

**Measurement and Reporting of Vapor Phase Mercury Emissions
from Low-Emitting Stationary Sources
(DRAFT 9/25/08)**

1. Scope and Application

The purpose of this protocol is to establish procedures for the measurement of vapor-phase mercury (Hg) emissions in combustion flue gas streams, using periodic source testing in conjunction with continuous monitoring of auxiliary parameters. Guidelines are also provided for reporting Hg emissions data and for using the data to demonstrate compliance with applicable Hg emission limits.

1.1 Analytes

The analyte measured by this protocol is total vapor-phase Hg in the flue gas, which represents the sum of elemental Hg (Hg⁰, 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

This protocol applies to the measurement 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). Use of the protocol is limited to units that emit 29.0 lb of Hg or less in a 12-month period.

2. Initial Qualification

2.1 Individual Units

To determine whether a unit is eligible to use this protocol, the owner or operator must perform Hg emission testing to measure the concentration of vapor phase Hg in the source effluent, as follows:

2.1.1 The testing shall be performed at a location that is representative of the Hg emissions to the atmosphere, using one of the following Hg reference methods: ASTM D6784-02 (the Ontario Hydro Method); Method 30-A in Appendix A-8 to 40 CFR Part 60; or Method 30-B in Appendix A-8 to 40 CFR Part 60.

2.1.2 A minimum of three test runs shall be done at the unit's normal operating load (determined in accordance with section 6.5.2.1 of appendix A to 40 CFR Part 75), while combusting coal. The coal combusted during the testing must be representative of, and preferably from the same source(s) of supply as, the coal that is used for day-to-day operation of the unit. If different coal ranks, as defined in ASTM D 388-05 (e.g., bituminous and subbituminous) are blended, then either:

2.1.2.1 Perform the test while combusting only the coal rank with the highest MPC value, as defined in section 6.1.1.2.5 of this protocol. For instance, if bituminous and sub-bituminous coals are blended, perform the test while combusting only sub-bituminous coal; or

2.1.2.2 Perform the test with a coal blend that contains the coal rank with the highest MPC in the highest percentage used for normal day-to-day operation. For example, if bituminous and sub-bituminous coals are blended and the highest percentage of sub-bituminous coal used for daily operation is 20%, perform the test with a blend of 80% bituminous and 20% sub-bituminous coals.

2.1.3 The minimum time per run shall be 1 hour if Method 30-A is used.

2.1.4 If the Ontario Hydro Method is used, paired samples are required for each test run and the runs must be long enough to ensure that sufficient Hg is collected to analyze. Test results shall be based on the vapor phase Hg collected in the back-half of the Ontario Hydro sampling trains (i.e., the non-filterable impinger catches). For each test run, calculate the relative deviation (RD) of the paired samples, using the following equation:

$$RD = \frac{|C_a - C_b|}{C_a + C_b} \times 100 \quad (\text{Eq. 1})$$

Where:

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

C_a = Hg concentration of Hg sample "a" ($\mu\text{g}/\text{dscm}$)

C_b = Hg concentration of Hg sample "b" ($\mu\text{g}/\text{dscm}$)

The following RD criteria must be met to validate the run. The RD must not exceed 10 percent, when the average Hg concentration is greater than 1.0 $\mu\text{g}/\text{dscm}$. If the average concentration is $\leq 1.0 \mu\text{g}/\text{dscm}$, the RD must not exceed 20 percent. The RD results are also acceptable if the absolute difference between the two Hg concentrations does not exceed 0.03 $\mu\text{g}/\text{dscm}$. If the RD specification is met, the results of the two samples shall be averaged arithmetically.

2.1.5 If the unit is equipped with a flue gas desulfurization (FGD) system or add-on Hg emission controls, the controls must be operating normally during the testing. To establish proper operation of the controls during the test period, the owner or operator shall record the appropriate parametric data (see section 8.2.2 of this protocol). Alternatively, for a unit with an FGD system, SO_2 concentration data from a certified continuous emission monitor (CEM) may be used to demonstrate that the FGD is working properly.

