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## **PERFORMANCE SPECIFICATION 4B—SPECIFICATIONS AND TEST PROCEDURES FOR CARBON MONOXIDE AND OXYGEN CONTINUOUS MONITORING SYSTEMS IN STATIONARY SOURCES**

### *1.0 Scope and Application*

#### 1.1. Analytes

<b>Analyte</b>	<b>CAS No.</b>
Carbon Monoxide (CO)	630-08-0
Oxygen (O <sub>2</sub> )	7782-44-7

#### 1.2. Applicability

1.2.1. This specification is to be used for evaluating the acceptability of carbon monoxide (CO) and oxygen (O<sub>2</sub>) continuous emission monitoring systems (CEMS) at the time of or soon after installation and whenever specified in the regulations. The CEMS may include, for certain stationary sources, (a) flow monitoring equipment to allow measurement of the dry volume of stack effluent sampled, and (b) an automatic sampling system

1.2.2. 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 auxiliary procedures to assess the CEMS' performance. The source owner or operator, however, is responsible to properly calibrate, maintain, and operate the CEMS. To evaluate the CEMS' performance, the Administrator may require, under section 114 of the Act, the operator to conduct CEMS performance evaluations at times other than the initial test.

1.2.3. The definitions, installation and measurement location specifications, test procedures, data reduction procedures, reporting requirements, and bibliography are the same as in PS 3 (for O<sub>2</sub>) and PS 4A (for CO) except as otherwise noted below.

### *2.0 Summary of Performance Specification*

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

### *3.0 Definitions*

The definitions are the same as in section 3.0 of PS2 with the following definitions added:

3.1. *Continuous Emission Monitoring System (CEMS)*. This definition is the same as PS 2 section 2.1 with the following addition. A continuous monitor is one in which the sample to be analyzed passes the measurement section of the analyzer without interruption.

3.2. *Response Time (RT)*. The time interval between the start of a step change in the system input and when the pollutant analyzer output reaches 95 percent of the final value.

3.3. *Calibration Error (CE)*. The difference between the concentration indicated by the CEMS and the known concentration generated by a calibration source when the entire CEMS, including the sampling interface is challenged. A CE test procedure is performed to document the accuracy and linearity of the CEMS over the entire measurement range.

#### *4.0 Interferences [Reserved]*

#### *5.0 Safety*

This performance specification may involve hazardous materials, operations, and equipment. This performance specification may not address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicable regulatory limitations prior to performing this performance specification. The CEMS user's manual should be consulted for specific precautions to be taken with regard to the analytical procedures.

#### *6.0 Equipment and Supplies*

Same as section 6.0 of PS 2, except for the following:

6.1 Data Recorder Scale. For O<sub>2</sub>, same as specified in PS 3, except that the span must be 25 percent. The span of the O<sub>2</sub> may be higher if the O<sub>2</sub> concentration at the sampling point can be greater than 25 percent. For CO, same as specified in PS 4A, except that the low-range span must be 200 ppm and the high range span must be 3000 ppm. In addition, the scale for both CEMS must record all readings within a measurement range with a resolution of 0.5 percent.

#### *7.0 Reagents and Standards*

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

##### *8.1. Installation and Measurement Location Specifications*

8.1.1. The CEMS Installation. This specification is the same as PS 2 section 8.1.1 with the following additions. Both the CO and O<sub>2</sub> monitors should be installed at the same general location. If this is not possible, they may be installed at different locations if the effluent gases at both sample locations are not stratified and there is no in-leakage of air between sampling locations.

8.1.2. Measurement Location. Same as section 8.1.2 of PS 2.

8.1.2.1. Point CEMS. The measurement point should be within or centrally located over the centroidal area of the stack or duct cross section.

8.1.2.2. Path CEMS. The effective measurement path should: (1) Have at least 70 percent of the path within the inner 50 percent of the stack or duct cross sectional area, or (2) be centrally located over any part of the centroidal area.

#### 8.1.3. Reference Method (RM) Measurement Location and Traverse Points

This specification is the same as PS 2 section 8.1.3 with the following additions. When pollutant concentration changes are due solely to diluent leakage and CO and O<sub>2</sub> are simultaneously measured at the same location, one half diameter may be used in place of two equivalent diameters.

8.2 Pretest Preparation. Install the CEMS, prepare the RM test site according to the specifications in section 8.1, and prepare the CEMS for operation according to the manufacturer's written instructions.

8.3 Stratification Test Procedure. Stratification is defined as the difference in excess of 10 percent between the average concentration in the duct or stack and the concentration at any point more than 1.0 meter from the duct or stack wall. To determine whether effluent stratification exists, a dual probe system should be used to determine the average effluent concentration while measurements at each traverse point are being made. One probe, located at the stack or duct centroid, is used as a stationary reference point to indicate change in the effluent concentration over time. The second probe is used for sampling at the traverse points specified in Method 1 (40 CFR part 60 appendix A). The monitoring system samples sequentially at the reference and traverse points throughout the testing period for five minutes at each point.

