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## **METHOD 7E—DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES (INSTRUMENTAL ANALYZER PROCEDURE)**

### *1.0 Scope and Application*

What is Method 7E?

Method 7E is a procedure for measuring nitrogen oxides (NO<sub>x</sub>) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis. This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this part:

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

*1.1 Analytes. What does this method determine?* This method measures the concentration of nitrogen oxides as NO<sub>2</sub>.

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

*1.2 Applicability. When is this method required?* The use of Method 7E may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans, and permits where measurement of NO<sub>x</sub> concentrations in stationary source emissions is required, either to determine compliance with an applicable emissions standard or to conduct performance testing of a continuous monitoring system (CEMS). Other regulations may also require the use of Method 7E.

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

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

## *2.0 Summary of Method*

In this method, a sample of the effluent gas is continuously sampled and conveyed to the analyzer for measuring the concentration of NO<sub>x</sub>. You may measure NO and NO<sub>2</sub> separately or simultaneously together but, for the purposes of this method, NO<sub>x</sub> is the sum of NO and NO<sub>2</sub>. You must meet the performance requirements of this method to validate your data.

## *3.0 Definitions*

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

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

*3.3 Calibration Gas* means the gas mixture containing NO<sub>x</sub> at a known concentration and produced and certified in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards," September 1997, as amended August 25, 1999, EPA-600/R-97/121 or more recent updates. The tests for analyzer calibration error, drift, and system bias require the use of calibration gas prepared according to this protocol. If a zero gas is used for the low-level gas, it must meet the requirements under the definition for "zero air material" in 40 CFR 72.2 in place of being prepared by the traceability protocol.

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

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

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

*3.4 Calibration Span* means the upper limit of the analyzer's calibration that is set by the choice of high-level calibration gas. No valid run average concentration may exceed the calibration span. To the extent practicable, the measured emissions should be between 20 to 100 percent of the selected calibration span. This may not be practicable in some cases of low-concentration measurements or testing for compliance with an emission limit when emissions are substantially less than the limit. In such cases, calibration spans that are practicable to achieving the data quality objectives without being excessively high should be chosen.

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

3.6 *Converter Efficiency Gas* means a calibration gas with a known NO or NO<sub>2</sub> concentration and of Traceability Protocol quality.

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

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

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

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

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

3.12 *Low-Concentration Analyzer* means any analyzer that operates with a calibration span of 20 ppm NO<sub>x</sub> or lower. Each analyzer model used routinely to measure low NO<sub>x</sub> concentrations must pass a manufacturer's stability test (MST). An MST subjects the analyzer to a range of line voltages and temperatures that reflect potential field conditions to demonstrate its stability following procedures similar to those provided in 40 CFR 53.23. Ambient-level analyzers are exempt from the MST requirements of section 16.3. A copy of this information must be included in each test report. Table 7E-5 lists the criteria to be met.

3.13 *Measurement System* means all of the equipment used to determine the NO<sub>x</sub> concentration. The measurement system comprises six major subsystems: Sample acquisition, sample transport, sample conditioning, calibration gas manifold, gas analyzer, and data recorder.

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

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

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

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

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

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

#### *4.0 Interferences*

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

#### *5.0 Safety*

*What safety measures should I consider when using this method?* This method may require you to work with hazardous materials and in hazardous conditions. We encourage you to establish safety procedures before using the method. Among other precautions, you should become familiar with the safety recommendations in the gas analyzer user's manual. Occupational Safety and Health Administration (OSHA) regulations concerning cylinder and noxious gases may apply. Nitric oxide and NO<sub>2</sub> are toxic and dangerous gases. Nitric oxide is immediately converted to NO<sub>2</sub> upon reaction with air. Nitrogen dioxide is a highly poisonous and insidious gas. Inflammation of the lungs from exposure may cause only slight pain or pass unnoticed, but the resulting edema several days later may cause death. A concentration of 100 ppm is dangerous for even a short exposure, and 200 ppm may be fatal. Calibration gases must be handled with utmost care and with adequate ventilation. Emission-level exposure to these gases should be avoided.

#### *6.0 Equipment and Supplies*

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

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

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

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

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

(4) All system components (excluding sample conditioning components, if used) must maintain the sample temperature above the moisture dew point. Ensure minimal contact between any condensate and the sample gas. Section 6.2 provides example equipment specifications for a NO<sub>x</sub> measurement system. Figure 7E-1 is a diagram of an example dry-basis measurement system that is likely to meet the method requirements and is provided as guidance. For wet-basis systems, you may use alternative equipment and supplies as needed (some of which are described in Section 6.2), provided that the measurement system meets the applicable performance specifications of this method.

