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

2012 PROGRESS REPORT

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Introduction

In 2006 the Canadian Council of Ministers of the Environment (CCME) endorsed Canada-wide Standards for Mercury Emissions from Coal-fired Electric Power Generation Plants (CWS). The CWS set targeted caps for each signatory jurisdiction for the year 2010. This report presents information on the attainment of 2010 emissions caps under the CWS. Only those jurisdictions with coal-fired electric power generation plants are required to report. In 2010, emissions of mercury from the plants covered by the CWS represented 94% of Canada's total mercury emissions from electric power generation.[1]

In the baseline year of 2003, 2695 kg of mercury were emitted and there was a total of 3725 kg of mercury in the amount of coal burned. This represented a capture rate of less than 28%. In 2012, 825.82 kg of mercury were emitted and the total mercury contained in the coal burned was 1868.06 kg representing a capture rate of 56%. Although this is not equal to the CWS goal of 60% capture, it does represent a nearly 70% reduction in total emissions from 2003. The 2010 emission caps were expected to produce a 52-58% reduction in total emissions. While the goal for capture rate has not yet been achieved, absolute emissions have been reduced more than expected through a combination of reduced coal consumption and emissions abatement. More information on the Canada-wide standards for mercury may be found on the CCME website at www.ccme.ca.

[1] National Emission Trends -- Heavy Metals and Persistent Organic Pollutants: www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=0EC58C98-1.

Summary

In 2012 there were 825.82 kilograms of mercury emitted in total from coal-fired power generation plants in signatory jurisdictions and, where applicable, jurisdictions have now achieved their 2010 mercury emissions cap (using credits in the case of Saskatchewan), or have put in place a plan with timelines for achievement.

Province	2008 Mercury Emissions (kg)	2009 Mercury Emissions (kg)	2010 Mercury Emissions (kg)	2011 Mercury Emissions (kg)	2012 Mercury Emissions (kg)	2010 Emissions Cap (kg)
Alberta	481	579	661	212.59	200.7	590
Manitoba	9.6	2.8	1.16	1.01	1.22	20
New Brunswick	41	107	30	18	13	25
Nova Scotia	161	140	81.5	94.6	93.9	65*
Ontario	191	59	87	43	27	Not set
Saskatchewan	648	707	601** (credits of 171 kg used to meet cap)	551** (credits of 121 kg used to meet cap)	490** (credits of 60 kg used to meet cap)	430
Total	**1532**	**1594.8**	**1461.66**	**920.2**	**825.82**	**1130**

*Nova Scotia's cap for 2010 was changed in provincial regulations from 65 kg to 110 kg.
**Saskatchewan's cap was achieved with the use of accumulated credits for early action.

Achievement of 2010 Caps and Review of the Standard

Under the CWS for Mercury Emissions from Coal-fired Electric Power Generation Plants all jurisdictions were to have met their emissions caps by 2010. The CWS was scheduled for review by 2012. Because several jurisdictions were not yet in achievement of the standard in 2010, the review was 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 eight 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 Sheerness Generating Station, the Sundance Generating Plant, the Keephills Generating Plants 1, 2 and 3, and the H.R. Milner Generating Station. The Wabamun plant was shut down in early 2010 as were Sundance units 1 and 2 in early 2011. Sundance Units 1 and 2 are being repaired and are expected to be restored to service in the fall of 2013.

Mercury Emissions from Alberta Facilities by Year

	Total Mass Mercury					
Facility	**Emissions (kg)**		**In coal burned (kg)**		**Retained in ash and residue (kg)**	
	2011	**2012**	**2011**	**2012**	**2011**	**2012**
Battle River	48.1	33.3	133.3	110.7	85.2	77.4
Genesee Unit 1&2	41.5	32.59	161.94	146.22	120.44	113.63
Genesee Unit 3	14.65	17.22	74.74	69.45	60.09	52.22
Sheerness	33.14	37.93	137.09	132.63	103.95	94.7
Sundance Units 3-6	56.2	49.9	241.3	188.3	185.1	138.4
Keephills 1-2	17.8	20.7	91.0	92.6	73.2	71.9
Keephills 3	1.2	8.2	18.3	45.1	17.1	36.9
HR Milner	N/A	0.86	N/A	17.5	N/A	16.29
Totals	212.59	200.7				

BATTLE RIVER GENERATING STATION

a) Annual Emission of Total Mercury
See table above.

b) Mercury Capture Rate
2011: 63.939%
2012: 75.993%

c) Monitoring Methods Used for All Parameters
2011: Mass Balance and Stack Testing, Ontario Hydro Method

2012: Mercury Continuous Emission Monitoring System (CEMS) and Stack Testing, Ontario Hydro Method

d) Justification for Alternative Methods
N/A

e) Additional Supporting Data
N/A

f) Mercury Speciation (Averages)

Stack	Year	Elemental Mercury	Oxidized Mercury	Particulate Mercury
B	2011	48%	37.9%	14.1%
C	2011	70.5%	11.1%	18.5%
B	2012	16.6%	50.7%	33.3%
C	2012	56.1%	45.2%	13.8%

*% calculated is based on actual measured values, therefore totals may not equal 100%
** The Elemental Mercury is different between stacks; therefore, the table shows the values for each stack

g) Mercury Content of Coal

	2011	2012
Mercury Content kg (ppb)	133.3 (53.79)	110.7 (49.85)
Coal Mass Burned dry kg	2,463,963,000	2,221,520,000

h) Combustion Residues Mercury Content, Mass and Management Method

Year	Residue	Tonnes (dry)	Mercury (ppb)	Disposal
2011	Raw Fly Ash	273,843,000	280	Marketed & Landfill
	Bottom Ash	216,765,000	5	Landfill
2012	Raw Fly Ash	302,957,000	281	Marketed and Landfill
	Bottom Ash	193,263,000	4	Landfill

GENESEE GENERATING STATION

a) Annual Emission of Total Mercury
See table, p. 5.

b) Mercury Capture Rate

	Genesee 1/2	Genesee 3
Year	**Capture rate %**	**Capture rate %**
2011	74.37	80.4
2012	77.71	75.2

c) Monitoring Methods Used for All Parameters
Stack Testing and Flow Monitoring (Mercury CEMS)

d) Justification for Alternative Methods
N/A

e) Additional Supporting Data
Relative Accuracy Test Audit (RATA) verification testing passed.

f) Mercury Speciation

Ontario Hydro Method

Unit 1 and 2:

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
1	May 2011	90%	8.8%	1.2%
1	June 2012	67.9%	30.1%	2%

Unit 3:

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
2	Feb 2012	99.8%	0.002%	0
2	July 2012	100%	0	0

On February 14 and 15, 2012, Maxxam Analytics conducted a source emission survey on Unit 3 (Stack 2). This test was to achieve the originally intended number of data sets on Stack 2 by the regulators for the test which could not be completed in 2011 owing to a forced outage which disabled Unit 3 from November 11 to January 19.

g) Mercury Content of Coal
See table, p. 5.

h) Combustion Residues Mercury Content, Mass and Management Method

G1/2 2011 Residue	Sold		Returned to Mine		Total (10^3 kg)
	10^3 kg	%	10^3 kg	%	
Fly Ash	215,172	48.2	230,900	51.8	446,072
Bottom Ash	0	0.0	414,900	100.0	414,900

G1/2 2012 Residue	Sold		Returned to Mine		Total (10^3 kg)
	10^3 kg	%	10^3 kg	%	
Fly Ash	219,268	48.6	231,800	51.4	451,067
Bottom Ash	0	0.0	352,200	100.0	352,200

G3 2011 Residue	Sold		Returned to Mine		Total (10^3 kg)
	10^3 kg	%	10^3 kg	%	
Fly Ash	0	0.0	283,320	100.0	283,320
Bottom Ash	0	0.0	129,120	100.0	129,120
G3 2012 Residue	**Sold**		**Returned to Mine**		**Total (10^3 kg)**
	10^3 kg	**%**	**10^3 kg**	**%**	
Fly Ash	0	0.0	275,880	100.0	275,880
Bottom Ash	0	0.0	100,560	100.0	100,560

SHEERNESS GENERATING STATION

a) Annual Emission of Total Mercury
See table, p. 5.

b) Mercury Capture Rate
Applies to new units only.

c) Monitoring Methods Used for All Parameters

- Stack Testing and Flow Monitoring (CEMS)
  The protocol of US EPA Method 30B for Relative Accuracy Test Audit of the Mercury CEMS was followed.
  The Alberta Stack Sampling Code, Method #2, Determination of Stack Gas Velocity and Volumetric Flow Rates.

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

- Mass Balance

For 2011: 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.

