

**Chapter 2**  
**Compliance Branch CEMS Guidance Manual**  
**Table of Contents**

	<b>Page No.</b>
Applicability.....	1.0
<b>1.0 Continuous Emissions Monitor Operating Principles.....</b>	<b>3.0</b>
1.1 Introduction.....	3.0
1.2 Definitions.....	4.0
1.3 General CEMS Design.....	5.0
<b>2.0 Performance Specifications and Certification Requirements.....</b>	<b>6.0</b>
2.1 Introduction.....	6.0
2.2 Indiana Certification Requirements.....	6.0
2.3 Recertification Requirements.....	7.0
<b>3.0 Quality Assurance Plan Requirements.....</b>	<b>7.0</b>
3.1 Introduction.....	7.0
3.2 Required Elements.....	8.0
3.3 Additional Elements.....	10
3.4 Submission of the Plan & Biannual Review.....	10
3.5 Example QA Plan.....	10
<b>4.0 Quality Control and Quality Assurance Requirements.....</b>	<b>11</b>
4.1 Introduction.....	11
4.2 Daily Checks.....	11
4.2.1 Calibration Drift (Zero and Span).....	11
4.2.2 Other Checks (Daily, Weekly or Monthly).....	13
4.3 Performance and System Audit Requirements (Periodic Checks).....	14
4.3.1 Performance Audit.....	14
4.3.1.1 Cylinder Gas Audit (CGA).....	14
4.3.1.2 Linearity Test.....	16
4.3.1.3 Relative Accuracy Test Audit (RATA).....	18

4.3.1.4	Relative Accuracy Audit (RAA).....	18
4.3.2	Systems Audit.....	18
4.4	Cylinder Gas Certification Requirements.....	19
4.41	Selection of Audit Gases.....	19
4.5	Data Availability Requirements and Calculations.....	19
<b>5.0</b>	<b>Monitoring System Malfunctions</b> .....	<b>20</b>
5.1	Initial Response.....	20
5.2	Alternative Monitoring.....	21
5.3	Example Alternative Monitoring Strategies.....	21
<b>6.0</b>	<b>Record Keeping and Reporting of Quality Assurance Activities</b> .....	<b>22</b>
6.1	Daily or Weekly Log Books and Check Sheets.....	22
6.2	Quarterly Reporting.....	22
<b>7.0</b>	<b>Record keeping and Reporting of Excess Emissions</b> .....	<b>23</b>
7.1	Excess Emissions Reports (EER).....	23
<b>8.0</b>	<b>Summary of Indiana CEMS Requirements</b> .....	<b>24</b>
<b>Form 1:</b>	Daily Log.....	13
<b>Form 2:</b>	Activity Matrix.....	14
<b>Form 3:</b>	Excess Emission Report.....	25
<b>Attachment 1:</b>	RATA, Linearity, and CGA Example Calculations.....	26
<b>Attachment 2:</b>	40 CFR Part 60 Appendix F.....	31
<b>Attachment 3:</b>	40 CFR Part 60 Appendix B, Performance Specifications.....	41
<b>Attachment 4:</b>	40 CFR Part 60 Appendix A, RM 3A, 6C & 7E.....	72
<b>Attachment 5:</b>	326 IAC Monitoring Rules.....	86
<b>Attachment 6:</b>	40 CFR Part 75 Appendix B.....	104

## **Reference Documents**

Air Pollution Training Institute (APTI) Course 474 Continuous Emissions Monitoring Systems Student Manual (Revised)

Useful Internet world wide web (www) sites:

### **EPA**

EPA Home Page <http://www.epa.gov/>

EPA Region 5 Home Page <http://www.epa.gov/Region5/home.html>

Acid Rain Program <http://www.epa.gov/acidrain/ardhome.html>

Technology Transfer Network (TTN) <http://www.epa.gov/ttn>

Emission Measurement Technolgy Info Center (EMTIC) Use the links on the TTN

### **State of Indiana**

IDEM Home Page <http://www.ai.org/idem/index.html>

### **Other Related Sites**

Air and Waste Management Association (AWMA) <http://www.awma.org/index1.html>

## **CHAPTER 2**

### **Continuous Emissions Monitoring Systems**

## APPLICABILITY

The Indiana Department of Environmental Management, Office of Air Management, Compliance Data Section (IDEM, OAM, CDS) issues these guidelines and requirements for reliable and accurate continuous emissions monitoring in this chapter of the IDEM, OAM Compliance Branch CEM Guidance.

The monitoring and quality assurance requirements for the parameters of Sulfur Dioxide-SO<sub>2</sub>, Oxides of Nitrogen-NO<sub>x</sub>, Carbon Dioxide-CO<sub>2</sub>, Oxygen-O<sub>2</sub>, Carbon Monoxide-CO, Hydrogen Sulfide-H<sub>2</sub>S, Total Reduced Sulfur-TRS, Total Hydrocarbons- THC, and Volumetric Flow include, but are not limited to:

- C Certification and recertification requirements
- C Performance specifications and test procedures
- C Equipment and design specifications
- C Data availability requirements
- C Quality assurance plan and standard operating procedure requirements
- C Quality assurance and quality control requirements
- C Reporting and record-keeping requirements

Requirements and guidelines contained in this chapter apply to sources required to operate continuous emissions monitoring systems used to determine compliance with federal (New Source Performance Standards-NSPS), state (rule, permit condition, agreed order, consent decree) and local regulations (rule, permit condition, agreed order, consent decree) in Indiana. Continuous Emissions Monitoring Systems (CEMS) used **exclusively** for Acid Rain requirements (40 CFR Part 75) are not subject to the **quality assurance** requirements set forth in this chapter. For reference and comparison the quality assurance requirements of Part 75 are explained in this chapter. However, IDEM requirements for protocol submission and test notification, including Part 75, apply to all sources conducting all Relative Accuracy Test Audits (RATAs) in Indiana.

Acid Rain CEMS which are also for NSPS, state and/or local agency monitoring are subject to the requirements set forth in this chapter. Requirements for Continuous Opacity Monitoring Systems (COMS), including COMS required by Part 75, are contained in Chapter 1 of this Manual.

The following Code of Federal Regulations (CFR) are incorporated by reference into this chapter:

- C 40 CFR Part 60, Appendix B, Performance Specification 2- Specifications and Test Procedures for SO<sub>2</sub> and NO<sub>x</sub> Continuous Emission Monitoring Systems in Stationary Sources (PS-2).

- C 40 CFR Part 60, Appendix B, Performance Specification 3 - Specifications and Test Procedures for O<sub>2</sub> and CO<sub>2</sub> Continuous Emission Monitoring Systems in Stationary Sources (PS-3).
- C 40 CFR Part 60, Appendix B, Performance Specification 4 - Specifications and Test Procedures for Carbon Monoxide Continuous Emission Monitoring Systems in Stationary Sources (PS-4).
- C 40 CFR Part 60, Appendix B, Performance Specification 4A - Specifications and Test Procedures for Carbon Monoxide Continuous Emission Monitoring Systems in Stationary Sources (PS-4A). \*
- C 40 CFR Part 60, Appendix B, Performance Specification 5 - Specifications and Test Procedures for TRS Continuous Emission Monitoring Systems in Stationary Sources (PS-5).
- C 40 CFR Part 60, Appendix B, Performance Specification 6 - Specifications and Test Procedures for Continuous Emission Rate Monitoring Systems in Stationary Sources (PS-6).
- C 40 CFR Part 60, Appendix B, Performance Specification 7 - Specifications and Test Procedures for Hydrogen Sulfide Continuous Emission Monitoring Systems in Stationary Sources (PS-7).
- 40 CFR Part 60, Appendix B, Performance Specification 8 - Performance Specifications For Volatile Organic Compound Continuous Emission Monitoring Systems in Stationary Sources (PS-8).
- 40 CFR Part 60, Appendix B, Performance Specification 9 - Specifications and Test Procedures for Gas Chromatographic Continuous Emission Monitoring Systems in Stationary Sources (PS-9).
- C 40 CFR Part 60, Appendix F, Quality Assurance Requirements for Gas Continuous Emission Monitoring Systems Used For Compliance Determination.
- C 40 CFR Part 75, Appendix A, Specifications and Test Procedures.
- C 40 CFR Part 75, Appendix B, Quality Assurance and Quality Control Procedures.
- C 40 CFR Part 266, Appendix IX, Methods Manual For Compliance With The BIF Regulations.

**\*Note:** May also be used in some circumstances as an alternative to PS-4 for gas concentrations below 100 PPM.

## **1.0 CONTINUOUS EMISSIONS MONITOR SYSTEMS OPERATING PRINCIPLES**

### **1.1 Introduction**

Continuous Emissions Monitoring Systems (CEMS) are used to measure air pollution emissions and other parameters of emissions (i.e., diluent gases and volumetric flow) from a variety of industrial sources. Federal, state and local agency rules, regulations, permit conditions or agreed orders may require CEMS. It is important for the source owner/operator to know which regulation(s) cover the installation, certification, operation, quality assurance and data reporting for each CEMS. While some activities such as sampling location, installation and certification are usually consistent from one regulation to another, activities such as quality assurance (i.e., frequency of audits and audit pass/fail limits) or reporting requirements may be very different depending upon the regulation, permit condition or other requirements. Many CEMS are used for more than one regulatory purpose; i.e., an Acid Rain CEMS (40 CFR Part 75) may also be used for New Source Performance Standards (NSPS) monitoring (40 CFR Part 60). In that case, emissions and QA data must be reported electronically to the Acid Rain Division of the U.S. EPA and also must be reported to the state or local agency as a paper report.

Quality assurance activities for NSPS CEMS are specified in 40 CFR Part 60, Appendix F and quality assurance activities for Acid Rain CEMS are specified in 40 CFR Part 75, Appendix B. If the source must monitor under both Part 60 and Part 75 then the CEMS must fulfill the quality assurance testing and reporting requirements of both appendices (F and B). Sources required to install and operate CEMS under permit requirements, agreed orders or other state requirements must fulfill the requirements of the state monitoring rule at 326 IAC 3.

Questions concerning anything contained in this chapter can be directed to the following address or phone number:

Indiana Department of Environmental Management  
Office of Air Management, Compliance Data Section  
100 North Senate Avenue, P.O. Box 6015  
Indianapolis, IN 46206-6015  
Attn: Dave Cline  
Phone (317) 233-5668  
FAX (317) 233-5967  
E-Mail: [dcline@dem.state.in.us](mailto:dcline@dem.state.in.us)

## 1.2 Definitions

Definitions of most terms used in this chapter are listed below. Additional definitions may be found in Attachments 2, 3, 4 and 5.

**Accuracy** - The measure of the closeness of a measurement to its "true value."

**Audit** - An audit is an independent assessment of the accuracy of data. Independence is achieved by having the audit performed by an operator other than the person conducting the routine measurements and by using audit standards and procedures different from those routinely used in the monitoring (see **Systems Audit** and **Performance Audit** in this Section).

**Calibration Drift (CD)** - See Attachment 2 (Appendix F, Section 2.5).

**Continuous Emission Monitoring System (CEMS)** - See Attachment 2 (Appendix F, Section 2.1).

**Data Recorder / Data Acquisition and Handling System (DAHS)** - See Attachment 3 (Reference Method 6C, Section 3.1.3).

**Effluent / Effluent Gas** - The gas produced as a result of combustion or some other industrial process. The gas may be made up of multiple components such as particulate matter, liquids, condensed solids, vapors and gases. The **effluent gas** may also be referred to as: stack gas, flue gas, duct gas or smoke.

**Monitor Malfunction** - Any interruption in the collection of data as a result of the failure of any component of the **CEMS** to operate within specifications of the manufacturer or Performance Specifications.

**Out-of-Control** - Means any data collected by a continuous monitoring system during periods immediately following an out of tolerance quality assurance assessment and prior to an acceptable quality assurance assessment.

**Performance Audit** - A *quantitative* evaluation of **CEMS** operation.

**Response Time** - See Attachment 3 (Reference Method 6C, Section 3.8).

**Routine Maintenance** - An orderly program of actions designed to prevent the failure of monitoring parts and systems during their use.

**(Daily) Span** - Refer to **Upscale Calibration Value in this section**.



**Span Value** - See Attachment 2 (Appendix F, Section 2.3).

**Systems Audit** - A *qualitative* evaluation of **CEMS** operation. Emissions data, logs, QA/QC data and other operational information are reviewed by regulatory officials or by a corporate environmental auditor in order to determine the operational status of the **CEMS** relative to the applicable regulations or to the company's objectives.

**Upscale Calibration Value** - Sometimes referred to as the span or daily span.

**Valid Data** - Any data collected by a continuous emissions monitoring system which has passed all applicable daily or quarterly quality assurance requirements and is not currently in malfunction mode.

**Zero** - See Attachment 2 (Appendix F, Section 2.4).

### **1.3 General CEMS Design**

The general design of a Continuous Emissions Monitoring System may be categorized by the location of the sample measurement and by the way a sample is measured or extracted. Two major categories of CEMS are:

1. **In-situ CEMS** - measurements are made in the stack without modifying the flue gas composition and are designed to detect gas concentrations in the presence of particulate matter. In-situ CEMS are further categorized by:
  - a. point
  - b. path (single-pass or double-pass, i.e., opacity monitor).
  
2. **Extractive CEMS** - sample gas is removed from the stack and transported to an instrument for measurement. Extractive CEMS are further categorized by:
  - a. dilution extractive
  - b. fully extractive

In Indiana the majority of CEMS measuring gaseous pollutants are dilution extractive monitors.

## **2.0 PERFORMANCE SPECIFICATIONS AND CERTIFICATION REQUIREMENTS**

### **2.1 Introduction**

CEMS, required by regulation, must go through a rigorous set of trials known as certification testing. The Code of Federal Regulations, 40 CFR Part 60, Appendix B, Performance Specifications, lists the requirements and methods for certification testing on a variety of CEMS. The following is a list of the Performance Specifications (PS) found in Part 60:

- C PS-2: Specifications and Test Procedures for SO<sub>2</sub> & NO<sub>x</sub> CEMS in Stationary Sources.
- PS-3: Specifications and Test Procedures for O<sub>2</sub> & CO<sub>2</sub> CEMS in Stationary Sources.
- PS-4: Specifications and Test Procedures for CO CEMS in Stationary Sources.
- C PS-4A: Specifications and Test Procedures for CO CEMS in Stationary Sources.
- C PS-5: Specifications and Test Procedures for TRS CEMS in Stationary Sources.
- C PS-6: Specifications and Test Procedures for CERMS in Stationary Sources.
- C PS-7: Specifications and Test Procedures for H<sub>2</sub>S CEMS in Stationary Sources.
- PS-8: Specifications and Test Procedures for VOC CEMS in Stationary Sources.
- PS-9: Specifications and Test Procedures for Gas Chromatographic CEMS in Stationary Sources.

### **2.2 Indiana CEMS Certification Requirements**

All CEMS in Indiana used to meet the regulatory monitoring requirements of federal, state and local agency entities must adhere to the following certification requirements:

1. Submit the proposed monitor location for review to IDEM, OAM, CDS at least 35 days prior to CEMS installation.
2. Install each CEMS as per the manufacturer's/contractor's recommendations, the requirements of Performance Specification 2 (or any other applicable PS in 40 CFR Part 60 Appendix B) and if applicable, any permit or agreed order requirements.
3. Submit a completed intent to test notification (test protocol) to IDEM, OAM, CDS at least 35 days prior to performing the certification testing.
4. Perform the certification test as per the appropriate performance specification (PS).
5. Submit the certification test report to IDEM, OAM, CDS within 45 days of the completion of the certification test.

Upon review and determination that the monitoring system has met the applicable PS requirements, IDEM issues a letter to the source owner or operator indicating the CEMS is certified. The date of this letter is the official certification date of the CEMS.

## **2.3 Recertification Requirements**

The certification procedure ensures that a specific CEMS at a specific location and, under a certain range of process conditions, will provide representative measurements of a source's emissions. When the monitor, its location, or the process producing the emissions are substantially altered, the CEMS may no longer be making measurements representative of true emissions.

A major modification of the monitor, a change of the monitor's span, a modification to its location, or a modification of the process producing the gas effluent may affect the certification of the CEMS. In these instances, the IDEM must evaluate the situation in order to determine if a recertification is necessary.

It would be difficult to list all possible events that would prompt a recertification. It is strongly recommended that the source contact IDEM, OAM if there is any question regarding recertification. Owners or operators of CEMS required by Acid Rain (40 CFR Part 75) requirements are encouraged to consult the Acid Rain Policy Manual or to contact the Clean Air Markets Division of the US EPA (Mr. Louis Nichols at 202/564-0161)

## **3.0 QUALITY ASSURANCE PLAN REQUIREMENTS**

### **3.1 Introduction**

A Quality Assurance (QA) program is a management system which ensures that Quality Control (QC) activities, such as preventive maintenance, daily calibrations and quarterly audits, are performed. QC activities certify that generated data is complete, representative, accurate and precise. Part of the Quality Assurance Plan are the Standard Operation Procedures (SOPs). Although not technically correct sometimes the SOP is also called the Quality Assurance Plan.

The QA program, as specified by the QA Plan, is the basis for assessing and maintaining the quality of continuous emission monitoring data. A Quality Assurance program has two distinct and equally important functions. These functions are:

- C the assessment of the quality of the data (accuracy and precision), and
- C the quality control, which involves activities used to maintain or improve data quality.

The above two functions form a control loop. When the assessment function indicates that data quality is inadequate, the quality control function must be increased until data quality is acceptable. The quality (and quantity) of valid data dictates the amount or degree of QC to be used in the monitoring program.

The QA Plan must provide detailed written descriptions of all current QC activities. When updates or changes to any activities are necessary the QA Plan must be revised to reflect those changes.

In the Plan, the company or plant should state its philosophy and approach to its QA program. Also, the procedures used to set up the QA program must be stated as a clearly defined set of activities. These activities, or SOPs, must be incorporated into the Quality Assurance Plan. SOPs provide monitor descriptions, company QA policies, monitor system QC procedures and audit procedures.

A well written QA Plan, along with the manufacturer's equipment operation manuals, provide the CEMS operator with most of the necessary information for proper monitor operation, maintenance and QC. Additional information such as the plant personnel's experience with the system should also be incorporated into the Plan. The QA Plan is a valuable tool for the evaluation and improvement of the monitoring system by the source and regulatory personnel.

The QA Plan should be reviewed and revised by the CEMS owner or operator anytime changes are made to CEMS procedures (anything from operation to reporting). The plan must also be updated whenever there are any changes in state and federal guidelines. The original QA Plan, and any revisions to it, must be submitted to the Indiana Department of Environmental Management, Office of Air Management, Compliance Data Section for review and approval as required by IAC 326 3-5-4, Standard operating procedures (see Section 1.1 for the IDEM mailing address and phone number and see Attachment 5 for the Standard operating procedures rule).

When a company's CEMS is evaluated (see Systems Audit, Section 4.3.2 of this chapter), IDEM uses the company's QA Plan as the basis for the evaluation. Therefore, it is extremely important that the QA Plan state the QA/QC activities a company is actually performing, not the QA/QC activities which should be performed.

It is worth noting again that SOP's are actually a part of a QA Plan. However, state and federal regulations only make reference to SOP requirements. QA and QC functions included in these state and federal regulations define the SOP. In practical terms, "SOP" and "QA Plan" can be used interchangeably.

### **3.2 Required Elements**

The owner or the operator of each affected facility operating a CEMS is required to submit to IDEM complete written continuous emission monitoring standard operating procedures (SOP) within ninety (90) days after monitor installation. The required elements for Standard Operating

Procedures are specified in state rule 326 IAC 3-5-4 Standard Operating Procedures. See Attachment #5 of this Chapter for a copy of the entire rule.

At a **minimum**, the SOPs must describe **complete step-by-step** procedures and operations as follows:

- (1) A description of the facility monitored.
- (2) A listing of the following:
  - (A) Each monitor's brand.
  - (B) Model number.
  - (C) Serial number.
  - (D) Monitoring location.
  - (E) Data handling and acquisition system.
- (3) Examples of all reporting and log forms.
- (4) Record keeping and reporting procedures that include the following:
  - (A) Reporting of instrument precision and accuracy.
  - (B) Reporting of emissions data.
- (5) Methods and procedures for analysis and data acquisition.
- (6) Calibration procedures that include the following:
  - (A) Calibration error limits and linearity.
  - (B) Calibration gas type as applicable, quality, and traceability to the National Institute of Standards and Technology.
  - (C) Calibration frequency.
  - (D) Criteria for recalibration, and analysis procedures to periodically verify the accuracy of span and calibration standards.
- (7) Operation procedures that include daily procedures, quantifying and recording daily zero (0) and high level drift that meet the requirements of 40 CFR 60, Appendix B, Performance specification 2, Section 4.2 or other applicable regulations, and other operating parameter checks indicating correct operational status.
- (8) Quality control and quality assurance procedures that include the following:
  - (A) A statement of quality policy and objectives.
  - (B) Organization and responsibilities description.
  - (C) Calibration and span and zero (0) drift criteria.
  - (D) Excessive drift criteria.
  - (E) Corrective action for excessive drift.
  - (F) Precision and accuracy results.
  - (G) Corrective action for accuracy audits failure.
  - (H) Data validity criteria.
  - (I) Participation in department performance audits.
  - (J) Data recording and calculation audits.
- (9) Preventive maintenance procedures and corrective maintenance procedures that include those procedures taken to ensure continuous operation and to minimize malfunctions.

(10) A listing of the manufacturer's recommended spare parts inventory.

### **3.3 Additional Elements**

The source owners or operators of CEMS are encouraged to develop and implement a more extensive QA/QC program than required by 326 IAC 3-5-4. Additional elements which could be included in a QA plan are:

- C A document control system which states how the Plan and its revisions are to be distributed. Each page of the Plan should be dated, numbered and marked with a revision number (i.e., a system similar to the top right corner of each page in this chapter).
- C A list of all applicable local, state and federal CEMS requirements (rules and regulations).
- C A copy of the operating permit.

### **3.4 Submission of the Plan and Biannual Review**

Indiana rule 326 IAC 3-5-4 requires the owner or the operator of each affected facility operating a CEMS to submit to IDEM complete written continuous emission monitoring standard operating procedures (SOP) within ninety (90) days after monitor installation. In addition, any revisions to the SOP must be submitted to IDEM biennially (once every two years). It is recommend that the company conduct an annual review of their QA Plan and update it as necessary.

Whenever excessive data loss (for any reason) occurs, the company/plant should perform a systems audit (see Section 4.3.2 of this chapter), review their QA Plan and make any appropriate revisions in QC and operational procedures.

### **3.5 Example QA Plan**

An example QA Plan is available to any company that is required to operate CEMS in Indiana. Please make the request to the Compliance Data Section (see Section 1.1 for the IDEM address and phone number). The example Plan has all the basic elements that comprise an acceptable QA/QC Plan, and may be used as a guide for the writing of a QA Plan specific to a source.

