METHOD 7E - DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES

Applicability and Principle

A sample is continuously extracted from the effluent stream and is conveyed to an instrumental analyzer for the determination of NOx concentrations. Performance specifications and test procedures are provided to ensure reliable data.

Apparatus

A **measurement system** for Nitrogen Oxides that meets the specifications in Section 13.0 of this method will be used. Analyzers operating on the principle of chemiluminescence, which includes a NO_2 to NO converter that converts NO_2 in the gas stream to NO, have been successfully used in the past. If the analyzer proposed is operated on a principle other than chemiluminescence, the details will be included at the end of this template in the protocol submittal. 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 the method) prior to testing and documentation will be included in the test report.

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

The **Sample Line** will be heated (sufficient to prevent condensation) stainless steel or Teflon® tubing, to transport the sample gas to the moisture removal system.

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 be 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.

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. All filters will be fabricated of materials that are nonreactive to the gas being sampled. 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.

The **Recorder** will be a computerized data acquisition system, digital recorder or data logger used 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.

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 <u>standard</u> 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 = 46 lb/lbmole
Stack Flow = _____ dscfm

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

$$\frac{(lb/hr) \times (387 \times 10^6)}{(MW) \times (dscfm) \times 60} = \underline{\hspace{2cm}} \text{ ppm.}$$

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 NO 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 $\pm$ 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 the method.

If the measurement system being used converts NO_2 to NO prior to analyzing for NOx, a **NO_2 to NO converter efficiency test** will be conducted as part of this test program in accordance with either;

(1) Section 8.2.4.1 (NO_2 cylinder procedure), or

(2) Section 16.2.1 (NOx generator procedure), or

(3) Section 16.2.2 (Tedlar bag procedure using NO calibration gas).

The procedure to be utilized in this test program will be _____.

A NOx converter efficiency of $\geq$ 90% is required for Options 1 or 2 above, calculated by Eqn. 7E-7. For Option 3 above, the final NOx reading must not drop more than 2% of the peak value measured to be considered acceptable, as calculated by Eqn. 7E-9. The NOx converter efficiency check will be conducted on each day of testing when the test consists of multiple test dates. Alternatively, the NOx converter check will be conducted, at a minimum, prior to the start of testing on the first day, and at the conclusion of the last day of testing. Should the final NOx converter check fail to meet acceptance criteria, all data since the last passing converter efficiency check will be considered invalid.

Documentation that an interference check has been conducted in accordance with Section 8.2.7 of the method 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.

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 the method. 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).

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.

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).

$$C_{gas} = (C_{avg} - C_o)\frac{CMA}{CM - Co} \qquad \text{Eqn. 7E-5b}$$

$$C_{gas} = (C_{avg} - CM)\frac{CMA - COA}{CM - Co} + CMA \qquad \text{Eqn. 7E-5a}$$

Emissions will be presented in the following units: _____.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)