CCME

Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

MONITORING PROTOCOL IN SUPPORT OF THE CANADA-WIDE STANDARDS FOR MERCURY EMISSIONS FROM COAL-FIRED ELECTRIC POWER GENERATION PLANTS

The Canada-wide Standards

The *Canada-wide Standards (CWSs) for Mercury Emissions from Coal-fired Electric Power Generation (EPG) Plants*, endorsed by CCME in October 2006, consist of two sets of targets:

- provincial caps (kg/yr) on mercury emissions from existing coal-fired EPG plants to be achieved by 2010; and
- capture rates (percent capture in coal burned) or emission limits (kg/TWh) for new plants, based on best available technology economically achievable, effective immediately.

Part 2 of the CWSs states that jurisdictions will establish and maintain testing in accordance with this *Monitoring Protocol*. Furthermore, the federal government, with support from the provinces and territories, will aggressively pursue further reductions in the global pool of mercury.

Purpose

The purpose of this *Monitoring Protocol* is to provide guidance to jurisdictions on monitoring and reporting to assess achievement of the CWSs for coal-fired EPG plants. This *Monitoring Protocol* is designed to collect consistent, comparable, and credible national information for public reporting on CWSs achievement, and support future decisions on effective management of mercury releases from this sector.

Canada has signed a number of regional and international agreements with the US and the United Nations Economic Commission for Europe that reduce emissions to the global pool of mercury. Information generated through this *Monitoring Protocol* will also assist Canada in meeting its obligations and in working with foreign states from a position of knowledge.

Review

CCME may review this *Monitoring Protocol* separately or as part of a review of the CWSs.

As part of a review, CCME should consider how to promote consistency between the requirements of this *Monitoring Protocol* and the National Pollutant Release Inventory.

Elements of the Monitoring Protocol

This *Monitoring Protocol* addresses the following elements:

1. monitoring;
2. reporting;
3. record keeping;
4. quality assurance and quality control (QA/QC); and
5. CWSs achievement determination.

Prior to implementation of a new or modified monitoring and reporting program in accordance with this *Monitoring Protocol*, jurisdictions should ensure that utilities submit a proposed plan for consideration and acceptance by the jurisdiction having authority. This plan should include QA/QC methodologies, and any other elements for which approval by the authority having jurisdiction has been identified.

1.0 MONITORING

Monitoring methods outlined in this *Monitoring Protocol* include:

- source testing stack surveys, which provide a discrete "snapshot" of emissions during a specified test period. The operating conditions during the test period should be representative of normal operating conditions if used to estimate annual emissions;
- Continuous Emissions Monitoring Systems (CEMS), which monitor the concentration of an air pollutant from a release source on a continuous basis;
- mass balance, where mercury in coal and residues are monitored, with the difference being determined as the amount of mercury emitted from the stack. The residue sampling must be timed such that it is representative of the coal that was burned;
- established data (see Section 1.4); and,
- other approaches of equal or better accuracy, such as the sorbent trap method (STM), which is a non-isokinetic test method that samples flue gas while minimizing particulate capture, and provides total vapour-phase mercury emissions.

For existing and new coal-fired EPG plants, total annual mercury emissions will be measured, including emissions occurring during both normal conditions and abnormal conditions (start-up, upsets, and equipment maintenance for example).

1.1 Coal-fired Power Generation Plants Commissioned Prior to 2012

Beginning January 1, 2008, monitoring of mercury emissions from existing plants defined in the CWS or from new units commissioned prior to 2012 shall be conducted using one of the following approaches outlined in Table 1.1

This does not prevent jurisdictions from encouraging or requiring such monitoring as described above prior to January 1, 2008.

1.2 New Coal-fired Power Generation Units

This section applies to new coal-fired power generation units commissioned by January 1, 2012 and thereafter. Beginning January 1, 2012, these new units shall monitor all its mercury emissions using continuous emissions monitoring systems capable of measuring total mercury and elemental mercury. Appendix A of this Protocol describes how mercury emissions will be calculated using CEMS.

1.3 Low Mass Emitters

1.3.1 Applicability of the Low Mass Emitter (LME) Option

Section 1.3 applies to existing plants as defined in the CWSs and to new coal-fired power generation units commissioned prior to January 1, 2012.

Beginning January 1, 2012, plants and units as defined by this section that have not qualified for the low mass emitters (LME) option (as described in section 1.3.2), or that have surpassed the LME option's threshold, shall monitor their mercury emissions thereafter using continuous emissions monitoring systems capable of measuring at a minimum total mercury and elemental mercury. Appendix A of this Protocol describes how mercury emissions will be calculated using CEMS.

