

**PROCEDURES FOR
TESTING AND MONITORING
SOURCES OF AIR POLLUTANTS**

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2.119 Fuel Burning Equipment

2.119.1 Applicability and Definition of Affected Facility

- (a) The affected facility to which this source category applies is any fuel burning equipment which is subject to the Georgia Rules for Air Quality Control, (Georgia Rule), Chapter 391-3-1.02(2)(ll), ~~and~~ including rule 391-3-1.02(6)(a)2.(xii).

2.119.2 Compliance and Performance Testing for Nitrogen Oxides

- (a) In conducting the performance tests required in Section 1.2, the owner or operator shall use as reference methods and procedures the test methods in Appendix A of this text or other methods and procedures as specified in this section, except as provided in Section 1.2(b). Acceptable alternative methods and procedures are given in Section 2.119.2(d).
- (b) For affected facilities with a maximum design heat input capacity below 100 million BTU/hr, the owner or operator shall determine compliance as follows:

- (1) Sample points shall be located as specified in Method 7E, Section 8.1.2. Method 1 shall be used for sample point selection, in lieu of the requirements in Section 11.2, the following table may be used to select the minimum number of traverse points:

For stacks with a diameter of d:	
For $d < 12$ inches.....	one traverse point located in centroid of the cross-sectional area;
For $12 \text{ inches} \leq d < 30$ inches.....	four traverse points located according to Table 1-2 of Method 1; and
For $d \geq 30$ inches.....	use the requirements of Section 11.2 of Method 1.

- (2) Method 3B shall be used for the determination of the oxygen concentration. For each run, the multi-point, integrated sampling and analytical procedure of Method 3B shall be used. The sample shall be taken simultaneously with, and at the same location, as the NO_x sample.
- (3) Method 7 shall be used to determine the NO_x concentration.
 - (i) Each run shall consist of a minimum of four grab samples, with each sample taken at about 15-minute intervals. The NO_x concentration shall be the arithmetic average of the four grab samples.

- (ii) The NO_x concentration shall be corrected to 3 percent oxygen using the following equation:

$$C_{\text{corr}} = C_{\text{meas}} (20.9-3)/(20.9-\%O_2)$$

where:

C_{corr} = corrected pollutant concentration, ppm
corrected to 3 percent oxygen;

C_{meas} = pollutant concentration measured on a
dry basis;

(20.9-3)= 20.9 percent oxygen - 3 percent oxygen
(defined oxygen correction basis);

20.9= oxygen concentration in air, percent;
and

$\%O_2$ = oxygen concentration measured on a
dry basis, percent.

- (c) To determine compliance with the emission limits for nitrogen oxides for affected emissions units with a maximum design heat input capacity equal to or greater than 100 million BTU/hr, the owner or operator of an affected facility shall conduct the performance test as required under Section 1.2 using the continuous monitoring system for nitrogen oxides as specified in Section 2.119.3(a).

- (1) For the ~~first compliance~~ initial performance test, nitrogen oxides from the unit are monitored for 30 successive operating days and the 30-day average emission rate is used to determine compliance with the nitrogen oxides emission standards. The 30-day average emission rate is calculated as the average of all hourly emissions data recorded by the monitoring system during the 30-day test period.
- (2) For each hour of operation, the owner or operator shall compute the concentration of nitrogen oxides corrected to 3 percent oxygen using the equation in paragraph 2.119.2(b)(3)(ii) of this section.
- (3) Except as provided in paragraph 2.119.2(c)(4) of this section, following the date on which the initial performance test is completed or required to be completed under Section 1.2, whichever date comes first, the owner or operator of an affected facility shall, upon request, determine compliance with the applicable nitrogen oxides standards through the use of a 30-day performance test. During periods when performance tests are not requested, nitrogen oxides emissions data collected pursuant to Section 2.119.3(a)(4)(i) or (ii) are used to calculate a 30-day rolling average emission rate on a daily basis and to prepare excess emission reports. A new 30-day rolling average emission rate is calculated each operating day as the average of all of the hourly nitrogen oxides emission data for the preceding 30 operating days.

- (4) In the event there are less than 30 operating days by the end of the period from May 1 to September 30, then the performance test or monitoring averaging period shall include all the operating days for that period.
- (d) As an alternative to Method 7, Method 7A, 7C, 7D, or 7E may be used.
- (e) For the purposes of this section, an operating day shall be defined as a 24-hour period between 12:00 midnight and the following midnight during which any fuel is combusted at any time in the affected unit. It is not necessary for fuel to be combusted continuously for the entire 24-hour period.

2.119.3 Emission Monitoring

- (a) The owner or operator of an affected facility, with a maximum design heat input capacity equal to or greater than 100 million BTU/hr, shall install, calibrate, maintain, and operate a continuous monitoring system for measuring nitrogen oxides and oxygen concentration discharged to the atmosphere and record the output of the system.
 - (1) The continuous monitoring systems shall be operated and data recorded during all periods of operation of the affected facility except for continuous monitoring system breakdowns, repairs, calibration checks, and zero and span adjustments.
 - (2) The 1-hour average nitrogen oxides emission rates measured by the continuous nitrogen oxides monitor shall be expressed in parts per million by volume (ppm) corrected to 3 percent oxygen and shall be used to calculate the average emission rate. The 1-hour averages shall be calculated using the data points required under Section 1.4(h). At least 2 data points must be used to calculate each 1-hour average.
 - (3) The procedures under Section 1.4 shall be followed for installation, evaluation, and operation of the continuous monitoring systems. The span value for nitrogen oxides shall be set at 90 ppm.
 - (4) The owner or operator of an affected facility may elect to:
 - (i) Comply with the provisions of paragraphs 2.119.3(a)(1), (2), and (3), of this section, or
 - (ii) Monitor operating conditions and predict nitrogen oxides emission rates as specified in a plan submitted pursuant to Section 2.119.4(d).
- (b) The owner or operator of an affected facility, with a maximum design heat input capacity equal to or greater than 10 million BTU/hr, but less than 100 million BTU/hr, shall monitor the emissions of nitrogen oxides during the period from May 1 through September 30 each year by performing a tune-up to demonstrate that the nitrogen oxides concentrations of the emissions are below 30 ppm corrected to 3 percent oxygen. The tune-up shall use the following procedures:

- (1) The tune-up shall be performed no earlier than March 1 and no later than May 1 of each calendar year. Should an affected facility become operational during the period from May 1 to September 30, a tune-up shall be performed within the first 120 hours of operation.
- (2) The tune-up shall be performed using the manufacturer recommended settings for reduced NO_x emissions, or using a NO_x analyzer so that NO_x emissions are reduced in a manner consistent with good combustion practices and safe fuel-burning equipment operation.
- (3) Following the adjustments, or determining adjustments are not required, the owner and/or operator shall carry out a measurement consisting of a minimum of three test runs to demonstrate that the average emissions are less than or equal to 30 ppm corrected to 3 percent oxygen. Each test run shall be a minimum of 30 minutes in length. Following emissions measurements in which the average is determined to be greater than 30 ppm corrected to 3 percent oxygen, the owner and/or operator shall make adjustments to the affected facility and conduct a new measurement prior to May 1, or within one day if the initial measurement is conducted during the period of May 1 through September 30. Subsequent adjustments followed by measurements shall be continued until a measurement shows the nitrogen oxides emissions are less than or equal to 30 ppm corrected to 3 percent oxygen.
- (4) All measurements of NO_x and oxygen concentrations in paragraphs 2.119.3(b)(2) and (b)(3) of this section shall be conducted using the procedures of the American Society for Testing and Materials Standard (ASTM) *Test Method for Determination of NO_x, Carbon Dioxide Monoxide(CO), and Oxygen Concentrations in Emissions from Natural Gas-Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers*, ASTM D 6522-00; or procedures of Gas Research Institute Method GRI-96/0008, EPA/EMC Conditional Test Method (CTM-30) *Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Emissions from Natural Gas-Fired Engines, Boilers and Process Heaters Using Portable Analyzers*, or Procedures of EPA Reference Methods 7E and 3A.
- (5) The owner and/or operator shall maintain records of all tune-ups performed in accordance with this section. These records shall indicate the date and time the tune-up was performed, the NO_x and Oxygen values determined during the measurement, state what operating parameters were adjusted to minimize NO_x emissions and explain how those settings were determined.
- (6) Following the tune-up, from the period May 1 through September 30 of each year, the owner and/or operator shall operate the affected facility using the settings determined during the annual tune-up. If no parameters can be monitored to indicate the performance of the affected facility, the owner and/or operator shall certify that no adjustments have been made to the affected facility by the owner, operator and/or any third party since the measurements in Section 2.119.3(b)(3) were conducted. This certification shall be made in writing no later than October 15 of each year and shall be maintained

with the records required to be maintained in paragraph 2.119.3(b)(5) of this section.

- (c) As an alternative to complying with the annual tune-up requirement of Section 2.119.3(b), the owner or operator of an affected source capable of operating with a NO_x emission rate of less than or equal to 15 ppm corrected to 3 percent oxygen may conduct measurements of NO_x at a reduced frequency following an ~~initial~~ tune-up and verification demonstrating that the affected facility is capable of a NO_x emission rate of less than or equal to 15 ppm corrected to 3 percent oxygen. The Permittee may conduct subsequent tune-ups at 48 calendar month intervals. Measurements of NO_x and oxygen concentrations shall be conducted demonstrating the NO_x concentration of the emissions of the affected unit to be less than 15 ppm corrected to 3 percent oxygen using the procedures of the American Society for Testing and Materials Standard (ASTM) *Test Method for Determination of NO_x, Carbon Dioxide Monoxide (CO), and Oxygen Concentrations in Emissions from Natural Gas-Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers*, ASTM D 6522-00, or procedures of Gas Research Institute Method GRI-96/0008, EPA/EMC Conditional Test Method (CTM-30) *Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Emissions from Natural Gas-Fired Engines, Boilers and Process Heaters Using Portable Analyzers*, or Procedures of EPA Reference Methods 7E and 3A. The owner/operator shall continue to make annual certifications of no adjustments since the previous tune-up.

2.119.4 Reporting and Recordkeeping Requirements

- (a) All records required under Section 2.119 shall be maintained by the owner or operator of the affected facility for a period of 5 years following the date of such record.
- (b) The owner or operator of an affected facility subject to the continuous monitoring requirements for nitrogen oxides under Section 2.119.3(a) shall maintain records of the following information for each operating day:
- (1) Calendar date.
 - (2) The average hourly nitrogen oxides emission rates (expressed as ppm corrected to 3 percent oxygen), unless the affected facility was not in operation for the day.
 - (3) The 30-day average nitrogen oxides emission rates (expressed as ppm corrected to 3 percent oxygen) calculated at the end of each operating day from the measured hourly nitrogen oxide emission rates for the preceding 30 operating days.
 - (4) Identification of any operating days when the calculated 30-day average nitrogen oxides emission rates are in excess of the nitrogen oxides emissions limits with the reasons for such excess emissions as well as a description of corrective actions taken.

- (5) Identification of any operating days for which pollutant data have not been obtained, including reasons for not obtaining sufficient data and a description of corrective actions taken.
 - (6) Identification of the times when emission data have been excluded from the calculation of average emission rates and the reasons for excluding data.
 - (7) Identification of the times when the pollutant concentration exceeded full span of the continuous monitoring system.
 - (8) Description of any modifications to the continuous monitoring system that could affect the ability of the continuous monitoring system to comply with Performance Specification 2 or 3.
- (c) The owner or operator of any affected facility subject to the continuous monitoring requirements for nitrogen oxides under Section 2.119.3(a) shall submit a quarterly report containing the information recorded under paragraph (b) of this section with the exception of item (b)(2). All quarterly reports shall be postmarked by the 30th day following the end of each calendar quarter.
- (d) The owner or operator of each affected facility who seeks to demonstrate compliance with the applicable nitrogen oxides emissions standards through the monitoring of operating conditions under the provisions of Section 2.119.3(a)(4)(ii) shall submit to the Director for approval a plan that identifies the operating conditions to be monitored under Section 2.119.3(a)(4)(ii). This plan shall be submitted to the Director for approval within 360 days of the initial startup of the affected facility. The plan shall:
- (1) Identify the specific operating conditions to be monitored and the relationship between these operating conditions and nitrogen oxides emission rates (i.e., ppm corrected to 3 percent oxygen). Operating conditions include, but are not limited to, the degree of staged combustion (i.e., the ratio of primary air to secondary and/or tertiary air) and the level of excess air (i.e., flue gas oxygen level);
 - (2) Include the data and information that the owner or operator used to identify the relationship between nitrogen oxides emission rates and these operating conditions;
 - (3) Identify how these operating conditions, including load, will be monitored under Section 2.119.3(a)(4) on an hourly basis by the owner or operator during the period of operation of the affected facility and the quality assurance procedures or practices that will be employed to ensure that the data generated by monitoring these operating conditions will be representative and accurate.

If the plan is approved, the owner or operator shall maintain records of predicted nitrogen oxide emission rates and the monitored operating conditions, including load, identified in the plan.

2.120 Stationary Gas Turbines and Stationary Engines used to Generate Electricity

2.120.1 Applicability

- (a) The affected facility to which this section applies is any stationary gas turbine or stationary engine which is subject to the requirements of the Georgia Rules for Air Quality Control (Georgia Rule), Chapter 391-3-1-.02(2)(mmm).

2.120.2 Test Methods and Procedures

- (a) In conducting the performance tests required in Section 1.2, the owner or operator shall use as reference methods and procedures the test methods in Appendix A of this text or other methods and procedures as specified in this section, except as provided in Section 1.2(b).

- oxides (b) The owner or operator shall determine compliance with the applicable nitrogen emission standards as follows:

- (1) Sample points shall be located as specified in Method 7E, Section 8.1.2. Method 1 shall be used for sample point selection, in lieu of the requirements in Section 11.2, the following table may be used to select the minimum number of traverse points:

~~For stacks with a diameter of d :~~
~~For $d < 12$ inches..... one traverse point~~
~~located in centroid of~~
~~the cross-sectional~~
~~area;~~
~~For 12 inches $\leq d < 30$ inches..... four traverse points~~
~~located according to~~
~~Table 1-2 of Method 1;~~
~~and~~
~~For $d \geq 30$ inches..... use the requirements of~~
~~Section 11.2 of Method~~
~~1.~~

- (2) Method 3B shall be used for the determination of the oxygen concentration. For each run, the multi-point, integrated sampling and analytical procedure of Method 3B shall be used. The sample shall be taken simultaneously with, and at the same location, as the NO_x sample.

- (3) Method 7E shall be used to determine the NO_x concentration.

- (i) The sampling time for each run shall be at least 60 minutes.
- (ii) The NO_x concentration shall be adjusted to 15 percent oxygen using the following equation:

$$C_{adj} = C_{meas} (20.9 - 15) / (20.9 - \% O_2)$$

where:

C_{adj} = pollutant concentration adjusted to 15 percent oxygen;

C_{meas} = pollutant concentration measured on a dry basis;

$(20.9-15)$ = 20.9 percent oxygen - 15 percent oxygen (defined oxygen correction basis);

20.9= oxygen concentration in air, percent; and

$\%O_2$ = oxygen concentration measured on a dry basis, percent.

METHOD 3A
DETERMINATION OF OXYGEN AND CARBON DIOXIDE CONCENTRATIONS
IN EMISSIONS FROM STATIONARY SOURCES
(~~[INSTRUMENTAL ANALYZER PROCEDURE]~~)

1. ~~Applicability and Principle~~

~~1.1 Applicability. This method is applicable to the determination of oxygen (O₂) and carbon dioxide (CO₂) concentrations in emissions from stationary sources only when specified within the regulations.~~

~~1.2 Principle. A sample is continuously extracted from the effluent stream; a portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of O₂ and CO₂ concentration(s). Performance specifications and test procedures are provided to ensure reliable data.~~

2. ~~Range and Sensitivity~~

~~Same as in Method 6C, Sections 2.1 and 2.2, except that the span of the monitoring system shall be selected such that the average O₂ or CO₂ concentration is not less than 20 percent of the span.~~

3. ~~Definitions~~

~~3.1 Measurement System. The total equipment required for the determination of the O₂ or CO₂ concentration. The measurement system consists of the same major subsystems as defined in Method 6C, Sections 3.1.1, 3.1.2, and 3.1.3.~~

~~3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, Response Time, and Calibration Curve. Same as in Method 6C, Sections 3.2 through 3.8, and 3.10.~~

~~3.3 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.~~

4. ~~Measurement System Performance Specifications~~

~~Same as in Method 6C, Sections 4.1 through 4.4.~~

5. ~~Apparatus and Reagents~~

~~5.1 Measurement System. Any measurement system for O₂ or CO₂ that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below:~~

~~5.1.1 Sample Probe. A leak-free probe of sufficient length to traverse the sample points.~~

~~5.1.2 Sample Line. Tubing to transport the sample gas from the probe to the moisture removal system. A heated sample line is not required for systems that measure the O₂ or CO₂ concentration on a dry basis, or transport dry gases.~~

~~5.1.3 Sample Transport Line, Calibration Valve Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as in Method 6C, Sections 5.1.3 through 5.1.9, and 5.1.11, except that the requirements to use stainless steel, Teflon, and nonreactive glass filters do not apply.~~

~~5.1.4 Gas Analyzer. An analyzer to determine continuously the O₂ or CO₂ concentration in the sample gas stream. The analyzer must meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.)~~

shall be provided at the analyzer. The requirements for measuring and controlling the analyzer for measuring and controlling the analyzer flow rate are not applicable if data are presented that demonstrate the analyzer is insensitive to flow variations over the range encountered during the test.

~~5.2 Calibration Gases. The calibration gases for CO₂ analyzers shall be CO₂ in N₂ or CO₂ in air. Alternatively, CO₂/SO₂, O₂/SO₂, or O₂/CO₂/SO₂ gas mixtures in N₂ may be used. Three calibration gases, as specified in Sections 5.3.1 through 5.3.4 of Method 6C, shall be used. For O₂ monitors that cannot analyze zero gas, a calibration gas concentration equivalent to less than 10 percent of the span may be used in place of zero gas.~~

~~6. Measurement System Performance Test Procedures~~

~~Perform the following procedures before measurement of emissions (Section 7).~~

~~6.1 Calibration Concentration Verification. Follow Section 6.1 of Method 6C, except if calibration gas analysis is required, use Method 3 and change the acceptance criteria for agreement among Method 3 results to 5 percent (or 0.2 percent by volume, whichever is greater).~~

~~6.2 Interference Response. Conduct an interference response test of the analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response (e.g., changes in the type of gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.~~

~~6.3 Measurement System Preparation, Analyzer Calibration Error, Response Time, and Sampling System Bias Check. Follow Sections 6.2 through 6.4 of Method 6C.~~

~~7. Emission Test Procedure~~

~~7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to tests performed using Method 3.~~

~~7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as that used during the response time test. Maintain constant rate sampling (i.e., "10 percent") during the entire run. The sampling time per run shall be the same as for tests conducted using Method 3 plus twice the average system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration.~~

~~7.3 Zero and Calibration Drift Test. Follow Section 7.4 of Method 6C.~~

~~8. Quality Control Procedures~~

~~The following quality control procedures are recommended when the results of this method are used for an emission rate correction factor, or excess air determination. The tester should select one of the following options for validating measurement results:~~

~~8.1 If both O₂ and CO₂ are measured using Method 3A, the procedures described in Section 4.4 of Method 3 should be followed to validate the O₂ and CO₂ measurement results.~~

~~8.2 If only O₂ is measured using Method 3A, measurements of the sample stream CO₂ concentration should be obtained at the sample by-pass vent discharge using an Orsat or Fyrite analyzer, or equivalent. Duplicate samples should be obtained concurrent with at least one run. Average the duplicate Orsat or Fyrite analysis results for each run. Use the average CO₂ values for comparison with the O₂ measurements in accordance with the procedures described in Section 4.4 of Method 3.~~

8.3 If only CO₂ is measured using Method 3A, concurrent measurements of the sample stream CO₂ concentration should be obtained using an Orsat or Fyrite analyzer as described in Section 8.2. For each run, differences greater than 0.5 percent between the Method 3A results and the average of the duplicate Fyrite analysis should be investigated.

9. Emission Calculation

9.1 For all CO₂ analyzers, and for O₂ analyzers that can be calibrated with zero gas, follow Section 8 of Method 6C, except express all concentrations as percent, rather than ppm.

9.2 For O₂ analyzers that use a low-level calibration gas in place of a zero gas, calculate the effluent gas concentration using Equation 3A-1.

$$C_{gas} = \frac{C_{ma} - C_{oa}}{C_m - C_o} (\bar{C} - C_m) + C_{ma}$$

(Equation 3A-1)

Where:

C_{gas} - Effluent gas concentration, dry basis, percent.

C_{ma} - Actual concentration of the upscale calibration gas, percent.

C_{oa} - Actual concentration of the low-level calibration gas, percent.

C_a - Average of initial and final system calibration bias check responses for the upscale calibration gas, percent.

C_o - Average of initial and final system calibration bias check responses for the low-level gas, percent.

- Average gas concentration indicated by the gas analyzer, dry basis, percent.

10. Bibliography

Same as in Bibliography of Method 6C.

1. Scope and Application

What is Method 3A? Method 3A is a procedure for measuring oxygen (O₂) and carbon dioxide (CO₂) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis.

This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this text:

- (a) Method 1—Sample and Velocity Traverses for Stationary Sources.
- (b) Method 3—Gas Analysis for the Determination of Molecular Weight.
- (c) Method 4—Determination of Moisture Content in Stack Gases.
- (d) Method 7E—Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure).

1.1 Analytes. What does this method determine? This method measures the concentration of oxygen and carbon dioxide.

Analyte	CAS No.	Sensitivity
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Oxygen (O ₂)	7782-44	Typically <2% of Calibration Span
Carbon Dioxide (CO ₂)	124-38-9	Typically <2% of Calibration Span

1.2 Applicability. When is this method required? The use of Method 3A may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans and permits, where measurements of O₂ and CO₂ concentrations in stationary source emissions must be made, either to determine compliance with an applicable emission standard or to conduct performance testing of a continuous emission monitoring system (CEMS). Other regulations may also require the use of Method 3A.

1.3 Data Quality Objectives. How good must my collected data be? Refer to Section 1.3 of Method 7E.

2. Summary of Method

In this method, you continuously or intermittently sample the effluent gas and convey the sample to an analyzer that measures the concentration of O₂ or CO₂. You must meet the performance requirements of this method to validate your data.

3. Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4. Interferences [Reserved]

5. Safety

Refer to Section 5.0 of Method 7E.

6. Equipment and Supplies

Figure 7E-1 in Method 7E is a schematic diagram of an acceptable measurement system.

6.1 What do I need for the measurement system? The components of the measurement system are described (as applicable) in Sections 6.1 and 6.2 of Method 7E, except that the analyzer described in Section 6.2 of this method must be used instead of the analyzer described in Method 7E. You must follow the noted specifications in Section 6.1 of Method 7E except that the requirements to use stainless steel, Teflon, or non-reactive glass filters do not apply. Also, a heated sample line is not required to transport dry gases or for systems that measure the O₂ or CO₂ concentration on a dry basis, provided that the system is not also being used to concurrently measure SO₂ and/or NO_x.

6.2 What analyzer must I use? You must use an analyzer that continuously measures O₂ or CO₂ in the gas stream and meets the specifications in Section 13.0.

7. Reagents and Standards

7.1 Calibration Gas. What calibration gases do I need? Refer to Section 7.1 of Method 7E for the calibration gas requirements. Example calibration gas mixtures are listed below.

- (a) CO₂ in nitrogen (N₂).
- (b) CO₂ in air.
- (c) CO₂/SO₂ gas mixture in N₂.
- (d) O₂/SO₂ gas mixture in N₂.
- (e) O₂/CO₂/SO₂ gas mixture in N₂.
- (f) CO₂/NO_x gas mixture in N₂.
- (g) CO₂/SO₂/NO_x gas mixture in N₂.

The tests for analyzer calibration error and system bias require high-, mid-, and low-level gases.

