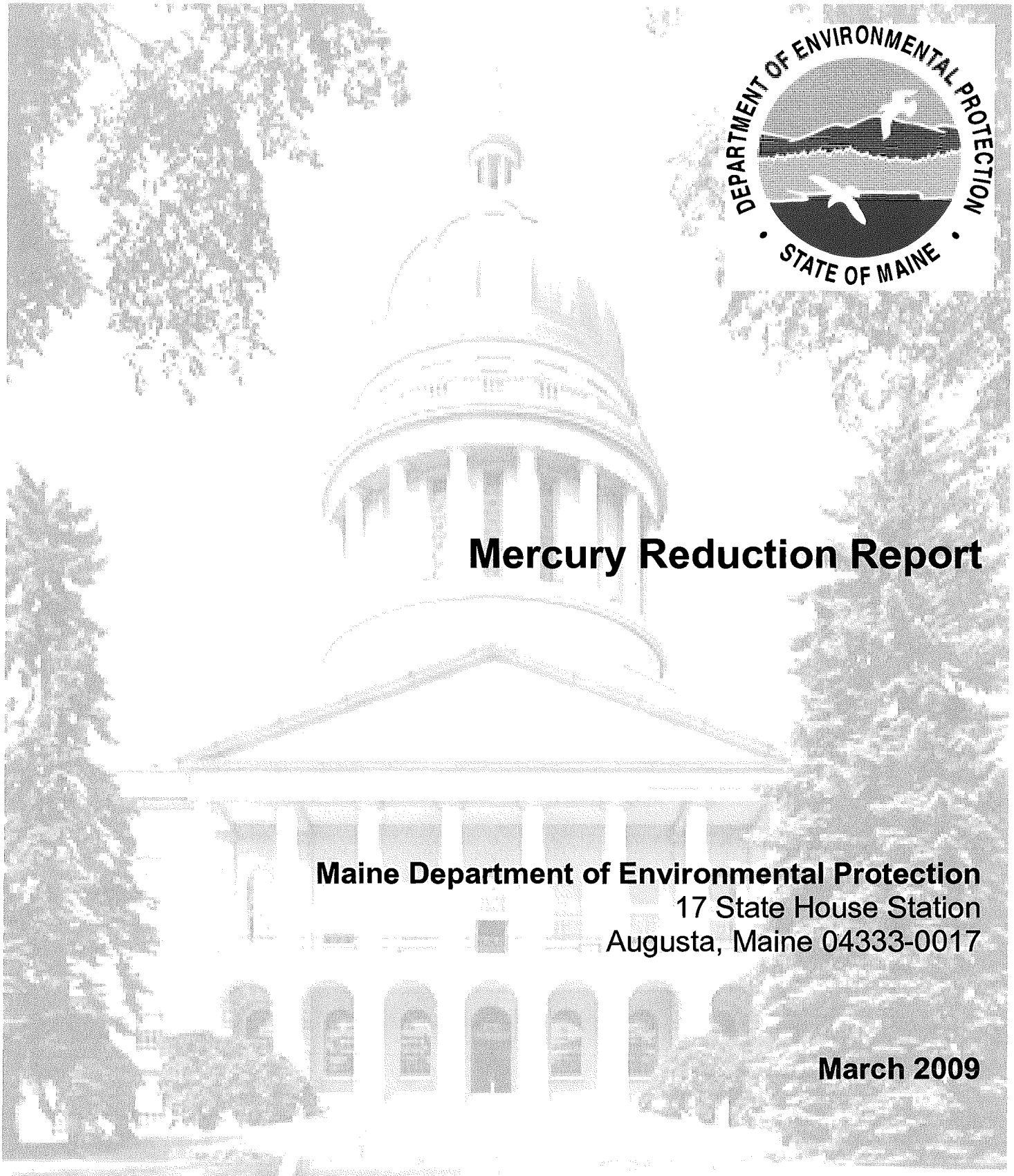

Mercury Reduction Report

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1. Executive Summary

1.1 Legislative Requirement

The Maine Department of Environmental Protection (the Department) is submitting this report to the Joint Standing Committee on Natural Resources pursuant to 38 M.R.S.A. §585-B, as amended by Public Law 2005 Chapter 590, which requires the Department to develop and submit a report on mercury emission reduction efforts by March 1, 2009.

1.2 Summary

Mercury, a naturally occurring element with serious toxicological effects on human health and the environment, is emitted from a variety of sources in Maine. Recognizing the significant public health and environmental threat posed by mercury emissions, the Maine Legislature enacted Public Law 2005 Chapter 590 on April 14, 2006 which established stringent new limits on mercury emissions from air emissions sources. These limits (38 M.R.S.A. §585-B (5)) include a mercury emission limit of thirty-five (35) pounds per year (lb/yr) after January 1, 2007, which decreases to twenty-five (25) pounds per year after January 1, 2010. In addition, this law (38 M.R.S.A. §585-B (6)) requires those sources emitting more than ten (10) pounds of mercury per year after January 1, 2007 to submit mercury reduction plans to the Department detailing their efforts to reduce mercury emissions, and whether additional emission reductions can be cost-effectively achieved.

Maine has been very successful in reducing mercury emissions through the implementation of legislation, regulations, pollution prevention practices and voluntary commitments such as the New England Governors Eastern Canadian Premiere's Mercury Action Plan. Mercury emissions from a wide variety of sources ranging from large industrial facilities to consumer products have been reduced through closure of the Holtra Chem chlor-alkali plant, closure of all medical waste incinerators, add-on controls at a variety of facilities, alternate technologies to replace medical waste incinerators, product substitution and recycling. For example, mercury emissions from municipal waste combustors (MWC) in Maine are now limited by regulations that are more stringent than the federal standard, and two of Maine's four facilities have installed state-of-the-art controls for capturing and removing mercury from their exhaust streams. Product substitution (e.g. a ban on mercury containing switches, relays and measuring devices) and required recycling of mercury-containing products such as automobile switches, thermostats and fluorescent lamps have also played a role in diverting this waste from municipal waste incinerators and reducing mercury from incineration. Together, these actions have resulted in Maine becoming a national leader in mercury emissions reductions. On an international level, organizations such as the *United Nations Environmental Partnership mercury programme* and the Commission for Environmental Cooperation have been promoting international partnerships to reduce mercury in the environment. In February 2009, 140 world environmental ministers, including the U.S., agreed to enter into a binding treaty by 2013 to reduce global mercury emissions.[1]

Since the enactment of Public Law 2005, Chapter 590 in 2006, the Department has received five responses from sources subject to the mercury reduction plan requirements for sources emitting more than 10 pounds of mercury per year. Three facilities submitted mercury reduction plans

which are summarized in this legislative report: Dragon Products Company, LLC (Dragon); ecomaine; and Penobscot Energy Recovery Company. Two companies, Domtar and Boralex, submitted updated source specific data which demonstrated that their mercury emissions were below 10 lb/yr during 2007. Penobscot Energy Recovery Company's average annual mercury emissions are also below 10 lb/year.

