CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

CANADA-WIDE STANDARD FOR MERCURY EMISSIONS FROM COAL-FIRED ELECTRIC POWER GENERATION PLANTS

2010 PROGRESS REPORT

PN 1488

ISBN 978-1-896997-95-7 PDF

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Introduction

This report presents information on the attainment of 2010 emissions caps under the Canada-wide Standards for Mercury Emissions from Coal-fired Electric Power Generation Plants. Only those jurisdictions with coal-fired electric power generation plants are required to report. More information on the Canada-wide standards for mercury may be found on the CCME website at www.ccme.ca.

Summary

In 2006 the Canadian Council of Ministers of the Environment (CCME) endorsed Canada-wide Standards (CWS) for Mercury Emissions from Coal-fired Electric Power Generation Plants. The CWS set targeted caps for each signatory jurisdiction for the year 2010. In 2010 there were 1461.66 kilograms of mercury emitted in total from coal-fired power generation plants in signatory jurisdictions. In 2003, the coal-fired electric power generation sector emitted an estimated 2,695 kilograms of mercury from an estimated 3,725 kilograms of mercury in coal burned.

Province	2008 Mercury Emissions (kg)	2009 Mercury Emissions (kg)	2010 Mercury Emissions (kg)	2010 Emissions Cap (kg)
Alberta	481	579	661	590
Manitoba	9.6	2.8	1.16	20
New Brunswick	41	107	30	25
Nova Scotia	161	140	81.5	65*
Ontario	191	59	87	Not set
Saskatchewan	648	707	601 (credits for early action of 171 kg used to meet cap)	430
Total	1532	1594.8	1461.66	1130

*Nova Scotia's cap for 2010 was changed in provincial regulations to 110kg.

Achievement of 2010 Caps and Review of the Standard

Under the CWS for Mercury Emissions from Coal-fired Electric Power Generation Plants all jurisdictions are to have met their emissions caps by 2010. Several jurisdictions have not yet been able to reduce emissions to the level of the caps, despite best efforts. Those jurisdictions that have not met their cap have articulated the means by which they will meet their 2010 cap in 2011. The CWS is scheduled for review by 2012. Because several jurisdictions are not yet in achievement of the standard, this review has been postponed.

Jurisdiction Reports

The following information was submitted by signatory jurisdictions in accordance with Section 2.1 of the CCME Monitoring Protocol in Support of the Canada-Wide Standards for Mercury Emissions from Coal-Fired Electric Power Generation Plants.

ALBERTA

The seven coal-fired power plant facilities in Alberta are the Battle River Generating Station, the Genesee Thermal Generating Station – Units 1 and 2, the Genesee Thermal Generating Station – Unit 3, the Keephills Generating Plant, the H.R. Milner Generating Station, the Sheerness Generating Station, the Sundance Generating Plant and the Wabamun Generating Station. The Wabamun plant was shut down in early 2010 and Sundance units 1 and 2 in early 2011. With the closure of these units, Alberta will meet the 2010 cap in 2011 as mercury emissions will be reduced by approximately 50 kg.

	Total Mass Mercury		
Facility	**Emissions (kg)**	**In coal burned (kg)**	**Retained in ash and residue (kg)**
Battle River	94.37	124	29.63
Genesee Unit 1&2	129.84	181.6	51.76
Genesee Unit 3	55.54	87.42	31.88
H.R Milner	4.28	20.74	29.367
Sheerness	94.78	125.49	30.71
Sundance	225.9	354.9	129.0
Keephills	41.2	132.2	91.1
Wabamun*	14.9	39.0	Did not calculate
Total	661		

* The Wabamun plant was only operational from January to March 2010.

SHEERNESS

a) Annual emissions of total mercury from each coal-fired EPG plant (kg/year)

	Facility 1	Total
Year	**Hg Emissions to Air (kg)**	**(kg)**
2008	87.62	87.62
2009	108.71	108.71
2010	94.78	94.78

The annual mercury emissions in 2010 as calculated by the mass balance method were 94.78 kg.

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable.

c) Monitoring methods used for all parameters

- Stack Testing and Flow Monitoring (CEMS).
  The protocol of ASTM Method D6784-02 was followed to test for the emission of mercury.
  The Alberta Stack Sampling Code, Method #2, Determination of Stack Gas Velocity and Volumetric Flow Rates.

- Flow and Sample Level Temperature.
  The protocols of methods 1, 2, 3, and 4 of the Alberta Stack Sampling Code were used to test Volumetric Flow and Sample Level Temperature.

- Mass Balance.
  Weekly Mass Balance: Equation 1.1b from the CCME Monitoring Protocol in Support of the Canada-Wide Standards for Mercury Emissions from Coal-Fired Power Generation Plants.

2010 Source Mercury Mass Balance Summary

Category	Metric	Unit of Measure	Annual
Ash Retention	Mercury Retained in Ash	%	24.5%
		kg	30.71
Source Emission	Mercury Emitted to Atmosphere	%	75.5%
		kg	94.78
Coal	Average Mercury Concentration	ppb	53.8
	Total Mercury Mass	kg	125.49
Sales Fly ash	Total Mass Stored	Mg	64,698
	Average Mercury Concentration	ppb	104.9
	Total Mercury Mass	kg	6.60
Raw Fly ash	Total Mass Stored	Mg	288,164
	Average Mercury Concentration	ppb	77.2
	Total Mercury Mass	kg	23.36
Bottom Ash	Total Mass Stored	Mg	121,328
	Average Mercury Concentration	ppb	5.6
	Total Mercury Mass	kg	0.74

d) Justification for alternative methods
Not applicable.

e) Any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action
Not applicable.

f) Mercury speciation
The ASTM Method D6784-02 was followed to test for the emission of mercury.

Summary of Average Mercury Results

Parameter	Unit	Average
Temperature	°C	170
Particle Bound	g/hour	< MDL
Oxidized Mercury	g/hour	3.77
Elemental	g/hour	10.2
Total Mercury	g/hour	13.9

MDL - Minimum Detection Limit

g) Mercury content of coal
Total mercury in coal was 125.49 kg.

h) Mercury content of coal combustion residues, the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues, e.g., to landfill, for sale for cement, etc.

Residues	Mg (dry)	kg (Mercury)	Disposal
Raw Fly ash	288,164	23.36	Engineered landfill
Sales Fly ash	64,698	6.60	Recycled, concrete production
Bottom Ash	121,328	0.74	Engineered landfill

SUNDANCE, KEEPHILLS, WABAMUN - TRANSALTA

a) Annual emissions of total mercury from each coal-fired EPG plant (kg/year)

	Sundance	Keephills	Wabamun	Total
Year	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	(kg)
2008	153.9	22.1	32	208
2009	165.8	29.3	40	229.4
2010	225.9	41.2	15	282.1

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable.

c) Monitoring methods used for all parameters;

- Stack Testing and Flow Monitoring (CEMS)
- Mass Balance (Mass Balance Method was used for Keephills and Sundance)
- Other equivalent method (Wabamun totals are calculated using a method based on the coal burned and the mercury content of the coal from the weekly coal analysis and based on a capture rate of 26% based on existing equipment).

d) Justification for alternative methods
Not applicable.

e) Any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action
Keephills and Sundance mercury data is provided to AENV in annual reports due April 30.

f) Mercury speciation

SUNDANCE

Stack Test Results (Ontario Hydro Method)

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
Sundance 2 (Units 3&4)	June 2000	86.0%	11.5%	2.48%
Sundance 3 (Units 5&6)	April 2004	94.9%	5.1%	0%
Sundance 1 (Units 1&2)	May 2006	77.2%	22.6%	0.26%
Sundance 2 (Units 3&4)	April 2008	83.0%	14.0%	3.00%
Sundance 3 (Units 5&6)	May 2009	86.1%	13.6%	0.3%
Sundance 1 (Units 1&2)	October 2010	74.0%	26.0%	0%

KEEPHILLS

Stack Test Results (Ontario Hydro Method)

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
Keephills Stack1	December 2005	76.0%	23.8%	0.12%
Keephills Stack1	June 2009	86.2%	13.3%	0.46%

No Ontario Hydro Stack Tests were conducted at Keephills in 2010.

g) Mercury content of coal

Sundance – 354.9kg
Keephills – 132.2kg

h) Mercury content of coal combustion residues, the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues

Sundance
124.1 kg (Fly ash)
4.89 kg (Bottom Ash)

At Sundance ~73% of fly ash is disposed of in the mine. The remaining 27% is sold.
Bottom Ash is disposed in the mine.

Keephills
86.0 kg (Fly ash)
5.04 kg (Bottom Ash)

Keephills ash is all transported via pipeline to the Keephills Ash Lagoon. Mercury totals have to be calculated based on ash content of the coal and by using the percentage split that was derived using the Sundance Plant.

All of the data provided above (with the exception of Wabamun) is available in more detail in the Sundance and Keephills 2010 Annual reports submitted to AENV in April 2011.

GENESSEE – CAPITAL POWER

a) Annual emissions of total mercury from each coal-fired EPG plant (kg/year)

	Genesee Unit 1 & 2	**Genesee Unit 3**	**Total**
Year	**Hg Emissions to Air (kg)**	**Hg Emissions to Air (kg)**	**(kg)**
2003			85.00
2008	75.11	29.72	104.83
2009	107.20	51.83	159.03
2010	129.84	55.54	185.38

Note that in 2008, Genesee Unit 1 & 2 had a 49 day outage and Genesee Unit 3 had a 66 day major outage, resulting in lower mercury emissions for the 2008 year.

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable.

c) Monitoring methods used for all parameters;
The annual emissions of total mercury and the capture rate for Genesee were calculated using the mass balance method detailed in the *Canadian Uniform Data Collection Program for Mercury from Coal-fired Electric Power Generation*.

Monitoring Methods Used:

Coal Monitoring Methods	
Component	**Analysis Method**
Sample Preparation	ASTM D2013 and ASTM D3302
Ash Content	ASTM D3174/ASTM D5142
Sulphur Content	ASTM D4239C
Chlorine Content	ASTM D4208
Moisture	ASTM D3174
Mercury	ASTM D6722
Heating Value	ISO 1928
Residue (Fly Ash, Bottom Ash) Monitoring Methods	
Ash Content	ASTM D3174/ASTM D5142
Sulphur Content	ASTM D4239C
Chlorine Content	ASTM D4208
Moisture	ASTM D3174
Mercury	ASTM D6722
Loss-on-Ignition	ASTM D7348
Flue Gas	
Mercury (total and speciation)	Ontario Hydro Stack Test

d) Justification for alternative methods
To determine the accuracy of the calculation used to determine the split between fly ash and bottom ash, a comparison between the amount of ash disposed and sold and the amount of ash calculated using the average ash content of the coal and total amount of the coal combusted was calculated.