7.2 Interference Check. What reagents do I need for the interference check? Potential interferences may vary among available analyzers. Table 7E-3 of Method 7E lists a number of gases that should be considered in conducting the interference test.

8. Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. You must follow the procedures of Section 8.1 of Method 7E to determine the appropriate sampling points, unless you are using Method 3A only to determine the stack gas molecular weight and for no other purpose. In that case, you may use single-point integrated sampling as described in Section 8.2 of Method 3. If the stratification test provisions in Section 8.1.2 of Method 7E are used to reduce the number of required sampling points, the alternative

acceptance criterion for 3-point sampling will be ± 0.5 percent CO_2 or O_2 , and the alternative acceptance criterion for single point sampling will be ± 0.3 percent CO_2 or O_2 .

8.2 Initial Measurement System Performance Tests. You must follow the procedures in Section 8.2 of Method 7E. If a dilution-type measurement system is used, the special considerations in Section 8.3 of Method 7E apply.

8.3 Interference Check. The O_2 or CO_2 analyzer must be documented to show that interference effects to not exceed 2.5 percent of the calibration span. The interference test in Section 8.2.7 of Method 7E is a procedure that may be used to show this. The effects of all potential interferences at the concentrations encountered during testing must be addressed and documented. This testing and documentation may be done by the instrument manufacturer.

8.4 Sample Collection. You must follow the procedures in Section 8.4 of Method 7E.

8.5 Post-Run System Bias Check and Drift Assessment. You must follow the procedures in Sections 8.5 of Method 7E.

9. Quality Control

Follow quality control procedures in Section 9.0 of Method 7E.

10. Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11. Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12. Calculations and Data Analysis

You must follow the applicable procedures for calculations and data analysis in Section 12.0 of Method 7E, substituting percent O_2 and percent CO_2 for ppmv of NO_x as appropriate.

13. Method Performance

The specifications for the applicable performance checks are the same as in Section 13.0 of Method 7E except for the alternative specifications for system bias, drift, and calibration error. In these alternative specifications, replace the term "0.5 ppmv" with the term "0.5 percent O_2 " or "0.5 percent CO_2 " (as applicable).

14. Pollution Prevention [Reserved]

15. Waste Management [Reserved]

16. Alternative Procedures [Reserved]

17. References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121

18. Tables, Diagrams, Flowcharts, and Validation Data

Refer to Section 18.0 of Method 7E.

METHOD 6C
DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY
SOURCES (INSTRUMENTAL ANALYZER PROCEDURE)

1. ~~Applicability and Principle~~

~~1.1 Applicability. This method is applicable to the determination of sulfur dioxide (SO₂) concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations.~~

~~1.2 Principle. A gas sample is continuously extracted from a stack, and a portion of the sample is conveyed to an instrumental analyzer for determination of SO₂ gas concentration using an ultraviolet (UV), nondispersive infrared (NDIR), or fluorescence analyzer. Performance specifications and test procedures are provided to ensure reliable data.~~

2. ~~Range and Sensitivity~~

~~2.1 Analytical Range. The analytical range is determined by the instrumental design. For this method, a portion of the analytical range is selected by choosing the span of the monitoring system. The span of the monitoring system shall be selected such that the pollutant gas concentration equivalent to the emission standard is not less than 30 percent of the span. If at any time during a run the measured gas concentration exceeds the span, the run shall be considered invalid.~~

~~2.2 Sensitivity. The minimum detectable limit depends on the analytical range, span, and signal-to-noise ratio of the measurement system. For a well designed system, the minimum detectable limit should be less than 2 percent of the span.~~

3. ~~Definitions~~

~~3.1 Measurement System. The total equipment required for the determination of gas concentration. The measurement system consists of the following major subsystems:~~

~~3.1.1 Sample Interface. That portion of a system used for one or more of the following: sample acquisition, sample transport, sample conditioning, or protection of the analyzers from the effects of the stack effluent.~~

~~3.1.2 Gas Analyzer. That portion of the system that senses the gas to be measured and generates an output proportional to its concentration.~~

~~3.1.3 Data Recorder. A strip chart recorder, analog computer, or digital recorder for recording measurement data from the analyzer output.~~

~~3.2 Span. The upper limit of the gas concentration measurement range displayed on the data recorder.~~

~~3.3 Calibration gas. A known concentration of a gas in an appropriate diluent gas.~~

~~3.4 Analyzer Calibration Error. The difference between the gas concentration exhibited by the gas analyzer and the known concentration of the calibration gas when the calibration gas is introduced directly to the analyzer.~~

~~3.5 Sampling System Bias. The difference between the gas concentrations exhibited by the measurement system when a known concentration gas is introduced at the outlet of the sampling probe and when the same gas is introduced directly to the analyzer.~~

~~3.6 Zero Drift. The difference in the measurement system output reading from the initial calibration response at the zero concentration level after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.~~

~~3.7 Calibration drift. The difference in the measurement system output reading from the initial calibration response at a mid-range calibration value after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.~~

~~3.8 Response Time. The amount of time required for the measurement system to display 95 percent of a step change in gas concentration on the data recorder.~~

~~3.9 Interference Check. A method for detecting analytical interferences and excessive biases through direct comparison of gas concentrations provided by the measurement system and by a modified Method 6 procedure. For this check, the modified Method 6 samples are acquired at the sample by-pass discharge vent.~~

~~3.10 Calibration Curve. A graph or other systematic method of establishing the relationship between the analyzer response and the actual gas concentration introduced to the analyzer.~~

~~4. Measurement System Performance Specifications~~

~~4.1 Analyzer Calibration Error. Less than 2 percent of the span for the zero, mid-range, and high-range calibration gases.~~

~~4.2 Sampling System Bias. Less than 5 percent of the span for the zero, and mid- or high-range calibration gases.~~

~~4.3 Zero Drift. Less than 3 percent of the span over the period of each run.~~

~~4.4 Calibration Drift. Less than 3 percent of the span over the period of each run.~~

~~4.5 Interference Check. Less than 7 percent of the modified Method 6 result for each run.~~

~~5. Apparatus and Reagents~~

~~5.1 Measurement System. Any measurement system for SO₂ that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1. The essential components of the measurement system are described below:~~

~~5.1.1 Sample Probe. Glass, stainless steel, or equivalent, of sufficient length to traverse the sample points. The sampling probe shall be heated to prevent condensation.~~

~~5.1.2 Sample Line. Heated (sufficient to prevent condensation) stainless steel or Teflon tubing, to transport the sample gas to the moisture removal system.~~

~~5.1.3 Sample Transport Lines.~~ Stainless steel or Teflon tubing to transport the sample from the moisture removal system to the sample pump, sample flow rate control, and sample gas manifold.

~~5.1.4 Calibration Valve Assembly.~~ A three-way valve assembly, or equivalent, for blocking the sample gas flow and introducing calibration gases to the measurement system at the outlet of the sampling probe when in the calibration mode.

~~5.1.5 Moisture Removal System.~~ A refrigerator-type condenser or similar device (e.g., permeation dryer), to remove condensate continuously from the sample gas while maintaining minimal contact between the condensate and the sample gas. The moisture removal system is not necessary for analyzers that can measure gas concentrations on a wet basis; for these analyzers, (1) heat the sample line and all interface components up to the inlet of the analyzer sufficiently to prevent condensation, and (2) determine the moisture content and correct the measured gas concentrations to a dry basis using appropriate methods, subject to the approval of the Director. The determination of sample moisture content is not necessary for pollutant analyzers that measure concentrations on a wet basis when (1) a wet basis CO₂ analyzer operated according to Method 3A is used to obtain simultaneous measurements, and (2) the pollutant/CO₂ measurements are used to determine emissions in units of the standard.

~~5.1.6 Particulate Filter.~~ An in-stack or heated (sufficient to prevent water condensation) out-of-stack filter. The filter shall be borosilicate or quartz glass wool, or glass fiber mat. Additional filters at the inlet or outlet of the moisture removal system and inlet of the analyzer may be used to prevent accumulation of particulate material in the measurement system and extend the useful life of the components. All filters shall be fabricated of materials that are nonreactive to the gas being sampled.

~~5.1.7 Sample Pump.~~ A leak-free pump, to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The pump may be constructed of any material that is nonreactive to the gas being sampled.

~~5.1.8 Sample Flow Rate Control.~~ A sample flow rate control valve and rotameter, or equivalent, to maintain a constant sampling rate within 10 percent.

~~(Note: The tester may elect to install a back-pressure regulator to maintain the sample gas manifold at a constant pressure in order to protect the analyzer(s) from overpressurization, and to minimize the need for flow rate adjustments.)~~

~~5.1.9 Sample Gas Manifold.~~ A sample gas manifold, to divert a portion of the sample gas stream to the analyzer, and the remainder to the by-pass discharge vent. The sample gas manifold should also include provisions for introducing calibration gases directly to the analyzer. The manifold may be constructed of any material that is nonreactive to the gas being sampled.

~~5.1.10 Gas Analyzer.~~ A UV or NDIR absorption or fluorescence analyzer, to determine continuously the SO₂ concentration in the sample gas stream. The analyzer shall meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) shall be provided at the analyzer.

~~(Note: Housing the analyzer(s) in a clean, thermally stable, vibration-free environment will minimize drift in the analyzer calibration.)~~

~~5.1.11 Data Recorder.~~ A strip chart recorder, analog computer, or digital recorder, for recording measurement data. The data recorder resolution (i.e., readability) shall be 0.5 percent of span. Alternatively, a digital or analog meter having a resolution of 0.5 percent of span may be used to obtain the analyzer responses and the readings may be recorded manually. If this alternative is used, the readings

~~shall be obtained at equally spaced intervals over the duration of the sampling run. For sampling run durations of less than 1 hour, measurements at 1-minute intervals or a minimum of 30 measurements, whichever is less restrictive, shall be obtained. For sampling run durations greater than 1 hour, measurements at 2-minute intervals or a minimum of 96 measurements, whichever is less restrictive, shall be obtained.~~

~~5.2 Method 6 Apparatus and Reagents. The apparatus and reagents described in Method 6, and shown by the schematic of the sampling train in Figure 6C-2, to conduct the interference check.~~

~~5.3 SO₂ Calibration Gases. The calibration gases for the gas analyzer shall be SO₂ in N₂ or SO₂ in air. Alternatively, SO₂/CO₂, SO₂/O₂, or SO₂/CO₂/O₂ gas mixtures in N₂ may be used. For fluorescence-based analyzers, the O₂ and CO₂ concentrations of the calibration gases as introduced to the analyzer shall be within 1 percent (absolute) O₂ and 1 percent (absolute) CO₂ of the O₂ and CO₂ concentrations of the effluent samples as introduced to the analyzer. Alternatively, for fluorescence-based analyzers, use calibration blends of SO₂ in air and the nomographs provided by the vendor to determine the quenching correction factor (the effluent O₂ and CO₂ concentrations must be known). Use three calibration gases as specified below:~~

~~5.3.1 High-Range Gas. Concentration equivalent to 80 to 100 percent of the span.~~

~~5.3.2 Mid-Range Gas. Concentration equivalent to 40 to 60 percent of the span.~~

~~5.3.3 Zero Gas. Concentration of less than 0.25 percent of the span. Purified ambient air may be used for the zero gas by passing air through a charcoal filter, or through one or more impingers containing a solution of 3 percent H₂O₂.~~

~~6. Measurement System Performance Test Procedures~~

~~Perform the following procedures before measurement of emissions (Section 7).~~

~~6.1 Calibration Gas Concentration Verification. There are two alternatives for establishing the concentrations of calibration gases. Alternative Number 1 is preferred.~~

~~6.1.1 Alternative Number 1--Use of calibration gases that are analyzed following the Environmental Protection Agency Traceability Protocol Number 1 (see Citation 1 in the Bibliography). Obtain a certification from the gas manufacturer that Protocol Number 1 was followed.~~

~~6.1.2 Alternative Number 2--Use of calibration gases not prepared according to Protocol Number 1. If this alternative is chosen, obtain gas mixtures with a manufacturer's tolerance not to exceed 2 percent of the tag value. Within 6 months before the emission test, analyze each of the calibration gases in triplicate using Method 6. Citation 2 in the Bibliography described procedures and techniques that may be used for this analysis. Record the results on a data sheet (example is shown in Figure 6C-3). Each of the individual SO₂ analytical results for each calibration gas shall be within 5 percent (or 5 ppm, whichever is greater) of the triplicate set average; otherwise, discard the entire set, and repeat the triplicate analyses. If the average of the triplicate analyses is within 5 percent of the calibration gas manufacturer's cylinder tag value, use the tag value; otherwise, conduct at least three additional analyses until the results of six consecutive runs agree with 5 percent (or 5 ppm, whichever is greater) of their average. Then use this average for the cylinder value.~~

~~6.2 Measurement System Preparation. Assemble the measurement system by following the manufacturer's written instructions for preparing and preconditioning the gas analyzer and, as applicable, the other system components. Introduce the calibration gases in any sequence, and make all necessary~~

adjustments to calibrate the analyzer and the data recorder. Adjust system components to achieve correct sampling rates.

~~6.3 Analyzer Calibration Error. Conduct the analyzer calibration error check by introducing calibration gases to the measurement system at any point upstream of the gas analyzer as follows:~~

~~6.3.1 After the measurement system has been prepared for use, introduce the zero, mid-range, and high-range gases to the analyzer. During this check, make no adjustments to the system except those necessary to achieve the correct calibration gas flow rate at the analyzer. Record the analyzer responses to each calibration gas on a form similar to Figure 6C-4.~~

~~(Note: A calibration curve established prior to the analyzer calibration error check may be used to convert the analyzer response to the equivalent gas concentration introduced to the analyzer. However, the same correction procedure shall be used for all effluent and calibration measurements obtained during the test.)~~

~~6.3.2 The analyzer calibration error check shall be considered invalid if the gas concentration displayed by the analyzer exceeds 2 percent of the span for any of the calibration gases. If an invalid calibration is exhibited, take corrective action, and repeat the analyzer calibration error check until acceptable performance is achieved.~~

~~6.4 Sampling System Bias Check. Perform the sampling system bias check by introducing calibration gases at the calibration valve installed at the outlet of the sampling probe. A zero gas and either the mid-range or high-range gas, whichever most closely approximates the effluent concentrations, shall be used for this check as follows:~~

~~6.4.1 Introduce the upscale calibration gas, and record the gas concentration displayed by the analyzer on a form similar to Figure 6C-5. Then introduce zero gas, and record the gas concentration displayed by the analyzer. During the sampling system bias check, operate the system at the normal sampling rate, and make no adjustments to the measurement system other than those necessary to achieve proper calibration gas flow rates at the analyzer. Alternately introduce the zero and upscale gases until a stable response is achieved. The tester shall determine the measurement system response time by observing the times required to achieve a stable response for both the zero and upscale gases. Note the longer of the two times as the response time.~~

~~6.4.2 The sampling system bias check shall be considered invalid if the difference between the gas concentrations displayed by the measurement system for the analyzer calibration error check and for the sampling system bias check exceeds 5 percent of the span for either the zero or upscale calibration gas. If an invalid calibration is exhibited, take corrective action, and repeat the sampling system bias check until acceptable performance is achieved. If adjustment to the analyzer is required, first repeat the analyzer calibration error check, then repeat the sampling system bias check.~~

~~7. Emission Test Procedure~~

~~7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to Method 6.~~

~~7.2 Interference Check Preparation. For each individual analyzer, conduct an interference check for at least three runs during the initial field test on a particular source category. Retain the results, and report them with each test performed on that source category.~~

~~If an interference check is being performed, assemble the modified Method 6 train (flow control valve, two midjet impingers containing 3 percent H₂O₂, and dry gas meter) as shown in Figure 6C-2. Install~~

the sampling train to obtain a sample at the measurement system sample-by-pass discharge vent. Record the initial dry gas meter reading.

~~7.3 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the sampling system bias check. Maintain constant rate sampling (i.e., 10 percent) during the entire run. The sampling time per run shall be the same as for Method 6 plus twice the system response time. For each run, use only those measurements obtained after twice response time of the measurement system has elapsed, to determine the average effluent concentration. If an interference check is being performed, open the flow control valve on the modified Method 6 train concurrent with the initiation of the sampling period, and adjust the flow to 1 liter per minute (10 percent).~~

~~(Note: If a pump is not used in the modified Method 6 train, caution should be exercised in adjusting the flow rate since overpressurization of the impingers may cause leakage in the impinger train, resulting in positively biased results).~~

~~7.4 Zero and Calibration Drift Tests. Immediately preceding and following each run, or if adjustments are necessary for the measurement system during the run, repeat the sampling system bias check procedure described in Section 6.4 (Make no adjustments to the measurement system until after the drift checks are completed.) Record the analyzer's responses on a form similar to Figure 6C-5.~~

~~7.4.1 If either the zero or upscale calibration value exceeds the sampling system bias specification, then the run is considered invalid. Repeat both the analyzer calibration error check procedure (Section 6.3) and the sampling system bias check procedure (Section 6.4) before repeating the run.~~

~~7.4.2 If both the zero and upscale calibration values are within the sampling system bias specification, then use the average of the initial and final bias check values to calculate the gas concentration for the run. If the zero or upscale calibration drift value exceeds the drift limits, based on the difference between the sampling system bias check responses immediately before and after the run, repeat both the analyzer calibration error check procedure (Section 6.3) and the sampling system bias check procedure (Section 6.4) before conducting additional runs.~~

~~7.5 Interference Check (if performed). After completing the run, record the final dry gas meter reading, meter temperature, and barometric pressure. Recover and analyze the contents of the midjet impingers, and determine the SO₂ gas concentration using the procedures of Method 6. (It is not necessary to analyze EPA performance audit samples for Method 6.) Determine the average gas concentration exhibited by the analyzer for the run. If the gas concentrations provided by the analyzer and the modified Method 6 differ by more than 7 percent of the modified Method 6 result, the run is invalidated.~~

8. Emission Calculation

~~The average gas effluent concentration is determined from the average gas concentration displayed by the gas analyzer, and is adjusted for the zero and upscale sampling system bias checks, as determined in accordance with Section 7.4. The average gas concentration displayed by the analyzer may be determined by integration of the area under the curve for chart recorders, or by averaging all of the effluent measurements. Alternatively, the average may be calculated from measurements recorded at equally spaced intervals over the entire duration of the run. For sampling run durations of less than 1 hour, measurements at 1-minute intervals or a minimum of 30 measurements, whichever is less restrictive, shall be used. For sampling run durations greater than 1 hour, measurements at 2-minute intervals or a minimum of 96 measurements, whichever is less restrictive, shall be used. Calculate the effluent gas concentration using Equation 6C-1.~~

$$C_{gas} = (\bar{C} - C_o) \frac{C_{Ma}}{C_m - C_o}$$

(Equation 6C-1)

Where:

C_{gas} - Effluent gas concentration, dry basis, ppm.

\bar{C} - Average gas concentration indicated by gas analyzer, dry basis, ppm.

C_o - Average of initial and final system calibration bias check responses for the zero gas, ppm.

C_m - Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm.

C_{ma} - Actual concentration of the upscale calibration gas, ppm.

9. Bibliography

1. Traceability Protocol for Establishing True Concentrations of Gases Used for Calibrations and Audits of Continuous Source Emission Monitors: Protocol Number 1. U.S. Environmental Protection Agency, Quality Assurance Division, Research Triangle Park, N.C.. June 1978.

2. Westlin, Peter R. and J. W. Brown. Methods for Collecting and Analyzing Gas Cylinder Samples. Source Evaluation Society Newsletter. 3(3):5-15. September 1978.

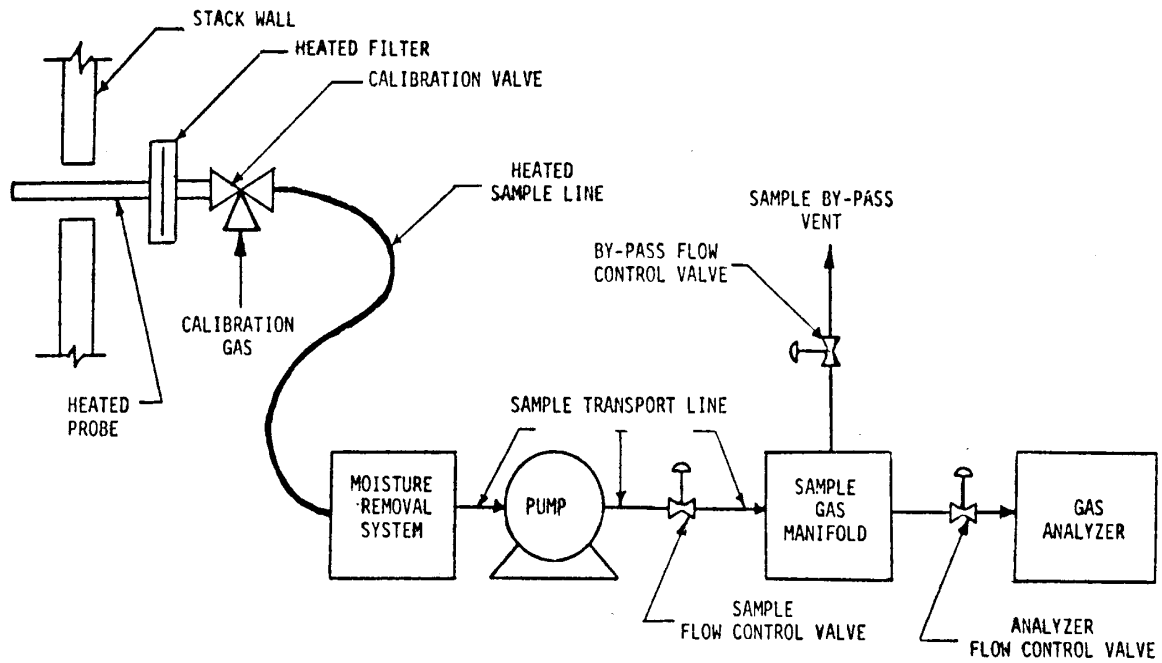


Figure 6C-1. Measurement system schematic.

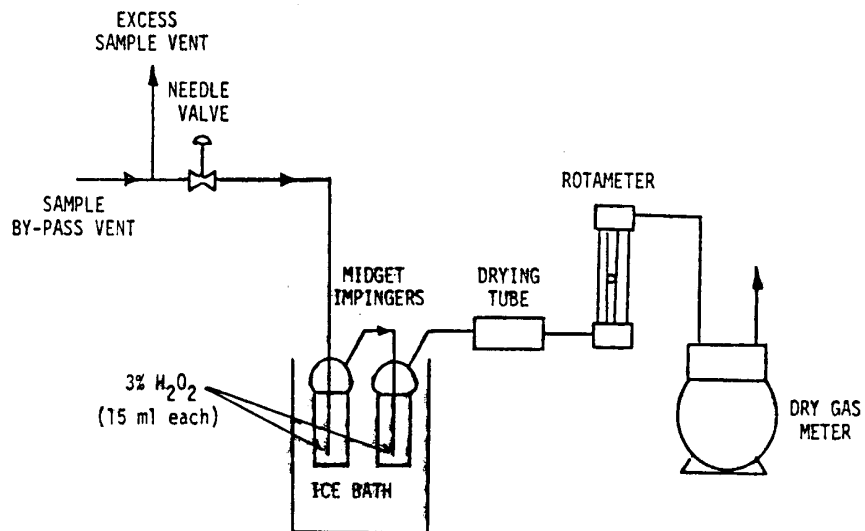


Figure 6C-2. Interference check sampling train.

FIGURE 6C-3—ANALYSIS OF CALIBRATION GASES

Analytic method used _____

Date _____

	Gas concentration (indicate units)		
	Zero ^a	Mid-range ^b	High-range ^c
Sample run:			
1.....			
2.....			
3.....			
Average.....			
Maximum percent deviation.....			

- ^a Average must be less than 0.25 percent of span.
- ^b Average must be 50 to 60 percent of span.
- ^c Average must be 80 to 90 percent of span.

