelf life. They are more likely to sell it quickly to preserve the

²¹ Phenylmercuric acetate, 3-(chloromethoxy) propylmercuric acetate, di(phenylmercury) dodeceny succinate, and phenylmercuric oleate.

²² Barr Engineering Company. Substance Flow Analysis of Mercury in Products. 2001. pp. 71

quality of the paint. Therefore, the duration of the “off-gassing” may have ended before the 2002 inventory.

5.7.2. Emission Estimate

There are no reported emissions of mercury from paint sources in the 2002 inventory. The previous inventory in 1998 contained 633 kg of mercury from paint sources and was approximately 4 percent of the total inventory.

6. CONCLUSIONS

The regional mercury emission inventory presented in this report was developed in part to help the New England Governors and Eastern Canadian Premiers assess emissions reduction progress made since the release of their Mercury Action Plan in 1998. Through aggressive, proactive efforts undertaken by states and provinces, significant reductions in mercury emissions have been made, in fact in excess of the goal of 50% reduction by 2003 (see caveats below). The inventory shows the region is well on its way to achieving its 2010 target of 75% reduction from the 1998 baseline.

According to the refined emission inventory estimates developed by the Northeast states for this study, approximately 4,693 kg of mercury are emitted to the air annually from anthropogenic sources in the region for which emissions data are available. This compares to 15,903 kg from the baseline 1998 inventory. Combustion source emissions represent 59 percent of the current inventory total. Manufacturing sources and area sources account for the remaining 14 and 27 percent balance, respectively.

In large part, the reductions achieved are the result of emissions controls and facility closings for municipal waste combustors and medical waste incinerators. Future reductions will be achieved in New England as Massachusetts, Connecticut, New Jersey, and New Hampshire have all adopted mercury emissions control requirements for coal-fired power plants that will go into effect over the next decade. Absolute comparisons of total emissions between the baseline inventory and the 2003 inventory are problematic due to a variety of factors. These include the addition of new categories to the current inventory (e.g. petroleum refineries and steel foundries) and methodological changes (emission factor revisions for fluorescent bulbs and oil combustion). Additionally, the inherent uncertainties in many of the emissions estimates need to be acknowledged in the interpretation of percentages and rankings of source categories.

Despite the significant reductions achieved to date, substantial mercury emissions remain in the region. Over time, new information regarding missing emission sources has come to light. The current available information points to a variety of source categories as candidates for future reductions. Two substantial contributors are SSIs and EGUs. Others are fluorescent lamps (revised) and steel foundries (new). Even with the effective controls placed on MWCs, they continue to represent a large source of mercury emissions in many areas in the region, indicating the need to refocus on waste reduction initiatives.

Although emissions from the combustion of municipal waste dominate the current inventory, new federal and state regulations and existing waste management programs are expected to substantially reduce mercury emissions from this source category. The removal of many mercury-containing products from the waste stream through product reformulation and recycling initiatives will continue to reduce the amount of mercury burned in MWCs. Furthermore, new regulations on combustion emissions are expected to reduce stack emission of this pollutant by 80 percent or more. These programs and others will be necessary for the region to accomplish its ultimate objective of virtual elimination of mercury emissions.

7. RECOMMENDATIONS

Based on the information gaps identified through the inventory development process, the following recommendations are suggested to improve the regional mercury inventory:

- An effort is needed to improve emission estimates for a number of source sectors with highly uncertain estimates, including fuel combustion in the region by commercial, industrial and residential boilers, fluorescent bulbs and crematoria.
- Data are needed to develop inventories for sources that are not currently included in this mercury inventory, such as landfills, hazardous waste sites (including the thermal treatment of contaminated soils), sludge application, residential woodstoves, mobile sources, and high-intensity discharge lamps.
- A systematic approach is needed to periodically update the mercury emission inventory for sources in the United States using new information generated by the activities recommended above.

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Appendix A: NESCAUM's Methods To Estimate Hg Emissions from ICI Boilers

A.1. Energy Information Administration (EIA) Methods

The EIA provides fuel consumption data from 1960 to 2000 for all fuels used by ICI boilers. The majority of fuels used by ICI boilers are distillate oil, residual oil, coal, and wood. A small portion of boilers use natural gas. NESCAUM's method to reflect EIA estimates was to take the 1999 EIA fuel consumption data for each fuel type and apply mercury emission factors to calculate the total mercury emissions. Table A-1 shows the emission factors used in the calculations²³. To account for the point source contribution, point sources were subtracted from the EIA estimate. The remaining emissions represented the area source category.