2.1.6 Based on the results of the emission testing, the following equation shall be used to provide an estimate of the potential annual Hg mass emissions from the unit:

$$E_p = K N C_{Hg} Q_{max} \quad (\text{Eq. 2})$$

Where:

E_p = Potential annual Hg mass emissions from the unit, (lb/year)

N = Either 8,760 (the number of hours in a year) or the maximum number of operating hours per year (if less than 8,760) allowed by the unit's enforceable operating permit.

C_{Hg} = The highest Hg concentration ($\mu\text{g}/\text{scm}$) from any of the test runs or 0.50 $\mu\text{g}/\text{scm}$, whichever is greater

Q_{max} = Maximum potential stack gas flow rate, determined according to section 2.1.4.1 of appendix A to 40 CFR Part 75 (scfh)

K = Units conversion constant, 6.236×10^{-11} lb-scm/ μg -scf

Equation 2 assumes that the unit operates at its maximum potential flow rate, either year-round or for the maximum number of hours per year allowed by the operating permit (if unit operation is restricted to less than 8,760 hours per year). Also, if the Hg concentration measured in each of the test runs is less than 0.50 $\mu\text{g}/\text{scm}$, a default value of 0.50 $\mu\text{g}/\text{scm}$ must be used in the calculation of E_p .

2.1.7 If the unit's operating permit restricts the unit's annual heat input, but not the number of annual unit operating hours, the owner or operator may divide the allowable annual heat input (mmBtu) by the design rated heat input capacity of the unit (mmBtu/hr) to determine the value of "N" in Equation 2.

2.1.8 If E_p , the potential annual Hg mass emissions calculated according to Equation 2, does not exceed 29.0 lb, the unit qualifies as a low-emitter and is eligible to use this protocol.

2.2 *Groups of Identical Units*

If two or more of units of the same type, at the same facility, qualify as a group of identical units in accordance with 40 CFR 75.19(c)(1)(iv)(B), the owner or operator may test a subset of these units in lieu of testing each unit individually.

2.2.1 For a qualifying group of identical units, the number of units required to be tested shall be determined from Table LM-4 in 40 CFR 75.19.

2.2.2 For each tested unit in the group, Equation 2 shall be used to calculate E_p . If the value of E_p is 29.0 lb/yr or less for each tested unit, the group of identical units is eligible to use this protocol. If the value of E_p exceeds 29.0 lb/yr for any tested unit, the units are disqualified from using the protocol as a group; however, any individual tested unit(s) for which value of E_p is 29.0 lb/yr or less may use the protocol.

2.3 *Common Stack Configurations*

For units that share a common stack, the Hg emission testing described in section 2.1 of this protocol may be performed at the common stack if the following conditions are met. Otherwise, testing of the individual units (or a subset of the units, if identical, as described section 2.2 of this protocol) is required:

2.3.1 The testing must be done at a combined load corresponding to the normal load level (low, mid, or high) for the units sharing the common stack, in accordance with section 6.5.2.1 of appendix A to 40 CFR Part 75.

2.3.2 All of the units that share the stack must be operating in a normal, stable manner and at typical load levels during the emission testing. The coal combusted in each unit during the testing must be representative of the coal that is used for the day-to-day operation of that unit (see section 2.1.2, above).

2.3.3 If flue gas desulfurization and/or add-on Hg emission controls are used to reduce the level of emissions exiting from the common stack, these emission controls must be operating normally during the emission testing and, for the purpose of establishing proper operation of the controls, the owner or operator shall record appropriate parametric data or SO₂ concentration data, as described in section 2.1.5 of this protocol.

2.3.4 To calculate E_p , substitute into Equation 2 the maximum potential flow rate through the common stack with all units that share the stack in operation, along with the highest Hg concentration from any test run (or 0.50 µg/scm, if greater).

2.3.5 Divide the calculated value of E_p by the number of units sharing the stack. If the result does not exceed 29.0 lb, the common stack configuration qualifies to use this protocol.