Dragon and ecomaine will be pursuing license modifications from the Board of Environmental Protection to establish alternative emission limits for mercury. Both companies submitted timely and complete air emission license amendment applications to the Department (as specified in Maine statute 38 M.R.S.A. §585-B (5) (B)) that included information to support their arguments for obtaining approval for alternative mercury emission limits.

Ecomaine's and Dragon's mercury emissions are affected by variations in the mercury content of their feedstocks. Ecomaine's emissions are largely dependent on the effectiveness of mercury reduction/removal programs that impact their municipal waste feedstock. However, their facility continues to achieve an average of 90% mercury removal efficiency with their carbon injection system. Similarly, Dragon's mercury emissions depend on the amount of mercury present in the process feedstock (limestone and fly ash) and fuel types (oil, petroleum coke, coal, or tires) that are input into their process, and increase linearly with production increases. EPA is required by March 2010 (under court decree) to revise the nationwide Portland cement manufacturing Maximum Achievable Control Technology (MACT) standard for hazardous air pollutant emissions, including mercury, which may also impact Dragon's mercury emissions. In this report, the Department summarizes the information provided in each facility's mercury reduction plan, including an examination of additional control options and associated costs for ecomaine and Dragon to reduce their mercury emissions.

Based on our review and analyses, the Department recommends the following:

- Retain the existing annual mercury limit provisions - 25lb/yr mercury emission limit beginning January 1, 2010, with the option to apply to the Board of Environmental Protection for an alternative higher emission limit;
- Amend the present statutory annual mercury emission limitation to require all air emission sources to meet either the 25 lb/yr mercury emission limit or achieve ninety percent mercury emission control efficiency by January 1, 2012;
- Amend 38 MRSA §585-B to require any mercury emission source emitting greater than 10 lb/yr to conduct mercury stack testing twice a year for two years, and to submit a mercury reduction plan at the end of the two-year period. The plan must contain the information currently required in the statute and the results of the four stack tests. Results of individual stack test runs may be averaged in accordance with DEP protocols; and
- Require the Department to provide a mercury emissions update report to the Joint Standing Committee on Natural Resources by March 2012.

2. Statutory Requirements

38 MRSA §585-B (5) and (6):

5. Standards for mercury. *Notwithstanding subsection 1, an air emission source may not emit mercury in excess of 45.4 kilograms, or 100 pounds, per year after January 1, 2000; 22.7 kilograms, or 50 pounds, per year after January 1, 2004; 15.9 kilograms, or 35 pounds, after January 1, 2007; and 11.4 kilograms, or 25 pounds, after January 1, 2010. Compliance with these limits must be specified in the license of the air emission source. The board shall establish by rule testing protocols and measurement methods for emissions sources for which the board has not established such protocols and methods for determining compliance with the emission standard for mercury. These rules are routine technical rules under Title 5, chapter 375, subchapter 2-A.*

An air emission source may apply to the board for an extension or modification of the 11.4-kilogram, or 25-pound, limit as follows.

- *A. An emission source may submit an application to the board no later than January 1, 2009 for a 6-month extension of the January 1, 2010 deadline to meet the 11.4-kilogram, or 25-pound, limit. The board shall grant the extension if the board determines, based on information presented by the source, that compliance with the limit is not achievable by the deadline due to engineering constraints, availability of equipment or other justifiable technical reasons.*
- *B. An emission source may submit an application to the board no later than January 1, 2009 for a license modification establishing an alternative emission limit for mercury. The board shall grant the license modification if the board finds that the proposed mercury emission limit meets the most stringent emission limitation that is achievable and compatible with that class of source, considering economic feasibility.*

Pending a decision on an application for an extension or a license modification under this subsection, the 15.9-kilogram, or 35-pound, limit applies to the emission source.

Notwithstanding the January 1, 2000 compliance date in this subsection, a resource recovery facility that is subject to an emissions limit for mercury adopted by rule by the board before January 1, 2000 shall comply with the 45.4-kilogram, or 100-pound, mercury emissions limit after December 19, 2000.

6. Mercury reduction plans. *Any air emission source emitting mercury in excess of 10 pounds per year after January 1, 2007 must develop a mercury reduction plan. The mercury reduction plan must be submitted to the department no later than September 1, 2008. The mercury reduction plan must contain:*

- *A. Identification, characterization and accounting of the mercury used or released at the emission source; and*
- *B. Identification, analysis and evaluation of any appropriate technologies, procedures, processes, equipment or production changes that may be utilized by the emission source to reduce the amount of mercury used or released by that emission source, including a financial analysis of the costs and benefits of reducing the amount of mercury used or released.*

The department may keep information submitted to the department under this subsection confidential as provided under section 1310-B.

The department shall submit a report to the joint standing committee of the Legislature having jurisdiction over natural resources matters no later than March 1, 2009 summarizing the mercury emissions and mercury reduction potential from those emission sources subject to this subsection. In addition, the department shall include an evaluation of the appropriateness of the 25-pound mercury standard established in subsection 5. The evaluation must address, but is not limited to, the technological feasibility, cost and schedule of achieving the standards established in subsection 5. The joint standing committee of the Legislature having jurisdiction over natural resources matters is authorized to report out to the 124th Legislature legislation relating to the evaluation.

3. Background on Mercury and Mercury in Maine

Mercury can be found in two forms, organic and inorganic. Elemental mercury is the shiny dense liquid metal found in thermometers, barometers, and other devices. Small amounts of elemental mercury are used in electrical devices such as batteries and lamps because of its unique electrical properties. Inorganic forms of mercury such as mercuric chloride are associated with chemical reactions of elemental mercury with elements or other compounds. Mercury is converted to organic forms, such as methyl mercury, through the biological activity of microorganisms and enters the food chain when fish and other larger organisms consume them.[2]

3.1 Health Effects of Mercury

Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. The primary route of exposure in humans is through consumption of fish. Research shows that most people's fish consumption does not cause a health concern. However, high levels of methyl mercury in the bloodstream of unborn babies and young children may harm the developing nervous system, affecting a child's cognitive function and ability to learn. Mercury impairs a child's fine motor, language, visual-spatial (e.g. drawing) and verbal memory skills; it may also adversely affect the cardiovascular, immune and reproductive systems of a child.[3] In 1999-2000, EPA research indicated that eight percent (8%) of United States women of childbearing age had levels of mercury in their blood above levels known to cause fetal damage. Recent analyses of maternal studies have indicated that a greater percentage of mercury is distributed to the fetus than previously estimated.[4] The Northeast States for Coordinated Air Use Management (NESCAUM) estimates that, in the Northeastern United States, over 46,000 newborns are at risk for neurological deficits and cardiovascular abnormalities due to mercury[5].