- Other equivalent method
  For 2012: A mercury CEMS was installed at Sheerness Generating Station and was fully operational as of January 1, 2012. The mercury captured and retained in the ash is the difference between the mercury mass in the coal by analyses and the mercury emissions as measured by the mercury CEMS.

d) Justification for Alternative Methods
Installation, operation and determination of mercury emissions using a mercury CEMS were prescribed by Alberta Regulation 34/2006 Mercury Emissions From Coal-Fired Power Plants Regulation.

e) Additional Supporting Data
N/A

f) Mercury Speciation
No mercury speciation testing was performed in 2011 or 2012.

g) Mercury Content of Coal
2011: 137.09 kg
2012: 132.63 kg

h) Combustion Residues Mercury Content, Mass and Management Method

Year	Residue	Tonnes (dry)	Mercury (kg)	Disposal
2011	Raw Fly Ash and Bottom Ash	489,045.87	75.06	Engineered landfill
	Sales Fly Ash	82,717.5	28.89	Sold, recycled, concrete production
2012	Raw Fly Ash and Bottom Ash	407,427.18	61.33	Engineered landfill
	Sales Fly Ash	87,984.5	33.37	Sold, recycled, concrete production

SUNDANCE, KEEPHILLS, WABAMUN GENERATING PLANTS

a) Annual Emission of Total Mercury
See table, p. 5.
Note: Keephills Unit 3 declared commercial operation on September 1, 2011. The plant was only operation for four months in 2011.

b) Mercury Capture Rate

Keephills Unit 3

2011 Emissions of Total Mercury (Average per month in Kg/TWh)

2011	September	October	November	December	Average
(Kg/TWh)	0.70	*0.74	0.68	0.85	**0.74**

* October emissions are a calculated backfilled average based on the remainder of the 2011 data. The hourly mercury mass emissions had to be backfilled due to an extended failure of the newly commissioned mercury CEMS. The hourly emissions were backfilled using the average of all of the valid hours from September to December 2011.

2012 Emissions of Total Mercury (Average per month in Kg/TWh)

2012	Jan	Feb	Mar	Apr	May	Jun	Average
Kg/Twh	1.69	1.43	1.51	2.32	1.64	2.88	**2.16**
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
	2.71	3.24	2.90	1.48	2.95	1.13	

2011 % Capture Totals

2011	September	October	November	December	Average
%	94.52	*91.99	94.84	91.99	**93.50**

* October emissions are a calculated backfilled average based on the remainder of the 2011 data.

2012 % Capture Totals

2012	Jan	Feb	Mar	Apr	May	Jun	Average
%	80.7	88.1	80.2	78.1	80.9	77.2	**81.7**
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
	80.7	82.4	78.3	84.5	79.4	90.3	

c) Monitoring Methods Used for All Parameters

Stack Testing and Flow Monitoring (CEMS)

d) Justification for Alternative Methods

N/A

e) Additional Supporting Data

N/A

f) Mercury Speciation

Ontario Hydro Stack Tests

2011 - Sundance

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
2	April 2011	75.7%	14.2%	10.1%
3	April 2011	71.4	13.3	15.3

2011 - Keephills 1-2

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
1	October 2011	49.8%	36.0%	14.2%

2012 - Keephills 3

Stack	Date	Elemental Mercury	Oxidized Mercury	Particulate Mercury
2	June 2012	99.5%	0%	0.005%

No Ontario Hydro stack tests were completed at Sundance or the Keephills unit 1-2 facilities in 2012.

g) Mercury Content of Coal

Facility	2011 kg	2012 kg
Sundance	241.3	188.3
Keephills 1-2	91.0	92.6
Keephills 3	18.3	45.1

h) Combustion Residues Mercury Content, Mass and Management Method

Facility	2011 kg	2012 kg
Sundance	185.1	138.4
Keephills 1-2	73.2	71.9
Keephills 3	17.1	36.9

At Sundance approximately 70% of fly ash is disposed of in the Highvale mine. The remaining 30% is sold for cement production. Bottom ash is disposed of in the Highvale mine.

Keephills 1-2 ash is all transported via pipeline to the Keephills Ash Lagoon. Keephills 1-2 has approval and is developing a dry ash haul system for the plant which is currently not yet in use.

All ash from the Keephills Unit 3 facility is disposed of by truck in the Highvale mine.

H.R. MILNER GENERATING STATION

The H.R. Milner Generating Station conforms to Low Mas Emitter (LME) status. Stack emissions of 0.86 kg/yr are less that 4% of the 20kg/yr threshold for LME status stipulated in the Monitoring Protocol in Support of the Canada-wide Standards for Mercury Emissions from Coal-fired Electric Power Generation Plants.

a) Annual Emission of Total Mercury
See table, p. 5.

b) Mercury Capture Rate
Applies to new units only.

c) Monitoring Methods Used for All Parameters
Stack Testing and Flow Monitoring (CEMS), Ontario Hydro Method
Testing data used for emissions to air.
Mass Balance used average of CANMET test analysis for coal, fly ash and bottom ash. A mercury mass balance was conducted following the UDCP mass balance approach. Based on those results 17.15 kg of mercury were accounted for in ash and stack emissions compared with 17.5 kg of Hg consumed at the plant representing 98% capture and a mass balance within -2%.

d) Justification for Alternative Methods
Coal (66), fly ash (71) and bottom (7) samples were collected and tested in a manner consistent with the Canadian Uniform Data Program (UDCP) for Mercury from Coal-fired Electric Power Generation. Bottom ash samples were collected at least 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, to calculate mercury in the coal burned, and mercury capture in fly ash and bottom ash.

e) Additional Supporting Data
N/A

f) Mercury Speciation (Averages)
Mercury speciation was conducted by Source Test Ltd. over the period August 28-30, 2012. The daily average of 0.0056 kg/d was the measured stack emissions from a manual stack survey. Those emission amounts were then pro-rated to actual MW produced over the year.

g) Mercury Content of Coal
2012 – 17.5 kg

h) Combustion Residues Mercury Content, Mass and Management Method

Year	Residue	Mercury (kg)	Disposal
2012	Raw Fly ash and Bottom Ash	16.29	Disposed at Flood Creek Ash Disposal Facility

MANITOBA

Manitoba has only one small coal-fired electricity generation plant located in the City of Brandon. Since January 1, 2010, Manitoba Hydro operated this facility in accordance with Manitoba Regulation 186/2009, Coal-fired Emergency Operations Regulation, under Manitoba's *Climate Change and Emissions Reduction Act*, C.C.S.M. c. C135. The *Act* and Regulation limits the facility operations to use coal and generate power only to support emergency operations.

Information for 2012 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 1.22 kilograms mercury are well within its 2010 cap of 20 kilograms per year.

BRANDON GENERATING STATION

a) Annual Emission of Total Mercury

	Brandon Unit 5	Total
Year	Mercury 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
2011	1.01	1.01
2012	1.22	1.22

b) Mercury Capture Rate

Reporting of mercury capture rate is not a requirement as Brandon Unit 5 is not a new generating unit. However, the percent mercury capture rate for 2012 was 9.34%.

c) Monitoring Methods Used for All Parameters

Manitoba Hydro uses the Mass Balance method of determining its total annual mercury emissions. Mass balance calculations are made following the UDCP guidance document for mercury from coal-fired electric power generation. The annual stack testing program for mercury

emissions provides mercury speciation data to support the mass balance calculations. The results of the 2012 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 UDCP guidance document. This test program employed wet chemistry stack testing in accordance with the Ontario Hydro Method. The table below outlines the test matrix that was followed in completing this objective.

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 submitted to 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 2012 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

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 D7582	Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis
Mercury	ASTM D6722	Standard Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis
% Ash	ASTM D7582	Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis
% Sulphur	ASTM D4239	Standard Test Methods for Sulfur in the Analysis Sample of Coal and Coke Using High Temperature Tube Furnace Combustion
Higher Heating Value	ISO 1928	Solid mineral fuels -- Determination of gross calorific value by the bomb calorimetric method, and calculation of net calorific value

FLYASH

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 D7582	Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis
Mercury	ASTM D6722	Standard Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis
% 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

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 (flyash and bottom ash) samples were collected for analysis of mercury, % chlorine, % carbon, % sulphur and % moisture.

d) Justification for 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 October 2012 source testing program. These modifications were discussed with and presented to Manitoba Conservation in a Pre-test Plan. Approval to proceed with the sampling program and minor test method modifications was received from Manitoba Conservation prior to testing.

e) Additional Supporting Data

N/A

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). Table 3.2 summarizes the results of the electrostatic precipitator inlet/outlet triplicate source testing program and the results of mercury analyses performed on coal, flyash 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 represents less than 0.3% of the total mercury in the upstream flue and only 0.11% of the total mercury in the downstream flue. Oxidized mercury represents 1.6% of the total mercury in the upstream flue and 7.9% of the total mercury in the downstream flue.

In summary, elemental mercury represents 92.0% of the total mercury emissions and oxidized mercury represents 7.9% of the total mercury emissions, based on the downstream flue results.