1.3.2 Low Mass Emitter (LME) Option

Beginning January 1, 2012, jurisdictions may consider exemptions from continuous emissions monitoring for low mass emitters (LME) on a per stack basis as explained below. The LME option is for those existing plants and new units, as defined in section 1.3.1, whose yearly stack emissions of mercury are below the threshold set by this *Monitoring Protocol* and as authorized by each jurisdiction.

Jurisdictions may consider an existing plant's application for the LME option. The LME option application for monitoring during the upcoming calendar year shall be based on the previous three calendar years of monitoring data gathered as per section 1.4 of this Protocol. Beginning in 2013 and thereafter**,** the LME option application for monitoring during the upcoming calendar year shall be based on the existing plant's monitoring results generated in the previous calendar year. The threshold for the LME option is either:

a) 10 kg of mercury per stack per year for existing plants/new units with multiple stacks; or
b) 20 kg of mercury per stack per year for existing plants/new units with one stack.

If yearly stack emission of mercury is below these thresholds, that plant is considered to be eligible for the LME option for the following year.

Existing plants and new units, as defined in section 1.3.1, that have qualified for the LME option must still monitor their mercury emissions using the UDCP mass balance approach as authorized by their jurisdiction and described in Method 1 of Appendix A of this Protocol. Under the LME option, monitoring only needs to be done during those periods in which the plant is in start-up, normal operating, stand-by, shutting-down, or process upset modes.

1.4 Established Data

1.4.1 Use of Historical Results for Assessment of the Canada-wide Standard Targets

Historical results will not be used to determine the mercury content in coal, the mercury content of combustion residues (excluding bottom ash) nor the mercury content of flue gas when any of these parameters are being used to assess achievement of the Canada-wide Standards' targets for total mercury emissions from existing plants and new units.

1.4.2 Establishment of a Baseline for Speciation Monitoring

Between January 1, 2008 and January 1, 2012, jurisdictions will require that existing plants and all new units conduct one (1) stack speciation test per year where the stack speciation testing is done in accordance with Table 1.2.

1.4.3 Establishment of a Baseline for Residue Monitoring

Between January 1, 2008 and January 1, 2012, if jurisdictions have not required that existing plants and all new units monitor their total mercury emissions using approach 2 in Table 1.1 (mass balance) then jurisdictions will require that existing plants and all new units monitor their mercury content of coal and coal combustion residues using the Reduced Monitoring Sub-approach given in Table 1.1.

1.4.4 Use of Established Data for Monitoring Parameters Other than Total Mercury

Subject to Section 1.4.2, and for purposes other than assessing achievement of the Canada-wide Standards' targets for total mercury emissions from existing plants and new units, this section applies to the monitoring of:

- mercury content of coal;
- coal combustion residues; and,
- stack concentration of the species of mercury.

For existing plants and new units that have established consistent levels of the above listed parameters for a given technology configuration and fuel source, and with approval of the authority having jurisdiction, a utility may rely on established results for those parameters.

Where a utility is relying on established results, with any change in technology or any change in fuel is expected to result in a measurable change in mercury speciation, mercury content of the combusted coal, or mercury content of coal combustion residues, and at least once every 3 years, jurisdictions should ensure that utilities monitor all of the parameters outlined in Table 1.2 using one of the recommended methods.

1.5 Recommended Monitoring Methods

To determine achievement of the CWSs, jurisdictions will ensure that utilities monitor total mercury using one of the approaches recommended in Table 1.1. A jurisdiction should consider the unique plant configuration and the full range of monitoring needs in approving a monitoring method. Other approaches of comparable or better accuracy may be approved or specified by the jurisdiction having authority.

To generate additional information in support of reducing the global pool of mercury, other parameters in Table 1.2 will be monitored using one of the recommended approaches.