3.2 Ecological Effects of Mercury

Birds and mammals that eat fish are more exposed to mercury than other animals in water ecosystems. Similarly, predators that eat fish-eating animals may be highly exposed. At high levels of exposure, harmful effects of methyl mercury on these animals include death, reduced reproduction, slower growth and development, and abnormal behavior. Mercury levels in Maine fish, loons, and eagles are among the highest in North America[6]. Due to the current mercury levels in fish, the Maine Department of Health and Human Services (MEDHHS) has issued health advisories for consumption of fish caught in Maine[7]. These advisories recommend that pregnant and nursing women, women who may get pregnant, and children under the age of eight (8) not eat any freshwater fish from Maine's inland waters. All other adults and children older than eight should not eat more than two freshwater fish meals per month. For brook trout and landlocked salmon, the suggested limit is one meal per week.[8] MEDHHS has issued similar health advisories for salt-water fish.[9]

3.3 Mercury Contamination in Maine

The economic impacts of mercury contamination in Maine include increased health care costs, loss of productivity, special education costs, and natural resource damages and reduced tourism. Fish consumption advisories and wildlife impacts are at odds with Maine's efforts to promote tourism and aquaculture. Tourism is Maine's largest industry, supporting 77,000 Maine jobs[10] and generating $8.9 billion in sales and $344 million in tax revenue. Maine's image of pristine mountains, quiet lakes, and rugged coast is an integral part of this success.

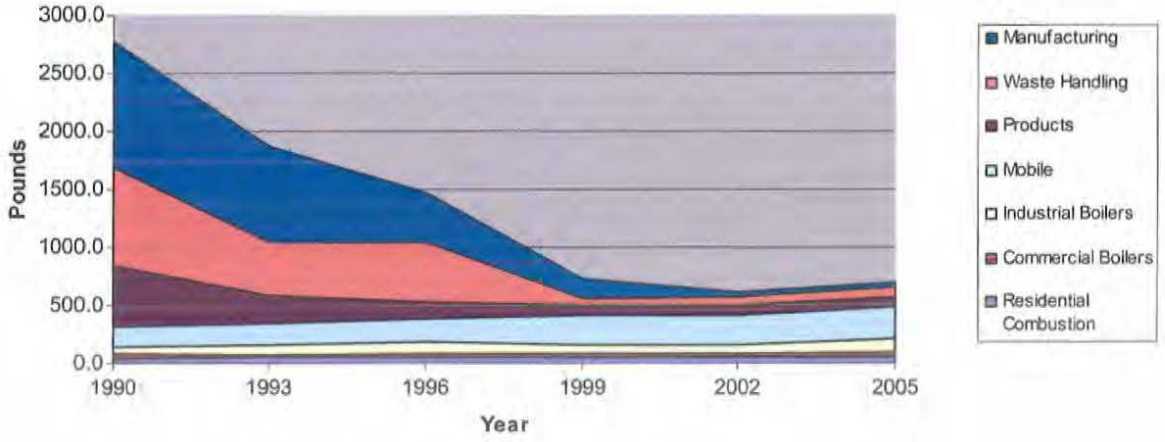
The advisories also undercut efforts to encourage people to eat more fish as a way of reducing the risk of heart disease. In Maine, cardiovascular disease is the leading cause of death. The disease accounts for 29,000 hospitalizations and about 4,000 deaths every year. Advising Maine women of childbearing age and young children to limit their fish consumption therefore has secondary health implications.

3.4 Maine has Significantly Reduced Local Mercury Emissions

Maine has cut in-state mercury releases significantly and worked regionally to cut emissions. The state's municipal waste incinerators have reduced mercury emissions by over 90% and the Department's MWC mercury concentration standard exceeds federal requirements. All medical waste incinerators in Maine have ceased operations. Furthermore, Maine has been a national leader in removing mercury from the waste stream.

Graph 1 illustrates the reduction of mercury in Maine (data from the Department's Mercury Emission Inventory):

Graph 1: Mercury Emissions by Sector



Graph 1 illustrates decreases in mercury emissions from 1990 to 2005. This is the result of tighter emission controls on point sources and the removal of mercury from our product waste streams.

Over the past several years, the Maine Legislature has passed laws that:

- Ban the sale of most mercury-added products including all mercury switches, relays, thermostats, thermometers and other measuring instruments by July 1, 2006;
- Require fluorescent lamps and other mercury-added products that remain in use and production be recycled when they are removed from service;
- Provide money and technical assistance to help municipalities separate mercury-added products from the waste stream;
- Require automakers to buy back mercury switches they put in cars;
- Require dentists who use mercury amalgam to install separator systems to prevent the discharge of mercury to wastewater; and
- Require all facilities to stay below a 35 lb/year of mercury emission limit which will be further reduced to 25 lb/year in 2010.

4. Mercury Reduction Plans Summary

4.1 Overview

On May 16, 2008, the Department sent outreach letters to the facilities in Table 1, based on estimated mercury emissions for 2002 and 2005. All of the facilities listed responded to the Department, by either clarifying that their emissions were below 10 lb/yr or through the submittal of a Mercury Reduction plan.

Table 1: The Department's mailing list and estimated mercury emissions

	Reporting Year	
Facility Name	**2002** (lb/yr)	**2005** (lb/yr)
Dragon Products Co., LLC - Thomaston	24.1	14.6
ecomaine (formerly RWS)	15.9	22.1
Penobscot Energy Recovery Co.	7.4	7.0
Domtar Maine Corp.	1.4	17.5
Boralex Stratton Energy, Inc.	20.2	13.0
Boralex Ashland	NR	10.8
Boralex Fort Fairfield	12.9	10.0
Boralex Livermore Falls	14.0	9.6

In accordance with 38 M.R.S.A. §585-B(6), facilities with mercury emissions greater than 10 lb/year after January 1, 2007 were required to submit a mercury reduction plan to the Department by September 1, 2008. Formal reduction plans were received from Dragon, ecomaine, and Penobscot Energy Recovery Company (PERC). Dragon estimated their 2007 annual emissions at 12.68 lbs using stack testing data and at 23.37 lbs utilizing a mass balance approach. Ecomaine's estimated 2007 mercury emissions were 17.5 lbs based on stack testing data and 25.2 lbs based on continuous emission monitoring data. These sources submitted plans that fulfill the requirements of the statute. PERC typically has average emissions below 10 lbs/yr. PERC filed a plan discussing the incoming waste to the facility and a possible test variation scenario. Domtar and Boralex provided updated data demonstrating mercury emission levels below 10 lb/yr.