Because quality control activities encompass a variety of policies, specifications, standards and corrective measures, this example QA Plan treats QC requirements in general terms. Each CEMS owner or operator is encouraged to develop and implement a QA Plan that is effective, efficient and reflective of their individual CEMS program.

## 4.0 QUALITY CONTROL AND QUALITY ASSURANCE REQUIREMENTS

### 4.1 Introduction

Quality Control activities are generally performed on a routine basis by the CEMS operator or are automatically initiated by the CEMS. In either case, the operator or some other designated individual must promptly review the results of all QC checks and take appropriate follow-up actions to correct any problems.

### 4.2 Daily Checks

#### 4.2.1 Calibration Drift Assessment (Zero and Upscale)

Source owners/operators of CEMS must check, record, and quantify the Calibration Drift (CD) at two concentrations values at least once daily (approximately every 24 hours). Calibration Drift (sometimes called the zero and span check) must be conducted in accordance with the method prescribed by the manufacturer and be conducted at a zero/low-level and an upscale/high-level. The CEMS calibration must, at a minimum, be adjusted whenever the daily zero (or low-level) CD or the daily high-level CD exceeds two times the limits of the applicable Performance Specification in Appendix B of Part 60. The CEMS shall be declared "out-of-control" if either the low-level or high-level CD result exceeds twice the specification of the applicable PS for five consecutive days or when the CD exceeds four times the specification of the applicable PS (see table 1-1 for example data and calculations). See Section 4.5 for a discussion of "out-of-control" and how it relates to data availability and valid data return (VDR).

Most CEMS are designed to provide for an automatic initiation of the CD check. After each CD check the CEMS will automatically calculate the CD before the CEMS self-adjusts for any drift within preset limits. A manual or computerized record (log) of the CD must be maintained by the CEMS owner or operator.

To manually calculate CD as well as the CD limits, use the following equations:

**Equation 1a:** CD in ppm,  $CD_{PPM} = C_v \& M_v$

**Equation 1b:** CD in percent,  $CD_{\%} = \frac{C_v \& M_v}{M_S} \times 100$

**Equation 1c:** CD limit in ppm,  $CD_{PPM\ Limit} = M_S (PS_{LIMIT})$

where:

$CD_{PPM}$  = Calibration Drift in PPM or pollutant concentration

$C_v$  = Certified Cylinder Value

$M_v$  = Monitor Value or Reading

$CD_{\%}$  = Calibration Drift in Percent

$M_s$  = Monitor Span

Example calculations using Equation 1a, PS-2 CD and Appendix F limit:

Monitor:  $SO_2$

Monitor Span: 1000 ppm

Applicable Performance Specification: PS-2

Applicable CD (PS-2, Section 4.2): 2.5% of CEMS span value

40 CFR Part 60, Appendix F CD 5-day limit = 2 x PS-2 CD limit

40 CFR Part 60, Appendix F CD 1-day limit = 4 x PS-2 CD limit

Using Equation 1c and the above data:

$$CD_{PPM \text{ Limit}} = 1000 \text{ ppm} * 0.025 = 25 \text{ ppm}$$

To apply the Appendix F 5-day limit, multiply the  $CD_{PPM \text{ Limit}}$  value by two (2):

$$CD_{PPM \text{ App F 5-day Limit}} = 2 * 25 \text{ ppm} = 50 \text{ ppm Calibration Drift limit for "out-of-control"}$$

To apply the Appendix F 1-day CD limit, multiply the  $CD_{PPM \text{ Limit}}$  value by four (4):

$$CD_{PPM \text{ Appendix F 1-day Limit}} = 4 * 25 \text{ ppm} = 100 \text{ ppm Calibration Drift limit for "out-of-control"}$$

Example calculations using Equation 1b:

$$1000 \text{ ppm} * 0.025 = 25 \text{ ppm}$$

$$2 * 25 \text{ ppm} = 50 \text{ ppm per day Appendix F limit for 5 consecutive days of unadjusted drift}$$

$$4 * 25 \text{ ppm} = 100 \text{ ppm Appendix F "out-of-control" limit for 1-day of drift}$$



Table 1-1

Monitor: SO <sub>2</sub>				Span (ppm):	1000	
low-level						
Date	Time	Calibration (ppm)	CEM (ppm)	Difference (ppm)	5-day consecutive CD Limit 2 * 0.025 (ppm)	1-day CD Limit 4 * 0.025 (ppm)
01/20/98	8:00	0.00	7.00	-7.00	50.00	100
01/21/98	8:00	0.00	6.10	-6.10	50.00	100
01/22/98	8:00	0.00	4.90	-4.90	50.00	100
01/23/98	8:00	0.00	-5.00	5.00	50.00	100
01/24/98	8:00	0.00	-3.00	3.00	50.00	100
high-level						
01/20/98	8:00	800.00	837.00	-37.00	50.00	100
01/21/98	8:00	800.00	826.10	-26.10	50.00	100
01/22/98	8:00	800.00	844.90	-44.90	50.00	100
01/23/98	8:00	800.00	825.00	-25.00	50.00	100
01/24/98	8:00	800.00	833.00	-33.00	50.00	100

#### 4.2.2 Other Checks (Daily, Weekly, or Monthly)

Other frequent checks (operational or preventive maintenance) may be required depending on the CEMS manufacturer's instructions and the operator's experience with the monitoring system. Include all additional checks on the daily/weekly/monthly log. Logs may be either kept on paper or by computerized records. A useful way to chart the type and frequency of operational and maintenance checks is to make an activity matrix. The CEMS manufacturer's manual is useful in constructing an activity matrix. An example of this type of matrix is:

Activity	Frequency
1. Check system zero and span results.	Daily
2. Check cylinder pressures..	Weekly
3. Check trace on the recorder and/or printer-legible printing	Daily
4. Change pen(s) and paper on the recorder/printer.	As required
5. Check for alarms and any malfunction	Daily
6. Check components of dilution system on the CEMS (if applicable)	Bi-weekly
7. Check filters, desiccants, dryers	As recommended by manufacturer
8. Conduct Performance Audit	Each calendar quarter
9. CEMS shelter temperature	Daily

### **4.3 Performance and System Audit Requirements (Periodic Checks)**

#### **4.3.1 Performance Audit**

A performance audit is used to check all of the individual CEMS components and factors which affect the precision and accuracy of monitoring data. CEMS accuracy is quantified by using audit standards of known values or by using U.S. EPA Reference Methods (RM).

All CEMS must be audited at least once each calendar quarter. The Code of the Federal Regulations, 40 CFR Part 60, Appendix F, lists three different types of performance audits and specifies the required elements of each audit.

The three types of performance audits are: Cylinder Gas Audit-CGA, Relative Accuracy Test Audit-RATA and, Relative Accuracy Audit-RAA.

##### **4.3.1.1 Cylinder Gas Audit (CGA)**

A CGA performance audit must be conducted in three of four calendar quarters, but in no more than three quarters in succession. A CGA applies to gaseous pollutant or diluent CEMS and is not intended to audit other types of monitors associated with CEMS such as flow or temperature monitors.

A CGA is conducted by challenging the CEMS (both pollutant and diluent portions of the CEMS, if applicable) with an audit gas of known concentration at two points within the following ranges:

Table 1.2

Audit Point	Audit Gas Range		
	Pollutant Monitors (i.e., SO <sub>2</sub> , NO <sub>x</sub> )	Diluent Monitors	
		CO <sub>2</sub>	O <sub>2</sub>
1	20% - 30% of span value	5% - 8% by volume	4% - 6% by volume
2	50% - 60% of span value	10% - 14% by volume	8% - 12% by volume

Each CEMS must be challenged three times at each audit point, and use the average of the three responses in determining accuracy. Separate audit gas cylinders for audit points 1 and 2 must be used. See Attachment 2, 40 CFR Part 60, Appendix F, Section 5.1.2 for the entire CGA procedure and Attachment 1 for CGA example data and calculations.

Three important CGA formulas are as follows (example data and calculations in Attachment 1):

1. Pollutant audit gas is within the correct range for monitor span:

Equation 2: 
$$P_r = \frac{C_v}{M_s} \times 100$$

where:

P<sub>r</sub> = Percent Pollutant Audit Gas of the Monitor Span

C<sub>v</sub> = Certified Cylinder concentration

M<sub>s</sub> = Monitor Span

Equation 3: 
$$C_m = \frac{1}{n} \sum_{i=1}^n C_i \quad \text{Average CEMS Response}$$

where:

C<sub>m</sub> = Average CEMS Response

C<sub>i</sub> = individual CEMS Responses

### 3. CEMS Accuracy:

Equation 4: 
$$A = \frac{C_m - C_a}{C_a} \times 100$$

where:

A = CEMS Accuracy in Percent (%)

C<sub>m</sub> = Average CEMS Response

C<sub>a</sub> = Audit Value (Certified Cylinder Gas Concentration)

Note: CGA Accuracy is **not** an absolute number therefore negative (-) accuracy values are possible.

#### **Important CGA elements:**

1. Challenge the CEMS three times at each audit point.
2. Use separate audit gas cylinder for audit points 1 and 2.
3. Do not dilute gas from audit cylinder when challenging the CEMS.
4. Allow enough time to assure a stable CEMS response.
5. Operate each CEMS in its normal sampling mode through all filters, scrubbers, conditioners, normal sampling, and as much of the sampling probe as is practical.
6. Use certified cylinder gases which meet the requirements of Appendix F, Section 5.1.2 (3).
7. Use cylinder gases with current (not expired) certification dates.
8. Use cylinders with pressures greater than 100 psi.

#### **4.3.1.2 Linearity Test**

A linearity test (performance audit) is required to be conducted on all Acid Rain CEMS subject to the Part 75 Appendix B - Quality Assurance and Quality Control Procedures. Simply stated, a linearity test is Part 75's version of the Part 60, Appendix F CGA. The linearity test differs from the CGA in the following ways:

1. A zero-level concentration is specified, defined and is a required part of the audit.
2. A third upscale pollutant gas concentration is required.
3. Additional requirements of cylinder audit gases including zero air materials.
4. The linearity error (LE) formula is different from the CGA accuracy formula (see formula below).
5. The LE limit is 5.0% (alternate limit: |R-A| is less than or equal to 5 ppm for SO<sub>2</sub> and NO<sub>x</sub>; or for dilutant monitors, 0.5% CO<sub>2</sub> or O<sub>2</sub> whichever is less restrictive.)

A linearity test requires the CEMS to be challenged at the following four concentration levels:

1. Zero-level concentration: 0 to 20% of span
2. Low-level concentration: 20 to 30% of span

3. Mid-level concentration: 50 to 60% of span
4. High-level concentration: 80 to 100% of span

Note: The linearity test low-level concentration range is the same range as that for the CGA low range. The linearity test mid-level concentration is the same range as that for the CGA high range. This overlap in concentration ranges between Part 75, Appendix B and Part 60, Appendix F allows sources which must meet both auditing and reporting requirements to conduct only one audit during the calendar quarter on those CEMS. However, as noted above, linearity (LE) and CGA accuracy (A) is calculated and reported differently.

Equation 5: 
$$LE' = \frac{*R\&A*}{R} \times 100$$

where:

LE = Percentage Linearity error, based upon the reference value

R = Reference value of Low-, mid-, or high-level calibration gas introduced into the CEMS

A = Average of the CEMS responses

<b>Differences between the Part 75 Linearity Test and the Part 60 CGA</b>	
<b>Linearity Test</b>	<b>CGA</b>
Zero-level concentration is defined and is a required part of the linearity test.	Zero is not defined nor is a required part of the CGA.
Three upscale gas concentrations and a zero concentration are required (four concentration levels).	Two upscale gas concentrations are required (no zero concentration is required).
Detailed zero-level and upscale audit gas certification requirements.	Some upscale audit gas certification requirements.
Linearity Error formula (absolute value, only positive results): $LE' = \frac{*R\&A*}{R} \times 100$	CGA accuracy formula (negative results possible): $A' = \frac{C_m \& C_a}{C_a} \times 100$
Linearity Error limit = 5.0%	CGA Accuracy limit = ±15%
Electronic report to EPA.	Paper report to state (IDEM).

#### **4.3.1.3 Relative Accuracy Test Audit (RATA)**

A RATA is an audit in which data from a CEMS is compared to data from EPA reference methods of 40 CFR Part 60, Appendix A. CEMS accuracy is determined **RELATIVE** to the EPA reference method. Although the same EPA reference methods are used to determine emissions for compliance purposes (as in a stack test), the primary function of reference method data in a RATA is as the benchmark for comparison with the CEMS data.

A RATA is initially conducted during the certification or performance specification testing period of each CEMS. After the initial certification had been completed the RATA performance audit must be conducted at least once every four calendar quarters.

Because of the amount of equipment, staff and time resources necessary to conduct a RATA, most sources elect to hire a contractor to perform this audit. IDEM maintains a list of test consults who are equipped to perform this type of testing. This list is available on request by contacting the OAM, CDS at the above mentioned number.

#### **4.3.1.4 Relative Accuracy Audit (RAA)**

A Relative Accuracy Audit is an abbreviated version of a RATA and was originally intended for auditing CEMS (3 out of 4 calendar quarters) which were not designed to accept Cylinder Gas Audits (CGA). Only three test runs are required for an RAA but as in a RATA, the PS requirements in Appendix B must be met. Currently, all gaseous CEMS in Indiana are capable of accepting a CGA so the expensive and time-consuming RAA is not routinely performed. For more information on RAA refer to Attachment 2 (40 CFR Part 60, Appendix F, Section 5.1.3).

#### **4.3.2 Systems Audit**

Volume III of the EPA Quality Assurance Handbook for Air Pollution Measurement Systems defines a systems audit as "a systematic *qualitative* review of facilities, equipment, training, procedures, record-keeping, validation, and reporting aspects of a total (quality assurance) system, to arrive at a measure of the capability and ability of the system." A systems audit may be conducted on a scheduled frequency by the source's environmental auditor. However, IDEM-OAM may conduct a systems audit on any source which exhibits problems with producing data of sufficient quality and quantity to demonstrate compliance with the applicable standard. The Quality Assurance Plan is used as a guide for conducting a systems audit. The Plan allows the auditor to determine if the source is following all QA/QC procedures specified in the Plan and it also guides the auditor when reviewing the source's CEMS operating logs, records, and data. In some cases a performance audit will also be conducted in conjunction with a systems audit. For the purpose of conducting quarterly audits, the CDS requires 35 day advanced notification for RATA's conducted for formal audit purposes. A source need not notify CDS whenever a CGA

or RAA is conducted. However, this office may request notification and may observe, or conduct source audits whenever a source has demonstrated, through failed audits, that their QA program is deficient.

#### **4.4 Cylinder Gas Certification Requirements**

##### **4.41 Selection of Audit Gases**

Table 1-2 and section 1.3.1.2 define the ranges of calibration gases which must be used for Part 60 and Part 75 CEMS audits. For the purpose of conducting the CGA, the individual performing the audit must use audit gases that have been certified by comparison to the National Bureau of Standards (NBS) gases Standard Reference Materials (SRM's) or, NBS EPA approved gas manufacturer's Certified Reference Materials (CRM's) following EPA Traceability Protocol No. 1. As an alternative, CRM's may be used directly as audit gases.

When performing linearity checks for Part 75 monitors, the auditor must use either SRM gases, NIST Traceable Reference Materials, or Certified Reference Materials following EPA Traceability Protocol No. 1.

Documentation in the form of a certification sheet specific for each gas used must be included in the final audit report.

##### **4.5 Data Availability Requirements and Calculations**

As the name states, a continuous emission monitoring system is expected to produce monitoring data **continuously** while the source is in operation. However, any monitor will have periods of down-time in which it may not be producing data. Short periods of missing data are expected and accounted for (not counted as missing data) when calculating monitor down-time. For example, calibrations and quarterly audits are not counted as missing data. Short periods of missing data might occur when performing preventative maintenance on the monitor(s). See Attachment 4, Section 5.5.6 for more information on data availability (data capture).

IDEM does **not** have a minimum valid data requirement for emissions data. Each source is expected to capture as much data as possible so that any emissions (such as excess emissions) can be documented. Periods of missing data and the reason for their occurrence must be included in the source's quarterly report to IDEM. IDEM evaluates each source with less than 100% valid data returned (VDR) and makes determinations **on a case by case basis** as to any enforcement action(s) that may be taken.

A CEMS which exceeds the limits of a daily calibration, quarterly audit, or any other QC check must be designated by the owner/operator as "out-of-control" and the problem must be corrected as soon as possible. Any data captured between two "out-of-control" periods is not considered valid data and does not count towards VDR requirements. Rapid corrective action in these cases

is necessary to avoid possible enforcement action based on unacceptably low valid data capture in any given quarter. Any data produced which the source deems questionable (not representative of the actual emissions) should be designated as suspect. The source must submit this suspect data, along with the reasons for the data being suspect, to IDEM for review. IDEM will make the final determination as to the validity of all data.

To calculate monitor down time use the following equation

$$\% \text{ Monitor Down Time} = \frac{(\text{Total Source Operating Hours} - \text{CEMS Operation Time})}{\text{Total Source Operating Time}} \times 100$$

**Example Calculation:**

Total Source Operating Time = 1659.5 hours

CEMS Operating Time = 1493.0 hours

$$\% \text{ of Monitor Down Time} = [(1659.5 - 1493.0) / 1659.5] \times 100 = 13.8\%$$

## **5.0 MONITORING SYSTEM MALFUNCTIONS**

### **5.1 Initial Source Response**

At some period during a monitoring systems lifetime it is likely to experience periods of malfunction. These malfunctions can be the result of general wear and tear on the system, or may be the result of an unforeseen circumstance such as a lightning strike or power surge. Regardless, malfunctions prevent the source from obtaining valid monitoring data and contribute to source downtime. These periods must be identified and included with the source's quarterly report. However, IDEM recognizes the nature of these types of malfunctions and evaluates them on a case by case basis.

When faced with a monitoring system malfunction the source should fix the problem and bring the monitor back into operation as quickly as possible. Please note that during the evaluation of a monitoring system malfunction, IDEM will take into consideration both the nature of the malfunction, and the source's response. Although certain types of malfunctions are inevitable, inadequate responses, or failure to correct the cause of repeated monitoring system malfunctions must be avoided.



## **5.2 Alternate Monitoring**

While some malfunctions may be able to be fixed relatively rapidly (hours), in other cases it may not be possible for the source to identify the amount of time the corrective actions will take. In these situations it is recommended the source implement an alternative monitoring strategy. The purpose of this alternative monitoring is to collect data which indicates that the unit which the monitoring system served remains in compliance. The source can then provide this information to the IDEM. This evidence may then be taken into account by the IDEM upon review of the source's compliance status with respect to percent downtime and data validity in the affected quarter/s.

## **5.3 Example Alternative Monitoring Strategies**

Although it is impossible to discuss all the alternative monitoring possibilities here, several examples are listed below. Be advised that for sources required to obtain a Title V permit, mandatory alternative monitoring strategies may be contained in the permit. For sources which do not have mandatory alternative monitoring conditions or are not required to obtain a Title V permit, the IDEM and the source must reach agreement on the parameters to be monitored prior to their use as a surrogate indicator of compliance. Failure to agree on the alternative monitoring parameters may prevent them from being recognized by the IDEM. A good place for a source to describe its potential alternative monitoring practices would be to include them in the source's monitoring plan. Using this approach the source can avoid confusion and immediately implement an approved alternative monitoring strategy in the event of a monitor malfunction.

### **Example 1**

#### **SO<sub>2</sub>/NO<sub>x</sub> Monitor Malfunction**

Alternative Monitoring could include the use of a portable analyzer to take pollutant/diluent readings. Supplemental monitoring of various unit or control device operational parameters deemed suitable by both the source and the IDEM as acceptable indicators may also be utilized. These could include parameters such as PH or pressure drops on a venturi scrubber for SO<sub>2</sub> control, or operational parameters of combustion for NO<sub>x</sub> emission rates. These parameters should be implemented at intervals no less frequent than once per hour unless a different sampling schedule has been agreed upon by both the source and the IDEM.

## **6.0 RECORD-KEEPING AND REPORTING OF QUALITY ASSURANCE ACTIVITIES**

### **6.1 Daily or Weekly Log Books and Check Sheets**

A daily or weekly log for QC checks must be maintained for each CEMS. This log helps to ensure that all daily and weekly maintenance and QC activities are performed. The log provides a permanent record for supervisors and for regulatory officials to verify that QC checks and routine maintenance were done on a specific date and time.

Activities such as the results of the daily zero and span check must be recorded in the log. The log should be patterned after the checks specific to each brand and model of CEMS. Refer to the CEMS manual for the items to include on the log. The operator's experience should also dictate which items to include and the amount of detail to add to the log. The log can take many forms, there is no requirement as to the exact organization or type of the daily log. All records related to CEMS QA/QC and operation must be kept by the source and available for inspection for a minimum of 3 years.

A bound numbered log book provides the most assurance that QC checks were performed daily should the data were ever be questioned. Bound log books are not required so, many operators may elect to use a loose leaf or three-ring binder type of log book. Since most CEMS use a computerized Data Acquisition and Handling System( DAHS), a PC complied log is also acceptable.

### **6.2 Quarterly Reporting**

Within thirty (30) days after the end of each calendar quarter, each source operating a CEMS must submit a quality assurance report to IDEM-OAM. Information which must be provided in this report includes:

1. The name(s) of contact person(s) responsible for the report,
2. The location of each CEMS (stack, unit or duct designation),
3. All data used to calculate the calibration error assessment (Section 4.3.1).

IDEM reviews all quarterly QA reports for completeness, correct use of equations and calculations, and audit results. A complete and descriptive audit report ensures that all concerned parties are adequately informed as to the operational status of the source's CEMS.

Unless specifically requested, sources **are not** required to submit to IDEM-OAM the following: daily, weekly, or monthly operational logs, daily zero and span data, and routine maintenance information.

## 7.0 RECORD-KEEPING AND REPORTING OF EXCESS EMISSIONS

### 7.1 Excess Emissions Reports (EER)

Quarterly excess emissions reports are required for sources which monitor emissions for compliance with an applicable rule or subpart. As the name implies, these reports are a summary of the instances in which the pollutant concentration exceeds the applicable limit during the source's averaging period.

The Excess Emissions Report is a summary of three parameters:

- a. **Facility Operating Time** may be reported as either the time in operation, or as the total process down-time.
- b. **CEMS Down-time** (due to malfunction, maintenance and QA/QC) must be reported in real-time hours. During periods of malfunction, the cause of the malfunction and corrective action taken should be described. For other periods of invalid data, the cause of the invalid data and the corrective action/s taken should be reported.

In addition to the above information, a source must indicate the identification of the monitored facility (i.e., No. 6 Boiler) as well as the period of time covered in the EER (i.e., First Quarter 1994).