Mercury Speciation				
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	1.97
Run 2				1.97
Run 3				1.93
Average				1.96
Bottom Ash				
Run 1	Not applicable	Not applicable	Not applicable	0.003
Run 2				0.002
Run 3				0.002
Average				0.002
Fly Ash				
Run 1	Not applicable	Not applicable	Not applicable	0.081
Run 2				0.086
Run 3				0.094
Average				0.087
Downstream Flue				
Run 1	1.68	0.157	0.002	1.84
Run 2	1.72	0.165	0.002	1.89
Run 3	1.58	0.109	0.002	1.69
Average	1.66	0.143	0.002	1.81
Upstream Flue				
Run 1	1.90	0.036	0.005	1.94
Run 2	---	---	---	---
Run 3	1.76	0.023	0.004	1.79
Average	1.83	0.030	0.005	1.87

Note 1: All bottom ash mercury contents were non-detect.
Note 2: Run 2 results were discarded due to a leak in the sampling train, and therefore excluded from the Upstream Flue average results.

g) Mercury Content of Coal

The mercury content of the coal during the 2012 calendar year (weekly sampling periods) ranged between 0.051 and 0.067 parts per million (ppm) with an average of 0.059 (the weighted average mercury content was 0.060 ppm). The mass amount of mercury in the coal was 1.315 kilograms. The mercury content of the coal during the annual stack test (comprised of three test runs) was 0.060, 0.062 and 0.062 ppm.

h) Combustion Residues Mercury Content, Mass and 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 (tonnes)	Total Mercury Released in the Ash (kgs)
FlyAsh	9	0.037 to 0.145	0.096	967	0.092
Bottom Ash	0	0	0	322	Negligible

Combining the amount of mercury in bottom ash and fly ash released results in a total release of mercury in the combustion residue of 0.092 (plus a negligible amount of bottom ash) 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 removed from the ash lagoon for use in 2012.

NEW BRUNSWICK

GRAND LAKE AND BELLEDUNE GENERATING STATIONS

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.

The Belledune Generating Station is the only remaining coal-fired power plant operating in New Brunswick. The Grand Lake Generating Station was taken out of service permanently in February 2010.

a) Annual Emission of Total Mercury

	Facility 1 Belledune	**Facility 2 Grand Lake**	**Total**
Year	**Mercury Emissions to Air (kg)**	**Mercury 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
2011	18	0	18
2012	13	0	13

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

b) Mercury Capture Rate
Applies to new units only.

c) Monitoring Methods Used for All Parameters

- Stack Testing
- Mass Balance

d) Justification for Alternative Methods
Not applicable.

e) Additional Supporting Data
Not applicable

f) Mercury Speciation

Comparison of Mercury Stack Test Results at the Belledune Generating Station

Year	2013	2011	2010	2008	2004	2000
Parameter						
Mercury Emission Rate (g/hr)	2.24	2.70	3.75	2.12	2.13	5.47
Fuel Flow during Testing (kg/hr)	176,100	121,700	163,851	166,139	161,700	158,050
Mercury Concentration in Fuel (mg/kg)	0.026	0.044	0.030	0.020	0.033	0.09
Particulate Bound Mercury (%)	0.07	0.8	0.1	0.5	3	0
Oxidized Mercury (%)	3.34	2.6	4.5	16.2	16	21.5
Elemental Mercury (%)	96.6	96.2	95.4	83.2	81	78.5

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

Year	2003	2000
Parameter		
Mercury Emission Rate (g/hr)	16.29	14.8
Fuel Flow During Testing (kg/hr)	23,350	22,007
Mercury 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

Belledune Generating Station:

Year	Fuel Consumption (tonnes)	Avg. Mercury Conc. in Fuel (mg/kg)	Mass of Mercury in Fuel (kg)
2012	951,627	0.031	30
2011	1,209,990	0.036	44
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 (tonnes)	Avg. Mercury Conc. in Fuel (mg/kg)	Mass of Mercury 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) Combustion Residues Mercury Content, Mass and Management Method

Belledune Generating Station:

Year	Combustion Residue	Quantity of Residue (tonnes)	Avg. Mercury Conc. in Residue (mg/kg)	Mass of Mercury in Residue (kg)	Destination/Disposal of Residue
2012	Gypsum	95,550	0.08	7.64	Wallboard manufacturing
	Bottom Ash	20,493	0.018	0.37	Landfill
	Fly Ash	36,956	0.036	1.33	Concrete additive
	Fly Ash	2,728	0.036	0.1	Landfill
2011	Gypsum	131,772	0.095	12.5	Wallboard manufacturing
	Gypsum	1,623	0.095	0.154	Landfill
	Bottom Ash	27,098	0.017	0.46	Landfill
	Fly Ash	49,796	0.047	2.34	Concrete additive
	Fly Ash	962	0.047	0.045	Landfill
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 (tonnes)	Avg. Mercury Conc. in Residue (mg/kg)	Mass of Mercury 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 amended its provincial 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. The annual emission allocations under provincial regulation for the years 2010 to 2020 are identified in the following table.

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

LINGAN, POINT ACONI, POINT TUPPER AND TRENTON GENERATING STATIONS

a) Annual Emission of Total Mercury

	Lingan	Point Aconi	Point Tupper	Trenton	Total
Year	Mercury Emissions to Air (kg)	Mercury Emissions to Air (kg)	Mercury Emissions to Air (kg)	Mercury Emissions to Air (kg)	Mercury 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
2011	61.2	4.4	6.4	22.6	94.6
2012	53.2	3.6	11.8	25.4	93.9

b) Mercury Capture Rate
Applies to new units only.

c) Monitoring Methods Used for All Parameters

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

d) Justification for Alternative Methods
Not applicable.

e) Additional Supporting Data
Not applicable.

f) Mercury Speciation

	Mercury Speciation 2011*		
	Oxidized (%)	**Elemental (%)**	**Particulate Bound (%)**
Lingan 1/2	39.6	60.1	0.3
Lingan 3/4	61.3	38.2	0.5
Trenton 5	70.4	12.1	17.5
Trenton 6	52.6	47.0	0.4
Point Tupper	38.5	60.2	1.3
Point Aconi	79.9	20.0	0.1

	Mercury Speciation 2012*		
	Oxidized (%)	**Elemental (%)**	**Particulate Bound (%)**
Lingan 1/2	65.8	34.0	0.3
Lingan 3/4**	61.1	38.8	0.1
Trenton 5	62.7	36.9	0.4
Point Tupper	49.8	50.0	0.2
Point Aconi	86.0	13.4	0.7
Trenton 6	NA***		

*Mercury speciation can vary significantly depending on the coal blend at the time of testing.
**Testing in 2012 for Lingan Unit 3/4 was deferred to 2013; results present above are from testing in March 2013.
***Testing was not completed for Trenton Unit 6 in 2012 due to an extended outage from March through October.

g) Mercury Content of Coal

	Total Mercury Content of Coal (kg)	
Year	2011*	2012*
Lingan	98.7	73.2
Point Aconi**	38.1	31.2
Trenton	36.0	30.1
Point Tupper	11.4	15.8
Total	**184.2**	**150.3**

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

**Point Aconi mercury content includes the mercury content in the limestone used in the circulating fluidized bed which is used as part of the mass balance equation.

h) Combustion Residues Mercury Content, Mass and Management Method

	Mercury Content of Coal Combustion Residues in 2011		
	Sales (kg)	**Landfill (kg)**	**Total (kg)**
Lingan	0.0	37.5	37.5
Point Aconi	0.1	33.6	33.7
Trenton	6.1	7.3	13.4
Point Tupper	0.0	5.0	5.0
Total	**6.2**	**83.4**	**89.6**

	Mercury Content of Coal Combustion Residues in 2012		
	Sales (kg)	**Landfill (kg)**	**Total (kg)**
Lingan	0.1	19.9	20.0
Point Aconi	0.0	27.6	27.6
Trenton	2.4	2.3	4.7
Point Tupper	0.3	3.7	4.0
Total	**2.8**	**53.5**	**56.3**

ONTARIO

In 2012 Ontario had four operating coal-fired thermal electric generating stations (GS): Lambton GS, Nanticoke GS, Thunder Bay GS, and Atikokan GS.

In 2007, Ontario passed a regulation stating that Ontario will phase out the use of coal at its thermal electricity generating stations by the end of 2014. The first retirement of coal-fired generating units occurred in 2010 when two units at both Lambton and Nanticoke GS were retired. In 2011, an additional two more units where retired at Nanticoke GS. In September 2012, the Atikokan GS came offline for conversion to burn biomass fuels.

For 2012, Ontario's total mercury emissions from coal-fired electric generating stations were 27 kilograms.

Generating Station	Kilograms emitted in 2012
Lambton	7 kg
Nanticoke	16 kg
Thunder Bay	2 kg
Atikokan	2 kg
Total	**27 kg**

LAMBTON GENERATING STATION

a) Annual Emission of Total Mercury

Year	Mass 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
2011	2
2012	**7**

b) Mercury Capture Rate
Applies to new units only.

