Measurement and Reporting of Vapor Phase Mercury Emissions,
Using a Continuous Emission Monitoring System
(DRAFT 9/25/08)

1. Scope and Application

The purpose of this protocol is to establish procedures for the performance-based monitoring of vapor-phase mercury (Hg) emissions in combustion flue gas streams, using a continuous emission monitoring system (CEMS) for mercury concentration. Guidelines are also provided for reporting emissions data from the Hg CEMS and for using the data to demonstrate compliance with applicable Hg emission limits. The performance-based approach allows for use of various suitable sampling and analytical technologies while maintaining a specified and documented level of data quality through performance criteria. Persons using this protocol should have a thorough working knowledge of Methods 1, 2, 3, 4 and 5 in appendices A−1 through A−3 to 40 CFR Part 60.

1.1 *Analytes*

The analyte measured by these procedures and specifications is total vapor-phase Hg in the flue gas, which represents the sum of elemental Hg (Hg^o, CAS Number 7439−97−6) and oxidized forms of Hg, in mass concentration units of micrograms per standard cubic meter (µg/scm).

1.2 *Applicability*

These performance criteria and procedures are applicable to monitoring of vapor-phase Hg emissions from coal-fired steam generators, under relatively low-dust conditions (i.e., sampling in the stack or duct after all pollution control devices).

2. Principle

A representative sample of flue gas is extracted continuously from a stack or duct. Particulate matter is removed and the gas sample is transported to an analyzer capable of measuring the total vapor phase Hg concentration. Elemental and oxidized mercury (i.e., Hg^o and Hg^{+2}) may be measured separately or simultaneously, but for purposes of this protocol, total vapor phase Hg is the sum of Hg^o and Hg^{+2}. To validate data from the CEMS, the performance specifications in sections 8 and 9 of this protocol must be met.

3. Definitions

3.1 *Mercury Continuous Emission Monitoring System or Hg CEMS* means all of the equipment used to determine the total vapor phase Hg concentration. The measurement system may generally include the following major subsystems: sample acquisition, Hg^{+2} to Hg^o converter, sample transport, sample conditioning, flow control/gas manifold, gas analyzer, and data recorder.

3.2 *Gas Analyzer* means the equipment that detects the total vapor phase Hg being measured and generates an output proportional to its concentration

3.3 *Converter* means a device that reduces oxidized mercury (Hg^{+2}) to elemental mercury (Hg^o).

3.4 *NIST* means the National Institute of Standards and Technology, located in Gaithersburg, Maryland.

3.5 *NIST-traceable elemental Hg standards* means either: (1) compressed gas cylinders having known concentrations of elemental Hg, which have been prepared according to the "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards"; or (2) calibration gases having known concentrations of elemental Hg, produced by a generator that meets the performance requirements of the "EPA Traceability Protocol for Qualification and Certification of Elemental Mercury Gas Generators", or an interim version of that protocol.

3.6 *NIST-traceable source of oxidized Hg* means a generator that is capable of providing known concentrations of vapor phase mercury chloride ($HgCl_2$), and that meets the performance requirements of the "EPA Traceability Protocol for Qualification and Certification of Mercuric Chloride Gas Generators", or an interim version of that protocol.

3.7 *Calibration Gas* means a gas standard containing Hg^o or $HgCl_2$ at a known concentration that is produced and certified in accordance with an EPA traceability protocol for certification of Hg calibration standards.

3.8 *Span value* means the upper limit of valid instrument response when the CEMS is measuring the Hg concentration of flue gas or calibration gas (see section 7.2 of this protocol).

3.9 *Zero-Level Gas* means calibration gas with a Hg concentration that is below the level detectable by the monitoring system.

3.10 *Low-Level Gas* means calibration gas with a Hg concentration that is 20 to 30 percent of the span value.

3.11 *Mid-Level Gas* means calibration gas with a Hg concentration that is 50 to 60 percent of the span value.

3.12 *High-Level Gas* means calibration gas with a Hg concentration that is 80 to 100 percent of the span value.

3.13 *Calibration Error Test* means a test designed to assess the ability of a Hg CEMS to accurately measure the Hg concentrations of calibration gases. A zero-level gas and an upscale gas (mid-level or high-level) are required for this test. The upscale gas may either be an elemental or oxidized Hg standard.

3.14 *Linearity Check* means a test designed to determine whether the response of a Hg analyzer is linear across its measurement range. Three elemental Hg gas standards (i.e., low, mid, and high-level gases) are required for this test.

3.15 *System Integrity Check* means a test designed to assess the efficiency with which a converter reduces oxidized Hg to elemental Hg. Oxidized Hg standards are used for this test. For a 3-level system integrity check, low, mid, and high-level calibration gases are required. For a single-level check, either a mid-level gas or a high-level gas may be used.

3.16 *Cycle Time Test* means a test designed to measure the amount of time it takes for a CEMS, while operating normally, to respond to a known step change in gas concentration. For the cycle time test of a Hg CEMS, a zero gas and a high-level gas are required. The high-level gas may be either an elemental or an oxidized Hg standard.

3.17 *Relative Accuracy Test Audit or RATA* means a series of nine or more test runs, directly comparing readings from a CEMS to measurements made with a reference stack test method. The relative accuracy (RA) of the CEMS is expressed as the absolute mean difference between the CEMS and reference method measurements plus the absolute value of the 2.5 percent error confidence coefficient, divided by the mean value of the reference method measurements.

4. Safety

4.1 *Site Hazards*

Site hazards must be thoroughly considered in advance of applying these procedures/specifications in the field; advance coordination with the site is critical to understand the conditions and applicable safety policies. At a minimum, portions of the sampling system will be hot, requiring appropriate gloves, long sleeves, and caution in handling this equipment.

4.2 *Toxicity or Carcinogenicity*

The toxicity or carcinogenicity of any reagents used must be considered. Depending upon the sampling and analytical technologies selected, this measurement may involve hazardous materials, operations, and equipment and this protocol does not address all of the safety problems associated with implementing this approach. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicable regulatory limitations prior to performance. Any chemical should be regarded as a potential health hazard and exposure to these compounds should be minimized. Chemists should refer to the Material Safety Data Sheet (MSDS) for each chemical used.

4.3 *Wastes*

Any wastes generated by this procedure must be disposed of according to a hazardous materials management plan that details and tracks various waste streams and disposal procedures.

5. Equipment and Supplies

The following list is presented as an example of key equipment and supplies likely required to perform vapor-phase Hg monitoring using a CEMS. It is recognized that additional equipment and supplies may be needed.

5.1 *Continuous Emission Monitoring System for Mercury Concentration*

A typical Hg CEMS is shown in Figure 1. The CEMS in Figure 1 is a dilution extractive system, which measures Hg concentration on a wet basis, and is the most commonly-used type of Hg CEMS. Other system designs may be used, provided that the CEMS meets the performance specifications of this protocol.
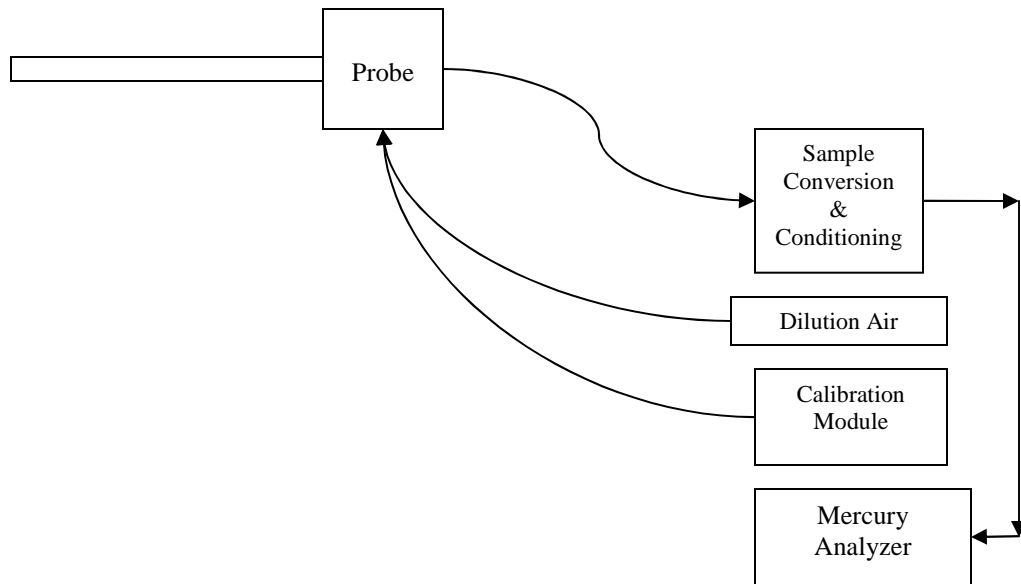
Figure 1. Typical Mercury CEMS