This section includes a summary of the mercury reduction plans focusing on the specific sources, the origin of their mercury emissions, the regulations already in place for mercury control, and the financial analyses of the costs and benefits of reducing the amount of mercury used or released provided by the sources in their plans.

4.2 Dragon Products Company, LLC,

Portland cement is the basic ingredient of concrete. Portland cement is manufactured using limestone, silica, and other materials (calcium, silicon, aluminum, iron, etc.) to which gypsum is added in the final grinding process to regulate the setting time of the concrete. Maine has one Portland cement facility: Dragon Products Company, LLC (Dragon) in Thomaston.

4.2.1 Rules in Place

Dragon is subject to 40 CFR, Part 63, Subpart LLL, *National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry.* On December 20, 2006, EPA reissued the Subpart LLL rule which included emission standards pursuant to section 112(d) of the Clean Air Act for mercury and total hydrocarbons (THC) for new Portland cement kilns. The regulation did not include standards for mercury or THC emissions from existing lime kilns. The D.C. Circuit court remanded the rule *without vacatur* to EPA, and as part of the settlement, EPA will be issuing a new rule addressing mercury, hydrochloric acid and total hydrocarbons from existing Portland cement kilns. The revised rule will be proposed this year with a final rule issued by March 2010.

4.2.2 Process Description

The Dragon facility, which manufactures Portland cement using a dry process, consists of a single pre-heater, pre-calciner cement kiln and an in-line raw mill. Associated processes include quarrying, raw material processing, and finished material processing.

Limestone is the primary raw material, quarried on-site. Additional raw materials include iron ore, recycled waste clinker, sand, utility fly ash, and other miscellaneous permitted raw material. Fuel includes coal, #2 and #4 fuel oil, specification and non-specification waste oil, whole tires and tire chips, and petroleum coke.

Limestone, iron ore, sand, recycled waste clinker and other raw materials are combined in the raw mill, ground, and stored in the raw feed blend silo. Recycled cement kiln dust (CKD) is mixed with the raw meal in the blend silo and is fed to the pre-calciner. From the pre-calciner, utility fly ash is mixed into the kiln feed prior to being fed to the rotary kiln. Clinker discharged from the kiln is cooled in a clinker cooler, transferred to clinker storage, then sent to the finishing mills to be combined with gypsum, cement kiln dust from the facility's cement kiln dust pile and other additives to make Portland cement.

4.2.3 Mercury Emissions

Dragon calculated mercury emissions using two different methods: stack test data and mass balance. The stack test calculations were based on stack testing results from April 2005 and calculated using 2007 operating hours as listed in Table 2. The mass balance calculation used data from periodic analysis of the raw materials and fuels used in the cement kiln, in addition to the clinker exiting the kiln. Dragon currently recycles all cement kiln dust captured in the air pollution control devices, so mercury can only leave the kiln process as part of the clinker, which

is the cement kiln's product, or as stack emissions. The results of the mass balance calculations are listed in Table 3.

Table 2: Dragon 2007 Estimated Hg Emissions Using Stack Test Data[11]

Operating Scenario	2005 Measured Stack Emissions (lb/hr)	2007 Annual Operating Hours	2007 Total Mercury Emissions (lb/yr)
Raw Mill On	0.00138	5151.4	7.11
Raw Mill Off	0.00823	676.5	5.77
			Total: **12.68**

Table 3: Dragon 2007 Estimated Hg Emissions Using Mass Balance[12]

Process Stream	No. of Samples	Range of Hg Conc. (ppm)	Average Hg Conc. (ppm)	2007 Usage (tons)	Average Hg Quantity (lb/yr)
Low Rock	4	0-0.02	0.013	236,561	5.91
High Rock	4	0-0.04	0.023	203,614	9.16
Mg Rock	4	ND* (= 0.01)	0.010	415,834	8.32
Iron Ore	4	0.04-0.07	0.053	8,999	0.94
Sand	4	ND* (= 0.01)	0.010	105,563	2.11
Foundry Sand	3	ND* (= 0.01)	0.010	692	0.01
OCS	1	ND* (= 0.01)	0.010	1,256	0.03
Perlite	2	ND* (= 0.01)	0.010	0	0.00
CKD Pile	4	0-0.07	0.058	0	0.00
CLK Pile	4	0-0.02	0.015	41,708	1.25
Fly Ash S (from Schiller Station in NH)	3	0.41-0.51	0.457	9,800	8.95
Fly Ash C (from Bucksport facility)	4	0-0.29	0.173	5,314	1.83
Slag	3	ND* (= 0.01)	0.010	12,624	0.25
Coke	4	0-0.02	0.013	58,548	1.46
					Total Input: 40.24
Clinker (product)	4	0-0.02	0.013	674,939	16.87
					Emissions (Total Input less Clinker): **23.37**

* Note: Table 3 assumes non-detect (ND) equals 0.01 ppm (half the detection level of 0.02 ppm)

4.2.4 Mercury Controls and Costs

Dragon reviewed control options for further mercury reduction as part of their mercury reduction plan. These options included: feed rate controls, activated carbon injection, wet scrubber, and recycled cement kiln dust (CKD) removal. The control options and associated costs estimated by Dragon are described below:

- ***Feed Rate Controls*:**

Reducing raw material input or using fuel substitution for substances containing mercury could reduce mercury emissions.

  - ***Limestone***

    Limestone, the primary feed material in Portland cement production, has been shown to be a large contributor of mercury. Dragon quarries three types of limestone on site: low rock, high rock, and magnesium rock. Dragon asserted that it would be infeasible to switch their limestone source based on mercury content, since the limestone would have to be transported from elsewhere and would make further operation at Thomaston impractical.

  - ***Iron Ore***

    Iron ore supplements the iron content in the process. Dragon uses off-site iron ore, so switching iron ore may be feasible. However, it has been calculated to be only 2.3 to 4% of the mercury fed to the kiln.

  - ***Reclaimed Clinker***

    Re-claimed waste clinker from the on-site waste clinker pile is used as an additional raw material source. The mercury content represents 3.1 to 3.5% of the detectable mercury feed. Eliminating the use of waste clinker would increase the use of limestone used at the site. Dragon is also required by the Department's solid waste Orders to actively reclaim the waste clinker until the area is returned to wetland (for another 7 to 10 years).

  - ***Fly Ash***

    Dragon uses fly ash as an alternative raw material to shale or clay. The fly ash is currently obtained from two sources: Schiller Station in Portsmouth, New Hampshire and the Verso mill in Bucksport, Maine. Fly ash represents a significant portion of the estimated mercury fed into Dragon's process, therefore replacing it with an alternative raw material is a potential mercury reduction option. However, Dragon asserted that if shale and/or clay replace the present fly ash, it may result in higher total hydrocarbon emissions. Shale and clay have a higher organic content than fly ash and would necessitate additional fuel consumption in the kiln to remove the organic carbon. Those materials also require more grinding and crushing during processing than fly ash. It may be possible, however, to replace the Schiller fly ash with a fly ash from a different source that has lower mercury content.