Table 1.1 Recommended Approaches and Methods for Monitoring Total Mercury

Parameters	Recommended Approaches	Recommended Methods
Total annual mercury emitted	1) Stack testing and flow monitoring	Stack testing using a continuous emission monitoring system (CEMS) as described in Appendix A of this Protocol. CEMS should be operated in accordance with the certification requirements of the US Environmental Protection Agency for mercury continuous emission monitoring systems, as updated [see Title 40 of the U.S. CFR §75]. The system should be operated in accordance with the manufacturer's recommended operating and QA/QC procedures, and as approved by the authority having jurisdiction. Mass emissions should be determined using stack gas flow data obtained from stack gas flow monitors. Specifications for stack gas flow monitors should be followed in accordance with Environment Canada's "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation" Report EPS 1/PG/7.*
	2) Mass Balance	Mass balance should be calculated in accordance with the requirements of the *Canadian Uniform Data Collection Program (UDCP) for Mercury from Coal-fired Electric Power Generation: A Guidance Document** or as authorized by a jurisdiction (see Method 1 of Appendix A). Stack speciation data will be provided by the yearly stack testing done in accordance with the UDCP. **<u>Reduced Monitoring:</u>** A coal-fired EPG plant that has established, following the UDCP mass balance monitoring procedures, consistent levels of: • total mercury content of the combusted coal; and/or • mercury content of coal combustion residues, arising from a given technology and fuel source configuration, may apply to the authority having jurisdiction for a reduced level of mass balance monitoring. At a minimum, monitoring of mercury in coal and ash should be undertaken one week every one month. Where monitoring frequency has been reduced, this monitoring should be supplemented with an annual stack test to corroborate the mass balance result reported for achievement determination. Where the results of the annual stack test are not within ± 20% of the mass balance results, the utility should account for this discrepancy.
	3) Other Equivalent Method	By any other method demonstrated to the satisfaction of the applicable jurisdiction to yield results with an accuracy equal to or greater than that achieved by approaches 1 or 2. In comparing the accuracy of any alternate method to that of approach 1 or 2, results within ± 20% of those obtained by either approach 1 or 2 should be considered as equal results. Guidance on determining this degree of relative accuracy can be taken from Appendix K of Title 40 of US CFR §75.

Table 1.2 Recommended Approaches and Methods for Monitoring Parameters other than Total Mercury

Parameters	Recommended Approaches	Recommended Methods
Mercury speciation in flue gas (elemental and oxidized)	a) Stack testing	i) Stack testing using CEMS (see total mercury above for more information)
		ii) Annual wet chemistry stack testing in accordance with the requirements of the *Ontario Hydro Method for the Measurement of Speciated Mercury Emissions: Sample Train Loading and Recovery Procedures*.
	b) Established data	See section 1.4 Established Data.
Mercury content of coal	a) Composite sampling	Sampling in accordance with the requirements of the *Canadian Uniform Data Collection Program (UDCP) for Mercury from Coal-fired Electric Power Generation: A Guidance Document.*
	b) Established data	See section 1.4 Established Data.
Mercury content of coal combustion residues (e.g. bottom ash and other waste streams)	a) Composite sampling	Sampling in accordance with the requirements of the *Canadian Uniform Data Collection Program (UDCP) for Mercury from Coal-fired Electric Power Generation: A Guidance Document.*
	b) Established data	See section 1.4 Established Data.

* Sample calculations are illustrated in Appendix A.

1.6 Modifications to Monitoring Programs

Modification to monitoring programs must be considered as a result of a change in technology or unanticipated change in fuel source expected to result in a measurable change in mercury speciation, mercury content of coal, or mercury content of coal combustion residues. Jurisdictions should ensure that utilities provide a revised monitoring proposal for approval by the authority having jurisdiction.

2.0 REPORTING

2.1 Jurisdictions

Jurisdictions will ensure that all information generated in accordance with this *Monitoring Protocol* is available to the public, including:

(a) annual emissions of total mercury from each coal-fired EPG plant (kg/year);
(b) capture rates (percent capture in coal burned) or emission limits (kg/TWh) for each new EPG unit;
(c) monitoring methods used for all parameters;
(d) justification for alternative methods;
(e) any supporting data or any other data requested by a jurisdiction to verify reported emissions or recognition for early action;
(f) mercury speciation;
(g) mercury content of coal; and,
(h) mercury content of coal combustion residues, the mass amounts 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..

2.2 CCME

Ministers will receive reports from jurisdictions in 2008, 2009, and 2010 and every two years thereafter until 2016 on the results of testing in accordance with this *Monitoring Protocol*. The reports in 2008, 2009, and 2010 will include reports on progress towards achievement of the CWSs. The reports in 2012, 2014, and 2016 will include reports on achievement of the CWSs. Ministers will ensure that a single report is prepared and posted on the CCME web site for public access for each reporting year.

For existing plants, jurisdictions will report a collective mercury emission number for comparison with provincial caps. For new units, jurisdictions will report individual mercury capture/emission rates for comparison with the CWSs limits. Jurisdictions should also report the results of testing for the parameters outlined in section 2.1.