The EER must be submitted to IDEM no later than thirty (30) days after the end of the quarter for reports due quarterly and no later than fifteen (15) days after the end of the month for reports due monthly. These reports should be submitted to:

Ed Surla, Chief,  
Compliance Data Section  
Office of Air Management  
P.O. Box 6015  
Indianapolis, IN 46206-6015

An example quarterly EER is available upon request to the Compliance Data Section of IDEM. The example EER is only a guideline and should be tailored to fit your monitoring needs. Form 3 on page 25 provides a template for a quarterly excess emissions summary report.

## **8.0 SUMMARY OF INDIANA CEMS REQUIREMENTS**

1. (Section 2.3) Submit the proposed CEMS location to IDEM, OAM for review and approval 35 days prior to installation.
2. (Section 2.3) Perform a certification test for each installed CEMS meeting the requirements of 40 CFR Part 60, Appendix B, PS-2 (and any other applicable PS)
3. (Section 2.3) Submit the certification test data to IDEM, OAM for review and approval within 45 days after the completed test.
4. (Section 3.4) Submit a Quality Assurance Plan to IDEM, OAM for review and approval within 45 days after the completed certification test. Submit any revisions to the QA Plan to IDEM, OAM at least biennially.
5. (Section 4.2.1) Daily, perform a calibration drift assessment (zero and span).
6. (Section 4.3.1) Quarterly, conduct a performance audit on each CEMS according to PS-2 and the manufacturer's instructions.
7. (Section 5.2) Within 30 days after the end of the calendar quarter, submit a QA report with the information specified in Section 5.2.
8. (Section 6.1) Within thirty (30) days following the end of each calendar quarter, submit an excess emission report to IDEM, OAM Compliance Data Section.
9. (Section 5.1) Maintain QC logs: daily or weekly.
10. (Section 5.1) Keep data, records and logs of QC, monitor operation for a minimum of three (3) years.

### Form 3 - Excess Emission Report

<b>Emissions Data Summary</b>	<b>CEMS Performance Summary</b>
1. Duration of excess emissions (in six minute averages) in reporting period due to:	1. CEMS down-time (in hours) in reporting period due to:
a: Startup/Shutdown _____	a: Monitor Equipment Malfunctions _____
b: Control Equipment Problems _____	b: Non-Monitor Equipment Malfunctions _____
c: Process Problems _____	c: Quality Assurance Calibrations _____
d: Other Known Causes _____	d: Other Known Causes _____
e: Unknown Causes _____	e: Unknown Causes _____
2. Total Duration of Excess Emissions	2. Total CEMS Down-Time

## Attachment 1

### Example CGA Data

**Table 1A-1**

Plant / Unit: Central / Unit #1		Company: ABC, Inc.	Audit Date: 1/5/98		Auditor: ABC, Inc / RJS	
Monitor Brand: TECO 42		S.N.: 42-1234-126	Parameter: SO2		Span: 500 ppm	
Audit Point 1 - Low Concentration [20% - 30% of Span]			Audit Point 2 - High Concentration [50% - 60% of Span]			
Cylinder S.N.: XY-102102		Concentration: 134.00 ppm		Cylinder S.N.: XY-102108		Concentration: 269.00 ppm
Cylinder Expiration Date: 9/12/98			Cylinder Expiration Date: 9/12/98			
Run Number	CEMS Response (ppm)		Run Number	CEMS Response (ppm)		
1	130.50		1	272.00		
2	131.20		2	262.50		
3	129.90		3	260.40		
Ave CEMS Response		130.53	Ave CEMS Response		264.97	
Accuracy		-2.59%	Accuracy		-1.50%	
Limit: Pass if $<\pm 15\%$		Pass	Limit: Pass if $<\pm 15\%$		Pass	
Monitor Brand: Milton Roy 3300		S.N.: N9G- 1234Q	Parameter: CO2		Span: 20%	
Audit Point 1 - Low Concentration [5%- 8% by Volume]			Audit Point 2 - High Concentration [10% -14% by Volume]			
Cylinder S.N.: XY-102102		Concentration: 6.20 %		Cylinder S.N.: XY-102108		Concentration: 12.30 %
Run Number	CEMS Response (%)		Run Number	CEMS Response (%)		
1	6.80		1	11.90		
2	6.10		2	11.80		
3	5.90		3	12.00		
Ave CEMS Response		6.27	Ave CEMS Response		11.90	
Accuracy		-1.08%	Accuracy		-3.25%	
*Limit: Pass if $<\pm 15\%$		Pass	*Limit: Pass if $<\pm 15\%$		Pass	
* or $\pm 5$ ppm, whichever is greater [40 CFR Part 60, Appendix F, Section 5.2.3 (2)].						

1. Pollutant audit gas is within the correct range for monitor span:

$$\text{Equation 2: } P_r = \frac{C_v}{M_s} \times 100$$

where:

$P_c$  = Percent Pollutant Audit Gas of the Monitor Span

$C_v$  = Certified Cylinder concentration

$M_s$  = Monitor Span

Example Calculations:

$C_v$  = 134 ppm (Audit Point 1 - Low Certified Cylinder Concentration)

$M_s$  = 500 ppm (SO<sub>2</sub> monitor span)

$$\text{Equation 2: } P_r = \frac{134}{500} \times 100 = 26.8\% \text{ Low Range requirement: 20\% - 30\%}$$

$C_v$  = 269 ppm (Audit Point 2 - High Certified Cylinder Concentration)

$M_s$  = 500 ppm (SO<sub>2</sub> monitor span)

$$\text{Equation 2: } P_r = \frac{269}{500} \times 100 = 53.8\% \text{ High Range requirement: 50\% - 60\%}$$

Note: the diluent gas ranges are not calculated, see table 1-1 for the specified ranges.

$$\text{Equation 3: } C_m = \frac{1}{n} \sum_{i=1}^n C_i \text{ Average CEMS Response}$$

where:

$C_m$  = Average CEMS Response

$C_i$  = individual CEMS Responses

Example Calculations:

$$\text{Equation 3: } C_m = \frac{130.5\% + 131.2\% + 129.9\%}{3} = 130.53 \text{ Audit Point 1 - Low Concentration CEMS Response}$$

$$\text{Equation 3: } C_m = \frac{272.0\% + 262.5\% + 260.4\%}{3} = 264.97 \text{ Audit Point 2 - High Concentration CEMS Response}$$

3. CEMS Accuracy:

$$\text{Equation 4: } A = \frac{C_m \& C_a}{C_a} \times 100$$

where:

A = CEMS Accuracy in Percent (%)

C<sub>m</sub> = Average CEMS Response

C<sub>a</sub> = Audit Value (Certified Cylinder Gas Concentration)

Example Calculations:

Equation 4:

Audit Point 1 - Low Concentration Accuracy

$$A = \frac{130.63 - 134.00}{134.00} \times 100 = -2.56\%$$

Audit Point 2 - High Concentration Accuracy

$$A = \frac{264.97 - 269.00}{269.00} \times 100 = -1.50\%$$

Note: CGA Accuracy is **not** an absolute number therefore minus (-) accuracy values are possible.

### Linearity Formulas and Calculations

Equation 5:  $LE = \frac{R \& A}{R} \times 100$

where:

LE = Percentage Linearity error, based upon the reference value

R = Reference value of low-, mid-, or high-level calibration gas introduced into the CEMS

A = Average of the CEMS responses

Example Calculations (using the data from Table 1A-1):

Equation 5:

$$LE = \frac{134.00 - 130.63}{134.00} \times 100 = 2.51\% \quad \text{Low-level}$$

$$LE = \frac{269.00 - 264.97}{269.00} \times 100 = 1.50\% \quad \text{Mid-level}$$





Arithmetic Mean:  $\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$

Example Calculation:

$$\bar{d} = \frac{.0223\% + .0205\% + .0034\% + .0065\% + .0004\% + .016\% + .0152\% + .0113\% + .0033}{9} = 0.0102$$

Standard Deviation:  $S_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1}}$

Example Calculation:  $S_d = \sqrt{\frac{.00159713 + \frac{(.0915)^2}{9}}{8}} = \sqrt{\frac{.00159713 + .00837225}{8}} = 0.0091$

Confidence Coefficient:  $CC = t_{0.975} \frac{S_d}{\sqrt{n}}$

Example Calculation:  $CC = 2.306 \frac{0.0091}{\sqrt{9}} = 0.0070$

Relative Accuracy:  $RA = \frac{\bar{d} * CC}{RM} * 100$

Example Calculation:  $RA = \frac{0.0102 * 0.0070}{0.3197} * 100 = 5.38\%$

## Attachment 2

### 40 CFR PART 60 APPENDIX F--QUALITY ASSURANCE PROCEDURES

#### PROCEDURE 1. QUALITY ASSURANCE REQUIREMENTS FOR GAS CONTINUOUS EMISSION MONITORING SYSTEMS USED FOR COMPLIANCE DETERMINATION

##### 1. Applicability and Principle

1.1 Applicability. Procedure 1 is used to evaluate the effectiveness of quality control (QC) and quality assurance (QA) procedures and the quality of data produced by any continuous emission monitoring system (CEMS) that is used for determining compliance with the emission standards on a continuous basis as specified in the applicable regulation. The CEMS may include pollutant (e.g., SO<sub>2</sub> and NO<sub>x</sub>) and diluent (e.g., O<sub>2</sub> or CO<sub>2</sub>) monitors.

This procedure specifies the minimum QA requirements necessary for the control and assessment of the quality of CEMS data submitted to the Environmental Protection Agency (EPA). Source owners and operators responsible for one or more CEMS's used for compliance monitoring must meet these minimum requirements and are encouraged to develop and implement a more extensive QA program or to continue such programs where they already exist.

Data collected as a result of QA and QC measures required in this procedure are to be submitted to the Agency. These data are to be used by both the Agency and the CEMS operator in assessing the effectiveness of the CEMS QC and QA procedures in the maintenance of acceptable CEMS operation and valid emission data.

Appendix F, Procedure 1 is applicable December 4, 1987. The first CEMS accuracy assessment shall be a relative accuracy test audit (RATA) (see section 5) and shall be completed by March 4, 1988 or the date of the initial performance test required by the applicable regulation, whichever is later.

1.2 Principle. The QA procedures consist of two distinct and equally important functions. One function is the assessment of the quality of the CEMS data by estimating accuracy. The other function is the control and improvement of the quality of the CEMS data by implementing QC policies and corrective actions. These two functions form a control loop:

When the assessment function indicates that the data quality is inadequate, the control effort must be increased until the data quality is acceptable. In order to provide uniformity in the assessment and reporting of data quality, this procedure explicitly specifies the assessment methods for

response drift and accuracy. The methods are based on procedures included in the applicable performance specifications (PS's) in appendix B of 40 CFR part 60. Procedure 1 also requires the analysis of the EPA audit samples concurrent with certain reference method (RM) analyses as specified in the applicable RM's.

Because the control and corrective action function encompasses a variety of policies, specifications, standards, and corrective measures, this procedure treats QC requirements in general terms to allow each source owner or operator to develop a QC system that is most effective and efficient for the circumstances.

## 2. Definitions

2.1 Continuous Emission Monitoring System. The total equipment required for the determination of a gas concentration or emission rate.

2.2 Diluent Gas. A major gaseous constituent in a gaseous pollutant mixture. For combustion sources, CO<sub>2</sub> and O<sub>2</sub> are the major gaseous constituents of interest.

2.3 Span Value. The upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable subpart of the regulation.

2.4 Zero, Low-Level, and High-Level Values. The CEMS response values related to the source specific span value. Determination of zero, low-level, and high-level values is defined in the appropriate PS in appendix B of this part.

2.5 Calibration Drift (CD). The difference in the CEMS output reading from a reference value after a period of operation during which no unscheduled maintenance, repair or adjustment took place. The reference value may be supplied by a cylinder gas, gas cell, or optical filter and need not be certified.

2.6 Relative Accuracy (RA). The absolute mean difference between the gas concentration or emission rate determined by the CEMS and the value determined by the RM's plus the 2.5 percent error confidence coefficient of a series of tests divided by the mean of the RM tests or the applicable emission limit.

## 3. QC Requirements

Each source owner or operator must develop and implement a QC program. As a minimum, each QC program must include written procedures which should describe in detail, complete, step-by-step procedures and operations for each of the following activities:

1. Calibration of CEMS.
2. CD determination and adjustment of CEMS.
3. Preventive maintenance of CEMS (including spare parts inventory).
4. Data recording, calculations, and reporting.
5. Accuracy audit procedures including sampling and analysis methods.
6. Program of corrective action for malfunctioning CEMS.

As described in Section 5.2, whenever excessive inaccuracies occur for two consecutive quarters, the source owner or operator must revise the current written procedures or modify or replace the CEMS to correct the deficiency causing the excessive inaccuracies.

These written procedures must be kept on record and available for inspection by the enforcement agency.

#### 4. CD Assessment

4.1 CD Requirement. As described in 40 CFR 60.13(d), source owners and operators of CEMS must check, record, and quantify the CD at two concentration values at least once daily (approximately 24 hours) in accordance with the method prescribed by the manufacturer. The CEMS calibration must, as minimum, be adjusted whenever the daily zero (or low-level) CD or the daily high-level CD exceeds two times the limits of the applicable PS's in appendix B of this regulation.

4.2 Recording Requirement for Automatic CD Adjusting Monitors. Monitors that automatically adjust the data to the corrected calibration values (e.g., microprocessor control) must be programmed to record the unadjusted concentration measured in the CD prior to resetting the calibration, if performed, or record the amount of adjustment.

4.3 Criteria for Excessive CD. If either the zero (or low-level) or high-level CD result exceeds twice the applicable drift specification in appendix B for five, consecutive, daily periods, the CEMS is out-of-control.

If either the zero (or low-level) or high-level CD result exceeds four times the applicable drift specification in appendix B during any CD check, the CEMS is out-of-control. If the CEMS is out-of-control, take necessary corrective action. Following corrective action, repeat the CD checks.

4.3.1 Out-Of-Control Period Definition. The beginning of the out-of-control period is the time corresponding to the completion of the fifth, consecutive, daily CD check with a CD in excess of two times the allowable limit, or the time corresponding to the completion of the daily CD check preceding the daily CD check that results in a CD in excess of four times the allowable limit. The

end of the out-of-control period is the time corresponding to the completion of the CD check following corrective action that results in the CD's at both the zero (or low-level) and high-level measurement points being within the corresponding allowable CD limit (i.e., either two times or four times the allowable limit in appendix B).

4.3.2 CEMS Data Status During Out-of-Control Period. During the period the CEMS is out-of-control, the CEMS data may not be used in calculating emission compliance nor be counted towards meeting minimum data availability as required and described in the applicable subpart [e.g., 60.47a(f)].

4.4 Data Recording and Reporting. As required in 60.7(d) of this regulation (40 CFR part 60), all measurements from the CEMS must be retained on file by the source owner for at least 2 years. However, emission data obtained on each successive day while the CEMS is out-of-control may not be included as part of the minimum daily data requirement of the applicable subpart [e.g., 60.47a(f)] nor be used in the calculation of reported emissions for that period.

## 5. Data Accuracy Assessment

5.1 Auditing Requirements. Each CEMS must be audited at least once each calendar quarter. Successive quarterly audits shall occur no closer than 2 months. The audits shall be conducted as follows:

5.1.1 Relative Accuracy Test Audit (RATA). The RATA must be conducted at least once every four calendar quarters. Conduct the RATA as described for the RA test procedure in the applicable PS in appendix B (e.g., PS 2 for SO<sub>2</sub> and NO<sub>x</sub>). In addition, analyze the appropriate performance audit samples received from EPA as described in the applicable sampling methods (e.g., Methods 6 and 7).

5.1.2 Cylinder Gas Audit (CGA). If applicable, a CGA may be conducted in three of four calendar quarters, but in no more than three quarters in succession.

To conduct a CGA: (1) Challenge the CEMS (both pollutant and diluent portions of the CEMS, if applicable) with an audit gas of known concentration at two points within the following ranges:

Audit point	Audit Range		
	Pollutant monitors	Diluent monitors for--	
		CO <sub>2</sub>	O <sub>2</sub>
1.....	20 to 30% of span value.	5 to 8% by volume.	4 to 6% by volume.
2.....	50 to 60% of span value.	10 to 14% by volume.	8 to 12% by volume.

Challenge the CEMS three times at each audit point, and use the average of the three responses in determining accuracy.

Use of separate audit gas cylinder for audit points 1 and 2. Do not dilute gas from audit cylinder when challenging the CEMS.

The monitor should be challenged at each audit point for a sufficient period of time to assure adsorption-desorption of the CEMS sample transport surfaces has stabilized.

(2) Operate each monitor in its normal sampling mode, i.e., pass the audit gas through all filters, scrubbers, conditioners, and other monitor components used during normal sampling, and as much of the sampling probe as is practical. At a minimum, the audit gas should be introduced at the connection between the probe and the sample line.

(3) Use audit gases that have been certified by comparison to National Bureau of Standards (NBS) gaseous Standard Reference Materials (SRM's) or NBS/EPA approved gas manufacturer's Certified Reference Materials (CRM's) (See Citation 1) following EPA Traceability Protocol No. 1 (See Citation 2). As an alternative to Protocol No. 1 audit gases, CRM's may be used directly as audit gases. A list of gas manufacturers that have prepared approved CRM's is available from EPA at the address shown in Citation 1. Procedures for preparation of CRM's are described in Citation 1. Procedures for preparation of EPA Traceability Protocol 1 materials are described in Citation 2.

The difference between the actual concentration of the audit gas and the concentration indicated by the monitor is used to assess the accuracy of the CEMS.

5.1.3 Relative Accuracy Audit (RAA). The RAA may be conducted three of four calendar quarters, but in no more than three quarters in succession. To conduct a RAA, follow the procedure described in the applicable PS in appendix B for the relative accuracy test, except that only three sets of measurement data are required. Analyses of EPA performance audit samples are also required.

The relative difference between the mean of the RM values and the mean of the CEMS responses will be used to assess the accuracy of the CEMS.

5.1.4 Other Alternative Audits. Other alternative audit procedures may be used as approved by the Administrator for three of four calendar quarters. One RATA is required at least once every four calendar quarters.

5.2 Excessive Audit Inaccuracy. If the RA, using the RATA, CGA, or RAA exceeds the criteria in section 5.2.3, the CEMS is out-of-control. If the CEMS is out-of-control, take necessary corrective action to eliminate the problem. Following corrective action, the source owner or operator must audit the CEMS with a RATA, CGA, or RAA to determine if the CEMS is operating within the specifications. A RATA must always be used following an out-of-control period resulting from a RATA. The audit following corrective action does not require analysis of EPA performance audit samples. If audit results show the CEMS to be out-of-control, the CEMS operator shall report both the audit showing the CEMS to be out-of-control and the results of the audit following corrective action showing the CEMS to be operating within specifications.

5.2.1 Out-Of-Control Period Definition. The beginning of the out-of-control period is the time corresponding to the completion of the sampling for the RATA, RAA, or CGA. The end of the out-of-control period is the time corresponding to the completion of the sampling of the subsequent successful audit.

5.2.2. CEMS Data Status During Out-Of-Control Period. During the period the monitor is out-of-control, the CEMS data may not be used in calculating emission compliance nor be counted towards meeting minimum data availability as required and described in the applicable subpart [e.g., 60.47a(f)].

5.2.3 Criteria for Excessive Audit Inaccuracy. Unless specified otherwise in the applicable subpart, the criteria for excessive inaccuracy are:

- (1) For the RATA, the allowable RA in the applicable PS in appendix B.
- (2) For the CGA,  $\pm 15$  percent of the average audit value or  $\pm 5$  ppm, whichever is greater.
- (3) For the RAA,  $\pm 15$  percent of the three run average or  $\pm 7.5$  percent of the applicable standard, whichever is greater.

5.3 Criteria for Acceptable QC Procedure. Repeated excessive inaccuracies (i.e., out-of-control conditions resulting from the quarterly audits) indicates the QC procedures are inadequate or that the CEMS is incapable of providing quality data. Therefore, whenever excessive inaccuracies occur for two consecutive quarters, the source owner or operator must revise the QC procedures (see Section 3) or modify or replace the CEMS.



## 6. Calculations for CEMS Data Accuracy

6.1 RATA RA Calculation. Follow the equations described in Section 8 of appendix B, PS 2 to calculate the RA for the RATA. The RATA must be calculated in units of the applicable emission standard (e.g., ng/J).

6.2 RAA Accuracy Calculation. Use Equation 1-1 to calculate the accuracy for the RAA. The RAA must be calculated in units of the applicable emission standard (e.g., ng/J).

6.3 CGA Accuracy Calculation. Use Equation 1-1 to calculate the accuracy for the CGA, which is calculated in units of the appropriate concentration (e.g., ppm SO<sub>2</sub> or percent O<sub>2</sub>). Each component of the CEMS must meet the acceptable accuracy requirement.

Eq. 1-1

$$A = \frac{C_m - C_a}{C_a}$$

where:

A = Accuracy of the CEMS, percent.

C<sub>m</sub> = Average CEMS response during audit in units of applicable standard or appropriate concentration.

C<sub>a</sub> = Average audit value (CGA certified value or three-run average for RAA) in units of applicable standard or appropriate concentration.

6.4 Example Accuracy Calculations. Example calculations for the RATA, RAA, and CGA are available in Attachment 3.

## 7. Reporting Requirements

At the reporting interval specified in the applicable regulation, report for each CEMS the accuracy results from Section 6 and the CD assessment results from Section 4. Report the drift and accuracy information as a Data Assessment Report (DAR), and include one copy of this DAR for each quarterly audit with the report of emissions required under the applicable subparts of this part.

As a minimum, the DAR must contain the following information:

1. Source owner or operator name and address.
2. Identification and location of monitors in the CEMS.
3. Manufacturer and model number of each monitor in the CEMS.
4. Assessment of CEMS data accuracy and date of assessment as determined by a RATA, RAA, or CGA described in Section 5 including the RA for the RATA, the A for the RAA or

CGA, the RM results, the cylinder gases certified values, the CEMS responses, and the calculations results as defined in Section 6. If the accuracy audit results show the CEMS to be out-of-control, the CEMS operator shall report both the audit results showing the CEMS to be out-of-control and the results of the audit following corrective action showing the CEMS to be operating within specifications.

5. Results from EPA performance audit samples described in Section 5 and the applicable RM's.

6. Summary of all corrective actions taken when CEMS was determined out-of-control, as described in Sections 4 and 5.

An example of a DAR format is shown in Figure 1.

## 8. Bibliography

1. "A Procedure for Establishing Traceability of Gas Mixtures to Certain National Bureau of Standards Standard Reference Materials." Joint publication by NBS and EPA-600/7-81-010. Available from the U.S. Environmental Protection Agency. Quality Assurance Division (MD-77). Research Triangle Park, NC 27711.

2. "Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors (Protocol Number 1)" June 1978. Section 3.0.4 of the Quality Assurance Handbook for Air Pollution Measurement Systems. Volume III. Stationary Source Specific Methods. EPA-600/4-77-027b. August 1977. U.S. Environmental Protection Agency. Office of Research and Development Publications, 26 West St. Clair Street, Cincinnati, OH 45268.