  - ***Other Raw Materials***

    Dragon is allowed to feed sand, foundry sand, oil contaminated soil, perlite, and slag into the process. The mercury analysis did not detect mercury in these components.

- *Fuels*

  Petroleum coke is currently the main fuel fired at Dragon with a mercury content of non-detect to 0.02 ppm. The facility also has the potential to fire coal (mercury content range from 0-1.3 ppm). To reduce mercury further, Dragon would need to switch to a different fuel such as natural gas.

- ***Activated Carbon Injection:***

Using activated carbon injection, the mercury is adsorbed on to injected carbon, which is then removed from the process. The cost associated with activated carbon is estimated by EPA to be $761,000 to $5.5 million per kiln[13] with an annual cost of $477,000 to $3.7 million[14].

- ***Wet Scrubbers:***

Wet Scrubbers are not widely used to control mercury. Five cement kilns in the United States utilize wet scrubbers for SO_2 emission control, but there is insufficient data on control efficiency for mercury. EPA has stated that there is "a reasonable basis that wet scrubbers remove oxidized mercury from cement kiln emissions"[15]. Using EPA's best-case efficiency of 42%, and EPA's estimated annualized cost of a wet scrubber system of $1.5 million per year [16], Dragon estimated a mercury emission control cost of $226,500 per pound of mercury controlled.

- ***Cement Kiln Dust (CKD) Removal:***

Cement kiln dust consists mostly of clinker dust and small amounts of raw material which is usually recycled back into the kiln. Studies have shown that some mercury adsorbs on the CKD captured in the air pollution control devices. The annual cost for the replacement of CKD (which is used as a raw material) and the disposal of the additional solid waste generated is estimated by EPA to be $3.7 million. [17]

Table 4 compiles the control technology information and its associated costs.

Table 4 : Cost Calculations Based on Emission Estimates [18]

Control Technology	Estimated Annualized Costs ($)	Uncontrolled Mercury Emissions*	Assumed Control Efficiency	Controlled Mercury (lb/yr)	Cost per pound Mercury controlled ($/lb)
Activated Carbon Injection (low range estimate)	$477,000	16.88	80%	13.51	$17,097
Activated Carbon Injection (High Range Estimate)	$3,700,000	16.88	80%	13.51	$132,617
Wet Scrubber	$1,542,000	16.88	42%	7.09	$105,275
CKD Removal	$3,700,000	16.88	100%	16.88	$106,094

* assumes non-detect feed analyses are ½ the detection limit

Dragon submitted a license application for an alternative mercury emission limit of 50 lb/yr. Dragon cited that their emissions can be calculated in a variety of ways: stack tests, mass balance, and mercury CEMS (a trial with CEMS was performed in the fall of 2008). A range of results occur depending on the method used, although Dragon's current license specifies that stack testing must be used to determine compliance with mercury emission limits. Using the CEMS data and the operating hours for 2005, 2006, and 2007, the estimated annual emissions were 37.5 lb/yr, 31.5 lb/yr, and 30.5 lb/yr respectively. In accordance with 38 M.R.S.A. 585-B (5), review of Dragon's license application will be subject to standard procedures for license amendments for sources subject to Title V of the Clean Air Act, including an evaluation of control options, the technical and economic feasibility of each option, and an opportunity for public input.

4.3 ecomaine

Municipal waste combustors (MWC) burn solid waste brought in to the facility from various municipalities and communities. Mercury emissions from MWCs are a function of the mercury in the waste collected. Because of this, mercury emissions vary depending on what is put in the waste stream at any given time. Annual emissions are estimated from MWC facilities based on a stack test average mass rate and then multiplied by the average operating hours of the facility. Ecomaine submitted a mercury reduction plan to the Department based on 2007 mercury emissions above 10 lb/year. Ecomaine also submitted an alternative mercury limit amendment application.

Background: There are two types of MWC in Maine: mass burn and refuse derived fuel (RDF). A mass burn facility, such as ecomaine in Portland and the Mid Maine Waste Action Corporation facility in Auburn, uses all trash delivered without preprocessing, except for unacceptable wastes. Any mercury released during the destruction of mercury-containing materials is limited by emission controls (activated carbon injection) in place at the facility. A RDF facility, such as Penobscot Energy Recovery Company (PERC) in Orrington or the Maine Energy Recovery Company in Biddeford, separates out metals and non-combustible materials through front-end processing. The preprocessed material is recycled or deposited in landfills. ***Note: Materials sent to the landfill may contain mercury that, when agitated at the landfill via waste distribution and compaction, will be released directly to the air without the benefit of emission controls.*** [19,20] ***This report focused on direct facility emissions and not on these indirect emission sources.*** The Mid Maine Waste Action Corporation and Maine Energy Recovery Company facilities reported mercury emissions less than 10 lbs per year.

4.3.1 Rules in Place

In addition to the limitations on mercury emissions in statute, 06-096 CMR Chapter 121 (Emission Limitations and Emission Testing of Resource Recovery Facilities) is applicable to Maine's MWC facilities. This regulation has more stringent limitations than the federal rules promulgated in Title 40 of the Code of Federal Regulations (CFR) Part 60 Subpart Cb (*Emission Guidelines and Compliance Times for Large Municipal Waste Combustors constructed on or before September 20, 2004*), Subpart Eb (*Standards of Performance for Large Municipal Waste Combustors for which construction commenced after September 20, 2004 or for which modification or reconstruction commenced after June 19, 1996*), and Subpart BBBB (*Emission*

Guidelines and Compliance Times for Small Municipal Waste Combustion units constructed on or before August 30, 1999). Subpart Cb contains a mercury emission limit of 0.050 micrograms per dry standard cubic meter (mg/dscm) at 7% O_2 or 85% removal by weight at 7% O_2, whichever is less stringent. The Department's regulation, 06-096 CMR Chapter 121, contains a mercury limit of 0.028 mg/DSCM (micrograms per dry standard cubic meter) at 7% O_2 or 85% removal by weight at 7% O_2, whichever is less stringent.

4.3.2 Process Description

Ecomaine operates two mass burn MWC units, each rated at 275 tons per day. Incineration of solid waste releases mercury and produces mercuric chloride ($HgCl_2$) and mercury oxide (HgO), which are formed in the presence of chlorides released from plastics. Emissions are controlled through the use of an electrostatic precipitator (ESP), selective non-catalytic reduction (SNCR), dry scrubbing, and an activated carbon injection system. The main mercury controlling technology involves the injection of powdered activated carbon into the exhaust gas of each boiler prior to the spray dryer. Mercury and mercury compounds in the exhaust gas are adsorbed onto the activated carbon, which is then removed in the ESP.