5.1.1 Materials of Construction.

All wetted sampling system components, including probe components prior to the point at which the calibration gas is introduced, must be chemically inert to all Hg species. Materials such as perfluoroalkoxy (PFA) TeflonTM, quartz, treated stainless steel (SS) are examples of such materials.

(Note: These materials of construction are required because components prior to the calibration gas injection point are not included in the system calibration error, linearity, system integrity, and cycle time tests.)

5.1.2 Temperature Considerations.

All system components prior to the Hg^{+2} to Hg^o converter must be maintained at a sample temperature above the acid gas dew point.

5.1.3 Measurement System Components.

5.1.3.1 Sample Probe.

The probe must be made of the appropriate materials as noted in Section 5.1.1, heated when necessary (see Section 5.1.2), configured with ports for introduction of calibration gases.

5.1.3.2 Filter or Other Particulate Removal Device.

The filter or other particulate removal device is part of the measurement system, must be made of appropriate materials, as noted in Section 5.1.1, and must be included in all system tests.

5.1.3.3 Sample Line.

The sample line that connects the probe to the converter, conditioning system and analyzer must be made of appropriate materials, as noted in Section 5.1.1.

5.1.3.4 Conditioning Equipment.

5.1.3.4.1 For wet basis systems, such as the one shown in Figure 1, the sample must be kept above its dew point either by: (a) Heating the sample line and all sample transport components up to the inlet of the analyzer (and, for hot-wet extractive systems, also heating the analyzer) or (b) by diluting the sample prior to analysis using a dilution probe system. The components required to do either (a) or (b) are considered to be conditioning equipment.

5.1.3.4.2 For dry basis measurements, a condenser, dryer or other suitable device is required to remove moisture continuously from the sample gas, and any equipment needed to heat the probe, or sample line to avoid condensation prior to the moisture removal component is also required.

5.1.3.5 Sampling Pump.

A pump is needed to push or pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. If a mechanical sample pump is used and its surfaces are in contact with the sample gas prior to detection, the pump must be leak free and must be constructed of a material that is non-reactive to the gas being sampled (see Section 5.1.1). For dilution-type measurement systems, such as the system shown in Figure 1, an ejector pump (eductor) may be used to create a sufficient vacuum that sample gas will be drawn through a critical orifice at a constant rate. The ejector pump may be constructed of any material that is non-reactive to the gas being sampled.

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5.1.3.6 Calibration Gas System(s).

Design and equip each mercury monitor to permit the introduction of known concentrations of elemental Hg and $HgCl_2$ separately, at a point immediately preceding the sample extraction filtration system, such that the entire measurement system can be checked. If the Hg monitor does not have a converter, the $HgCl_2$ injection capability is not required. The calibration gas system(s) must be able to flood the sampling probe sufficiently to prevent entry of stack gas from the effluent stream.

5.1.3.7 Sample Gas Delivery.

The sample line may feed directly to a converter, to a by-pass valve (for speciating systems), or to a sample manifold. All valve and/or manifold components must be made of material that is non-reactive to the gas sampled and the calibration gas, and must be configured to safely discharge any excess gas.

5.1.3.8 Hg Analyzer.

An instrument is required that continuously measures the total vapor phase Hg concentration in the gas stream. The analyzer may also be capable of measuring elemental and oxidized Hg separately.

5.1.3.9 Data Recorder.

A recorder, such as a computerized data acquisition and handling system (DAHS), digital recorder, or data logger, is required for recording measurement data.

5.2 *Auxiliary Monitoring Systems*

When an applicable regulation specifies an emission limit or a percentage reduction requirement for Hg, the auxiliary monitoring systems described in sections 5.2.1 through 5.2.3, below will likely be needed to convert the mercury concentrations measured with the Hg CEMS to the units of the emission standard. All auxiliary monitoring systems shall be certified and quality-assured according to 40 CFR Part 75.

5.2.1   Mass Emission Limits

When a cumulative Hg mass emissions limit is specified (e.g., lb Hg per year), a certified stack gas volumetric flow monitor is required. Further, if the Hg concentration is measured on a dry basis, the stack gas moisture content must also be accounted for. In that case, either: (a) determine the stack gas moisture content using a moisture monitoring system that is certified according to 40 CFR Part 75; or (b) use the appropriate fuel-specific moisture default value provided in 40 CFR 75.11(b) (see section 10.2.1 of this protocol).

5.2.2 Heat Input-Based Emission Rates and Percentage Reduction

If Hg mass emissions are to be expressed on a heat input basis (e.g., lb/TBtu), or if a certain percentage reduction of Hg must be demonstrated, a method of quantifying unit heat input is needed. Therefore, in addition to the auxiliary monitoring systems described in section 5.2.1, above, a certified diluent gas (CO_2 or O_2) monitor and a fuel-specific F-factor are required to determine the hourly heat input rates (see sections 10.2.2 and 10.2.4 of this protocol).

5.2.3 Electrical Output-Based Emission Rates

If Hg mass emissions are to be expressed in terms of electrical output (e.g., lb/GW-hr), measurements of hourly electrical load and unit operating time are required in addition to hourly data from the auxiliary monitoring systems described in section 5.2.1, above (see section 10.2.3 of this protocol).

6. Reagents and Standards

6.1 *NIST Traceability.*

Only NIST-certified or NIST-traceable calibration gas standards and reagents (as defined in sections 3.5 and 3.6 of this protocol) shall be used for the tests and procedures required under this protocol. Calibration gases with known concentrations of Hg^o and $HgCl_2$ are required. Special reagents and equipment may be needed to prepare the Hg^o and $HgCl_2$ gas standards (e.g., NIST-traceable solutions of $HgCl_2$ and gas generators equipped with mass flow controllers).

6.2 *Required Calibration Gas Concentrations.*

6.2.1 Zero-Level Gas.

A zero-level calibration gas with a Hg concentration below the detectable limit of the analyzer is required for calibration error tests and cycle time tests of the CEMS.

6.2.2 Low-Level Gas.

A low-level calibration gas with a Hg concentration of 20 to 30 percent of the span value is required for linearity checks and 3-level system integrity checks of the CEMS. Elemental Hg standards are required for the linearity checks and oxidized Hg standards are required for the system integrity checks.

6.2.3 Mid-Level Gas.

A mid-level calibration gas with a Hg concentration of 50 to 60 percent of the span value: (a) is required for linearity checks and 3-level system integrity checks of the CEMS; and (b) is optional for calibration error tests and single-level system integrity checks. Elemental Hg standards are required for the linearity checks, oxidized Hg standards are required for the system integrity checks, and either elemental or oxidized Hg standards may be used for the calibration error tests.