FIGURE 6C-4—ANALYZER CALIBRATION DATA

Analyzer calibration data for sampling

Source identification: _____
 Test personnel: _____
 Date: _____

runs: _____
 Span: _____

	Cylinder value (indicate units)	Analyzer calibration response (indicate units)	Absolute difference (indicate units)	Difference (percent of span)
Zero gas.....				
Mid-range gas.....				
High-range gas.....				

FIGURE 6C-5—SYSTEM CALIBRATION BIAS AND DRIFT DATA

Date: _____

Run number: _____

Source identification: _____
 Test personnel: _____

Span: _____

	Analyzer calibration response	Initial values		Final values		Drift (percent of span)
		System calibration response	System cal. bias (percent of span)	System calibration response	System cal. bias (percent of span)	
Zero gas.....						
Upscale gas.....						

$$\text{System Calibration Bias} = \frac{\text{System Cal. Response} - \text{Analyzer Cal. Response}}{\text{Span}} \times 100$$

1. Scope and Application

What is Method 6C? Method 6C is a procedure for measuring sulfur dioxide (SO₂) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis.

This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this text:

- (a) Method 1—Sample and Velocity Traverses for Stationary Sources.
- (b) Method 4—Determination of Moisture Content in Stack Gases.
- (c) Method 6—Determination of Sulfur Dioxide Emissions from Stationary Sources.
- (d) Method 7E—Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure).

1.1 Analytes. What does this method determine? This method measures the concentration of sulfur dioxide.

<u>Analyte</u>	<u>CAS No.</u>	<u>Sensitivity</u>
<u>SO₂</u>	<u>7446-09-5</u>	<u>Typically <2% of Calibration Span</u>

1.2 Applicability. When is this method required? The use of Method 6C may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans, and permits where SO₂ concentrations in stationary source emissions must be measured, either to determine compliance with an applicable emission standard or to conduct performance testing of a continuous emission monitoring system (CEMS). Other regulations may also require the use of Method 6C.

1.3 Data Quality Objectives. How good must my collected data be? Refer to Section 1.3 of Method 7E.

2. Summary of Method

In this method, you continuously sample the effluent gas and convey the sample to an analyzer that measures the concentration of SO₂. You must meet the performance requirements of this method to validate your data.

3. Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4. Interferences

Refer to Section 4.1 of Method 6.

5. Safety

Refer to Section 5.0 of Method 7E.

6. Equipment and Supplies

Figure 7E-1 of Method 7E is a schematic diagram of an acceptable measurement system.

6.1 What do I need for the measurement system? The essential components of the measurement system are the same as those in Sections 6.1 and 6.2 of Method 7E, except that the SO₂ analyzer described in Section 6.2 of this method must be used instead of the analyzer described in Section 6.2 of Method 7E. You must follow the noted specifications in Section 6.1 of Method 7E.

6.2 What analyzer must I use? You may use an instrument that uses an ultraviolet, non-dispersive infrared, fluorescence, or other detection principle to continuously measure SO₂ in the gas stream and meets the performance specifications in Section 13.0. The low-range and dual-range analyzer provisions in Section 6.2.8.1 of Method 7E apply.

7. Reagents and Standards

7.1 Calibration Gas. What calibration gases do I need? Refer to Section 7.1 of Method 7E for the calibration gas requirements. Example calibration gas mixtures are listed below.

- (a) SO₂ in nitrogen (N₂).
- (b) SO₂ in air.
- (c) SO₂ and CO₂ in N₂.
- (d) SO₂ and O₂ in N₂.
- (e) SO₂/CO₂/O₂ gas mixture in N₂.
- (f) CO₂/NO_x gas mixture in N₂.
- (g) CO₂/SO₂/NO_x gas mixture in N₂.

7.2 Interference Check. What additional reagents do I need for the interference check? The test gases for the interference check are listed in Table 7E-3 of Method 7E. For the alternative interference check, you must use the reagents described in Section 7.0 of Method 6.

8. Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. You must follow the procedures of Section 8.1 of Method 7E.

8.2 Initial Measurement System Performance Tests. You must follow the procedures in Section 8.2 of Method 7E. If a dilution-type measurement system is used, the special considerations in Section 8.3 of Method 7E also apply.

8.3 Interference Check. You must follow the procedures of Section 8.2.7 of Method 7E to conduct an interference check, substituting SO₂ for NO_x as the method pollutant. For dilution-type measurement systems, you must use the alternative interference check procedure in Section 16 and a co-located, unmodified Method 6 sampling train.

8.4 Sample Collection. You must follow the procedures of Section 8.4 of Method 7E.

8.5 Post-Run System Bias Check and Drift Assessment. You must follow the procedures of Section 8.5 of Method 7E.

9. Quality Control

Follow quality control procedures in Section 9.0 of Method 7E.

10. Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11. Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12. Calculations and Data Analysis

You must follow the applicable procedures for calculations and data analysis in Section 12.0 of Method 7E as applicable, substituting SO₂ for NO_x as appropriate.

13. Method Performance

13.1 The specifications for the applicable performance checks are the same as in Section 13.0 of Method 7E.

13.2 Alternative Interference Check. The results are acceptable if the difference between the Method 6C result and the modified Method 6 result is less than 7.0 percent of the Method 6 result for each of the three test runs. For the purposes of comparison, the Method 6 and 6C results must be expressed in the same units of measure.

14. Pollution Prevention [Reserved]

15. Waste Management [Reserved]

16. Alternative Procedures

16.1 Alternative Interference Check. You may perform an alternative interference check consisting of at least three comparison runs between Method 6C and Method 6. This check validates the Method 6C results at each particular facility of known potential interferences. When testing under conditions of low concentrations (< 15 ppm), this alternative interference check is not allowed. Note: The procedure described below applies to non-dilution sampling systems only. If this alternative interference check is used for a dilution sampling system, use a standard Method 6 sampling train and extract the sample directly from the exhaust stream at points collocated with the Method 6C sample probe.

(1) Build the modified Method 6 sampling train (flow control valve, two midjet impingers containing 3 percent hydrogen peroxide, and dry gas meter) shown in Figure 6C-1. Connect the sampling train to the sample bypass discharge vent. Record the dry gas meter reading before you begin sampling. Simultaneously collect modified Method 6 and Method 6C samples. Open the flow control valve in the modified Method 6 train as you begin to sample with Method 6C. Adjust the Method 6 sampling rate to 1 liter per minute (0.10 percent). The sampling time per run must be the same as for Method 6 plus twice the average measurement system response time. If your modified Method 6 train does not include a pump, you risk biasing the results high if you over-pressurize the midjet impingers and cause a leak. You can reduce this risk by cautiously increasing the flow rate as sampling begins.

(2) After completing a run, record the final dry gas meter reading, meter temperature, and barometric pressure. Recover and analyze the contents of the midjet impingers using the procedures in Method 6. You must analyze performance audit samples as described in Method 6 with this interference check. Determine the average gas concentration reported by Method 6C for the run.

17. References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121.

18. Tables, Diagrams, Flowcharts, and Validation Data

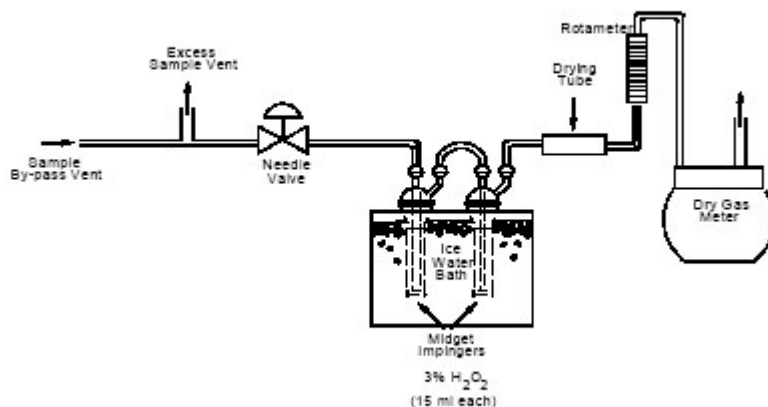


Figure 6C-1. Modified Method 6
Alternative Interference Check Sampling Train

METHOD 7E

DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES (INSTRUMENTAL ANALYZER PROCEDURE)

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of nitrogen oxides (NO_x) concentrations in emissions from stationary sources only when specified within the regulations.

1.2 Principle. A gas sample is continuously extracted from a stack, and a portion of the sample is conveyed to an instrumental chemiluminescent analyzer for determination of NO_x concentration. Performance specifications and test procedures are provided to ensure reliable data.

2. Range and Sensitivity

Same as Method 6C, Sections 2.1 and 2.2.

3. Definitions

3.1 Measurement System. The total equipment required for the determination of NO_x concentration. The measurement system consists of the following major subsystems:

3.1.1 Sample Interface, Gas Analyzer, and Data Recorder. Same as Method 6C, Sections 3.1.1, 3.1.2 and 3.1.3.

3.1.2 NO₂ to NO Converter. A device that converts the nitrogen dioxide (NO₂) in the sample gas to nitrogen oxide (NO).

~~3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, and Response Time. Same as Method 6C, Sections 3.2 through 3.8.~~

~~3.3 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.~~

~~4. Measurement System Performance Specifications~~

~~Same as Method 6C, Sections 4.1 through 4.4.~~

~~5. Apparatus and Reagents~~

~~5.1 Measurement System. Any measurement system for NO_x that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below:~~

~~5.1.1 Sample Probe, Sample Line, Calibration Valve Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as Method 6C, Sections 5.1.1 through 5.1.9 and 5.1.11.~~

~~5.1.2 NO₂ to NO Converter. That portion of the system that converts the nitrogen dioxide (NO₂) in the sample gas to nitrogen oxide (NO). An NO₂ to NO converter is not necessary if data are presented to demonstrate that the NO₂ portion of the exhaust gas is less than 5 percent of the total NO_x concentration.~~

~~5.1.3 NO_x Analyzer. An analyzer based on the principles of chemiluminescence, to determine continuously the NO_x concentration in the sample gas stream. The analyzer shall meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) shall be provided at the analyzer.~~

~~5.2 NO_x Calibration Gases. The calibration gases for the NO_x analyzer shall be NO in N₂. Three calibration gases, as specified in Sections 5.3.1 through 5.3.3 of Method 6C, shall be used. Ambient air may be used for the zero gas.~~

~~6. Measurement System Performance Test Procedures~~

~~Perform the following procedures before measurement of emissions (Section 7).~~

~~6.1 Calibration Gas Concentration Verification. Follow Section 6.1 of Method 6C, except if calibration gas analysis is required, use Method 7, and change all 5 percent performance values to 10 percent (or 10 ppm, whichever is greater).~~

~~6.2 Interference Response. Conduct an interference response test of the analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response (e.g., changes in the gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.~~

~~6.3 Measurement System Preparation, Analyzer Calibration Error, and Sample System Bias Check. Follow Sections 6.2 through 6.4 of Method 6C.~~

~~6.4 NO₂ to NO Conversion Efficiency. Unless data are presented to demonstrate that the NO₂ concentration within the sample stream is not greater than 5 percent of the NO_x concentration, conduct an NO₂ to NO conversion efficiency test in accordance with Section 5.6 of Method 20.~~

~~7. Emission Test Procedure~~

~~7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to tests performed using Method 7.~~

~~7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the system calibration drift test. Maintain constant rate sampling (i.e., 10 percent) during the entire run. The sampling time per run shall be the same as the total time required to perform a run using Method 7, plus twice the system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed, to determine the average effluent concentration.~~

~~7.3 Zero and Calibration Drift Test. Follow Section 7.4 of Method 6C.~~

~~8. Emission Calculation~~

~~Follow Section 8 of Method 6C.~~

~~9. Bibliography~~

~~Same as Bibliography of Method 6C.~~

1. Scope and Application

What is Method 7E? Method 7E is a procedure for measuring nitrogen oxides (NO_x) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis. This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this text:

- (a) Method 1—Sample and Velocity Traverses for Stationary Sources.
- (b) Method 4—Determination of Moisture Content in Stack Gases.

1.1 Analytes. What does this method determine? This method measures the concentration of nitrogen oxides as NO₂.

<u>Analyte</u>	<u>CAS No.</u>	<u>Sensitivity</u>
<u>Nitric oxide (NO)</u>	<u>10102-43-9</u>	<u>Typically <2% of</u>
<u>Nitrogen dioxide (NO₂)</u>	<u>10102-44-0</u>	<u>Calibration Span</u>

1.2 Applicability. When is this method required? The use of Method 7E may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans, and permits where measurement of NO_x concentrations in stationary source emissions is required, either to determine compliance with an applicable emissions standard or to conduct performance testing of a continuous monitoring system (CEMS). Other regulations may also require the use of Method 7E.

1.3 Data Quality Objectives (DQO). How good must my collected data be? Method 7E is designed to provide high-quality data for determining compliance with Federal and State emission standards and for relative accuracy testing of CEMS. In these and other applications, the principal objective is to ensure the accuracy of the data at the actual emission levels encountered. To meet this objective, the use of EPA traceability protocol calibration gases and measurement system performance tests are required.

1.4 Data Quality Assessment for Low Emitters. Is performance relief granted when testing low-emission units? Yes. For low-emitting sources, there are alternative performance specifications for analyzer calibration error, system bias, drift, and response time. Also, the alternative dynamic spiking procedure in Section 16 may provide performance relief for certain low-emitting units.

2. Summary of Method

In this method, a sample of the effluent gas is continuously sampled and conveyed to the analyzer for measuring the concentration of NO_x. You may measure NO and NO₂ separately or simultaneously together but, for the purposes of this method, NO_x is the sum of NO and NO₂. You must meet the performance requirements of this method to validate your data.

3. Definitions

3.1 Analyzer Calibration Error, for non-dilution systems, means the difference between the manufacturer certified concentration of a calibration gas and the measured concentration of the same gas when it is introduced into the analyzer in direct calibration mode.

3.2 Calibration Curve means the relationship between an analyzer's response to the injection of a series of calibration gases and the actual concentrations of those gases.

3.3 Calibration Gas means the gas mixture containing NO_x at a known concentration and produced and certified in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous

Calibration Standards,” September 1997, as amended August 25, 1999, EPA-600/R-97/121 or more recent updates. The tests for analyzer calibration error, drift, and system bias require the use of calibration gas prepared according to this protocol.

3.3.1 Low-Level Gas means a calibration gas with a concentration that is less than 20 percent of the calibration span and may be a zero gas.

3.3.2 Mid-Level Gas means a calibration gas with a concentration that is 40 to 60 percent of the calibration span.

3.3.3 High-Level Gas means a calibration gas with a concentration that is equal to the calibration span.

3.4 Calibration Span means the upper limit of valid instrument response during sampling. To the extent practicable, the measured emissions should be between 20 to 100 percent of the selected calibration span.

3.5 Centroidal Area means the central area of the stack or duct that is no greater than 1 percent of the stack or duct cross section. This area has the same geometric shape as the stack or duct.

3.6 Converter Efficiency Gas means a calibration gas with a known NO or NO₂ concentration and of Traceability Protocol quality.

3.7 Data Recorder means the equipment that permanently records the concentrations reported by the analyzer.

3.8 Direct Calibration Mode means introducing the calibration gases directly into the analyzer (or into the assembled measurement system at a point downstream of all sample conditioning equipment) according to manufacturer’s recommended calibration procedure. This mode of calibration applies to non-dilution-type measurement systems.

3.9 Drift means the difference between the measurement system readings obtained in the pre-run and post-run system bias (or system calibration error) checks at a specific calibration gas concentration level (i.e. low-, mid-, or high-).

3.10 Gas Analyzer means the equipment that senses the gas being measured and generates an output proportional to its concentration.

3.11 Interference Check means the test to detect analyzer responses to compounds other than the compound of interest, usually a gas present in the measured gas stream, that is not adequately accounted for in the calibration procedure and may cause measurement bias.

3.12 Low-Concentration Analyzer means any analyzer that operates with a calibration span of 20 ppm NO_x or lower. Each analyzer model used routinely to measure low NO_x concentrations must pass a Manufacturer’s Stability Test (MST). A MST subjects the analyzer to a range of potential effects to demonstrate its stability following the procedures provided in 40 CFR 53.23, 53.55, and 53.56 and provides the information in a summary format. A copy of this information must be included in each test report. Table 7E-5 lists the criteria to be met.

3.13 Measurement System means all of the equipment used to determine the NO_x concentration. The measurement system comprises six major subsystems: sample acquisition, sample transport, sample conditioning, calibration gas manifold, gas analyzer, and data recorder.

3.14 Response Time means the time it takes the measurement system to respond to a change in gas concentration occurring at the sampling point when the system is operating normally at its target sample flow rate or dilution ratio.

3.15 Run means a series of gas samples taken successively from the stack or duct. A test normally consists of a specific number of runs.

3.16 System Bias means the difference between a calibration gas measured in direct calibration mode and in system calibration mode. System bias is determined before and after each run at the low- and mid- or high concentration levels. For dilution-type systems, pre- and post-run system calibration error is measured, rather than system bias.

3.17 System Calibration Error applies to dilution-type systems and means the difference between the measured concentration of low-, mid-, or high-level calibration gas and the certified concentration for each gas when introduced in system calibration mode. For dilution-type systems, a 3-point system calibration error test is conducted in lieu of the analyzer calibration error test, and 2-point system calibration error tests are conducted in lieu of system bias tests.

3.18 System Calibration Mode means introducing the calibration gases into the measurement system at the probe, upstream of the filter and all sample conditioning components.

3.19 Test refers to the series of runs required by the applicable regulation.

4. Interferences

(Note: that interferences may vary among instruments and that instrument-specific interferences must be evaluated through the interference test.)

5. Safety

What safety measures should I consider when using this method? This method may require you to work with hazardous materials and in hazardous conditions. We encourage you to establish safety procedures before using the method. Among other precautions, you should become familiar with the safety recommendations in the gas analyzer user's manual. Occupational Safety and Health Administration (OSHA) regulations concerning cylinder and noxious gases may apply. Nitric oxide and NO₂ are toxic and dangerous gases. Nitric oxide is immediately converted to NO₂ upon reaction with air. Nitrogen dioxide is a highly poisonous and insidious gas. Inflammation of the lungs from exposure may cause only slight pain or pass unnoticed, but the resulting edema several days later may cause death. A concentration of 100 ppm is dangerous for even a short exposure, and 200 ppm may be fatal. Calibration gases must be handled with utmost care and with adequate ventilation. Emission-level exposure to these gases should be avoided.

6. Equipment and Supplies

The performance criteria in this method will be met or exceeded if you are properly using equipment designed for this application.

6.1 What do I need for the measurement system? You may use any equipment and supplies meeting the following specifications.

(1) Sampling system components that are not evaluated in the system bias or system calibration error test must be glass, Teflon, or stainless steel. Other materials are potentially acceptable, subject to approval by the Director.

(2) The interference, calibration error, and system bias criteria must be met.

(3) Sample flow rate must be maintained within 10 percent of the flow rate at which the system response time was measured.

(4) All system components (excluding sample conditioning components, if used) must maintain the sample temperature above the moisture dew point.

Section 6.2 provides example equipment specifications for a NO_x measurement system. Figure 7E-1 is a diagram of an example dry basis measurement system that is likely to meet the method requirements and is provided as guidance. For wet-basis systems, you may use alternative equipment and supplies as needed (some of which are described in Section 6.2), provided that the measurement system meets the applicable performance specifications of this method.

6.2 Measurement System Components

6.2.1 Sample Probe. Glass, stainless steel, or other approved material, of sufficient length to traverse the sample points.

6.2.2 Particulate Filter. An in-stack or out-of-stack filter. The filter media must be included in the system bias test and made of material that is non-reactive to the gas being sampled. This particulate filter requirement may be waived in applications where no significant particulate matter is expected (e.g., for emission testing of a combustion turbine firing natural gas).

6.2.3 Sample Line. The sample line from the probe to the conditioning system/sample pump should be made of Teflon or other material that does not absorb or otherwise alter the sample gas. For a dry-basis measurement system (as shown in Figure 7E-1), the temperature of the sample line must be maintained at a sufficiently high level to prevent condensation before the sample conditioning components. For wet-basis measurement systems, the temperature of the sample line must be maintained at a sufficiently high level to prevent condensation before the analyzer.

6.2.4 Conditioning Equipment. For dry basis measurements, a condenser, dryer or other suitable device is required to remove moisture continuously from the sample gas. Any equipment needed to heat the probe or sample line to avoid condensation prior to the sample conditioning component is also required.

For wet basis systems, you must keep the sample above its dew point either by: (1) 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 (2) by diluting the sample prior to analysis using a dilution probe system. The components required to do either of the above are considered to be conditioning equipment.

6.2.5 Sampling Pump. For systems similar to the one shown in Figure 7E-1, a leak-free pump is needed to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The pump may be constructed of any material that is non-reactive to the gas being sampled. For dilution-type measurement systems, an ejector pump (eductor) is used to create a vacuum that draws the sample through a critical orifice at a constant rate.

6.2.6 Calibration Gas Manifold. Prepare a system to allow the introduction of calibration gases either directly to the gas analyzer in direct calibration mode or into the measurement system, at the probe, in system calibration mode, or both, depending upon the type of system used. In system calibration mode, the system should be able to block the sample gas flow and flood the sampling probe. Alternatively, calibration gases may be introduced at the calibration valve following the probe. Maintain a constant pressure in the gas manifold. For in-stack dilution-type systems, a gas dilution subsystem is required to transport large volumes of purified air to the sample probe and a probe controller is needed to maintain the proper dilution ratio.

6.2.7 Sample Gas Manifold. For the type of system shown in Figure 7E-1, the sample gas manifold diverts a portion of the sample to the analyzer, delivering the remainder to the by-pass discharge vent. The manifold should also be able to introduce calibration gases directly to the analyzer (except for dilution-type systems). The manifold must be made of material that is non-reactive to the gas sampled or the calibration gas and be configured to safely discharge the bypass gas.

6.2.8 NO_x Analyzer. An instrument that continuously measures NO_x in the gas stream and meets the applicable specifications in Section 13.0. An analyzer that operates on the principle of chemiluminescence with an NO₂ to NO converter is one example of an analyzer that has been used successfully in the past. Analyzers operating on other principles may also be used provided the performance criteria in Section 13.0 are met.

6.2.8.1 Dual Range Analyzers. For certain applications, a wide range of gas concentrations may be encountered, necessitating the use of two measurement ranges. Dual-range analyzers are readily available for these applications. These analyzers are often equipped with automated range-switching capability, so that when readings exceed the full-scale of the low measurement range, they are recorded on the high range. As an alternative to using a dual-range analyzer, you may use two segments of a single, large measurement scale to serve as the low and high ranges. In all cases, when two ranges are used, you must quality-assure both ranges using the proper sets of calibration gases. You must also meet the interference, calibration error, system bias, and drift checks. However, we caution that when you use two segments of a large measurement scale for dual range purposes, it may be difficult to meet the performance specifications on the low range due to signal-to-noise ratio considerations.

6.2.8.2 Low Concentration Analyzer. When the calibration span is less than or equal to 20 ppmv, the manufacturer's stability test (MST) is required. See Table 7E-5.

6.2.9 Data Recording. A strip chart recorder, computerized data acquisition system, digital recorder, or data logger for recording measurement data may be used.

7. Reagents and Standards

7.1 Calibration Gas. What calibration gases do I need? Your calibration gas must be NO in nitrogen and certified (or recertified) within an uncertainty of 2.0 percent in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997, as amended August 25, 1999, EPA-600/R-97/121. Blended gases meeting the Traceability Protocol are allowed if the additional gas components are shown not to interfere with the analysis. The calibration gas must not be used after its expiration date.

Except for applications under 40 CFR Part 75**, it is acceptable to prepare calibration gas mixtures from EPA Traceability Protocol gases in accordance with Method 205 in M to part 51 of this chapter. For Part 75 applications, the use of Method 205 is subject to the approval of the Administrator. The goal and recommendation for selecting calibration gases is to bracket the sample concentrations.

The following calibration gas concentrations are required:

7.1.1 High-Level Gas. This concentration sets the calibration span and results in measurements being 20 to 100 percent of the calibration span.