Based on the method outlined above, the total amount of ash sold and disposed of was within 10% of the amount calculated using the ash content of the weekly composite coal samples for both Units 1 & 2, and Unit 3.

e) Any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action
Not applicable at this time.

f) Mercury speciation
Mercury and total speciation were sampled as part of the Ontario Hydro Stack Test conducted once a year on each stack (Stack 1 – Unit 1 & 2; Stack 2 – Unit 3). Mercury samples were collected and analyzed following the protocols in the *Canadian Uniform Data Collection Program (UHDCP) for Mercury from Coal-fired Electric Power Generation, January 2003*.

Unit 1 & 2:
Total Mercury = 13.29 g/hr
Particulate Mercury = 0.028 g/hr

Oxidized Mercury = 2.99 g/hr
Elemental Mercury = 10.28 g/hr

On June 21 and 22, 2010, Maxxam Analytics conducted a source emission survey on Unit 1 & 2 Stack at Genesee for mercury speciation in flue gas. On June 15 and 16, 2010, Maxxam Analytics conducted a source emission survey on Unit 3 Stack at Genesee for mercury speciation in flue gas. Stack testing was conducted in accordance with the requirements of the Ontario Hydro Method.

<u>Unit 3:</u>
Total Mercury = 5.11 g/hr
Particulate Mercury = 0.014 g/hr
Oxidized Mercury = 0.023 g/hr
Elemental Mercury = 5.07 g/hr

Please note for 2010, Unit 3: An average of three stack emission tests was used in order to establish the most representative annual mercury emission rate for 2010. An Ontario Hydro stack emission test was conducted on June 15 and 16, 2010. The results of this test provided a mercury flow rate of 5.11 g/hr. In addition to the Ontario Hydro stack survey, two RATA tests using method #30B were completed on March 23 and September 2 and 3. The results of the RATA tests provided an emission rate of 14.84 g/hr and 4.44 g/hr respectively. The average of the three stack tests provided an **annual emissions rate of 8.13 g/hr**. The CCME protocol identifies the sorbent trap method as an alternative monitoring method for mercury. The EPA classifies the sorbent trap method as an alternative to the Ontario Hydro test.

g) Mercury content of coal

Genesee Unit 1 & 2 = 181.60 kg/yr
Genesee Unit 3 = 87.42 kg/yr

h) Mercury content of coal combustion residues, the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues

Total Mercury in Ash (includes fly ash and bottom ash):
Genesee Unit 1 & 2 = 51.76 kg/yr
Genesee Unit 3 = 31.88 kg/yr

Genesee Unit 1 & 2 sell a portion of the fly ash and bottom ash residues for use in concrete production, and the remainder of the ash is returned to the mine to be land filled. The fly ash and bottom ash sold are weighed prior to leaving the site.

In 2010, Capital Power was able to find a suitable buyer for the Unit 3 ash and has sold a small portion of the fly ash and bottom ash (approximately 1% of the total G3 ash) in the 2010 year. As a result of the G3 sold ash, the fly ash and bottom ash split will be calculated the same way as Unit 1 & 2 to be consistent.

According to the EPEA Operating Approval for the Genesee Mine, the ash returned to the mine is to be buried no less than 1.2 meters below the surface of the reconstructed land, and must be deposited as least 1.5 meters above the level of the re-established water table of the reconstructed land.

BATTLE RIVER – ATCO POWER

2010	Mercury Mass (kg)
Total Coal Burned	124
Total Retained in Ash and Residues	29.63
Total Emissions	94.37

a) Annual Mercury Emissions
The annual mercury emissions calculated in 2010 was 94.37 kg for the station.

b) Mercury Capture Rates
The rate of capture, based on captured mercury to total inlet mercury was 23.9%.

c) Monitoring Methods Used for All Parameters

- Mass Balance
- Stack Testing, Ontario Hydro Method

d) Justification for Alternative Methods
Not applicable.

e) Supporting Data
Not applicable.

f) Mercury Speciation (Averages)
Particulate and Oxidized Mercury – 19.6%
Elemental – 80.4%

g) Mercury Content of Coal
Mercury Content was 54.33 ppb
Coal Mass Burned (dry) 2,284,773,000 kg

h) Combustion Residues Mercury Content, Mass and Management Method
Raw Fly ash – 122 ppb – 204,194,000 kg – marketed and landfill
Classified Ash – 127 ppb – 26,687,000 kg – marketed for concrete and other uses
Bottom Ash – 6 ppb – 215,695,000 kg – landfill

HR MILNER

	Total Hg Emissions (kg)	Total Hg in Coal (kg)	Total Hg in Fly Ash (kg)	Total Hg in Bottom Ash (kg)
2010	4.28	20.74	29.30	0.067
2009	3.40	24.65	26.94	0.05
2008	7.89	16.83	13.87	0.0345

- The Hg Emissions to air therefore reflect 90% full production load for 365 days based on fuel being consumed during the test period
- The data presented for coal and residues are based on analytical results from CANMET laboratories as per the UDCP

a) Annual emissions of total mercury from each coal-fired EPG plant (kg/year)
The data are extrapolations based on annual source testing. See Appendix A: 2008, 2009, 2010 Source Testing. The mercury emissions to air therefore reflect 90% full production load for 365 days based on fuel being consumed during the test period.

	Facility 1	Total
Year	Hg Emissions to Air (kg)	(kg)
2008	7.89	7.89
2009	3.40	3.40
2010	4.28	4.28

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable

c) Monitoring methods used for all parameters

- Stack Testing and Flow Monitoring (CEMS)
- Mass Balance
- Other equivalent method

Example: 2010 coal, fly ash and bottom ash mass calculations

- Coal (16) and fly ash (14) samples were collected and tested once/month as per the Canadian Uniform Data Program (UDCP) for Mercury. Bottom ash samples were collected once per quarter. The data for coal, fly ash and bottom ash were averaged (respectively) over the year. The averages were multiplied by the coal consumed, fly ash and bottom ash produced (respectively) to calculate mercury in the coal burned, mercury in fly ash and bottom ash captured.
- Based on the documented range of concentrations found in the Milner Power fuel supply, there is a 95% confidence level using the UDCP mass balance approach as per

Method 1 of Appendix A of the CCME Monitoring Protocol, that Milner's 2010 emissions meet the low mass emitters criteria.

d) Justification for alternative methods

Not applicable

e) Any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action
Milner Mercury Control Program, presentation to Alberta Environment January 2010

f) Mercury speciation
Based on Ontario Hydro Method

Parameter	**Test 1**	**Test 2**	**Test 3**	**Average**
Test Date	Sept. 17/10	Sept. 17.10	Sept. 17/10	-
Test Time	912-1022	1040-1150	1209-1317	-
Particle Bound Mercury				
mg/m^3 (dry basis)	0.000034	0.000045	0.000034	0.000038
Oxidized Mercury				
mg/m^3 (dry basis)	0.00030	0.00034	0.00049	0.00038
Elemental Mercury				
mg/m^3 (dry basis)	0.00031	0.00011	0.00038	0.00027
Total Mercury				
mg/m^3 (dry basis)	0.00064	0.00050	0.00091	0.00068
kg/year	4.08	3.08	5.68	4.28
Particulate Concentration				
mg/m^3 (dry basis)	25.9	24.1	23.3	24.4
mg/m^3 (wet basis)	24.2	22.0	21.5	22.6
Particulate Emissions Rates				
Tonnes/hr (dry basis)	0.019	0.017	0.017	0.018
g/Kg (dry basis)	0.021	0.019	0.019	0.020
g/Kg (dry basis) @ 50% EA	0.021	0.019	0.019	0.020
Flow Rate				
m^3/sec.	201	196	199	199
Actual m^3/sec.	353	353	356	354
Temperature ºC	165	165	168	166
Moisture Vol. %	606	8.6	7.7	7.6
Oxygen Vol. %	701	7.1	7.0	7.1

Carbon Dioxide Vol. %	12.9	12.8	12.8	12.8
Excess Air %	50.6	50.2	49.0	49.9

g) Mercury content of coal
The data presented are based on analytical results from CANMET laboratories as per the UDCP:

kg Hg in fuel consumed
2010 20.74
2009 24.65
2008 16.83

h) Mercury content of coal combustion residues, the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues
The data presented are based on analytical results from CANMET laboratories as per the UDCP. Both combustion residues (fly ash and bottom ash) are managed at the Flood Creek ash disposal facility.

	Fly Ash (Mg)	**Hg/Fly Ash (Mg)**	**Bottom Ash (Mg)**	**Hg/Bottom Ash (Mg)**
2008	59280	13.87	17260	0.0345
2009	83548.5	26.94	17001.7	0.05
2010	88251	29.30	17639	0.067

MANITOBA

Brandon Unit 5 is Manitoba Hydro's sole remaining small coal-fired generating unit and is assumed to remain available into 2019. Operation of Brandon Unit 5 is subject to *Manitoba Regulation 186/2009, the Coal-Fired Emergency Operations Regulation* (under Manitoba Statute *The Climate Change and Emissions Reduction Act*, C.C.S.M. c. C135 which states Manitoba Hydro must not use coal to generate power, except to support emergency operations). Activities to maintain the reliable operation of the unit and system reliability support under emergency condition results were previously estimated at 125 GW.h/year of generation (13.6% Capacity Factor). During 2010, the Unit operated less than 10% of the time.

Information for 2010 generated in accordance with the *Monitoring Protocol in support of the Canada-wide Standards for Mercury Emissions from Coal-fired Electric Power Generation Plants* follows. Manitoba’s total emissions of 1.2 kilograms mercury were well within its 2010 CWS cap of 20 kilograms per year.

BRANDON GENERATING STATION

a) Annual mercury emissions
The annual emissions of total mercury from Unit 5 in calendar year 2010 were 1.16 kilograms via the air and 0.075 kilograms in the ash.