3. Calculation and Interpretation of Accuracy for Continuous Emission Monitoring Systems (CEMS). Section 3.0.7 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods. EPA-600/4-77-027b. August 1977. U.S. Environmental Protection Agency. Office of Research and Development Publications, 26 West St. Clair Street, Cincinnati, OH 45268.

Figure 1--EXAMPLE FORMAT FOR DATA ASSESSMENT REPORT

Period ending date -----  
Year-----  
Company name-----  
Plant name-----  
Source unit no.-----  
CEMS manufacturer-----

Model no.-----  
 CEMS serial no.-----  
 CEMS type (e.g., in situ)-----  
 CEMS sampling location (e.g., control device outlet)-----  
 CEMS span values as per the applicable regulation: \_\_\_\_\_  
 (e.g., SO<sub>2</sub> \_\_\_\_\_ ppm, NO<sub>x</sub> \_\_\_\_\_ ppm).-----

I. Accuracy assessment results (Complete A, B, or C below for each CEMS or for each pollutant and diluent analyzer, as applicable.) If the quarterly audit results show the CEMS to be out-of-control, report the results of both the quarterly audit and the audit following corrective action showing the CEMS to be operating properly.

A. Relative accuracy test audit (RATA) for \_\_\_\_\_ (e.g., SO<sub>2</sub> in ng/J).

1. Date of audit \_\_\_\_\_.
2. Reference methods (RM's) used \_\_\_\_\_ (e.g., Methods 3 and 6).
3. Average RM value \_\_\_\_\_ (e.g., ng/J, mg/dsm<sup>3</sup>, or percent volume).
4. Average CEMS value \_\_\_\_\_
5. Absolute value of mean difference [d] \_\_\_\_\_
6. Confidence coefficient [CC] \_\_\_\_\_
7. Percent relative accuracy (RA) \_\_\_\_\_ percent.
8. EPA performance audit results:
  - a. Audit lot number (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - b. Audit sample number (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - c. Results (mg/dsm<sup>3</sup>) (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - d. Actual value (mg/dsm<sup>3</sup>)\* (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - e. Relative error\* (1) \_\_\_\_\_ (2) \_\_\_\_\_

B. Cylinder gas audit (CGA) for \_\_\_\_\_, (e.g., SO<sub>2</sub> in ppm).

	Audit point 1	Audit point 2	
1. Date of audit.....	.....	.....	
2. Cylinder ID number.....	.....	.....	
3. Date of certification.....	.....	.....	
4. Type of certification.....	.....	.....	(e.g., EPA Protocol 1 or CRM).
5. Certified audit value.....	.....	.....	(e.g., ppm).
6. CEMS response value.....	.....	.....	(e.g., ppm).
7. Accuracy.....	.....	.....	percent.

C. Relative accuracy audit (RAA) for \_\_\_\_\_ (e.g., SO<sub>2</sub> in ng/J).

1. Date of audit \_\_\_\_\_.
2. Reference methods (RM's) used \_\_\_\_\_ (e.g., Methods 3 and 6).
3. Average RM value \_\_\_\_\_ (e.g., ng/J).
4. Average CEMS value \_\_\_\_\_.
5. Accuracy \_\_\_\_\_ percent.
6. EPA performance audit results:
  - a. Audit lot number (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - b. Audit sample number (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - c. Results (mg/dsm<sup>3</sup>) (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - d. Actual value (mg/dsm<sup>3</sup>) \* (1) \_\_\_\_\_ (2) \_\_\_\_\_
  - e. Relative error \* (1) \_\_\_\_\_ (2) \_\_\_\_\_

D. Corrective action for excessive inaccuracy.

1. Out-of-control periods.
  - a. Date(s) \_\_\_\_\_.
  - b. Number of days \_\_\_\_\_.
2. Corrective action taken-----
3. Results of audit following corrective action. (Use format of A, B, or C above, as applicable.)

II. Calibration drift assessment.

A. Out-of-control periods.

1. Date(s) \_\_\_\_\_.
2. Number of days \_\_\_\_\_.

B. Corrective action taken-----

\* To be completed by the Agency.

[52 FR 21008, June 4, 1987; 52 FR 27612, July 22, 1987, as amended at 56 FR 5527, Feb. 11, 1991]

## Attachment 3

### PERFORMANCE SPECIFICATION 2 - SPECIFICATIONS AND TEST PROCEDURES FOR SO<sub>2</sub> AND NO<sub>x</sub> CONTINUOUS EMISSION MONITORING SYSTEMS IN STATIONARY SOURCES

#### 1. APPLICABILITY AND PRINCIPLE

##### 1.1 Applicability.

1.1.1 This specification is to be used for evaluating the acceptability of SO<sub>2</sub> and NO<sub>x</sub> continuous emission monitoring systems (CEMS's) at the time of or soon after installation and whenever specified in the regulations. The CEMS may include, for certain stationary sources, a diluent (O<sub>2</sub> or CO<sub>2</sub>) monitor.

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

1.2 Principle. Installation and measurement location specifications, performance and equipment specifications, test procedures, and data reduction procedures are included in this specification. Reference method tests and calibration drift tests are conducted to determine conformance of the CEMS with the specification.

#### 2. DEFINITIONS

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

2.1.1 Sample Interface. That portion of the CEMS used for one or more of the following: Sample acquisition, sample transportation, and sample conditioning, or protection of the monitor from the effects of the stack effluent.

2.1.2 Pollutant Analyzer. That portion of the CEMS that senses the pollutant gas and generates an output proportional to the gas concentration.

2.2 Point CEMS. A CEMS that measures the gas concentration either at a single point or along a path equal to or less than 10 percent of the equivalent diameter of the stack or duct cross section.

2.3 Path CEMS. A CEMS that measures the gas concentration along a path greater than 10 percent of the equivalent diameter of the stack or duct cross section.

2.4 Span Value. The upper limit of a gas concentration measurement range specified for affected source categories in the applicable subpart of the regulations.

2.5 Relative Accuracy (RA). The absolute mean difference between the gas concentration or emission rate determined by the CEMS and the value determined by the reference methods (RM's) plus the 2.5 percent error confidence coefficient of a series of tests divided by the mean of the RM tests or the applicable emission limit.

2.6 Calibration Drift (CD). The difference in the CEMS output readings from the established reference value after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

2.7 Centroidal Area. A concentric area that is geometrically similar to the stack or duct cross section and is no greater than 1 percent of the stack or duct cross-sectional area.

2.8 Representative Results. As defined by the RM test procedure outlined in this specification.

### 3. INSTALLATION AND MEASUREMENT LOCATION SPECIFICATIONS

3.1 CEMS Installation and Measurement Location. Install the CEMS at an accessible location where the pollutant concentration or emission rate measurements are directly representative or can be corrected so as to be representative of the total emissions from the affected facility or at the measurement location cross section. Then select representative measurement points or paths for monitoring in locations that the CEMS will pass the RA test (see Section 7). If the cause of failure to meet the RA test is determined to be the measurement location and a satisfactory correction technique cannot be established, the Administrator may require the CEMS to be relocated. Suggested measurement locations and points or paths that are most likely to provide data that will meet the RA requirements are listed below.

3.1.1 Measurement Location. It is suggested that the measurement location be (1) at least two equivalent diameters downstream from the nearest control device, the point of pollutant generation, or other point at which a change in the pollutant concentration or emission rate may occur and (2) at least a half equivalent diameter upstream from the effluent exhaust or control device.

3.1.2 Point CEMS. It is suggested that the measurement point be (1) no less than 1.0 meter from the stack or duct wall or (2) within or centrally located over the centroidal area of the stack or duct cross section.

3.1.3 Path CEMS. It is suggested that the effective measurement path (1) be totally within the inner area bounded by a line 1.0 meter from the stack or duct wall, or (2) have at least 70 percent of the path within the inner 50 percent of the stack or duct cross-sectional area, or (3) be centrally located over any part of the centroidal area.

### 3.2 Reference Method Measurement Location and Traverse Points.

3.2.1 Select, as appropriate, an accessible Reference Method (RM) measurement point at least two equivalent diameter downstream from the nearest control device, the point of pollutant generation, or other point at which a change in the pollutant concentration or emission rate may occur, and at least a half equivalent diameter upstream from the effluent exhaust or control device. When pollutant concentration changes are due solely to diluent leakage (e.g., air heater leakages) and pollutants and diluents are simultaneously measured at the same location, a half diameter may be used in lieu of two equivalent diameters. The CEMS and RM locations need not be the same.

3.2.2 Then select traverse points that assure acquisition of representative samples over the stack or duct cross section. The minimum requirements are as follows: Establish a "measurement line" that passes through the centroidal area and in the direction of any expected stratification. If this line interferes with the CEMS measurements, displace the line up to 30 cm (or 5 percent of the equivalent diameter of the cross section, whichever is less) from the centroidal area. Locate three traverse points at 16.7, 50.0, and 83.3 percent of the measurement line. If the measurement line is longer than 2.4 meters and pollutant stratification is not expected, the tester may choose to locate the three traverse points on the line at 0.4, 1.2, and 2.0 meters from the stack or duct wall. This option must not be used after wet scrubbers or at points where two streams with different pollutant concentrations are combined. The tester may select other traverse points, provided that they can be shown to the satisfaction of the Administrator to provide a representative sample over the stack or duct cross section. Conduct all necessary RM tests within 3 cm (but no less than 3 cm from the stack or duct wall) of the traverse points.

## 4. PERFORMANCE AND EQUIPMENT SPECIFICATIONS

4.1 Data Recorder Scale. The CEMS data recorder response range must include zero and a high-level value. The high-level value is chosen by the source owner or operator and is defined as follows:

4.1.1 For a CEMS intended to measure an uncontrolled emission (e.g., SO<sub>2</sub> measurements at the inlet of a flue gas desulfurization unit), the high-level value must be between 1.25 and 2 times the average potential emission level, unless otherwise specified in an applicable subpart of the regulations. For a CEMS installed to measure controlled emissions or emissions that are in compliance with an applicable regulation, the high-level value must be between 1.5 times the pollutant concentration corresponding to the emission standard level and the span value. If a lower high-level value is used, the source must have the capability of measuring emissions which exceed the full-scale limit of the CEMS in accordance with the requirements of applicable regulations.

4.1.2 The data recorder output must be established so that the high-level value is read between 90 and 100 percent of the data recorder full scale. (This scale requirement may not be applicable to digital data recorders.) The calibration gas, optical filter, or cell values used to establish the data recorder scale should produce the zero and high-level values. Alternatively, a calibration gas, optical filter, or cell value between 50 and 100 percent of the high-level value may be used in place of the high-level value provided the data recorder full-scale requirements as described above are met.

4.1.3 The CEMS design must also allow the determination of calibration drift at the zero and high-level values. If this is not possible or practical, the design must allow these determinations to be conducted at a low-level value (zero to 20 percent of the high-level value) and at a value between 50 and 100 percent of the high-level value. In special cases, if not already approved, the Administrator may approve a single-point calibration-drift determination.

4.2 Calibration Drift. The CEMS calibration must not drift or deviate from the reference value of the gas cylinder, gas cell, or optical filter by more than 2.5 percent of the span value. If the CEMS includes pollutant and diluent monitors, the calibration drift(CD) must be determined separately for each in terms of concentrations (See Performance Specification 3 for the diluent specifications).

4.3 The CEMS Relative Accuracy. The RA of the CEMS must be no greater than 20 percent of the mean value of the RM test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater. For SO<sub>2</sub> emission standards between 130 and 86 ng/J (0.30 and 0.20 lb/million Btu), use 15 percent of the applicable standard; below 86 ng/J (0.20 lb/million Btu), use 20 percent of emission standard.



## 5. PERFORMANCE SPECIFICATION TEST PROCEDURE

5.1 Pretest Preparation. Install the CEMS, prepare the RM test site according to the specifications in Section 3, and prepare the CEMS for operation according to the manufacturer's written instructions.

5.2 Calibration Drift 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 calibration drift (CD) once each day (at 24-hour intervals) for 7 consecutive days according to the procedure given in Section 6. To meet the requirement of Section 4.2, none of the CD's must exceed the specification.

5.3 RA Test Period. Conduct the RA test according to the procedure given in Section 7 while the affected facility is operating at more than 50 percent or normal load, or as specified in an applicable subpart. To meet the specifications, the RA must be equal to or less than 20 percent of the mean value of the RM test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater. For instruments that use common components to measure more than one effluent gas constituent, all channels must simultaneously pass the RA requirement, unless it can be demonstrated that any adjustments made to one channel did not affect the others. The RA test may be conducted during the CD test period.

## 6. CEMS CALIBRATION DRIFT TEST PROCEDURE

6.1 The CD measurement is to verify the ability of the CEMS to conform to the established CEMS calibration used for determining the emission concentration or emission rate. Therefore, if periodic automatic or manual adjustments are made to the CEMS zero and calibration settings, conduct the CD test immediately before these adjustments, or conduct it in such a way that the CD can be determined.

6.2 Conduct the CD test at the two points specified in Section 4.1. Introduce to the CEMS the reference gases, gas cells, or optical filters (these need not be certified). Record the CEMS response and subtract this value from the reference value (see example data sheet in Figure 2-1).

## 7. RELATIVE ACCURACY TEST PROCEDURE

7.1 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 correlated to the CEMS data. Although it is preferable to conduct the diluent (if applicable), moisture (if needed), and pollutant measurements simultaneously, the diluent and moisture measurements that are taken within a 30-

to 60-minute period, which includes the pollutant measurements, may be used to calculate dry pollutant concentration and emission rate. In order to correlate the CEMS and RM data properly, mark the beginning and end of each RM test period of each run (including the exact time of the day) on the CEMS chart recordings or other permanent record of output. Use the following strategies for the RM tests:

7.1.1 For integrated samples, e.g., Method 6 and Method 4, make a sample traverse of at least 21 minutes, sampling for 7 minutes at each traverse point.

7.1.2 For grab samples, e.g., Method 7, take one sample at each traverse point, scheduling the grab samples so that they are taken simultaneously (within a 3-minute period) or are an equal interval of time apart over a 21-minute (or less) period. A test run for grab samples must be made up of at least three separate measurements.

7.1.3 Note: At times, CEMS RA tests are conducted during new source performance standards performance tests. In these cases, RM results obtained during CEMS RA tests may be used to determine compliance as long as the source and test conditions are consistent with the applicable regulations.

7.2 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 or emission rate for each pollutant RM test period. Consider system response time, if important, and confirm that the pair of results are on a consistent moisture, temperature, and diluent concentration basis. Then, compare each integrated CEMS value against the corresponding average RM value. Use the following guidelines to make these comparisons.

7.2.1 If the RM has an integrated sampling technique, make a direct comparison of the RM results and CEMS integrated average value.

7.2.2 If the RM has a grab sampling technique, first average the results from all grab samples taken during the test run, and then compare this average value against the integrated value obtained from the CEMS chart recording or output during the run. If the pollutant concentration is varying with time over the run, the tester may choose to use the arithmetic average of the CEMS value recorded as the time of each grab sample.

7.3 Number of RM Tests. Conduct a minimum of nine sets of all necessary RM tests. Conduct each set within a period of 30 to 60 minutes. Note: The tester may choose to perform more than nine sets of RM tests. If this option is chosen, the tester may, at his discretion, reject a maximum of three sets of the test results so long as the total number of test results used to determine the RA is greater than or equal to nine, but he must report all data including the rejected data.

7.4 Reference Methods. Unless otherwise specified in an applicable subpart of the regulations, Methods 3, 4, 6, and 7, or their approved alternatives, are the reference methods for diluent (O<sub>2</sub> and CO<sub>2</sub>), moisture, SO<sub>2</sub>, and NO<sub>x</sub>, respectively.

7.5 Calculations. Summarize the results on a data sheet. An example is shown in Figure 2-2. Calculate the mean of the RM values. Calculate the arithmetic differences between the RM and the CEMS output sets. Then calculate the mean of the difference, standard deviation, confidence coefficient, and CEMS RA, using Equations 2-1, 2-2, 2-3, and 2-4.

## 8. EQUATIONS

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

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i \quad \text{Eq. 2-1}$$

where:

*n* = number of data points

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

When the mean of the differences of pairs of data is calculated, be sure to correct the data for moisture, if applicable.

8.2 Standard Deviation. Calculate the standard deviation, *S<sub>d</sub>*, as follows:

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

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

$$CC = t_{0.975} \frac{S_d}{\sqrt{n}} \quad \text{Eq. 2-3}$$

where:  $t_{0.975}$  = t-value (see Table 2-1).

TABLE 2-1. t-VALUES

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

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

8.4 Relative Accuracy. Calculate the RA of a set of data as follows:

$$RA = \left[ \frac{|\bar{d}|}{|CC|} \right] \frac{100}{RM} \quad \text{Eq. 2-4}$$

where:

$|\bar{d}|$  = Absolute value of the mean differences  
(from Equation 2-1).

$|CC|$  = Absolute value of the confidence coefficient  
(from Equation 2-3).

$\bar{RM}$  = Average RM value or applicable standard.

## 9. REPORTING

At a minimum (check with the appropriate regional office, or State, or local agency for additional requirements, if any) summarize in tabular form the results of the CD tests and the RA tests or alternative RA procedure as appropriate. Include all data sheets, calculations, charts (records of CEMS responses), cylinder gas concentration certifications, and calibration cell response certifications (if applicable), necessary to substantiate that the performance of the CEMS met the performance specifications.

## 10. ALTERNATIVE PROCEDURES

10.1 Alternative to RA Procedure in Section 7. Paragraphs 60.13(c)(1) and (2) contain criteria for which the RM RA may be waived and the following procedure substituted.

10.1.1 Conduct a complete CEMS status check following the manufacturer's written instructions. The check should include operation of the light source, signal receiver, timing mechanism functions, data acquisition and data reduction functions, data recorders, mechanically operated functions (mirror movements, zero pipe operation, calibration gas valve operations, etc.), sample filters, sample line heaters, moisture traps, and other related functions of the CEMS, as applicable. All parts of the CEMS shall be functioning properly before proceeding to the alternative RA procedure.

10.1.2 Challenge each monitor (both pollutant and diluent, if applicable) with cylinder gases of known concentrations or calibration cells that produce known responses at two measurement points within the following ranges:

Measurement Range

Measurement Point	Pollutant Monitor	Diluent Monitor for CO <sub>2</sub>	Diluent Monitor for O <sub>2</sub>
1	20-30% of span value	5-8% by volume	4-6% by volume
2	50-60% of span value	10-14% by volume	8-12% by volume

Use a separate cylinder gas or calibration cell for measurement points 1 and 2. Challenge the CEMS and record the responses three times at each measurement point. Do not dilute gas from a cylinder when challenging the CEMS. Use the average of the three responses in determining relative accuracy.

Operate each monitor in its normal sampling mode as nearly as possible. When using cylinder gases, pass the cylinder gas through all filters, scrubbers, conditioners, and other monitor components used during normal sampling and as much of the sampling probe as practical. When using calibration cells, the CEMS components used in the normal sampling mode should not be by-passed during the RA determination. These include light sources, lenses, detectors, and reference cells. The CEMS should be challenged at each measurement point for a sufficient period of time to assure adsorption-desorption reactions on the CEMS surfaces have stabilized.

Use cylinder gases that have been certified by comparison to National Bureau of Standards (NBS) gaseous standard reference material (SRM) or NBS/EPA approved gas manufacturer's certified reference material (CRM) (See Citation 2 in the Bibliography) following EPA traceability protocol Number 1 (See Citation 3 in the Bibliography). As an alternative to protocol Number 1 gases, CRM's may be used directly as alternative RA cylinder gases. A list of gas manufacturers that have prepared approved CRM's is available from EPA at the address shown in Citation 2. Procedures for preparation of CRM are described in Citation 2.

Use calibration cells certified by the manufacturer to produce a known response in the CEMS. The cell certification procedure shall include determination of CEMS response produced by the calibration cell in direct comparison with measurement of gases of known concentration. This can be accomplished using SRM or CRM gases in a laboratory source simulator or through extended tests using reference methods at the CEMS location in the exhaust stack. These procedures are discussed in Citation 4 in the Bibliography. The calibration cell certification procedure is subject to approval of the Administrator.

10.1.3 The differences between the known concentrations of the cylinder gases and the concentrations indicated by the CEMS are used to assess the accuracy of the CEMS.

The calculations and limits of acceptable relative accuracy (RA) are as follows:

(a) For pollutant CEMS:

$$RA = \left( \frac{d}{AC} \right) 100 \# 15 \text{ percent}$$

where:

d= difference between the response and the concentration/response.

AC = The known concentration/response of the cylinder gas or calibration cell.

(b) For diluent CEMS:

$$RA = |d| \leq 0.7 \text{ percent O}_2 \text{ or CO}_2, \text{ as applicable.}$$

Note: Waiver of the relative accuracy test in favor of the alternative RA procedure does not preclude the requirements to complete the (CD) tests nor any other requirements specified in the applicable regulation(s) for reporting CEMS data and performing CEMS drift checks or audits.

## 11. BIBLIOGRAPHY

1. Department of Commerce. Experimental Statistics. Handbook 91. Washington, D.C. p. 3-31, paragraphs 3-3.1.4.
2. "A Procedure for Establishing Traceability of Gas Mixtures to Certain National Bureau of Standards Standard Reference Materials." Joint publication by NBS and EPA. EPA 600/7-81-010. Available from U.S. Environmental Protection Agency, Quality Assurance Division (MD-77), Research Triangle Park, North Carolina 27711.
3. "Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors. (Protocol Number 1)." June 1978. Protocol Number 1 is included in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods. EPA-600/4-77-027b. August 1977. Volume III is available from the U.S. EPA, Office of Research and Development Publications, 26 West St. Clair Street, Cincinnati, Ohio 45268.
4. "Gaseous Continuous Emission Monitoring Systems - Performance Specification Guidelines for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, O<sub>2</sub>, and TRS." EPA-450/3-82-026. Available from U.S. Environmental Protection Agency, Emission Standards and Engineering Division (MD-19), Research Triangle Park, North Carolina 27711.

## **PERFORMANCE SPECIFICATION 3 - SPECIFICATIONS AND TEST PROCEDURES FOR O<sub>2</sub> AND CO<sub>2</sub> CONTINUOUS EMISSION MONITORING SYSTEMS IN STATIONARY SOURCES**

### **1. APPLICABILITY AND PRINCIPLE**

#### **1.1 Applicability.**

1.1.1 This specification is to be used for evaluating acceptability of O<sub>2</sub> and CO<sub>2</sub> continuous emission monitoring systems (CEMS's) at the time of or soon after installation and whenever specified in an applicable subpart of the regulations. This specification applies to O<sub>2</sub> or CO<sub>2</sub> monitors that are not included under Performance Specification 2 (PS 2).

1.1.2 This specification is not designed to evaluate the installed CEMS performance over an extended period of time, nor does it identify specific calibration techniques and other auxiliary procedures to assess the CEMS performance. The source owner or operator, however, is responsible to calibrate, maintain, and operate the CEMS properly. To evaluate the CEMS performance, the Administrator may require, under Section 114 of the Act, the operator to conduct CEMS performance evaluations in addition to the initial test. See Section 60.13(c).