2.4 *Multiple Stack Configurations*

2.4.1 For a unit with a multiple stack exhaust configuration where stack gases flow continuously through all of the stacks, perform the Hg emission testing described in section 2.1 of this protocol separately on each stack. If the sum of the E_p values calculated for the individual stacks is 29.0 lb/yr or less, the unit is eligible to use this protocol.

2.4.2 Notwithstanding the requirements of section 2.4.1, a single qualification test may be performed in the ductwork leading to the exhaust stacks, provided there is a test location in the ductwork that is representative of the unit's total vapor phase Hg emissions.

2.4.3 For a unit with a main stack and a bypass stack, Hg emission testing described in section 2.1 of this protocol shall be performed only on the main stack, with no flue gas

flowing through the bypass stack. If the calculated value of E_p is 29.0 lb/yr or less, the unit is eligible to use this protocol.

3. Retest Requirements

The Hg emission testing described in section 2 of this protocol shall be repeated periodically for each unit or group of units that initially qualifies to use this protocol.

3.1 First Retest

3.1.1 Individual Units

3.1.1.1 If the value of E_p calculated from the results of the initial qualification testing described in section 2.1 of this protocol is 9.0 lb/yr or less, the first retest of the unit is due by the end of the fourth QA operating quarter¹ following the calendar quarter of the qualification testing.

3.1.1.2 If the value of E_p calculated from the results of the initial qualification testing described in section 2.1 of this protocol is greater than 9.0 lb/yr, the first retest of the unit is due by the end of the second QA operating quarter following the calendar quarter of the qualification testing.

3.1.2 Groups of Identical Units

3.1.2.1 If the value of E_p calculated from the results of the initial qualification testing is 9.0 lb/yr or less for all tested units in the group, the first retest is due by the end of the fourth QA operating quarter following the calendar quarter of the qualification testing.

3.1.2.2 If the value of E_p calculated from the results of the initial qualification testing is greater than 9.0 lb/yr for any tested unit in the group, the first retest is due by the end of the second QA operating quarter following the calendar quarter of the qualification testing.

3.1.2.3 In the first required retest, a different subset of the units than was tested for initial qualification must be tested, unless circumstances beyond the control of the owner or operator prevent this. In subsequent retests (see section 3.2, below), make every effort to ensure that each unit in the group is tested in a timely manner.

3.1.3 Common Stack Configurations

3.1.3.1 If the value of E_p calculated from the results of the initial qualification testing at the common stack, when divided by the number of units sharing the common stack, is 9.0 lb/yr or less, the first retest is due by the end of the fourth QA operating quarter following the calendar quarter of the qualification testing.

¹ A “QA operating quarter” is a calendar quarter in which the unit operates for 168 hours or more (see 40 CFR 72.2).

3.1.3.2 If the value of E_p calculated from the results of the initial qualification testing at the common stack, when divided by the number of units sharing the common stack, is greater than 9.0 lb/yr, the first retest is due by the end of the second QA operating quarter following the calendar quarter of the qualification testing.

3.1.4 Multiple Stack Configurations

3.1.4.1 If the initial qualification testing is performed in each of the multiple stacks and the sum of the E_p values for the individual stacks is 9.0 lb/yr or less, the first retest is due by the end of the fourth QA operating quarter following the calendar quarter of the qualification testing. If the sum of the E_p values exceeds 9.0 lb/yr, the first retest of the stacks is due by the end of the second QA operating quarter following the calendar quarter of the qualification testing.

3.1.4.2 If the initial test is performed in the ductwork, as described in section 2.4.2 of this protocol, determine the due date for the first retest of the unit in accordance with sections 3.1.1.1 and 3.1.1.2 of this protocol, using the E_p value from the qualification testing

3.1.4.3 For a unit with a main stack and a bypass stack, determine the due date for the first retest in accordance with sections 3.1.1.1 and 3.1.1.2 of this protocol, using the E_p value from the qualification testing at the main stack.