Ecomaine is required to maintain a minimum amount of carbon injection. Compliance with the mercury emission limit is demonstrated by annual stack testing. The mercury controls currently in place at ecomaine remove mercury in excess of 85% of the inlet; and in fact ecomaine averages over 90% control.

4.3.3 Mercury Emissions

Table 5 lists ecomaine's submitted mercury emissions data from the facility over the last two decades and illustrates the variability in ecomaine's annual mercury emissions. Except as noted, annual emissions were calculated using one annual stack test result from each year and an assumption of 8760 hours per year operating time.

Table 5: ecomaine calculated Hg emissions [21]
Combined Boilers (A&B) Stack Test Data @ 100% uptime (8760 hr/yr)
550 tons/day mass burn facility

	1989	1990	1999	2000	2001	2002	2003	2004	2005	2006	2007	Ave (post 2000)
Hg emissions lb/yr	717	467.4+ 399.5	147.0	24.7	12.8	48.5	62.7	31.6	29.6	14.4	17.5^ 25.2*	30.2
% Hg Removed	N/A	N/A	N/A	91.5	92.3	87.7	90.7	90.6	93.5	90.2	87.8	90.5%

Notes:
+ Two tests performed in 1990
° Activated Carbon installed (2000)
* Based on CEM Hg data
^ Based on Stack Test Hg data

Continuous Emission Monitors. A five week comparison study was performed at ecomaine in the fall of 2007 using a Continuous Emission Monitoring System (CEMS) for mercury and stack

test results. The mercury CEMS used probe technology to calculate real time mercury emission rates. As seen in Table 5 for the year 2007, stack test results produced an estimated 17.5 lb/yr and the mercury CEMS produced an estimated 25.2 lb/yr. The mercury CEMS technology ecomaine operated during that time period was developed to measure mercury from coal fired power plants and not municipal waste combustion facilities, and ecomaine asserts that calibration ranges and probe saturation issues may have caused unreliable emission data.

Education and Outreach. In addition to using activated carbon control, ecomaine has taken other steps to reduce mercury emissions, including a proactive involvement in mercury educational outreach to reduce mercury coming into the facility in the waste. Various approaches include press releases, pamphlets, brochures, frequently asked questions (FAQ) sheets, handouts, and area newspaper reports. Ecomaine has also been involved in several mercury household collection programs and has had a communications specialist at the facility since 2005. Ecomaine estimated an expenditure of $500,000 to $750,000 on the topic of mercury education outreach over the past decade.

Research. Ecomaine has also performed research studies on the following: *Continuous Emissions Monitoring System for Mercury Report* (January 2008), *Pilot Study Investigating Maine's CFL Take-back Program* (February 2008), *Mercury Controls Analysis Literature Search* (June 2008), *Feasibility Study on Mercury Control* (August 2008), *Mercury Reduction Plan* (September 2008), and *Mercury Waste Characterization Report* (October 2008). [22] These reports have increased the mercury emission knowledge of the facility.

4.3.4 Mercury Controls and Costs

As part of the submitted mercury reduction plan, ecomaine presented current ongoing activities as mentioned above, and researched additional controls to further reduce mercury emissions. The control options considered were: sodium tetra-sulfide, amended silicates, MerCAP Sorption on Gold, COHPAC (Compact Hybrid PArticulate collector), and wet scrubbers. Ecomaine noted that although there has been a lot of research in coal-fired utility boilers and some on waste combustor facilities, the removal of mercury and its compounds from the exhaust is complicated by factors such as low exhaust concentrations, difficulty controlling elemental mercury as a gas, and frequent reactions with other flue gas constituents. The control options and associated costs identified by ecomaine are described below and presented in Table 6:

- ***Sodium Tetra-Sulfide:***

Sodium tetra-sulfide (Na_2S_4) builds on activated carbon systems as an additive, but is not currently used in the United States. Injected Na_2S_4 produces elemental sulfur and ionic sulfide forms that combine into more thermally stable compounds. Cost information is not available because it is not used widely (and not at all in the U.S.). The limitations include an inability to control all species of mercury and it can leave a strong odor of hydrogen sulfide in the ash. The Na_2S_4 must be imported from Europe and it may require special handling. During discussions with the vendor, ecomaine reported that the vendor would not give a removal efficiency guarantee.

- ***Amended Silicates:***

Chemically impregnated silicates to adsorb or chemisorb mercury are in the early stages of development with EPA and Department of Energy (DOE) funding. The sorbent is a

clay based silicate amendment with a metal sulfide that theoretically serves as a substitute for carbon. Due to the lack of performance data and the fact that it is not yet commercially available, ecomaine determined that amended silicates are not an option.

- ***MerCAP Sorption on Gold:***

A process has been in development called MerCAP (Mercury Control Adsorption Processes) which involves placing a rigid mercury-adsorbing sorbent coated structure with parallel plates in the exhaust duct. The sorbent material is sited on the precious metal gold which coats the plates where the mercury is attracted to the sorbent. The MerCAP sorption on gold is not commercially available and ecomaine determined that it is not an option.

- ***COHPAC (Compact Hybrid PArticulate Collector):***

The COHPAC is either a stand alone baghouse or it can augment an existing electrostatic precipitator (ESP). The COHPAC technology is particularly effective for aging ESP applications. By combining an ESP that utilizes carbon injection with a baghouse, a facility can control inorganic mercury as well as elemental mercury. The cost of COHPAC ranges from $4-$10 million dollars for installation and labor for two units.

- ***Wet Scrubber:***

Wet scrubber technology usually involves capturing sulfur dioxide, but it has been used to reduce mercury emissions by bringing the flue gas into contact with the scrubbing liquid. Published data shows that wet scrubbers are effective in removing inorganic mercury but not as effective with elemental mercury. However, inorganic mercury may reappear through a series of reactions in the scrubbing process.

Table 6: Summary of ecomaine's Mercury Reduction Control Technology Study[23]

Feasible Technology Alternative	Improved Hg Removal?	Commercially Available?	Cost to Implement
Sodium Tetra-sulfide	Possible	No	Indeterminate
Amended silicates	No evidence available	No	Speculative cost
MerCAP Sorption on Gold	No evidence available	No	Indeterminate
Baghouse (w/o ESP)	Marginal Improvement	Yes	High Cost ($7-10 million dollars)
COHPAC I (baghouse w/ESP)	Marginal Improvement	Yes	High Cost ($7-10 million dollars)
COHPAC I (baghouse in ESP)	Marginal Improvement	Yes	High Cost ($4-6 million dollars)
Wet Scrubber	Unchanged	Yes	Indeterminate

Ecomaine submitted an application for an alternative mercury limit of 25 lb/year or 85% reduction. Ecomaine continues to participate in pollution prevention, recycling and mercury elimination efforts, but mercury emissions continue to hover around 25 lb/year. In accordance with 38 M.R.S.A. 585-B (5), review of ecomaine's license application will be subject to standard procedures for license amendments for sources subject to Title V of the Clean Air Act, including

an evaluation of control options, the technical and economic feasibility of each option, and an opportunity for public input.