1.1.3 The definitions, installation and measurement location specifications, test procedures, data reduction procedures, reporting requirements, and bibliography are the same as in PS 2, Sections 2, 3, 5, 6, 8, 9, and 10, and also apply to O<sub>2</sub> and CO<sub>2</sub> CEMS's under this specification. The performance and equipment specifications and the relative accuracy (RA) test procedures for O<sub>2</sub> and CO<sub>2</sub> CEMS do not differ from those for SO<sub>2</sub> and NO<sub>x</sub> CEMS, except as noted below.

1.2 Principle. Reference method (RM) tests and calibration drift (CD) tests are conducted to determine conformance of the CEMS with the specification.

### **2. PERFORMANCE AND EQUIPMENT SPECIFICATIONS**

2.1 Instrument Zero and Span. Same as Section 4.1 of PS 2.

2.2 Calibration Drift. The CEMS calibration must not drift by more than 0.5 percent O<sub>2</sub> or CO<sub>2</sub> from the reference value of the gas, gas cell, or optical filter.

2.3 CEMS Relative Accuracy. The RA of the CEMS must be no greater than 20 percent of the mean value of the RM test data or 1.0 percent O<sub>2</sub> or CO<sub>2</sub>, whichever is greater.



### 3. RELATIVE ACCURACY TEST PROCEDURE

3.1 Sampling Strategy for RM Tests, Correlation of RM and CEMS Data, Number of RM Tests, and Calculations. Same as PS 2, Sections 7.1, 7.2, 7.3, and 7.5, respectively.

3.2 Reference Method. Unless otherwise specified in an applicable subpart of the regulations, Method 3 or any approved alternative is the RM for O<sub>2</sub> or CO<sub>2</sub>.

**PERFORMANCE SPECIFICATION 4 - SPECIFICATIONS AND TEST  
PROCEDURES FOR CARBON MONOXIDE CONTINUOUS EMISSION  
MONITORING SYSTEMS IN STATIONARY SOURCES**

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability.

1.1.1 This specification is to be used for evaluating the acceptability of carbon monoxide (CO) continuous emission monitoring systems (CEMS) at the time of or soon after installation and whenever specified in an applicable subpart of the regulations.

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

1.1.3 The definitions, installation specifications, test procedures, data reduction procedures for determining calibration drifts (CD) and relative accuracy (RA), and reporting of Performance Specification 2 (PS 2), Sections 2, 3, 5, 6, 8, and 9 apply to this specification.

1.2 Principle. Reference method (RM), CD, and RA tests are conducted to determine that the CEMS conforms to the specification.

2. PERFORMANCE AND EQUIPMENT SPECIFICATIONS

2.1 Instrument Zero and Span. Same as Section 4.1 of PS 2.

2.2 Calibration Drift. The CEMS calibration must not drift or deviate from the reference value of the calibration gas, gas cell, or optical filter by more than 5 percent of the established span value for 6 out of 7 test days (e.g., the established span value is 1000 ppm for Subpart J affected facilities).

2.3 Relative Accuracy. The RA of the CEMS shall be no greater than 10 percent of the mean value of the RM test data in terms of the units of the emission standard or 5 percent of the applicable standard, whichever is greater.

### 3. RELATIVE ACCURACY TEST PROCEDURE

3.1 Sampling Strategy for RM Tests, Correlation of RM and CEMS Data, Number of RM Tests, and Calculations. These are the same as PS 2, Sections 7.1, 7.2, 7.3, and 7.5, respectively.

3.2 Reference Methods. Unless otherwise specified in an applicable subpart of the regulation, Method 10 is the RM for this PS. When evaluation nondispersive infrared continuous emission analyzers, Method 10 shall use the alternative interference trap specified in Section 10.1 of the method. Method 10A or 10B is an acceptable alternative to Method 10.

### 4. BIBLIOGRAPHY

1. Ferguson, B.B., R.E. Lester, and W.J. Mitchell. Field Evaluation of Carbon Monoxide and Hydrogen Sulfide Continuous Emission Monitors at an Oil Refinery. U.S. Environmental Protection Agency. Research Triangle Park, N.C. Publication No. EPA-600/4-82-054. August 1982. 100 p.
2. Repp, M. Evaluation of Continuous Monitors for Carbon Monoxide in Stationary Sources. U.S. Environmental Protection Agency. Research Triangle Park, N.C. Publication No. EPA-600/2-77-063. March 1977. 155 p.
3. Smith, F., D.E. Wagoner, and R.P. Donovan. Guidelines for Development of a Quality Assurance Program:  
Volume VIII - Determination of CO Emissions from Stationary Sources by NDIR Spectrometry. U.S. Environmental Protection Agency. Research Triangle Park, N.C. Publication No. EPA-650/4-74-005-h. February 1975. 96 p.

**APPENDIX B - PERFORMANCE SPECIFICATIONS**  
**PERFORMANCE SPECIFICATION 4A - SPECIFICATIONS**  
**AND TEST PROCEDURES FOR CARBON MONOXIDE CONTINUOUS**  
**EMISSION MONITORING SYSTEMS IN STATIONARY SOURCES**

1. Applicability and Principle

1.1 Applicability.

1.1.1 This specification is to be used for evaluating the acceptability of carbon monoxide (CO) continuous emission monitoring systems (CEMS) at the time of or soon after installation and whenever specified in an applicable subpart of the regulations. This specification may be used in some cases as an alternative to PS-4 if the gas concentration is less than or equal to 100 ppm.

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

1.1.3 The definitions, installation specifications, test procedures, data reduction procedures for determining calibration drifts (CD) and relative accuracy (RA), and reporting of Performance Specification 2 (PS 2), Sections 2, 3, 5, 6, 8, and 9 apply to this specification.

1.2 Principle. Reference method (RM), CD and RA tests are conducted to determine that the CEMS conforms to the specification.

2. Performance and Equipment Specifications

2.1 Data Recorder Scale. This specification is the same as Section 4.1 of PS 2. The CEMS shall be capable of measuring emission levels under normal conditions and under periods of short-duration peaks of high concentrations. This dual-range capability may be met using two separate analyzers, one for each range, or by using dual-range units which have the capability of measuring both levels with a single unit. In the latter case, when the reading goes above the full-scale measurement value of the lower range, the higher-range operation shall be started automatically. The CEMS recorder range must include zero and a high-level value.

For the low-range scale, the high-level value shall be between 1.5 times the pollutant concentration corresponding to the emission standard level and the span value. For the high-range scale, the high-level value shall be set at 2000 ppm, as a minimum, and the range shall include the level of the span value. There shall be no concentration gap between the low- and high- range scales.

2.2 Interference Check. The CEMS must be shown to be free from the effects of any interferences.

2.3 Response Time. The CEMS response time shall not exceed 1.5 min to achieve 95 percent of the final stable value.

2.4 Calibration Drift. The CEMS calibration must not drift or deviate from the reference value of the calibration gas, gas cell, or optical filter by more than 5 percent of the established span value for 6 out of 7 test days. 2.5 Relative Accuracy. The RA of the CEMS shall be no greater than 10 percent of the mean value of the RM test data in terms of the units of the emission standard or 5 ppm, whichever is greater. Under conditions where the average CO emissions are less than 10 percent of the standard and this is verified by Method 10, a cylinder gas audit may be performed in place of the RA test to determine compliance with these limits. In this case, the cylinder gas shall contain CO in 12 percent carbon dioxide as an interference check.

### 3. Response Time Test Procedure

The response time test applies to all types of CEMS's, but will generally have significance only for extractive systems. The entire system is checked with this procedure including applicable sample extraction and transport, sample conditioning, gas analyses, and data recording.

Introduce zero gas into the system. For extractive systems, the calibration gases should be introduced at the probe as near to the sample location as possible. For in-situ systems, introduce the zero gas at the sample interface so that all components active in the analysis are tested. When the system output has stabilized (no change greater than 1 percent of full scale for 30 sec), switch to monitor stack effluent and wait for a stable value. Record the time (upscale response time) required to reach 95 percent of the final stable value. Next, introduce a high-level calibration gas and repeat the procedure (stabilize, switch to sample, stabilize, record). Repeat the entire procedure three times and determine the mean upscale and downscale response times. The slower or longer of the two means is the system response time.

#### 4. Relative Accuracy Test Procedure

4.1 Sampling Strategy for RM Tests, Correlation of RM and CEMS Data, Number of RM Tests, and Calculations. These are the same as PS 2, Sections 7.1, 7.2, 7.3, and 7.5, respectively.

4.2 Reference Methods. Unless otherwise specified in an applicable subpart of the regulation, Method 10 is the RM for this PS. When evaluating nondispersive infrared continuous emission analyzers, Method 10 shall use the alternative interference trap specified in Section 10.1 of the method. Method 10A or 10B is an acceptable alternative to Method 10.

#### 5. Bibliography

1. Same as in Performance Specification 4, Section 4.
2. "Gaseous Continuous Emission Monitoring Systems - Performance Specification Guidelines for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, O<sub>2</sub>, and TRS." EPA-450/3-82-026. Available from U.S. Environmental Protection Agency, Technical Support Division (MD-19), Research Triangle Park, N.C. 27711.

## **PERFORMANCE SPECIFICATION 5 - SPECIFICATIONS AND TEST PROCEDURES FOR TRS CONTINUOUS EMISSION MONITORING SYSTEMS IN STATIONARY SOURCES**

### **1. APPLICABILITY AND PRINCIPLE**

1.1 **Applicability.** This specification is to be used for evaluating the applicability of total reduced sulfur (TRS) continuous emission monitoring systems (CEMS) and whenever specified in an applicable subpart of the regulations. Sources affected by the promulgation of the specification shall be allowed 1 year beyond the promulgation date to install, operate, and test the CEMS. The CEMS's may include oxygen monitors which are subject to Performance Specification 3.

The definitions, installation specifications, test procedures, and data reduction procedures for determining calibration drifts (CD) and relative accuracy (RA) and reporting of PS 2, Sections 2,3,4,5,6,8, and 9 also apply to this specification and must be consulted. The performance and equipment specifications do not differ from PS 2 except as listed below and are included in this specification.

1.2 **Principle.** The CD and RA tests are conducted to determine conformance of the CEMS with the specification.

### **2. PERFORMANCE AND EQUIPMENT SPECIFICATIONS**

2.1 **Instrument Zero and Span.** The CEMS recorder span must be set at 90 to 100 percent of recorder full-scale using a span level between 1.5 and 2.0 times the pollutant concentration corresponding to the emission standard level and the span value. The CEMS design shall also allow the determination of calibration at the zero level of the calibration curve. If zero calibration is not possible or is impractical, this determination may be conducted at a low level (up to 20 percent of span value) point. The components of an acceptable permeation tube system are listed on pages 87-94 of Citation 4.2 of the Bibliography.

2.2 **Calibration Drift.** The CEMS detector calibration must not drift or deviate from the reference value of the calibration gas by more than 5 percent (1.5 ppm) of the established span value of 30 ppm for 6 out of 7 test days. If the CEMS includes pollutant and diluent monitors, the CD must be determined separately for each in terms of concentrations (see PS 3 for the diluent specifications).

2.3 **Relative Accuracy.** The RA of the CEMS shall be no greater than 20 percent of the mean value of the reference method (RM) test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater.

### 3. RELATIVE ACCURACY TEST PROCEDURE

3.1 Sampling Strategy for RM Tests, Correlation of RM and CEMS Data, Number of RM Tests, and Calculations. This is the same as PS 2, Sections 7.1, 7.2, 7.3, and 7.5, respectively, Note: For Method 16, a sample is made up of at least three separate injects equally space over time. For Method 16A, a sample is collected for at least 1 hour.

3.2 Reference Methods. Unless otherwise specified in the applicable subpart of the regulations, Method 16, Method 16A, or other approved alternative, shall be the RM for TRS.

### 4. BIBLIOGRAPHY

4.1 Department of Commerce. Experimental Statistics, National Bureau of Standards, Handbook 91. 1963. Paragraphs 3-3.1.4, p. 3-31.

4.2 A Guide to the Design, Maintenance and Operation of TRS Monitoring Systems. National Council for Air and Stream Improvement Technical Bulletin No. 89. September 1977.

4.3 Observation of Field Performance of TRS Monitors on a Kraft Recovery Furnace. National Council for Air and Stream Improvement Technical Bulletin No. 91. January 1978.



**PERFORMANCE SPECIFICATION 7 - SPECIFICATIONS  
AND TEST PROCEDURES FOR HYDROGEN  
SULFIDE CONTINUOUS EMISSION  
MONITORING SYSTEMS IN STATIONARY SOURCES**

1. Applicability and Principle

1.1 Applicability.

1.1.1 This specification is to be used for evaluating the acceptability of hydrogen sulfide (H<sub>2</sub>S) continuous emission monitoring systems (CEMS's) at the time of or soon after installation and whenever specified in an applicable subpart of the regulations.

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

1.1.3 The definitions, installation specifications, test procedures, data reduction procedures for determining calibration drifts (CD) and relative accuracy (RA), and reporting of Performance Specification 2 (PS 2), Sections 2, 3, 5, 6, 8, and 9 apply to this specification.

1.2 Principle. Reference method (RM), CD, and RA tests are conducted to determine that the CEMS conforms to the specification.

2. Performance and Equipment Specifications

2.1 Instrument Zero and Span. This specification is the same as Section 4.1 of PS 2.

2.2 Calibration Drift. The CEMS calibration must not drift or deviate from the reference value of the calibration gas or reference source by more than 5 percent of the established span value for 6 out of 7 test days (e.g., the established span value is 300 ppm for Subpart J fuel gas combustion devices).

2.3 Relative Accuracy. The RA of the CEMS shall be no greater than 20 percent of the mean value of the RM test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater.

### 3. Relative Accuracy Test Procedure

3.1 Sampling Strategy for RM Tests, Correlation of RM and CEMS Data, Number of RM Tests, and Calculations. These are the same as that in PS 2, Sections 7.1, 7.2, 7.3, and 7.5, respectively.

3.2 Reference Methods. Unless otherwise specified in an applicable subpart of the regulation, Method 11 is the RM for this PS.

### 4. Bibliography

1. U.S. Environmental Protection Agency. Standards of Performance for New Stationary Sources; Appendix B; Performance Specifications 2 and 3 for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, and O<sub>2</sub> Continuous Emission Monitoring Systems; Final Rule. 48 CFR 23608. Washington, D.C. U.S. Government Printing Office. May 25, 1983.

2. U.S. Government Printing Office. Gaseous Continuous Emission Monitoring Systems - Performance Specification Guidelines for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, O<sub>2</sub>, and TRS. U.S. Environmental Protection Agency. Washington, D.C. EPA-450/3-82-026. October 1982. 26 p.

3. Maines, G.D., W.C. Kelly (Scott Environmental Technology, Inc.), and J.B. Homolya. Evaluation of Monitors for Measuring H<sub>2</sub>S in Refinery Gas. Prepared for the U.S. Environmental Protection Agency. Research Triangle Park, N.C. Contract No. 68-02-2707. 1978. 60 p.

4. Ferguson, B.B., R.E. Lester (Harmon Engineering and Testing), and W.J. Mitchell. Field Evaluation of Carbon Monoxide and Hydrogen Sulfide Continuous Emission Monitors at an Oil Refinery. Prepared for the U.S. Environmental Protection Agency. Research Triangle Park, N.C. Publication No. EPA-600/4-82-054. August 1982. 100 p.

**PERFORMANCE SPECIFICATION 8**  
**PERFORMANCE SPECIFICATIONS FOR VOLATILE**  
**ORGANIC COMPOUND CONTINUOUS EMISSION**  
**MONITORING SYSTEMS IN STATIONARY SOURCES**

1.0 Scope and Application.

1.1 Analytes. Volatile Organic Compounds (VOCs).

1.2 Applicability.

1.2.1 This specification is to be used for evaluating a continuous emission monitoring system (CEMS) that measures a mixture of VOC's and generates a single combined response value. The VOC detection principle may be flame ionization (FI), photoionization (PI), non-dispersive infrared absorption (NDIR), or any other detection principle that is appropriate for the VOC species present in the emission gases and that meets this performance specification. The performance specification includes procedures to evaluate the acceptability of the CEMS at the time of or soon after its installation and whenever specified in emission regulations or permits. This specification is not designed to evaluate the installed CEMS performance over an extended period of time, nor does it identify specific calibration techniques and other auxiliary procedures to assess the CEMS performance. The source owner or operator, however, is responsible to calibrate, maintain, and operate the CEMS properly. To evaluate the CEMS performance, the Administrator may require, under Section 114 of the Act, the operator to conduct CEMS performance evaluations in addition to the initial test. See Section 60.13(c).

1.2.2 In most emission circumstances, most VOC monitors can provide only a relative measure of the total mass or volume concentration of a mixture of organic gases, rather than an accurate quantification. This problem is removed when an emission standard is based on a total VOC measurement as obtained with a particular detection principle. In those situations where a true mass or volume VOC concentration is needed, the problem can be mitigated by using the VOC CEMS as a relative indicator of total VOC concentration if statistical analysis indicates that a sufficient margin of compliance exists for this approach to be acceptable. Otherwise, consideration can be given to calibrating the CEMS with a mixture of the same VOC's in the same proportions as they actually occur in the measured source. In those circumstances where only one organic species is present in the source, or where equal incremental amounts of each of the organic species present generate equal CEMS responses, the latter choice can be more easily achieved.

## 2.0 Summary of Performance Specification.

2.1 Calibration drift and relative accuracy tests are conducted to determine adherence of the CEMS with specifications given for those items. The performance specifications include criteria for installation and measurement location, equipment and performance, and procedures for testing and data reduction.

## 3.0 Definitions.

Same as Section 3.0 of PS 2.

## 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 application regulatory limitations prior to performing these procedures. The CEMS user's manual and materials recommended by the reference method should be consulted for specific precautions to be taken.

## 6.0 Equipment and Supplies.

6.1 VOC CEMS Selection. When possible, select a VOC CEMS with the detection principle of the reference method specified in the regulation or permit (usually either FI, NDIR, or PI). Otherwise, use knowledge of the source process chemistry, previous emission studies, or gas chromatographic analysis of the source gas to select an appropriate VOC CEMS. Exercise extreme caution in choosing and installing any CEMS in an area with explosive hazard potential.

6.2 Data Recorder Scale. Same as Section 6.1 of PS 2.

## 7.0 Reagents and Standards. [Reserved]

## 8.0 Sample Collection, Preservation, Storage, and Transport.

8.1 Installation and Measurement Location Specifications. Same as Section 8.1 of PS 2.

8.2 Pretest Preparation. Same as Section 8.2 of PS 2.

8.3 Reference Method (RM). Use the method specified in the applicable regulation or permit, or any approved alternative, as the RM.

8.4 Sampling Strategy for RM Tests, Correlation of RM and CEMS Data, and Number of RM Tests. Follow PS 2, Sections 8.4.3, 8.4.5, and 8.4.4, respectively.

8.5 Reporting. Same as Section 8.5 of PS 2.

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 for specific analytical procedures.

12.0 Calculations and Data Analysis.

Same as Section 12.0 of PS 2.

13.0 Method Performance.

13.1 Calibration Drift. The CEMS calibration must not drift by more than 2.5 percent of the span value.

13.2 CEMS Relative Accuracy. Unless stated otherwise in the regulation or permit, the RA of the CEMS must not be greater than 20 percent of the mean value of the RM test data in terms of the units of the emission standard, or 10 percent of the applicable standard, whichever is greater.

14.0 Pollution Prevention. [Reserved]

15.0 Waste Management. [Reserved]

16.0 References.

Same as Section 17.0 of PS 2.

17.0 Tables, Diagrams, Flowcharts, and Validation Data. [Reserved]

**PERFORMANCE SPECIFICATION 9 - SPECIFICATIONS  
AND TEST PROCEDURES FOR GAS CHROMATOGRAPHIC  
CONTINUOUS EMISSION MONITORING SYSTEMS  
IN STATIONARY SOURCES**

1.0 Scope and Application.

1.1 Applicability. These requirements apply to continuous emission monitoring systems (CEMSs) that use gas chromatography (GC) to measure gaseous organic compound emissions. The requirements include procedures intended to evaluate the acceptability of the CEMS at the time of its installation and whenever specified in regulations or permits. Quality assurance procedures for calibrating, maintaining, and operating the CEMS properly at all times are also given in this procedure.

2.0 Summary of Performance Specification.

2.1 Calibration precision, calibration error, and performance audit tests are conducted to determine conformance of the CEMS with these specifications. Daily calibration and maintenance requirements are also specified.

3.0 Definitions.

3.1 Gas Chromatograph (GC). That portion of the system that separates and detects organic analytes and generates an output proportional to the gas concentration. The GC must be temperature controlled.

Note: The term temperature controlled refers to the ability to maintain a certain temperature around the column. Temperature-programmable GC is not required for this performance specification, as long as all other requirements for precision, linearity and accuracy listed in this performance specification are met. It should be noted that temperature programming a GC will speed up peak elution, thus allowing increased sampling frequency.

3.1.1 Column. Analytical column capable of separating the analytes of interest.

3.1.2 Detector. A detection system capable of detecting and quantifying all analytes of interest.

3.1.3 Integrator. That portion of the system that quantifies the area under a particular sample peak generated by the GC.

3.1.4 Data Recorder. A strip chart recorder, computer, or digital recorder capable of recording all readings within the instrument's calibration range.

3.2 Calibration Precision. The error between triplicate injections of each calibration standard.

4.0 Interferences. [Reserved]

5.0 Safety.

The procedures required under this performance specification may involve hazardous materials, operations, and equipment. This performance specification does not purport to address all of the safety problems associated with these procedures. It is the responsibility of the user to establish appropriate safety problems associated with these procedures. It is the responsibility of the user to establish appropriate safety and health practices and determine the application regulatory limitations prior to performing these procedures. The CEMS user's manual and materials recommended by the reference method should be consulted for specific precautions to be taken.

6.0 Equipment and Supplies.

6.1 Presurvey Sample Analysis and GC Selection. Determine the pollutants to be monitored from the applicable regulation or permit and determine the approximate concentration of each pollutant (this information can be based on past compliance test results). Select an appropriate GC configuration to measure the organic compounds. The GC components should include a heated sample injection loop (or other sample introduction systems), separatory column, temperature-controlled oven, and detector. If the source chooses dual column and/or dual detector configurations, each column/detector is considered a separate instrument for the purpose of this performance specification and thus the procedures in this performance specification shall be carried out on each system. If this method is applied in highly explosive areas, caution should be exercised in selecting the equipment and method of installation.

6.2 Sampling System. The sampling system shall be heat traced and maintained at a minimum of 120EC with no cold spots. All system components shall be heated, including the probe, calibration valve, sample lines, sampling loop (or sample introduction system), GC oven, and the detector block (when appropriate for the type of detector being utilized, e.g., flame ionization detector).