3.2 *Subsequent Retests*

3.2.1 Retests shall be done either semiannually or annually (i.e., by the end of the second or fourth QA operating quarter following the quarter of the previous test).

3.2.2 Each time that a retest is performed, substitute the highest Hg concentration from the test or 0.50 $\mu\text{g}/\text{scm}$ (whichever is greater) into Equation 2. Then, determine the due date for the next retest according to section 3.1.1, 3.1.2, 3.1.3, or 3.1.4 of this protocol (as applicable), replacing the words “initial qualification testing” and “qualification testing” with the words “current test”, and replacing the words “first retest” with the words “next retest”.

(Note: The calculations described in section 3.2.2, above, are used solely to determine the due date for the next retest. If, for a particular unit, group of identical units, or common stack configuration the results of these calculations exceed the 29.0 lb/yr threshold value, this does not disqualify the unit, group of units, or common stack from using this protocol. As explained in section 5, below, ongoing qualification is based on the actual (not potential) Hg mass emissions in a specified 12-month period.)

3.3 *Special Considerations for Common Stack Retests*

For the retest of a common stack configuration, it is not necessary for all of the units that share the stack to be in operation during the test, provided that the required load level is attained (see section 2.3.1, above), and that all of the units that share the stack are fed from the same on-site coal supply during their normal, day-to-day operation. However, if two or more of the units are normally fed from different on-site coal supplies (e.g., one unit burns only low-sulfur coal for compliance and the other units combust higher-sulfur coal), then either:

3.3.1 Perform the retest with all units in normal operation; or

3.3.2 If operation of all units at the time of the scheduled test is not possible due to circumstances beyond the control of the owner or operator (e.g., a forced unit outage), perform the retest with the available units operating and assess the test results as follows:

3.3.2.1 If the concentration obtained in the retest is greater than or equal to the value from previous test, use the Hg concentration from the retest for reporting purposes and to determine the due date for the next retest; or

3.3.2.2 If the retested value is lower than the value from the previous test, continue using the Hg concentration from the previous test for reporting purposes, and use the Hg concentration from the previous test in Equation 2 to determine the due date for the next retest.

3.4 *Additional Retests*

An additional retest is required: (a) when there is a change in the coal rank of the primary fuel (e.g., when the primary fuel is switched from bituminous coal to lignite); or (b) when a rank of coal that had not previously been combusted begins to be blended with the primary fuel (e.g., if a blend of sub-bituminous coal and bituminous coal begins to be combusted in a unit that had previously combusted only bituminous coal).

3.4.1 Use ASTM D388-05 to determine the coal rank. The four principal coal ranks are anthracitic, bituminous, subbituminous, and lignitic. For the purposes of this protocol, the ranks of anthracite coal refuse (culm) and bituminous coal refuse (gob) shall be anthracitic and bituminous, respectively.

3.4.2 The retests described in this section shall be performed within 720 unit operating hours of the change in coal rank or the commencement of coal blending (as applicable).

4. Auxiliary Monitors and Measurements

4.1 Flow Monitor

Following the initial qualification testing, the owner or operator must demonstrate, on an on-going basis, that the unit, group of identical units, or common stack configuration remains eligible to use this protocol (see section 5, below). To make this demonstration, a continuous monitor to measure the stack gas volumetric flow rate is required, in order to determine hourly Hg mass emissions (see section 6.1.1 of this protocol). The flow monitor shall be installed, certified, maintained, and quality-assured according to 40 CFR Part 75.

4.2 Other Auxiliary Monitors and Measurements

4.2.1 Moisture Correction

If the reference method used for the emission testing measures Hg concentration 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). If different ranks of coal are blended and option (b) is chosen, use the lowest default moisture percentage of any coal rank in the blend in the emissions calculations.