3.0 RECORDKEEPING

Jurisdictions should ensure that utilities keep appropriate records to demonstrate that the methods recommended in this *Monitoring Protocol*, or alternatives approved by an authority having jurisdiction, were utilized in monitoring mercury emissions from coal-fired EPG plants. Records that should be retained for possible future review by the authority having jurisdiction include:

(a) annual emissions from each stack and supporting calculations; and
(b) the specific methodology used to monitor each parameter, including:
   - for CEMS, information on instrumentation, procedures followed, and measured results;
   - for stack tests, a summary of the conditions and methods used;
   - for mass balance, measured amount of coal into the plant, measured amount of combustion residues generated, frequency and type of sampling conducted as well as results of mercury testing on coal and combustion residues;
   - for composite sampling, information on frequency and type of sampling; and,
   - for any other parameters used in mercury calculations, information such as flow and annual electricity production.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Jurisdictions will require that utilities undertake QA/QC programs to ensure that the objectives of this *Monitoring Protocol* are met. QA/QC programs should include, but not be limited to:

- procedures to ensure that an emission measurement method is performed as described in the method approved by the authority having jurisdiction. This requires that the correct methodology and equipment be available at the facility, as well as people who are qualified in its use. Records should be kept that demonstrate that the correct procedures were followed;
- documentation and justification for any alternative methods used for monitoring;
- documentation of any procedural changes to the recommended methodology and their incorporation into the QA/QC program.; and,
- annual examination of emission values and trends on an individual source basis, with verification processes initiated where unexplained changes occur.

Additional QA/QC procedures may be required by the authority having jurisdiction.

5.0 CWS ACHIEVEMENT DETERMINATION

Achievement of the CWSs will be determined for each calendar year based on annual stack emissions, capture rates, or emission rates, as appropriate. See Appendix A – Method 3 and Method 4 for sample calculations for achievement determination.

APPENDIX A: SAMPLE CALCULATIONS

The following sample calculations are provided as an example of how achievement is determined:

<u>Method 1 — Mass Balance Approach</u>

The mass balance method is to be carried out in accordance with the requirements of the *Canadian Uniform Data Collection Program (UDCP) for Mercury from Coal-fired Electric Power Generation: A Guidance Document* or as authorized by a jurisdiction.

It is important to note that the UDCP requires that mercury concentrations be on a dry basis.

Furthermore, a jurisdiction must be satisfied that all coal and ash samples used by existing plants and new units in carrying out this method are representative of the larger samples from which they were drawn. As such, and as an aid to verify emissions, a jurisdiction may request from existing plants and new units any data that would support an existing plant's or new unit's claim that its samples are representative.

The following is a description of the general steps taken in performing the mass balance method:

- An annual average is determined from all coal samples analysed for mercury (ppm or g/tonne of coal) in a year.
- Total coal burned in the year is determined (tonnes/year).
- Annual average mercury in coal is multiplied by total coal burned to obtain (g/year).
- An annual average is determined from all ash samples analysed for mercury (ppm or g/tonne of coal) in a year.
- Total ash generated in the year is determined (tonnes/year).
- Annual average mercury in ash is multiplied by total ash to obtain (g/year).
- The total Hg in coal is subtracted by total mercury in residue to obtain mercury emissions through stack.
- The total mercury in residue is divided by total mercury in coal to obtain capture rate.

For those cases in which a jurisdiction deems that the mass of coal combusted during each sample periods is relatively consistent across all sample periods, the annual average mercury concentrations in coal and ash (H_c and H_a) are calculated as follows:

$$\mathrm{H_c \text{ or } H_a} = \frac{\sum_{1}^{n}\left(\mathrm{M_{c\,i}}\right)}{n} \qquad \textbf{Equation 1.1a}$$

Where:

i = the i^{th} sample period in a plants monitoring plan using mass balance as described in option 2) of Table 1 of this *Monitoring Protocol*

$M_{c\,i}$ = representative mercury concentration from coal or ash analyses, on a dry basis, during the i^{th} sample period

n = total number of coal or ash samples taken throughout the year

However, in those cases where the mass of coal combusted during each of the sample periods has not remained consistent, the annual average mercury concentrations in coal and ash (H_c and H_a) are calculated as follows:

$$H_c \text{ or } H_a = \frac{\sum_{1}^{n}\left(m_i \times M_{c\,i}\right)}{\sum_{1}^{n} m_i} \qquad \textbf{Equation 1.1b}$$

Where:

i = the i^{th} sample period in a plants monitoring plan using mass balance as described in option 2) of Table 1 of this *Monitoring Protocol*

$M_{c\,i}$ = representative mercury concentration from coal or ash analyses, on a dry basis, during the i^{th} sample period

m_i = total mass of coal combusted or ash generated during the period i for which $M_{c\,i}$ is representative

n = total number of coal or ash samples taken throughout the year

Data collected from the development of the CWS would suggest that when the mass of coal combusted during any one sample period in the year has not differed by more than ±20% from one twelfth of the yearly total of combusted coal, the difference in the average concentrations calculated by equations 1.1a and 1.1.b should not differ by more than 5%. Therefore, jurisdictions should consider the sample masses of coal combusted as being consistent when no one mass differs more than ±20% from one twelfth of the yearly total, i.e., apply equation 1.1a. Conversely, jurisdictions should consider the sample masses of coal combusted as being inconsistent when any one mass differs more than ±20% from one twelfth of the yearly total, i.e., apply equation 1.1b.