## 6.2 Measurement System Components

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

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

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

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

For wet basis systems, you must keep the sample above its dew point either by: (1) Heating the sample line and all sample transport components up to the inlet of the analyzer (and, for hot-wet extractive systems, also heating the analyzer) or (2) by diluting the sample prior to analysis

using a dilution probe system. The components required to do either of the above are considered to be conditioning equipment.

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

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

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

*6.2.8 NO<sub>x</sub> Analyzer.* An instrument that continuously measures NO<sub>x</sub> in the gas stream and meets the applicable specifications in section 13.0. An analyzer that operates on the principle of chemiluminescence with an NO<sub>2</sub> to NO converter is one example of an analyzer that has been used successfully in the past. Analyzers operating on other principles may also be used provided the performance criteria in section 13.0 are met.

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

*6.2.8.2 Low Concentration Analyzer.* When an analyzer is routinely calibrated with a calibration span of 20 ppmv or less, the manufacturer's stability test (MST) is required. See Table 7E-5 for test parameters.

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

## *7.0 Reagents and Standards*

*7.1 Calibration Gas.* What calibration gases do I need? Your calibration gas must be NO in N<sub>2</sub> and certified (or recertified) within an uncertainty of 2.0 percent in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997, as amended August 25, 1999, EPA-600/R-97/121. Blended gases meeting the Traceability Protocol are allowed if the additional gas components are shown not to interfere with the analysis. If a zero gas is used for the low-level gas, it must meet the requirements under the definition for "zero air material" in 40 CFR 72.2. The calibration gas must not be used after its expiration date. Except for applications under part 75 of this chapter, it is acceptable to prepare calibration gas mixtures from EPA Traceability Protocol gases in accordance with Method 205 in appendix M to part 51 of this chapter. For part 75 applications, the use of Method 205 is subject to the approval of the Administrator. The goal and recommendation for selecting calibration gases is to bracket the sample concentrations. The following calibration gas concentrations are required:

*7.1.1 High-Level Gas.* This concentration is chosen to set the calibration span as defined in Section 3.4.

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

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

*7.1.4 Converter Efficiency Gas.* What reagents do I need for the converter efficiency test? The converter efficiency gas is a manufacturer-certified gas with a concentration sufficient to show NO<sub>2</sub> conversion at the concentrations encountered in the source. A test gas concentration in the 40 to 60 ppm range is suggested, but other concentrations may be more appropriate to specific sources. For the test described in section 8.2.4.1, NO<sub>2</sub> is required. For the alternative converter efficiency tests in section 16.2, NO is required.

*7.2 Interference Check.* What reagents do I need for the interference check? Use the appropriate test gases listed in Table 7E-3 or others not listed that can potentially interfere (as indicated by the test facility type, instrument manufacturer, etc.) to conduct the interference check. These gases should be manufacturer certified but do not have to be prepared by the EPA traceability protocol.

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

Emission Test Procedure

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

### *8.1 What sampling site and sampling points do I select?*

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

8.1.2 Determination of Stratification. Perform a stratification test at each test site to determine the appropriate number of sample traverse points. If testing for multiple pollutants or diluents at the same site, a stratification test using only one pollutant or diluent satisfies this requirement. A stratification test is not required for small stacks that are less than 4 inches in diameter. To test for stratification, use a probe of appropriate length to measure the NO<sub>x</sub> (or pollutant of interest) concentration at 12 traverse points located according to Table 1-1 or Table 1-2 of Method 1. Alternatively, you may measure at three points on a line passing through the centroidal area. Space the three points at 16.7, 50.0, and 83.3 percent of the measurement line. Sample for a minimum of twice the system response time (see section 8.2.6) at each traverse point. Calculate the individual point and mean NO<sub>x</sub> concentrations. If the concentration at each traverse point differs from the mean concentration for all traverse points by no more than:  $\pm 5.0$  percent of the mean concentration; or  $\pm 0.5$  ppm (whichever is less restrictive), the gas stream is considered unstratified, and you may collect samples from a single point that most closely matches the mean. If the 5.0 percent or 0.5 ppm criterion is not met, but the concentration at each traverse point differs from the mean concentration for all traverse points by not more than:  $\pm 10.0$  percent of the mean concentration; or  $\pm 1.0$  ppm (whichever is less restrictive), the gas stream is considered to be minimally stratified and you may take samples from three points. Space the three points at 16.7, 50.0, and 83.3 percent of the measurement line. Alternatively, if a 12-point stratification test was performed and the emissions were shown to be minimally stratified (all points within  $\pm 10.0$  percent of their mean or within  $\pm 1.0$  ppm), and if the stack diameter (or equivalent diameter, for a rectangular stack or duct) is greater than 2.4 meters (7.8 ft), then you may use 3-point sampling and locate the three points along the measurement line exhibiting the highest average concentration during the stratification test at 0.4, 1.2 and 2.0 meters from the stack or duct wall. If the gas stream is found to be stratified because the 10.0 percent or 1.0 ppm criterion for a 3-point test is not met, locate 12 traverse points for the test in accordance with Table 1-1 or Table 1-2 of Method 1.