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

d) Justification for Alternative Methods
A removal efficiency method was used to determine emissions.

Selective catalytic reduction (SCR) operation was determined by assessing the positions of the inlet, outlet and bypass dampers. Based on this information the SCR was flagged as being either online or bypassed for all periods when the unit was operational. The SCR operational data were summarized into monthly % totals for each operating scenario and the monthly total mass of input mercury was split using this information. The removal efficiency was then applied for each operating scenario to determine the mercury emissions to air. The equations below detail these calculations.

$$\mathrm{Hg}_{\text{SCR Online}} = \mathrm{Hg}_{\text{Coal}} \times \%\ \text{SCR Online} \times (1\text{-Removal Efficiency}_{\text{SCR Online}})$$
$$\mathrm{Hg}_{\text{SCR Bypassed}} = \mathrm{Hg}_{\text{Coal}} \times \%\ \text{SCR Bypassed} \times (1\text{-Removal Efficiency}_{\text{SCR Bypassed}})$$
$$\mathrm{Hg}_{\text{Total to Air}} = \mathrm{Hg}_{\text{SCR Online}} + \mathrm{Hg}_{\text{SCR Bypassed}}$$

e) Additional Supporting Data
The following tables show the monthly total mass consumed of coal and average mercury concentrations used to calculate the 2012 mercury emissions. It also presents the % of time the unit was operating with the SCR online and bypassed as well as the measured mercury removal efficiencies.

Unit 3&4 Operational Data

Unit 3&4	Coal		SCR Operation		Measured Mercury Removal Efficiency	
	Mass (Tonnes)	Mercury (mg/kg)	SCR Bypassed	SCR Online	SCR Bypassed	SCR Online
January	45775	0.094	61.01%	38.99%	83.6%	97.0%
February	71163	0.096	29.86%	70.14%		
March	61247	0.115	23.05%	76.95%		
April	23417	0.113	14.59%	85.4%		
May	31263	0.105	27.27%	72.7%		
June	94691	0.242	39.24%	60.8%		
July	131922	0.121	15.69%	84.3%		
August	95635	0.092	19.82%	80.2%		
September	82205	0.098	22.06%	77.9%		
October	53982	0.103	7.52%	92.5%		
November	42174	0.113	15.63%	84.4%		
December	112768	0.100	23.78%	76.7%		

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

The following tables show the monthly mass of mercury in coal, the mercury emissions to air and the quantity of mercury diverted to by-products (gypsum, ash and flue gas desulphurization sludge).

Unit 3&4 Mercury Mass (kg)

Unit 3&4	Input	Emitted to Air			Total Diverted
	Coal	SCR Bypassed	SCR Online	Total Released	Gypsum, Ash & FGD Sludge
January	4.3	0.43	0.05	0.48	3.82
February	6.8	0.33	0.14	0.48	6.32
March	7	0.26	0.16	0.43	6.57
April	2.6	0.06	0.07	0.13	2.47
May	3.3	0.15	0.07	0.22	3.08
June	23	1.48	0.02	1.90	21.10
July	15.9	0.41	0.40	0.81	15.09
August	8.8	0.29	0.21	0.50	8.30
September	8.1	0.29	0.19	0.48	7.62
October	5.6	0.07	0.16	0.22	5.38
November	4.8	0.12	0.12	0.24	4.56
December	11.3	0.44	0.26	0.70	10.60
Total	101.5	4.34	2.25	6.59	94.91

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

Source Test Verification

To show that these assumptions are responsible, a source test verification was performed on the total mass of mercury released (shown above) for each operating scenario versus a calculated total mass of mercury for units 3&4. The evaluations were weighted using a weighting factor which equates to the percent of time in the reporting year each operating scenario applied. The error between the weighted calculated mercury emissions based on the results of the annual source tests and removal efficiency calculated emission method should be less than 20%.

The following formula was used.

$$\text{Calculated Annual Hg Release (kg)} = \frac{\text{Annual Gross Load (Gw - hr)} \times \text{Measured Hg Emission Rate}\left(\frac{\text{mg}}{\text{s}}\right)}{\text{Avg. Load During Source Test (Gw)}} \times \frac{3600\left(\frac{\text{s}}{\text{hr}}\right)}{1{,}000{,}000\left(\frac{\text{mg}}{\text{kg}}\right)} \times \text{Weighting Factor}$$

The table below shows the inputs as well as the resultant calculated annual release of mercury.

Mercury Source Test Verification	Unit 4 - SCR Bypassed*	Unit 3 - SCR Online*
Annual Gross Load (Gw-Hr)	2465.45	2465.45
Average Load during Source Test (Gw)*	0.297	0.401
Measured Mercury Emission Rate (mg/s)*	0.46	0.1
Weighting Factor	25.00%	75.00%
Calculated Annual Release (kg)	3.44	1.66
Annual Release from Table (kg)	3.01	1.88
Difference (kg)	0.43	0.22
% Difference	14%	13%

* depicts conditions of 2012 Annual Source Test

The results of both verification tests show acceptable agreement between the calculated mercury emissions and the removal efficiency method calculated emissions.

Emissions during periods when SCR was bypassed shows 86% agreement. Lambton operated under these conditions for approximately 25% of its annual output. This shows excellent data quality under the flue gas desulphurization (FGD) online, SCR bypassed scenario.

Emissions during periods when SCR was online showed 87% agreement. Lambton operated under these conditions for approximately 75% of its annual output. Ontario Power Generation (OPG) considers these emissions to be reasonable and the data quality is still considered good under the both SCR and FGD online scenario.

f) Mercury Speciation

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

Historic Mercury Emission Testing at Lambton Generating Station

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%		
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
Lambton	4	March, 2011				0.13	0.28
Lambton	3	March, 2012				0.10	0.25
Lambton	4	March, 2012				0.46	1.35

Note: special mercury stack testing was discontinued at Lambton in 2009 as described in section 2.7 of the approved MMRP.

g) Mercury Content of Coal

Please see section e) on Supporting Data. It details the quantity of coal consumed as well as the associated mercury content.

h) Combustion Residues Mercury Content, Mass and Management Method

Please see section e) 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 2012, 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 and FGD sludge was landfilled onsite.

Mercury Content of Coal Combustion Residues

Ash Type	Quantity Diverted from Disposal (tonnes)	Quantity Land Filled on Site (tonnes)	Total (tonnes)	Avg. Mercury Concentration (ug/g)
Bottom Ash	9,975	0	9,975	0.05
Fly Ash	58,155	11,666	69,822	0.39
Gypsum	135,839	0	135,839	0.336
FGD Sludge	0	6,591	6,591	20.44

The historical stack sampling results are reported in section f) on Mercury Speciation or Total Mercury Stack Test Results. A summary of the coal, ash and gypsum data from the year 2005 – 2012 follows.

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (tonnes)	Total Mercury (kg)	Mercury Emitted to Air (kg)
2012	Low Sulphur Bituminous Coal	0		0	0	4.88
	High-Sulphur Bituminous Coal	0.116	6.9	846,242	80.8	
	Bottom Ash	0.05		3,160		
	Fly Ash	0.39		69,822		
	Gypsum	0.336		135,839		
2011	Low Sulphur Bituminous Coal	0		0	0	2.1
	High-Sulphur Bituminous Coal	0.107	7.47	466,075	49.1	
	Bottom Ash	0.08		5,251		
	Fly Ash	0.03		36,776		
	Gypsum	0.2		102,437		
2010	Low Sulphur Bituminous Coal	0.07		165,018	11	8.1
	Mid-Sulphur Bituminous Coal	0.08	7.5	1,073,754	94	
	Bottom Ash	0.06		14,506		
	Fly Ash	U1&2 – 0.326		16,596		
		U3&4 – 0.213		79,478		
	Gypsum	0.303		155,532		
2009	Low Sulphur Bituminous Coal	0.08	8.1	191,117	16	19
	Mid-Sulphur Bituminous Coal	0.1	5.8	1,174,917	121	
	Bottom Ash	0.043		15,806		
	Fly Ash	U1&2 - 0.328		17,535		
		U3&4 - 0.272		87,258		
	Gypsum	0.222		199,014		

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (tonnes)	Total Mercury (kg)	Mercury Emitted to Air (kg)
2008	Low Sulphur Bituminous Coal	0.09	6.9	651,737	56	58
	Mid-Sulphur Bituminous Coal	0.1	7.9	1,692,915	175	
	Bottom Ash	0.049		28,764		
	Fly Ash	U1&2 - 0.300		63,511		
		U3&4 - 0.230		128,712		
	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.