Annual mercury mass from coal is determined:

$$C_m = H_c \times T_c \qquad \textbf{Equation 1.2}$$

Where:

C_m = total annual mercury mass from coal (g/year)

H_c = annual average mercury concentration in coal (ppm or g/tonne)

T_c = total coal burned in the year (tonne), i.e., the sum of all m_is

Annual mercury mass in ash is determined:

$$A_m = H_a \times T_a \qquad \textbf{Equation 1.3}$$

Where:

A_m = total annual mercury mass in ash (g/year)
H_a = annual average mercury concentration in ash (ppm or g/tonne)
T_a = total ash generated in the year (tonne)

Compliance with limits is evaluated using either Equation 1.4 or 1.5:

$$\text{Mercury Emission Rate} = \frac{C_m - A_m}{G_a} \qquad \textbf{Equation 1.4}$$

Where:

Ga = total annual net energy generated (TWh)

$$\text{Percent Capture} = \frac{A_m}{C_m} \times 100 \qquad \textbf{Equation 1.5}$$

Method 2 — Stack Monitoring

2.0 Determination Using Real-Time Stack Gas Flow Monitors[1]

The calculation of the mass emission rate of mercury using a real-time stack gas flow monitor and mercury analyzer is shown in Equation 2.1. See Appendix B for protocols on validating CEMS data. Note that Q_w and C_w are both expressed on a wet basis at 25°C and 101.325 kPa.

$$ER = Q_w \times C_w \times 10^{-9} \times K \qquad \textbf{Equation 2.1}$$

where:

- ER = emission rate of mercury (kg/h)
- Q_w = wet stack gas volumetric flow rate (WSm^3/h)
- C_w = hourly averaged wet-basis concentration of mercury (µg/WSm^3), based on a minimum of 1 reading every 15 minutes
- K = concentration factor, use 1 if C_w in µg/WSm^3 or 8.199 if C_w in ppb (v/v)

Example: The flow from a power plant burning bituminous coal measured at the stack with a real-time stack gas flow monitor is 28,000 WSm^3/min (wet at 25°C and 101.325kPa). The wet basis concentration of mercury is 9.3µg/WSm^3.

Parameter	Input
Q_w	= 28,000 WSm^3/min × 60 min/h
C_w	9.3 (This is equivalent to 1.13 ppb, v/v) Note: If concentration is on a dry basis, multiply C_d by (100 - B_{ws})/100 where B_{ws} is the stack gas moisture content (%, v/v). See Report EPS 1/PG/7 (Revised), December 2005 for the determination of B_{ws}.
K	1
ER = 28,000 × 60 WSm^3/h × 9.3 µg/WSm^3 × 10^{-9} kg /µg × 1 = 0.01562 kg/h (Note this value represents total gaseous mercury)	

2.1 Energy Input Method - Metering of Fuel Flows[1]

The weight of solid fuel consumed must be continuously monitored and recorded automatically by the data acquisition system, and an hourly mass consumption calculated and recorded. The device used to continuously meter the fuel flow rate must meet a 2% accuracy specification and

[1] Equations derived from Environment Canada's *Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation,* Report EPS 1/PG/7 (REVISED), December 2005

must be calibrated at the frequency indicated by the supplier as adequate to maintain the accuracy within the specifications.

A continuous sample of the as-fired solid fuel must be taken and a 24-hour composite is analyzed for Gross Calorific Value (GCV). Determine the hourly heat input to the unit by multiplying the daily GCV by the hourly mass flow rate of the fuel.

The calculation of the mass emission rate of mercury using an oxygen-based dry system is shown in Equation 2.2. Note that F_d and concentration are both expressed on a dry basis at 25°C and 101.325 kPa.

$$ER = HI \times C_d \times 10^{-9} \times F_d \times K \times [20.9/(20.9 - \%O_{2d})] \qquad \textbf{Equation 2.2}$$

where:

ER	=	emission rate of mercury (g/h)
HI	=	gross heat input (GJ/h)
C_d	=	dry-basis concentration of mercury (µg/DSm^3 or ppb,v/v)
F_d	=	ratio of the volume of dry gas resulting from stoichiometric combustion of the fuel with air to the amount of heat produced (DSm^3/GJ)
K	=	concentration factor, use 1 if C_d in µg/DSm^3 or 8.199 if C_d in ppb (v/v)
$\%O_{2d}$	=	dry-basis concentration of oxygen (%, v/v)

Example: A power plant burning bituminous coal has a gross heat input of 5000 GJ/h. On a dry basis, the mercury concentration at the stack is 10 µg/DSm^3 and the oxygen level is 3.2%.