4.4 Penobscot Energy Recovery Company

Penobscot Energy Recovery Company (PERC) submitted a mercury reduction plan to the Department based on 2007 mercury emissions above 10 lb/year. Based on annual stack tests, PERC is expecting to continue to be under the 25 lb/year limit.

4.4.1 Process Description

PERC is a RDF facility with two combustor units each rated at 360.5 tons per day of RDF, each controlled by a dry scrubber and fabric filter baghouse. A RDF facility separates metals and non-combustible materials including grit, glass, and other items through front-end processing. The preprocessed material residue is recycled or deposited in landfills. As mentioned in Section 4.3, there is a potential for mercury-containing items to release uncontrolled mercury due to waste distribution and compaction activities.

For the last four years, emissions have been calculated as shown in Table 7. In 2007, mercury emissions measured from one stack test run were significantly higher than the other two. Therefore, PERC submitted a mercury reduction plan pursuant to 38 M.R.S.A. §585-B (5)(B).

4.4.2 Mercury Emissions

Table 7: PERC Calculated Hg Emissions[24]

Year	lb/hr (based on stack tests)	Operating Hours	lb/yr
2005	0.0009	7791	7.0
2006	0.0009	7702	6.9
2007	0.0018	7926	14.3
2008	0.0003	8070*	2.4

* estimated based on year being almost complete when numbers submitted.

PERC is meeting the current standard of 35 lb/year and is expected to meet the future standard of 25 lb/year.

4.4.3 Mercury Controls and Costs

PERC's mercury reduction plan consisted primarily of an outreach program designed for its area communities to keep waste that is high in mercury out of PERC's incoming fuel streams. PERC proposed the following timeline to distribute various education materials, including those found on State and EPA websites:

- By March 31, 2009, each town will receive a letter advising of the need to remove mercury from the waste stream and listing items that are prohibited from disposal in ordinary trash;
- By June 30, 2009, one or more poster(s) will be developed with information on mercury removal, to be posted at the member communities' town offices and transfer stations; and
- By August 30, 2009, pamphlets will be made up with information on the proper disposal of mercury containing items, to be sent to the member communities to be available to interested citizens.

As directed by a letter dated March 23, 2006 from the Natural Resources Committee, the Department will continue to work with PERC, and other sources, to establish a feasible averaging and stack testing protocol to address operating variations.

4.5 Domtar and Boralex

The Department identified facilities that may be subject to 38 MRSA §585-B (5) and (6), by using the facilities' annual fuel usage, operating rates and emission factors published by the EPA. Emission factors are factors used to estimate emissions when better information (such as data gathered from continuous emission monitors or stack tests) is not available or when there is limited facility emission data.

Continuous Emission Monitoring Systems (CEMS) for mercury have been developed for some industries, but are not being used on wood fired boilers like the boilers located at the Domtar and Boralex facilities. EPA's emission factors are based on stack testing at representative facilities and can vary significantly from facility specific emission factors calculated using stack test results.

Domtar and Boralex provided data to the Department to support the use of facility specific emission factors or factors more representative of their emissions than the EPA factors, and to demonstrate their annual mercury emissions are below 10 lb/yr.

4.5.1 Regulatory Overview

On September 13, 2004, EPA promulgated the *National Emission Standards for Hazardous Air Pollutants for Industrial /Commercial /Institutional Boilers and Process Heaters* (also known as the Boiler MACT). The rule established a mercury emission limit of 0.000003 pounds per million British thermal units (lb/MMBtu) for large new solid fuel boilers, and 0.000009 lb/MMBtu for existing boilers. By comparison, Boralex Stratton was emitting 0.0000026 lb/MMBtu during its highest mercury emitting stack test while burning construction demolition wood fuel (CDW), below the emission limit for new sources. This rule also required fuel analysis of CDW fuels being burned. The Boiler MACT is now vacated and a new rule is under development. As of January 2009, EPA was in the process of requiring additional testing at several Maine facilities including the Boralex Stratton and Livermore Falls facilities in an effort to gather data to develop emission standards. EPA is planning to propose the revised Boiler MACT rule during the summer of 2009 with a final rule due the following summer.

4.5.2 Domtar

Domtar is a pulp and paper facility located in Baileyville, Maine. Domtar operates a 740 MMBtu/hr capacity boiler (power boiler #9). The boiler's licensed allowed fuel mix includes: biomass, #6 fuel oil with less than 2.5% sulfur, sludge, tire derived fuel, specification waste oil, HVLC (high volume, low concentration gases), LVHC (low volume, high concentration gases), general mill yard waste, oily rags, absorbent material, stripper off gas, and propane. Controls for power boiler #9 consist of a multi-clone and wet venturi scrubber.

Domtar reviewed the emission estimate developed by the Department and updated the 2007 mercury emission estimate using stack test data. Domtar's emissions ranged from 3.8-4.8 lb/yr based on two stack tests conducted in 2005. The Department accepted Domtar's stack testing information, especially since it falls within the same range as similar units in Maine. Domtar's annual mercury emissions are below 10 lb/yr based on the stack test data. Therefore, Domtar did not submit a mercury reduction plan.

4.5.3 Boralex

Boralex operates a number of biomass electric utility boiler facilities in the State. The capacities of the spreader stoker units range from 532-672 MMBtu/yr and each is controlled by a high efficiency electrostatic precipitator.

Boralex tested for mercury as well as other pollutants while burning construction and demolition wood fuel (CDW) as part of its fuel mix. Prior to 2007, the mercury testing at the Boralex – Stratton facility was conducted while burning CDW fuel, resulting in estimated emissions ranging from 9.66 lb/yr – 15.6 lb/yr of mercury, with the mercury emissions decreasing as Boralex improved its CDW fuel quality. Boralex – Stratton has not conducted any recent testing on their present fuel mix which does not include CDW, thus Boralex requested that the Department recalculate Stratton's emissions using mercury emissions from similar boilers and burning similar fuels. Recent testing at the Boralex – Livermore Falls facility showed mercury emissions of 5.82 lb/yr. The Boralex – Livermore Falls facility was the only Boralex facility burning CDW as part of its fuel mix in 2007. CDW fuel comprised 25 percent of the fuel burned at Livermore Falls. Boralex – Fort Fairfield, with the smallest design capacity of the four Boralex facilities, also requested that the Department evaluate the mercury emissions for the Fort Fairfield facility.