4.2.2 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 flow monitor and (if applicable) the moisture correction method described in sections 4.1 and 4.2.1, above, a certified diluent gas (CO₂ or O₂) monitor and a fuel-specific F-factor are required to determine the hourly heat input rates. The diluent gas monitor shall be installed, certified, maintained, and quality-assured according to 40 CFR Part 75 (see section 6.1.2 of this protocol). The appropriate F-factor shall be obtained from section 3.3.5 or 3.3.6 of Appendix F to 40 CFR Part 75.

4.2.3 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 flow monitor and (if applicable) the moisture correction method described in sections 4.1 and 4.2.1, above (see section 6.1.3 of this protocol).

5. On-going Qualification

Following initial qualification, the owner or operator must continue to demonstrate on an on-going 12-month basis (which may be either successive calendar years or successive rolling 12-month periods) that the Hg emissions threshold value of 29.0 lb per unit is not exceeded, in order for a unit, group of identical units, or common stack configuration to remain eligible to use this protocol. To make these demonstrations:

5.1 Data from the flow monitor and (if applicable) moisture data are used together with the measured Hg concentrations from the emission tests and retests described in sections 2 and 3 of this protocol, to calculate hourly Hg mass emissions (see section 6.1 of this protocol).

5.2 The hourly Hg mass emissions are summed over each 12-month period, to determine whether or not the Hg emissions threshold has been exceeded. The threshold has been exceeded when, for the 12-month period:

5.2.1 The cumulative Hg mass emissions from an individual unit have exceeded 29.0 lb; or

5.2.2 The cumulative Hg mass emissions from a unit that is part of a group of identical units have exceeded 29.0 lb; or

5.2.3 The cumulative Hg mass emissions measured at a common stack have exceeded 29.0 lb times the number of units sharing the stack; or

5.2.4 The sum of the cumulative Hg mass emissions from all stacks of a unit with a multiple stack configuration have exceeded 29.0 lb; or

5.2.5 The cumulative Hg mass emissions from a unit with a main stack and bypass stack configuration have exceeded 29.0 lb.

5.3 If the Hg emissions threshold is exceeded as described in section 5.2 above, the unit, group of identical units, or common stack is disqualified from using this protocol. However, in the case where a group of identical units is disqualified, the protocol may continue to be used for any individual unit(s) in the group for which the emissions threshold was not exceeded.

5.4 When a particular unit or common stack configuration is disqualified from using this protocol, a mercury CEMS or a sorbent trap monitoring system may have to be installed and certified within a reasonable amount of time, to meet the on-going monitoring and reporting requirements of an applicable regulation. Unless otherwise specified by regulation or by the permitting authority: (a) 180 days (minimum) should be allowed to install and certify the monitoring system, starting with the first day after the 12-month period in which the unit, group of identical units, or common stack

configuration was disqualified from using this protocol; and (b) this protocol may be used for reporting purposes until the monitoring system has been certified or until the 180-day window expires (whichever occurs first).

6. Calculations

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

Use the calculation methods in sections 6.1.1 through 6.1.4, below, to demonstrate compliance with an applicable regulation that requires a particular Hg emission limit to be met or a certain percentage reduction of Hg to be achieved, unless other calculation methods are specified in the regulation. To ensure that the calculation methods in sections 6.1.1 through 6.1.4 are applied correctly, the missing data substitution provisions of section 6.1.5, below, must be taken into account.

Also, use the Hg mass emissions calculation methods in sections 6.1.1.1 through 6.1.1.3, below for the required on-going demonstrations that a unit, group of identical units, or common stack configuration continues to qualify to use this protocol (see section 5, above).

6.1.1 Hourly Hg Mass Emissions

6.1.1.1 Calculate hourly Hg mass emissions using Equation 3A (for wet-basis reference method measurements of Hg concentration) or Equation 3B (for dry-basis reference method measurements), as applicable:

$$M_h = K C_h Q_h t_h \quad (\text{Equation 3A})$$

Where:

M_h = Hg mass emissions for the hour (lb)

K = Units conversion constant, 6.236×10^{-11} lb-scm/ μ g-scf,

C_h = Hg concentration from emission testing, wet basis (μ g/scm)

Q_h = Stack gas volumetric flow rate for the hour, adjusted for bias, if necessary (scfh)

t_h = Unit or stack operating time², 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 hour³, etc.)

or

$$M_h = K C_h Q_h t_h (1 - B_{ws}) \quad (\text{Equation 3B})$$

² “Unit operating time and “stack operating time” are defined in 40 CFR 72.2.