Parameter	**Input**
HI	5000 GJ/h
C_d	10 (This is equivalent to 1.22 ppb, v/v)
F_d	From Table A-1 in Appendix A of PG/7, F_d for bituminous coal is: 267 DSm^3/GJ
K	1
$\%O_{2d}$	3.2 (The quantity 20.9 /(20.9 - 3.2) denotes the combustion air ratio)
ER = 5000 GJ/h ×10 µg/DSm^3 × 10^{-6} g/kg × 267 DSm^3/GJ × 1 × 20.9/(20.9 - 3.2) = 15.76 g/h (Note this value represents total gaseous mercury)]	

Method 3 — Compliance for Existing Facilities

3.0 Annual Mass Emissions

Compliance with annual provincial caps is determined by summing the mass of mercury emitted from all the facilities for one-calendar-year.

Table 1: Current Provincial Emissions and Compliance Caps.

Province	2010 Cap (kg/yr)
Alberta	590
Saskatchewan	430
Manitoba	20
Ontario	TBD
New Brunswick	25
Nova Scotia	65
Total	*TBD*

3.1 Determining Annual Emissions with the use of CEMS

Hourly emissions recorded by CEMS[2] and calculated using Method 2 of Appendix A, will be summed for each operating hour throughout the calendar year to yield the total annual emitted mass of mercury.

$$M_a = \sum_{i=1}^{n} (ER)_i \, n_i \qquad \textbf{Equation 3.1}$$

where:

M_a = total annual emitted mercury, (kg)
ER = mercury emitted in a valid unit operating hour i as calculated in Equation 2.1 (kg/h)
n = total number of valid unit operating hours in the calendar-year
n_i = the i^{th} valid unit operating hour in the calendar-year

3.2 Determining Annual Emissions without the use of CEMS

In facilities where CEMS are not installed, refer to the 'Mass Balance Approach' outlined in Method 1 of Appendix A to determine annual emissions.

[2] A minimum recording of 1 data value is required for each quarter-hour (15-minute interval)

Method 4 — Compliance for New Facilities

4.0 Annual Mass Emissions

Compliance with annual provincial caps is determined by summing the mass of mercury emitted from all the facilities for one-calendar-year.

Table 2: Mercury Control Standards for New Coal-Fired EPGs.

Coal Type	**Percent Capture in Coal Burned (%)**	**Emission Rate[3] (kg/TWh)**
Bituminous	85	3
Sub-bituminous	75	8
Lignite	75	15
Blends	85	3

4.1 Emission Rate Standard

For unit-based analysis, emission rate compliance is based on a 12-month total, (E_{tot}), weighted based upon on the amount of energy produced in the year.

$$E_{tot} = \frac{M_a}{G_a} \qquad \textbf{Equation 4.1}$$

where:

E_{tot} = total emission rate for the calendar-year (kg/TWh)
M_a = total mass emitted[4] for the calendar-year (kg)
G_a = total net energy generated for the calendar-year (TWh)

4.2 Capture Rates Standard

The calculations applied must be suitable to the mercury (Hg) capture configuration employed.

[3] Compliance is based on an average annual emission rate as specified in the CWS

[4] Total mass emitted as determined by hourly CEMS data as outlined in Method 2 or the Mass Balance Approach detailed in Method 1.

4.2.1 Facilities Using Two Operating CEMS

Place one CEMS upstream[6] and one CEMS downstream from mercury control equipment.

- For both CEMS, hourly emissions, calculated using Method 2, are summed for operating hours in a specified time to determine mass emissions, $(M)_{upstream}$ and $(M)_{downstream}$.
- The difference in mass totals $(M)_{upstream}$ and $(M)_{downstream}$, represents mercury capture.
- Divide the mercury capture by the upstream CEMS emissions data $(M)_{upstream}$, to yield capture rates (CR)[7].

$$CR = \frac{(M)_{upstream} - (M)_{downstream}}{(M)_{upstream}} \times 100 \qquad \textbf{Equation 4.2}$$

where:

CR	=	mercury capture rate (%)
$(M)_{upstream}$	=	total mass of mercury upstream of Hg control equipment in a calendar year (kg/yr)
$(M)_{downstream}$	=	total mass of mercury downstream of Hg control equipment in a calendar year (kg/yr)

4.2.2 Facilities Using One-Operating CEMS and Weekly Coal Measurements

Place one CEMS downstream from mercury control equipment.

