METHOD 10 - DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

Applicability and Principle

Principle. An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content. Performance specifications and test procedures are provided to ensure reliable data.

Applicability. This method is applicable for the determination of carbon monoxide emissions from stationary sources. The process will dictate whether a continuous or an integrated sample is required. If the process produces CO spikes that would exceed the span (as determined from the allowable), then an integrated procedure is required.

Interferences

Any substance having a strong absorption of infrared energy will interfere to some extent, for example water and carbon dioxide. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume will be corrected if these traps are used employing Equation 10-1 listed in Section 12.1 of the method.

Alternatively, the use of GFC NDIR will alleviate this need.

In the sections that follow, the proposed Apparatus, Analytical Method and Sampling Procedure to be used will be noted.

Apparatus (check one)

_____ Continuous Sample

A **measurement system** for Carbon Monoxide that meets the specifications in Section 13.0 of this method will be used.

The **Sample Probe** will be of sufficient length to traverse the sample points. The sampling probe shall be heated to prevent condensation if also being used to measure SO_2 and/or NOx.

The **Sample Line** will transport the sample gas to the moisture removal system and be heated (sufficient to prevent condensation) if also being used to measure SO_2 and/or NOx.

The **Moisture Removal System** will be a refrigerator-type condenser or similar device to continuously remove condensate from the sample gas while maintaining minimal contact between the condensate and the sample gas. If a wet-basis system is being proposed, details will be included at the end of this template in the protocol submittal.

The **Sample Transport Lines** will transport the sample from the moisture removal system to the sample pump, sample flow rate control, and sample gas manifold.

A **Calibration Valve Assembly** with a three-way valve assembly, or equivalent, for introducing calibration gases either directly to the analyzer in direct calibration mode, or into the measurement system at the probe in system calibration mode, will be utilized. When in the system calibration mode, the system must be able to flood the sampling probe and vent excess gas.

A **Particulate Filter**, either an in-stack or heated (sufficient to prevent water condensation) out-of-stack filter will be used. If an out-of-stack filter is used, it will be included in the system bias test.

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 will be used. The pump will be constructed of any material that is nonreactive to the gas being sampled.

A **Recorder**, a strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute. A strip-chart recorder can only be used as a back-up system.

_____ **Integrated Sample**

Probe. Same as above.

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

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

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

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

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

Analysis (check one)

A measurement system for Carbon Monoxide that meets the specifications in Section 13.0 of this method will be used. Dual range analyzers may be used when needed, provided that both ranges meet all the quality assurance requirements of this method. When an analyzer is routinely calibrated with a calibration span of less than or equal to 20 ppmv, the manufacturer's stability test (MST) is required (Table 7E-5 of Method 7E) prior to testing and documentation will be included in the test report. Instruments using a Luft-type nondispersive infrared analyzer (NDIR) or gas filter correlation (GFC) NDIR have successfully been used in the past. The instrument to be used will be:

_____ **NDIR Carbon Monoxide Analyzer.** Nondispersive infrared spectrometer, or equivalent.
Silica Gel and Ascarite Traps (check one)
_____ will be used as detailed in the method.
_____ will not be used **because**:

_____ **GFC Carbon Monoxide Analyzer.** Gas filter correlation NDIR analyzer.

If the analyzer proposed is operated on a principle other than one of the above, the details will be included at the end of this template in the protocol submittal.

Analytical Span and Calibration Gases

The span of the monitoring system is equivalent to the high-level calibration gas value (see below) and will be selected such that to the extent practicable, the measured emissions will be between 20 – 100% of the selected calibration span. In practical terms, the span is selected such that a pollutant gas concentration equivalent to the emission standard is not less than 30% of the span. If at any time during the run the measured gas concentration exceeds the readable range of the analyzer, the run may be considered invalid. If the average of any run exceeds the calibration span value, the run is invalid.

Allowable = _____ lb/hr   MW = 28 lb/lbmole
Stack Flow = _____ dscfm

The in-stack concentration based on the emission standard and stack flow parameters is

$$\frac{(lb/hr) \times (387 \times 10^6)}{(MW) \times (dscfm) \times 60} = \text{_____ ppm.}$$

Note: when actual concentrations differ significantly from the standard, the span may need to be modified accordingly, such that the method criteria for span selection are met. Determining the emission standard is the first step in approximating the necessary span.

The **high-level calibration gas sets the calibration span** and results in measurements being (to the extent practicable) equivalent to 20 to 100 percent of the span. Based on the calculation above, the high-level gas (span) concentration to be used during the source test will be _____.

The **mid-level calibration gas** will be equivalent to 40 to 60 percent of the span. The mid-level calibration gas concentration to be used during the source test will be _____.

The **low-level calibration gas** will be less than 20 percent of the calibration span. A zero gas meeting the definition of "zero air material" in 40CFR72.2 may be used. The low-level gas concentration to be used during the source test will be _____.

The calibration gases will be CO in N_2. The calibration gases will be (check one):

    ____ Certified within an uncertainty of 2.0 percent in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" (EPA Protocol gases). If a zero gas is used for the low-level gas, it will meet the definition of "zero air material" in 40CFR72.2, as opposed to being an EPA Protocol gas.

    ____ Blended gas mixtures meeting the protocol above, provided that the additional gas components are shown not to interfere with the analysis.