³ When using Equations 3A and 3B, calculate the hourly Hg mass emissions on a clock hour basis. For non-operating hours, the Hg mass emissions will, of course, be zero.

Where:

M_h = Hg mass emissions for the hour (lb)

K = Units conversion constant, 6.236×10^{-11} lb-scm/ μ g-scf,

C_h = Hg concentration from emission testing, dry basis (μ g/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, etc.)

B_{ws} = Moisture fraction of the stack gas, expressed as a decimal (equal to % H₂O/100)

6.1.1.2 In Equations 3A and 3B, the term “ C_h ” is a default Hg concentration value derived from the required emission testing. For each test, the appropriate value of C_h is determined according to sections 6.1.1.2.1 through 6.1.1.2.6, below and is applied to each hour, beginning with the first hour after completion of the test. There is one exception to this. When a retest is triggered by a change in the coal rank of the primary fuel or when a new coal rank is blended with the primary fuel, the value of C_h from the retest is applied beginning with the first hour after the date and hour of the fuel switch or the commencement of fuel blending (as applicable).

6.1.1.2.1 For an individual unit that is not part of a group of identical units, the value of C_h shall either be the highest Hg concentration measured in any of the test runs or 0.50 μ g/scm, whichever is greater.

6.1.1.2.2 For a group of identical units, the value of C_h shall either be the highest Hg concentration measured in any test run, across all tested units, or 0.50 μ g/scm, whichever is greater.

6.1.1.2.3 For a common stack configuration, the value of C_h shall either be the highest Hg concentration measured in any of the test runs or 0.50 μ g/scm, whichever is greater.

6.1.1.2.4 For a unit with a multiple stack configuration, if testing is performed in the individual stacks, the value of C_h for each stack shall either be the highest value obtained in any test run for that stack or 0.50 μ g/scm, whichever is greater.

6.1.1.2.5 For a unit with a main stack and bypass stack configuration, the value of C_h for the main stack shall either be the highest value obtained in any test run or 0.50 μ g/scm, whichever is greater, except when the bypass stack is used. When the main stack is bypassed, the maximum potential Hg concentration (MPC) shall be used in the calculations. For the purposes of this protocol, the MPC values shall be: (a) 9 μ g/scm for bituminous coal; (b) 10 μ g/scm for sub-bituminous coal; (c) 16 μ g/scm for lignite; and (d) 1 μ g/scm for waste coal, i.e., anthracite culm or bituminous gob. If different types of coal are blended, use the highest MPC for any coal in the blend (e.g., if bituminous and sub-bituminous coals are blended, use 10 μ g/scm).

6.1.1.2.6 For a unit or common stack that is equipped with a flue gas desulfurization system or add-on Hg controls, use the appropriate value of C_h from sections 6.1.1.2.1 through 6.1.1.2.5, for each operating hour in which proper operation of the emission controls is documented. However, for any operating hour in which this documentation is unavailable (e.g., during a control device malfunction or when the control device is bypassed), the maximum potential Hg concentration (as defined in section 6.1.1.2.5) must be used in the calculations.

6.1.1.3 For the on-going qualification demonstrations described in section 5 of this protocol, use Equation 4 to calculate the cumulative Hg mass emissions for each 12-month period (i.e., calendar year or rolling 12-month period):

$$M_t = \sum_{h=1}^n M_h \quad (\text{Equation 4})$$

Where:

M_t = Cumulative Hg mass emissions over the 12-month period (lb)

M_h = Hg mass emissions for clock hour “h” in the 12-month period, from Equation 3A or 3B, as applicable (lb)

n = Number of clock hours in the 12-month period

(Note: Equation 4 may also be used to demonstrate compliance with a cumulative Hg mass emissions limit specified in an applicable regulation. If the compliance period is other than 12 months, simply replace the words “12-month period” in the Equation 4 nomenclature with the words “specified compliance period”).