6.2.4 High-Level Gas.

A high-level calibration gas with a Hg concentration of 80 to 100 percent of the span value: (a) is required for linearity checks, 3-level system integrity checks, and cycle time tests of the CEMS; and (b) is optional for calibration error tests and single-level system integrity checks. Elemental Hg standards are required for the linearity checks, oxidized Hg standards are required for the system integrity checks, and either elemental or oxidized Hg standards may be used for the calibration error and cycle time tests.

7. Preliminary Procedures

7.1 *Installation and Measurement Location*

7.1.1 Hg CEMS

For the Hg CEMS, select a monitoring location that is representative of the Hg emissions from the source, where the CEMS is likely to pass the relative accuracy test audit (RATA) e.g., a location that: (a) conforms to the guidelines in section 8.1.1 of Performance Specification 2 in appendix B to 40 CFR Part 60; and/or (b) is shown to be free of stratification or minimally stratified through measurement traverses for Hg or other gases such as SO_2 and NO_x. If the CEMS is unable to pass the RATA and the measurement location is determined to be the cause, relocate the probe.

7.1.2 Auxiliary Monitors

For any auxiliary monitors that are needed to convert Hg concentrations to the desired units of measure (i.e., flow monitors, CO_2 or O_2 monitors, and/or moisture monitors, as applicable), follow the installation and measurement location guidelines in section 1 of appendix A to 40 CFR Part 75.

7.2 *Monitor Span and Range Requirements*

7.2.1 Hg CEMS

Determine the appropriate span and range value(s) for each Hg CEMS as described in sections 7.2.1.1 through 7.2.1.3, below, so that all potential and expected Hg concentrations can be accurately measured.

7.2.1.1 Maximum Potential Concentration

For the purposes of this protocol, there are two options for determining the maximum potential Hg concentration: (a) use one of the following default values: 9 µg/scm for bituminous coal; 10 µg/scm for sub-bituminous coal; 16 µg/scm for lignite, and 1 µg/scm for waste coal, i.e., anthracite culm or bituminous gob. If different coals are blended, use the highest MPC for any fuel in the blend; or (b) base the MPC on the results of site-specific emission testing using the one of the Hg reference methods in section 8.1.1.5.1 of this protocol. Option (b) may only be used if the unit does not have

add-on Hg emission controls or a flue gas desulfurization system, or if testing is performed upstream of all emission control devices. At least 3 test runs are required, at the normal operating load, and the highest Hg concentration obtained in any of the tests shall be the MPC.

7.2.1.2 Maximum Expected Concentration

For units with FGD systems that significantly reduce Hg emissions (including fluidized bed units that use limestone injection) and for units equipped with add-on Hg emission controls (e.g., carbon injection), determine the maximum expected Hg concentration (MEC) during normal, stable operation of the unit and emission controls. To calculate the MEC, substitute the MPC value from section 7.2.1.1, above, into Equation A-2 in section 2.1.1.2 of appendix A to 40 CFR Part 75. For units with add-on Hg emission controls, base the percent removal efficiency on design engineering calculations. For units with FGD systems, use the best available estimate of the Hg removal efficiency of the FGD system.

7.2.1.3 Span and Range Requirements

7.2.1.3.1 High Span and Range

For each Hg monitor, determine a high span value, by rounding the MPC value from section 7.2.1.1 of this protocol upward to the next highest multiple of 5.0 µg/scm, unless the MPC is already a multiple of 5.0 µg/scm. Therefore, if the option to use the default MPC value in section 7.2.1.1 is selected, the high span value shall be 10.0 µg/scm for bituminous coal and sub-bituminous coal, 5.0 µg/scm for waste coal, and 20.0 µg/scm for lignite. For the purposes of this protocol, set the "high range value" equal to the high span value.

7.2.1.3.2 Low Span and Range

For an affected unit equipped with a flue gas desulfurization system or a unit with add-on Hg emission controls, compare the MEC value from section 7.2.1.2 of this protocol to the high range value from section 7.2.1.3.1 of this protocol. If the MEC is greater than 20 percent of the high range value, a second (low) span value is not required. However, if: (a) the MEC is less than or equal to 20 percent of the high range value; and (b) the high range value is greater than or equal to 10.0 µg/scm, a second, low span value must be defined. Set the low span value to the lowest multiple of 5.0 µg/scm that is above the MEC. For example, if the high range value is 10.0 µg/scm and the MEC is 1.5 µg/scm, set the low span value at 5.0 µg/scm. For the purposes of this protocol, set the "low range value" equal to the low span value.

7.2.1.3.3 Dual Range Considerations

When two span values are required, you may either: (a) record the Hg concentration data on two separate measurement ranges, with full-scale values equal to the high and low range values from sections 7.2.1.3.1 and 7.2.1.3.2 of this protocol (e.g., 0-10 µg/scm and 0-5 µg/scm); or (b) quality-assure two segments of a single

measurement scale, where the upper boundaries of the two segments are the high and low range values.

7.2.2 Auxiliary Monitoring Systems

Determine the span and range requirements for auxiliary CO_2 (or O_2) and flow monitoring systems (if applicable) in accordance with sections 2.1.3 and 2.1.4 of appendix A to 40 CFR Part 75. For a continuous moisture sensor, there is no span value requirement; set the range of the instrument according to the manufacturer's instructions.

8. Initial Certification and Recertification

8.1 *Certification Requirements*

8.1.1 Mercury CEMS

Table 1, below, summarizes the certification test requirements and performance specifications for a Hg CEMS. The CEMS may not be used to report quality-assured data until these performance criteria are met. Sections 8.1.1.1 through 8.1.1.5, below, provide specific instructions for the required tests. Section 8.1.2 gives general certification guidelines for the auxiliary monitoring systems. Recertification is discussed in section 8.2.

8.1.1.1 7-Day Calibration Error Test

Perform the 7-day calibration error test, using a zero-level gas and either a high-level or a mid-level calibration gas standard (as defined in section 6.2 of this protocol). Follow the procedures in sections 6.1.1 and 6.3.1 of appendix A to 40 CFR Part 75. Either elemental or oxidized NIST-traceable Hg standards (as defined in sections 3.5 and 3.6 of this protocol) may be used for the test. If moisture and/or chlorine is added to the calibration gas, the dilution effect of the moisture and/or chlorine addition on the calibration gas concentration must be accounted for in an appropriate manner. For dual-span applications, perform the test on both measurement ranges. Calculate the calibration error (CE) on each day of the test using Equation A-5 in section 7.2.1 of appendix A to 40 CFR Part 75. To evaluate the alternative CE specification, use the term |R – A| in the numerator of Equation A-5.

8.1.1.2 Linearity Check

Perform the linearity check using low, mid, and high-level concentrations of NIST-traceable elemental Hg standards (as defined in sections 3.5 and 6.2 of this protocol). Follow the general procedures in sections 6.1.1 and 6.2 of appendix A to 40 CFR Part 75. If moisture and/or chlorine is added to the calibration gas, the dilution effect of the moisture and/or chlorine addition on the calibration gas concentration must be accounted for in an appropriate manner. For dual-span applications, perform the test on both measurement ranges. Calculate the linearity error (LE) using Equation A-4 in section 7.1 of appendix A to 40 CFR Part 75. To evaluate the alternative LE specification, use the term |R – A| in the numerator of Equation A-4.