Note: Re-computation of the values in this table may not yield the exact results due to rounding. A summary of the ash & other residues disposition data from the year 2005 - 2009 follows:

Year	Ash Type	Quantity Diverted from Disposal (tonnes)	Quantity Land Filled on Site (tonnes)	Total (tonnes)
2011	Bottom Ash	5,251	0	5,251
	Fly Ash	36,388	378	36,766
	Gypsum	102,437	0	102,437
2010	Bottom Ash	14,506	0	14,506
	Fly Ash	40,518	55,556	96,074
	Gypsum	155,533	0	155,532
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 Emission of Total Mercury

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
2011	32

2012	**16**

b) Mercury Capture Rate
Applies to new units only.

c) Monitoring Methods Used for All Parameters
The sampling and analytical procedures used to compile the mercury emission figures are described in the accepted Mercury Monitoring and Reporting Program MMRP dated September 2012.

d) Justification for Alternative Methods
No alternate methods were used in 2012.

e) Additional Supporting Data
The following table shows the coal consumption, ash production, and average mercury concentrations used to calculate emissions for 2012.

Material	**Mercury Concentration (mg/kg) H_c/H_a**	**Moisture (%)**	**Amount Consumed or Produced (tonnes) T_c/T_a**	**Total Mercury (kg) C_m/A_m**
Sub-bituminous Coal (PRB)	0.074	27.6	818,040	44
Bituminous Coal (USLS)	0.073	9.1	185,909	12
Bottom Ash	0.022		9,583	0
Fly Ash	0.747		53,547	40
Emitted to Air				16

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

f) Mercury Speciation
The 2012 source testing on all units measured total vapour phase mercury emissions.

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	6	Jan 2012	-	-	-	0.75	2.04
Nanticoke	1	Nov 2010	-	-	-	0.69	1.55

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)
Nanticoke	2	July 2009	0.0034	0.34	0.56	0.89	1.9
			0.4%	37.5%	62.1%		
Nanticoke	3	June 2008	0.0044	0.89	1.31	2.2	4.2
			0.2%	40.4%	59.4%		
Nanticoke	2	April 2007	0.018	0.84	1.0	1.86	3.4
			1.0%	45.6%	54.3%		
Nanticoke	2	April 2005	0.021	0.86	1.24	2.12	4.2
			1.0%	40.5%	58.5%		
Nanticoke	3	June 2007	0.00	0.89	1.31	2.20	4.2
			0.2%	40.3%	59.5%		
Nanticoke	3	April 2005	0.16	0.65	0.47	1.28	2.4
			12.5%	50.8%	36.7%		
Nanticoke	6	Aug 2004	0.02	0.59	0.63	1.24	2.5
			1.9%	47.4%	50.7%		
Nanticoke	6	June 1999	0.04	0.44	0.54	1.03	2.1
			4.1%	43.0%	52.9%		
Group 2							
Nanticoke	5	Jan 2012	-	-	-	1.60	5.13
Nanticoke	5	May 2011	-	-	-	1.30	2.97
Nanticoke	5	June 2010	-	-	-	1.59	3.71
Nanticoke	5	Dec 2009	0.004	0.52	0.70	1.22	2.3
			0.3%	42.9%	57.1%		
Nanticoke	5	March 2009	0.012	0.38	0.73	1.12	2.1
			1.0%	33.6%	65.2%		
Nanticoke	5	March 2007	0.23	0.53	0.43	1.18	2.3
			19.2%	44.5%	36.3%		
Nanticoke	5	Sept 2004	0..02	1.02	0.28	1.32	2.5
			1.7%	76.9%	21.4%		
Nanticoke	5	April 2002	0.54	0.73	0.23	1.50	2.8
			35.9%	49.0%	15.1%		
Group 3							
Nanticoke	7	Jan 2012	-	-	-	1.80	4.54
Nanticoke	8	March 2011	-	-	-	1.06	2.82
Nanticoke	7	April 2010	-	-	-	2.48	5.01
Nanticoke	8	July 2009	-	-	-	0.96	2.2

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)
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%		

g) Mercury Content of Coal, and
h) Combustion Residues Mercury Content, Mass and Management Method

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

In 2012 fly ash and bottom ash were sold to the cement and concrete industries. The remainder was landfilled on site.

Ash Type	Quantity Diverted from Disposal (tonnes)	Quantity Land Filled on Site (Mg)	Total (Mg)
Bottom Ash	1,439	8,144	9,583
Fly Ash	89,831*	0*	53,547

* Values take into account usage of recovered fly ash from storage pile

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

A summary of the coal and ash data from 2005 to 2012 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 (tonnes)	Total Mercury (kg)
2012	Sub-bituminous Coal	0.074	27.56	818,040	44
	Bituminous Coal	0.073	9.08	185,909	12
	Bottom Ash	0.022		9,583	0
	Fly Ash	0.747		53,547	40
	Emitted to Air				16
2011	Sub-bituminous Coal	0.071	28.45	1,175,897	60
	Bituminous Coal	0.068	8.81	259,390	16
	Bottom Ash	0.006		13,244	0
	Fly Ash	0.594		74,003	44
	Emitted to Air				32
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		40,40	0.6
	Fly Ash	0.716		225,78	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

Year	Material	Mercury Concentration (mg/kg)	Moisture (%)	Amount Consumed or Produced (tonnes)	Total Mercury (kg)
	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-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 (tonnes)	Quantity Land Filled on Site (tonnes)	Total (Mg)
2012	Bottom Ash	1,439	8,144	9,583
	Fly Ash	89,831	*	53,547
2011	Bottom Ash	1,985	11,259	13,244
	Fly Ash	51,885	22,118	74,003
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 Emission of Total Mercury

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
2011	4
2012	**2**

b) Mercury Capture Rate
Applies to new units only.

c) 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 September 2012.

d) Justification for Alternative Methods
No alternate methods were used in 2012.

e) Additional 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 (tonnes wet)	Coal Consumed or Ash Produced (tonnes dry)	Total Mercury (kg)
PRB Coal	0.0605	39,289	27,459	1.665
Bottom Ash	0.016		416	0.007
Fly Ash	0.020		1,243	0.025
Emitted to Air				2

f) Mercury Speciation

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
Thunder Bay	3	Feb, 2011*				0.53	5.37
Thunder Bay	3	Feb, 2012*				0.58	5.72

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

g) Mercury Content of Coal, and
h) Combustion Residues Mercury Content, Mass and Management Method
Please see section (e) 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 2012, fly ash was sold to the cement making and concrete industries. The remainder was landfilled on site.

Ash Type	Quantity Diverted from Disposal (tonnes)	Quantity Land Filled on Site (tonnes)	Total (tonnes)
Bottom Ash	0	416	416
Fly Ash	1,804	*	1,243

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

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 2005 to 2011 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 (tonnes wet)	Coal Consumed or Ash Produced (tonnes dry)	Total Mercury (kg)
2011	Sub-bituminous Coal	0.0605	74,851	54,731	3.34
	Bottom Ash	0.025		852	0.021
	Fly Ash	<0.005		2,457	0.012
	Mercury Emitted to Air				4
2010	Sub-bituminous Coal	0.0605	110,832	81,040	4.90
	Lignite Coal	0.100	35,986	23,743	2.37
	Bottom Ash	<0.005		2,014	0.010
	Fly Ash	<0.005		6,024	0.030
	Mercury Emitted to Air				7

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	0.063	89,673	66,849	4
	Lignite Coal	0.086	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	0.050	55,865	41,450	2
	Lignite Coal	0.085	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 2005 to 2011 follows:

Year	Ash Type	Quantity Diverted from Disposal (tonnes)	Quantity Land Filled on Site (tonnes)	Total (tonnes)
2011	Bottom Ash	0	822	822
	Fly Ash	3,403	0*	2,457
2010	Bottom Ash	0	2,014	2,014
	Fly Ash	1,517	4,507	6,024
2009	Bottom Ash	767	87	854
	Fly Ash	3,116	0*	2,563
2008	Bottom Ash	0	7,463	7,463
	Fly Ash	24,099	0*	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 Emission of Total Mercury

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
2011	5
2012	**2**

b) Mercury Capture Rate

Applies to new units only.

c) 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 September 2012

d) Justification for Alternative Methods
No alternate methods were used in 2012

e) Additional 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 (tonnes wet)	Coal Consumed or Ash Produced (tonnes dry)	Total Mercury (kg)
Lignite Coal	0.107	27,444	18,761	1.98
Bottom Ash	0.013		416	0.005
Fly Ash	0.047		2,314	0.109
Emitted to Air				2

f) Mercury Speciation
The following table summarizes the results of mercury tests conducted to date.
As per the revised MMRP, no stack testing occurred at Atikokan in 2012.

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
Atikokan	1	Sept, 2011*				1.19	7.28

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

g) Mercury Content of Coal and,
h) Combustion Residues Mercury Content, Mass and Management Method
Please see section e) on Supporting Data which details the amount of the different types of coal consumed and the amount of ash generated as well as the associated mercury content.

In 2012, flyash was sold to the cement making and concrete industries. The remainder was land filled on site.