7.0 Reagents and Standards.

7.1 Calibration Gases. Obtain three concentrations of calibration gases certified by the manufacturer to be accurate to within 2 percent of the value on the label. A gas dilution system may be used to prepare the calibration gases from a high concentration certified standard if the gas dilution system meets the requirements specified in Test Method 205, 40 CFR Part 51, Appendix M. The performance test specified in Test Method 205 shall be repeated quarterly, and the results of the Method 205 test shall be included in the report. The calibration gas concentration of each target analyte shall be as follows (measured concentration is based on the presurvey concentration determined in Section 6.1).

NOTE: If the low level calibration gas concentration falls at or below the limit of detection for the instrument for any target pollutant, a calibration gas with a concentration at 4 to 5 times the limit of detection for the instrument may be substituted for the low-level calibration gas listed in Section 7.1.1.

7.1.1 Low-level. 40-60 percent of measured concentration.

7.1.2 Mid-level. 90-110 percent of measured concentration.

7.1.3 High-level. 140-160 percent of measured concentration, or select highest expected concentration.

7.2 Performance Audit Gas. A certified EPA audit gas shall be used, when possible. A gas mixture containing all the target compounds within the calibration range and certified by EPA's Traceability Protocol for Assay and Certification of Gaseous Calibration Standards may be used when EPA performance audit materials are not available. The instrument relative error shall be < 10 percent of the certified value of the audit gas.

## 8.0 Sample Collection, Preservation, Storage, and Transport.

8.1 Installation and Measurement Location Specifications. Install the CEMs in a location where the measurements are representative of the source emissions. Consider other factors, such as ease of access for calibration and maintenance purposes. The location should not be close to air in-leakages. The sampling location should be at least two equivalent duct diameters downstream from the nearest control device, point of pollutant generation, or other point at which a change in the pollutant concentration or emission rate occurs. The location should be at least 0.5 diameter upstream from the exhaust or control device. To calculate equivalent duct diameter, see Section 12.2 of Method 1 (40 CFR Part 60, Appendix A). Sampling locations not conforming to the requirements in this section may be used if necessary upon approval of the Administrator.

8.2 Pretest Preparation Period. Using the procedures described in Method 18 (40 CFR Part 60, Appendix A), perform initial tests to determine GC conditions that provide good resolution and minimum analysis time for compounds of interest. Resolution interferences that may occur can be eliminated by appropriate GC column and detector choice or by shifting the retention times through changes in the column flow rate and the use of temperature programming.

8.3 7-Day Calibration Error (CE) Test Period. At the beginning of each 24-hour period, set the initial instrument setpoints by conducting a multi-point calibration for each compound. The multi-point calibration shall meet the requirements in Section 13.3. Throughout the 24-hour period, sample and analyze the stack gas at the sampling intervals prescribed in the regulation or permit. At the end of the 24 hour period, inject the three calibration gases for each compound in triplicate and determine



the average instrument response. Determine the CE for each pollutant at each level using the equation in Section 9-2.

Each CE shall be < 10 percent. Repeat this procedure six more times for a total of 7 consecutive days.

8.4 Performance Audit Test Periods. Conduct the performance audit once during the initial 7-day CE test and quarterly thereafter. Sample and analyze the EPA audit gas(es) (or the gas mixture prepared by EPA's traceability protocol if an EPA audit gas is not available) three times. Calculate the average instrument response. Report the audit results as part of the reporting requirements in the appropriate regulation or permit (if using a gas mixture, report the certified cylinder concentration of each pollutant).

8.5 Reporting. Follow the reporting requirements of the applicable regulation or permit. If the reporting requirements include the results of this performance specification, summarize in tabular form the results of the CE tests. Include all data sheets, calculations, CEMS data records, performance audit results, and calibration gas concentrations and certifications.

9.0 Quality Control. [Reserved]

10.0 Calibration and Standardization.

10.1 Initial Multi-Point Calibration. After initial startup of the GC, after routine maintenance or repair, or at least once per month, conduct a multi-point calibration of the GC for each target analyte. The multi-point calibration for each analyte shall meet the requirements in Section 13.3.

10.2 Daily Calibration. Once every 24 hours, analyze the mid-level calibration standard for each analyte in triplicate. Calculate the average instrument response for each analyte. The average instrument response shall not vary more than 10 percent from the certified concentration value of the cylinder for each analyte. If the difference between the analyzer response and the cylinder concentration for any target compound is greater than 10 percent, immediately inspect the instrument making any necessary adjustments, and conduct an initial multi-point calibration as described in Section 10.1.

11.0 Analytical Procedure. Sample collection and analysis are concurrent for this Performance Specification (see Section 8.0).

12.0 Calculations and Data Analysis.

### 12.1 Nomenclature.

- $C_m$  = average instrument response, ppm.  
 $C_a$  = cylinder gas value, ppm.  
 $F$  = Flow rate of stack gas through sampling system, in Liters/min.  
 $n$  = Number of measurement points.  
 $r^2$  = Coefficient of determination.  
 $V$  = Sample system volume, in Liters, which is the volume inside the sample probe and tubing leading from the stack to the sampling loop.  
 $x$  = CEMS response.  
 $y$  = Actual value of calibration standard.

12.2 Coefficient of Determination. Calculate  $r^2$  using linear regression analysis and the average concentrations obtained at three calibration points as shown in Equation 9-1.

$$r^2 = \left( \frac{n \sum x_i y_i - (\sum x_i)(\sum y_i)}{\sqrt{(n \sum y_i^2 - \sum y_i^2)(n \sum x_i^2 - \sum x_i^2)}} \right)^2 \quad \text{Eq. 9-1}$$

12.3 Calibration Error Determination. Determine the percent calibration error (CE) at each concentration for each pollutant using the following equation.

$$CE = \frac{C_m - C_a}{C_a} \times 100 \quad \text{Eq. 9-2}$$

12.4 Sampling System Time Constant (T).

$$T = \frac{V}{F} \quad \text{Eq. 9-3}$$

### 13.0 Method Performance.

13.1 Calibration Error (CE). The CEMS must allow the determination of CE at all three calibration levels. The average CEMS calibration response must not differ by more than 10 percent of calibration gas value at each level after each 24-hour period of the initial test.

13.2 Calibration Precision and Linearity. For each triplicate injection at each concentration level for each target analyte, any one injection shall not deviate more than 5 percent from the average concentration measured at that level. The linear regression curve for each organic compound at all

three levels shall have an  $r^2 \geq 0.995$  (using Equation 9-1).

13.3 Measurement Frequency. The sample to be analyzed shall flow continuously through the sampling system. The sampling system time constant shall be  $< 5$  minutes or the sampling frequency specified in the applicable regulation, whichever is less. Use Equation 9-3 to determine T. The analytical system shall be capable of measuring the effluent stream at the frequency specified in the appropriate regulation or permit.

14.0 Pollution Prevention. [Reserved]

15.0 Waste Management. [Reserved]

16.0 References. [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data. [Reserved]

## Attachment 4

### 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 (SO<sub>2</sub>) 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 SO<sub>2</sub> 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  $\pm 2$  percent of the span for the zero, mid-range, and high-range calibration gases.

**4.2 Sampling System Bias.** Less than  $\pm 5$  percent of the span for the zero and mid-range calibration gases.

**4.3 Zero Drift.** Less than  $\pm 3$  percent of the span over the period of each run.

**4.4 Calibration Drift.** Less than  $\pm 3$  percent of the span over the period of each run.

**4.5 Interference Check.** Less than  $\pm 7$  percent of the modified Method 6 result for each run.

#### **5. APPARATUS AND REAGENTS**

**5.1 Measurement System.** Use any measurement system for SO<sub>2</sub> 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 Administrator. The determination of sample moisture content is not necessary for pollutant analyzers that measure concentrations on a wet basis when (1) a wet basis CO<sub>2</sub> analyzer operated according to Method 3A is used to obtain simultaneous measurements, and (2) the pollutant/CO<sub>2</sub> 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 SO<sub>2</sub> 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 are used to conduct the interference check.

**5.3 SO<sub>2</sub> Calibration Gases.** The calibration gases for the gas analyzer shall be SO<sub>2</sub> in N<sub>2</sub> or SO<sub>2</sub> in air. Alternatively, SO<sub>2</sub>/CO<sub>2</sub>, SO<sub>2</sub>/O<sub>2</sub>, or SO<sub>2</sub>/CO<sub>2</sub>/O<sub>2</sub> gas mixtures in N<sub>2</sub> may be used. For fluorescence-based analyzers, the O<sub>2</sub> and CO<sub>2</sub> concentrations of the calibration gases as introduced to the analyzer shall be within 1 percent (absolute) O<sub>2</sub> and 1 percent (absolute) CO<sub>2</sub> of the O<sub>2</sub> and CO<sub>2</sub> concentrations of the effluent samples introduced to the analyzer. Alternatively, for fluorescence-based analyzers, use calibration blends of SO<sub>2</sub> in air and the nomographs provided by the vendor to determine the quenching <sup>f f f f</sup>

correction factor (the effluent O<sub>2</sub> and CO<sub>2</sub> 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 H<sub>2</sub>O<sub>2</sub>.

## 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 No. 1 is preferred.

**6.1.1 Alternative No. 1--**Use of calibration gases that are analyzed following the Environmental Protection Agency Traceability Protocol No. 1 (see Citation 1 in Bibliography). Obtain a certification from the gas manufacturer that Protocol No. 1 was followed.

**6.1.2 Alternative No. 2--**Use of calibration gases not prepared according to Protocol No. 1. If this alternative is chosen, obtain gas mixtures with a manufacturer's tolerance not to exceed  $\pm 2$  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 describes 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 SO<sub>2</sub> 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 within 5 percent (or 5 ppm, whichever is greater) of the 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  $\pm 2$  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  $\pm 5$  percent of the span for either the zero or upscale calibration gases. 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 per 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 midget impingers containing 3 percent H<sub>2</sub>O<sub>2</sub>, 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 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. 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 over-pressurization 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 midget impingers, and determine the SO<sub>2</sub> 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.

$$C_{gas} = (\bar{C} & C_o) \frac{C_{ma}}{C_m & C_o}$$

where:

$C_{gas}$  = Effluent gas concentration, dry basis, ppm.

$C_{avg}$  = 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.

## 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 John W. Brown. Methods for Collecting and Analyzing Gas Cylinder Samples. Source Evaluation Society Newsletter. 3(3):5-15. September 1978.

**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<sub>x</sub>) 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 chemiluminescent analyzer for determination of NO<sub>x</sub> concentration. 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.

**3. DEFINITIONS**

**3.1 Measurement System.** The total equipment required for the determination of NO<sub>x</sub> concentration. The measurement system consists of the following major subsystems:

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

**3.1.2 NO<sub>2</sub> to NO Converter.** A device that converts the nitrogen dioxide (NO<sub>2</sub>) 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 in 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 in Method 6C, Sections 4.1 through 4.4.

**5. APPARATUS AND REAGENTS**

**5.1 Measurement System.** Use any measurement system for NO<sub>x</sub> 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 in Method 6C, Sections 5.1.1 through 5.1.9, and 5.1.11.

**5.1.2 NO<sub>2</sub> to NO Converter.** That portion of the system that converts NO<sub>2</sub> in the sample gas to NO. A NO<sub>2</sub> to NO converter is not necessary if the NO<sub>2</sub> portion of the exhaust gas is less than 5 percent of the total NO<sub>x</sub> concentration.

**5.1.3 NO<sub>x</sub> Analyzer.** An analyzer based on the principles of chemiluminescence to determine continuously the NO<sub>x</sub> 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.) must be provided at the analyzer.

**5.2 NO<sub>x</sub> Calibration Gases.** The calibration gases for the NO<sub>x</sub> analyzer shall be NO in N<sub>2</sub>. Use four calibration gases as specified in Method 6C, Sections 5.3.1 through 5.3.3. 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.** Same as in Method 6C, Section 6.1, 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, Response Time, and Sample System Bias Check.** Same as in Method 6C, Sections 6.2 through 6.4.

**6.4 NO<sub>2</sub> to NO Conversion Efficiency.** If the NO<sub>2</sub> concentration within the sample stream is greater than 5 percent of the NO<sub>x</sub> concentration, conduct an NO<sub>2</sub> 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 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 the total time required to perform a run using Method 7 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.** Same as in Method 6C, Section 7.4.

## **8. EMISSION CALCULATION**

Same as in Method 6C, Section 8.

## **BIBLIOGRAPHY**

Same as the bibliography of Method 6C.

**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 (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) 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 O<sub>2</sub> and CO<sub>2</sub> 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 O<sub>2</sub> or CO<sub>2</sub> 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 O<sub>2</sub> or CO<sub>2</sub> 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 O<sub>2</sub> or CO<sub>2</sub> 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 O<sub>2</sub> or CO<sub>2</sub> 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 O<sub>2</sub> or CO<sub>2</sub> 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 CO<sub>2</sub> analyzers shall be CO<sub>2</sub> in N<sub>2</sub> or CO<sub>2</sub> in air. Alternatively, CO<sub>2</sub>/SO<sub>2</sub>, O<sub>2</sub>/SO<sub>2</sub>, or O<sub>2</sub>/CO<sub>2</sub>/SO<sub>2</sub> gas mixtures in N<sub>2</sub> may be used. Three calibration gases, as specified in Sections 5.3.1 through 5.3.4 of Method 6C, shall be used. For O<sub>2</sub> 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 O<sub>2</sub> and CO<sub>2</sub> are measured using Method 3A, the procedures described in Section 4.4 of Method 3 should be followed to validate the O<sub>2</sub> and CO<sub>2</sub> measurement results.

**8.2** If only O<sub>2</sub> is measured using Method 3A, measurements of the sample stream CO<sub>2</sub> 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 CO<sub>2</sub> values for comparison with the O<sub>2</sub> measurements in accordance with the procedures described in Section 4.4 of Method 3.

**8.3** If only CO<sub>2</sub> is measured using Method 3A, concurrent measurements of the sample stream CO<sub>2</sub> 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 CO<sub>2</sub> analyzers, and for O<sub>2</sub> 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 O<sub>2</sub> analyzers that use a low-level calibration gas in place of a zero gas, calculate the effluent gas concentration using Equation 3A-1.

$$C_{\text{gas}} = \frac{C_{\text{ma}} - C_{\text{oa}}}{C_{\text{m}} - C_{\text{o}}} (C - C_{\text{m}}) + C_{\text{ma}} \quad \text{Eq. 3A-1}$$

Where:

C<sub>gas</sub> = Effluent gas concentration, dry basis, percent.

C<sub>ma</sub> = Actual concentration of the upscale calibration gas, percent.

C<sub>oa</sub> = Actual concentration of the low-level calibration gas, percent.

C<sub>m</sub> = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent.

C<sub>o</sub> = Average of initial and final system calibration bias check responses for the low level gas, percent.

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



## **10. BIBLIOGRAPHY**

Same as in Bibliography of Method 6C.

## Attachment 5

Note: The following approved rules\* (Title 326 Air Pollution Control Board) are included in this attachment. These rules have direct bearing on the certification and quality assurance/quality control and other related topics of Chapter 2 Continuous Emissions Monitoring Systems (CEMS).

\* *LSA Document #97-218(F)*

*Notice of Intent Published: August 1, 1997; 20 IR 3024*

*Proposed Rule Published: October 1, 1997; 21 IR 139*

*Hearing Held: October 28, 1997*

*Approved by Attorney General: January 12, 1998*

*Approved by Governor: January 27, 1998*

*Filed with Secretary of State: January 30, 1998, 11:00 a.m.*

### Rule 4. General Provisions

#### 326 IAC 3-4-1 Definitions

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-11; IC 13-15; IC 13-17**

Sec. 1. In addition to the definitions provided in IC 13-11, 326 IAC 1-2, and 326 2-7, the following definitions apply throughout this article unless expressly stated otherwise:

(1) "Applicable emission limitation or standard" means any of the following:

(A) A state or federal emission limitation or standard applicable to a regulated hazardous air pollutant under 40 CFR 61\* or 40 CFR 63\*.

(B) A state or federal emission limitation or standard applicable to a regulated air pollutant, other than a hazardous air pollutant under Section 112 of the CAA, for which the source is classified as a major source.

(2) "Calendar quarter" means a three (3) month period beginning January 1, April 1, July 1, or October 1.

(3) "Certified emissions monitor" means an emissions monitor that meets all applicable performance specifications of 40 CFR 60\* or any other performance specification, and for which performance data had been submitted to and approved by the department.

(4) "Emission test", "source sampling test", "compliance test", or "performance test" means a procedure for sampling a gas stream from a single sampling location at a facility, unit, or pollution control equipment, to determine a pollutant emission rate, concentration, or parameter while the facility, unit, or pollution control equipment is operating at conditions that result in measurement of the highest emission or parameter values (prior to any control device), or at other operating conditions approved by the department or U.S. EPA. A test shall comprise three (3) sampling runs for a specified sampling time span. Additional conditions may be required by applicable rules, permit, or enforcement order. The test shall be performed using sampling and analytical procedures approved by the department or U.S. EPA for the specific pollutant or parameter and

facility, unit, pollution control equipment, process, or operation.

(5) "Emissions unit" means any part of or activity at a source that emits or has the potential to emit any regulated air pollutant for which an emission limitation or standard has been established. This term does not alter or affect the definition of the term "unit" for purposes of Title V of the CAA.

(6) "Major source" means any major source as defined in 326 IAC 2-7-1(22), excluding any source described in 326 IAC 2-7-1(22)(A).

(7) "Monitoring" means any form of collecting data on a routine basis to determine or otherwise assess compliance with emission limitations or standards.

(8) "Monitor system malfunction" means any interruption in the collection of valid data as a result of the failure of any component of the system to operate within the specifications of the applicable performance specification.

(9) "Out of control" means any data collected by a continuous monitoring system during periods immediately following an out of tolerance quality assurance assessment and prior to an acceptable quality assurance assessment.

(10) "Permit" means any applicable permit issued, renewed, revised, or modified under 326 IAC 2-1, 326 IAC 2-2, 326 IAC 2-3, 326 IAC 2-7, 326 IAC 2-8, or 326 IAC 2-9.

(11) "Quality assurance" means those activities performed to ensure that monitoring data are sufficiently representative, accurate, precise, reliable, frequent, and timely. Those activities include, but are not limited to, frequent activities (daily) and less frequent activities (weekly, monthly, quarterly, and yearly).

\*Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Mänge, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board; 326 IAC 3-4-1; filed Jan 30, 1998, 4:00 p.m.: 21 IR 2062*)

### **326 IAC 3-4-2 Certification**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

**Sec. 2.** Each report submitted under this article shall contain certification of truth, accuracy, and completeness. This certification and any other certification required under this article shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete. (*Air Pollution Control Board; 326 IAC 3-4-2; filed Jan 30, 1998, 4:00 p.m.: 21 IR 2063*)

### **326 IAC 3-4-3 Conversion factors**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

**Sec. 2.** (a) Owners or operators of facilities subject to this article shall use the following procedures for converting monitoring data to units of the standard where necessary:

(1) For fossil fuel-fired steam generators, the following procedures shall be used to convert gaseous emission monitoring data in parts per million (ppm) to pounds per million British thermal units (Btu) (lbs/MMBTU) where necessary:

(A) When the owner or operator of a fossil fuel-fired steam generator elects under this article to measure oxygen (O<sub>2</sub>) in flue gases, the measurements of the pollutant concentration and oxygen shall be on a dry basis and the following conversion procedure used:

$$E' = CF \frac{(20.9)}{(20.9 \& \% O_2)}$$

(B) When the owner or operator elects under this article to measure carbon dioxide (CO<sub>2</sub>) in flue gases, the measurement of the pollutant concentration and the CO<sub>2</sub> concentration shall each be on a consistent basis (wet or dry) and the following conversion procedure used:

$$E' = CF_c \frac{(100)}{(\% CO_2)}$$

(C) When the owner or operator elects under this article to measure sulfur dioxide (SO<sub>2</sub>) or nitrogen oxides (NO<sub>x</sub>) in the flue gases, the measurement of the diluent concentration and the SO<sub>2</sub> and the NO<sub>x</sub> concentration shall each be on a wet basis and the following conversion procedure used, except where wet scrubbers are employed or where moisture is otherwise added to the stack gases:

$$E' = C_{ws} F_w \frac{(20.9)}{(20.9 (1 \& B_{ws}) \& \% O_{2_{ws}})}$$

(D) When the owner or operator elects under this article to measure sulfur dioxide (SO<sub>2</sub>) or nitrogen oxides (NO<sub>x</sub>) in the flue gases, the measurement of the diluent concentration and the SO<sub>2</sub> and the NO<sub>x</sub> concentration shall each be on a wet basis and the following conversion procedure used where wet scrubbers or moisture is otherwise present in the stack gases, provided water vapor content of the stack gas is measured at least once every fifteen (15) minutes at the same point as the pollutant and oxygen measurements are made:

$$E' = C_{ws} F \frac{(20.9)}{(20.9 (1 \& B_{ws}) \& \% O_{2_{ws}})}$$

(E) The values used in the equations under this subdivision are derived as follows:

$C_{ws}$  = Pollutant concentration at stack conditions in grams per wet standard cubic meter (g/wscm) or pounds per wet standard cubic meter (lbs/wscm), determined by multiplying the average concentration in parts per million (ppm) for each one (1) hour period by  $4.15 \times 10^{-5}$  M g/wscm per ppm or  $2.59 \times 10^{-9}$  M lbs/wscm per ppm, where M is pollutant

molecular weight in grams per gram-mole (g/g-mole) or pounds per pound-mole (lb/lb-mole).

M = 64.07 for SO<sub>2</sub> and 46.01 for oxides of nitrogen (NO<sub>x</sub>) as NO<sub>2</sub>.

C = Pollutant concentration at stack conditions in pounds per dry standard cubic meter (lbs/dscm) or grams per dry standard cubic meter (g/dscm).

F, F<sub>c</sub> = A factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted (F), and a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the fuel combusted (F<sub>c</sub>), respectively. Values of F and F<sub>c</sub> are given in 40 CFR 60\*, Appendix A, Method 19, as applicable.

F<sub>w</sub> = A factor representing a ratio of the volume of wet flue gases generated to the calorific value of the fuel combusted. Values of F<sub>w</sub> are given in 40 CFR 60\*, Appendix A, Method 19.

B<sub>wa</sub> = Proportion by volume of water vapor in the ambient air.

B<sub>ws</sub> = Proportion by volume of water vapor in the stack gas.

E = Oxygen or carbon dioxide volume (expressed as percent) determined with equipment specified under this article.

Percent O<sub>2</sub>,

percent CO<sub>2</sub> = Oxygen volume (expressed as percent) measurements made at stack conditions on a wet basis.

(2) For sulfuric acid plants or production facilities, the owner or operator shall:

(A) establish a conversion factor three (3) times daily according to procedures for 40 CFR 60.84(b)\*;

(B) multiply the conversion factor by the average sulfur dioxide (SO<sub>2</sub>) concentration in the flue gases to obtain average SO<sub>2</sub> emissions in pounds per ton (lbs/ton); and

(C) report the average sulfur dioxide emissions for each three (3) hour period in excess of the emission standard set forth in 326 IAC 7 in the quarterly summary.