	Brandon Unit 5	Total
Year	Hg Emissions to Air (kg)	(kg)
2003	20.122	20.122
2008	9.575	9.575
2009	2.822	2.822
2010	1.16	1.16

b) Mercury capture rates
This is not a requirement as Brandon Unit 5 is not a new generating unit. However, during 2010 the percent mercury capture rate was 8.07%.

c) Monitoring methods used for all parameters
Manitoba Hydro utilizes the Mass Balance method of determining its total annual mercury emissions. Mass balance calculations are made following the UDCP guide for mercury from coal-fired electric power generation. The station 2010 stack test was delayed until 2011 due to changes to the Brandon Unit 5 operating schedule. The annual stack testing program for mercury emissions, conducted in June 2011, provides mercury speciation data to support the mass balance calculations. The results of the 2011 stack testing program are within ±20% of the mass balance results, thereby corroborating the mass balance results reported.

The mercury speciation in flue gas sampling program was designed to comply with the requirements of "*The Canadian Uniform Data Collection Program (UDCP) for Mercury from Coal-Fired Electric Power Generation*", developed by the Canadian Council of Ministers of the Environment Mercury Canada-Wide Standards Development Committee in January 2003. This test program employed wet chemistry stack testing in accordance with the Ontario Hydro Method. The following table outlines the test matrix that was followed in completing this objective.

Test Matrix

Sampling Locations	**No. of Runs**	**Sample/Type Pollutant**	**Sampling Method**	**Sample Run Time (min)**	**Analytical Method**	**Analytical Laboratory**
Precipitator Inlet	3	Speciated Mercury	Ontario Hydro Method	144	CVAAS(1) or CVAFS(2)	ALS(3)
Precipitator Outlet	3	Speciated Mercury	Ontario Hydro Method	150	CVAAS(1) or CVAFS(2)	ALS(3)

(1) CVAAS – Cold vapour atomic absorption spectrometry
(2) CVAFS – Cold vapour atomic fluorescence spectrometry
(3) ALS – ALS Laboratory Group, Burlington, Ontario

The speciated mercury samples were collected isokinetically which allowed the simultaneous determination of stack gas temperatures and velocities, stack gas composition and moisture content.

Mercury content of coal and coal combustion residues (fly ash, bottom ash) are determined routinely by Manitoba Hydro throughout the year. The sampling protocol is outlined in the document received by Manitoba Conservation entitled “Manitoba Hydro Brandon Generating Station Site Specific Test Plan for Mercury in Coal, Ash & Residue Sampling and Analysis Program”. The program is designed to collect and analyze coal and residue composite samples every week during the year when Brandon Unit 5 is generating. Weekly composite samples are comprised of three daily samples taken during the week. Bottom ash samples were not obtained in 2010 due to the low mercury ash content levels in 2008. The weekly coal and residue sampling program employs the following test methods:

Applicable Reference Methods

COAL

TOPIC	**STANDARD**	**TITLE**
Sampling	ASTM D6609	Standard Guide for Part-Stream Sampling of Coal
Sample Preparation	ASTM D2013	Standard Practice of Preparing Coal Samples for Analysis
% Moisture	ASTM D3302	Standard Test Method for Total Moisture in Coal
% Moisture	ASTM D3173	Standard Test Method for Moisture in the Analysis Sample of Coal and Coke
Mercury	ASTM D6722	Standard Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis
Mercury	EPA Method 7473	Mercury in Solids and Solutions by Thermal

		Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry
% Ash	ASTM D3174	Standard Test Method for Ash in the Analysis Sample of Coal and Coke from Coal
% Sulphur	ASTM D4239C	Standard Test Methods for Sulfur in the Analysis Sample of Coal and Coke Using High Temperature Tube Furnace Combustion Methods
Higher Heating Value	ASTM D5865	Standard Test Method for Gross Calorific Value of Coal and Coke
Higher Heating Value	ISO 1928	Solid mineral fuels – Determination of gross calorific value by the bomb calorimetric method, and calculation of net calorific value

FLY ASH

TOPIC	STANDARD	TITLE
Sampling	No Standard	Not Applicable
Sample Preparation	No Standard	Recommended size reduction is 150-um (No. 100) U.S.A. standard sieve
% Moisture	ASTM D3302	Standard Test Method for Total Moisture in Coal
% Moisture	ASTM D3173	Standard Test Method for Moisture in the Analysis Sample of Coal and Coke
Mercury	ASTM D6722	Standard Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis
Mercury	EPA Method 7473	Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry
% Sulphur	ASTM D5016	Standard Test Method for Sulphur in Ash from Coal, Coke, and Residues from Coal Combustion Using High-Temperature Tube Furnace Combustion Method with Infrared Absorption

BOTTOM ASH

TOPIC	STANDARD	TITLE
Sampling	No Standard	Not Applicable
Sample Preparation	No Standard	Recommended size reduction is 150-um (No. 100) U.S.A. standard sieve
Mercury	ASTM D6722	Standard Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis
Mercury	EPA Method 7473	Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry

Additionally, coal and ash composite samples were collected in conjunction with the speciated mercury emission testing to allow mercury mass balance calculations per the UDCP for mercury guide. Coal composite samples from the pulverizer pipes were collected, prepared and analyzed for ultimate and proximate analysis, calorific value, % chlorine, % sulphur, % ash, % moisture and mercury. Composite samples from the coal feeders were also collected, prepared and analyzed for % moisture and mercury. Composite combustion residue (fly ash and bottom ash) samples were collected for analysis of mercury, % chlorine, % carbon, % sulphur and % moisture.

d) Justification of Alternative Methods
No alternative methodologies are employed by Manitoba Hydro for the determination of total annual mercury emissions.

Minor modifications to the speciated mercury emissions testing methodologies were employed for the June 2011 source testing program. These modifications were previously received by Manitoba Conservation in a Pre-test Plan. The sampling program and minor test method modifications were approved by Manitoba Conservation prior to the 2008 testing program.

e) Supporting Data
No supporting data was requested by Manitoba Conservation.

f) Mercury Speciation
Mercury speciation of the total annual mercury air emissions is available from the results of the mercury source testing program. The Ontario Hydro Method allows for the determination of elemental mercury and oxidized mercury (both particle-bound and non-particle-bound). The following table summarizes the results of the electrostatic precipitator inlet/outlet triplicate source testing program and the results of mercury analyses performed on coal, fly ash and bottom ash samples collected concurrently with the air emissions testing. Based on the flue testing results, the majority of mercury loading to the electrostatic precipitator and emissions from the electrostatic precipitator is in the elemental form. The quantity of particle-bound mercury is approximately three times higher than the oxidized mercury in the upstream flue while the amount of particle-bound mercury is approximately sixty times lower than the oxidized mercury in the downstream flue.

On a percentage basis, elemental mercury represents 89.5% of the total mercury emissions and oxidized mercury represents 10.5% of the total mercury emissions, based on the downstream flue results.

Summary of Results				
Sample Location	**Elemental Mercury (g/hr)**	**Oxidized Mercury (g/hr)**	**Particle-Bound Mercury (g/hr)**	**Total Mercury (g/hr)**
Coal				
Run 1	Not applicable	Not applicable	Not applicable	2.80
Run 2				1.49
Run 3				2.01
Average				2.10
Bottom Ash				
Run 1	Not applicable	Not applicable	Not applicable	0.003
Run 2				0.002
Run 3				0.003
Average				0.003
Fly Ash				
Run 1	Not applicable	Not applicable	Not applicable	0.360
Run 2				0.236
Run 3				0.286
Average				0.294
Downstream Flue				
Run 1	1.85	0.107	0.003	1.96
Run 2	1.34	0.111	0.004	1.45
Run 3	1.45	0.308	0.003	1.76
Average	1.54	0.175	0.003	1.72
Upstream Flue				
Run 1	1.84	0.121	0.341	2.30
Run 2	1.03	0.054	0.480	1.57
Run 3	1.73	0.144	0.049	1.92
Average	1.54	0.106	0.290	1.93

Note: All bottom ash mercury contents were non-detect.

g) Mercury Content of Coal

The mercury content of the coal during the 2010 calendar year (weekly sampling periods) ranged between 0.038 and 0.067 parts per million with an average of 0.062 (the weighted average mercury content was 0.060 ppm). The mass amount of mercury in the coal was 1.232 kilograms. The mercury content of the coal during the annual stack test (comprised of three test runs) was 0.064, 0.058 and 0.057 parts per million.

h) Combustion Residues Mercury Content, Mass & Management Method
The coal combustion residue mercury content and mass amounts are provided in the following table:

Coal Combustion Residue Type	Number of Samples	Mercury Content (ppm)	Average (ppm)	Mass Amounts (Mg)	Total Mercury Released in the Ash (kg)
Fly Ash	11	0.047 to 0.103	0.076	964	0.075
Bottom Ash	0	0	0	321	0.000

Combining the amount of mercury in bottom ash and fly ash released results in a total release of mercury in the combustion residue of 0.075 kilograms.

The coal combustion residues are sent to an ash lagoon for storage. The Brandon Generating Station has approval to utilize the coal combustion residues for various purposes, including, but not limited to; unstabilized sub-base or base course in roads, as a component of cement-stabilized road bases and as an embankment material for roads, area fills and dikes. However, no coal ash was utilized at Brandon in 2010.

NEW BRUNSWICK

Through the CWS, New Brunswick has committed to reducing mercury emissions from existing coal-fired power plants within the province to 25 kilograms per year by 2010.

GRAND LAKE AND BELLEDUNE GENERATING STATIONS

There are two existing coal-fired power plants in New Brunswick (Grand Lake and Belledune Generating Stations). Mercury emissions from these two power plants totalled approximately 107 kg. NB Power has committed to take the Grand Lake Generating Station out of service by June 2010, which will enable New Brunswick to meet the mercury emission cap of 25 kilograms per year.

a) Annual emissions of total mercury from each coal-fired EPG plant (kg/year)

	Belledune	Grand Lake	Total
Year	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	(kg)
2000	43	105	148
2001	44	112	156
2002	12	106	118
2003	13	105	118

2004	17	101	118
2005	12	88	100
2006	7	56	63
2007	7	88	95
2008	11	33	44
2009	23	84	107
2010	22	8*	30

* The Grand Lake Generating Station ceased operation on February 23, 2010.