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Table 1: Required Certification Tests and Performance Specifications for Hg CEMS

For this required certification test.....	The main performance specification[1] is.....	The alternate performance specification[1] is.....	And the conditions of the alternate specification are.....
7-day calibration error test[2]	5.0% of span value, on each of the 7 days	$\lvert R - A \rvert \leq 1.0$ µg/scm	Span value ≤ 10 µg/scm
Linearity check[3]	$\lvert R - A_{avg} \rvert \leq 10.0\%$ of the reference gas concentration at each calibration gas level	$\lvert R - A_{avg} \rvert \leq 0.8$ µg/scm	The alternate specification may be used at any gas level
3-level system integrity check[4]	$\lvert R - A_{avg} \rvert \leq 10.0\%$ of the reference gas concentration at each calibration gas level	$\lvert R - A_{avg} \rvert \leq 0.8$ µg/scm	The alternate specification may be used at any gas level
RATA and bias test	20.0% RA	$\lvert RM_{avg} - C_{avg} \rvert \leq 1.0$ µg/scm[**]	$RM_{avg} < 5.0$ µg/scm
Cycle time test[2]	15 minutes[5]	---------------------------	---------------------------

[1] Note that $\lvert R - A \rvert$ is the absolute value of the difference between the reference gas value and the analyzer reading. $\lvert R - A_{avg} \rvert$ is the absolute value of the difference between the reference gas concentration and the average of the analyzer responses, at a particular gas level.

[2] Use either elemental or oxidized Hg standards. For dual-span applications, perform the test on both measurement ranges.

[3] Use elemental Hg standards. For dual-span applications, perform the test on both measurement ranges.

[4] Use oxidized Hg standards. For dual-span applications, perform the test on both measurement ranges. Not required if the CEMS does not have a converter.

[5] Stability criteria---Readings change by $< 2.0\%$ of span <u>or</u> by ≤ 0.5 µg/m^3, for 2 minutes. For dual-span applications, perform the test on both measurement ranges.

[**] Note that $\lvert RM_{avg} - C_{avg.} \rvert$ is the absolute difference between the mean reference method value and the mean CEMS value from the RATA. The arithmetic difference between RM_{avg} and C_{avg} can be either + or -.

8.1.1.3 Three-Level System Integrity Check

Perform the 3-level system integrity check using low, mid, and high-level calibration gas concentrations generated by a NIST-traceable source of oxidized Hg (as defined in sections 3.6 and 6.2 of this protocol). Follow the procedures and instructions in sections 6.1.1, 6.2, and 6.2(g) of appendix A to 40 CFR Part 75. If moisture and/or chlorine is added to the calibration gas, the dilution effect of the moisture and/or chlorine addition on the calibration gas concentration must be accounted for in an appropriate manner. For dual-span applications, perform the test on both measurement ranges. To calculate the results of the test, use Equation A-4 in section 7.1 of appendix A to 40 CFR Part 75, replacing the term "LE" (linearity error) with "SIE" (system integrity error). To evaluate the alternative performance specification, use the term |R – A| in the numerator of Equation A-4.

(Note: This test is not required if the CEMS does not have a converter).

8.1.1.4 Cycle Time Test

Perform the cycle time test, using a zero-level gas and a high-level calibration gas (as defined in section 6.2 of this protocol). Follow the procedures in sections 6.1.1 and 6.4 of appendix A to 40 CFR Part 75. Either elemental or oxidized NIST-traceable Hg standards (as defined in sections 3.5 and 3.6 of this protocol) may be used for the test. Use the following criterion to determine when a stable reading of stack emissions or calibration gas has been attained---the reading is stable if it changes by no more than 2.0 percent of the span value or 0.5 µg/scm (whichever is less restrictive) for two minutes. For dual-span applications, perform the test on both measurement ranges and report the longer of the two cycle times as the system cycle time. To calculate the cycle time, use Figures 6a and 6b and the associated text in appendix A to 40 CFR Part 75.

8.1.1.5 Relative Accuracy Test Audit (RATA)

Perform the RATA of the Hg CEMS according to the general procedures for gas monitoring system RATAs described in sections 6.5 through 6.5.8 of appendix A to 40 CFR Part 75, supplemented by the special instructions in sections 8.1.1.5.1 through 8.1.1.5.4, below.

8.1.1.5.1 Reference Methods

Acceptable Hg reference methods for the RATA of a mercury concentration monitoring system include ASTM D6784-02 (the Ontario Hydro Method), Method 30-A in appendix A-8 to 40 CFR Part 60, and Method 30-B in appendix A-8 to 40 CFR Part 60. When the Ontario Hydro Method is used, paired sampling trains are required. To validate an Ontario Hydro test run, calculate the relative deviation (RD) as follows:

$$RD = \frac{|C_a - C_b|}{C_a + C_b} \; x \, 100$$

Where:

RD = Relative deviation between the Hg concentrations of samples "a" and "b" (percent)

C_a = Hg concentration of Hg sample "a" (µg/dscm)

C_b = Hg concentration of Hg sample "b" (µg/dscm)

The RD must not exceed 10 percent, when the average concentration is greater than 1.0 µg/dscm. If the average concentration is ≤ 1.0 µg/dscm, the RD must not exceed 20 percent. The RD results are also acceptable if the absolute difference between the Hg concentrations measured by the paired trains does not exceed 0.03 µg/dscm. If the RD criterion is met, the run is valid. For each valid run, average the Hg concentrations measured by the two trains (vapor phase Hg, only).

8.1.1.5.2 Special Considerations

The RATA must be done at normal load (as defined in section 6.5.2.1 of appendix A to 40 CFR Part 75), while combusting coal. Locate the reference method (RM) sampling points according to section 6.5.6(b) in appendix A to 40 CFR Part 75. If stratification testing is deemed necessary to justify using fewer RM sample points or alternative RM point locations, follow the applicable procedures in sections 8.1.3 through 8.1.3.5 of Method 30-A in appendix A-8 to 40 CFR Part 60. A minimum of 9 valid test runs must be performed, directly comparing the CEMS measurements to the reference method. If more than 9 runs are done, a maximum of three runs may be discarded. The minimum time per run is 21 minutes if instrumental Method 30-A is used. If the Ontario Hydro Method or Method 30-B is used, the time per run must be long enough to collect a sufficient mass of Hg to analyze. Complete the RATA within 168 unit operating hours, except when the Ontario Hydro Method is used, in which case up to 336 operating hours may be taken to finish the test.

8.1.1.5.3 Calculation of RATA Results

Calculate the relative accuracy (RA) of the monitoring system, on a µg/scm basis, according to section 7.3 in appendix A to 40 CFR Part 75. For a unit that qualifies as a low emitter of Hg (i.e., the mean reference method (RM) concentration during the RATA is < 5 µg/scm), if the calculated RA exceeds 20.0%, the results of the RATA are still acceptable if the absolute difference between the mean RM and CEMS concentrations does not exceed 1.0 µg/scm.

8.1.1.5.4   Bias Adjustment

To ensure that Hg concentration is not under-reported, the bias test described in section 7.6.4 of Appendix A to 40 CFR Part 75 shall be performed each time that a RATA of the Hg CEMS is done. If the bias test is failed, a bias adjustment factor (BAF) must be calculated in accordance with section 7.6.5(a) of Appendix A to 40 CFR Part 75, and applied to the hourly data from the CEMS, beginning with the hour after the RATA is completed. For low emitting sources (mean RM concentration during the RATA < 5 µg/scm), if the calculated BAF exceeds 1.250, a BAF of 1.250 may be used for reporting

purposes.

8.1.2 Auxiliary Monitoring Systems

8.1.2.1 Certification Test Requirements.

Auxiliary monitoring systems that are used to measure stack gas volumetric flow rate and/or diluent gas concentration and/or moisture must be certified. The certification test procedures and performance specifications for these systems are found in 40 CFR §75.20(c), and in sections 3 and 6 of appendix A to 40 CFR Part 75.

8.1.2.2 Bias Adjustment

For a flow monitor that is certified and quality-assured according to 40 CFR Part 75, bias adjustment is mandatory, in accordance with sections 7.6.4 and 7.6.5 of appendix A to Part 75. Bias adjustment is not required for diluent gas monitors or moisture monitoring systems.