- An average mercury content is calculated from weekly coal analyses (kg Hg/tonnes of coal).
- Over a specified time period, total coal burned is determined (tonnes).
- Mercury content in coal is multiplied by total coal burned in the calendar year to obtain the mercury input mass $(M)_{input}$, (kg/yr).

$$(M)_{input} = \text{Average Hg content in coal} \times \text{Total coal burned} \qquad \textbf{Equation 4.3}$$

- With data recorded from the CEMS, hourly emission rates calculated using Method 2 are summed over the unit's operating hours to determine mass emissions, $(M)_{downstream}$.
- The difference between Hg mass input and mass emissions data, $(M)_{input}$ and $(M)_{downstream}$, indicate mass capture.

[6] No preceding coal processing (i.e. coal washing) shall occur prior to reaching the upstream CEMS to achieve accurate Hg concentration measurement.
[7] Monthly capture rate CR_m, may be used as an option for provincial emission compliance.

- Divide the mass capture by the mass input $(M)_{input}$, to yield a capture rate (CR).

$$CR = \frac{(M)_{input} - (M)_{downstream}}{(M)_{input}} \times 100 \qquad \textbf{Equation 4.4}$$

where:

CR	=	mercury capture rate (%)
$(M)_{input}$	=	total mass of mercury input to the boiler in a given calendar year (kg/yr)
$(M)_{downstream}$	=	total mass of mercury downstream of Hg control equipment (kg) in a given calendar year (kg/yr)

4.2.3 Facilities Without CEMS

This approach only applies to units qualifying for the LME option. Refer to the 'Mass Balance Approach' outlined in Method 1 of Appendix A.

APPENDIX B: DATA VALIDATION[5]

Data measured and recorded from a certified (or recertified) CEMS is considered valid and quality-assured when it is in compliance with the performance specifications outlined in each of the QA tests described below in Table 3: Performance Specifications for Part 75 Hg Continuous Monitoring Systems. An out-of-control period occurs when QA test results exceed performance specifications. Emissions data recorded from an out-of-control monitor shall not be reported and must be substituted according to the missing data procedures outlined in Table 5: Backfilling and Substitution of Missing Data in Appendix D.

Table 3: Performance Specifications for Part 75 Hg Continuous Monitoring Systems.

QA Test	Frequency	Performance Specification	Qualifications and Exceptions
7-day Calibration Error Test	Daily	± 5.0% of span value, on each of the 7 days	7-day calibration error tests may be done with Hg0 or a NIST-traceable source of oxidized Hg.
Linearity Check	Quarterly	$|R - A_{avg}|$[6] ≤ 10.0% of the reference gas tag value, at each calibration gas level	Linearity checks must be done with elemental Hg standards. 3-level system integrity checks using oxidized Hg standards may be used, in lieu of this test.
Single-Level System Integrity Check[7]	Weekly	$|R - A_{avg}|$[2] ≤ 5.0% of the span value at each calibration gas level	Not required if daily calibrations are done with a NIST-traceable source of oxidized Hg.
3-Level System Integrity Check[2]	Quarterly	$|R - A_{avg}|$[2] ≤ 5.0% of the span value at each calibration gas level	Linearity checks using elemental Hg standards may be performed, in lieu of this test.
RATA	Annually	20% RA	
Bias Test	------------	Must not be low with respect to the reference method, based on the RATA results	
Cycle Time Test	------------	15 minutes	

[5] Based on (US EPA Part 75 App. B § 2.1.4)
[6] $|R - A_{avg}|$ is the absolute value of the difference between the reference gas concentration and average of the analyzer responses, at a certain gas level.
[7] System integrity checks apply only to Hg monitors with converters.