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable.

c) Monitoring methods used for all parameters

- Stack Testing
- Mass Balance

d) Justification for alternative methods
Not applicable

e) Any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action
Not applicable.

f) Mercury speciation

Comparison of Mercury Stack Test Results at the Belledune Generating Station

Parameter	**2010**	**2008**	**2004**	**2000**
Hg Emission Rate (g/hr)	3.75	2.12	2.13	5.47
Fuel Flow during Testing (kg/hr)	163,851	166,139	161,700	158,050
Hg Concentration in Fuel (mg/kg)	0.030	0.020	0.033	0.09
Particulate Bound Mercury (%)	0.1	0.5	3	0
Oxidized Mercury (%)	4.5	16.2	16	21.5
Elemental Mercury (%)	95.4	83.2	81	78.5

Comparison of Mercury Stack Test Results at the Grand Lake Generating Station

Parameter	**2003**	**2000**
Hg Emission Rate (g/hr)	16.29	14.8
Fuel Flow During Testing (kg/hr)	23,350	22,007
Hg Concentration in Fuel (mg/kg)	0.62	0.5

Particulate Bound Mercury (%)	0.25	1.73
Oxidized Mercury (%)	78.83	58.73
Elemental Mercury (%)	20.92	39.55

g) Mercury content of coal, the mass amount (kg)

Belledune Generating Station

Year	Fuel Consumption (Mg)	Avg. Hg Conc. in Fuel (mg/kg)	Mass of Hg in Fuel (kg)
2010	1,160,329	0.045	52
2009	1,321,536	0.040	53
2008	1,286,804	0.018	23
2007	1,199,772	0.018	22
2006	1,213,418	0.021	25
2003	1,387,879	0.05	69

Grand Lake Generating Station

Year	Fuel Consumption (Mg)	Avg. Hg Conc. in Fuel (mg/kg)	Mass of Hg in Fuel (kg)
2010	14,485	0.52	8
2009	133,532	0.57	76
2008	75,234	0.41	31
2007	177,992	0.46	82
2006	109,193	0.48	52
2003	156,395	0.74	116

h) Mercury content of coal combustion residues, the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues, e.g., to landfill, for sale for cement, etc.

Belledune Generating Station

Year	Combustion Residue	Quantity of Residue (Mg)	Avg. Hg Conc. in Residue (mg/kg)	Mass of Hg in Residue (kg)	Destination/Disposal of Residue
2010	Gypsum	111,034	0.113	12.5	Wallboard manufacturing
	Gypsum	168	0.113	0.02	Landfill
	Bottom Ash	27,206	0.015	0.4	Landfill
	Fly Ash	45,089	0.017	0.77	Concrete additive

2009	Gypsum	144,830	0.09	13.0	Wallboard manufacturing
	Bottom Ash	32,267	0.008	0.3	Landfill
	Fly Ash	57,896	0.02	1.2	Concrete additive
2008	Gypsum	139,441	0.09	12.5	Wallboard manufacturing
	Gypsum	1,052	0.09	0.1	Landfill
	Bottom Ash	22,920	0.008	0.2	Landfill
	Fly Ash	72,583	0.02	1.5	Concrete additive

Grand Lake Generating Station

Year	Combustion Residue	Quantity of Residue (Mg)	Avg. Hg Conc. in Residue (mg/kg)	Mass of Hg in Residue (kg)	Destination/Disposal of Residue
2010	Bottom Ash	803	<0.01	0	Landfill
	Fly Ash	3,210	0.01	0.03	Landfill
2009	Bottom Ash	6,249	<0.01	0	Landfill
	Fly Ash	24,997	0.01	1.7	Landfill
2008	Bottom Ash	2,799	<0.01	0	Landfill
	Fly Ash	11,195	0.01	0.66	Landfill

NOVA SCOTIA

Nova Scotia has four coal-fired electric power generation plants which utilize a combination of coal and petroleum coke for fuel. Mercury emissions for these plants are regulated through a fleet-wide cap under the Air Quality Regulations. The Air Quality Regulations established a mercury cap of 168 kg for emissions from coal-fired plants in 2005. The Air Quality Regulations were amended to reduce this cap to 65 kg in 2010 to comply with the Canada-wide Standards. However, the province has extended this deadline for achieving the 2010 cap to reduce the impact of rising fuel costs and the associated power rate increases. As a result, Nova Scotia did not meet its 2010 target in the Canada-wide Standards

Nova Scotia has amended the Air Quality Regulations to extend achievement of the 65 kg cap to 2014 from 2010, with annual declining emission caps from 2010 to 2013. In addition, the province has established a cap of 35 kg in 2020. Nova Scotia is also requiring the utility, Nova Scotia Power, to compensate with additional emission reductions, for all annual emissions over the 65kg in the 2010-2013 period, by 2020. The annual emission allocations for the years 2010 to 2020 are identified in the following table.

Annual Mercury Emission Caps

Calendar Year	Mercury Emission Cap (kilograms)
2010	110
2011	100
2012	100
2013	85
2014	65
2020	35

The power utility intends to achieve these emissions caps through a selection of possible options:

1. Use of fuels with mercury content and other attributes that will reduce atmospheric mercury emissions
2. Use of sorbents for mercury in flue gas streams to capture mercury with the various solids in the particulate collection equipment, including the modification of that equipment where necessary
3. Reduction in mercury emissions as co-benefits of the installation of air pollution control devices or modified management practices intended principally for reduction in atmospheric emissions of other substances
4. Modification in production levels at existing coal plants from addition of lower-emitting new generation, including, but not limited to renewable energy.

LINGAN, POINT ACONI, POINT TUPPER AND TRENTON

a) Annual emissions of total mercury from each coal-fired EPG plant (kg/year)

	Lingan	Point Aconi	Point Tupper	Trenton	Total
Year	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)
2003	83	2.5	24	49	158.5
2008	95	2.9	24	40	163
2009	92.0	2.7	16.5	28.8	140
2010	49.7	2.8	9.5	19.4	81.5

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable.

c) Monitoring methods used for all parameters
A mass balance was used to calculate mercury emissions at all facilities.

d) Justification for alternative methods
No alternative methods used.

e) Any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action
No supporting data needed**.**

f) Mercury speciation;

	Mercury Speciation* 2010		
	Oxidized (%)	**Elemental (%)**	**Particulate Bound (%)**
Lingan 1, 2	64.22	35.7	0.08
Lingan 3, 4	50.70	49.10	0.20
Trenton 5	69.84	25.01	5.16
Point Tupper	53.09	35.72	11.19
Trenton 6	N/A		
Point Aconi	N/A		

*Mercury speciation can vary significantly depending on the coal blend at the time of testing.

Stack testing for Trenton 6 and Point Aconi was not possible in 2010 due to safety and technical reasons, and was postponed to 2011.

g) Mercury content of coal, the mass amount (kg)

	Mercury Content of Coal in 2010 (kg)*
Lingan	90.02
Point Aconi	24.71
Trenton	39.34
Point Tupper	21.27
Total	175.34

* The compliance requirement for Nova Scotia Power is total mercury emitted on a fleet-wide basis. Unit specific inlet mercury content will vary by year.

h) Mercury content of coal combustion residues, the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues

	Mercury Content of Coal Combustion Residues		
	Sales (kg)	**Landfill (kg)**	**Total (kg)**
Lingan	0.48	39.84	40.32
Point Aconi	0.35	21.56	21.91
Trenton	10.83	9.11	19.94
Point Tupper	0.00	11.77	11.77
Total	11.66	82.28	93.94

ONTARIO

Ontario currently has four operating coal-fired electric generating stations.

Ontario Power Generation (OPG) is making the transition to a lower carbon future and will phase out the use of coal at its four coal-fuelled thermal electricity generating stations by the end of 2014.

In 2010, two coal-fired generators at Nanticoke Generating Station (GS) and two generators at Lambton GS, both in southwestern Ontario, were retired. Advancing the shut down of these coal generators saved costs for consumers without risking the reliability of electricity supply and maintained the lowest emission coal generators in-service.

OPG has been exploring options to “repower” (change fuel in) some of its coal-fuelled electricity generating stations with natural gas and/or forest or agriculture-based biomass. Repowering these stations allows continued use of existing facilities owned by the people of Ontario, costs less than building new stations, reduces greenhouse gas emissions considerably, provides effective back up for growing intermittent renewable electricity sources like wind and solar and maintains employment and economic benefits in the station communities.

The Ontario Long-Term Energy Plan (LTEP), announced by the Ministry of Energy in November 2010, states that Atikokan GS will be converted to biomass fuel; that Thunder Bay GS will be converted to natural gas fuel; and that Nanticoke GS will shutdown two more coal-fuelled generators by late 2011. While there is no current commitment to convert Nanticoke GS or Lambton GS, the LTEP recognizes gas is an option that could be considered in the future if the stations are required for system reliability. Co-firing of natural gas and biomass may be considered for OPG stations which are first converted to natural gas.

For 2010, Ontario’s total mercury emissions from coal-fired electric generating stations were 87 kilograms.

Generating Station	**2010 Hg Emissions to Air (kg)**
Lambton	8 kg
Nanticoke	51 kg
Thunder Bay	7 kg
Atikokan	21 kg
Total	87 kg

Since the 2003 baseline year Ontario has reduced its mercury emissions from coal-fired electric power generation plants by around 80%.

Closing the Lakeview coal-fired electricity generating station in April 2005 was an important first step in reducing Ontario's mercury emissions. Since the coal phase-out was announced, Ontario has not and will not be initiating any new coal-fired electric power generation.

LAMBTON GENERATING STATION

a) Annual Emissions of Total Mercury from Lambton Generating Station

Year	Mercury Emissions to Air (kg)
2000	174
2001	164
2002	130
2003	122
2004	46
2005	67
2006	53
2007	107
2008	58
2009	19
2010	8

b) Monitoring methods Used for All Parameters
The sampling and analytical procedures used to compile the mercury emission figure are described in the accepted Mercury Monitoring and Reporting Program (MMRP) dated November 2010.

c) Justification for Alternative Methods
Unit 1 & 2 March and April 2010 fly ash mercury concentrations are based on a simple average of all the monthly values. This was done as a result of very low operational time for the unit pair which did not allow for the collection of adequate samples.

d) Supporting Data
The following tables show the monthly total mass consumed of coal and production of its various residues and average mercury concentrations for each unit pair used to calculate the 2010 mercury emissions.