7.1.2 Mid-Level Gas. 40 to 60 percent of the calibration span.

7.1.3 Low-Level Gas. Less than 20 percent of the calibration span.

7.1.4 Converter Efficiency Gas. What reagents do I need for the converter efficiency test? The converter efficiency gas for the test described in Section 8.2.4.1 must have a concentration of NO₂ that is between 40 and 60 ppmv. For the alternative converter efficiency tests in Section 16.2, NO is required. In either case, the test gas must be prepared according to the EPA Traceability Protocol.

7.2 Interference Check. What reagents do I need for the interference check? Use the appropriate test gases listed in Table 7E-3 (i.e., the potential interferents for the test facility, as identified by the instrument manufacturer) to conduct the interference check.

8. Sample Collection, Preservation, Storage, and Transport

Emission Test Procedure. Since you are allowed to choose different options to comply with some of the performance criteria, it is your responsibility to identify the specific options you have chosen, to document that the performance criteria for that option have been met, and to identify any deviations from the method.

What sampling site and sampling points do I select?

8.1.1 Unless otherwise specified in an applicable regulation or by the Administrator, when this method is used to determine compliance with an emission standard, conduct a stratification test as described in Section 8.1.2 to determine the sampling traverse points to be used. For performance testing of continuous emission monitoring systems, follow the sampling site selection and traverse point layout procedures described in the appropriate performance specification or applicable regulation (e.g., Performance Specification 2 in appendix B to this text).

8.1.2 Determination of Stratification. To test for stratification, use a probe of appropriate length to measure the NO_x (or pollutant of interest) concentration at twelve traverse points located according to Table 1-1 or Table 1-2 of Method 1 of this text. Alternatively, you may measure at three points on a line passing through the centroidal area. Space the three points at 16.7, 50.0, and 83.3 percent of the measurement line. Sample for a minimum of twice the system response time (see Section 8.2.6) at each traverse point. Calculate the individual point and mean NO_x concentrations. If the concentration at each traverse point differs from the mean concentration for all traverse points by no more than: (a) ± 5.0 percent of the mean concentration; or (b) ± 0.5 ppm (whichever is less restrictive), the gas stream is considered unstratified and you may collect samples from a single point that most closely matches the mean. If the 5.0 percent or 0.5 ppm criterion is not met, but the concentration at each traverse point differs from the mean concentration for all traverse points by no more than: (a) ± 10.0 percent of the mean; or (b) ± 1.0 ppm (whichever is less restrictive), the gas stream is considered to be minimally stratified, and you may take samples from three points. Space the three points at 16.7, 50.0, and 83.3 percent of the measurement line. Alternatively, if a twelve point stratification test was performed and the emissions shown to be minimally stratified (all points within ± 10.0 percent of their mean or within ± 1.0 ppm), and if the stack diameter (or equivalent diameter, for a rectangular stack or duct) is greater than 2.4 meters (7.8 ft), then you may use 3-point sampling and locate the three points along the measurement line exhibiting the highest average concentration during the stratification test, at 0.4, 1.0 and 2.0 meters from the stack or duct wall. If the gas stream is found to be stratified because the 10.0 percent or 1.0 ppm criterion for a 3-point test is not met, locate twelve traverse points for the test in accordance with Table 1-1 or Table 1-2 of Method 1 of this text.

8.2 Initial Measurement System Performance Tests. What initial performance criteria must my system meet before I begin collecting samples?

Before measuring emissions, perform the following procedures:

- (a) Calibration gas verification,
- (b) Measurement system preparation,

- (c) Calibration error test,
- (d) NO₂ to NO conversion efficiency test, if applicable,
- (e) System bias check,
- (f) System response time test, and
- (g) Interference check

8.2.1 Calibration Gas Verification. How must I verify the concentrations of my calibration gases? Obtain a certificate from the gas manufacturer and confirm that the documentation includes all information required by the Traceability Protocol. Confirm that the manufacturer certification is complete and current. Ensure that your calibration gases certifications have not expired. This documentation should be available on-site for inspection. To the extent practicable, select a high-level gas concentration that will result in the measured emissions being between 20 and 100 percent of the calibration span.

8.2.2 Measurement System Preparation. How do I prepare my measurement system? Assemble, prepare, and precondition the measurement system according to your standard operating procedure. Adjust the system to achieve the correct sampling rate or dilution ratio (as applicable).

8.2.3 Calibration Error Test. How do I confirm my analyzer calibration is correct? After you have assembled, prepared and calibrated your sampling system and analyzer, you must conduct a 3-point analyzer calibration error test (or a 3-point system calibration error test for dilution systems) before the first run and again after any failed system bias test (or 2-point system calibration error test for dilution systems) or failed drift test. Introduce the low-, mid-, and high-level calibration gases sequentially. For non-dilution-type measurement systems, introduce the gases in direct calibration mode. For dilution-type measurement systems, introduce the gases in system calibration mode.

(1) For non-dilution systems, you may adjust the system to maintain the correct flow rate at the analyzer during the test, but you may not make adjustments for any other purpose. For dilution systems, you must operate the measurement system at the appropriate dilution ratio during all system calibration error checks, and may make only the adjustments necessary to maintain the proper ratio.

- (2) Record the analyzer's response to each calibration gas on a form similar to Table 7E-1. For each calibration gas, calculate the analyzer calibration error using Equation 7E-1 in section 12.2 or the system calibration error using Equation 7E-3 in Section 12.4 (as applicable). The calibration error specification in Section 13.1 must be met for the low-, mid-, and high-level gases. If the calibration error specification is not met, take corrective action and repeat the test until an acceptable 3-point calibration is achieved.

8.2.4 NO₂ to NO Conversion Efficiency Test. Before each field test, you must conduct an NO₂ to NO conversion efficiency test if your system converts NO₂ to NO before analyzing for NO_x. Follow the procedures in Section 8.2.4.1, or 8.2.4.2. If desired, the converter efficiency factor derived from this test may be used to correct the test results for converter efficiency if the NO₂ fraction in the measured test gas is known. Use Equation 7E-8 in Section 12.8 for this correction.

8.2.4.1 Introduce a concentration of 40 to 60 ppmv NO₂ to the analyzer in direct calibration mode and record the NO_x concentration displayed by the analyzer. If a dilution system is used, introduce the NO₂ calibration gas at a point before the dilution takes place. Calculate the converter efficiency using Equation 7E-7 in Section 12.7. The specification for converter efficiency in Section 13.5 must be met. The user is cautioned that state-of-the-art NO₂ calibration gases may not be sufficiently stable and thus make it more difficult to pass the 90 percent conversion efficiency requirement. The NO₂ must be prepared according to the EPA Traceability Protocol and have an accuracy within 2.0 percent.

8.2.4.2 Alternatively, either of the procedures for determining conversion efficiency using NO in Section 16.2 may be used.

8.2.5 Initial System Bias and System Calibration Error Checks. Before sampling begins, determine whether the high-level or mid-level calibration gas best approximates the emissions and use it as the upscale gas. Introduce the upscale gas at the probe upstream of all sample conditioning components in system calibration mode. Record the time it takes for the measured concentration to increase to a value that is within 95 percent or 0.5 ppm (whichever is less restrictive) of the certified gas concentration. Continue to observe the gas concentration reading until it has reached a final, stable value. Record this value on a form similar to Table 7E-2.

(1) Next, introduce the low-level gas in system calibration mode and record the time required for the concentration response to decrease to a value that is within 5.0 percent or 0.5 ppm (whichever is less restrictive) of the certified low-range gas concentration. If the low-level gas is a zero gas, use the procedures described above and observe the change in concentration until the response is 0.5 ppm or 5.0 percent of the upscale gas concentration (whichever is less restrictive).

(2) Continue to observe the low-level gas reading until it has reached a final, stable value and record the result on a form similar to Table 7E-2. Operate the measurement system at the normal sampling rate during all system bias checks. Make only the adjustments necessary to achieve proper calibration gas flow rates at the analyzer.

(3) From these data, calculate the measurement system response time (see Section 8.2.6) and then calculate the initial system bias using Equation 7E-2 in Section 12.3. For dilution systems, calculate the system calibration error in lieu of system bias using equation 7E-3 in Section 12.4. See Section 13.2 for acceptable performance criteria for system bias and system calibration error. If the initial system bias (or system calibration error) specification is not met, take corrective action. Then, you must repeat the applicable calibration error test from Section 8.2.3 and the initial system bias (or 2-point system calibration error) check until acceptable results are achieved, after which you may begin sampling. (Note: For dilution-type systems, data from the 3-point system calibration error test described in Section 8.2.3 may be used to meet the initial 2-point system calibration error test requirement of this section, if the calibration gases were injected as described in this section, and if response time data were recorded).

8.2.6 Measurement System Response Time. As described in section 8.2.5, you must determine the measurement system response time during the initial system bias (or 2-point system calibration error) check. Observe the times required to achieve 95 percent of a stable response for both the low-level and upscale gases. The longer interval is the response time.

8.2.7 Interference Check. Conduct an interference response test of the gas analyzer prior to its initial use in the field. If you have multiple analyzers of the same make and model, you need only perform this alternative interference check on one analyzer. You may also meet the interference check requirement if the instrument manufacturer performs this or similar check on the same make and model of analyzer that you use and provides you with documented results.

(1) You may introduce the appropriate interference test gases (that are potentially encountered during a test, see examples in Table 7E-3) into the analyzer (or measurement system for dilution-type systems) separately or as mixtures. This test must be performed both with and without NO_x (NO and NO₂) (the applicable pollutant gas). For analyzers measuring NO_x greater than 20 ppm, use a calibration gas with an NO_x concentration of 80 to 100 ppm and set this concentration equal to the calibration span. For analyzers measuring less than 20 ppm NO_x, select an NO concentration for the calibration span that reflects the emission levels at the sources to be tested, and perform the interference check at that level. Measure the total interference response of the analyzer to these gases in ppmv. Record the responses and determine the interference using Table 7E-4. The specification in Section 13.4 must be met.

(2) A copy of this data, including the date completed and signed certification, must be available for inspection at the test site and included with each test report. This interference test is valid for the life of the instrument unless major analytical components (e.g., the detector) are replaced. If major components are replaced, the interference gas check must be repeated before returning the analyzer to service. The tester must ensure that any specific technology, equipment, or procedures that are intended to remove interference effects are operating properly during testing.

8.3 Dilution-Type Systems—Special Considerations. When a dilution-type measurement system is used, there are three important considerations that must be taken into account to ensure the quality of the emissions data. First, the critical orifice size and dilution ratio must be selected properly so that the sample dew point will be below the sample line and analyzer temperatures. Second, a high-quality, accurate probe controller must be used to maintain the dilution ratio during the test. The probe controller should be capable of monitoring the dilution air pressure, eductor vacuum, and sample flow rates. Third, differences between the molecular weight of calibration gas mixtures and the stack gas molecular weight must be addressed because these can affect the dilution ratio and introduce measurement bias.

8.4 Sample Collection. (1) Position the probe at the first sampling point. Purge the system for at least two times the response time before recording any data. Then, traverse all required sampling points and sample at each point for an equal length of time, maintaining the appropriate sample flow rate or dilution ratio (as applicable). You must record at least one valid data point per minute during the test run. The minimum time you must sample at each point is two times the system response time. Usually the test is designed for sampling longer than this to better characterize the source's temporal variation.

(2) After recording data for the appropriate period of time at the first traverse point, you may move to the next point and continue recording, omitting the requirement to wait for two times the system response time before recording data at the subsequent traverse points. For example, if you use a sampling system with a two-minute system response time, initially purge the system for at least four minutes, then record a minimum of four one-minute averages at each sample point. However, if you remove the probe from the stack, you must recondition the sampling system for at least two times the system response time prior to your next recording. If the average of any run exceeds the calibration span value, the run is invalidated.

(3) You may satisfy the multipoint traverse requirement by sampling sequentially using a single-hole probe or a multi-hole probe designed to sample at the prescribed points with a flow within 10 percent of mean flow rate. Notwithstanding, for applications under 40 CFR Part 75**, the use of multi-hole probes is subject to the approval of the Administrator.

8.5 Post-Run System Bias Check and Drift Assessment. How do I confirm that each sample I collect is valid? After each run, repeat the system bias check or 2-point system calibration error check (for dilution systems) to validate the run. Do not make adjustments to the measurement system (other than to maintain the target sampling rate or dilution ratio) between the end of the run and the completion of the post-run system bias or system calibration error check. Note that for all post-run system bias or 2-point system calibration error checks, you may inject the low-level gas first and the upscale gas last, or vice-versa.

(1) If you do not pass the post-run system bias (or system calibration error) check, then the run is invalid. You must diagnose and fix the problem and pass another initial 3-point calibration error test (see Section 8.2.3) and another system bias (or 2-point system calibration error) check (see Section 8.2.5) before repeating the run. In these additional bias and calibration error tests, the gases may be injected in any order. Record the system bias (or system calibration error) check results on a form similar to Table 7E-2.

(2) After each run, calculate the low-level and upscale drift, using Equation 7E-4 in Section 12.5. If the post-run low- and upscale bias (or 2-point system calibration error) checks are passed, but the low- or upscale drift exceeds the specification in Section 13.3, the run data are valid, but a 3-point calibration error test and a system bias (or 2-point system calibration error) check must be performed and passed before any more test runs are done.

(3) For dilution systems, data from a 3-point system calibration error test may be used to met the pre-run 2-point system calibration error requirement for the first run in a test sequence. Also, the post-run bias (or 2-point calibration error) check data may be used as the pre run data for the next run in the test sequence at the discretion of the tester.

8.6 Alternative Interference and System Bias Checks (Dynamic Spike Procedure). If I want to use the dynamic spike procedure to validate my data, what procedure should I follow? Except for applications

under 40 CFR Part 75**, you may use the dynamic spiking procedure and requirements provided in Section 16.1 during each test as an alternative to the interference check and the pre- and post-run system bias checks. The calibration error test is still required under this option. Use of the dynamic spiking procedure for Part 75 applications is subject to the approval of the Administrator.

8.7 Moisture correction. You must determine the moisture content of the flue gas and correct the measured gas concentrations to a dry basis using Method 4 or other appropriate methods, subject to the approval of the Director, when the moisture basis (wet or dry) of the measurements made with this method is different from the moisture basis of either: (1) the applicable emissions limit; or (2) the CEMS being evaluated for relative accuracy. Moisture correction is also required if the applicable limit is in lb/mmBtu and the moisture basis of the Method 7E NO_x analyzer is different from the moisture basis of the Method 3A diluent gas (CO₂ or O₂) analyzer.

9. Quality Control

What quality control measures must I take? The following table is a summary of the mandatory, suggested, and alternative quality assurance and quality control measures and the associated frequency and acceptance criteria. All of the QC data, along with the sample run data, must be documented and included in the test report.

Summary Table of QA/QC

<u>Status</u>	<u>Process or Element</u>	<u>QA/QC Specification</u>	<u>Acceptance Criteria</u>	<u>Checking Frequency</u>
<u>S</u>	<u>Identify Data User</u>		<u>Regulatory Agency or other primary end user of data</u>	<u>Before designing test</u>
<u>S</u>	<u>Analyzer Design</u>	<u>Analyzer resolution or sensitivity</u>	<u>< 2.0 % of full-scale range</u>	<u>Manufacturer design</u>
<u>M</u>		<u>Interference gas check</u>	<u>Sum of responses ≤ 2.5 % of calibration span Alternatively, sum of responses: ≤ 0.5 ppmv for calibration spans of 5 to 10 ppmv ≤ 0.2 ppmv for calibration spans < 5 ppmv See Table 7E-3</u>	
<u>M</u>	<u>Calibration Gases</u>	<u>Traceability protocol (G1, G2)</u>	<u>Valid certificate required Uncertainty ≤ 2.0 % of tag value</u>	
<u>M</u>		<u>High-level gas</u>	<u>Equal to the calibration span</u>	<u>Each test</u>
<u>M</u>		<u>Mid-level gas</u>	<u>40 to 60% of calibration span</u>	<u>Each test</u>
<u>M</u>		<u>Low-level gas</u>	<u>< 20% of calibration span</u>	<u>Each test</u>
<u>S</u>	<u>Data Recorder Design</u>	<u>Data resolution</u>	<u>≤ 0.5% of full-scale range</u>	<u>Manufacturer design</u>
<u>S</u>	<u>Sample Extraction</u>	<u>Probe material</u>	<u>SS or quartz if stack > 500 F</u>	<u>Each test</u>
<u>M</u>	<u>Sample Extraction</u>	<u>Probe, filter And sample line temperature</u>	<u>For dry-basis analyzers, keep sample above the dew point by heating, prior to sample conditioning For wet-basis analyzers, keep sample above dew point at all times, by heating or dilution.</u>	<u>Each run</u>
<u>S</u>	<u>Sample Extraction</u>	<u>Calibration valve material</u>	<u>SS</u>	<u>Each test</u>
<u>S</u>	<u>Sample Extraction</u>	<u>Sample pump material</u>	<u>Inert to sample constituents</u>	<u>Each test</u>
<u>S</u>	<u>Sample Extraction</u>	<u>Manifolding material</u>	<u>Inert to sample constituents</u>	<u>Each test</u>
<u>S</u>	<u>Moisture Removal</u>	<u>Equipment efficiency</u>	<u>< 5% target compound removal</u>	<u>Verified through System bias check</u>
<u>S</u>	<u>Particulate Removal</u>	<u>Filter inertness</u>	<u>Pass system bias check</u>	<u>Each bias check</u>
<u>M</u>	<u>Analyzer & Calibration Gas Performance</u>	<u>Analyzer calibration error (or 3-point system calibration</u>	<u>Within ± 2.0 percent of the calibration span of the analyzer for the low-, mid-, and high-level calibration gases Alternative specification: 0.5 ppmv</u>	<u>Before initial run and after a failed system bias test or drift test</u>

		<u>error for dilution systems)</u>	<u>absolute difference</u>	
<u>M</u>	<u>System Performance</u>	<u>System bias (or pre- and post-run 2-point system calibration error for dilution Systems)</u>	<u>Within ± 5.0 % of the analyzer calibration span for low-scale and upscale calibration gases</u> <u>Alternative specification: 0.5 ppmv absolute difference</u>	<u>Before and after each run</u>
<u>M</u>	<u>System Performance</u>	<u>System response time</u>	<u>Determines minimum sampling time per point</u>	<u>During initial Sampling system bias test</u>
<u>M</u>	<u>System Performance</u>	<u>Drift</u>	<u>3.0 % of calibration span for low-level and mid- or high-level gases</u> <u>Alternative specification: 0.5 ppmv absolute difference</u>	<u>After each test run</u>
<u>M</u>	<u>System Performance</u>	<u>NO2-NO conversion efficiency</u>	<u>≥ 90% of certified test gas concentration</u>	<u>Before each test</u>
<u>M</u>	<u>System Performance</u>	<u>Purge time</u>	<u>≥ 2 times system response time</u>	<u>Before starting the first run and when probe is removed from and reinserted into the stack</u>
<u>M</u>	<u>System Performance</u>	<u>Minimum sample time at each point</u>	<u>Two times the system response time</u>	<u>Each sample point</u>
<u>M</u>	<u>System Performance</u>	<u>Stable sample flow rate (surrogate for maintaining system response time)</u>	<u>Within 10% of flow rate established during system response time check</u>	<u>Each run</u>
<u>M</u>	<u>Sample Point Selection</u>	<u>Stratification test</u>	<u>All points within:</u> <u>± 5% of mean for 1-point sampling</u> <u>± 10% of mean for 3-point</u> <u>Alternatively, all points within:</u> <u>± 0.5 ppm of mean for 1-point sampling</u> <u>± 1.0 ppm of mean for 3-point sampling</u>	<u>Prior to first run</u>
<u>A</u>	<u>Multiple sample points simultaneously</u>	<u>No. of openings in probe</u>	<u>Multi-hole probe with verifiable constant flow through all holes within 10% of mean flow rate (requires Administrative approval for 40 CFR Part 75**)</u>	<u>Each run</u>
<u>M</u>	<u>Data Recording</u>	<u>Frequency</u>	<u>1 minute average</u>	<u>During run</u>
		<u>Sample</u>	<u>All 1-minute averages within</u>	<u>Each run</u>

<u>S</u>	<u>Data Parameters</u>	<u>concentration range</u>	<u>calibration span</u>	
<u>M</u>	<u>Data Parameters</u>	<u>Average concentration for the run</u>	<u>Run average ≤ calibration span</u>	<u>Each run</u>

S = Suggested
M = Mandatory
A = Alternative

10. Calibration and Standardization

What measurement system calibrations are required?

(1) The initial 3-point calibration error test as described in Section 8.2.3 and the system bias (or system calibration error) checks described in Section 8.2.5 are required and must meet the specifications in Section 13 before you start the test. Make all necessary adjustments to calibrate the gas analyzer and data recorder. Then, after the test commences, the system bias or system calibration error checks described in Section 8.5 are required before and after each run. Your analyzer must be calibrated for all species of NO_x that it detects. If your analyzer measures NO and NO₂ separately, then you must use both NO and NO₂ calibration gases.

(2) You must include a copy of the manufacturer's certification of the calibration gases used in the testing as part of the test report. This certification must include the 13 documentation requirements in the EPA Traceability Protocol For Assay and Certification of Gaseous Calibration Standards, September 1997, as amended August 25, 1999. When Method 205 is used to produce diluted calibration gases, you must document that the specifications for the gas dilution system are met for the test. You must also include the date of the most recent dilution system calibration against flow standards and the name of the person or manufacturer who carried out the calibration in the test report.

11. Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12. Calculations and Data Analysis

You must follow the procedures for calculations and data analysis listed in this section.

12.1 Nomenclature. The terms used in the equations are defined as follows:

ACE = Analyzer calibration error, percent of calibration span.

BWS = Moisture content of sample gas as measured by Method 4 or other approved method, percent/100.

C_{Avg} = Average unadjusted gas concentration indicated by data recorder for the test run, ppmv.

C_D = Pollutant concentration adjusted to dry conditions, ppmv.

C_{Dir} = Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode, ppmv.

C_{Gas} = Average effluent gas concentration adjusted for bias, ppmv.

C_M = Average of initial and final system calibration bias (or 2-point system calibration error) check responses for the upscale calibration gas, ppmv.

C_{MA} = Actual concentration of the upscale calibration gas, ppmv.

C_0 = Average of the initial and final system calibration bias (or 2-point system calibration error) check responses from the low-level (or zero) calibration gas, ppmv.

C_s = Measured concentration of a calibration gas (low, mid, or high) when introduced in system calibration mode, ppmv.

C_{SS} = Concentration of NO_x measured in the spiked sample, ppmv.

C_{Spike} = Concentration of NO_x in the undiluted spike gas, ppmv.

C_{Calc} = Calculated concentration of NO_x in the spike gas diluted in the sample, ppmv.

C_v = Manufacturer certified concentration of a calibration gas (low, mid, or high), ppmv.

C_w = Pollutant concentration measured under moist sample conditions, wet basis, ppmv.

CS = Calibration span, ppmv.

D = Drift assessment, percent of calibration span.

Eff_{NO2} = NO₂ to NO converter efficiency, percent.

NO_{Final} = The average NO concentration observed with the analyzer in the NO mode during the converter efficiency test in Section 16.2.2, ppmv.

NO_{XCorr} = The NO_x concentration corrected for the converter efficiency, ppmv.

NO_{XFinal} = The final NO_x concentration observed during the converter efficiency test in Section 16.2.2, ppmv.

NO_{XPeak} = The highest NO_x concentration observed during the converter efficiency test in Section 16.2.2, ppmv.

Q_{Spike} = Flow rate of spike gas introduced in system calibration mode, L/min.

Q_{Total} = Total sample flow rate during the spike test, L/min.

R = Spike recovery, percent.

SB = System bias, percent of calibration span.

SB_i = Pre-run system bias, percent of calibration span.

SB_f = Post-run system bias, percent of calibration span.

SCE = System calibration error, percent of calibration span.

SCE_i = Pre-run system calibration error, percent of calibration span.

SCE_{final} = Post-run system calibration error, percent of calibration span.