6.1.2 Heat Input-Based Hg Emission Rates.

6.1.2.1 Use Equation 5 to calculate the Hg emission rate in units of pounds per trillion Btu (lb/TBtu), for each unit or stack operating hour⁴:

$$E_{hm} = \frac{M_h}{(HI)_h(t_h)} \times 10^6 \quad (\text{Equation 5})$$

Where:

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

M_h = Hg mass emissions for the hour, from Equation 3A or 3B, 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)

⁴ “Unit operating hour” and “stack operating hour” are defined in 40 CFR 72.2

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

6.1.2.2 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 6 to calculate the average emission rate.

$$\bar{E}_{hm} = \frac{\sum_{h=1}^n E_{hm}}{n} \quad (\text{Equation 6})$$

Where:

\bar{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 5 (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).

6.1.3 Electrical Output-Based Emission Rates.

6.1.3.1 Use Equation 7 to calculate the Hg emission rate in units of pounds per gigawatt hour for each unit or stack operating hour (lb/GW-hr):

$$E_{ho} = \frac{M_h}{(MW)_h(t_h)} \times 10^3 \quad (\text{Equation 7})$$

Where:

E_{ho} = Electrical output-based Hg emission rate (lb/GW-hr)
 M_h = Hg mass emissions for the hour, from Equation 3A or 3B, 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

6.1.3.2 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 8 to calculate the average emission rate:

$$\bar{E}_o = \frac{\sum_{h=1}^n E_{ho}}{n} \quad (\text{Equation 8})$$

Where:

\bar{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 7 (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).

6.1.4 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 6.1.4.1 through 6.1.4.4, below.

6.1.4.1 Fuel sampling and analysis, using the methods listed in section 7 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.

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

6.1.4.3 Percentage Reduction (Mass Basis)

6.1.4.3.1 Coal Consumption.

Use Equation 9 to determine the amount of coal combusted during the specified time period:

$$(Coal)_p = \frac{\sum_{h=1}^n (HI)_h(t_h)}{GCV} \times 10^6 \quad (\text{Equation 9})$$

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 hours⁵ in the specified time period

6.1.4.3.2 Inlet Hg Mass

Use Equation 10 to calculate the “inlet Hg mass”, i.e., the mass of Hg in the coal combusted during the specified time period:

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

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--- see section 6.1.4.2, above---(ppm, mass basis)

$(Coal)_p$ = Mass of coal combusted during the specified time period, from Equation 9 (lb)

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

6.1.4.3.3 Calculation of Percentage Reduction

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

$$(\%R)_{mass} = \frac{(Mass)_{Hg-coal} - M_t}{(Mass)_{Hg-coal}} \times 100 \quad (\text{Equation 11})$$

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 10 (lb)

M_t = Cumulative Hg mass emissions over the specified time period, from Equation 4 (lb)

⁵ Calculate $(Coal)_p$ on a clock hour basis. For non-operating hours, $(HI)_h$ and t_h , will be zero.

6.1.4.4 Percentage Reduction (Emission Rate Basis)

6.1.4.4.1 Inlet Hg Emission Rate

Use Equation 12 to calculate the “inlet Hg emission rate” for the specified time period, in units of lb/TBtu:

$$E_r = \frac{(Mass)_{Hg-coal}}{\sum_{h=1}^n (HI)_h t_h} \times 10^6 \quad (\text{Equation 12})$$

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 specified time period, from Equation 10 (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.)