Unit 1 & 2 Mass and Mercury Concentration

Unit 1 & 2	Coal		Fly Ash		Bottom Ash	
	Mass (Mg)	Hg (mg/kg)	Mass (Mg)	Hg (mg/kg)	Mass (Mg)	Hg (mg/kg)
January	13333	0.068	1342	0.317	2399	0.181
February	4795	0.065	473	0.316		
March	1515	0.073	146	0.326		
April	2299	0.075	232	0.326		
May	20233	0.076	2056	0.370		
June	15585	0.075	1563	0.302		
July	71852	0.064	7403	0.307		
August	29135	0.062	2815	0.324		
September	6271	0.090	565	0.346		
October	0		0			
November	0		0			
December	0		0			

Note: Due to rounding, re-computation of the values in this table may not yield the exact results.

Unit 3 & 4 Mass and Mercury Concentration

	Coal		Gypsum		EWTP Sludge		Fly Ash		Bottom Ash	
	Mass (Mg)	Hg (mg/kg)	Mass (Mg)	Hg (mg/kg)	Mass (Mg)	Hg (mg/kg)	Mass (Mg)	Hg (mg/kg)	Mass (Mg)	Hg (mg/kg)
January	208948	0.101	28840	0.416	358	15.270	15579	0.136	12105	0.058
February	146332	0.091	20529	0.421	195	12.087	10637	0.195		
March	78961	0.094	2130	0.311	171	18.103	5683	0.251		
April	53343	0.080	8677	0.272	117	16.490	3734	0.209		
May	23313	0.080	3769	0.418	70	9.466	1800	0.251		
June	104506	0.084	13938	0.379	121	3.086	7851	0.200		
July	70746	0.073	11246	0.395	117	7.439	5098	0.150		
August	146019	0.091	22726	0.287	267	7.700	10867	0.160		
September	54934	0.077	11539	0.244	153	13.587	4155	0.283		
October	20055	0.092	6923	0.123	57	22.376	1394	0.298		
November	67985	0.076	12411	0.162	144	9.586	5286	0.211		
December	98612	0.071	12805	0.214	203	17.2	7394	0.204		

The following tables show the calculated mass of mercury in coal and its various residues for each unit pair used to calculate the 2010 mercury emissions.

Note: Due to rounding, re-computation of the values in this table may not yield the exact results. Also note that the effluent from the Flue Gas Desulfurization (FGD) sludge dewatering process was not included in the mass balance as analysis shows that no mercury is captured in the aqueous effluent.

Unit 1 & 2 Mercury Mass (kg)

Month	Coal	Fly Ash	Bottom Ash
January	0.9	0.4	
February	0.3	0.1	
March	0.1	0.0	
April	0.2	0.1	
May	1.5	0.8	
June	1.2	0.5	
July	4.6	2.3	
August	1.8	0.9	
September	0.6	0.2	
October	0.0	0.0	
November	0.0	0.0	
December	0.0	0.0	
Total	11.1	5.3	0.4
Total Released to Air	5.4		

Unit 3 & 4 Mercury Mass (kg)

Month	Coal	Fly Ash	Bottom Ash	Gypsum	Sludge
January	21.2	2.1		12.0	5.5
February	13.3	2.1		8.7	2.4
March	7.4	1.4		0.7	3.1
April	4.3	0.8		2.4	1.9
May	1.9	0.5		1.6	0.7
June	8.7	1.6		5.3	0.4
July	5.2	0.8		4.4	0.9
August	13.2	1.7		6.5	2.1
September	4.2	1.2		2.8	2.1
October	1.9	0.4		0.9	1.3
November	5.2	1.1		2.0	1.4
December	7.0	1.5		2.7	3.5
Total	93.5	15.1	0.7	49.9	25.0
Total Released to Air	2.7				

Two final issues around calculating FGD sludge mass needed to be resolved before we could confidently report our total release of mercury. First, an un-measureable portion of the FGD sludge is sent to a lagoon during periods when the filter press is out of service. Second, the FGD sludge mercury concentration is measured on a dry basis while the mass of land filled sludge is measured on a wet basis.

Mass Balance Assumptions & Justifications

The following assumptions and justifications were required to complete the mass balance.

Estimating FGD Sludge Moisture

The FGD sludge mercury concentration is measured on a dry basis while the mass of land filled sludge is measured on a wet basis. To account for the moisture in the sludge each load of FGD sludge is ranked by the Effluent Water Treatment Plant (EWTP) operator on its apparent moisture content, from dry to very wet. Nominally, FGD sludge ranges from 50% - 60% moisture. A moisture value of 54% was selected for dry, 62% for wet and 70% for very wet to represent the average moisture of the sludge. Mass of dry sludge was calculated using the following formula.

Mass Sludge (dry) = Mass Sludge Land Filled (wet) x (1-Moisture Content)

Estimating FGD Sludge Sent to the Lagoon

An un-measurable portion of the FGD sludge is sent to a lagoon during periods when the filter press is out of service. Periods when the FGD sludge is sent to the lagoon is estimated using operational data. 10 minute average flow data for all of 2010 was gathered from the archival system and evaluated. Each period in the month when the sludge was sent to the EWTP and when the sludge was sent to the lagoon was tabulated and a percent total period of time the sludge was sent to the lagoon was calculated (Equation 1). The average monthly flow of sludge to the EWTP and sludge to the lagoon was also calculated.

Using this data the monthly mass of sludge (dry) sent to landfill per unit flow of sludge sent to the EWTP was calculated (Equation 2). This value was then multiplied by the monthly flow of sludge sent to the lagoon and the percentage of time the FGD sludge was sent to the lagoon to calculate the theoretical mass of sludge (dry) sent to the lagoon (Equation 3).

This monthly mass of sludge (dry) sent to the lagoon was then added to the monthly mass of sludge landfilled (dry) to estimate the total mass of sludge (dry) generated during the year (Equation 4).

The following data table shows the final mass of sludge including the intermediate calculations as described above.

Estimation of FGD Sludge sent to Lagoon & Calculation Total FGD Sludge Generated

Month	% Time Sludge Sent to Lagoon	Avg Flow of Sludge to EWTP (m3/hr)	Avg Flow of Sludge to Lagoon (m3/hr)	Mass Sludge Landfilled [dry] (Mg)	Mass Sludge Landfilled per unit flow to EWT (Mg / m3/hr)	Mass Sludge Put in Lagoon [dry] (Mg)	Mass Total Sludge Landfill + Lagoon [dry] (Mg)
January	18%	25.4	19.5	314	12.4	44.0	358
February	15%	26.4	16.2	179	6.8	16.7	196
March	5%	29.5	22.4	164	5.6	6.7	171
April	3%	31.3	14.7	115	3.7	1.8	117
May	26%	18.2	11.5	63	3.5	10.5	73
June	56%	29.4	20.2	88	3.0	33.6	121
July	59%	25.1	24.0	75	3.0	42.4	117
August	31%	23.2	22.5	206	8.9	61.7	267
September	14%	19.9	29.0	126	6.4	26.6	153
October	9%	21.4	30.9	50	2.3	6.7	57
November	27%	21.3	24.1	110	5.2	33.2	144
December	2%	30.4	11.6	202	6.6	1.2	203

Equations used in the table above:

Equation 1

$$\text{\% Time Sludge Sent to Lagoon} = \frac{\text{Sum of Periods Sludge Sent to Lagoon}}{\text{Sum of Periods EWTP Operational}} \times 100\%$$

Equation 2

$$\text{Mass Sludge Land Filled (dry) per Unit Flow Sludge to EWTP} = \frac{\text{Mass Sludge Land Filled (dry)}}{\text{Sludge to EWTP}}$$

Equation 3

$$\text{Mass Sludge Sent to Lagoon (dry)} = \text{Mass Sludge Landfilled (dry) Per Unit Flow Sludge to EWTP} \times \text{Avg. Flow Sludge to Lagoon} \times \text{\% Total Time Sludge Sent to Lagoon}$$

Equation 4

Mass Total Sludge (dry) = Mass Sludge Land Filled (dry) + Mass Sludge Sent to Lagoon (dry)

Source Test Verification

To show that these assumptions are reasonable, a source test verification was performed on the total mass of mercury released (as shown by the mass balance) versus a calculated total mass of mercury for units 3 & 4. This calculated total mass of mercury is based on the mercury emission rate measured during the mercury emission source tests. The following formula was used to calculate this value.

$$\text{Calc. Ann. Hg Release (kg)} = \frac{\text{Ann. Gen. for Unit Pair (Gw-hr)} \times \text{Source Test Measured Hg Emiss. Rate (mg/s)}}{\text{Avg. Load During Source Test for Unit Pair (Gw)}} \times \frac{3600 \text{ (s/hr)}}{1000000 \text{ (mg/kg)}}$$

The table below shows the inputs as well as the resultant calculated annual release of mercury. Please note that this verification was not completed for Units 1 & 2 since a source test on Units 1 & 2 was not required in 2010 as a result of their closure.

Hg Source Test Verification	**Unit 3 & 4**
Annual Generation (Gw-hr)	3213.0
Average Load during Source Test (Gw)	0.483
Mercury Emission Rate from Source Test (mg/s)	0.3
Annual Hg Release – From Source Test (kg)	7.2
Annual Hg Release – From Mass Balance (kg)	2.7
Difference (kg)	4.5
% Difference	90.6%

The annual release of mercury calculated from the source test was compared to the annual release of mercury from the mass balance on Unit 3 & 4. As shown in the table above, there was a 4.5 kg difference between the two values. This equates to a 91% difference from the calculated annual source test emissions.

For the mass balance, the sources of error leading to the 91% difference most likely occur in the calculations deriving the total weight of FGD sludge. There are also errors inherent with any stack testing however it’s difficult to make a determination as to its contribution to the error observed in this verification.

The moisture content estimation is based on operator observations. Since ~4000 filter press runs are completed each year, it would be impractical to collect samples from each filter press run in order to develop a representative moisture content for each truck load of sludge sent to the landfill.

The largest error is attributed to the greater than normal percentage of time that the FGD sludge was diverted to the emergency lagoon as indicated in Table 5. On average, during 2010, the sludge was diverted to the emergency lagoon 22% of the time. In comparison, in 2009 the FGD sludge was diverted only 7% of the time and as a result the 2009 source test verification showed much better correlation with a percent difference of only 13% versus this year's 91%. The calculations used to estimate the mass of sludge deposited in the emergency lagoon are based on measured flow rates and measured quantities of sludge removed using the filter press. Since the composition of the raw FGD sludge stream is unknown and highly variable this level of error is expected with this method.