12.2 Analyzer Calibration Error. For non-dilution systems, use Equation 7E-1 to calculate the analyzer calibration error for the low-, mid-, and high-level calibration gases.

$$ACE = \left(\frac{C_{Dir} - C_v}{CS} \right) \times 100 \quad \text{Eq. 7E-1}$$

12.3 System Bias. For non-dilution systems, use Equation 7E-2 to calculate the system bias separately for the low-level and upscale calibration gases.

$$SB = \left(\frac{C_s - C_{Dir}}{CS} \right) \times 100 \quad \text{Eq. 7E-2}$$

12.4 System Calibration Error. Use Equation 7E-3 to calculate the system calibration error for dilution systems. Equation 7E-3 applies to both the initial 3-point system calibration error test and the subsequent 2-point between run tests.

$$SCE = \left(\frac{C_s - C_v}{CS} \right) \times 100 \quad \text{Eq. 7E-3}$$

12.5 Drift Assessment. Use Equation 7E-4 to separately calculate the low-level and upscale drift over each test run. For dilution systems, replace “SB_{final}” and “SB_i” with “SCE_{final}” and “SCE_i”, respectively, to calculate and evaluate drift.

$$D = |SB_{Final} - SB_i| \quad \text{Eq. 7E-4}$$

12.6 Effluent Gas Concentration. For each test run, calculate C_{avg}, the arithmetic average of all valid NO_x concentration values (e.g., 1-minute averages). Then adjust the value of C_{avg} for bias, using Equation 7E-5.

$$C_{Gas} = (C_{Avg} - C_o) \frac{C_{MA}}{C_M - C_o} \quad \text{Eq. 7E-5}$$

12.7 NO₂ - NO Conversion Efficiency. If the NO_x converter efficiency test described in Section 8.2.4.1 is performed, calculate the efficiency using Equation 7E-7.

$$Eff_{NO_2} = \frac{C_{Dir}}{C_v} \times 100 \quad \text{Eq. 7E-7}$$

12.8 NO₂ - NO Conversion Efficiency Correction. If desired, calculate the total NO_x concentration with a correction for converter efficiency using Equations 7E-8.

$$NO_{XCorr} = NO + \frac{NO_x - NO}{Eff_{NO_2}} \times 100 \quad \text{Eq. 7E-8}$$

12.9 Alternative NO₂ Converter Efficiency. If the alternative procedure of Section 16.2.2 is used, calculate the converter efficiency using Equation 7E-9.

$$Eff_{NO_2} = \frac{(NO_{XFinal} - NO_{Final})}{(NO_{XPeak} - NO_{Final})} \times 100 \quad \text{Eq. 7E-9}$$

12.10 Moisture Correction. Use Equation 7E-10 if your measurements need to be corrected to a dry basis.

$$C_D = \frac{C_w}{1 - B_{WS}} \quad \text{Eq. 7E-10}$$

12.11 Calculated Spike Gas Concentration and Spike Recovery for the Example Alternative Dynamic Spiking Procedure in Section 16.1.3. Use Equation 7E-11 to determine the calculated spike gas concentration. Use Equation 7E-12 to calculate the spike recovery.

$$C_{Calc} = \frac{(C_{Spike})(Q_{Spike})}{Q_{Total}} \quad \text{Eq. 7E-11}$$

$$R = \frac{C_{SS} - C_{Avg}}{C_{Calc}} \times 100 \quad \text{Eq. 7E-12}$$

13. Method Performance

13.1 Calibration Error. This specification is applicable to both the analyzer calibration error and the 3-point system calibration error tests described in Section 8.2.3. At each calibration gas level (low, mid, and high) the calibration error must either be within ± 2.0 percent of the calibration span. Alternatively, the results are acceptable if $|C_{dir} - C_v|$ or $|C_s - C_v|$ (as applicable) is ≤ 0.5 ppmv.

13.2 System Bias. This specification is applicable to both the system bias and 2-point system calibration error tests described in Section 8.2.5 and 8.5. The pre- and post-run system bias (or system calibration error) must be within ± 5.0 percent of the calibration span for the low-level and upscale calibration gases. Alternatively, the results are acceptable if $|C_s - C_{dir}|$ is ≤ 0.5 ppmv or if $|C_s - C_v|$ is ≤ 0.5 ppmv (as applicable).

13.3 Drift. For each run, the low-level and upscale drift must be less than or equal to 3.0 percent of the calibration span. The drift is also acceptable if the pre- and post-run bias (or the pre- and post-run system calibration error) responses do not differ by more than 0.5 ppmv at each gas concentration (i.e. $|C_s \text{ post-run} - C_s \text{ pre-run}| \leq 0.5$ ppmv).

13.4 Interference Check. The total interference response (i.e., the sum of the interference responses of all tested gaseous components) must not be greater than 2.50 percent of the calibration span for the analyzer tested. In summing the interferences, use the larger of the absolute values obtained for the interferent tested with and without the pollutant present. The results are also acceptable if the sum of the responses does not exceed 0.5 ppmv for a calibration span of 5 to 10 ppmv, or 0.2 ppmv for a calibration span < 5 ppmv.

13.5 NO₂ to NO Conversion Efficiency Test (as applicable). The NO₂ to NO conversion efficiency, calculated according to Equation 7E-7 or Equation 7E-9, must be greater than or equal to 90 percent.

13.6 Alternative Dynamic Spike Procedure. Recoveries of both pre-test spikes and post-test spikes must be within 100 ± 10 percent. If the absolute difference between the calculated spike value and measured spike value is equal to or less than 0.20 ppmv, then the requirements of the ADSC are met.

14. Pollution Prevention [Reserved]

15. Waste Management [Reserved]

16. Alternative Procedures

16.1 Dynamic Spike Procedure. Except for applications under 40 CFR Part 75**, you may use a dynamic spiking procedure to validate your test data for a specific test matrix in place of the interference check and pre- and post-run system bias checks. For Part 75 applications, use of this procedure is subject to the approval of the Administrator. Best results are obtained for this procedure when source emissions are steady and not varying. Fluctuating emissions may render this alternative procedure difficult to pass. To use this alternative, you must meet the following requirements.

16.1.1 Procedure Documentation. You must detail the procedure you followed in the test report, including how the spike was measured, added, verified during the run, and calculated after the test.

16.1.2 Spiking Procedure Requirements. The spikes must be prepared from EPA traceability Protocol gases. Your procedure must be designed to spike field samples at two target levels both before and after the test. Your target spike levels should bracket the average sample NO_x concentrations. The higher target concentration must be less than the calibration span. You must collect at least 5 data points for each target concentration. The spiking procedure must be performed before the first run and repeated after the last run of the test program.

16.1.3 Example Spiking Procedure. Determine the NO concentration needed to generate concentrations that are 50 and 150 percent of the anticipated NO_x concentration in the stack at the total sampling flow rate while keeping the spike flow rate at or below 10 percent of this total. Use a mass flow meter (accurate within 2.0 percent) to generate these NO spike gas concentrations at a constant flow rate. Use Equation 7E-11 in Section 12.11 to determine the calculated spike concentration in the collected sample.

(1) Prepare the measurement system and conduct the analyzer calibration error test as described in Sections 8.2.2 and 8.2.3. Following the sampling procedures in Section 8.1, determine the stack NO_x concentration and use this concentration as the average stack concentration (C_{avg}) for the first spike level, or if desired, for both pre-test spike levels. Introduce the first level spike gas into the system in system calibration mode and begin sample collection. Wait for at least two times the system response time before measuring the spiked sample concentration. Then record at least five successive 1-minute averages of the spiked sample gas. Monitor the spike gas flow rate and maintain at the determined addition rate. Average the five 1-minute averages and determine the spike recovery using Equation 7E-12. Repeat this procedure for the other pre-test spike level. The recovery at each level must be within the limits in Section 13.6 before proceeding with the test.

(2) Conduct the number of runs required for the test. Then repeat the above procedure for the post-test spike evaluation. The last run of the test may serve as the average stack concentration for the post-test spike test calculations. The results of the post-test spikes must meet the limits in Section 13.6.

16.2 Alternative NO₂ to NO Conversion Efficiency Procedures. You may use either of the following procedures to determine converter efficiency in place of the procedure in Section 8.2.4.1.

16.2.1 The procedure for determining conversion efficiency using NO in 40 CFR 86.123-78***.

16.2.2 Tedlar Bag Procedure. Perform the analyzer calibration error test to document the calibration (both NO and NO_x modes, as applicable). Fill a Tedlar bag approximately half full with either ambient air, pure oxygen, or an oxygen standard gas with at least 19.5 percent by volume oxygen content. Fill the remainder of the bag with mid-level NO in nitrogen calibration gas. (Note that the concentration of the NO standard should be sufficiently high that the diluted concentration will be easily and accurately measured on the scale used. The size of the bag should be large enough to accommodate the procedure and time required).

(1) Immediately attach the bag to the inlet of the NO_x analyzer (or external converter if used). In the case of a dilution-system, introduce the gas at a point upstream of the dilution assembly. Measure the NO_x concentration for a period of 30 minutes. If the NO_x concentration drops more than 2 percent absolute from the peak value observed, then the NO₂ converter has failed to meet the criteria of this test. Take corrective action. The highest NO_x value observed is considered to be NO_{xPeak}. The final NO_x value observed is considered to be NO_{xfinal}.

(2) If the NO_x converter has met the criterion of this test, then switch the analyzer to the NO mode (note that this may not be required for analyzers with auto-switching). Document the average NO concentration for a period of 30 seconds to one minute. This average value is NO_{final}. Switch the analyzer back to the NO_x mode and document that the analyzer still meets the criteria of not dropping more than 2 percent from the peak value.

(3) In sequence, inject the zero and the upscale calibration gas that most closely matches the NOX concentration observed during the converter efficiency test. Repeat this procedure in both the NO and NOX modes. If the gases are not within 1 percent of scale of the actual values, reject the converter efficiency test and take corrective action. If the gases are within this criterion, use Equation 7E-9 to determine the converter efficiency. The converter efficiency must meet the specification in Section 13.5.

16.3 Manufacturer's Stability Test. A manufacturer's stability test is required for all analyzers that routinely measure emissions below 20 ppm and is optional but recommended for other analyzers. This test evaluates each analyzer model by subjecting it to the tests listed in Table 7E-5 following the procedures in 40 CFR Part 53.23, 53.55, and 53.56¹ to demonstrate its stability. A copy of this information in summary format must be included in each test report.

17. References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121.

18. Tables, Diagrams, Flowcharts, and Validation Data

*Code of Federal Regulations, Title 40, Part 53.

**Code of Federal Regulations, Title 40, Part 75.

***Code of Federal Regulations, Title 40, Part 86.

Figure 7E-1. Measurement System

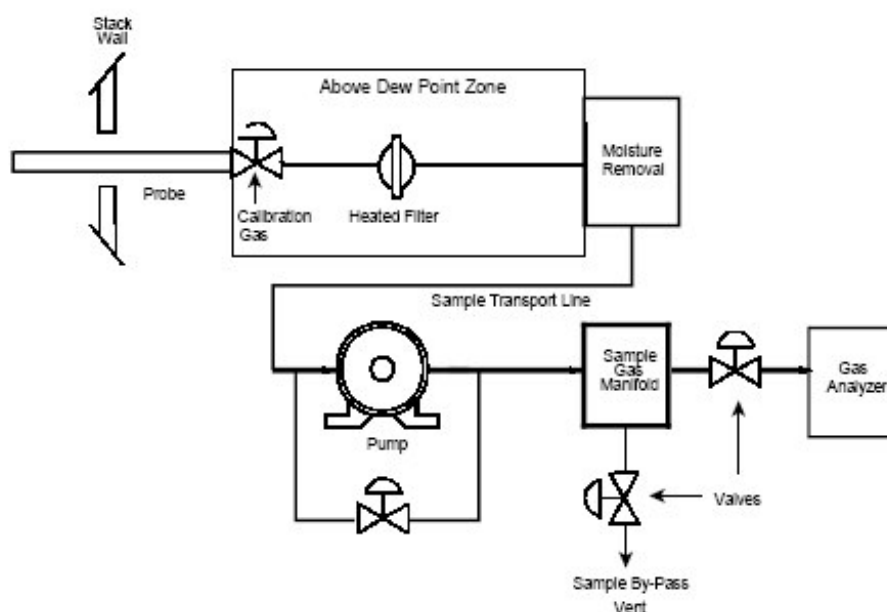


Figure 7E-2 Testing Flow Chart

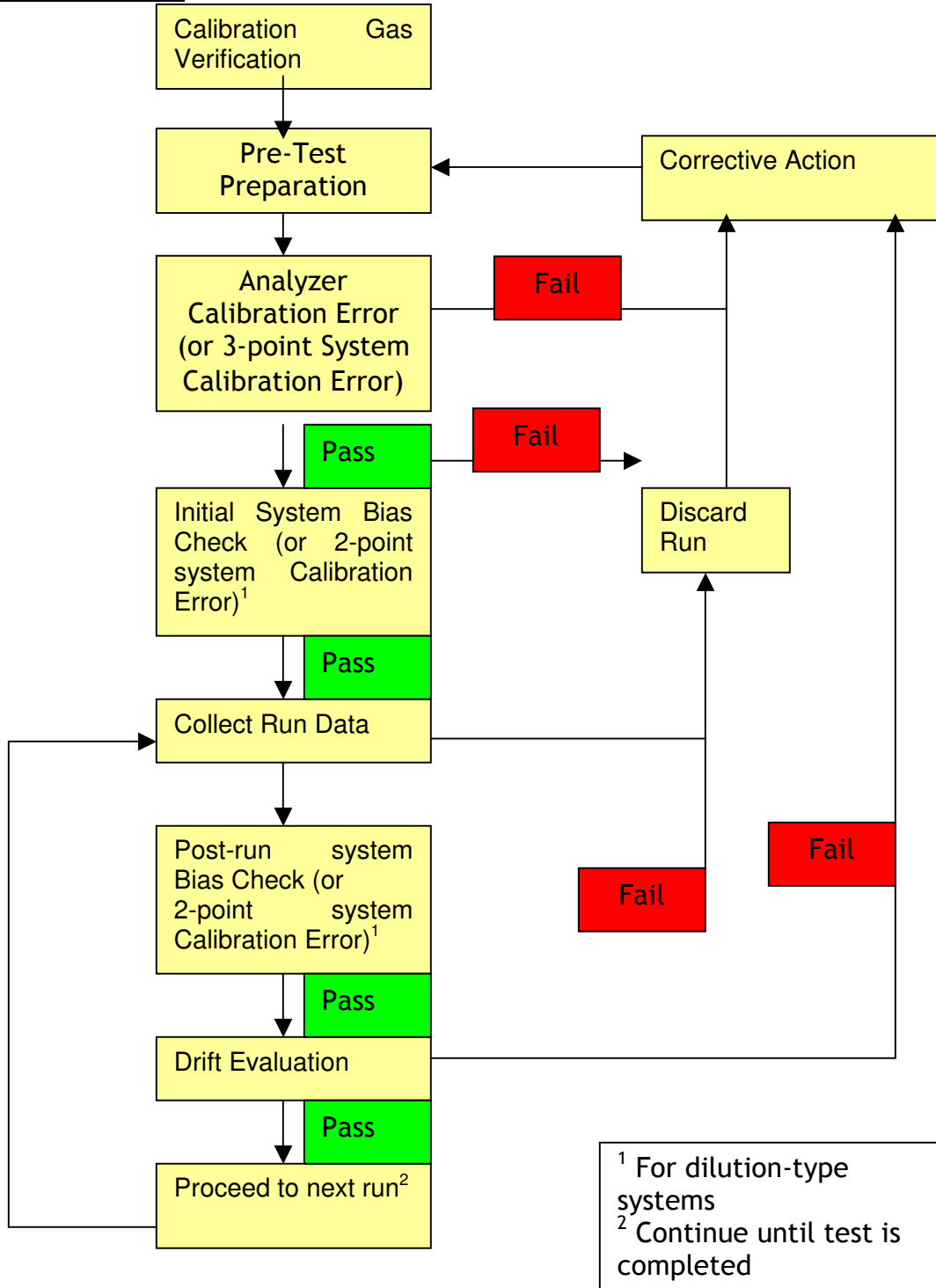


Table 7E-1 Analyzer (or System) Calibration Error Data

<u>Source Identification:</u>		<u>Analyzer¹ or System² calibration error data for</u>		
_____		<u>sampling runs:</u> _____		
<u>Test Personnel:</u> _____		<u>Analyzer Model No:</u> _____		
<u>Date:</u> _____		<u>Serial No:</u> _____		
<u>Time:</u> _____		<u>Calibration Span (CS):</u> _____		
	<u>Manufacturer Certified Cylinder Value (indicate units) A</u>	<u>Analyzer Calibration Response (indicate units) B</u>	<u>Absolute Difference (indicate units) A-B</u>	<u>Calibration Error (percent of calibration span) $\frac{A - B}{CS} \times 100$</u>
<u>Low level (or zero) calibration gas</u>				
<u>Mid-level calibration gas</u>				
<u>High level calibration gas</u>				

¹ Refers to data from the analyzer calibration error test of a non-dilution system.

² Refers to data from a 3-point system calibration error test of a dilution system.

Table 7E-2 - System Bias (or System Calibration Error) and Drift Data

Source Identification: _____		Run Number: _____				
Test Personnel: _____		Calibration Span: _____				
Date: _____		Response Time: _____				
Analyzer Model No: _____		Serial No: _____				
Initial Values			Final Values			
Calibration Gas Level	Certified Calibration gas value (indicate units)	System Response (indicate units)	System Bias ¹ or Calibration Error ² (% of calibration span)	System response (indicate units)	System Bias ¹ or Calibration Error ² (% of calibration span)	Drift (% of calibration span)
Low-level gas						
Upscale (high- or mid-) level gas						

¹ Refers to the pre- and post-run system bias checks of a non-dilution system.

² Refers to the pre- and post-run system calibration error checks of a dilution system.

Table 7E-3 Interference Check Gas Concentrations

<u>Potential Interferent</u>	<u>Sample Conditioning Type²</u>	
	<u>Hot Wet</u>	<u>Dried</u>
<u>CO₂</u>	<u>5 and 15%</u>	<u>5 and 15%</u>
<u>H₂O</u>	<u>25%</u>	<u>1%</u>
<u>NO</u>	<u>15 ppmv</u>	<u>15 ppmv</u>
<u>NO₂</u>	<u>15 ppmv</u>	<u>15 ppmv</u>
<u>N₂O</u>	<u>10 ppmv</u>	<u>10 ppmv</u>
<u>CO</u>	<u>50 ppmv</u>	<u>50 ppmv</u>
<u>NH₃</u>	<u>10 ppmv</u>	<u>10 ppmv</u>
<u>CH₄</u>	<u>50 ppmv</u>	<u>50 ppmv</u>
<u>SO₂</u>	<u>20 ppmv</u>	<u>20 ppmv</u>
<u>H₂</u>	<u>50 ppmv</u>	<u>50 ppmv</u>
<u>HCl</u>	<u>10 ppmv</u>	<u>10 ppmv</u>

- 1) Any of the above specific gases can be eliminated or tested at a lower level if the manufacturer has provided reliable means for limiting or scrubbing that gas to a specified level.
- 2) For dilution extractive systems, use the Hot Wet concentrations divided by the minimum targeted dilution ratio to be used during the test.

Table 7E-4 - Interference Response

Date of Test: _____		
Analyzer Type: _____		
Model No: _____		
Serial No: _____		
Calibration Span: _____		
<u>Test Gas Type</u>	<u>Concentration (ppm)</u>	<u>Analyzer Response</u>
<u>Sum of Responses</u>		
<u>% of Calibration Span</u>		

Table 7E-5. Manufacturer Stability Test

Each Model Must Be Tested Quarterly or Once Per 50 Production Units

<u>Test Description</u>	<u>Acceptance Criteria</u> (Note 1)
<u>Thermal Stability</u>	Temperature range when drift does not exceed 3.0% of analyzer range over a 12-hour run when measured with NO _x present @ .80% of calibration span.
<u>Fault Conditions</u>	Identify conditions which, when they occur, result in performance which is not in compliance with the Manufacturer's Stability Test criteria. These are to be indicated visually or electrically to alert the operator of the problem.
<u>Insensitivity to Supply Voltage Variations</u>	±10.0% (or manufacturers alternative) variation from nominal voltage must produce a drift of ≤ 2.0% of calibration span for either zero or concentration ≥ 80% NO _x present
<u>Analyzer Calibration Error</u>	For a low-, medium-, and high- calibration gas, the difference between the manufacturer certified value and the analyzer response in direct calibration mode, no more than 2.0% of calibration span

Note 1: If the instrument is to be used as a Low Range analyzer, all tests must be performed at a calibration span of 20 ppm or less.

METHOD 10

DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES (INSTRUMENTAL ANALYZER PROCEDURE)

1. ~~Principle and Applicability~~

~~1.1 Principle. An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content using a Luft type nondispersive infrared analyzer (NDIR) or equivalent.~~

~~1.2 Applicability. This method is applicable for the determination of carbon monoxide emissions from stationary sources only when specified by the test procedures contained in this text or otherwise specified by the Director. The test procedure will indicate whether a continuous or an integrated sample is to be used.~~

2. ~~Range and Sensitivity~~

~~2.1 Range. 0 to 1,000 ppm.~~

~~2.2 Sensitivity. Minimum detectable concentration is 20 ppm for a 0 to 1,000 ppm span.~~

3. ~~Interferences~~

~~Any substance having a strong absorption of infrared energy will interfere to some extent. For example, discrimination ratios for water (H₂O) and carbon dioxide (CO₂) are 3.5 percent H₂O per 7 ppm CO and 10 percent CO₂ per 10 ppm CO, respectively, for devices measuring in the 1,500 to 3,000 ppm range. For devices measuring in the 0 to 100 ppm range, interference ratios can be as high as 3.5 percent H₂O per 25 ppm CO and 10 percent CO₂ per 50 ppm CO. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume must be corrected if these traps are used.~~

4. ~~Precision and Accuracy~~

~~4.1 Precision. The precision of most NDIR analyzers is approximately ±2 percent of span.~~

~~4.2 Accuracy. The accuracy of most NDIR analyzers is approximately ±5 percent of span after calibration.~~

5. ~~Apparatus~~

~~5.1 Continuous sample (Figure 10-1).~~

~~5.1.1 Probe. Stainless steel or sheathed Pyrex¹ glass, equipped with a filter to remove particulate matter.~~

~~5.1.2 Air-cooler condenser or equivalent. To remove any excess moisture.~~

~~1Mention of trade names or specific products does not constitute endorsement by the Georgia Department of Natural Resources.~~

~~5.2 Integrated sample (Figure 10-2).~~

~~5.2.1 Probe. Stainless steel or sheathed Pyrex glass, equipped with a filter to remove particulate matter.~~

~~5.2.2 Air-cooler condenser or equivalent. To remove any excess moisture.~~

~~5.2.3 Valve. Needle valve, or equivalent, to adjust flow rate.~~

~~5.2.4 Pump. Leak-free diaphragm type, or equivalent, to transport gas.~~

~~5.2.5 Rate meter. Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per min. (0.035 cfm).~~

~~5.2.6 Flexible bag. Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft³). Leak-test the bag in the laboratory before using by evacuating bag with a pump followed by a dry gas meter. When evacuation is complete, there should be no flow through the meter.~~

~~5.2.7 Pitot tube. Type S, or equivalent, attached to the probe so that the sampling rate can be regulated proportional to the stack gas velocity when velocity is varying with the time or a sample traverse is conducted.~~

~~5.3 Analysis (Figure 10-3).~~

~~5.3.1 Carbon monoxide analyzer. Nondispersive infrared spectrometer, or equivalent. This instrument should be demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method.~~

~~5.3.2 Drying tube. To contain approximately 200 g of silica gel.~~

~~5.3.3 Calibration gas. Refer to Section 6.1.~~

~~5.3.4 Filter. As recommended by NDIR manufacturer.~~

~~5.3.5 CO₂ removal tube. To contain approximately 500 g of ascarite.~~

~~5.3.6 Ice water bath. For ascarite and silica gel tubes.~~

~~5.3.7 Valve. Needle valve, or equivalent, to adjust flow rate.~~

~~5.3.8 Rate meter. Rotameter or equivalent to measure gas flow rate of 0 to 1.0 liter per minute (0.035 cfm) through NDIR.~~

~~5.3.9 Recorder (optional). To provide permanent record of NDIR readings.~~

~~6. Reagents~~

~~6.1 Calibration gases. Known concentration of CO in nitrogen (N₂) for instrument span, prepurified grade of N₂ for zero, and two additional concentrations corresponding approximately to 60 percent and 30 percent span. The span concentration shall not exceed 1.5 times the applicable source performance standard. The calibration gases shall be certified by the manufacturer to be within ±2 percent of the specified concentration.~~

——— 6.2 Silica gel. Indicating type, 6 to 16 mesh, dried at 175°C (347°F) for 2 hours.