8.2 *Recertification*

Whenever the owner or operator makes a replacement, modification, or change in a certified Hg CEMS or auxiliary monitoring system that may significantly affect the ability of the system to accurately measure or record the Hg concentration, stack gas volumetric flow rate, CO_2 concentration, O_2 concentration, or percent moisture, the owner or operator shall recertify the monitoring system. Furthermore, whenever the owner or operator makes a replacement, modification, or change to the flue gas handling system or the unit operation that may significantly change the flow or concentration profile, the owner or operator shall recertify the monitoring system. The same tests performed for the initial certification of the monitoring system shall be repeated for recertification, unless otherwise specified in the applicable regulation. The conditional data validation provisions in 40 CFR 75.20(b)(3) may be used for recertification events. Examples of changes that require recertification include: (a) replacement of a gas analyzer; and (b) change in location or orientation of the sampling probe.

9. On-Going Quality Assurance (QA) and Data Validation

9.1 *Hg CEMS*

9.1.1 Required QA Tests

Periodic QA testing of the Hg CEMS is required following initial certification. The required tests, the test frequencies, and the performance specifications that must be met are summarized in Table 2, below.

9.1.2 Test Frequency

Perform calibration error tests and linearity checks of the Hg CEMS at the frequencies specified for gas monitors in sections 2.1 and 2.2 of appendix B to 40 CFR Part 75. The dual span provisions in those sections of appendix B to Part 75 apply to the

Hg CEMS. The test frequency for 3-level system integrity checks (if performed in lieu of linearity checks---see third column in Table 2, below) is the same as for linearity checks. The weekly system integrity check (if required---see third column in Table 2, below) must be done at least once every 168 unit operating hours. For dual span applications, perform the test on both measurement scales. The test frequency for the RATAs of the Hg CEMS shall be annual (i.e., once every four "QA operating quarters", as defined in 40 CFR 72.2). Use Equation A-5 in section 7.2.1 of appendix A to 40 CFR Part 75 to evaluate the calibration error tests, Equation A-4 in section 7.1 of appendix A to 40 CFR Part 75 to evaluate linearity checks and system integrity checks, and calculate RATA results according to section 7.3 of appendix A to 40 CFR Part 75.

9.1.3 Data Validation

        Data validation for calibration error tests, linearity checks, and RATAs of the Hg CEMS shall be done in accordance with sections 2.1.4, 2.1.5, 2.2.3, and 2.3.2 of appendix B to 40 CFR Part 75.   Data validation for 3-level system integrity checks (if performed in lieu of linearity checks) shall be the same as for linearity checks. For weekly system integrity checks, if the performance specifications in Table 2 below are not met, the monitoring system is considered out-of-control, from the hour of the failed check until a subsequent system integrity check is passed. Also, if a required weekly system integrity check is not performed and passed within 168 unit or stack operating hours of last successful check, the monitoring system is considered to be out-of-control, beginning with the 169th unit or stack operating hour after the last successful check, and continuing until a subsequent system integrity check is passed.

9.1.4 Grace Periods

         The grace periods for calibration error tests, linearity checks, and RATAs described in sections 2.1.5.2, 2.2.4, and 2.3.3 of appendix B to 40 CFR Part 75 apply to the Hg CEMS. The grace period in section 2.2.4 of appendix B to Part 75 applies to quarterly 3-level system integrity checks of the Hg CEMS. There is no grace period for weekly system integrity checks.

9.1.5 Overscaling and Adjustment of Span

        Whenever the measured Hg concentration exceeds the high range value or the low range value defined in section 7.2.1.3 of this protocol and the "overscaling" is not caused by a malfunction of the CEMS, proceed as follows:

9.1.5.1 For Hg monitors with a single (high) span and range, report 200 percent of the high range value until the readings are back "on-scale", i.e., at or below the high range value.

9.1.5.2 For Hg monitors with two span and range values, when the low range value is exceeded, no further action is required, provided that the high range is available and is not out-of-control or out-of-service. However, if the high range is not able to provide quality assured data at the time of the low range exceedance or at any time during the continuation of the exceedance (e.g., if its most recent calibration error test, linearity check, or system integrity check has expired), report the MPC until the readings return to

Table 2: On-Going QA Test Requirements for Hg CEMS

Perform this type of QA test....	At this frequency....	With these qualifications and exceptions....	Acceptance criteria....
Calibration error test	Daily	• Use either a mid- or high-level gas • Use either elemental or oxidized Hg • For dual span applications, test both ranges • Calibrations are not required when the unit is not in operation.	5.0% of span value <u>or</u> $\|R - A\| \leq 1.0$ µg/scm
Single-level system integrity check	Weekly[1]	• Required only for systems with converters • Use oxidized Hg ---either mid- or high-level • For dual span applications, test both ranges • Not required if daily calibrations are done with a NIST-traceable source of oxidized Hg	$\|R - A_{avg}\| \leq 10.0\%$ of the reference gas value <u>or</u> $\|R - A_{avg}\| \leq 0.8$ µg/scm
Linearity check <u>or</u> 3-level system integrity check	Quarterly[3]	• Required only in "QA operating quarters"[2] ---but no less than once a year • 168 operating hour grace period available • Use elemental Hg for linearity check • Use oxidized Hg for system integrity check • For dual span applications, test both ranges • For system integrity check, CEMS must have a converter	$\|R - A_{avg}\| \leq 10.0\%$ of the reference gas value, at each calibration gas level <u>or</u> $\|R - A_{avg}\| \leq 0.8$ µg/scm
RATA and Bias test	Annual[4]	▪ 720 operating hour grace period available	20.0% RA <u>or</u> $\|RM_{avg} - C_{avg}\| \leq 1.0$ µg/scm, <u>if</u> $RM_{avg} < 5.0$ µg/scm

[1] "Weekly" means once every 168 unit operating hours.

[2] A "QA operating quarter", as defined in 40 CFR 72.2, is a calendar quarter with at least 168 hours of unit operation.

[3] "Quarterly" means once every QA operating quarter (see 40 CFR Part 75, Appendix B, section 2.2.1).

[4] "Annual" means once every four QA operating quarters (see 40 CFR Part 75, Appendix B, section 2.3.1.2).

the low range or until the high range is able to provide quality assured data, with one exception. If the reason that the high-scale range is not able to provide quality assured data is that the high range value has also been exceeded, follow the procedures in section 9.1.5.1 of this protocol.

9.1.5.3   If deemed appropriate (e.g., when the high range value is exceeded for more than 2 percent of the unit operating hours in a calendar quarter), make adjustments to the MPC, high span value, and high range value to prevent future overscaling.

9.2 *Auxiliary Monitoring Systems*

On-going QA testing of the auxiliary monitoring systems (if used) shall be performed according to appendix B to 40 CFR Part 75. The data validation and grace period provisions in appendix B to Part 75 apply to these monitoring systems. Provisions addressing overscaling and adjustment of span and range are found in sections 2.1.3.3 and 2.1.4.3 of appendix A to 40 CFR Part 75.

9.3 *QA/QC Program*

The owner or operator shall develop and implement a quality assurance/quality control (QA/QC) program for the Hg CEMS and (if applicable) for the auxiliary monitoring systems used to convert Hg concentration data from the Hg CEMS to the appropriate units of measure. At a minimum, include in the QA/QC program a written plan that describes in detail (or that refers to separate documents containing) complete, step-by-step procedures and operations for the following activities. Electronic storage of the QA/QC plan is permissible, provided that the information can be made available in hard copy to auditors and inspectors:

9.3.1 General Requirements

9.3.1.1 Preventive Maintenance

Keep a written record of procedures needed to maintain the monitoring system in proper operating condition and a schedule for those procedures. This shall, at a minimum, include procedures specified by the manufacturers of the equipment and, if applicable, additional or alternate procedures developed for the equipment.