    ____ Calibration gases will be prepared from EPA Protocol gases using Method 205. Separate procedures for Method 205 will be included in the protocol. Note: Part 75 applications require EPA approval for the use of Method 205.

Analyzer Calibration

The **analyzer calibration error check** (or system calibration test for dilution systems) will be conducted by introducing the low-level, mid-level, and high-level gases to the analyzer (or through the entire measurement system, introduced at the probe, for a dilution system). During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded. The analyzer calibration error check will be considered invalid if the gas concentration displayed by the analyzer exceeds ±2 percent of the span for any of the calibration gases, or > 0.5 ppmv absolute difference.

The **sampling system bias check** will be performed by introducing first an upscale gas (mid-range or high-level, whichever more closely approximates the stack concentration) at the calibration valve assembly installed at the outlet of the sampling probe, and then the low-level gas. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow at the analyzer. This check will be considered invalid if the difference between the calibration bias check and the calibration error check for the same calibration gas exceeds ± 5% of the span, or > 0.5 ppmv absolute difference.

During the initial sampling system bias check, the **measurement system response time** is determined, as detailed in Sections 8.2.5 and 8.2.6 of Method 7E. Documentation that an interference check has been conducted in accordance with Section 8.2.7 of Method 7E will be available on-site and will be included in the final test report. Any specific technology, equipment or procedures intended to remove interference effects will be operating properly during the stack test. The Alternative Interference Check listed in Section 16.1 of Method 6C may be used instead.

Stratification Determination

Prior to sampling, or as part of the first test run, a stratification check must be performed in accordance with Section 8.1.2 of Method 7E. If more than one instrumental method that requires a stratification check is being performed, the stratification check need only be done on one of them. A stratification check is not required for stacks < 4 inches in diameter.

The stratification check will be conducted at either (1) twelve traverse points selected in a accordance with EPA Method 1, or (2) three traverse points spaced on a line passing through the centroidal area at 16.7, 50.0 and 83.3 percent of the measurement line. Each point will be sampled for a minimum of twice the response time.

The minimum number of traverse points required for sampling will be determined as follows. If each traverse point differs from the mean by no more than the least restrictive of:

Difference from mean	Stratification Class	Number of required sample points
$\pm$ 5% or $\pm$ 0.5 ppm	Unstratified	A single point that most closely matches the mean.
Between $\pm$ 5% and $\pm$ 10%, or between $\pm$ 0.5 ppm and $\pm$ 1.0 ppm	Minimally stratified	Three (3) sample points spaced at 16.7, 50.0 and 83.3 percent of the measurement line. *
Greater than $\pm$ 10% and greater than $\pm$ 1.0 ppm	Stratified	Twelve (12) sample points located consistent with EPA Method 1 criteria.

* For a minimally stratified stack with an internal diameter greater than 2.4 meters (7.8 feet), the three sampling points may be located at 0.4 meters (1.3 feet), 1.0 meters (3.28 feet) and 2.0 meters (6.56 feet) along the measurement line showing the highest average concentration. This option will only be available if the stratification check consisted of twelve points.

Emission Measurement Test Procedure

The sampling probe will be placed at the first sample point and sampling will begin at the same rate used during the bias check. A constant rate $\pm$ 10 percent will be maintained during the entire sample run. Sampling will commence only after twice the response time has elapsed. Sampling will be conducted for an equal length of time at each traverse point.

Immediately following the completion of the test period and hourly during the test period, the low-level calibration gas and an upscale calibration gas (the mid-level or high-level as appropriate) will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the measurement system will be made until both the low-level and upscale bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Eqn. 7E-5b (Eqn. 7E-5a if a non-zero gas is used for the low-level calibration gas) of Method 7E.

Measurement System Performance Specifications

Drift, less than or equal to ±3 percent of the span value for the low-level or upscale gas.
Sampling System Bias, less than or equal to ±5 percent of span value for the low-level or upscale gas. **Calibration Error**, less than or equal to ±2 percent of span for each calibration gas.

An alternative acceptance criteria for each of these measurements is less than or equal to ± 0.5 ppmv absolute difference.

Sampling Procedure (check one)

_____ **Continuous Sampling.** See above.

_____ **Integrated Sampling.** The flexible bag will be evacuated. The equipment will be set up with the bag disconnected. The probe will be placed in the stack, and the sampling line purged. The bag will be connected, making sure that all connections are leak free. The sampling rate will be proportional to the stack velocity. CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures, or by weighing the ascarite CO_2 concentration from the gas volume sampled and the weight gain of the tube, if applicable.

Emission Calculation

The average gas effluent concentration will be 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 the procedures specified above. The average gas concentration displayed by the analyzer may be determined by averaging all of the effluent measurements indicated by the data acquisition system for the test run. The minimum frequency for data recording will be one-minute averages during the run. A chart recorder will only be used as a backup to the data acquisition system. The effluent gas concentration will be calculated using Eqn. 7E-5b (Eqn. 7E-5a if a non-zero gas is used for the low-level calibration gas) of Method 7E.

$$Cgas = (Cavg - Co)\frac{CMA}{CM - Co} \qquad \text{Eqn. 7E-5b}$$

$$Cgas = (Cavg - CM)\frac{CMA - COA}{CM - Co} + CMA \quad \text{Eqn. 7E-5a}$$

Emissions will be presented in the following units:
_____.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)