Ash Type	Quantity Diverted from Disposal (tonnes)	Quantity Land Filled on Site (tonnes)	Total (tonnes)
Bottom Ash	0	580	580
Fly Ash	943	1,372	2,315

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 2005 to 2011 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 (tonnes wet)	Coal Consumed or Ash Produced (tonnes dry)	Total Mercury (kg)
2011	Lignite Coal	0.119	51,224	36,594	4.346
	Bottom Ash	0.013		1,231	0.016
	Fly Ash	0.047		4,923	0.231
	Emitted to Air				5
2010	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
2009	Lignite Coal	0.110	123,351	81,165	8.90
	Bottom Ash	0.007		2,715	0.02
	Fly Ash	0.013		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 2005 to 2011 follows:

Year	**Ash Type**	**Quantity Diverted from Disposal (tonnes)**	**Quantity Land Filled on Site (tonnes)**	**Total (tonnes)**
2011	Bottom Ash	0	1,235	1,235
	Fly Ash	1,927	2,998	4,925
2010	Bottom Ash	0	6,970	6,968
	Fly Ash	10,414	6,058	27,788
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

In accordance with Saskatchewan's commitment to the Canada-wide Standards for Mercury Emissions From Coal-Fired Electric Power Generation Plants, an agreement on monitoring mercury emissions from SaskPower's coal-fired power plants was reached between the Saskatchewan Ministry of Environment (MoE) and SaskPower. With the application of credits for early action, Saskatchewan achieved its emissions cap in 2011 and 2012.

BOUNDARY DAM, POPLAR RIVER AND SHAND POWER STATIONS

a) Annual Emission of Total Mercury

Facility	2011 Mass Mercury Emissions – to Air (kg)	2012 Mass Mercury Emissions – to Air (kg)
Boundary Dam Power Station Unit 1	18	21
Boundary Dam Power Station Unit 2	18	21
Boundary Dam Power Station Unit 3	43	46
Boundary Dam Power Station Unit 4	46	42
Boundary Dam Power Station Unit 5	40	45
Boundary Dam Power Station Unit 6	81	70
Total for Boundary Dam Power Station	**245**	**246**
Poplar River Power Station Unit 1	112	88
Poplar River Power Station Unit 2	97	85
Total for Poplar River Power Station	**208**	**173**
Shand Power Station Unit 1	98	72
Total for Shand Power Station	**98**	**72**
Total for SaskPower	**551**	**490**
Net for SaskPower (with credits for early action)	**430**	**430**

The total mercury emissions for 2012 are lower than in 2011, primarily due to improved performance of the carbon injection systems at Poplar River as well as decreased generation at Shand due to an extended outage.

Under the Canada-wide standards for mercury SaskPower is eligible to claim credits for collecting mercury vehicle switches and for mercury reduced as a result of the research program at Poplar River Power Station, up to the end of 2009. Credits in the amounts of 121 kg and 60 kg were used to achieve the compliance limit of 430 kg in 2011 and 2012 respectively. SaskPower's collection of mercury credits is discussed in more detail in Section e) of this report.

b) Mercury Capture Rate

Facility	Percent of Mercury Captured
Boundary Dam Power Station Unit 1	12.76%
Boundary Dam Power Station Unit 2	7.23%
Boundary Dam Power Station Unit 3	1.70%
Boundary Dam Power Station Unit 4	3.15%
Boundary Dam Power Station Unit 5	1.91%
Boundary Dam Power Station Unit 6	4.81%
Average for Boundary Dam Power Station	**4.41%**
Poplar River Power Station Unit 1	56.23%
Poplar River Power Station Unit 2	53.46%
Average for Poplar River Power Station	**54.91%**
Shand Power Station Unit 1	11.77%
Average for Shand Power Station	**11.77%**
Average for SaskPower	**32.03%**

The percentage of mercury captured from coal in each unit is quite consistent for Boundary Dam Power Station. For Poplar River Power Station the percentage of mercury captured increased in 2012, due to improved activated carbon injection performance. For Shand Power Stationthe percentage of mercury captured decreased from 2011, this may be due to differences in combustion from previous years.

Emission Rate of Mercury for Each Unit (kg/TWh)

Facility	kg/TWh
Boundary Dam Power Station Unit 1	42.7
Boundary Dam Power Station Unit 2	44.7
Boundary Dam Power Station Unit 3	41.8
Boundary Dam Power Station Unit 4	40.6
Boundary Dam Power Station Unit 5	39.7
Boundary Dam Power Station Unit 6	36.3
Average for Boundary Dam Power Station	**39.8**
Poplar River Power Station Unit 1	37.6
Poplar River Power Station Unit 2	36.9
Average for Poplar River Power Station	**37.3**
Shand Power Station Unit 1	43.6
Average for Shand Power Station	**43.6**
Average for SaskPower	**40.2**

The emission rate of mercury remained largely unchanged for BDPS and SHPS, the emission rate for PRPS decreased as expected with the increased mercury capture.

c) Monitoring Methods Used for All Parameters

Mass Balance Approach

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 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 Electric Power Generation Plants. Any modifications from the previously used methods are based on the requirements of the agreement between MoE and SaskPower and 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).

Mercury in Coal Monitoring

The coal sampling procedure is in line with existing plant practices where coal is collected by automated sampling equipment on a daily basis according to ASTM D2234. Mercury analysis is performed at SaskPower's Asset Management and Operations Support chemistry laboratory using either the Leeman Labs Hydra C or the Leeman Labs Hydra C Appendix K mercury analyzer. The Hydra C Appendix K instrument is very similar to the Hydra C, but is can also analyze samples from sorbent traps, should they become more suitable for monitoring mercury emissions. A Sorbent Trap Mercury Monitoring System was purchased in 2011 and testing began at the Emissions Control Research Facility (ECRF) at Poplar River to determine its usefulness for monitoring mercury emissions. In the event SaskPower's mercury analytical equipment is not available, even with this redundancy, samples are still collected as described below and analyzed once the equipment becomes operational again. If the mercury analytical equipment is not available for a lengthy period of time, SaskPower may use the services of an external lab with a demonstrated ability to analyze mercury, such as CANMET or the University of North Dakota Energy and Environmental Research Center.

Under conditions of 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. If the sampling equipment is not available, feeder samples are collected and analyzed considering the recommendations of the CCCI report. 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.

Mercury in Fly Ash Monitoring

Flyash samples representing each unit are collected once every two weeks and analyzed according to ASTM D-6722 using either the Leeman Labs Hydra C mercury analyzer or the Leeman Hydra C Appendix K.

At Shand fly ash is collected from the silo used for holding fly ash before it is sent to storage or from the trucks transporting the fly ash for utilization.

At Poplar River fly ash was initially collected from the hoppers of each depth of an electrostatic precipitator (ESP) row. Subsequent data analysis has shown that representative data could be obtained by analyzing mercury from the first ESP fields. However, due to the variability seen in mercury concentrations once carbon injection started occurring Poplar River fly ash is now sampled from all fields.

There is statistical evidence showing that mercury determined in the first ESP field can reliably estimate the total mercury in Boundary Dam fly ash; therefore, sampling of the BDPS ESPs since 2010 has been done by sampling the first ESP field exclusively with the values for the remaining rows projected from first row analysis.

The mercury mass leaving the unit in the fly ash is determined from the mercury concentration of the fly ash analyzed and the amount of fly ash leaving the unit over the period of time represented by the analyzed fly ash.

Mercury in Bottom Ash Monitoring

The mercury content of bottom ash tends to be insignificant due to the almost complete volatilization of mercury during combustion and the subsequent transport of mercury with the flue gas away from where bottom ash is formed. Consequently, bottom ash is sampled on a quarterly basis and analyzed according to ASTM D-6722 to verify that the amount of mercury retained by the bottom ash remains negligible. The mercury mass leaving the unit in the bottom ash is determined from the mercury concentration of the bottom ash analyzed and the amount of bottom ash leaving the unit over the period of time represented by the analyzed bottom ash.

Quality Assurance and Quality Control (QA/QC)

SaskPower employs a number of QA/QC practices including the following:

i. Performing mercury analyses for each sample in quadruplicate. In cases where three of these mercury values do not agree within 10%, the analyses are repeated until three values agreeing within 10% are obtained.
ii. Daily analysis of standard and blank samples to verify the validity of mercury data collected for that day.
iii. Documentation and reasoning for any deviations from previously discussed methods.
iv. Comparison of data between reporting periods and determination of reasons for any differences.

v. Annual stack testing for speciated mercury to be performed from 2009 to 2012 after which time Saskatchewan MoE is to review the data to determine whether mercury testing can be coordinated with the stack testing required for criteria air contaminants under the Permit to Operate for each plant. Initially, the Ontario Hydro Method is to be used for speciated mercury emissions determination. Alternative methods may be used once they become available upon agreement to do this between SaskPower and MoE.

d) Justification for Alternative Methods

Mercury Analysis

Mercury analysis was performed using ASTM D-6722. The coal and flyash analysis was done using the Leeman Hydra-C instrument and the Hydra C Appendix K instrument. Both instruments experienced some maintenance issues as is usual with heavily used analytical equipment.