APPENDIX C: CEMS CERTIFICATION REQUIREMENTS

1.0 Initial Certification

Table 4: Certification tests performed against Hg CEMS.
(Source: Table 14: Required Certification Test for Part 75 Monitoring Systems, US EPA)

Test	Objective
7-day calibration error test	Evaluates the accuracy and stability of a gas or flow monitor's calibration over an extended period of unit operation.
Linearity check	Determines whether the response of a gas monitor is linear across its range.
System integrity check	For a mercury CEMS equipped with a converter, this test verifies that the converter is working properly.
Relative Accuracy Test Audits (RATA)	Compare emissions data recorded by a CEMS to data collected concurrently with an EPA emission test method.
Bias test	Determines whether a monitoring system is biased low with respect to the reference method, based on the RATA results. If a low bias is found, a bias adjustment factor (BAF) must be calculated and applied to the subsequent hourly emissions data. This test is required only for SO2, NOx, Hg, and flow monitoring systems.
Cycle time test	Determines whether a gas monitoring system is capable of completing at least one cycle of sampling, analyzing and data recording every 15 minutes.
Data Acquisition and Handling Systems (DAHS) Verification	Ensures that all emissions calculations are being performed correctly and that the missing data routines are being applied properly.

2.0 Recertification

(Source: 7.10 Recertification and Diagnostic Testing (PEG to Part 75), US EPA)

Whenever a replacement, modification, or other change is made to a monitoring system that may affect the ability of the system to accurately measure emissions, the system must be recertified. Also, changes to the flue gas handling system or manner of unit operation that affect the flow profile or the concentration profile in the stack may trigger recertification. Examples of situations that require recertification of Part 75 monitoring systems include:

- Replacement of analyzer
- Replacement of an entire CEMS
- Change in location or orientation of a sampling probe
- Fuel flow meter replacement

APPENDIX D: CEMS MISSING DATA PROTOCOL

Emission data that is missing due to a malfunction of the CEM must be backfilled. The backfilling technique must be fully described in the QA/QC manual developed for each CEM system and approved by the appropriate regulatory agency. The following is an example of backfilling technique from the US EPA:

1.0 US EPA - Hg Method

The US EPA requires data to be recorded for all hours units are operating. Data missing due to start up, shut down, maintenance or malfunction must be accounted for according to the amount of quality-assured data[8] available, as well as the duration of the CEMS outage. How to determine data availability and substitute data values for missing/invalid hours of CEMS operation is outlined below.

Determination of Data Availability:

i) Prior to Completion of 8,760 unit (or stack) operating hours after certification:

$$\text{\% Monitor Data Availability} = \frac{\begin{array}{c}\text{Total unit operating hours}\\ \text{for which quality assured data were}\\ \text{recorded since certification}\end{array}}{\text{Total unit operating hours since certification}} \times 100$$

ii) Upon Completion of 8,760 unit (or stack) operating hours after certification:

$$\text{\% Monitor Data Availability} = \frac{\begin{array}{c}\text{Total unit operating hours}\\ \text{for which quality assured data were recorded}\\ \text{during previous 8760 unit operating hours}\end{array}}{8760} \times 100$$

[8] Quality-assured hours include data that is recorded from a certified CEMS in compliance with the performance specifications of Table 3: Performance Specifications for Part 75 Hg Continuous Monitoring Systems. According to US EPA, *Quality-assured monitor operating hour* means any unit operating hour or portion thereof over which a certified CEMS, or other monitoring system approved by the Administrator under EPA's 40 CFR part 75, is operating:

(1) Within the performance specifications set forth in EPA's 40 CFR part 75, appendix A and the quality assurance/quality control procedures set forth in EPA's 40 CFR part 75, appendix B without unscheduled maintenance, repair, or adjustment; and

(2) In accordance with EPA's 40 CFR § 75.10(d), (e), and (f).

iii) Units accumulating fewer than 8,760 unit (or stack) hours in the previous 3-years:

No hours from more than three years (26,280 clock hours) earlier shall be used.

$$\%\ \text{Monitor Data Availability} = \frac{\begin{array}{c}\text{Total unit operating hours}\\ \text{for which quality assured data were recorded}\\ \text{during previous 8760 unit operating hours}\end{array}}{\text{Total unit operating hours in the previous three years}} \times 100$$

US EPA § 75.24 (b): When a monitor or continuous emission monitoring system is out-of-control, any data recorded by the monitor or monitoring system are not quality-assured and shall not be used in calculating monitor data availabilities.

Table 5: Backfilling and Substitution of Missing Data

Monitor Data Availability (%)	Duration of CEMS outage (hours)	Method	Look-back Period
90 or more	≤24	Average	HB, HA[9]
	24 or more	Substitute the greater of: a) Average or b) 90th percentile	 HB, HA 720 hrs[10]
80 - <90	≤8	Average	HB, HA
	>8	Substitute the greater of: a) Average or b) 90th percentile	 HB, HA 720 hrs[3]
70 - <80	>0	Maximum value	720 hrs[3]
<70	>0	Maximum potential concentration or %	none

[9] HB, HA – is the immediate hour before and the hour after the occurrence of a CEMS outage.
[10] Quality-assured, monitor operating hours, during unit operation.