Considering the magnitude of the calculated mercury emission for units 3 & 4, and that the overall mass balance still indicates a mercury removal efficiency of 97% which is in the range of the accepted mercury removal efficiency of these units, as indicated in previous mercury mass balance reports, the 91% (4.5kg) percent difference is considered acceptable.

e) Mercury Speciation or Total Mercury Stack Test Results

The following table summarizes the results of mercury tests conducted to date.

Emission Source	**Unit**	**Sample Date**	**Particulate Mercury (mg/s)**	**Oxidized Mercury (mg/s)**	**Elemental Mercury (mg/s)**	**Total Mercury (mg/s)**	**Emission Concentration (ug/Rm3 dry)**
Group 4							
Lambton	2	July, 2000	0.04	2.88	0.91	3.83	7.1
			1%	75%	24%		
Lambton	1	October, 2008	0.27	2.13	0.06	3	6
			9%	71%	20%		
Lambton	2	June, 2009	0.003	1.3	0.42	1.72	4.7
			0.2%	75.4%	24.4%		

Emission Source	**Unit**	**Sample Date**	**Particulate Mercury (mg/s)**	**Oxidized Mercury (mg/s)**	**Elemental Mercury (mg/s)**	**Total Mercury (mg/s)**	**Emission Conc. (ug/Rm3 dry)**
Group 5							
Lambton	3	May, 2001	<0.01	0.06	0.64	0.7	1.3
			<1%	9%	91%		
Lambton	4	September, 2003	<0.01	0.07	0.14	0.21	0.4
			<1%	32%	67%		
Lambton	4	November, 2004	<0.01	0.02	0.13	0.16	0.3
			1%	15%	84%		
Lambton	3	September, 2005	0.01	0.09	0.18	0.27	0.5
			4%	33%	67%		
Lambton	3	September, 2008	0.01	0.18	0.33	1.37	2.7
			3%	34%	64%		
Lambton	4	April, 2009				0.39	0.75

Lambton	3	July, 2010				0.3	0.58

f) Mercury Content of Coal and
g) Mercury Content of Coal Combustion Residues

Please see section d) on Supporting Data. It details the amount of the different types of coal consumed and the amount of by-products generated as well as the associated mercury content.

In 2010, bottom ash was sold as a gravel substitute and gypsum was sold into the wallboard industry. Fly ash was either landfilled on site or sold to various industries.

Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
Bottom Ash	14,506	0	14,506
Fly Ash	40,518	55,556	96,074
Gypsum	155,533	0	155,533

h) Various Tables Summarizing Historical Stack Sampling, Fuel, and Residue Analytical Results

The historical stack sampling results are reported in section e on Mercury Speciation or Total Mercury Stack Test Results. A summary of the coal, ash and gypsum data from the year 2005 – 2009 follows. Note: Re-computation of the values in this table may not yield the exact results due to rounding.

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (Mg)	Total Mercury (kg)	Mercury Emitted to Air (kg)
2009	Low Sulphur Bituminous Coal	0.08	8.1	191117	16	19
	Mid-Sulphur Bituminous Coal	0.1	5.8	1174917	121	
	Bottom Ash	0.043		15806		
	Fly Ash	U1&2 - 0.328		17,535		
		U3&4 - 0.272		87258		
	Gypsum	0.222		199,014		
2008	Low Sulphur Bituminous Coal	0.09	6.9	651737	56	58

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (Mg)	Total Mercury (kg)	Mercury Emitted to Air (kg)
	Mid-Sulphur Bituminous Coal	0.1	7.9	1692915	175	
	Bottom Ash	0.049		28764		
	Fly Ash	U1&2 - 0.300		63,511		
		U3&4 - 0.230		128712		
	Gypsum	0.26		219,284		
2007	Low Sulphur Bituminous Coal	0.1	7.8	1,377,309	132	107*
	Mid-Sulphur Bituminous Coal	0.1	6.7	1,761,267	161	
	Bottom Ash	0.06		38,358		
	Fly Ash	U1, 2 – 0.23		133,997		
		U3, 4 – 0.27		134,510		
	Gypsum	0.04		241,305		
2006	Low Sulphur Bituminous Coal	Type 1 – 0.05	6.4	219,293	10	53*
		Type 2 – 0.10	8.8	459,964	43	
	Mid-Sulphur Bituminous Coal	0.1	7.1	1,803,755	165	
	Bottom Ash	0.08		29,193		
	Fly Ash	U1, 2 – 0.21		66,951		
		U3, 4 – 0.29		137,401		
	Gypsum	na		243,983		
2005	Low Sulphur Bituminous Coal	Type 1 – 0.03	8.7	769,565	20	67*
		Type 2 – 0.11	8.7	460,816	48	
	Mid-Sulphur Bituminous Coal	0.11	6.8	2,127,994	211	
	Bottom Ash	0.07		39,388		
	Fly Ash	U1, 2 – 0.15		113,243		
		U3, 4 – 0.29		162,361		
	Gypsum	0.02		268,870		

* Assume 90% retained by FGD units, and 31% retained by non-FGD units

A summary of the ash & other residues disposition data from the year 2005 - 2009 follows:

Year	Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
2009	Bottom Ash	15,806	0	15,806
	Fly Ash	34,819	69,974	104,793
	Gypsum	199,014	0	199,014
2008	Bottom Ash	28,763	0	28,763
	Fly Ash	23,395	168,828	192,223
	Gypsum	219,284	0	219,284
2007	Bottom Ash	38,358	0	38,358
	Fly Ash	3,228	265,279	268,507
	Gypsum	241,305	0	241,305
2006	Bottom Ash	29,193	0	29,193
	Fly Ash	1,264	203,088	204,352
	Gypsum	243,983	0	243,983
2005	Bottom Ash	39,388	0	39,388
	Fly Ash	0	275,603	275,603
	Gypsum	268,870	0	268,870

NANTICOKE GENERATING STATION

a) Annual Emissions of Total Mercury from the Nanticoke Generating Station

Year	Mass Mercury Emissions – to Air (kg)
2000	229
2001	226
2002	250
2003	205
2004	134
2005	156
2006	145
2007	148
2008	84
2009	27
2010	51

Note: The increase in mass mercury emissions in 2010 compared to 2009 is due to an increase in electricity produced and a corresponding increase in coal burned.

b) Monitoring Methods Used for All Parameters

The sampling and analytical procedures used to compile the mercury emission figures are described in the accepted MMRP dated November 2010 with the minor exception listed in (c) below.

c) Justification for Alternative Methods

Due to limited production in October 2010, the October 2010 fly ash sample was collected from the fly ash storage silo instead of from the electrostatic precipitator hoppers. Three bulk samples of 5-10 kg each was collected and deemed to be representative of the ash produced for that month. No other alternate methods were used in 2010.

d) Supporting Data

The following table shows the coal consumption, ash production, and average mercury concentrations used to calculate emissions for 2010.

Material	Mercury Conc (mg/kg) Hc/Ha	Moisture (%)	Amount Consumed or Produced (Mg) Tc/Ta	Total Mercury (kg) Cm/Am
Sub-bituminous Coal (PRB)	0.068	28.8	3,476,672	167.4
Bituminous Coal (USLS)	0.062	9.3	824,221	46.1
Bottom Ash	0.015		40,405	0.6
Fly Ash	0.716		225,787	161.6
Emitted to Air				51

Note: Due to rounding, re-computation of the values in this table may not yield the exact results.

e) Mercury Speciation or Total Mercury Stack Test Results

The results of mercury source tests conducted on Unit 1 (Group 1), Unit 5 (Group 2) and Unit 7 (Group 3) in 2010 are below. The 2010 source testing on all units measured total vapour phase mercury emissions.

The following table summarizes the results of mercury testing conducted to date.

Emission Source	Unit	Sample Date	Particulate Mercury (mg/s)	Oxidized Mercury (mg/s)	Elemental Mercury (mg/s)	Total Mercury (mg/s)	Emission Concentration (ug/Rm3 dry)
Group 1							
Nanticoke	1	Nov 2010	-	-	-	0.69	1.55
Nanticoke	2	July 2009	0.0034 0.4%	0.34 37.5%	0.56 62.1%	0.89	1.9
Nanticoke	3	June 2008	0.0044 0.2%	0.89 40.4%	1.31 59.4%	2.2	4.2
Nanticoke	2	April 2007	0.018 1.0%	0.84 45.6%	1.0 54.3%	1.86	3.4
Nanticoke	2	April 2005	0.021 1.0%	0.86 40.5%	1.24 58.5%	2.12	4.2
Nanticoke	3	June 2007	0.00 0.2%	0.89 40.3%	1.31 59.5%	2.20	4.2
Nanticoke	3	April 2005	0.16 12.5%	0.65 50.8%	0.47 36.7%	1.28	2.4
Nanticoke	6	Aug 2004	0.02 1.9%	0.59 47.4%	0.63 50.7%	1.24	2.5
Nanticoke	6	June 1999	0.04 4.1%	0.44 43.0%	0.54 52.9%	1.03	2.1
Group 2							
Nanticoke	5	June 2010	-	-	-	1.59	3.71
Nanticoke	5	Dec 2009	0.004 0.3%	0.52 42.9%	0.70 57.1%	1.22	2.3
Nanticoke	5	March 2009	0.012 1.0%	0.38 33.6%	0.73 65.2%	1.12	2.1
Nanticoke	5	March 2007	0.23 19.2%	0.53 44.5%	0.43 36.3%	1.18	2.3
Nanticoke	5	Sept 2004	0..02 1.7%	1.02 76.9%	0.28 21.4%	1.32	2.5
Nanticoke	5	April 2002	0.54 35.9%	0.73 49.0%	0.23 15.1%	1.50	2.8

Emission Source	Unit	Sample Date	Particulate Mercury (mg/s)	Oxidized Mercury (mg/s)	Elemental Mercury (mg/s)	Total Mercury (mg/s)	Emission Concentration (ug/Rm3 dry)
Group 3							
Nanticoke	7	April 2010	-	-	-	2.48	5.01
Nanticoke	8	July 2009	-	-	-	0.96	2.2
Nanticoke	7	June 2008	0.01	2.04	0.63	2.68	5.1
			0.4%	76.0%	23.6%		
Nanticoke	7	April 2005	0.09	1.10	0.11	1.31	2.4
		Test 1	6.9%	84.4%	8.7%		
Nanticoke	7	April 2005	0.20	0.89	0.09	1.18	2.3
		Test 2	16.5%	75.7%	7.8%		
Nanticoke	7	Aug 2004	0.03	1.46	0.36	1.85	3.7
			1.9%	78.8%	19.3%		
Nanticoke	7	July 2004	0.01	2.17	0.13	2.31	4.6
			0.6%	93.9%	5.5%		
Nanticoke	7	May 2004	0.01	1.16	0.20	1.37	2.7
			0.6%	84.7%	14.7%		
Nanticoke	7	April 2004	0.17	1.05	0.08	1.30	2.5
			12.8%	81.2%	6.0%		

f) Mercury Content of Coal and
g) Mercury Content of Coal Combustion Residues

Please see section (d) on Supporting Data. Section (d) details the amount of the different types of coal consumed and the amount of ash generated as well as the associated mercury content.