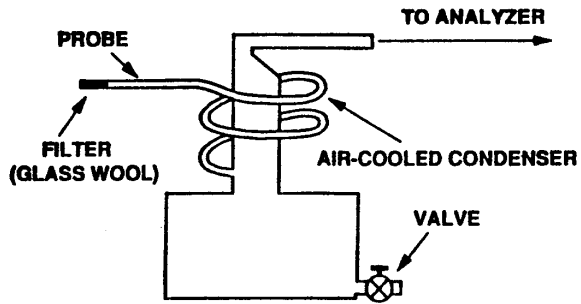


Figure 10-1. Continuous Sampling Train

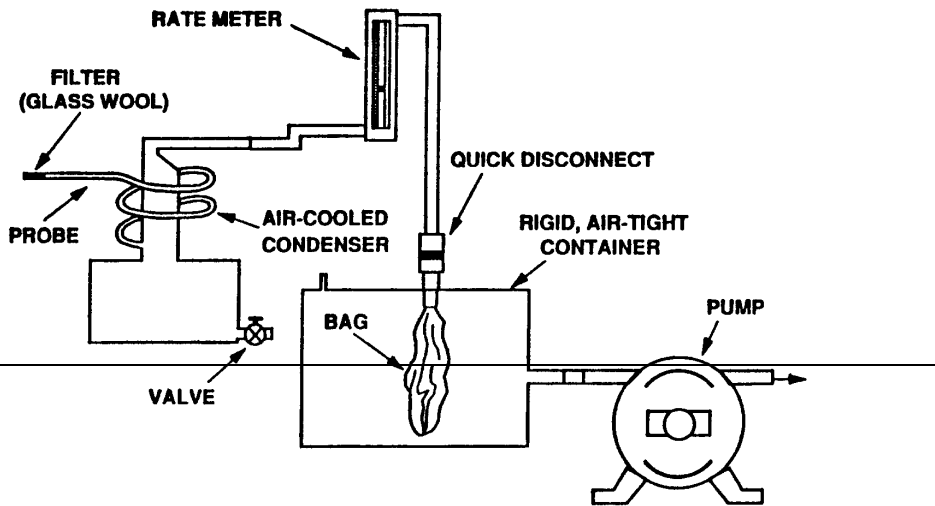


Figure 10-2. Integrated Gas-Sampling Train

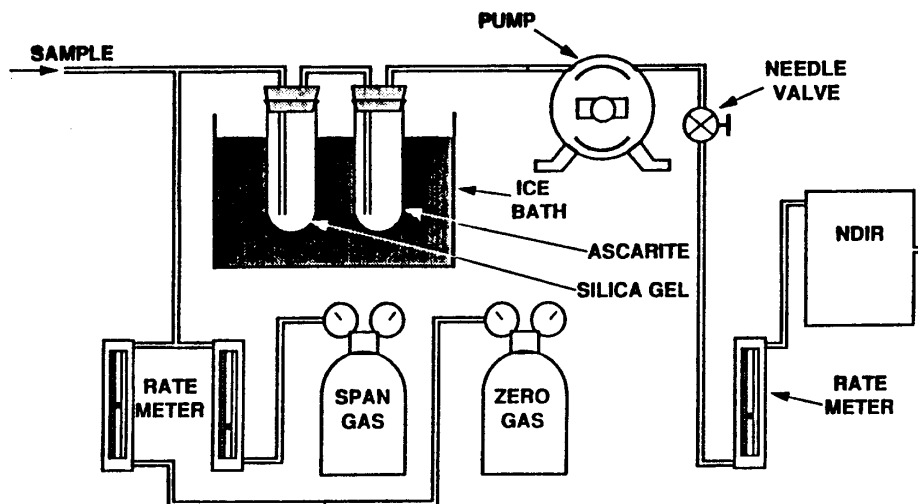


Figure 10-3. Analytical Equipment

~~6.3 Ascarite. Commercially available.~~

~~7. Procedure~~

~~7.1 Sampling.~~

~~7.1.1 Continuous sampling. Set up the equipment as shown in Figure 10-1 making sure all connections are leak free. Place the probe in the stack at a sampling point and purge the sampling line. Connect the analyzer and begin drawing sample into the analyzer. Allow 5 minutes for the system to stabilize, then record the analyzer reading as required by the test procedure. (See Sections 7.2 and 8). CO₂ content of the gas may be determined by using the Method 3 integrated sample procedure, or by weighing the ascarite CO₂ removal tube and computing CO₂ concentration from the gas volume sampled and the weight gain of the tube.~~

~~7.1.2 Integrated sampling. Evacuate the flexible bag. Set up the equipment as shown in Figure 10-2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are leak free. Sample at a rate proportional to the stack velocity. CO₂ content of the gas may be determined by using the Method 3 integrated sample procedures, or by weighing the ascarite CO₂ removal tube and computing CO₂ concentration from the gas volume sampled and the weight gain of the tube.~~

~~7.2 CO Analysis. Assemble the apparatus as shown in Figure 10-3, calibrate the instrument, and perform other required operations as described in Section 8. Purge analyzer with N₂ prior to introduction of each sample. Direct the sample stream through the instrument for the test period, recording the readings. Check the zero and span again after the test to assure that any drift or malfunction is detected. Record the sample data on Table 10-1.~~

~~8. Calibration~~

~~Assemble the apparatus according to Figure 10-3. Generally an instrument requires a warm-up period before stability is obtained. Follow the manufacturer's instructions for specific procedure. Allow a minimum time of 1 hour for warm-up. During this time check the sample conditioning apparatus, i.e., filter, condenser, drying tube, and CO₂ removal tube, to ensure that each component is in good operating condition. Zero and calibrate the instrument according to the manufacturer's procedures using, respectively, nitrogen and the calibration gases.~~

TABLE 10-1. FIELD DATA

Location	Comments:
Test	
Date	
Operator	
Clock Time	Rotameter setting, liters per minute (cubic feet per minute)

~~9. Calculation~~

~~Calculate the concentration of carbon monoxide in the stack using Equation 10-1.~~

$$\text{---} C_{CO_{stack}} = C_{CO_{NDIR}} (1 - F_{CO_2})$$

where:

$C_{CO_{stack}}$ = concentration of CO in stack, ppm by volume (dry basis).

$C_{CO_{DNIR}}$ = concentration of CO measured by NDIR analyzer, ppm by volume (dry basis).

F_{CO_2} = volume fraction of CO₂ in sample, i.e., percent CO₂ from Orsat analysis divided by 100.

10. Alternative Procedure

10.1 Interference Trap. The sample condition system described in Method 10A, Sections 2.1.2 and 4.2 may be used as an alternate to the silica gel and ascarite traps.

11. Bibliography

1. McElroy, Frank, The Intertech NDIR-CO Analyzer, Presented at 11th Methods Conference on Air Pollution, University of California, Berkeley, Calif., April 1, 1970.

2. Jacobs, M. B., et al., Continuous Determination of Carbon Monoxide and Hydrocarbons in Air by a Modified Infrared Analyzer, J. Air Pollution Control Association, 9(2):110-114, August 1959.

3. MSA LIRA Infrared Gas and Liquid Analyzer Instruction Book, Mine Safety Appliances Co., Technical Products Division, Pittsburgh, Pa.

4. Models 215A, 315A, and 415A Infrared Analyzers, Beckman Instruments, Inc., Beckman Instructions 1635-B, Fullerton, Calif., October 1967.

5. Continuous CO Monitoring System, Model A5611, Intertech Corp., Princeton, N.J.

6. UNOR Infrared Gas Analyzers, Bendix Corp., Ronceverte, West Virginia.

ADDENDA

A. Performance Specifications for NDIR Carbon Monoxide Analyzers.

Range (minimum)	0-1000 ppm.
Output (minimum)	0-10mV.
Minimum detectable sensitivity	20 ppm.
Rise time, 90 percent (maximum)	30 seconds.
Fall time, 90 percent (maximum)	30 seconds.
Zero drift (maximum)	10% in 8 hours.
Span drift (maximum)	10% in 8 hours.
Precision (minimum)	±2% of full scale.
Noise (maximum)	±1% of full scale.
Linearity (maximum deviation)	2% of full scale.
Interference rejection ratio	CO ₂ -1000 to 1, H ₂ O-500 to 1.

B. Definitions of Performance Specifications.

~~———— Range -- The minimum and maximum measurement limits.~~

~~———— Output -- Electrical signal which is proportional to the measurement; intended for connection to readout or data processing devices. Usually expressed as millivolts or milliamps full scale at a given impedance.~~

~~———— Full scale -- The maximum measuring limit for a given range.~~

~~———— Minimum detectable sensitivity -- The smallest amount of input concentration that can be detected as the concentration approaches zero.~~

~~———— Accuracy -- The degree of agreement between a measured value and the true value; usually expressed as \pm percent of full scale.~~

~~———— Time to 90 percent response -- The time interval from a step change in the input concentration at the instrument inlet to a reading of 90 percent of the ultimate recorded concentration.~~

~~———— Rise Time (90 percent) -- The interval between initial response time and time to 90 percent response after a step increase in the inlet concentration.~~

~~———— Fall Time (90 percent) -- The interval between initial response time and time to 90 percent response after a step decrease in the inlet concentration.~~

~~———— Zero Drift -- The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is zero; usually expressed as percent full scale.~~

~~———— Span Drift -- The change in instrument output over a stated time period, usually 24 hours of unadjusted continuous operation when the input concentration is a stated upscale value; usually expressed as percent full scale.~~

~~———— Precision -- The degree of agreement between repeated measurements of the same concentration, expressed as the average deviation of the single results from the mean.~~

~~———— Noise -- Spontaneous deviations from a mean output not caused by input concentration changes.~~

Linearity -- The maximum deviation between an actual instrument reading and the reading predicted by a straight line drawn between upper and lower calibration points.

1. Scope and Application

What is Method 10? Method 10 is a procedure for measuring carbon monoxide (CO) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis. This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 4—Determination of Moisture Content in Stack Gases.

(c) Method 7E—Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure).

1.1 Analytes. What does this method determine? This method measures the concentration of carbon monoxide.

<u>Analyte</u>	<u>CAS No.</u>	<u>Sensitivity</u>
<u>CO</u>	<u>630-08-0</u>	<u>Typically <2% of Calibration Span</u>

1.2 Applicability. When is this method required? The use of Method 10 may be required by specific New Source Performance Standards, State Implementation Plans, and permits where CO concentrations in stationary source emissions must be measured, either to determine compliance with an applicable emission standard or to conduct performance testing of a continuous emission monitoring system (CEMS). Other regulations may also require the use of Method 10.

1.3 Data Quality Objectives. Refer to Section 1.3 of Method 7E.

2. Summary of Method

In this method, you continuously or intermittently sample the effluent gas and convey the sample to an analyzer that measures the concentration of CO. You must meet the performance requirements of this method to validate your data.

3. Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4. Interferences

Substances having a strong absorption of infrared energy may interfere to some extent in some analyzers. Instrumental correction may be used to compensate for the interference. You may also use silica gel and ascarite traps to eliminate the interferences. If this option is used, correct the measured gas volume for the carbon dioxide (CO₂) removed in the trap.

5. Safety

Refer to Section 5.0 of Method 7E.

6. Equipment and Supplies

What do I need for the measurement system?

6.1 Continuous Sampling. Figure 7E-1 of Method 7E is a schematic diagram of an acceptable measurement system. The components are the same as those in Sections 6.1 and 6.2 of Method 7E, except that the CO analyzer described in Section 6.2 of this method must be used instead of the analyzer described in Section 6.2 of Method 7E. You must follow the noted specifications in Section 6.1 of Method 7E except that the requirements to use stainless steel, Teflon, or non-reactive glass filters do not apply. Also, a heated sample line is not required to transport dry gases or for systems that measure the CO concentration on a dry basis.

6.2 Integrated Sampling.

6.2.1 Air-Cooled Condenser or Equivalent. To remove any excess moisture.

6.2.2 Valve. Needle valve, or equivalent, to adjust flow rate.

6.2.3 Pump. Leak-free diaphragm type, or equivalent, to transport gas.

6.2.4 Rate Meter. Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per minute (0.035 cfm).

6.2.5 Flexible Bag. Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft³). Leak-test the bag in the laboratory before using by evacuating with a pump followed by a dry gas meter. When the evacuation is complete, there should be no flow through the meter.

6.3 What analyzer must I use? You must use an instrument that continuously measures CO in the gas stream and meets the specifications in Section 13.0. The dual range analyzer provisions in Section 6.2.8.1 of Method 7E apply.

7. Reagents and Standards

7.1 Calibration Gas. What calibration gases do I need? Refer to Section 7.1 of Method 7E for the calibration gas requirements.

7.2 Interference Check. What additional reagents do I need for the interference check? Use the appropriate test gases listed in Table 7E-3 of Method 7E (i.e., potential interferents, as identified by the instrument manufacturer) to conduct the interference check.

8. Sample Collection, Preservation, Storage, and Transport Emission Test Procedure

8.1 Sampling Site and Sampling Points. You must follow Section 8.1 of Method 7E.

8.2 Initial Measurement System Performance Tests. You must follow the procedures in Section 8.2 of Method 7E. If a dilution-type measurement system is used, the special considerations in Section 8.3 of Method 7E also apply.

8.3 Interference Check. You must follow the procedures of Section 8.2.7 of Method 7E.

8.4 Sample Collection.

8.4.1 Continuous Sampling. You must follow the procedures of Section 8.4 of Method 7E.

8.4.2 Integrated Sampling. Evacuate the flexible bag. Set up the equipment as shown in Figure 10-1 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are leak-free. Sample at a rate proportional to the stack velocity. If needed, the CO₂ content of the gas may be determined by using the Method 3 integrated sample procedures, or by weighing an ascarite CO₂ removal tube used and computing CO₂ concentration from the gas volume sampled and the weight gain of the tube. Data may be recorded on a form similar to Table 10-1.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures in Sections 8.5 and 8.6 of Method 7E.

9. Quality Control

Follow the quality control procedures in Section 9.0 of Method 7E.

10. Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11. Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12. Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in Section 12.0 of Method 7E, as applicable, substituting CO for NO_x as applicable.

12.1 Concentration Correction for CO₂ Removal. Correct the CO concentration for CO₂ removal (if applicable) using Eq. 10-1.

$$C_{Avg} = C_{COstack} (1 - F_{CO2})$$

Where:

C_{Avg} = Average gas concentration for the test run, ppm.

C_{COstack} = Average unadjusted stack gas CO concentration indicated by the data recorder for the test run, ppmv.

F_{CO₂} = Volume fraction of CO₂ in the sample, i.e., percent CO₂ from Orsat analysis divided by 100.

13. Method Performance

The specifications for analyzer calibration error, system bias, drift, interference check, and alternative dynamic spike procedure are the same as in Section 13.0 of Method 7E.

14. Pollution Prevention [Reserved]

15. Waste Management [Reserved]

16. Alternative Procedures

The dynamic spike procedure and the manufacturer stability test are the same as in Sections 16.1 and 16.3 of Method 7E.

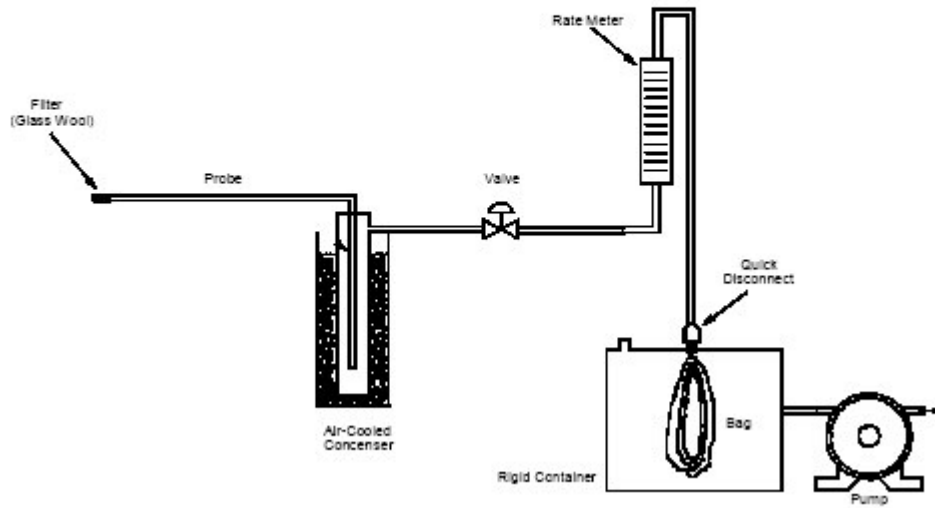
17. References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121.

18. Tables, Diagrams, Flowcharts, and Validation Data

Figure 10-1. Integrated Gas Sampling Train.

Figure 10-1. Integrated Gas Sampling Train.



METHOD 20
DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT
EMISSIONS FROM STATIONARY GAS TURBINES

1. Principle and Applicability

~~1.1 Applicability. This method is applicable for the determination of nitrogen oxides (NO_x), sulfur dioxide (SO₂), and a diluent gas, either oxygen (O₂) or carbon dioxide (CO₂), emissions from stationary gas turbines. For the NO_x and diluent concentration determinations, this method includes: (1) Measurement system design criteria; (2) Analyzer performance specifications and performance test procedures; and (3) Procedures for emission testing.~~

~~1.2 Principle. A gas sample is continuously extracted from the exhaust stream of a stationary gas turbine; a portion of the sample stream is conveyed to instrumental analyzers for determination of NO_x and diluent content. During each NO_x and SO₂ determination, a separate measurement of SO₂ emissions is made, using Method 6, or its equivalent. The diluent determination is used to adjust the NO_x and SO₂ concentrations to a reference condition.~~

2. Definitions

~~2.1 Measurement System. The total equipment required for the determination of a gas concentration or a gas emission rate. The system consists of the following major subsystems:~~

~~2.1.1 Sample Interface. That portion of a system that is used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzers from the effects of the stack effluent.~~

~~2.1.2 NO_x Analyzer. That portion of the system that senses NO_x and generates an output proportional to the gas concentration.~~

~~2.1.3 O₂ Analyzer. That portion of the system that senses O₂ and generates an output proportional to the gas concentration.~~

~~2.1.4 CO₂ Analyzer. That portion of the system that senses CO₂ and generates an output proportional to the gas concentration.~~

~~2.1.5 Data Recorder. That portion of the measurement system that provides a permanent record of the analyzer(s) output. The data recorder may include automatic data reduction capabilities.~~

~~2.2 Span Value. The upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations.~~

~~2.3 Calibration Gas. A known concentration of a gas in an appropriate diluent gas.~~

~~2.4 Calibration Error. The difference between the gas concentration indicated by the measurement system and the known concentration of the calibration gas.~~

~~2.5 Zero Drift. The difference in the measurement system output readings before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place and the input concentration at the time of the measurements was zero.~~

~~2.6 Calibration Drift. The difference in the measurement system output readings before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place and the input at the time of the measurements was a high-level value.~~

~~2.7 Response Time. The amount of time required for the measurement system to display on the data output 95 percent of a step change in pollutant concentration.~~

~~2.8 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.~~

~~3. Measurement System Performance Specifications~~

~~3.1 NO₂ to NO Converter. Greater than 90 percent conversion efficiency of NO₂ to NO.~~

~~3.2 Interference Response. Less than ±2 percent of the span value.~~

~~3.3 Response Time. No greater than 30 seconds.~~

~~3.4 Zero Drift. Less than ±2 percent of the span value over the period of each test run.~~

~~3.5 Calibration Drift. Less than ±2 percent of the span value over the period of each test run.~~

~~4. Apparatus and Reagents~~

~~4.1 Measurement System. Use any measurement system for NO₂ and diluent that is expected to meet the specifications in this method. A schematic of an acceptable measurement system is shown in Figure 20-1. The essential components of the measurement system are described below:~~

~~4.1.1 Sample Probe. Heated stainless steel, or equivalent, open-ended, straight tube of sufficient length to traverse the sample points.~~

~~4.1.2 Sample Line. Heated (>95°C) stainless steel or Teflon tubing to transport the sample gas to the sample conditioners and analyzers.~~

~~4.1.3 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the sample conditioners and to the analyzers. The calibration valve assembly shall be capable of blocking the sample gas flow and of introducing calibration gases to the measurement system when in the calibration mode.~~

~~4.1.4 NO₂ to NO Converter. That portion of the system that converts the nitrogen dioxide (NO₂) in the sample gas to nitrogen oxide (NO). Some analyzers are designed to measure NO_x as NO₂ on a wet basis and can be used without an NO₂ to NO converter or a moisture removal trap provided the sample line to the analyzer is heated (>95°C) to the inlet of the analyzer. In addition, an NO₂ to NO converter is not necessary if the NO₂ portion of the exhaust gas is less than 5 percent of the total NO_x concentration. As a guideline, an NO₂ to NO converter is not necessary if the gas turbine is operated at 90 percent or more of peak load capacity. A converter is necessary under lower load conditions.~~

~~4.1.5 Moisture Removal Trap. A refrigerator type condenser or other type device designed to continuously remove condensate from the sample gas while maintaining minimal contact between any condensate and the sample gas. The moisture removal trap is not necessary for analyzers that can measure NO_x concentrations on a wet basis; for these analyzers, (a) heat the sample line up to the inlet of the analyzers, (b) determine the moisture content using methods subject to the approval of the Director, and (c) correct the NO_x and diluent concentrations to a dry basis.~~

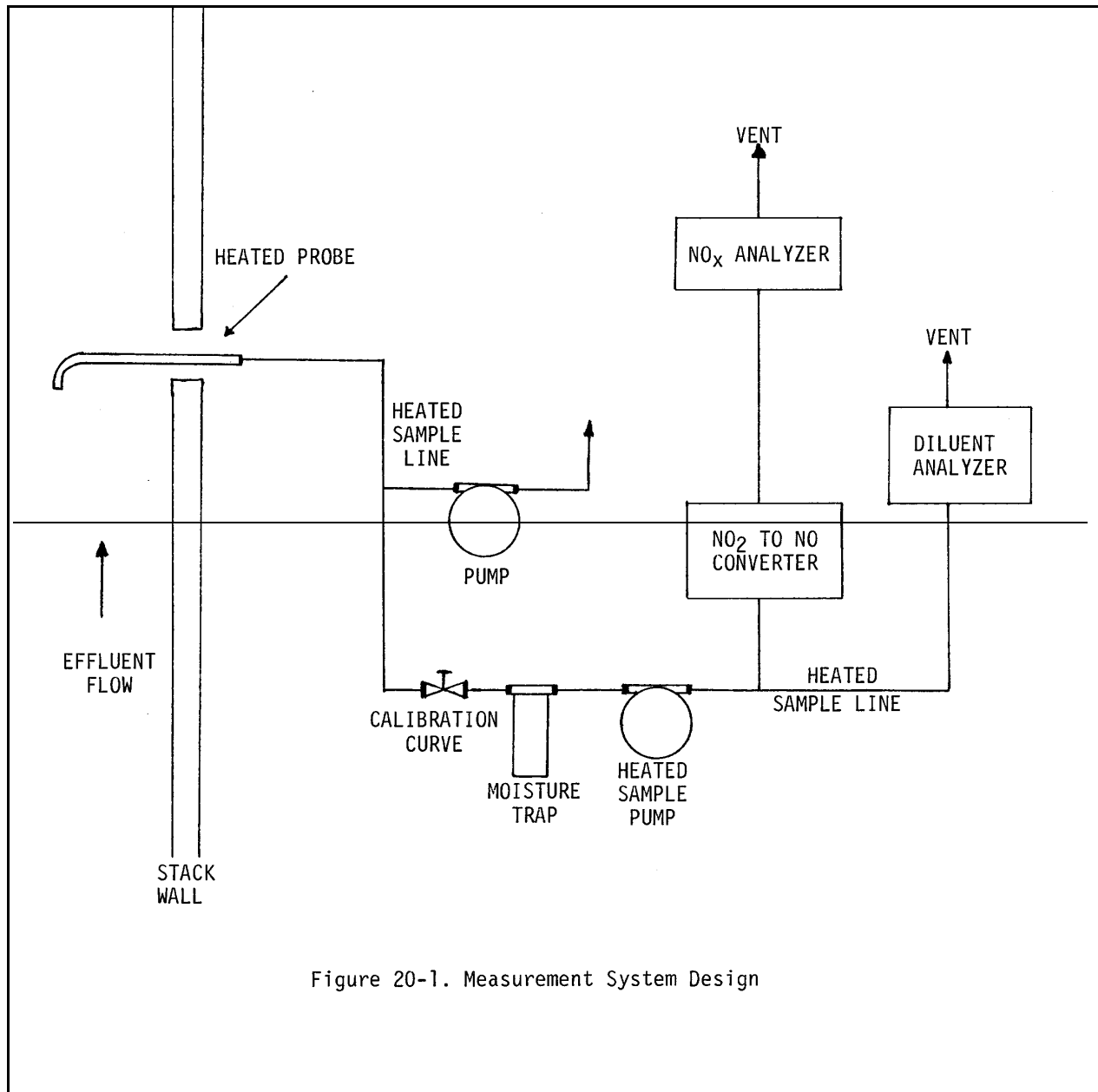


Figure 20-1. Measurement System Design

4.1.6 Particulate Filter. An in-stack or an out-of-stack glass fiber filter, of the type specified in EPA Method 5; however, an out-of-stack filter is recommended when the stack gas temperature exceeds 250 to 300°C.