Table 8 lists the results of stack testing conducted by the facilities with wood fired boilers.

Table 8: Wood Fired Boiler Stack Test Results

Date	Facility	Boiler capacity MMBtu/ hr	Licensed Fuel includes CDW	Licensed Fuel includes Coal	Mercury Emission Rate (lb/hr)	Mercury Emission Estimate Rate (lb/yr)
June 2005	Domtar - # 9 Power Boiler	740	No	No	*2.8E-04	2.35 (facility = 3.86)
Oct. 2005	Domtar - # 9 Power Boiler	740	No	No	*3.93E-04	3.3 (facility = 4.81)
Feb 2005	Boralex - Stratton	672	**Yes**	No	1.77E-03	*15.6
July 2006	Boralex - Stratton	672	**Yes**	No	1.40E-03	*11.76
Nov 2006	Boralex Stratton	672	**Yes**	No	4.84E-03	*9.66
May 2006	Boralex – Livermore falls	585.9	**Yes**	No	1.2E-03	*6.953
Dec 2006	Boralex – Livermore Falls	585.9	**Yes**	No	3.93E-04	*3.31
July 2008	Boralex – Livermore Falls	585.9	**Yes**	No	4.84E-04	*4.07
June 2007	Boralex - Ashland	585.9	No	No	4.99E-04	4.371
Not tested	Boralex – Fort Fairfield	532	No	No		No recent testing conducted
Jan. 2005	SAPPI – No. 1 HFB	848	No	No	4.53E-04	3.80
Nov. 2007	SAPPI – Westbrook Boiler #21	1074	No	Yes	1.08E-04	0.91
Nov. 2003	New Page – Rumford Unit #6	630	No	Yes- coal only	4.74-04	*3.98
Nov 2003	New Page – Rumford Unit #7	630	No	Yes – Coal & biomass	3.30E-04	*2.77

*based on 350 days of operation

Based on the data above, mercury emissions from wood fired boilers range from 0.000108 – 0.000499 lb/hour. Therefore, mercury emissions for the Boralex - Stratton and the Boralex - Fort Fairfield facilities can be estimated using the Boralex - Ashland mercury emission rate (0.000499 lb/hr Hg) when burning wood fuel only and prorating for boiler size using their design capacity. This results in estimated mercury emissions when burning wood fuel only for Boralex - Stratton of 4.81 lb/year and 3.81 lb/year for the Fort Fairfield facility, both below the 10 lb/year threshold. Boralex - Stratton is required by their air emission license to conduct stack testing for mercury and other metals when accepting CDW as a fuel.[25] CDW is currently combusted only at the Boralex - Livermore Falls facility

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5. Department Recommendations

A reduction of mercury from stationary sources in Maine has occurred over the past decade and most sources in the state can meet the future limit of 25 lb/yr of mercury. Currently two sources, ecomaine and Dragon, are requesting alternative mercury limits.

Based on the Department's review of the information summarized in this report, the Department makes the following recommendations:

- **Retain the existing annual mercury limit provisions – 25 lb/yr mercury emission limit beginning January 1, 2010, with the option to apply for an alternative higher emission limit with the Board of Environmental Protection;**

- **Amend the statute to require all air emission sources to meet either the 25 lb/yr mercury emission limit or achieve ninety percent mercury emission control efficiency by January 1, 2012;**

- **Amend 38 MRSA §585-B to require any mercury emission source emitting greater than 10 lb/yr to conduct mercury stack testing twice a year for two years, and to submit a mercury reduction plan at the end of the two-year period. The plan must contain the information currently required in the statute and the results of the four (4) stack tests. Results of individual stack test runs may be averaged in accordance with DEP protocols. Stack test must be done at least 4 months apart.**

    - This requirement compels facilities to re-evaluate their mercury emissions on a regular basis and to submit a mercury reduction plan containing the requirements outlined in the statute.

- **Reporting Requirement for the Department. By March 2012, provide the Joint Standing Committee on Natural Resources an updated mercury emissions report.**

6. Endnotes

[1] United Nations Environmental Programme, 2/20/09, Historic Treaty to Tackle Toxic Heavy Metal Mercury Gets Green Light, (http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=562&ArticleID=6090&l=en)

[2] ecomaine Mercury Reduction Plan submitted to the Department, dated September 1, 2008. p. 2-2

[3] Woodruff, Tracey J., Daniel A Axelrad, Amy D. Kyle, Onyemaechi Nweke, Gregory G. Miller; America's Children and the Environment: Measures of Contaminants, Body Burdens and Illness, 2nd Ed., US Environmental Protection Agency and National Center for Environmental Economics (EPA240-R-03-001,) February 2003, Pg 59.

[4] An Assessment of the Cord Blood: Maternal Blood Methyl mercury Ration: Implications for Risk Assessment, Alan Stern and Andrew E. Smith. Environmental Health Perspective Volume 111, No. 12, September 2003, pages 1465-1470.

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[7] MEDHHS, 2/20/01Procedure for Developing Fish Tissue Action Levels **PDF** (31K) (This document is only available via a PDF file at: http://www.maine.gov/dhs/ehu/fish/Action Levels Writeup.pdf)

[8] MEDHHS, 2/20/01, WARNING About Eating Freshwater Fish (http://www.maine.gov/dhs/ehu/fish/2KFCA.shtml)

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[11] Dragon Mercury Reduction Plan submitted to the Department, revised December 23, 2008

[12] ibid

[13] 70 FR 72334, December 2, 2005

[14] 70 FR 72335, December 2, 2005

[15] 71 FR 76523, December 20, 2006

[16] 71 FR 76525, December 20, 2006

[17] 71 FR 76524, December 20, 2006

[18] Dragon Mercury Reduction Plan submitted to the Department, August 29, 2008, Appendix B – Control Technology and Financial Analysis Cost Estimates

[19] ISSN 1047-3289 *J. Air & Waste Manage. Assoc.* 55:859-869 Technical Paper: Airborne Emissions of Mercury from Municipal Solid Waste. I: New Measurements from Six Operating Landfills in Florida. Lindbert, Southworth, Bogle, Blasing, Owens, Roy, Zhang, Kulken, Price, Reinhart, Sfeir ©2005 Air & Waste Management Association

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[21] 12/3/08 Memo from Anne Hewes, ecomaine to Lisa Higgins and Kathy Tarbuck, Maine Department of Environmental Protection, RE: Request for Mercury Related Information

[22] ecomaine Mercury Reduction Plan submitted to the Department, dated September 1, 2008

[23] ibid

[24] PERC Mercury Reduction Plan submitted to the Department, dated December 18, 2008.

[25] Boralex Stratton Energy Inc., Part 70 Air Emission License, A-368-70-H-A, http://www.maine.gov/dep/air/licensing/TitleVlicenses/a368ha.pdf