8.4 Calibration Drift Test Procedure. Same as section 8.3 in PS 2.

*Note :* The CE and RT tests must be conducted during the CD test period

8.5 Calibration Error Test Procedure. Challenge each monitor (both low and high range CO and O<sub>2</sub>) with zero gas and EPA Protocol 1 cylinder gases at three measurement points within the ranges specified in Table 4B-1 (in section 18.0).

Operate each monitor in its normal sampling mode as nearly as possible. The calibration gas must be injected into the sample system as close to the sampling probe outlet as practical and should pass through all CEMS components used during normal sampling. Challenge the CEMS three non-consecutive times at each measurement point and record the responses. The duration of each gas injection should be sufficient to ensure that the CEMS surfaces are conditioned.

8.6 Response Time Test Procedure. Same as section 8.3 in PS 4A and must be carried out for both the CO and O<sub>2</sub> monitors.

8.7 Relative Accuracy Test Procedure. Sampling Strategy for reference method (RM) Tests, Number of RM Tests, and Correlation of RM and CEMS Data are the same as PS 2, sections 8.4.3, 8.4.4, and 8.4.5, respectively.

### *9.0 Quality Control [Reserved]*

### *10.0 Calibration and Standardization [Reserved]*

### *11.0 Analytical Procedure*

Sample collection and analysis are concurrent for this performance specification (see section 8.0). Refer to the RM for specific analytical procedures.

### *12.0 Calculation and Data Analysis*

Summarize the results on a data sheet as shown in Figure 4B-1 (in section 18.0)

Calibration Error. Average the differences between the instrument response and the certified cylinder gas value for each gas. Calculate the CE results for the CO monitor according to:

$$CE = \left| \frac{d}{FS} \right| \times 100 \quad \text{Eq. 4B-1}$$

Where:

d = mean difference between the CEMS response and the known reference concentration, and  
FS = span value.

The CE for the O<sub>2</sub> monitor is the average percent O<sub>2</sub> difference between the O<sub>2</sub> monitor and the certified cylinder gas value for each gas.

### *13.0 Method Performance*

13.1. Calibration Drift Performance Specification. For O<sub>2</sub>, same as specified in PS 3. For CO, the same as specified in PS 4A except that the CEMS calibration must not drift from the reference value of the calibration standard by more than 3 percent of the span value on either the high or low range.

13.2. Calibration Error (CE) Performance Specification. The mean difference between the CEMS and reference values at all three test points (see Table 4B-1) must be no greater than 5 percent of span value for CO monitors and 0.5 percent for O<sub>2</sub> monitors.

13.3. Response Time Performance Specification. The response time for the CO or O<sub>2</sub> monitor must not exceed 240 seconds.

13.4. Relative Accuracy (RA) Performance Specification. For O<sub>2</sub>, same as specified in PS 3. For CO, the same as specified in PS 4A.

### *14.0 Pollution Prevention [Reserved]*

### *15.0 Waste Management [Reserved]*

### *16.0 Alternative Procedure*

Alternative RA Procedure. Under some operating conditions, it may not be possible to obtain meaningful results using the RA test procedure. This includes conditions where consistent, very low CO emission or low CO emissions interrupted periodically by short duration, high level

spikes are observed. It may be appropriate in these circumstances to waive the RA test and substitute the following procedure.

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, sample filters, sample line heaters, moisture traps, and other related functions of the CEMS, as applicable. All parts of the CEMS must be functioning properly before the RA requirement can be waived. The instrument must also successfully pass the CE and CD specifications. Substitution of the alternate procedure requires approval of the Regional Administrator.

#### *17.0 Reference*

1. 40 CFR Part 266, Appendix IX, section 2, "Performance Specifications for Continuous Emission Monitoring Systems."

#### *18.0 Tables, Diagrams, Flowcharts, and Validation Data*

Measurement point	CO Low range (ppm)	CO High range (ppm)	O2 (%)
1	0 – 40	0 – 600	0 – 2
2	60 – 80	900 – 1200	8 -10
3	140 - 160	2100 - 2400	14 - 16

Table 4B-1. Calibration Error Concentration Range

Run Number	Calibration Value	Monitor Response	Difference		
			Zero	Mid	High
1-Zero					
2-Mid					
3-High					
4-Mid					
5-Zero					
6-High					
7-Zero					
8-Mid					
9-High					
Mean Difference =					
Calibration Error =			%	%	%

Figure 4B-1. Calibration Error Data Sheet