9.3.1.2 Record Keeping and Reporting

Keep a written record describing procedures that will be used to implement the recordkeeping and reporting requirements of the applicable regulation.

9.3.1.3 Maintenance Records

Keep a record of all testing, maintenance, or repair activities performed on any monitoring system in a location and format suitable for inspection. A maintenance log may be used for this purpose. The following records should be maintained: date, time, and description of any testing, adjustment, repair, replacement, or preventive maintenance action performed on any monitoring system and records of any corrective

actions associated with a monitor outage period. Additionally, any adjustment that recharacterizes a system's ability to record and report emissions data must be recorded (e.g., changing of flow monitor or moisture monitoring system polynomial coefficients, K factors or mathematical algorithms, changing of temperature and pressure coefficients and dilution ratio settings), and a written explanation of the procedures used to make the adjustment(s) shall be kept.

9.3.2 Specific Requirements

9.3.2.1 Daily Calibrations, Linearity Checks and System Integrity Checks

Keep a written record of the procedures used for daily calibrations of the Hg CEMS and all auxiliary monitoring systems. If moisture and/or chlorine is added to the Hg calibration gas, explain how the dilution effect of the moisture and/or chlorine addition on the calibration gas concentration is accounted for. Also keep records of the procedures used to perform linearity checks (of the Hg CEMS and, if applicable, the CO_2 or O_2 monitor) and the procedures for system integrity checks of the Hg CEMS. Explain how the test results are calculated and evaluated.

9.3.2.2 Monitoring System Adjustments

Explain how each component of the continuous emission monitoring system will be adjusted to provide correct responses to calibration gases or reference signals after routine maintenance, repairs, or corrective actions.

9.3.2.3 Relative Accuracy Test Audits

Keep a written record of procedures used for RATAs of the monitoring systems. Indicate the reference methods used and explain how the test results are calculated and evaluated.

9.3.2.4 Verification of Emission Controls Performance

For units and common stack configurations that have FGD systems or add-on Hg emission controls, if parametric data are used to verify proper control device operation during missing data periods (see Section 10.2.5, below), the QA plan shall identify the parameters that are monitored and the acceptable range of values for each parameter. If data from a certified SO_2 CEMS are used to verify proper FGD operation, the SO_2 monitoring system must be included in the QA plan.

10. Data Reduction and Calculations

10.1 *Data Reduction*

Reduce the data from the Hg CEMS and (if applicable) from the auxiliary monitoring systems to hourly averages, in accordance with 40 CFR 75.10(d).

10.2 *Calculation of Hg Mass Emissions, Emission Rates, and Percentage Reduction.*

When an applicable regulation requires a Hg emission limit or a certain percentage reduction of Hg to be achieved, use the calculation methods in sections 10.2.1 through 10.2.4 below to demonstrate compliance with these requirements unless other methods are specified in the regulation. To ensure that the methods in sections 10.2.1 through 10.2.4 are applied correctly, the missing data substitution provisions of section 10.2.5 must be taken into account.

10.2.1 Hg Mass Emissions

10.2.1.1 Calculate the Hg mass emissions for each hour in the time period of interest, using Equation 1A (for wet-basis measurements of Hg concentration) or Equation 1B (for dry-basis measurements), as applicable:

$$M_h = K\, C_h\, Q_h\, t_h \qquad\qquad \text{(Equation 1A)}$$

Where:
M_h = Hg mass emissions for the hour (lb)
K = Units conversion constant, 6.236×10^{-11} lb-scm/µg-scf,
C_h = Hourly average Hg concentration, wet basis, as measured by the CEMS, adjusted for bias, if necessary (µg/scm).
Q_h = Stack gas volumetric flow rate for the hour, adjusted for bias, if necessary (scfh)
t_h = Unit or stack operating time[1], fraction of the hour, expressed as a decimal (e.g., 1.00 for a full operating hour, 0.5 for 30 minutes of operation, 0.00 for a non-operating hour, etc.)

or

$$M_h = K\, C_h\, Q_h\, t_h \left(1 - B_{ws}\right) \qquad\qquad \text{(Equation 1B)}$$

Where:
M_h = Hg mass emissions for the hour (lb)
K = Units conversion constant, 6.236×10^{-11} lb-scm/µg-scf,
C_h = Hourly average Hg concentration, dry basis, as measured by the CEMS, adjusted for bias, if necessary (µg/dscm).
Q_h = Stack gas volumetric flow rate for the hour, adjusted for bias, if necessary (scfh)
t_h = Unit or stack operating time, fraction of the hour, expressed as a decimal (e.g., 1.00 for a full operating hour, 0.5 for 30 minutes of operation, 0.00 for a non-operating hour[2], etc.)

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[1] "Unit operating time and "stack operating time" are defined in 40 CFR 72.2.

[2] When Equations 1A and 1B are used, calculate the hourly Hg mass emissions on a <u>clock</u> hour basis. For non-operating hours, the Hg mass emissions will, of course, be zero.

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B_{ws} = Moisture fraction of the stack gas, expressed as a decimal (equal to % H_2O/100)

10.2.1.2 If the applicable regulation specifies a limit on Hg mass emissions over a given time period (e.g., day, month, year, 12-month rolling period), use Equation 2 to calculate the cumulative Hg mass emissions:

$$M_t = \sum_{h=1}^{n} M_h \qquad \text{(Equation 2)}$$

Where:

M_t = Cumulative Hg mass emissions over the specified time period (lb)

M_h = Hg mass emissions for hour "h" in the specified time period, from Equation 1A or 1B, as applicable (lb)

n = Number of hours in the specified time period

10.2.2 Heat Input-Based Hg Emission Rates.

10.2.2.1 Use Equation 3 to calculate the Hg emission rate in units of pounds per trillion Btu (lb/TBtu), for each unit or stack operating hour[3] in the time period of interest:

$$E_{hm} = \frac{M_h}{(HI)_h (t_h)} \times 10^6 \qquad \text{(Equation 3)}$$

Where:

E_{hm} = Hg emission rate for the hour (lb/TBtu)

M_h = Hg mass emissions for the hour, from Equation 1A or 1B, as applicable (lb)

$(HI)_h$ = Heat input rate from coal combustion for the hour, calculated from measurements of stack gas flow rate, diluent gas concentration, and moisture (if needed), or appropriate substitute data values for these parameters, together with a fuel-specific F-factor and an appropriate equation from section 5.2 of appendix F to 40 CFR Part 75 (mmBtu/hr)

t_h = Unit or stack operating time, fraction of the hour, expressed as a decimal (e.g., 1.00 for a full operating hour, 0.5 for 30 minutes of operation, etc.)

10^6 = Conversion factor from mmBtu to TBtu

10.2.2.2 If the applicable regulation requires a heat input-based Hg emission rate limit to be met over a specified averaging period (e.g., day, month, year, rolling 12-month period), use Equation 4 to calculate the average emission rate.

$$\overline{E}_{hm} = \frac{\sum_{h=1}^{n} E_{hm}}{n} \qquad \text{(Equation 4)}$$

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[3] "Unit operating hour" and "stack operating hour" are defined in 40 CFR 72.2

Where:

$\overline{E}_{hm}$ = Hg emission rate for the specified averaging period (lb/TBtu)
E_{hm} = Hg emission rate for unit or stack operating hour "h" in the averaging period, from Equation 3 (lb/TBtu)
n = Number of unit or stack operating hours in the averaging period

(Note: Do not include non-operating hours with zero emission rates in the average).