(b) Alternate procedures for computing emission averages that do not require integration of data or alternative methods of converting pollutant concentration measurements of units of the emission standard may be approved by the department if the owner or operator shows that the alternative procedures are at least as accurate as those in this rule.

\*Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Mänge, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board; 326 IAC 3-4-3; filed Jan 30, 1998, 4:00 p.m.: 21 IR 2062*)

## **Rule 5. Continuous Monitoring of Emissions**

### **326 IAC 3-5-1 Applicability; monitoring requirements for applicable pollutants**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

Sec. 1.(a) This rule establishes the following:

(1) Substantive requirements for monitoring certain types of sources.

(2) A process for developing suitable monitoring requirements for other types of sources.

(b) This rule applies to the following sources and facilities hereinafter referred to as affected facilities:

(1) Any facility required to perform continuous monitoring under 326 IAC 12, which incorporates by reference the requirements of 40 CFR 60\*, or by a standard for hazardous air pollutants under 326 IAC 14, which incorporates by reference the requirements of 40 CFR 61\*, or 326 IAC 20, which incorporates by reference the requirements of 40 CFR 63\*.

(2) Fossil fuel-fired steam generators of greater than one hundred million (100,000,000) British thermal units (Btus) per hour heat input capacity.

(3) Sulfuric acid plants or production facilities of greater than three hundred (300) tons per day acid production capacity.

(4) Petroleum refinery catalyst regenerators for fluid bed catalytic cracking units of greater than twenty thousand (20,000) barrels (eight hundred forty thousand (840,000) gallons) per day fresh feed capacity.

(5) Portland cement plants.

(6) Facilities that combust sewage sludge.

(7) Sources making coke from raw material, including the following:

(A) Coal refining byproducts.

(B) Petroleum refining byproducts.

(8) Facilities in Clark and Floyd Counties that:

(A) have potential to emit NO<sub>x</sub> greater than or equal to forty (40) tons per year; and

(B) are located at sources that have potential to emit NO<sub>x</sub> greater than or equal to one hundred (100) tons per year as described in 326 IAC 10.

(c) Sources and facilities described in subsection (b) are subject to the following requirements or an approved streamlined requirement established in accordance with 326 IAC 2-7-24:

(1) Any facility subject to 326 IAC 12, which incorporates by reference the requirements of 40 CFR 60\*, 326 IAC 14, which incorporates by reference the requirements of 40 CFR 61\*, or 326 IAC 20, which incorporates by reference the requirements of 40 CFR 61\*, shall comply with the following:

(A) The monitoring and reporting requirements as specified for the applicable rule.

(B) All requirements of this rule.

(2) Fossil fuel-fired steam generators of greater than one hundred million (100,000,000) Btu per hour heat input capacity shall monitor the following:

(A) Opacity, unless:

(i) Gaseous fuel is the only fuel combusted.

(ii) Oil or a mix of gas and oil are the only fuels combusted and the facility is able to comply with both of the following without using particulate matter collection equipment:

(AA) 326 IAC 5-1.

(BB) 326 IAC 6-2.

(iii) An alternative monitoring requirement request has been granted by the department. An alternative monitoring requirement may be requested when installation of an opacity monitoring system would not provide accurate determinations of emissions as a result of interference from condensed uncombined water vapor. Any alternative monitoring requirement request shall address the following:

(AA) Information pertaining to the inability of the affected facility to find a acceptable monitoring location prior to the source of the condensed, uncombined water vapor.

(BB) A list of proposed alternative monitoring requirements. For each proposed alternative monitoring requirement, the request must provide a detailed description of thresholds or triggers for corrective action resulting from deviation from normal operating parameters and how deviations from key surrogate parameters shall be addressed to insure continuous compliance with all applicable particulate and opacity requirements. An example of an acceptable alternative monitoring requirement is a particulate compliance demonstration that is no less frequent than annual in accordance with 326 IAC 3-6 and a compliance monitoring plan that, at a minimum, satisfies monitoring requirements under 326 IAC 2-7 or 326 2-8.

(CC) Record keeping that is constant with section 6 of this rule.

(DD) Reporting frequency that is no less frequent than that required in section 7 of this rule.

(iv) An alternative monitoring requirement request granted by the department under item (iii) shall be submitted to U.S. EPA as a SIP revision and shall not be in effect until approved as a SIP revision.

(B) Sulfur dioxide (SO<sub>2</sub>) under the following conditions:

(i) SO<sub>2</sub> pollution control equipment has been installed.

(ii) A monitor is required to determine compliance with either of the following:

(AA) 326 IAC 12.

(BB) A construction permit required under 326 IAC 2.

(C) Nitrogen oxide (NO<sub>x</sub>) under the following conditions:

(i) NO<sub>x</sub> pollution control equipment has been installed.

(ii) A monitor is required to determine compliance with either of the following:

(AA) 326 IAC 12.

(BB) A construction permit required under 326 IAC 2.

(D) The percent O<sub>2</sub> or CO<sub>2</sub> if measurements of O<sub>2</sub> or CO<sub>2</sub> in the flue gas are required to convert either SO<sub>2</sub> or NO<sub>x</sub> continuous monitoring data, or both, to units of emission limitation for the particular facility.

(3) Sulfuric acid plants or production facilities of greater than three hundred (300) tons per day acid production capacity shall monitor SO<sub>2</sub> for each sulfuric acid production facility within the

source.

(4) Petroleum refinery catalyst regenerators for fluid bed catalytic cracking units of greater than twenty thousand (20,000) barrels (eight hundred forty thousand (840,000) gallons) per day fresh feed capacity shall monitor opacity for each regenerator within the source.

(5) Portland cement plants shall monitor opacity at the following facilities:

(A) Kilns.

(B) Clinker coolers.

(6) Facilities that combust sewage shall monitor from the effluent gas exiting incinerator the following:

(A) Total hydrocarbons.

(B) Oxygen.

(C) Moisture, unless an alternative method is approved by the department and the U.S. EPA.

(D) Temperature.

(7) Sources making coke from coal shall monitor opacity on the underfire stack associated with each coke oven battery.

(8) Facilities in Clark and Floyd Counties that have potential to emit NO<sub>x</sub> greater than or equal to forty (40) tons per year and are located at sources that have potential to emit NO<sub>x</sub> greater than or equal to one hundred (100) tons per year shall install NO<sub>x</sub> continuous emission monitors as described in 326 IAC 10-1.

(d) The department may require, as a condition of a construction or operating permit issued under 326 IAC 2-1, 326 IAC 2-2, 326 IAC 2-3, 326 IAC 2-7, 326 IAC 2-8, or 326 IAC 2-9 that the owner or operator of a new or existing source of air emissions monitor emissions to ensure compliance with the following:

(1) An emission limitation or standard established in one (1) of the permits listed in subsection (d) [*this subsection*].

(2) Permit requirements.

(3) Monitoring requirements in 326 IAC 2-7.

(e) Unless explicitly stated otherwise, nothing in this rule shall:

(1) Excuse the owner or operator of a source from any monitoring, record keeping, or reporting requirement that applies under any provision of the CAA or state statutes or regulations.

(2) Restrict the authority of the department to impose additional or more restrictive monitoring, record keeping, testing, or reporting requirements on any owner or operator of a source under any other provision of the CAA, including Section 114(a)(1), or state statutes or regulations, as applicable.

(f) Within one hundred eighty (180) days of start-up or, for a source existing on the effective date of this rule, within three hundred sixty-five (365) days of becoming an affected facility under this rule, all continuous monitoring systems shall be installed, operational, and the certification testing complete pursuant to section 3 of this rule.



\*Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Management, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board; 326 IAC 3-5-1; filed Jan 30, 1998, 4:00 p.m.: 21 IR 2064*)

### **326 IAC 3-5-2 Minimum performance and operating specifications**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

**Sec. 2.** Owners and operators of monitoring equipment installed to comply with this rule shall comply with the performance and operating requirements as follows:

(1) Performance specifications set forth in 40 CFR 60\*, Appendix B, shall be used to certify monitoring equipment installed pursuant to this rule; however, where reference is made to the administrator in 40 CFR 60\*, Appendix B, the term “department” shall be inserted for purposes of this rule, and where continuous emissions monitors were installed prior to March 1983 for measuring opacity, the performance specifications in 40 CFR 60\*, Appendix B, 1982 Edition, shall apply.

(2) Cycling times, which include the total time a monitoring system requires to sample, analyze, and record an emission measurement, shall be as follows:

(A) Continuous monitoring systems for measuring opacity shall complete a minimum of one (1) cycle of operation (sampling, analyzing, and data recording) for each successive ten (10) second period.

(B) Continuous monitoring systems that measure the following emissions shall complete a minimum of one (1) cycle of operation (sampling, analyzing, and data recording) for each successive fifteen (15) minute measuring period:

- (i) Carbon dioxide (CO<sub>2</sub>).
- (ii) Carbon monoxide (CO).
- (iii) Hydrogen sulfide (H<sub>2</sub>S).
- (iv) Oxides of nitrogen (NO<sub>x</sub>).
- (v) Oxygen (O<sub>2</sub>).
- (vi) Sulfur dioxide (SO<sub>2</sub>).
- (vii) Total hydrocarbons (THC).
- (viii) Total reduced sulfur (TRS).
- (ix) Volatile organic compound (VOC).

(3) For opacity monitoring when effluent from two (2) or more affected facilities is combined before being released to the atmosphere, the owner or operator may either:

(A) install a continuous opacity monitoring system on the combined effluent; or

(B) install a continuous opacity monitoring system comprised of, and capable of combining the signals from, component transmissometers on each effluent stream.

Results shall be reported on combined effluent. This requirement shall not apply to facilities utilizing wet flue gas desulfurization equipment. For facilities using wet flue gas desulfurization

equipment, opacity may be reported on the combined exhaust or on individual exhausts except as provided for facilities affected by an NSPS as described at 40 CFR 60.13 (i)\*. Compliance for facilities that opt to report on the individual exhausts shall be determined on the individual exhausts based on data provided in accordance with section 7 of this rule.

(4) When the effluent from two (2) or more affected facilities subject to the same emission standard, other than opacity, are combined before being released to the atmosphere, the owner or operator may report the results as required for each affected facility or for the combined effluent.

(5) Instrument full-scale response or upper limit of concentration measurement range for all opacity monitoring systems shall be set at one hundred percent (100%) opacity if possible. If the monitoring system is a requirement of 40 CFR 60\*, 40 CFR 61\*, 40 CFR 63\*, or 40 CFR 75\*, then the appropriate instrument span values and cycling times pursuant to the applicable part shall be used. In all cases, the manufacturer's procedures for calibration shall be followed and may result in an upscale maximum response of less than one hundred percent (100%). The minimum instrument full-scale response for gaseous monitoring systems shall be set at two hundred percent (200%) of the expected instrument data display output corresponding to the emission limitation for the facility unless a request for an alternative setting that provides the following information is submitted to and approved by the department in writing:

- (A) The proposed alternative instrument span value.
- (B) The expected range of pollutant measured concentrations.
- (C) The control device is use.
- (D) The process to be controlled.
- (E) The location of the monitor, such as stack or duct.
- (F) The reason for requesting the alternate instrument span value.

(6) Locations for installing continuous monitoring systems or monitoring devices that vary from locations provided under the performance specifications of 40 CFR 60\*, Appendix B, shall be approved by the department and the U.S. EPA upon a demonstration by the owner or operator that installation at alternative locations will enable accurate and representative measurements.

(7) Owners or operators of affected facilities shall conduct continuous emission monitoring system performance evaluations, upon the request of the department, to demonstrate continuing compliance of the continuous emission monitoring systems with performance specifications as follows:

(A) A performance evaluation is a quantitative and qualitative evaluation of the performance of the continuous emission monitor in terms of:

- (i) accuracy;
- (ii) precision;
- (iii) reliability;
- (iv) representativeness; and
- (v) comparability;

of the data acquired by the monitoring system.

(B) The department may request owners or operators of affected facilities, as defined in section 1(b) of this rule, to conduct continuous emission monitoring system performance evaluations if the department has reason to believe, based on review of monitoring data,

quality assurance data, inspections, or other information, that the continuous emission monitoring system is malfunctioning or may be providing invalid data over an extended period.

(C) A written report containing the complete information of the performance evaluations shall be furnished to the department within forty-five (45) days after the test date. The department may conduct performance evaluations of the continuous emission monitoring systems at any time in order to verify the continued compliance of the systems with the performance specifications.

\* Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Mänge, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board; 326 IAC 3-5-2; filed Jan 30, 1998, 4:00 p.m.: 21 IR 2066*)

### **326 IAC 3-5-3 Monitor system certification**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

**Sec. 3.** Monitor system certification requirements apply to sources and facilities subject to this rule as follows:

(1) The owner or operator shall conduct the applicable performance specifications tests in accordance with the procedures specified in 40 CFR 60\*\*, or other applicable federal regulations, for the required monitoring system as follows:

(A) Not later than one hundred eighty (180) days after a facility start-up or initial monitor installation date; and

(B) Not later than forty-five (45) days after monitor replacement date, or significant monitor repair\* which affects the ability of the analyzer to function date.

(2) The owner or operator shall notify the department in writing as follows:

(A) No less than fourteen (14) days in advance of the start of continuous opacity monitor (COM) certification; and

(B) No less than thirty-five (35) days in advance of the certification of a gaseous monitoring system.

(3) The owner or operator shall submit all the required test data and information in the form of a written report to the department for review and approval with forty-five (45) days of completion of the performance test.

(4) The department shall issue a written notice of certification status upon review of the complete certification test report. A required monitoring system is certified when the department issues a certification letter stating that the required monitoring system, including all applicable components, has satisfactorily met all federal and state monitoring requirements.

(5) The department may decertify a required monitoring system if an audit or performance evaluation reveals that such monitoring system or a component thereof does not meet applicable

performance specifications or requirements. The owner or operator shall repeat the certification process for the required monitoring system within forty-five (45) days of the date of the department's decertification of the required monitoring system.

\* As described in IDEM's Quality Assurance Manual, Chapter 20. Copies of the Quality Assurance Manual are available for copying at the Indiana Department of Environmental Management, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015.

\*\* Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Management, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board*; 326 IAC 3-5-3)

### **326 IAC 3-5-4 Standard operating procedures**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

Sec. 4. (a) The owner or operator of each affected facility specified in section 1(b) of this rule, any facility subject to 326 IAC 12, or any other facility required to monitor emissions on a continuous basis shall submit to the department, within ninety (90) days after monitor installation, a complete written continuous monitoring standard operating procedures (SOP). If revisions are made to the SOP, updates shall be submitted to the department biennially. At a minimum, the SOP shall describe complete step-by-step procedures and operations as follows:

- (1) A description of the facility monitored.
- (2) A listing of the following:
  - (A) Each monitor's brand.
  - (B) Model number.
  - (C) Serial number.
  - (D) Monitoring location.
  - (E) Data handling and acquisition system.
- (3) Examples of all reporting and log forms.
- (4) Record keeping and reporting procedures that include the following:
  - (A) Reporting of instrument precision and accuracy.
  - (B) Reporting of emissions data.
- (5) Methods and procedures for analysis and data acquisition.
- (6) Calibration procedures that include the following:
  - (A) Calibration error limits and linearity.
  - (B) Calibration gas type as applicable, quality, and traceability to the National Institute of Standards and Technology.
  - (C) Calibration frequency.
  - (D) Criteria for recalibration, and analysis procedures to periodically verify the accuracy of span and calibration standards.

- (7) Operation procedures that include daily procedures, quantifying and recording daily zero (0) and high level drift that meet the requirements of 40 CFR 60\*, Appendix B, Performance Specification 2, Section 4.2 or other applicable regulations, and other operating parameter checks indicating correct operational status.
- (8) Quality control and quality assurance procedures that include the following:
  - (A) A statement of quality policy and objectives.
  - (B) Organization and responsibilities description.
  - (C) Calibration and span and zero (0) drift criteria.
  - (D) Excessive drift criteria.
  - (E) Corrective action for excessive drift.
  - (F) Precision and accuracy results.
  - (G) Corrective action for accuracy audits failure.
  - (H) Data validity criteria.
  - (I) Participation in department performance audits.
  - (J) Data recording and calculation audits.
- (9) Preventive maintenance procedures and corrective maintenance procedures that include those procedures taken to ensure continuous operation and to minimize malfunctions.
- (10) A listing of the manufacturer's recommended spare parts inventory.

(b) If a facility owner or operator fails to submit a SOP or submits a SOP that fails the address the factors provided under subsection (b) the department may require a performance evaluation pursuant to section 2 or this rule.

\* Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Mangement, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board*; 326 IAC 3-5-4)

### **326 IAC 3-5-5 Quality assurance requirements**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

Sec. 5. (a) Except where 40 CFR 75\* is applicable for affected facilities under the acid rain program, quality assurance requirements specified in this section and 40 CFR 60\*, Appendix F apply to continuous emission monitors that monitor the following:

- (1) Carbon dioxide (CO<sub>2</sub>).
- (2) Carbon monoxide (CO).
- (3) Hydrogen sulfide (H<sub>2</sub>S).
- (4) Nitrogen oxide (NO<sub>x</sub>).
- (5) Oxygen (O<sub>2</sub>).
- (6) Sulfur dioxide (SO<sub>2</sub>).
- (7) Total hydrocarbons (THC).

- (8) Total reduced sulfur (TRS).
- (9) Volatile organic compounds (VOC).

(b) Quality control (QC) requirements for continuous opacity monitoring systems (COMS) are as follows:

(1) For calibration drift (CD) assessment, the COMS shall be checked at least once daily. The CD shall be quantified and recorded at zero (0) (or low level) and upscale level opacity. The COMS shall be adjusted whenever the CD exceeds the specification of 40 CFR 60\*, Appendix B, Performance Specification 1 (PS-1), and the COMS shall be declared out of control when the CD exceeds twice the specification of PS-1. Corrective actions, followed by a validating CD assessment, are required when the COMS is out of control.

(2) For fault indicators assessment, the fault lamp indicators, data acquisition system error messages, and other system self-diagnostic indicators shall be checked at least daily. Appropriate corrective actions should be taken when the COMS is operating outside the preset limits.

(3) For performance audits, checks of the individual COMS components and factors affecting the accuracy of the monitoring data, as described in this subdivision, shall be conducted at a minimum on a quarterly basis. The absolute minimum checks included in the performance audit are as follows:

(A) The status of the optical alignment of the monitor components shall be checked and recorded according to the procedure specified by the monitor manufacturer. Monitor components must be realigned as necessary.

(B) The apparent effluent opacity shall be compare and recorded before and after cleaning each of the exposed optical surfaces. The total optical surface dust accumulation shall be determined by summing the apparent reductions in opacity for all of the optical surfaces that are cleaned. Caution should be employed in performing this check since fluctuations in effluent opacity occurring during the cleaning cycle may adversely affect the results.

(C) The zero and upscale response errors shall be determined and recorded according to the CD procedures. The errors is defined as the difference (in percent opacity) between the correct value and the observed value for the zero and high-level calibration checks.

(D) The value of the zero compensation applied at the time of the audit shall be calculated as equivalent opacity, corrected to stack exit conditions, according to the procedures specified by the manufacturer. The compensation applied to the effluent recorded by the monitor system shall be recorded.

(E) The optical pathlength correction ratio (OPLR) shall be computed from the monitor pathlength and stack exit diameter and shall be compared, and the difference recorded, to the monitor setup value. The stack exit correlation error shall be determined as the absolute value of the difference between the measured value and the correct value, expressed as a percentage of the correct value.

(F) A three-point calibration error test of the COMS shall be conducted. Three (3) neutral density filters meeting the requirements of PS-1 shall be placed in the COMS

light beam path. The monitor response shall be independently recorded from the COMS permanent data recorder. Make a total of five (5) nonconsecutive readings for each filter.

The low-, mid-, and high-range calibration error results shall be computed as the mean difference and ninety-five percent (95%) confidence interval for the difference between the expected and the actual responses of the monitor as corrected to stack exit conditions. These values shall be calculated using the procedure of Section 8.0 of PS-1. The following are requirements for these values:

- (i) The calibration error test require the installation of an external calibration audit device (zero-jig). The zero-jig shall be adjusted to provide the same zero (0) response as the monitors simulated zero (0).
- (ii) Use calibration attenuators, that is, neutral density filters or screens, with values that have been determined according to PS-1, Section 7.1.3, "Attenuator Calibration", and produce simulated opacities (as corrected to stack exit conditions) in the ranges listed in Table 1-2 in PS-1.
- (iii) The stability of the attenuator values shall be checked at least once per year according to the procedures specified in PS-1. The attenuators shall be recalibrated if the stability checks indicate a change of two percent (2%) opacity or greater.

(4) The following are requirements for monitoring acceptance criteria:

(A) The following criteria are to be used for determining if the COMS audit results are acceptable:

TABLE 1. PERFORMANCE AUDIT CRITERIA

Stack Exit Correlation Error	~ 2 percent
Zero and Upscale Responses	~ 2 percent opacity
Zero Compensation	~ 4 percent opacity
Optical Alignment	Misalignment error ~ 2 percent opacity
Optical Surface Dust Accumulation	~ 4 percent opacity
Calibration Error	~ 3 percent opacity.

(B) The COMS is out-of-control whenever the results of a quarterly performance audit indicate noncompliance with any of the performance assessment criteria of TABLE 1 in clause (A). If the COMS is out-of-control, the owner or operator must take the action necessary to eliminate the problem.

Following corrective action, the source owner or operator must reconduct the appropriate failed portion of the audit and other applicable portions to determine whether the COMS is operating properly and within specifications.

The COMS owner or operator shall record both audit result showing the COMS to be out-of-control and the results following corrective action. COMS data obtained during any out-of-control period may not be used for compliance determination; the data may be used for identifying periods where there has been a failure to meet quality assurance and control criteria.

(C) Repeated audit failures, that is, out-of-control conditions resulting from the quarterly audits, indicate that the QC procedures are inadequate or the COMS is incapable of providing quality data. The source owner or operator shall increase the frequency of the of the above QC procedures until the performance criteria is maintained or modify or replace the COMS whenever two (2) consecutive quarters of unacceptable performance occurs.

(5) The performance audit calculations contained in PS-1, Section 8 shall be followed.

(c) Except where 40 CFR 75\* is applicable for affected facilities under the acid rain program, quality control requirements for flow monitoring systems are as follows:

(1) For calibration drift (CD) assessment, the flow monitoring system shall be checked at least once daily. The CD shall be quantified and recorded at zero (0) (or low level) and upscale level. The flow monitoring system shall be adjusted whenever the CD exceeds the specification of 40 CFR 60\*, Appendix B, Performance Specification 6 (PS-6). Corrective actions, followed by a validating CD assessment, are required when the flow monitoring system is out of control.

(2) An annual relative accuracy test, conducted concurrently with the RATA on the pollutant concentration monitor.