Table A-1: Emissions Factors Used for 1999 EIA Calculations

Fuel Type ²⁴	Emission Factor
Distillate Oil	3.0E-6 lb/million Btu
Residual Oil	.000113 lb/1000 gallons
Coal	1.6E-5 lb/million Btu
Wood	5.15 E-6 lb/ ton of wood burned

Each state consumes different amounts of fuels; therefore state data were separated in the Northeast region. The EIA-calculated mercury estimates were compared to the 2002 state-reported totals to identify inconsistencies. Distillate oil and coal burning ICI boilers were believed to be severely misrepresented in the current inventory by NESCAUM. Wood and residual fuel EIA estimates were generally similar and fairly close to state reported estimates; therefore these were not modified. The EIA and State emission estimates comparisons can be seen in Table A-2.

²³ Emission factors were found using USEPAs most recent Factor Information Retrieval system (FIRE) version 6.24. Emission factors assume no controls for all boiler types.

²⁴ Emission factors were available in million Btu for coal and distillate oil only. Wood and Residual emission factors were based on 1000 gallons of oil burned and tons of wood burned respectively.

Table A-2: 1999 EIA Hg Estimates* vs. 2002 State Reported Hg Estimates*

	Distillate Oil		Residual Oil		Coal		Wood	
	EIA	State	EIA	State	EIA	State	EIA	State
Connecticut	27.4	1.0	1.6	8.6	110.3	1.3	0.2	0.3
Massachusetts	40.1	36.0	5.4	15.0	741.7	7.0	0.4	0.0
Maine	12.0	10.6	13.9	0.9	49.4	1.5	0.1	14.0
New Hampshire	33.7	15.4	1.9	8.7	1.5	1.1	0.1	0.6
New Jersey	49.4	29.2	3.2	18.3	153.1	0.2	0.2	0.0
New York	138.7	40.4	23.4	6.6	1461.7	39.1	2.4	12.6
Rhode Island	6.0	3.4	1.6	2.1	0.4	0.2	0.1	0.0
Vermont	10.8	4.1	0.6	0.7	14.9	0.3	0.0	1.7
Totals	318.0	140.1	51.6	60.9	2532.9	50.8	3.6	29.2

*All emission estimates are in kg/yr

Tables A-3 and A-4 show the area source comparative factor calculations by state for distillate oil and coal. However, this method was deemed too uncertain to justify a change in the inventory estimate. The emission factors were based on data that did not use controls and some boilers may be employing various control types. Furthermore, the estimates based on EIA consumptions are higher than any other category in the inventory, which is not believed to be the case.

Table A-3: Area Sources Distillate Oil

State	2002 Point Sources	2002 Area Sources	EIA Estimate	EIA - 2002 Point (remaining area sources)	“Comparative Factor”
Connecticut	0	0.98	27.35	27.35	27.90
Massachusetts	25.06	10.98	40.14	15.08	1.37
Maine	0.05	10.57	11.97	11.93	1.13
New Hampshire	1.11	14.27	33.75	32.64	2.29
New Jersey	23.62	5.54	49.40	25.78	4.66
New York	0.26	40.15	138.66	138.40	3.45
Rhode Island	1.43	1.97	5.99	4.56	2.32
Vermont	2.72	1.38	10.75	8.03	5.82

*All emissions estimates are in kg/yr

** Numbers have been rounded slightly

Table A-4: Area Sources Coal ICI boilers

State	2002 Point Sources	2002 Area Sources	EIA Estimate	EIA - 2002 Point (remaining area sources)	“Comparative Factor”
Connecticut	0	1.31	110.31	110.31	84.18
Massachusetts	3.17	3.85	741.71	738.55	191.71
Maine	0	1.52	49.35	49.35	32.46
New Hampshire	0	1.09	1.45	1.45	1.33
New Jersey	0	0.25	153.13	153.13	614.45
New York	33.66	5.44	1,461.66	1,427.99	262.70
Rhode Island	0	0.24	0.36	0.36	1.51
Vermont	3.56	0.27	14.88	14.88	55.50

*All emissions estimates are in kg/yr

** Numbers have been rounded slightly

A.2. National Emissions Inventory (NEI) Methods

NESCAUM’s second attempt to update ICI boiler sources was a comprehensive crosschecking into the 1999 NEI version 3. A significant number of missing sources were identified and a preliminary summary of all boiler sources was constructed. In order to prevent double counts, facility IDs were crosschecked between the NESCAUM inventory and the 1999 NEI. The 1999 NEI was relied on to provide the missing sources by filtering the mercury pollutant code and source classification codes (SCC). This method identified whether or not a source was in fact an ICI boiler with mercury emissions. The pollutant code distinguishes mercury emissions from other pollutants and the SCC code describes the type of fuel use i.e. coal, distillate/ residual oil, or wood. If the source met the filtering requirements and was not a double count, it was added to the inventory.

This method, however, did not meet NESCAUM’s requirements to attempt to construct an accurate inventory. The sources that had been identified as missing could not be confirmed as still active in time for NESCAUM to start the modeling process.