4.1.7 Sample Pump. A nonreactive leak free sample pump to pull the sample gas through the system at a flow rate sufficient to minimize transport delay. The pump shall be made from stainless steel or coated with Teflon or equivalent.

4.1.8 Sample Gas Manifold. A sample gas manifold to divert portions of the sample gas stream to the analyzers. The manifold may be constructed of glass, Teflon, stainless steel, or equivalent.

4.1.9 Diluent Gas Analyzer. An analyzer to determine the percent O₂ or CO₂ concentration of the sample gas.

~~4.1.10 Nitrogen Oxides Analyzer. An analyzer to determine the ppm NO_x concentration in the sample gas stream.~~

~~4.1.11 Data Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data.~~

~~4.2 Sulfur Dioxide Analysis. EPA Method 6 apparatus and reagents.~~

~~4.3 NO_x Calibration Gases. The calibration gases for the NO_x analyzer shall be NO in N₂. Use four calibration gas mixtures as specified below:~~

~~4.3.1 High-level Gas. A gas concentration that is equivalent to 80 to 90 percent of the span value.~~

~~4.3.2 Mid-level Gas. A gas concentration that is equivalent to 45 to 55 percent of the span value.~~

~~4.3.3 Low-level Gas. A gas concentration that is equivalent to 20 to 30 percent of the span value.~~

~~4.3.4 Zero Gas. A gas concentration of less than 0.25 percent of the span value. Ambient air may be used for the NO_x zero gas.~~

~~4.4 Diluent Calibration Gases.~~

~~4.4.1 For O₂ calibration gases, use purified air at 20.9 percent O₂ as the high-level O₂ gas. Use a gas concentration between 11 and 15 percent O₂ in nitrogen for the mid-level gas, and use purified nitrogen for the zero gas.~~

~~4.4.2 For CO₂ calibration gases, use a gas concentration between 8 and 12 percent CO₂ in air for the high-level calibration gas. Use a gas concentration between 2 and 5 percent CO₂ in air for the mid-level calibration gas, and use purified air (<100 ppm CO₂) as the zero-level calibration gas.~~

~~5. Measurement System Performance Test Procedures~~

~~Perform the following procedures prior to measurement of emissions (Section 6) and only once for each test program, i.e., the series of all test runs for a given gas turbine engine.~~

~~5.1 Calibration Gas Checks. There are two alternatives for checking the concentrations of the calibration gases. (a) The first is to use calibration gases that are documented traceable to National Bureau of Standards Reference Materials. Use **Traceability Protocol for Establishing True Concentrations of Gases Used for Calibrations and Audits of Continuous Source Emission Monitors** (Protocol Number 1) that is available from the Environmental Monitoring Systems Laboratory, Quality Assurance Branch, Mail Drop 77, Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Obtain a certification from the gas manufacturer that the protocol was followed. These calibration gases are not to be analyzed with the Reference Methods. (b) The second alternative is to use calibration gases not prepared according to the protocol. If this alternative is chosen, within 1 month prior to the emission test, analyze each of the calibration gas mixtures in triplicate using Method 7 or the procedure outlined in Citation 1 for NO_x and use Method 3 for O₂ or CO₂. Record the results on a data sheet (example is shown in Figure 20-2). For the low-level, mid-level, or high-level gas mixtures, each of the individual NO_x analytical results must be within 10 percent (or 10 ppm, whichever is greater) of the triplicate set average (O₂ or CO₂ test results must be within 0.5 percent O₂ or CO₂); otherwise, discard the entire set and repeat the triplicate analyses. If the average of the triplicate reference method test results is within 5 percent for NO_x gas or 0.5 percent O₂ or CO₂ for the O₂ or CO₂ gas of the calibration gas manufacturer's tag value, use the tag value; otherwise, conduct at least three additional reference method test analyses until the results of six individual NO_x runs (the three original plus three~~

additional) agree within 10 percent (or 10 ppm, whichever is greater) of the average (O_2 or CO_2 test results must be within 0.5 percent O_2 or CO_2). Then use this average for the cylinder value.

~~5.2 Measurement System Preparation. Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing and operating the NO_2 to NO converter, the NO_x analyzer, the diluent analyzer, and other components.~~

~~5.3 Calibration Check. Conduct the calibration checks for both the NO_x and the diluent analyzers as follows:~~

~~5.3.1 After the measurement system has been prepared for use (Section 5.2), introduce zero gases and the mid-level calibration gases; set the analyzer output responses to the appropriate levels. Then introduce each of the remainder of the calibration gases described in Sections 4.3 or 4.4, one at a time, to the measurement system. Record the responses on a form similar to Figure 20-3.~~

~~5.3.2 If the linear curve determined from the zero and mid-level calibration gas responses does not predict the actual response of the low-level (not applicable for the diluent analyzer) and high-level gases within 2 percent of the span value, the calibration shall be considered invalid. Take corrective measures on the measurement system before proceeding with the test.~~

~~5.4 Interference Response. Introduce the gaseous components listed in Table 20-1 into the measurement system separately, or as gas mixtures. Determine the total interference output response of the system to these components in concentration units; record the values on a form similar to Figure 20-4. If the sum of the interference responses of the test gases for either the NO_x or diluent analyzers is greater than 2 percent of the applicable span value, take corrective measure on the measurement system.~~

~~Conduct an interference response test of each analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response, e.g., changes in the type of gas detector.~~

~~In lieu of conducting the interference response test, instrument vendor data, which demonstrate that for the test gases of Table 20-1 the interference performance specification is not exceeded, are acceptable.~~

Date: _____ (Must be within 1 month prior to the test period)

Reference method used: _____

Sample Run	Gas Concentration, ppm		
	Low Level ^a	Mid Level ^b	High Level ^c
1			
2			
3			
Average			
Maximum % deviation ^d			

^aAverage must be 20 to 30% of span value.

^bAverage must be 45 to 55% of span value.

^cAverage must be 80 to 90% of span value.

^dMust be $\leq \pm 10\%$ of applicable average or 10 ppm, whichever is greater.

Figure 20-2. Analysis of Calibration Gases

	Cylinder Value ppm or %	Initial Analyzer Response, ppm or %	Final Analyzer Response, ppm or %	Difference: Initial-Final ppm or %
Zero Gas				
Low-Level Gas				
Mid-Level Gas				
High-Level Gas				

$$\text{Percent Drift} = \frac{\text{Absolute Difference}}{\text{Span Value}} \times 100$$

Figure 20-3. Zero and Calibration Data

TABLE 20-1. Interference Test Gas Concentration

CO	500±50 ppm
SO ₂	200±20 ppm
CO ₂	10±1 percent
O ₂	20.9±1 percent

5.5 Response Time. To determine response time, first introduce zero gas into the system at the calibration valve until all readings are stable; then, switch to monitor the stack effluent until a stable reading can be obtained. Record the upscale response time. Next, introduce high-level calibration gas into the system. Once the system has stabilized at the high-level concentration, switch to monitor the stack effluent and wait until a stable value is reached. Record the downscale response time. Repeat the procedure three times. A stable value is equivalent to a change of less than 1 percent of span value for 30 seconds or less than 5 percent of the measured average concentration for 2 minutes. Record the response time data on a form similar to Figure 20-5, the readings of the upscale or downscale response time, and report the greater time as the "response time" for the analyzer. Conduct a response time test prior to the initial field use of the measurement system, and repeat if changes are made in the measurement system.

5.6 NO₂ to NO Conversion Efficiency.

5.6.1 Add gas from the mid-level NO in N₂ calibration gas cylinder to a clean, evacuated, leak-tight Tedlar bag. Dilute this gas approximately 1:1 with 20.9 percent O₂, purified air. Immediately attach the bag outlet to the calibration valve assembly and begin operation of the sampling system. Operate the sampling system, recording the NO_x response, for at least 30 minutes. If the NO₂ to NO conversion is 100 percent, the instrument response will be stable at the highest peak value observed. If the response at the end of 30 minutes decreases more than 2.0 percent of the highest peak value, the system is not acceptable and corrections must be made before repeating the check.

5.6.2 Alternatively, the NO₂ to NO converter check described in Title 40, Part 86: Certification and Test Procedures for Heavy-Duty Engines for 1979 and Later Model Years may be used. Other alternative procedures may be used with approval of the Director.

6. Emission Measurement Test Procedure

6.1 Preliminaries.

6.1.1 Selection of a Sampling Site. Select a sampling site as close as practical to the exhaust of the turbine. Turbine geometry, stack configuration, internal baffling, and point of introduction of dilution air will vary for different turbine designs. Thus, each of these factors must be given special consideration in order to obtain a representative sample. Whenever possible, the sampling site shall be located upstream of the point of introduction of dilution air into the duct. Sample ports may be located before or after the upturn elbow, in order to accommodate the configuration of the turning vanes and baffles and to permit a complete, unobstructed traverse of the stack. The sample ports shall not be located within 5 feet or 2 diameters (whichever is less) of the gas discharge to atmosphere. For supplementary-fired, combined-cycle plants, the sampling site shall be located between the gas turbine and the boiler. The diameter of the sample ports shall be sufficient to allow entry of the sample probe.

6.1.2 A preliminary O₂ or CO₂ traverse is made for the purpose of selecting sampling points of low O₂ or high CO₂ concentrations, as appropriate for the measurement system. Conduct this test at the turbine operating condition that is the lowest percentage of peak load operation included in the test program. Follow the procedure below, or use an alternative procedure subject to the approval of the Director.

Date of test: _____

Analyzer type: _____ Serial No.: _____

Test Gas Type	Concentration, ppm	Analyzer Output Response	% of Span
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

$$\% \text{ of Span} = \frac{\text{Analyzer Output Response}}{\text{Instrument Span}} \times 100$$

Figure 20-4. Interference Response

Date of test: _____

Analyzer type: _____ S/N: _____

Span gas concentration: _____ ppm

Analyzer span setting: _____ ppm

Upscale

1 _____ seconds

2 _____ seconds

3 _____ seconds

Average upscale response _____ seconds

Downscale

1 _____ seconds

2 _____ seconds

3 _____ seconds

Average downscale response _____ seconds

System response time = slower average time = _____ seconds

Figure 20-5. Response Time

~~6.1.2.1 Minimum Number of Points. Select a minimum number of points as follows: (1) Eight, for stacks having cross-sectional areas less than 1.5 m² (16.1 ft²); (2) eight plus one additional sample point for each 0.2 m² (2.2 ft²) of areas, for stacks of 1.5 m² to 10.1 m² (16.1-107.6 ft²) in cross-sectional area; and (3) 49 sample points (48 for circular stacks) for stacks greater than 10.1 m² (107.6 ft²) in cross-sectional area. Note that for circular ducts, the number of sample points must be a multiple of 4, and for rectangular ducts, the number of points must be one of those listed in Table 20-2; therefore, round off the number of points (upward), when appropriate.~~

~~6.1.2.2 Cross-sectional Layout and Location of Traverse Points. After the number of traverse points for the preliminary diluent sampling has been determined, use Method 1 to locate the traverse points.~~

~~6.1.2.3 Preliminary Diluent Measurement. While the gas turbine is operating at the lowest percent of peak load, conduct a preliminary diluent measurement as follows: Position the probe at the first traverse point and begin sampling. The minimum sampling time at each point shall be 1 minute plus the average system response time. Determine the average steady-state concentration of diluent at each point and record the data on Figure 20-6.~~

~~6.1.2.4 Selection of Emission Test Sampling Points. Select the eight sampling points at which the lowest O₂ concentrations or highest CO₂ concentrations were obtained. Sample at each of these selected points during each run at the different turbine load conditions. More than eight points may be used, if desired, providing that the points selected as described above are included.~~

TABLE 20-2. Cross-Sectional Layout for Rectangular Stacks

<u>No. of Traverse Points</u>	<u>Matrix Layout</u>
9	3 x 3
12	4 x 3
16	4 x 4
20	5 x 4
25	5 x 5
30	6 x 5
36	6 x 6
42	7 X 6
49	7 X 7

~~6.2 NO_x and Diluent Measurement. This test is to be conducted at each of the specified load conditions. Three test runs at each load condition constitute a complete test.~~

~~6.2.1 At the beginning of each NO_x test run and, as applicable, during the run, record turbine data as indicated in Figure 20-7. Also, record the location and number of the traverse points on a diagram.~~

~~6.2.2 Position the probe at the first point determined in the preceding section and begin sampling. The minimum sampling time at each point shall be at least 1 minute plus the average system response time. Determine the average steady-state concentration of diluent and NO_x at each point and record the data on Figure 20-8.~~

~~6.2.3 After sampling the last point, conclude the test run by recording the final turbine operating parameters and by determining the zero and calibration drift, as follows:~~

~~Immediately following the test run at each load condition, or if adjustments are necessary for the measurement system during the tests, reintroduce the zero and mid-level calibration gases as described~~

Location: _____	Date: _____
Plant: _____	
City, State: _____	
Turbine identification:	
Manufacturer: _____	
Model, serial number: _____	
Sample Point	Diluent concentration, ppm

Figure 20-6. Preliminary Oxygen Traverse

TURBINE OPERATION RECORD	
Test operator: _____	Date: _____
Turbine identification:	
Type _____	Ultimate fuel _____
Serial No. _____	Analysis C _____
	H _____
Location: _____	O _____
Plant: _____	N _____
City: _____	S _____
	Ash _____
	H ₂ O _____
Ambient temperature: _____	Trace Metals _____
Ambient humidity: _____	Na _____
Test time start: _____	Va _____
Test time finish: _____	K _____
Fuel flow rate ^a : _____	etc ^b _____
Water or steam: _____	Operating load: _____
Flow rate ^a _____	
Ambient pressure: _____	
^a Describe measurement method, i.e., continuous flow meter, start finish volumes, etc. ^b i.e., additional elements added for smoke suppression	

Figure 20-7. Stationary Gas Turbine Data

Turbine identification: Manufacturer: _____ Model, Serial No.: _____ Location: Plant: _____ City, State: _____ Ambient temperature: _____ Ambient pressure: _____ Date: _____ Test time/start: _____ Test time/finish: _____	Test operator name: _____ O ₂ /CO ₂ instrument type: _____ Serial No.: _____ NO _x instrument type: _____ Serial No.: _____ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Sample Point</th> <th style="width: 15%;">Time, min.</th> <th style="width: 20%;">O₂/CO₂^a %</th> <th style="width: 50%;">NO_x^a ppm</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table> <p>^aAverage steady-state value from recorder or instrument readout.</p>	Sample Point	Time, min.	O ₂ /CO ₂ ^a %	NO _x ^a ppm																				
Sample Point	Time, min.	O ₂ /CO ₂ ^a %	NO _x ^a ppm																						

Figure 20-8. Stationary Gas Turbine Sample Point Record

in Sections 4.3, and 4.4, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until after the drift checks are made). Record the analyzers' responses on a form similar to Figure 20-3. If the drift values exceed the specified limits, the test run preceding the check is considered invalid and will be repeated following corrections to the measurement system. Alternatively, recalibrate the measurement system and recalculate the measurement data. Report the test results based on both the initial calibration and the recalibration data.

6.3 SO₂ Measurement. This test is conducted only at the 100 percent peak load condition. Determine SO₂ using Method 6, or equivalent, during the test. Select a minimum of six total points from those required for the NO_x measurements; use two points for each sample run. The sample time at each point shall be at least 10 minutes. Average the O₂ readings taken during the NO_x test runs at sample points corresponding to the SO₂ traverse points (see Section 6.2.2) and use this average O₂ concentration to correct the integrated SO₂ concentration obtained by Method 6 to 15 percent O₂ (see Equation 20-1).

If the applicable regulation allows fuel sampling and analysis for fuel sulfur content to demonstrate compliance with sulfur emission unit, emission sampling with Method 6 is not required, provided the fuel sulfur content meets the limits of the regulation.

7. Emission Calculations

7.1 Moisture Correction. Measurement data used in most of these calculations must be on a dry basis. If measurements must be corrected to dry conditions, use the following equation:

$$C_d = \frac{C_w}{1 - B_{ws}}$$

(Equation 20-1)

where:

C_d = Pollutant or diluent concentration adjusted to dry conditions, ppm or percent.

C_w = Pollutant or diluent concentration measured under moist sample conditions, ppm or percent.

B_{ws} = Moisture content of sample gas as measured with Method 4, reference method, or other approved method, percent/100.

7.2 CO₂ Correction Factor. If pollutant concentrations are to be corrected to 15 percent O₂ and CO₂ concentration is measured in lieu of O₂ concentration measurement, a CO₂ correction factor is needed. Calculate the CO₂ correction factor as follows:

7.2.1 Calculate the fuel-specific F_o value for the fuel burned during the test using values obtained from Method 19, Section 5.2, and the following equation:

$$F_o = \frac{0.209 F_d}{F_c}$$

(Equation 20-2)

where:

F_o = Fuel factor based on the ratio of oxygen volume to the ultimate CO₂ volume produced by the fuel at zero percent excess air, dimensionless.

0.209 = Fraction of air that is oxygen, percent/100.

F_d — ~~Ratio of the volume of dry effluent gas to the gross calorific value of the fuel from Method 19, dsm^3/J ($\text{dscf}/10^6 \text{ Btu}$).~~

F_o — ~~Ratio of the volume of carbon dioxide produced to the gross calorific value of the fuel from Method 19, dsm^3/J ($\text{dscf}/10^6 \text{ Btu}$).~~

~~7.2.2 Calculate the CO_2 correction factor for correcting measurement data to 15 percent oxygen, as follows:~~

$$X_{\text{CO}_2} = \frac{5.9}{F_o}$$

(Equation 20-3)

where:

X_{CO_2} — ~~CO_2 correction factor, percent.~~

5.9 — ~~20.9 percent O_2 - 15 percent O_2 , the defined O_2 correction value, percent.~~

~~7.3 Correction of Pollutant Concentrations to 15 percent O_2 . Calculate the NO_x and SO_2 gas concentrations adjusted to 15 percent O_2 using Equation 20-4 or 20-5, as appropriate. The correction to 15 percent O_2 is very sensitive to the accuracy of the O_2 or CO_2 concentration measurement. At the level of the analyzer drift specified in Section 3, the O_2 or CO_2 correction can exceed 5 percent at the concentration levels expected in gas turbine exhaust gases. Therefore, O_2 or CO_2 analyzer stability and careful calibration are necessary.~~

~~7.3.1 Correction of Pollutant Concentration Using O_2 Concentration. Calculate the O_2 corrected pollutant concentration, as follows:~~

$$C_{adj} = C_d \frac{5.9}{20.9 - \% \text{O}_2}$$

(Equation 20-4)

where:

C_{adj} — ~~Pollutant concentration corrected to 15 percent O_2 , ppm.~~

C_d — ~~Pollutant concentration measured, dry basis, ppm.~~

$\% \text{O}_2$ — ~~Measured O_2 concentration dry basis, percent.~~

~~7.3.2 Correction of Pollutant Concentration Using CO_2 Concentration. Calculate the CO_2 corrected pollutant concentration, as follows:~~

$$C_{adj} = C_d \frac{X_{\text{CO}_2}}{\% \text{CO}_2}$$

(Equation 20-5)

where:

$\%CO_2$ = Measured CO_2 concentration measured, dry basis, percent.

7.4 Average Adjusted NO_x Concentration. Calculate the average adjusted NO_x concentration by summing the adjusted values for each sample point and dividing by the number of points for each run.

7.5 NO_x and SO_2 Emission Rate Calculations. The emission rates for NO_x and SO_2 in units of pollutant mass per quantity of heat input can be calculated using the pollutant and diluent concentrations and fuel-specific F factors based on the fuel combustion characteristics. The measured concentrations of pollutant in units of parts per million by volume (ppm) must be converted to mass per unit volume concentration units for these calculations. Use the following table for such conversions:

CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply By
g/sm^3	ng/sm^3	10^9
mg/sm^3	ng/sm^3	10^6
lb/scf	ng/sm^3	1.602×10^{13}
ppm (SO_2)	ng/sm^3	2.660×10^6
ppm (NO_x)	ng/sm^3	1.912×10^6
ppm (SO_2)	lb/scf	1.660×10^{-7}
ppm (NO_x)	lb/scf	1.194×10^{-7}

7.5.1 Calculation of Emission Rate Using Oxygen Correction. Both the O_2 concentration and the pollutant concentration must be on a dry basis. Calculate the pollutant emission rate, as follows:

$$E = C_d F_d \frac{20.9}{20.9 - \% O_2}$$

(Equation 20-6)

where:

E = Mass emission rate of pollutant, ng/J (lb/10⁶ Btu).

7.5.2 Calculation of Emission Rate Using Carbon Dioxide Correction. The CO_2 concentration and the pollutant concentration may be on either a dry basis or a wet basis, but both concentrations must be on the same basis for the calculations. Calculate the pollutant emission rate using Equation 20-7 or 20-8:

$$E = C_d F_c \frac{100}{\% CO_2}$$

(Equation 20-7)

$$E = C_w F_c \frac{100}{\% CO_{2w}}$$

(Equation 20-8)

where:

C_w = Pollutant concentration measured on a moist sample basis, ng/cm³ (lb/scf).

$\%CO_{2w}$ = Measured CO₂ concentration measured on a moist sample basis, percent.

8. Bibliography

1. Curtis, F. A Method for Analyzing NO_x Cylinder Gases-Specific Ion Electrode Procedure, Monograph available from Emission Measurement Laboratory, ESED, Research Triangle Park, N.C. 27711. October 1978.

2. Sigsby, John E., F. M. Black, T. A. Bellar, and D. L. Klosterman. Chemiluminescent Method for Analysis of Nitrogen Compounds in Mobile Source Emissions (NO, NO₂, and NH₃). "Environmental Science and Technology," 7:51-54. January 1973.

3. Shigehara, R. T., R. M. Neulicht, and W. S. Smith. Validating Orsat Analysis Data from Fossil Fuel-Fired Units. Emission Measurement Branch, Emission Standards and Engineering Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. June 1975.