10^6 = Conversion factor from mmBtu to TBtu

n = Number of clock hours in the specified time period

6.1.4.4.2 Calculation of Percentage Reduction

Use Equation 13 to calculate the percentage reduction of Hg achieved in the specified time period:

$$(\%R)_{rate} = \frac{E_r - \bar{E}_{hm}}{E_r} \times 100 \quad (\text{Equation 13})$$

Where:

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

E_r = Inlet Hg emission rate for the specified time period, from Equation 12 (lb/TBtu)

\bar{E}_{hm} = Outlet Hg emission rate for the specified time period, from Equation 6 (lb/TBtu)

6.1.5 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, as applicable, to provide

substitute data values when essential data from Hg emission tests, CEMS, auxiliary monitoring systems, certified backup monitoring systems, reference methods, or coal sampling and analysis are unavailable.

6.1.5.1 Hg Emission Tests

If the initial qualification test described in section 2 of this protocol is not successfully completed by the compliance deadline specified in an applicable regulation, use the maximum potential Hg concentration (as defined in section 6.1.1.2.5 of this protocol) in the emissions calculations until the required test is completed. If a retest required by section 3 of this protocol is not successfully completed by the deadline, multiply the value of C_h from the previous test by 1.5 and use the resultant value in the emissions calculations until the required retest is completed.

6.1.5.2 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.

6.1.5.3 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, apply the results of the first valid sample retrospectively to all missing data days.

6.1.5.4 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.

7. Analytical Procedures

For the fuel sampling and analysis described in section 6.1.4.1 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.

8. Quality Assurance

8.1 On-going QA Testing of Auxiliary Monitoring System(s)

On-going quality-assurance (QA) testing of the auxiliary monitoring system(s) shall be performed according to appendix B to 40 CFR Part 75.

8.2 QA/QC Program

The owner or operator shall develop and implement a quality assurance/quality control (QA/QC) program, as follows:

8.2.1 The reference method(s) used for the Hg emission tests and retests required by sections 2 and 3 of this protocol shall be identified and a copy of the test procedures shall be kept on file. All test data, calculations and final results shall be kept for at least three years, in a format suitable for audit and inspection.

8.2.2 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, the QA plan shall identify the parameters that are monitored and the acceptable range of values for each parameter. If data from a certified SO₂ monitor are used to verify proper operation of a FGD system, the monitor shall be included in the QA plan.

8.2.3 For the auxiliary monitoring system(s), follow the applicable procedures in section 1 of appendix B to 40 CFR Part 75.

8.2.4 The QA plan shall include an explanation of the procedures used for coal sampling and analysis (if applicable). The results of all coal analyses shall be kept on file in a format suitable for inspection and auditing, for at least three years.

9. Reporting Guidelines

Quarterly electronic reporting of data from the Hg emission tests and 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:

9.1 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. For a group of identical units, assign a group ID number and identify each unit in the group.

9.2 *Stack Information*

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

9.3 *Monitoring System Information*

Report information for each auxiliary 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.).

9.4 *Span and Range Information*

Report span and range information for the auxiliary monitoring system(s).

9.5 *Formulas*

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

9.6 *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.

9.7 *Emissions Data*

9.7.1 Hourly Data

9.7.1.1 Raw Data

Report hourly Hg concentrations, derived from the results of the required Hg emission tests (i.e., the appropriate C_h values from sections 6.1.1.2.1 through 6.1.1.2.6, above). Also report hourly data from the flow monitor and from any other auxiliary monitoring systems. 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.

9.7.1.2 Derived Values.

Report the hourly Hg mass emissions (from Equation 3A or 3B) and, if applicable, the calculated hourly emission rates.

9.7.2 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).

9.8 *Test Data and Results*

9.8.1 Report the results of all Hg emissions tests and retests required under sections 2 and 3 of this protocol. Indicate the value of C_h derived from each test.

9.8.2 Report, as applicable, detailed quality assurance test data and summarized results, for the following QA tests of the auxiliary monitoring systems: calibration error tests, linearity checks, and RATAs.

9.8.3 If applicable, report the results of all coal analyses for Hg content and GCV.

10. 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 $\mu\text{g}/\text{dscm}$ to 100 $\mu\text{g}/\text{dscm}$.