Mercury in Coal Monitoring

Boundary Dam Power Station

In 2012, 75 of the 79 (95%) scheduled coal samples were collected by ASTM D-2234 and subsequently analyzed for mercury by ASTM D-6722.

Poplar River Power Station

In 2012, 74 of the 79 (94%) scheduled coal samples were collected by ASTM D-2234.

Shand Power Station

The mechanical sampler at Shand did not operate correctly in 2012; therefore, feeder samples were collected throughout the reporting period. In order to compensate for the reduced representativeness of the feeder compared to the mechanical samples, feeder samples were collected each regular working day at the plant. 155 total feeder samples were collected during 2012 with data for the remaining days backfilled by using the respective quarterly average. The total number of feeder samples is less than in previous years due to the three month long major overhaul at Shand in 2012.

Mercury in Fly Ash Monitoring

Boundary Dam Power Station

In 2012, flyash samples were collected and analyzed for all units for the first fields. Mercury data for the remaining rows were estimated using statistical analysis as discussed previously. A total of 164 samples were collected out of the total 182 samples for all of BDPS (90%).

Poplar River Power Station

In 2012, 217 out of 234 scheduled samples were collected (97%). Additional flyash samples were taken in the last 3 months of 2012 to see if additional samples provided more information on fly ash mercury retention where activated carbon injection was occurring.

Shand Power Station
In 2012, 15 out of the 21 (71%) scheduled samples were collected, five fewer samples were scheduled to be collected due to the overhaul from May to July. Due to fewer samples collected in 2012, a rolling 3 sample average was not used. The week before and after were averaged for one sample missed; when two tothree samples in succession were missed the two weeks before and after were averaged; when greater than three samples were missed, the yearly average was used.

Mercury in Bottom Ash Monitoring
Boundary Dam Power Station
In 2012, bottom ash samples were supposed to be collected for each unit once per sampling quarter as specified by the CWS. No bottom ash samples were taken for the third quarter, all other quarters had the scheduled samples taken.

Poplar River Power Station
In 2012, bottom ash samples were supposed to be collected for each unit once per sampling quarter as specified by the CWS. All samples were collected in 2012.

Shand Power Station
In 2012, bottom ash samples were supposed to be collected once per sampling quarter as specified by the CWS. All samples were collected in 2012.

e) Additional Supporting Data

The Canada-wide Standards contain provisions for SaskPower to use credits for early actions to meet its caps. Examples of early action include a mercury switch collection program and early mercury controls at the Poplar River Power Station up to the end of 2009.

Mercury collection
Starting in 2003, SaskPower implemented a collection program with several scrap metal companies to recover old mercury switches in automobiles before they were fed to a steel mill furnace. In 2006 SaskPower announced a free service to its customers to recycle old home thermostats which contain mercury. SaskPower has also been collecting spent fluorescent light bulbs and all of SaskPower’s streetlight lamps for mercury recovery.

The mercury collected to date is summarized below:

Year	Mercury Collected from Mercury Switches, kg	Mercury Collected from Other Sources, kg	Total Mercury Collected, kg
2003/2004	48.568	0	48.568
2005	52.570	0	52.570
2006	36.276	6.210	42.486
2007	41.600	10.122	51.722
2008	29.541	13.473	43.014
2009	37.674	6.291	43.965
2010	26.888	1.416	28.304
2011	15.701	3.912	19.613
2012	18.285	1.461	19.746
Total	**307.103**	**42.885**	**349.987**

Mercury Reduction at Poplar River Power Station

SaskPower has taken on an extensive research and development program to enhance the development of technologies that may be used to control the mercury emitted from SaskPower's units, which is primarily elemental in nature. This work also has applications to other Canadian utilities that emit mainly elemental mercury, in contrast to U.S. coal plants where flue gas mercury tends to have significant fractions of oxidized mercury. A key milestone of this work was the commissioning of SaskPower's Emissions Control Research Facility where selected technologies can be assessed for their capability to remove mercury from a slipstream of Poplar River's flue gas. Since the ECRF started operations, mercury removal from Poplar River has become more significant as:

- the ECRF has operated more consistently;
- a full-scale mercury removal demonstration occurred on Poplar River Unit 2;
- various modifications were made to the plant to prepare for the installation of long-term mercury controls and;
- Canada's first permanent mercury control system was installed for both units of Poplar River in 2009.
- An additional mercury control system was installed at Shand Power Station in 2012 and is still being worked on.

The changes in mercury emissions at Poplar River since this work began are summarized below:

Year	Baseline Mercury Emissions, kg	Mercury Emissions, kg	Reduction in Mercury Emissions, kg
2003	297.82	297.82	0
2004	297.82	294.80	3.02
2005	297.82	281.11	16.71
2006	297.82	222.12	75.70
2007	297.82	311.73	-13.91
2008	297.82	239.13	58.69
2009	297.82	308.96	-11.14
Total	**2084.74**	**1955.67**	**129.07**

In accordance with SaskPower's ongoing efforts to reduce its mercury emissions, SaskPower installed a new activated carbon injection system at its Shand Power Station during the 2012 overhaul; commissioning and optimization are still underway.

The overall inventory of mercury credits collected and used is summarized below.

Year	Mercury Credits from Mercury Switch Collection, kg	Reduction of Mercury Emissions from PRPS Early Action, kg	Total Credits for Early Action	Mercury Collected from Other Sources, kg (non-eligible for credits)	Credits Used, kg	Current Year Credits Remaining, kg
2003/04	48.568	3.02	51.588	0	-	51.59
2005	52.570	16.71	69.280	0	-	120.87
2006	36.276	75.70	111.976	6.21	-	232.84
2007	41.600	-13.91	27.690	10.122	-	260.53
2008	29.541	58.69	88.231	13.473	-	348.77
2009	37.674	-11.14	26.534	6.291	-	375.30
2010	26.888	n/a	26.888	1.416	171	231.19
2011	15.701	n/a	15.701	3.912	121	125.89
2012	18.285	n/a	18.285	1.461	60	84.17
Total	**307.103**	**129.07**	**436.173**	**42.885**	**352**	

The net amount of mercury credits available for further use is 84 kg. With the reductions of mercury emissions from carbon injection system operation at PRPS and the installation/commissioning of the control system at Shand, the remaining 84 kg of credits should cover any emissions exceeding limits in 2013.

f) Mercury Speciation

In accordance with the draft memorandum of understanding between the Saskatchewan Ministry of Environment and SaskPower on mercury monitoring, SaskPower has agreed to conduct annual speciated mercury testing at all of its stacks annually starting in 2009. The results for 2012 testing are summarized in the following table:

Stack	Test Dates	Contractor	Particulate Mercury	Oxidized Mercury	Elemental Mercury
Boundary Dam 1 & 2	Sept 18-20, 2012	SRC	0.08%	18.79%	81.17%
Boundary Dam 3	n/a	n/a	n/a	n/a	n/a
Boundary Dam 4	Sept 26-27, 2012	SRC	0.07%	18.27%	81.73%
Boundary Dam 5	Sept 28, 2012	SRC	0.07%	13.19%	86.81%
Boundary Dam 6	Sept 25, 2012	SRC	0.10%	19.21%	80.79%
Shand	Sept 26, 2012	Source Test	0.01%	7.07%	92.93%
Poplar River 1 & 2	May 2-3, 2012	Maxxam	7.67%	18.12%	73.87%

Speciated mercury was determined by the Ontario Hydro Test in all cases. Poplar River missed one test in 2011 and planned for two tests in 2012, but only one was completed. Unit 3 at Boundary Dam could not be tested in 2012 due to construction activities that prevented stack access. The mercury emissions as determined from the 2012 Ontario Hydro tests showed the emissions being primarily elemental in nature, consistent with data collected in previous years.

g) Mercury Content of Coal

Facility	Mercury Content of Coal (kg)
Boundary Dam Power Station Unit 1	24
Boundary Dam Power Station Unit 2	23
Boundary Dam Power Station Unit 3	47
Boundary Dam Power Station Unit 4	43
Boundary Dam Power Station Unit 5	46
Boundary Dam Power Station Unit 6	74
Total for Boundary Dam Power Station	**257**
Poplar River Power Station Unit 1	200
Poplar River Power Station Unit 2	182
Total for Poplar River Power Station	**382**
Shand Power Station Unit 1	81
Total for Shand Power Station	**81**
Total for SaskPower	**721**

The amount of mercury in coal is very similar between 2011 and 2012 for BDPS and PRPS. The amount of mercury in coal for SHPS is lower in 2012; this is due to the lower generation.