In 2010 fly ash and bottom ash was sold to the cement and concrete industries. The remainder was land filled on site.

Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
Bottom Ash	6,062	34,343	40,405
Fly Ash	145,519	80,268	225,787

h) Various Tables Summarizing Historical Stack Sampling, Fuel, and Residue Analytical Results

The historical stack sampling results are reported in section (e), Mercury Speciation or Total Mercury Stack Test Results section.

A summary of the coal and ash data from the year 2005 follows. Re-computation of the values in this table may not yield the exact results due to rounding.

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (Mg)	Total Mercury (kg)
2010	Sub-bituminous Coal	0.068	28.8	3,476,672	167.4
	Bituminous Coal	0.062	9.3	824,221	46.1
	Bottom Ash	0.015		40,405	0.6
	Fly Ash	0.716		225,787	161.6
	Emitted to Air				51
2009	Sub-bituminous Coal	0.067	28.3	2,390,197	115.1
	Bituminous Coal	0.069	7.8	607,403	38.8
	Bottom Ash	0.09		28,200	2.4
	Fly Ash	0.79		157,588	124.3
	Emitted to Air				27
2008	Sub-bituminous Coal	0.060	28.0	6,385,386	277
	Bituminous Coal	0.070	7.1	1,427,466	92
	Bottom Ash	0.01		72,793	<1
	Fly Ash	0.70		406,739	285
	Emitted to Air				84
2007	Sub-bituminous Coal	0.071	28.8	7,564,352	382
	Bituminous Coal	0.071	8.1	1,496,324	98
	Bottom Ash	0.02		83,557	2
	Fly Ash	0.70		472,955	330
	Emitted to Air				148
2006	Sub-				

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (Mg)	Total Mercury (kg)
	bituminous Coal	0.071	28.8	6,551,991	332
	Bituminous Coal	0.071	8.1	1,535,669	100
	Bottom Ash	0.01		74,714	0
	Fly Ash	0.69		422,929	287
	Emitted to Air				145
2005	Sub-bituminous Coal	0.068	28.8	6,190,571	300
	Bituminous Coal	0.065	8.1	2,206,795	131
	Bottom Ash	0.03		82,276	2
	Fly Ash	0.59		465,702	273
	Emitted to Air				156

A summary of the ash disposition data from the year 2005 follows:

Year	Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
2010	Bottom Ash	6,062	34,343	40,405
	Fly Ash	145,519	80,268	225,787
2009	Bottom Ash	4,230	23,970	28,200
	Fly Ash	118,286	39,302	157,588
2008	Bottom Ash	55,330	17,463	72,793
	Fly Ash	253,168	153,571	406,739
2007	Bottom Ash	110,314	*	83,557
	Fly Ash	320,934	152,021	472,955
2006	Bottom Ash	106,233	*	74,714
	Fly Ash	279,023	143,906	422,929
2005	Bottom Ash	118,975	*	82,276
	Fly Ash	256,640	209,062	465,702

* indicates that sales exceeded production; the remainder was recovered from storage

THUNDER BAY GENERATING STATION

a) Annual Emissions of Total Mercury from Thunder Bay Generating Station

Year	Mass Mercury Emissions – to Air (kg)
2000	56
2001	78
2002	72
2003	57
2004	37
2005	37
2006	39
2007	24
2008	31
2009	4
2010	7

b) Monitoring methods Used for All Parameters

The sampling and analytical procedures used to compile the mercury emission figure are described in the accepted MMRP dated November 2010.

c) Justification for Alternative Methods

No alternate methods were used in 2010.

d) Supporting Data

The following table shows the coal consumption, ash production, and average mercury concentrations used to calculate emissions. Due to rounding, re-computation of the values in this table may not yield the exact results.

Material	Mercury Concentration (mg/kg dry)	Coal Consumed (Mg wet)	Coal Consumed or Ash Produced (Mg dry)	Total Mercury (kg)
Lignite Coal	0.100	35,986	23,743	2.37
PRB Coal	0.0605	110,832	81,040	4.90
Bottom Ash	<0.005		2,014	0.010
Fly Ash	<0.005		6,024	0.030
Emitted to Air				7

e) Mercury Speciation or Total Mercury Stack Test Results
The following table summarizes the results of mercury tests conducted to date.

Emission Source	Unit	Sample Date	Particulate Mercury (mg/s)	Oxidized Mercury (mg/s)	Elemental Mercury (mg/s)	Total Mercury (mg/s)	Emission Concentration (ug/Rm3 dry)
Group 6							
Thunder Bay	2	June, 1998	<0.01	0.07	1.76	1.83	10.7
			1%	4%	96%		
Thunder Bay	2	Dec, 2006	<0.01	0.16	1.59	1.75	10.0
			0%	9%	91%		
Thunder Bay	2	Dec, 2008	<0.01	0.05	1.09	1.14	6.3
			0%	4%	96%		
Thunder Bay	2	Jan, 2010				0.54	5.23

*2010 source testing did not include Mercury Speciation (as per MMRP)

f) Mercury Content of Coal and
g) Mercury Content of Coal Combustion Residues

Please see the section on Supporting Data. It details the amount of the different types of coal consumed and the amount of ash generated as well as the associated mercury content.

In 2010, fly ash was sold to the cement making and concrete industries. The remainder was land filled on site.

Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
Bottom Ash	0	2,014	2,014
Fly Ash	1,517	4,507	6,024

h) Various Tables Summarizing Historical Stack Sampling, Fuel, and Residue Analytical Results

The historical stack sampling results are reported in the Mercury Speciation or Total Mercury Stack Test Results section.

A summary of the coal and ash data from the year 2005 follows. Re-computation of the values in this table may not yield the exact results due to rounding.

	Material	Mercury Concentration (mg/kg dry)	Coal Consumed (Mg wet)	Coal Consumed or Ash Produced (Mg dry)	Total Mercury (kg)
2009	Sub-bituminous Coal	0.055	91,193.86	67,902.95	3.8
	Lignite Coal	0.067	555.61	358.70	0.02
	Bottom Ash	0.022	854.35	843.75	0.02
	Fly Ash	<0.005	2,563.04	2,554.25	0.01
	Mercury Emitted to Air				4
2008	Sub-bituminous Coal	0.085	243,075	181,212	15
	Lignite Coal	0.112	212,913	142,183	16
	Bottom Ash	0.034		7,463	0
	Fly Ash	<0.005		22,385	0
	Mercury Emitted to Air				31
2007	Sub-bituminous Coal	.063	89,673	66,849	4
	Lignite Coal	.086	345,230	231,493	20
	Bottom Ash	0.035		8,383	0
	Fly Ash	0.010		25,146	0
	Mercury Emitted to Air				24
2006	Sub-bituminous Coal	.050	55,865	41,450	2
	Lignite Coal	.085	662,449	446,481	38
	Bottom Ash	0.038		15,716	1
	Fly Ash	0.01		47,148	0
	Mercury Emitted to Air				39
2005	Sub-bituminous Coal	0.050	108,589	80,573	4
	Lignite Coal	0.085	597,323	401,243	34
	Bituminous Coal	0.05	4,548	3,400	0
	Bottom Ash	0.043		15,205	1
	Fly Ash	0.010		45,616	0
	Mercury Emitted to Air				37

A summary of the annual ash disposition data from the year 2005 follows:

Year	Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
2009	Bottom Ash	767	87	854
	Fly Ash	3,116	*	2,563
2008	Bottom Ash	0	7,463	7,463
	Fly Ash	24,099	*	22,385
2007	Bottom Ash	0	8,383	8,383
	Fly Ash	18,819	6,327	25,146
2006	Bottom Ash	11	15,705	15,716
	Fly Ash	35,834	11,314	47,148
2005	Bottom Ash	0	15,205	15,205
	Fly Ash	44,444	1,172	45,616

* indicates that sales exceeded production; the remainder was recovered from storage

ATIKOKAN GENERATING STATION

a) Annual Emissions of Total Mercury from Atikokan Generating Station

Year	Mass Mercury Emissions – to Air (kg)
2000	35
2001	37
2002	38
2003	39
2004	42
2005	40
2006	26
2007	25
2008	18
2009	9
2010	21

b) Monitoring Methods Used for All Parameters
The sampling and analytical procedures used to compile the mercury emission figure are described in the accepted MMRP dated November 2010.

c) Justification for Alternative Methods
No alternate methods were used in 2010.

d) Supporting Data

The following table shows the coal consumption, ash production, and average mercury concentrations used to calculate emissions. Due to rounding, re-computation of the values in this table may not yield the exact results.

Material	Mercury Concentration (mg/kg dry)	Coal Consumed (Mg wet)	Coal Consumed or Ash Produced (Mg dry)	Total Mercury (kg)
Lignite Coal	0.096	320,329	211,385	20.84
Bottom Ash	0.009		6,968	0.063
Fly Ash	0.023		27,788	0.65
Emitted to Air				21

e) Mercury Speciation or Total Mercury Stack Test Results
The following table summarizes the results of mercury tests conducted to date.

Emission Source	Unit	Sample Date	Particulate Mercury (mg/s)	Oxidized Mercury (mg/s)	Elemental Mercury (mg/s)	Total Mercury (mg/s)	Emission Concentration (ug/Rm3 dry)
Group 7							
Atikokan	1	Sep, 1998	<0.01	0.18	2.46	2.64	10.1
			0%	7%	93%		
Atikokan	1	June, 2009	<0.01	0.21	2.08	2.29	11.6
			0%	9%	91%		
Atikokan	1	June, 2010*				1.91	9.91

*2010 source testing did not include Mercury Speciation (as per MMRP)

f) Mercury Content of Coal and
g) Mercury Content of Coal Combustion Residues

Please see the section on Supporting Data. It details the amount of the different types of coal consumed and the amount of ash generated as well as the associated mercury content.