1. Scope and Application

What is Method 20? Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in Section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO _x) as nitrogen dioxide Nitric oxide (NO) Nitrogen dioxide (NO ₂)	10102-43-9 10102-44-0	Typically <2% of Calibration Span
Diluent oxygen (O ₂) or carbon dioxide (CO ₂)		Typically <2% of Calibration Span
Sulfur dioxide (SO ₂)	7446-09-5	Typically <2% of Calibration Span

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and

permits where measuring SO₂, NO_x, CO₂, and/or O₂ concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.2 Data Quality Objectives. How good must my collected data be? Refer to Section 1.3 of Method 7E.

2. Summary of Method

In this method, NO_x, O₂ (or CO₂), and SO₂ are measured using the following methods found in appendix A to this text:

- (a) Method 1—Sample and Velocity Traverses for Stationary Sources.
- (b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).
- (c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).
- (d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).
- (e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3. Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4. Interferences

Refer to Section 4.0 of Methods 3A, 6C, and 7E as applicable.

5. Safety

Refer to Section 5.0 of Method 7E.

6. Equipment and Supplies

The measurement system design is shown in Figure 7E-1 of Method 7E. Refer to the appropriate methods listed in Section 2.0 for equipment and supplies.

7. Reagents and Standards

Refer to the appropriate methods listed in Section 2.0 for reagents and standards.

8. Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of Section 8.1 of Method 7E. For the stratification test in Section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in Section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in Section 8.3 of Method 3A or 6C, or Section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of Section 8.4 of the appropriate methods listed in Section 2.0.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of Sections 8.5 and 8.6 of the appropriate methods listed in Section 2.0.

9. Quality Control

Follow quality control procedures in Section 9.0 of Method 7E.

10. Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11. Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12. Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in Section 12.0 of the appropriate method listed in Section 2.0. Follow the procedures in Section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13. Method Performance

The specifications for the applicable performance checks are the same as in Section 13.0 of Method 7E.

14. Pollution Prevention [Reserved]

15. Waste Management [Reserved]

16. Alternative Procedures

Refer to Section 16.0 of the appropriate method listed in Section 2.0 for alternative procedures.

17. References

Refer to Section 17.0 of the appropriate method listed in Section 2.0 for references.

18. Tables, Diagrams, Flowcharts, and Validation Data

Refer to Section 18.0 of the appropriate method listed in Section 2.0 for tables, diagrams, flowcharts, and validation data.

PERFORMANCE SPECIFICATION 12A
SPECIFICATIONS AND TEXT PROCEDURES FOR TOTAL VAPOR PHASE MERCURY
CONTINUOUS EMISSION MONITORING SYSTEMS IN STATIONARY SOURCES

1.0 Scope and Application

1.1 Analyte

<u>ANALYTE</u>	<u>CAS No.</u>
<u>Mercury</u> <u>(Hg)</u>	<u>7439-97-6</u>

1.2 Applicability

1.2.1 This specification is for evaluating the acceptability of total vapor phase Hg continuous emission monitoring systems (CEMS) installed on the exit gases from fossil fuel fired boilers at the time of or soon after installation and whenever specified in the regulations. The Hg CEMS must be capable of measuring the total concentration in $\mu\text{g}/\text{m}^3$ (regardless of speciation) of vapor phase Hg, and recording that concentration on a wet or dry basis. Particle bound Hg is not included in the measurements.

This specification is not designed to evaluate an installed CEMS's performance over an extended period of time nor does it identify specific calibration techniques and auxiliary procedures to assess the CEMS's performance. The source owner or operator, however, is responsible to calibrate, maintain, and operate the CEMS properly. The Administrator may require, under Clean Air Act (CAA) section 114, the operator to conduct CEMS performance evaluations at other times besides the initial test to evaluate the CEMS performance. See §60.13(c).

1.2.2 For an affected facility that is also subject to the requirements of subpart I of part 75 of this chapter, the owner or operator may conduct the performance evaluation of the Hg CEMS according to §75.20(c)(1) of this chapter and section 6 of appendix A to part 75 of this chapter, in lieu of following the procedures in this performance specification.

2.0 Summary of Performance Specification

Procedures for measuring CEMS relative accuracy, measurement error and drift are outlined. CEMS installation and measurement location specifications, and data reduction procedures are included. Conformance of the CEMS with the Performance Specification is determined.

3.0 Definitions

3.1 Continuous Emission Monitoring System (CEMS) means the total equipment required for the determination of a pollutant concentration. The system consists of the following major subsystems: sample interface, Hg analyzer, and data recorder.

- 3.2 Sample Interface means that portion of the CEMS used for one or more of the following: sample acquisition, sample transport, sample conditioning, and protection of the monitor from the effects of the stack effluent.
- 3.3 Hg Analyzer means that portion of the Hg CEMS that measures the total vapor phase Hg mass concentration and generates a proportional output.
- 3.4 Data Recorder means that portion of the CEMS that provides a permanent electronic record of the analyzer output. The data recorder may provide automatic data reduction and CEMS control capabilities.
- 3.5 Span Value means the upper limit of the intended Hg concentration measurement range. The span value is a value equal to two times the emission standard. Alternatively, for an affected facility that is also subject to the requirements of subpart I of 40 CFR part 75, the Hg span value(s) may be determined according to section 2.1.7 of appendix A to 40 CFR part 75.
- 3.6 Measurement Error (ME) means the absolute value of the difference between the concentration indicated by the Hg analyzer and the known concentration generated by a reference gas, expressed as a percentage of the span value, when the entire CEMS, including the sampling interface, is challenged. An ME test procedure is performed to document the accuracy and linearity of the Hg CEMS at several points over the measurement range.
- 3.7 Upscale Drift (UD) means the absolute value of the difference between the CEMS output response and an upscale Hg reference gas, expressed as a percentage of the span value, when the entire CEMS, including the sampling interface, is challenged after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.
- 3.8 Zero Drift (ZD) means the absolute value of the difference between the CEMS output response and a zero-level Hg reference gas, expressed as a percentage of the span value, when the entire CEMS, including the sampling interface, is challenged after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.
- 3.9 Relative Accuracy (RA) means the absolute mean difference between the pollutant concentration(s) determined by the CEMS and the value determined by the reference method (RM) plus the 2.5 percent error confidence coefficient of a series of tests divided by the mean of the RM tests. Alternatively, for low concentration sources, the RA may be expressed as the absolute value of the difference between the mean CEMS and RM values.
- 4.0 Interferences [Reserved]
- 5.0 Safety
- The procedures required under this performance specification may involve hazardous materials, operations, and equipment. This performance specification may not address all of the safety problems associated with these procedures. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicable regulatory limitations prior to performing these procedures. The CEMS user's manual and materials recommended by the RM should be consulted for specific precautions to be taken.
- 6.0 Equipment and Supplies
- 6.1 CEMS Equipment Specifications

6.1.1 Data Recorder Scale. The Hg CEMS data recorder output range must include zero and a high level value. The high level value must be approximately two times the Hg concentration corresponding to the emission standard level for the stack gas under the circumstances existing as the stack gas is sampled. A lower high-level value may be used, provided that the measured values do not exceed 95 percent of the high level value. Alternatively, for an affected facility that is also subject to the requirements of subpart I of 40 CFR part 75, the owner or operator may set the full-scale range(s) of the Hg analyzer according to section 2.1.7 of appendix A to 40 CFR part 75.

6.1.2 The CEMS design should also provide for the determination of calibration drift at a zero value (zero to 20 percent of the span value) and at an upscale value (between 50 and 100 percent of the high-level value).

6.2 Reference Gas Delivery System. The reference gas delivery system must be designed so that the flowrate of reference gas introduced to the CEMS is the same at all three challenge levels specified in Section 7.1 and at all times exceeds the flow requirements of the CEMS.

6.3 Other equipment and supplies, as needed by the applicable reference method used. See Section 8.6.2.

7.0 Reagents and Standards

7.1 Reference Gases. Reference gas standards are required for both elemental (Hg⁰) and oxidized Hg (Hg and mercuric chloride, HgCl₂). The use of National Institute of Standards and Technology (NIST)-certified or NIST-traceable standards and reagents is required. The following gas concentrations are required.

7.1.1 Zero-level. 0 to 20 percent of the span value.

7.1.2 Mid-level. 50 to 60 percent of the span value.

7.1.3 High-level. 80 to 100 percent of the span value.

7.2 Reference gas standards may also be required for the reference methods. See Section 8.6.2.

8.0 Performance Specification (PS) Test Procedure

8.1 Installation and Measurement Location Specifications

8.1.1 CEMS Installation. Install the CEMS at an accessible location downstream of all pollution control equipment. Since the Hg CEMS sample system normally extracts gas from a single point in the stack, use a location that has been shown to be free of stratification for SO₂ and NO_x through concentration measurement traverses for those gases. If the cause of failure to meet the RA test requirement is determined to be the measurement location and a satisfactory correction technique cannot be established, the Administrator may require the CEMS to be relocated.

Measurement locations and points or paths that are most likely to provide data that will meet the RA requirements are listed below.

8.1.2 Measurement Location. The measurement location should be (1) at least two equivalent diameters downstream of the nearest control device, point of pollutant generation or other point at which a change of pollutant concentration may occur, and (2) at least half an equivalent diameter upstream

- from the effluent exhaust. The equivalent duct diameter is calculated as per 40 CFR part 60, appendix A, Method 1.
- 8.1.3 Hg CEMS Sample Extraction Point. Use a sample extraction point (1) no less than 1.0 meter from the stack or duct wall, or (2) within the centroidal velocity traverse area of the stack or duct cross section.
- 8.2 RM Measurement Location and Traverse Points. Refer to PS 2. The RM and CEMS locations need not be immediately adjacent.
- 8.3 ME Test Procedure. The Hg CEMS must be constructed to permit the introduction of known concentrations of Hg and HgCl₂ separately into the sampling system of the CEMS immediately preceding the sample extraction filtration system such that the entire CEMS can be challenged. Sequentially inject each of the three reference gases (zero, mid-level, and high level) for each Hg species. Record the CEMS response and subtract the reference value from the CEMS value, and express the absolute value of the difference as a percentage of the span value (see example data sheet in Figure 12A-1). For each reference gas, the absolute value of the difference between the CEMS response and the reference value shall not exceed 5 percent of the span value. If this specification is not met, identify and correct the problem before proceeding.
- 8.4 UD Test Procedure
- 8.4.1 UD Test Period. While the affected facility is operating at more than 50 percent of normal load, or as specified in an applicable subpart, determine the magnitude of the UD once each day (at 24-hour intervals, to the extent practicable) for 7 consecutive unit operating days according to the procedure given in Sections 8.4.2 through 8.4.3. The 7 consecutive unit operating days need not be 7 consecutive calendar days. Use either Hg⁰ or HgCl₂ standards for this test.
- 8.4.2 The purpose of the UD measurement is to verify the ability of the CEMS to conform to the established CEMS response used for determining emission concentrations or emission rates. Therefore, if periodic automatic or manual adjustments are made to the CEMS zero and response settings, conduct the UD test immediately before these adjustments, or conduct it in such a way that the UD can be determined.
- 8.4.3 Conduct the UD test at either the mid-level or high-level point specified in Section 7.1. Introduce the reference gas to the CEMS. Record the CEMS response and subtract the reference value from the CEMS value, and express the absolute value of the difference as a percentage of the span value (see example data sheet in Figure 12A-1). For the reference gas, the absolute value of the difference between the CEMS response and the reference value shall not exceed 5 percent of the span value. If this specification is not met, identify and correct the problem before proceeding.
- 8.5 ZD Test Procedure
- 8.5.1 ZD Test Period. While the affected facility is operating at more than 50 percent of normal load, or as specified in an applicable subpart, determine the magnitude of the ZD once each day (at 24-hour intervals, to the extent practicable) for 7 consecutive unit operating days according to the procedure given in Sections 8.5.2 through 8.5.3. The 7 consecutive unit operating days need not be 7 consecutive calendar days. Use either nitrogen, air, Hg⁰, or HgCl₂ standards for this test.
- 8.5.2 The purpose of the ZD measurement is to verify the ability of the CEMS to conform to the established CEMS response used for determining emission concentrations or emission rates. Therefore, if periodic automatic or manual adjustments are made to the CEMS zero and response settings, conduct the ZD test immediately before these adjustments, or conduct it in such a way that the ZD can be determined.

8.5.3 Conduct the ZD test at the zero level specified in Section 7.1. Introduce the zero gas to the CEMS. Record the CEMS response and subtract the zero value from the CEMS value and express the absolute value of the difference as a percentage of the span value (see example data sheet in Figure 12A-1). For the zero gas, the absolute value of the difference between the CEMS response and the reference value shall not exceed 5 percent of the span value. If this specification is not met, identify and correct the problem before proceeding.

8.6 RA Test Procedure

8.6.1 RA Test Period. Conduct the RA test according to the procedure given in Sections 8.6.2 through 8.6.6 while the affected facility is operating at normal full load, or as specified in an applicable subpart. The RA test may be conducted during the ZD and UD test period.

8.6.2 RM. Unless otherwise specified in an applicable subpart of the regulations, use either Method 29, or American Society of Testing and Materials (ASTM) Method D 6784-02 (incorporated by reference, see §60.17) as the RM for Hg concentration. Alternatively, an instrumental RM may be used, subject to the approval of the Administrator. Do not include the filterable portion of the sample when making comparisons to the CEMS results. When Method 29 or ASTM D6784-02 is used, conduct the RM test runs with paired or duplicate sampling systems. When an approved instrumental method is used, paired sampling systems are not required. If the RM and CEMS measure on a different moisture basis, data derived with Method 4 shall also be obtained during the RA test.

8.6.3 Sampling Strategy for RM Tests. Conduct the RM tests in such a way that they will yield results representative of the emissions from the source and can be compared to the CEMS data. It is preferable to conduct moisture measurements (if needed) and Hg measurements simultaneously, although moisture measurements that are taken within an hour of the Hg measurements may be used to adjust the Hg concentrations to a consistent moisture basis. In order to correlate the CEMS and RM data properly, note the beginning and end of each RM test period for each paired RM run (including the exact time of day) on the CEMS chart recordings or other permanent record of output.

8.6.4 Number and length of RM Tests. Conduct a minimum of nine RM test runs. When Method 29 or ASTM D6784-02 is used, only test runs for which the data from the paired RM trains meet the relative deviation (RD) criteria of this PS shall be used in the RA calculations. In addition, for Method 29 and ASTM D 6784-02 use a minimum sample run time of 2 hours.

Note: More than nine sets of RM tests may be performed. If this option is chosen, paired RM test results may be excluded so long as the total number of paired RM test results used to determine the CEMS RA is greater than or equal to nine. However, all data must be reported, including the excluded data.

8.6.5 Correlation of RM and CEMS Data. Correlate the CEMS and the RM test data as to the time and duration by first determining from the CEMS final output (the one used for reporting) the integrated average pollutant concentration for each RM test period. Consider system response time, if important, and confirm that the results are on a consistent moisture basis with the RM test. Then, compare each integrated CEMS value against the corresponding RM value. When Method 29 or ASTM D6784-02 is used, compare each CEMS value against the corresponding average of the paired RM values.

8.6.6 Paired RM Outliers

8.6.6.1 When Method 29 or ASTM D6784-02 is used, outliers are identified through the determination of relative deviation (RD) of the paired RM tests. Data that do not meet this criteria should be flagged as a data quality problem. The primary reason for performing paired RM sampling is to ensure the quality of the RM data. The percent RD of paired data is the parameter used to quantify data quality. Determine RD for two paired data points as follows:

$$RD = 100 \times \frac{|(C_a - C_b)|}{C_a + C_b} \quad \text{Eq. 12A-1}$$

where C_a and C_b are concentration values determined from each of the two samples respectively.

8.6.6.2 A minimum performance criteria for RM Hg data is that RD for any data pair must be ≤ 10 percent as long as the mean Hg concentration is greater than $1.0 \mu\text{g}/\text{m}^3$. If the mean Hg concentration is less than or equal to $1.0 \mu\text{g}/\text{m}^3$, the RD must be ≤ 20 percent. Pairs of RM data exceeding these RD criteria should be eliminated from the data set used to develop a Hg CEMS correlation or to assess CEMS RA.

8.6.7 Calculate the mean difference between the RM and CEMS values in the units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), the standard deviation, the confidence coefficient, and the RA according to the procedures in Section 12.0.

8.7 Reporting. At a minimum (check with the appropriate EPA Regional Office, State or local Agency for additional requirements, if any), summarize in tabular form the results of the RD tests and the RA tests or alternative RA procedure, as appropriate. Include all data sheets, calculations, charts (records of CEMS responses), reference gas concentration certifications, and any other information necessary to confirm that the performance of the CEMS meets the performance criteria.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Sample collection and analysis are concurrent for this PS (see Section 8.0). Refer to the RM employed for specific analytical procedures.

12.0 Calculations and Data Analysis

Summarize the results on a data sheet similar to that shown in Figure 2-2 for PS 2.

12.1 Consistent Basis. All data from the RM and CEMS must be compared in units of $\mu\text{g}/\text{m}^3$, on a consistent and identified moisture and volumetric basis (STP = 20°C , 760 millimeters (mm) Hg).

12.1.1 Moisture Correction (as applicable). If the RM and CEMS measure Hg on a different moisture basis, use Equation 12A-2 to make the appropriate corrections to the Hg concentrations.

$$\text{Concentration}_{(\text{dry})} = \frac{\text{Concentration}_{(\text{wet})}}{(1 - B_{\text{ws}})} \quad \text{Eq. 12A-2}$$

In Equation 12A-2, B_{ws} is the moisture content of the flue gas from Method 4, expressed as a decimal fraction (e.g., for 8.0 percent H_2O , $B_{\text{ws}} = 0.08$).

12.2 Arithmetic Mean. Calculate the arithmetic mean of the difference, d , of a data set as follows:

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i \quad \text{Eq. 12A-3}$$

where:

n = Number of data points; and

$\sum_{i=1}^n d_i$ = Algebraic summation of the individual differences, d_i .

12.3 Standard Deviation. Calculate the standard deviation, S_d , as follows:

$$S_d = \left[\frac{\sum_{i=1}^n d_i^2 - \frac{\left(\sum_{i=1}^n d_i\right)^2}{n}}{n-1} \right]^{\frac{1}{2}} \quad \text{Eq. 12A-4}$$

12.4 Confidence Coefficient (CC). Calculate the 2.5 percent error confidence coefficient (one-tailed), CC, as follows:

$$CC = t_{0.975} \frac{S_d}{\sqrt{n}} \quad \text{Eq. 12A-5}$$

where:

$t_{0.975}$ = t-value (see Table 12A-1)

12.5 RA. Calculate the RA of a set of data as follows:

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100 \quad \text{Eq. 12A-6}$$

where:

$|\bar{d}|$ = Absolute value of the mean differences (from Equation 12A-3);

$|CC|$ = Absolute value of the confidence coefficient (from Equation 12A-5); and

RM = Average RM value.

13.0 Method Performance

13.1 ME. ME is assessed at zero-level, mid-level and high-level values as given below using standards for both Hg^0 and $HgCl_2$. The mean difference between the indicated CEMS concentration and the

reference concentration value for each standard shall be no greater than 5 percent of the span value.

13.2 UD. The UD shall not exceed 5 percent of the span value on any of the 7 days of the UD test.

13.3 ZD. The ZD shall not exceed 5 percent of the span value on any of the 7 days of the ZD test.

13.4 RA. The RA of the CEMS must be no greater than 20 percent of the mean value of the RM test data in terms of units of $\mu\text{g}/\text{m}^3$. Alternatively, if the mean RM is less than $5.0 \mu\text{g}/\text{m}^3$, the results are acceptable if the absolute value of the difference between the mean RM and CEMS values does not exceed $1.0 \mu\text{g}/\text{m}^3$.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures [Reserved]

17.0 Bibliography

17.1 40 CFR part 60, appendix B, "Performance Specification 2—Specifications and Test Procedures for SO₂ and NO_X Continuous Emission Monitoring Systems in Stationary Sources."

17.2 40 CFR part 60, appendix A, "Method 29—Determination of Metals Emissions from Stationary Sources."

17.3 ASTM Method D6784–02, "Standard Test Method for Elemental, Oxidized, Particle-Bound and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method)."

18.0 Tables and Figures

Table 12A-1: t

<u>n^a</u>	<u>t_{0.975}</u>	<u>n^a</u>	<u>t_{0.975}</u>	<u>n^a</u>	<u>t_{0.975}</u>
<u>2</u>	<u>12.706</u>	<u>7</u>	<u>2.447</u>	<u>12</u>	<u>2.201</u>
<u>3</u>	<u>4.303</u>	<u>8</u>	<u>2.365</u>	<u>13</u>	<u>2.179</u>
<u>4</u>	<u>3.182</u>	<u>9</u>	<u>2.306</u>	<u>14</u>	<u>2.160</u>
<u>5</u>	<u>2.776</u>	<u>10</u>	<u>2.262</u>	<u>15</u>	<u>2.145</u>
<u>6</u>	<u>2.571</u>	<u>11</u>	<u>2.228</u>	<u>16</u>	<u>2.131</u>

^a The values in this table are already corrected for n-1 degrees of freedom. Use n equal to the number of individual values.

Figure 12A-1: ME, ZD, and UD Deterr

	<u>Date</u>	<u>Time</u>	<u>Reference gas value (mg/m³)</u>	<u>CEMS measured value (mg/m³)</u>	<u>Absolute difference</u>	<u>Drift or measurement error (% of span value)</u>
<u>Low Level</u>						
<u>Mid Level</u>						
<u>High Level</u>						

2.124 Multipollutant Control for Electric Utility Steam Generating Units

2.124.1 Applicability and Definition of Affected Facility

- (a) This source category applies to affected facilities covered by the Georgia Rules for Air Quality Control (Georgia Rule) 391-3-1-.02(2)(sss).

2.124.2 Parametric Monitoring

- (a) Within 180 days of each of the applicable effective dates specified in Georgia Rule 391-3-1-.02(2)(sss)1. through 11., or July 1, 2009, whichever is later, the owner or operator shall conduct performance tests on the affected unit(s) to determine the emissions of nitrogen oxides, sulfur dioxide, and mercury using the reference methods specified in 40 CFR Part 75 for each applicable pollutant or shall use data from a continuous emissions monitoring system (CEMS) installed and certified according to the requirements of 40 CFR Part 75.
- (b) For each applicable pollutant, the owner or operator shall establish, through performance testing or quality assured CEMS data, the parameters and indicator ranges necessary to demonstrate proper operation and maintenance of the installed control equipment for the purposes of complying with Georgia Rules 391-3-1-.02(sss) and 391-3-1-.02(2)(a)10. for the anticipated range of operation of the affected unit(s), excluding periods of startup, shutdown, or malfunction. The owner or operator shall submit, to the Division within 60 days of completion of the requirements of paragraph (a) of this section or by September 1, 2009, whichever is later, a report containing the chosen parameters and data collected during the performance testing or supporting quality assured CEMS data. The report shall also identify the value(s) which have been established as indicative of proper operation and a justification for the chosen parameters and values.
- (c) The applicable parameters chosen and the corresponding values indicative of proper operation established under paragraph (b) of this section shall be included in the most recent revision of the Quality Assurance Plan (QAP) required to be maintained by 40 CFR Part 75. Any recorded instance of an applicable monitored parameter outside the established range recorded in the QAP shall be reported as an excursion in the Part 70 Operating Permit quarterly report. This report shall also include identification of any periods of startup, shutdown, or malfunction or other period specified by Georgia Rule 391-3-1-.02(2)(sss)16.
- (d) The owner or operator may request to be exempt from the requirements of paragraphs (a) and (b) and (c) of this section if the affected unit's emission limits for NO_x and SO₂ have been set by the Division. However, to the extent there are any operating and maintenance parameters of the control equipment that would affect the emissions of mercury but not the emissions of nitrogen oxides or sulfur dioxide, the owner or operator shall comply with paragraphs (a), (b) and (c) with respect to such mercury-specific operating and maintenance parameters.
- (e) As an alternative to the requirements of this section, the owner or operator may request mercury emission target values be established for the affected unit(s). The owner or operator shall report any exceedance of the mercury emission "target values" as an excursion in the Part 70 Operating Permit quarterly reports.