10.2.3 Electrical Output-Based Emission Rates.

10.2.3.1 Use Equation 5 to calculate the Hg emission rate in units of pounds per gigawatt hour for each unit or stack operating hour in the time period of interest (lb/GW-hr):

$$E_{ho} = \frac{M_h}{(MW)_h (t_h)} \, x \, 10^3 \qquad \text{(Equation 5)}$$

Where:

E_{ho} = Electrical output-based Hg emission rate (lb/GW-hr)
M_h = Hg mass emissions for the hour, from Equation 1A or 1B, as applicable (lb)
$(MW)_h$ = Electrical load for the hour, in megawatts (MW)
t_h = Unit or stack operating time, fraction of the hour, expressed as a decimal (e.g., 1.00 for a full operating hour, 0.5 for 30 minutes of operation, etc.)
10^3 = Conversion factor from megawatts to gigawatts

10.2.3.2   If the applicable regulation requires an electrical output-based Hg emission rate limit to be met over a specified averaging period (e.g., day, month, year, 12-month rolling period), use Equation 6 to calculate the average emission rate:

$$\overline{E}_o = \frac{\sum\limits_{h=1}^{n} E_{ho}}{n} \qquad \text{(Equation 6)}$$

Where:

$\overline{E}_o$ = Hg emission rate for the specified averaging period (lb/GW-hr)
E_{ho} = Electrical output-based hourly Hg emission rate for unit or stack operating hour "h" in the averaging period, from Equation 5 (lb/GW-hr)
n = Number of unit or stack operating hours in the averaging period

(Note: Do not include non-operating hours with zero emission rates in the average).

10.2.4 Percentage Reduction of Hg

If the applicable regulation requires a certain percentage reduction of Hg to be achieved over a specified period of time (e.g., day, month, year, 12-month rolling period), follow the applicable procedures in sections 10.2.4.1 through 10.2.4.4, below.

10.2.4.1 Fuel sampling and analysis, using the methods listed in section 11 of this protocol, is required to determine either the "inlet" Hg content of the coal or the gross calorific value (GCV) of the coal. Coal sampling is required on each day that the unit operates. Collect the coal samples from feeders or other representative locations.

10.2.4.2 When multiple values of Hg content or GCV are obtained over a specified time period (e.g., a 12-month period), use the arithmetic average of all valid sample results and substitute data values in the calculations.

10.2.4.3 Percentage Reduction (Mass Basis)

10.2.4.3.1 Coal Consumption.

Use Equation 7 to determine the amount of coal combusted during the specified time period:

$$(Coal)_p = \frac{\sum_{h=1}^{n} (HI)_h (t_h)}{GCV} \; x \; 10^6 \qquad \text{(Equation 7)}$$

Where:
$(Coal)_p$ = Mass of coal combusted during the specified time period (lb)
$(HI)_h$ = Heat input rate from coal combustion for hour "h" in the specified time period, calculated from measurements of stack gas flow rate, diluent gas concentration, and moisture (if needed), or appropriate substitute data values for these parameters, together with a fuel-specific F-factor and an appropriate equation from section 5.2 of appendix F to 40 CFR Part 75 (mmBtu/hr)
t_h = Unit or stack operating time for hour "h" in the specified time period, fraction of the hour, expressed as a decimal (e.g., 1.00 for a full operating hour, 0.5 for 30 minutes of operation, 0.00 for a non-operating hour, etc.)
GCV = Gross calorific value of the coal for the specified time period (Btu/lb)
10^6 = Conversion factor from mmBtu to Btu
n = Number of clock hours[4] in the specified time period

10.2.4.3.2 Inlet Hg Mass

Use Equation 8 to calculate the "inlet Hg mass", i.e., the mass of Hg in the coal combusted during the specified time period:

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[4] Calculate $(Coal)_p$ on a <u>clock</u> hour basis. For non-operating hours, $(HI)_h$, t_h, and $(Coal)_p$ will all be zero.

$$(Mass)_{Hg-coal} = (C_{Hg-coal})(Coal)_p \ x \ 10^{-6} \qquad \text{(Equation 8)}$$

Where:

$(Mass)_{Hg-coal}$ = Total mass of Hg in the coal combusted during the specified time period (lb)

$C_{Hg-coal}$ = Measured Hg content of the coal combusted during the specified time period (ppm, mass basis)

$(Coal)_p$ = Mass of coal combusted during the specified time period, from Equation 7 (lb)

10^{-6} = Conversion factor, ppm to lb

10.2.4.3.3 Calculation of Percentage Reduction

Use Equation 9 to calculate the percentage reduction of Hg achieved in the specified time period:

$$(\%R)_{mass} = \frac{(Mass)_{Hg-coal} - M_t}{(Mass)_{Hg-coal}} \ x \ 100 \qquad \text{(Equation 9)}$$

Where:

$(\%R)_{mass}$ = Percentage reduction of Hg achieved in the specified time period, mass basis (percent)

$(Mass)_{Hg-coal}$ = Total mass of Hg in the coal combusted during the specified time period, from Equation 8 (lb)

M_t = Cumulative Hg mass emissions over the specified time period, from Equation 2 (lb)

10.2.4.4 Percentage Reduction (Emission Rate Basis)

10.2.4.4.1 Inlet Hg Emission Rate

Use Equation 10 to calculate the "inlet Hg emission rate" for the specified time period, in units of lb/TBtu:

$$E_r = \frac{(Mass)_{Hg-coal}}{\sum_{h=1}^{n} (HI)_h \ t_h} \ x \ 10^6 \qquad \text{(Equation 10)}$$

Where:

E_r = Inlet Hg emission rate for the specified time period (lb/TBtu)

$(Mass)_{Hg-coal}$ = Total mass of Hg in the coal combusted during the averaging period, from Equation 8 (lb)

$(HI)_h$ = Heat input rate from coal combustion for hour "h" in the specified time period, calculated from measurements of stack gas flow rate, diluent gas concentration, and moisture (if needed), or appropriate substitute data values for these parameters, together with a fuel-specific F-factor and an appropriate equation from section 5.2 of appendix F to 40 CFR Part 75 (mmBtu/hr)

t_h = Unit or stack operating time for hour "h" in the specified time period, fraction of the hour, expressed as a decimal (e.g., 1.00 for a full operating hour, 0.5 for 30 minutes

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of operation, 0.00 for a non-operating hour, etc.)
10^6 = Conversion factor from mmBtu to TBtu
n = Number of clock hours in the specified time period

10.2.4.4.2 Calculation of Percentage Reduction

Use Equation 11 to calculate the percentage reduction of Hg achieved in the specified time period:

$$\left(\%R\right)_{rate} = \frac{E_r - \overline{E}_{hm}}{E_r} \; x \; 100 \qquad \text{(Equation 11)}$$

Where:
$(\%R)_{rate}$ = Percentage reduction of Hg achieved in the specified time period, emission rate basis (percent)
E_r = Inlet Hg emission rate in the specified time period, from Equation 10 (lb/TBtu)
$\overline{E}_{hm}$ = Outlet Hg emission rate in the specified time period, from Equation 4 (lb/TBtu)

10.2.5 Missing Data Provisions

Missing data substitution is required whenever a measured value of a parameter needed to calculate the hourly Hg mass emissions, Hg emission rate, or percentage reduction is not available. Use the following procedures to provide substitute data values when essential data from Hg CEMS, auxiliary monitoring systems, certified backup monitoring systems, reference methods, or coal sampling and analysis (as applicable) are unavailable.

10.2.5.1 Mercury CEMS

10.2.5.1.1 Definition of a Missing Data Period

For a certified Hg CEMS, a missing data period occurs whenever a quality-assured hour of Hg concentration data is not obtained during unit operation (e.g., during a monitoring system malfunction or when the system undergoes maintenance), and Hg concentration data from a certified backup Hg monitoring system or from a Hg reference method are not available.