In 2010, fly ash was sold to the cement making and concrete industries. The remainder was land filled on site.

Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
Bottom Ash	0	6,970	6,968
Fly Ash	21,730	6,058	27,788

h) Various Tables Summarizing Historical Stack Sampling, Fuel, and Residue Analytical Results

The historical stack sampling results are reported in the Mercury Speciation or Total Mercury Stack Test Results section.

A summary of the coal and ash data from the year 2005 follows. Re-computation of the values in this table may not yield the exact results due to rounding.

	Material	Mercury Concentration (mg/kg dry)	Coal Consumed (Mg wet)	Coal Consumed or Ash Produced (Mg dry)	Total Mercury (kg)
2009	Lignite Coal	0.110	123,351	81,165	8.90
	Bottom Ash	0.007	2,721	2,715	0.02
	Fly Ash	0.013	10,849	10,839	0.14
	Emitted to Air				8.9
2008	Lignite Coal	0.112	242,459	160,241	18
	Bottom Ash	<0.005		5,115	0
	Fly Ash	0.027		20,395	1
	Emitted to Air				18
2007	Lignite Coal	.086	454,274	297,320	26
	Bottom Ash	0.008		9,028	0
	Fly Ash	0.019		35,999	1
	Emitted to Air				25
2006	Lignite Coal	.079	518,441	339,358	27
	Bottom Ash	0.008		10,115	0
	Fly Ash	0.016		40,337	1
	Emitted to Air				26
2005	Lignite Coal	0.092	670,364	439,332	41
	Bottom Ash	0.008		13,276	0
	Fly Ash	0.016		52,937	1
	Emitted to Air				40

A summary of the annual ash disposition data from the year 2005 follows:

Year	Ash Type	Quantity Diverted from Disposal (Mg)	Quantity Land Filled on Site (Mg)	Total (Mg)
2009	Bottom Ash	0	2,721	2,721
	Fly Ash	10,414	435	10,849
2008	Bottom Ash	0	5,115	5,115
	Fly Ash	11,829	8,566	20,395
2007	Bottom Ash	0	9,028	9,028
	Fly Ash	28,659	7,340	35,999
2006	Bottom Ash	0	10,115	10,115
	Fly Ash	39,688	649	40,337
2005	Bottom Ash	0	13,276	13,276
	Fly Ash	45,642	7,295	52,937

SASKATCHEWAN

Saskatchewan has three coal-fired electric power generation plants including Boundary Dam Power Station (BDPS), Poplar River Power Station (PRPS), and Shand Power Station (SHPS). All three plants are operated by SaskPower.

In 2010, the total amount of mercury emitted from all the coal-fired power plants in Saskatchewan was 601 kg. In order to meet its cap of 430 kg, Saskatchewan is using credits for early action accumulated from 2003 to 2010. Early actions include a mercury switch collection program and early mercury controls at the Poplar River Power Station.

SaskPower plans to meet the mercury standard in 2011 and 2012 by utilizing their credits for early action gained at their Poplar River Power Station and the remaining credits from the mercury switch collection program. In 2013, Shand Power Station will be operating an activated carbon system for mercury capture. In future years, unit retirements and refurbishments along with activated carbon installations will allow SaskPower to successfully meet the annual mercury cap of 430 kg.

The information on Saskatchewan coal-fired electric power generating plants was provided by SaskPower.

In the *Canada-wide Standard for Mercury Emissions from Coal-fired Electric Power Generation Plants: 2009 Progress Report* the emissions for the Poplar River Power Station were incorrectly reported. Emissions were lower than reported. The following table gives corrected information.

BOUNDARY DAM, POPLAR RIVER AND SHAND POWER STATIONS

a) Net annual emissions of total mercury from each coal-fired EPG plant (kg/yr)

	BDPS	PRPS	SHPS	Mercury Switch Credits		Net
Year	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	Hg Emissions to Air (kg)	Collected	Used	(kg)
2003	301	293	116	137.4 (2003-06)	0	710
2007	270	311	107	41.6	0	688
2008	292	240	115	29.5	0	648
2009	288	309*	110	37.7	0	707*
2010	253	243	105	26.9	171	430

*These numbers were incorrectly reported in the 2009 Progress Report.

b) Capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit
Not applicable.

c) Monitoring methods used for all parameters
SaskPower uses the mass balance approach where over a given period of time the masses of mercury entering the unit in the coal stream and leaving the unit in solid by-product residue streams are determined. The difference between these masses represents the amount of mercury emitted from the unit. The methods for mass balance determinations are based on the successful program in which SaskPower and Saskatchewan Ministry of Environment (MoE) (at the time Saskatchewan Environment) worked together to determine the mercury inventories from SaskPower's coal-fired units during the development of the Canada-wide Standards for Mercury Emissions from Coal-Fired EPG Plants.

Under normal plant coal sampling equipment availability, three daily samples are collected over a two week period and analyzed for mercury according to ASTM D-6722. One sample per week is analyzed if the equipment availability is reduced. If the sampling equipment is not available, feeder samples are collected and analyzed as agreed to by MoE and SaskPower. The mercury mass entering the unit is determined from the mercury concentration of the coal analyzed and the amount of coal fed to the unit over the period of time represented by the analyzed coal. The mercury mass leaving the unit in the combustion residues is determined from the mercury concentration of the combustion residues analyzed and the amount of combustion residues leaving the unit over the period of time represented by the analyzed combustion residues.

d) Justification for alternative methods
Any modifications from the previously used methods are based on the agreement between MoE and SaskPower plus recommendations from the report, "Review of and Comments on SaskPower's Past and Future Sampling Protocols for Mercury in Coal and Coal Combustion By-Products" prepared by Champagne Coal Consulting Inc. (CCCI).

e) Supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action

The mercury sampling program is based on the recommendations of CCCI, which performed detailed analysis of the data collected during the determination of the mercury inventories from SaskPower's coal-fired units during the development of the Canada-wide Standards for Mercury Emissions from Coal-Fired EPG Plants. The CCCI report has been submitted to Saskatchewan MoE.

SaskPower keeps all the analytical data collected from the mass balance determinations in a secure fashion on its corporate computer network. This data includes the raw data from the individual analyses of the mass balance samples as well as the data from the various checks and standards used to verify the sample data.

f) Mercury speciation

In accordance with the agreement between the Saskatchewan MoE and SaskPower on mercury monitoring, SaskPower conducts annual speciated mercury testing at all of its stacks annually starting in 2009. The results for 2010 testing are summarized in the following table:

Stack	Test Dates	Contractor	Particulate Mercury	Oxidized Mercury	Elemental Mercury
Boundary Dam 1 & 2	July 15, 2010	SRC	0.2%	15.7%	85.1%
Boundary Dam 3	July 6-7, 2010	SRC	0.2%	15.7%	85.1%
Boundary Dam 4	July 9, 2010	SRC	0.4%	8.4%	90.9%
Boundary Dam 5	July 13, 2010	SRC	<0.1%	9.8%	90.9%
Boundary Dam 6	July 7-8, 2010	SRC	<0.1%	12.4%	87.6%
Shand	n/a	n/a	n/a	n/a	n/a
Poplar River 1	May 18-19, 2010	Maxxam	0.1%	20.6%	79.3%
Poplar River 2	May 18-19, 2010	Maxxam	0.1%	20.6%	79.3%

Speciated mercury was determined by the Ontario Hydro Test in all cases. Ontario Hydro testing was scheduled for Shand several times, but human resource issues, illness and weather problems prevented any testing in 2010.

g) Mercury content of coal (kg)

Year	BDPS Hg in Coal (kg)	PRPS Hg in Coal (kg)	SHPS Hg in Coal (kg)	Total (kg)
2003	331	315	122	766
2007	288	372	113	773
2008	310	309	119	738
2009	303	364	115	781
2010	268	369	116	753

h) Mercury content of coal combustion residues (kg), the mass amounts (kg) of these coal combustion residues and the means used to manage the disposal of these residues

Mercury in Coal Combustion Residues:

	BDPS	PRPS	SHPS	Total
Year	**Hg in Residues (kg)**	**Hg in Residues (kg)**	**Hg in Residues (kg)**	**(kg)**
2003	31.8	22.9	7.4	62.1
2007	18.1	59.9	5.8	83.7
2008	17.9	68.8	4.6	91.3
2009	15.4	31.5	4.3	51.2
2010	15.8	90.6	10.9	117.3

Total Coal Combustion Residues:

	BDPS	PRPS	SHPS	Total
Year	**Combustion Residues (kg)**	**Combustion Residues (kg)**	**Combustion Residues (kg)**	**(kg)**
2003	589,599,000	480,239,000	214,568,000	1,284,406,000
2007	663,841,811	495,027,180	232,005,135	1,390,874,126
2008	621,352,021	439,876,972	204,364,212	1,267,141,999
2009	584,540,969	532,964,331	206,553,354	1,324,058,654
2010	560,695,120	520,660,162	215,466,290	1,296,821,573

Fly ash and bottom ash are hydraulically transported to ash lagoons at both Boundary Dam and Poplar River and the transport water is circulated back to the plant to collect more ash. Lagoons at both plants are lined and monitored to ensure ash constituents do not migrate into the environment. Extensive testing of by-products resulting from the test work at the ECRF have demonstrated that any mercury captured by activated carbon is effectively fixed and that less mercury is released than when activated carbon is not present. Consequently ashes containing carbon at Poplar River are also placed in the lagoons. None of the ash produced at Poplar River is currently utilized, although interest in this by-product is increasing. About 12-15% of the ash produced at Boundary Dam is utilized, but greater demand is being experienced and SaskPower is planning to upgrade the infrastructure at Boundary Dam to accommodate the anticipated added activity.

At Shand, fly ash and bottom ash are dry hauled to a dedicated placement site that is designed to minimize any contact with water. The site is also lined and monitored to prevent ash constituents from entering the environment. Recent fly ash utilization at Shand has been about 20-30%, but applications for most, if not all, of the fly ash produced at Shand are expected to occur in the next few years.

% Fly Ash Sales to Total Ash Produced:

	BDPS	SHPS	PRPS
Year	**% fly ash sales**	**% fly ash sales**	**% fly ash sales**
2003	10%	19%	none
2007	16%	14%	none
2008	15%	28%	none
2009	13%	23%	none
2010	14%	21%	none