(d) Reporting requirements for performance audits are as follows:

(1) Owners or operators of facilities required to conduct any of the following audits:

(A) cylinder gas audit;

(B) relative accuracy audit; or

(C) continuous opacity monitor calibration error audit;

on continuous emission monitors shall prepare a written report of the results of the performance audit for each calendar quarter, or for other periods required by the department. Quarterly reports shall be submitted to the department within thirty (30) calendar days after the end of each quarter.

(2) The performance audit report shall contain the following information:

(A) Plant and monitor information, including the following:

(i) The plant name and address.

(ii) The monitor brand, model, and serial number.

(iii) The monitor span.

(iv) The monitor location, for example, duct, boiler, unit or stack designation.

(B) Performance audit information, including the following:

(i) The auditor's name.

(ii) A copy of the audit standard's certification, for example, the vendor's Protocol 1 certification, or neutral density filter certification.

(iii) All data used to calculate the audit results.

(iv) The audit results and an indication if the monitor passed or failed the audit.



If the performance audit results show the CEMS or COMS to be out of control, the CEMS or COMS owner or operator must report both the audit results showing the CEMS or COMS to be out of control and the results of the audit following correction action showing the COMS to be operating within specification.  
(v) Any correction actions performed as the result of a failed audit.

(e) If a relative accuracy test audit of any continuous emission monitor listed in subsection (a) is performed, the department must be notified at least thirty-five (35) days prior to the audit.

\* Copies of the Code of Federal Regulations (CFR) referenced may be obtained from the Government Printing Office, Washington, D.C. 20402 and are available for copying at the Indiana Department of Environmental Mangement, Indiana Government Center - North, 100 Senate Avenue, Indianapolis, Indiana 46206-6015. (*Air Pollution Control Board; 326 IAC 3-5-5*)

### **326 IAC 3-5-6 Record keeping requirements**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

Sec. 6. (a) On and after the certification of a monitoring system, the owner or operator of a source subject to this rule shall maintain records, including raw data, of all monitoring data and supporting information for a minimum of five (5) years from the date of any of the following:

- (1) A monitoring sample.
- (2) A measurement.
- (3) A test.
- (4) A certification.
- (5) A report.
- (6) Any other activity required under this article.

(b) The records described in subsection (a) shall include the following:

- (1) All documentation relating to:
  - (A) design, installation, and testing of all elements of the monitoring system;  
and
  - (B) required corrective action or compliance plan activities.
- (2) All maintenance logs, calibration checks, and other required quality assurance activities.
- (3) All records of corrective and preventive action.
- (4) A log of plant operations, including the following:
  - (A) Date of facility downtime.
  - (B) Time of commencement and completion of each downtime.
  - (C) Reason for each downtime.

(c) The owner or operator of a source subject to this rule shall maintain records required by this section at the source, or at such other site, in a manner so that they may be inspected by the department or the U.S. EPA, if so requested. (*Air Pollution Control Board; 326 IAC 3-5-6*)

### **326 IAC 3-5-7 Reporting requirements**

**Authority: IC 13-14-8; IC 13-17-3-4; IC 13-17-3-11**

**Affected: IC 13-14-4-3; IC 13-15; IC 13-17**

Sec. 7. The following reporting requirements apply to source subject to this rule:

- (1) For sources required to report monthly, such reports of excess emissions shall be:
  - (A) submitted by the facility owner or operator to the department; and
  - (B) postmarked or delivered by other means no later than fifteen (15) calendar days after the end of each month.
- (2) For sources required to report quarterly, such monitoring reports shall be:
  - (A) submitted by the facility owner or operator to the department; and
  - (B) postmarked or delivered by other means no later than thirty (30) calendar days following the last day of the reporting period.
- (3) Gaseous excess emissions data reports shall be reported using three (3) hour block periods ending at 03:00, 06:00, 09:00, 12:00, 15:00, 18:00, 21:00, and 24:00. For facilities that must demonstrate compliance with hourly (one (1) hour), daily (twenty-four (24) hour) average, or thirty (30) day averages, such information shall be submitted as part of the quarterly report required in this section.
- (4) The monitoring report shall contain the following continuous monitoring information summaries, with all times reported in real time:

(A) Monitoring facility operation time during the reporting period.

(B) Excess emissions parameters, as applicable, reported in units of the standard, or the applicable parameter unit as follows:

(i) Date of excess emissions, or other applicable dates.

(ii) Time of commencement and completion for each applicable parameter deviation or excess emission data.

(C) Magnitude of each excess emission as follows:

(i) For opacity as follows:

(AA) The actual percent opacity of all six (6) minute (block) averages exceeding the applicable opacity limit shall be reported. If the exceedance occurs continuously beyond one (1) six (6) minute period, the percent opacity for each six (6) minute period or the highest six (6)-minute average opacity for the entire period shall be reported.

(BB) For department approved opacity averaging times other than six (6)-minutes, the actual percent opacity of each averaging period in excess of the applicable limit shall be reported.

(CC) A summary by cause shall be prepared and submitted as part of this report itemizing exceedances by cause.

(ii) For gaseous emissions, the excess emissions, in units of the applicable standard, must be reported based on the applicable averaging time, for

example, one (1) hour block, three (3) hour block, three (3) hour rolling, in addition to any other reporting requirements that may be applicable. The averaging time is specified in the applicable federal or state rules, or facility operating permit.

(5) Continuous monitoring system instrument downtime, except for zero (0) and span checks, which shall be reported separately, shall include the following:

- (A) Date of downtime.
- (B) Time of commencement.
- (C) Duration of each downtime.
- (D) Reasons for each downtime.
- (E) Nature of system repairs and adjustments.

*(Air Pollution Control Board; 326 IAC 3-5-7)*

## **Attachment 6**

### **40 CFR Part 75 APPENDIX B TO PART 75-QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES**

#### **1. QUALITY CONTROL PROGRAM**

Develop and implement a quality control program for the continuous emission monitoring systems and their components. As a minimum, include in each quality control program a written plan that describes in detail complete, step-by-step procedures and operations for each of the following activities.

1.1 Calibration Error Test and Linearity Check Procedures. Identify calibration error test and linearity check procedures specific to the continuous emission monitoring system that may require variance from the procedures in Appendix A to this part (e.g., how gases are to be injected, adjustments of flow rates and pressures, introduction of reference values, length of time for injection of calibration gases, steps for obtaining calibration error or error in linearity, determination of interferences, and when calibration adjustments should be made).

1.2 Calibration and Linearity Adjustments. Explain how each component of the continuous emission monitoring system will be adjusted to provide correct responses to calibration gases, reference values, and/or indications of interference both initially and after repairs or corrective action. Identify equations, conversion factors, assumed moisture content, and other factors affecting calibration of each continuous emission monitoring system.

1.3 Preventive Maintenance. Keep a written record of procedures, including those specified by the manufacturers, needed to maintain the continuous emission monitoring system in proper operating condition and a schedule for those procedures. Include provisions for maintaining an inventory of spare parts.

1.4 Audit Procedures. Keep a written record of procedures and details peculiar to the installed continuous emission monitoring system that are to be used for relative accuracy test audits, such as sampling and analysis methods.

1.5 Record keeping and Reporting. Keep a written record describing procedures that will be used to implement the Record keeping and reporting requirements in subparts F and G of this part.

2. FREQUENCY OF TESTING. A summary chart showing each quality assurance test and the frequency at which each test is required is located at the end of this appendix in Figure 1.

2.1 Daily Assessments. For each monitor or continuous emission monitoring system, perform the following assessments during each day in which the unit combusts any fuel (hereafter referred to as a "unit operating day"), or for a monitor or continuous emission monitoring system on a

bypass stack/duct, during each day that emissions pass through the by-pass stack or duct. These requirements are effective as of the date when the monitor or continuous emission monitoring system completes certification testing. The provisions in this section 2.1 are suspended from July 17, 1995 through December 31, 1996.

2.1.1 Calibration Error Test for Pollutant Concentration and CO<sub>2</sub> or O<sub>2</sub> Monitors. Test, record, and compute the calibration error of each SO<sub>2</sub> and NO<sub>x</sub> pollutant concentration and CO<sub>2</sub> or O<sub>2</sub> monitor at least once on each unit operating day, or for monitors or monitoring systems on bypass ducts/stacks, on each day that emissions pass through the by-pass stack or duct. Conduct calibration error checks, to the extent practicable, approximately 24 hours apart. Perform the daily calibration error test according to the procedure in Appendix A, section 6.3.1 of this part. For units with add-on emission controls and dual span or auto-ranging monitors, and other units that use maximum expected concentration value to determine calibration gas values, perform the daily calibration error test on each scale that has been used since the previous calibration error test. For example, if the emissions concentration has not exceeded the low-scale span value (based on the maximum expected concentration) since the calibration test during the previous calendar day, the calibration error test may be performed on the low-scale only. If, however, the emissions concentration has exceeded the low-scale span value for one hour or longer since the previous calibration error test, perform the calibration error on both the low- and high-scales.

2.1.2 Calibration Error Test for Flow Monitors. Test, compute, and record the calibration error of each flow monitor at least once on each unit operating day, or for monitors or monitoring systems on bypass ducts/stacks, on each day that emissions pass through the by-pass stack or duct. Introduce the reference values (specified in section 2.2.2.1 of Appendix A to this part) to the probe tip (or equivalent) or to the transducer. Record flow monitor output from the data acquisition and handling system before and after any adjustments to the flow monitor. Keep a record of all maintenance and adjustments. Calculate the calibration error using Equation A-6 in Appendix A of this part.

2.1.3 Interference Check. Perform the daily flow monitor interference checks specified in section

2.2.2.2 of Appendix A to this part at least once per operating day (when the unit(s) operate for any part of the day).

2.1.4 Recalibration. The EPA recommends adjusting the calibration, at a minimum, whenever the daily calibration error exceeds the limits of the applicable performance specification for the pollutant concentration monitor, CO<sub>2</sub>, or O<sub>2</sub> monitor, or flow monitor in appendix A of this part.

2.1.5 Out-of-Control Period. An out-of-control period occurs when the calibration error of an SO<sub>2</sub> or NO<sub>x</sub> pollutant concentration monitor exceeds 5.0 percent based upon the span value (or exceeds 10 ppm, for span values <200 ppm), when the calibration error of a diluent gas monitor exceeds 1.0 percent O<sub>2</sub> or CO<sub>2</sub>, or when the calibration error of a flow monitor exceeds 6.0 percent based upon the span value, which is twice the applicable specification of Appendix A of this part. The out-of-control period begins with the hour of completion of the failed calibration error test and ends with the hour of completion following an effective recalibration. Whenever the

failed calibration, corrective action, and effective recalibration occur within the same hour, the hour is not out of control if 2 or more valid readings are obtained during that hour as required by 75.10 of this part. A  $\text{NO}_x$  continuous emission monitoring system is considered out-of-control if either component monitor exceeds twice the applicable specification in Appendix A of this part. An out-of-control period also occurs whenever interference of a flow monitor is identified. The out-of-control period begins with the hour of completion of the failed interference check and ends with the hour of completion of an interference check that is passed.

2.1.6 Data Recording. Record and tabulate all calibration error test data according to month, day, clock-hour, and magnitude in either ppm, percent volume, or scfh. Program monitors that automatically adjust data to the corrected calibration values (e.g., microprocessor control) to record either: (1) The unadjusted concentration or flow rate measured in the calibration error test prior to resetting the calibration, or (2) the magnitude of any adjustment. Record the following applicable flow monitor interference check data: (1) Sample line/sensing port pluggage, and (2) malfunction of each RTD, transceiver, or equivalent.

2.1.7 Daily Assessments. For each monitor or continuous emission monitoring system, perform the following assessments during each day in which the unit combusts any fuel (hereafter referred to as a "unit operating day"), or for a monitor on a bypass stack/duct, during each day that emissions pass through the by-pass stack or duct. If the unit discontinues operation or if use of the by-pass stack or duct is discontinued prior to performance of the calibration error test, data from the monitor or continuous emission monitoring system may be considered quality assured prospectively for 24 consecutive clock hours from the time of successful completion of the previous daily test performed while the unit is operating. These requirements are effective as of the date when the monitor or continuous emission monitoring system completes certification testing.

2.2 Quarterly Assessments. For each monitor or continuous emission monitoring system, perform the following assessments during each unit operating quarter, or for monitors or monitoring systems on bypass ducts or bypass stacks, during each bypass operating quarter to be performed not less than once every 2 calendar years. This requirement is effective as of the calendar quarter following the calendar quarter in which the monitor or continuous emission monitoring system is provisionally certified.

2.2.1 Linearity Check. Perform a linearity check for each  $\text{SO}_2$  and  $\text{NO}_x$  pollutant concentration monitor and each  $\text{CO}_2$  or  $\text{O}_2$  monitor at least once during each unit operating quarter or each bypass operating quarter, in accordance with the procedures in appendix A, section 6.2 of this part. For units using emission controls and other units using a low-scale span value to determine calibration

gases, perform a linearity check on both the low- and high-scales. Conduct the linearity checks no less than 2 months apart, to the extent practicable.

2.2.2 Leak Check. For differential pressure flow monitors, perform a leak check of all sample lines (a manual check is acceptable) at least once during each unit operating quarter or each bypass operating quarter. Conduct the leak checks no less than 2 months apart, to the extent practicable.

2.2.3 Out-of-Control Period. An out-of-control period occurs when the error in linearity at any of the three concentrations (six for dual range monitors) in the quarterly linearity check exceeds the applicable specification in Appendix A, section 3.2 of this part. The out-of-control period begins with the hour of the failed linearity check and ends with the hour of a satisfactory linearity check following corrective action and/or monitor repair. For the NO<sub>x</sub> continuous emission monitoring system, the system is considered out-of-control if either of the component monitors exceed the applicable specification in Appendix A, section 3.2 of this part. An out-of-control period occurs when a flow monitor sample line leak is detected. The out-of-control period begins with the hour of the failed leak check and ends with the hour of a satisfactory leak check following corrective action.

2.3 Semiannual and Annual Assessments. For each monitor or continuous emission monitoring system, perform the following assessments once semiannually (within two calendar quarters) or once annually (within four calendar quarters) after the calendar quarter in which the monitor or monitoring system was last tested, as specified below for the type of test and the performance achieved, except as provided below in section 2.3.1 of this appendix for monitors or continuous emission monitoring systems on bypass ducts or stacks or on peaking units. This requirement is effective as of the calendar quarter, unit operating quarter (for peaking units), or bypass operating quarter (for bypass stacks or ducts) following the calendar quarter in which the monitor or continuous emission monitoring system is provisionally certified. A summary chart showing the frequency with which a relative accuracy test audit must be performed, depending on the accuracy achieved, is located at the end of this appendix in Figure 2.

2.3.1 Relative Accuracy Test Audit. Perform relative accuracy test audits semiannually and, to the extent practicable, no less than 4 months apart for each SO<sub>2</sub> or CO<sub>2</sub> pollutant concentration monitor, flow monitor, NO<sub>x</sub> continuous emission monitoring system, or SO<sub>2</sub>-diluent continuous emission monitoring systems used by units with a Phase I qualifying technology for the period during which the units are required to monitor SO<sub>2</sub> emission removal efficiency, from January 1, 1997 through December 31, 1999, except as provided for monitors or continuous emission monitoring systems on peaking units or bypass stacks or ducts. For monitors on bypass stacks/ducts, perform relative accuracy test audits no less than once every two successive bypass operating quarters, or once every two calendar years, whichever occurs first, in accordance with the procedures in section 6.5 of Appendix A of this part. For monitors on peaking units, perform relative accuracy test audits no less than once every two successive unit operating quarters, or once every two calendar years, whichever occurs first. Audits required under this section shall be performed no less than 4 months apart, to the extent practicable. The audit frequency may be reduced, as specified below for monitors or monitoring systems which qualify for less frequent testing.

For flow monitors, one-level and three-level relative accuracy test audits shall be performed alternately (when a flow RATA is conducted semiannually), such that the three-level relative accuracy test audit is performed at least once annually. The three-level audit shall be performed at the three different operating or load levels specified in appendix A, section 6.5.2 of this part, and the one-level audit shall be performed at the normal operating or load level. Notwithstanding that requirement, relative accuracy test audits need only be performed at the normal operating or load level for monitors and continuous emission monitoring systems on peaking units and bypass

stacks/ducts.

Relative accuracy test audits may be performed on an annual basis rather than on a semiannual basis (or for monitors on peaking units and bypass ducts or bypass stacks, no less than (1) once every four successive unit or bypass operating quarters, or (2) every two calendar years, whichever occurs first) under any of the following conditions: (1) The relative accuracy during the previous audit for an SO<sub>2</sub> or CO<sub>2</sub> pollutant concentration monitor (including an O<sub>2</sub> pollutant monitor used to measure CO<sub>2</sub> using the procedures in appendix F of this part), or for a NO<sub>x</sub> or SO<sub>2</sub>-diluent continuous emissions monitoring system is 7.5 percent or less; (2) prior to January 1, 2000, the relative accuracy during the previous audit for a flow monitor is 10.0 percent or less at each operating level tested; (3) on and after January 1, 2000, the relative accuracy during the previous audit for a flow monitor is 7.5 percent or less at each operating level tested; (4) on low flow ( $\leq 10.0$  fps) stacks/ducts, when

the monitor mean, calculated using Equation A-7 in appendix A of this part is within  $\pm 1.5$  fps of the reference method mean or achieves a relative accuracy of 7.5 percent (10 percent if prior to January 1, 2000) or less during the previous audit; (5) on low SO<sub>2</sub> emitting units (SO<sub>2</sub> concentrations  $\leq 250.0$  ppm, or equivalent lb/MMBTU value for SO<sub>2</sub>-diluent continuous emission monitoring systems), when the monitor mean is within  $\pm 8.0$  ppm (or equivalent in lb/MMBTU for SO<sub>2</sub>-diluent continuous emission monitoring systems) of the reference method mean or achieves a relative accuracy of 7.5 percent or less during the previous audit; or (6) on low NO<sub>x</sub> emitting units (NO<sub>x</sub> emission rate  $\leq 0.20$  lb/MMBTU), when the NO<sub>x</sub> continuous emission monitoring system achieves a relative accuracy of 7.5 percent or less or when the monitoring system mean, calculated using Equation A-7 in appendix A of this part is within  $\pm 0.02$  lb/MMBTU of the reference method mean. A maximum of two relative accuracy test audit trials may be performed for the purpose of achieving the results required to qualify for less frequent relative accuracy test audits.

Whenever two trials are performed, the results of the second (later) trial must be used in calculating both the relative accuracy and bias.

**2.3.2 Out-of-Control Period.** An out-of-control period occurs under any of the following conditions: (1) The relative accuracy of an SO<sub>2</sub>, CO<sub>2</sub>, or O<sub>2</sub> pollutant concentration monitor or a NO<sub>x</sub> or SO<sub>2</sub>-diluent continuous emission monitoring system exceeds 10.0 percent; (2) prior to January 1, 2000, the relative accuracy of a flow monitor exceeds 15.0 percent; (3) on and after January 1, 2000, the relative accuracy of a flow monitor exceeds 10.0 percent; (4) for low flow situations ( $\leq 10.0$  fps), the flow monitor mean value (if applicable) exceeds  $\pm 2.0$  fps of the reference method mean whenever the relative accuracy is greater than 15.0 percent for Phase I or 10 percent for Phase II; (5) for low SO<sub>2</sub> emitter situations, the monitor mean values exceeds  $\pm 15.0$  ppm (or  $\pm 0.03$  lb/MMBTU for SO<sub>2</sub>-diluent continuous emission monitoring systems from January 1, 1997 through December 31, 1999) of the reference method mean whenever the relative accuracy is greater than 10.0 percent; or (6) for low NO<sub>x</sub> emitting units (NO<sub>x</sub> emission rate  $\leq 0.2$  lb/MMBTU), the NO<sub>x</sub> continuous emission monitoring system mean values exceed  $\pm 0.02$  lb/MMBTU of the reference method mean whenever the relative accuracy is greater than 10.0 percent. For SO<sub>2</sub>, CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub> emission rate, and flow relative accuracy test audits performed at only one level, the out-of-control period begins with the hour of completion of the failed relative accuracy test audit and ends with the hour of completion of



a satisfactory relative accuracy test audit. For a flow relative accuracy test audit at 3 operating levels, the out-of-control period begins with the hour of completion of the first failed relative accuracy test audit at any of the three operating levels, and ends with the hour of completion of a satisfactory three-level relative accuracy test audit. Failure of the bias test does not result in the system or monitor being out-of-control.

2.3.3 Bias Adjustment Factor. If an SO<sub>2</sub> pollutant concentration monitor, flow monitor, or NO<sub>x</sub> continuous emission monitoring system fails the bias test specified in Section 7.6 of Appendix A of this part, use the bias adjustment factor given in Equations A-11 and A-12 of Appendix A of this part to adjust the monitored data.

2.4 Other Audits. Affected units may be subject to relative accuracy test audits at any time. If a monitor or continuous emission monitoring system fails the relative accuracy test during the audit, the monitor or continuous emission monitoring system shall be considered to be out-of-control beginning with the date and time of completion of the audit, and continuing until a successful audit test is completed following corrective action. If a monitor or monitoring system fails the bias test during an audit, use the bias adjustment factor given by Equations A-11 and A-12 in Appendix A to this part to adjust the monitored data. Apply this adjustment factor from the date and time of completion of the audit until the date and time of completion of a relative accuracy test audit that does not show bias.

Figure 1.-Quality Assurance Test Requirements

Test	QA test frequency requirements		
	Daily	Quarterly	Semiannual
Calibration Error (2 pt.)	T		
Interference (flow)	T	T	
Linearity (3 pt.)		T	
RATA (SO <sub>2</sub> , NO <sub>x</sub> , CO <sub>2</sub> )**			T
Flow***			T

\* For monitors on bypass stack/duct, bypass operating days or quarters, only.

\*\* Conduct annually, if monitor meets accuracy requirements to qualify for less frequent testing.

\*\*\* Conduct RATAs annually if requirements to qualify for less frequent testing are met.

Figure 2.-Relative Accuracy Test Frequency Incentive System

<b>RATA</b>	<b>Semiannually</b>	<b>Annual</b>
SO <sub>2</sub>	RA ≤ 10%	RA ≤ 7.5% or ± 8ppm**
NO <sub>x</sub>	RA ≤ 10%	RA ≤ 7.5%
Flow (Phase I) <sup>3</sup>	RA ≤ 7.5%	RA ≤ 10% or ± 1.5 fp

{1} For monitors on bypass stack/duct, bypass operating quarters, not to exceed two calendar years. For monitors on peaking units, unit operating quarters, not to exceed two calendar years.

{2} The difference between monitor and reference method mean values; low emitters or low flow, only.

{3} Conduct 3-load RATAs annually, if requirements to qualify for less frequent testing are met.

[58 FR 3701, Jan. 11, 1993; 58 FR 40750, July 30, 1993; 60 FR26510, July 17, 1995]