10.2.5.1.2 Initial Missing Data Procedures.

Immediately following the initial certification of a Hg CEMS, apply the initial missing data algorithms in 40 CFR 75.31(b) for Hg concentration[5], until 720 hours of quality-assured Hg concentration data have been collected. Calculate, and update hourly, the percent monitor data availability (PMA) for Hg concentration, in accordance with

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[5] These missing data procedures, which apply to SO_2 concentration, CO_2 concentration, and moisture, are equally suitable for Hg concentration.

40 CFR 75.32.

10.2.5.1.3 Standard Missing Data Procedures.

Once 720 quality-assured hours of Hg concentration data have been obtained following initial certification, provide substitute data for Hg concentration in accordance with the standard missing data procedures in 40 CFR 75.33(b)(1) through (b)(4), except that the term "Hg concentration" shall apply rather than "SO_2 concentration", the term "Hg CEMS" shall apply rather than "SO_2 pollutant concentration monitor", the term "maximum potential Hg concentration" shall apply, rather than "maximum potential SO_2 concentration", and the 95.0, 90.0, and 80.0 percent monitor data availability trigger conditions prescribed 40 CFR 75.33(b)(1) through (b)(4) shall be replaced, respectively, with 90.0, 80.0, and 70.0 percent (see Table 3, below).

10.2.5.1.4 Special Considerations for Units With Emission Controls

For a unit equipped with a flue gas desulfurization (FGD) system that significantly reduces the concentration of Hg emitted to the atmosphere (including circulating fluidized bed units that use limestone injection), or for a unit equipped with add-on Hg emission controls (e.g., carbon injection), the standard missing data procedures in section 10.2.5.1.3 may only be used for hours in which the SO_2 or Hg emission controls are documented to be operating properly, based on parametric data[6] recorded during the missing data period.   For any hour(s) in the missing data period for which this documentation is unavailable, report the maximum potential Hg concentration (MPC), as defined in section 7.2.1.1 of this protocol.

Table 3: Standard Missing Data Procedures for Hg Concentration

Trigger Conditions		Calculation Routines	
Percent Monitor Data Availability (PMA)	Duration (N) of Monitor Outage (Hours)	Method	Lookback Period
90 or more	N ≤ 24	Average of......................................	HB and HA[1]
	N > 24	The greater of: Average of……………………….. 90th percentile………………………	HB and HA 720 hours*
80 or more, but below 90	N ≤ 8	Average of..………………………..	HB and HA
	N > 8	The greater of: Average of……………………….. 95th percentile………………………	HB and HA 720 hours*
70 or more, but below 80	N > 0	Maximum value…………………..	720 hours*
Below 70	N > 0	Maximum potential concentration…..	None

[1] HB and HA = Quality-assured Hg concentrations in the hour before and hour after the monitor outage.

* Quality-assured monitor operating hours, during unit operation

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[6] Note: hourly SO_2 concentration data from a certified CEMS may be used to demonstrate that a FGD system is working properly.

However, when the PMA is less than 80.0 percent, but greater than or equal to 70.0 percent, and a missing data period occurs, you may report the maximum <u>controlled</u> Hg concentration in the previous 720 hours of quality-assured data, in lieu of reporting the maximum value in the 720-hour lookback, for each missing data hour in which the FGD or Hg emission controls are documented to be operating properly. Further, when the PMA is less than 70.0 percent and a missing data period occurs, you may report the greater of: (a) the maximum expected Hg concentration (MEC); or (b) 1.25 times the maximum controlled Hg concentration recorded in the previous 720 quality-assured hours of data, for each missing data hour in which the FGD or Hg emission controls are documented to be operating properly. The MEC shall be determined in accordance with section 7.2.1.2 of this protocol.

10.2.5.2 Auxiliary Monitoring Systems.

For the auxiliary monitoring systems (flow rate, diluent gas, and moisture), follow the applicable missing data procedures in Subpart D of 40 CFR Part 75.

10.2.5.3 Coal Sampling and Analysis

If the results of the analysis of a daily coal sample are either invalid or unavailable, use a substitute data value for that day. The substitute data value shall either be: (a) the average Hg content or average GCV (as applicable) from the previous 30 valid daily samples; or (b) the average of all Hg content or GCV values (as applicable) obtained to date if the fewer than 30 valid historical sample results are available. If no valid historical Hg content or GCV data are available data are available, apply the results of the first valid sample retrospectively to all missing data days.

10.2.5.4 Data Availability

Every effort should be made to obtain valid data and to minimize the use of missing data substitution. Data availability of at least 90 percent for all parameters is believed to be both reasonable and achievable.

11. Analytical Procedures

For the fuel sampling and analysis described in section 10.2.4.1 of this protocol, use the following sampling and analytical methods. Sample the coal using ASTM Method D 2234-00, with Type I increment collection, Conditions A, B, or C and systematic spacing. Alternatively, coal samples may be collected according to 40 CFR 63.7521(c). Use ASTM D 2013-04 to prepare the samples for analysis. Determine the Hg content of the coal using ASTM D 6722-01, ASTM D 6414-01, or ASTM D 3684-01. Determine the GCV using ASTM D 5865-04 or ASTM D 3176-02. More recent versions of any of these ASTM methods may be used.

12. Reporting Guidelines

Quarterly electronic reporting of data from the certified Hg CEMS (and, if applicable, the auxiliary monitoring systems) is recommended, unless otherwise specified in an applicable regulation or policy. If electronic reporting is implemented, supporting

information must also be provided to enable comprehensive electronic auditing of the emissions data. At a minimum, the following data elements should be reported electronically:

12.1 *Unit Information*

Report unit information, including, but not limited to, the unit ID number, the maximum rated heat input capacity, the operating range (in terms of load), the normal operating load(s), the type(s) of fuel combusted, and the type(s) of emission controls.

12.2 *Stack Information*

For units that share a monitored common stack or for units with monitored multiple stack exhaust configurations, report the stack ID number(s) and show the unit/stack relationships.

12.3 *Monitoring System Information*

Report information for each monitoring system, including, but not limited to, system location, parameter monitored, system and component ID numbers, and component data (e.g., component type, manufacturer, model, serial number, installation date, etc.).

12.4 *Span and Range Information*

Report span and range information for the Hg CEMS and (as applicable) the auxiliary monitoring systems.

12.5 *Formulas*

Report, as applicable, the mathematical formulas that are used to calculate hourly Hg mass emissions and Hg emission rates.

12.6 *Operating Data*

Report hourly unit operating data including, but not limited to, date and hour, unit (or stack) operating time, unit load, and the type of fuel combusted.

12.7 *Emissions Data*

12.7.1 Hourly Data

Report hourly Hg concentration data from the Hg CEMS and (if applicable) hourly data from the auxiliary monitoring systems that are used to calculate Hg mass emissions and Hg emission rates. Where bias adjustment is required, report both the unadjusted and bias-adjusted values. Report the hour-by-hour percent monitor data availability (PMA) for all monitored parameters. Indicate which hourly values of each monitored parameter are quality-assured and which ones are substitute data values. Also report, if applicable, the calculated hourly Hg mass emissions and/or Hg emission rates.

12.7.2 Cumulative and Average Values

Report, as applicable, the cumulative Hg mass emissions and/or average Hg emission rates (e.g., quarterly and year-to-date totals or averages).

12.8 *QA Test Data and Results*

Report, as applicable, detailed quality assurance test data and summarized results, for the following QA tests of the Hg CEMS and auxiliary monitoring systems: calibration error tests, linearity checks, system integrity checks and RATAs. For QA tests that use Hg calibration gas standards, indicate whether elemental or oxidized Hg was used. Also, if applicable, report the results of all coal analyses for Hg content and GCV.

13. Method Performance

These monitoring criteria and procedures have been applied to coal-fired utility boilers (including units with post-combustion emission controls), having vapor-phase Hg concentrations ranging from 0.03 µg/dscm to 100 µg/dscm.