Mercury Retained in Fly Ash

Facility	Mercury Retained in Fly Ash (kg)
Boundary Dam Power Station Unit 1	2.9
Boundary Dam Power Station Unit 2	1.6
Boundary Dam Power Station Unit 3	0.8
Boundary Dam Power Station Unit 4	1.3
Boundary Dam Power Station Unit 5	0.8
Boundary Dam Power Station Unit 6	3.5
Total for Boundary Dam Power Station	**11.0**
Poplar River Power Station Unit 1	112.4
Poplar River Power Station Unit 2	97.2
Total for Poplar River Power Station	**209.6**
Shand Power Station Unit 1	9.5
Total for Shand Power Station	**9.5**
Total for SaskPower	**230.1**

The amount of mercury retained in fly ash is quite similar for BDPS in 2011 and 2012. PRPS had an increase in mercury retained in fly ash due to the better operation and performance of the activated carbon injection systems. SHPS had a decrease in the amount of mercury retained in fly ash from 2011 (24 kg), the 9 kg seen in 2012 is more consistent with previous years. This is likely from combustion tuning changes after the recent overhaul, as work was done in 2011 with combustion tuning that saw increases in mercury capture, the overhaul in 2012 may have resulted in the loss of the mercury retention benefits previously seen in 2011.

Mercury Retained in Bottom Ash

Facility	Mercury Retained in Bottom Ash (kg)
Boundary Dam Power Station Unit 1	0.19
Boundary Dam Power Station Unit 2	0.02
Boundary Dam Power Station Unit 3	0.04
Boundary Dam Power Station Unit 4	0.03
Boundary Dam Power Station Unit 5	0.04
Boundary Dam Power Station Unit 6	0.05
Total for Boundary Dam Power Station	**0.37**
Poplar River Power Station Unit 1	0.29
Poplar River Power Station Unit 2	0.01
Total for Poplar River Power Station	**0.30**
Shand Power Station Unit 1	0.00
Total for Shand Power Station	**0.00**
Total for SaskPower	**0.66**

The amount of mercury retained in bottom ash is consistent with previous years, very little overall capture.

h) Combustion Residues Mercury Content, Mass and Management Method

Facility	Combustions Residues (Mg)
Boundary Dam Power Station Unit 1	47,343
Boundary Dam Power Station Unit 2	44,414
Boundary Dam Power Station Unit 3	91,575
Boundary Dam Power Station Unit 4	84,043
Boundary Dam Power Station Unit 5	89,723
Boundary Dam Power Station Unit 6	144,310
Total for Boundary Dam Power Station	**501,407**
Poplar River Power Station Unit 1	296,467
Poplar River Power Station Unit 2	270,453
Total for Poplar River Power Station	**566,920**
Shand Power Station Unit 1	143,451
Total for Shand Power Station	**143,451**
Total for SaskPower	**1,211,778**

The amount of coal combustion residues is consistent with previous years except for SHPS, which had lower overall generation.

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 is increasing. About 30% of the ash produced at Boundary Dam was utilized in 2012, which is lower than what was utilized in 2011 (56%), but still more than the usual ~15% in previous years, showing the increased demand of SaskPower fly ash.

At Shand flyash 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 36% which is similar to 2011 sales, continuing the increase in fly ash sales from previous years that averaged about 25%. Applications for most, if not all, of the fly ash produced at Shand are expected to occur in the next few years.

Research and Development

The Canada-wide Standards implementation plan states “SaskPower will participate in a significant R&D program to determine the most suitable way to manage mercury emissions from lignite-fired power plants.”

SaskPower has carried out significant research and development to ensure that this provision of the Canada-wide Standards is met. Much of this work has been described in previous Mercury Monitoring Reports. Highlights of work for 2011 included:

Emissions Control Research Facility

The most significant work SaskPower has been involved in is the work leading to the design, construction and subsequent test work of its ECRF, which draws a continuous stream equivalent to about 1 MW of generation from its Poplar River Power Station. The ECRF was originally designed and built in order to determine how to comply with the Canada-wide Standards for Mercury Emissions from Coal-fired Electric Power Generation Plants, which were under development at the time. Because of the work done at the ECRF, SaskPower was awarded the Canadian Electricity Association’s Environmental Commitment and Responsibility Award for Environmental Stewardship in January 2009. In 2011 this work was recognized through the presentation of the Distinguished Service Award for Research and Development by the Lignite Energy Council (LEC). SaskPower belongs to the LEC along with several utilities and other lignite stakeholders in order to jointly develop solutions to problems associated with producing electricity by burning lignite.

The primary success of the ECRF test program was the determination that injecting brominated activated carbon upstream of an electrostatic precipitator was the most suitable means of controlling mercury emissions for power plants burning the kind of coal used at SaskPower. Recent improvements in product formulations have been claimed by numerous activated carbon suppliers. In addition, some suppliers have been promoting alternate materials to activated carbon for mercury control. In 2012 MoE granted approval to SaskPower to test several of these products at the ECRF. Testing began in 2012 and will continue into 2013.

After achieving encouraging results in the ECRF tests, a temporary full-scale system was installed on Unit 2 of Poplar River in 2007 and run until 2009. This led to the installation of Canada's first permanent utility-scale carbon injection system to control mercury at both units at Poplar River. This system incorporated many design changes based on experiences with the temporary system, and was handed over to the plant on June 5, 2009. Various problems have been encountered in achieving the reliability required to achieve consistent on-going mercury removal. Considerable effort has been made to address these and much better reliability was achieved in 2011, with further improvements noted in 2012. In 2012 a full-scale carbon injection system was installed at Shand. Several design features were incorporated into this system, based on experiences with the Poplar River system.

SaskPower has installed equipment at the ECRF that was designed to achieve better flue gas mixing in order to reduce particulate emissions. This mixing should also achieve better contact between injected activated carbon and mercury in flue gas, resulting in more efficient mercury capture.

Coal Treatment
SaskPower continues investigating various options to treat coal prior to combustion in order to remove mercury and other undesirable constituents of the coal.

In 2012 a study by the manufacturer of one of SaskPower's boilers was initiated to assess whether adverse impacts on certain boiler components would result from the implementation of coal treatment. This work will continue into 2013. In 2012 SaskPower and other members of the Canadian Clean Power Coalition continued their evaluation of coal treatment technologies for application to the coals burned in Canada. SaskPower also started a study in 2012 by the project team to do more detailed analyses of selected technologies for application to the kind of coals that SaskPower burns.

Other Research
In 2012 SaskPower started to evaluate sorbent trap monitoring for mercury analysis at the ECRF. SaskPower is working with the supplier of this system to develop a customized system for monitoring mercury and SaskPower will continue this work in 2013. Various field tests occurred in 2012 in a project SaskPower is co-sponsoring to develop a method to monitor mercury and other flue gas trace constituents by a technique similar to sorbent trap monitoring. This work will also continue in 2013 and U.S. Environmental Protection Agency approval of the method being developed will be sought.

In May of 2011 SaskPower started construction of a carbon capture system on Unit 3 at Boundary Dam Power Station. Commissioning of this system will occur in 2013, at which time the project's effect on mercury emissions will be evaluated.

Due to using carbon injection at Poplar River Power Station to control mercury emissions, the differences between mercury in the coal entering the plant and the mercury retained in the ashes has become considerably less than previously when mercury emissions were uncontrolled, and in 2012 greater variability in mercury emissions determinations were noted.

In order to deal with the increased variability in mercury determinations noted at Poplar River, and to assess SaskPower's mercury compliance status on a timelier basis, a predictive tool has been developed to estimate mercury emissions based on previous mass balance data. Comparisons between mass balance data and estimates from this tool have generally agreed to within 10%.

SaskPower is evaluating mercury CEMs and sorbent trap systems at the ECRF as potential alternatives to mass balance monitoring at Poplar River. So far the mercury CEMs have not shown the reliability required in the CCME Monitoring Protocol in Support of the Canada-Wide Standards for Mercury Emissions from Coal-Fired Power Generation Plants. Initial tests of the sorbent trap systems at Poplar River discussed above have been encouraging, but further work is required to determine the efficacy of these systems.

SaskPower is installing a CO_2 capture system at its Boundary Dam Unit 3. The CO_2 capture system has multiple process streams that could make mass balance monitoring challenging. Sorbent traps and mercury CEMs are being considered as alternatives.

Future Achievement of Canada-wide Standards

At the end of 2012 84 kg of credits for collecting mercury vehicle switches and for mercury reduced as a result of the research program at Poplar River Power Station remained. Assuming credits similar in amount will be required in 2013 for compliance, SaskPower should have enough credits left to meet compliance in 2013. The work on optimizing the Shand and PRPS activated carbon injection systems should help to meet the 430 kg limit once credits are exhausted.

No new units have come on line at SaskPower during this reporting period. Any new units that may be installed in the future will be designed to meet the limits for new facilities based on the coal type. For lignite coal this means achievement of 75% capture of mercury in coal burned, and an emission rate limit of 15 kg/TWh.