*8.2 Initial Measurement System Performance Tests. What initial performance criteria must my system meet before I begin collecting samples?* Before measuring emissions, perform the following procedures:

- (a) Calibration gas verification,
- (b) Measurement system preparation,
- (c) Calibration error test,
- (d) NO<sub>2</sub> to NO conversion efficiency test, if applicable,
- (e) System bias check,
- (f) System response time test, and
- (g) Interference check

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

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

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

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

(2) Record the analyzer's response to each calibration gas on a form similar to Table 7E-1. For each calibration gas, calculate the analyzer calibration error using Equation 7E-1 in section 12.2 or the system calibration error using Equation 7E-3 in section 12.4 (as applicable). The calibration error specification in section 13.1 must be met for the low-, mid-, and high-level

gases. If the calibration error specification is not met, take corrective action and repeat the test until an acceptable 3-point calibration is achieved.

*8.2.4 NO<sub>2</sub> to NO Conversion Efficiency Test.* Before or after each field test, you must conduct an NO<sub>2</sub> to NO conversion efficiency test if your system converts NO<sub>2</sub> to NO before analyzing for NO<sub>x</sub>. You may risk testing multiple facilities before performing this test provided you pass this test at the conclusion of the final facility test. A failed final conversion efficiency test in this case will invalidate all tests performed subsequent to the test in which the converter efficiency test was passed. Follow the procedures in section 8.2.4.1, or 8.2.4.2. If desired, the converter efficiency factor derived from this test may be used to correct the test results for converter efficiency if the NO<sub>2</sub> fraction in the measured test gas is known. Use Equation 7E-8 in section 12.8 for this correction.

8.2.4.1 Introduce NO<sub>2</sub> converter efficiency gas to the analyzer in direct calibration mode and record the NO<sub>x</sub> concentration displayed by the analyzer. Calculate the converter efficiency using Equation 7E-7 in section 12.7. The specification for converter efficiency in section 13.5 must be met. The user is cautioned that state-of-the-art NO<sub>2</sub> calibration gases may have limited shelf lives, and this could affect the ability to pass the 90-percent conversion efficiency requirement.

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

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

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

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

(3) From these data, calculate the measurement system response time (see section 8.2.6) and then calculate the initial system bias using Equation 7E-2 in section 12.3. For dilution systems,

calculate the system calibration error in lieu of system bias using equation 7E-3 in section 12.4. See section 13.2 for acceptable performance criteria for system bias and system calibration error. If the initial system bias (or system calibration error) specification is not met, take corrective action. Then, you must repeat the applicable calibration error test from section 8.2.3 and the initial system bias (or 2-point system calibration error) check until acceptable results are achieved, after which you may begin sampling.

(NOTE: For dilution-type systems, data from the 3-point system calibration error test described in section 8.2.3 may be used to meet the initial 2-point system calibration error test requirement of this section, if the calibration gases were injected as described in this section, and if response time data were recorded).

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

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

(1) You may introduce the appropriate interference test gases (that are potentially encountered during a test; see examples in Table 7E-3) into the analyzer separately or as mixtures. Test the analyzer with the interference gas alone at the highest concentration expected at a test source and again with the interference gas and NO<sub>x</sub> at a representative NO<sub>x</sub> test concentration. For analyzers measuring NO<sub>x</sub> greater than 20 ppm, use a calibration gas with a NO<sub>x</sub> concentration of 80 to 100 ppm and set this concentration equal to the calibration span. For analyzers measuring less than 20 ppm NO<sub>x</sub>, select an NO concentration for the calibration span that reflects the emission levels at the sources to be tested, and perform the interference check at that level. Measure the total interference response of the analyzer to these gases in ppmv. Record the responses and determine the interference using Table 7E-4. The specification in section 13.4 must be met.

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

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

#### *8.4 Sample Collection.*

(1) Position the probe at the first sampling point. Purge the system for at least two times the response time before recording any data. Then, traverse all required sampling points, sampling at each point for an equal length of time and maintaining the appropriate sample flow rate or dilution ratio (as applicable). You must record at least one valid data point per minute during the test run.

(2) Each time the probe is removed from the stack and replaced, you must recondition the sampling system for at least two times the system response time prior to your next recording. If the average of any run exceeds the calibration span value, that run is invalid.

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

#### *8.5 Post-Run System Bias Check and Drift Assessment.*

How do I confirm that each sample I collect is valid? After each run, repeat the system bias check or 2-point system calibration error check (for dilution systems) to validate the run. Do not make adjustments to the measurement system (other than to maintain the target sampling rate or dilution ratio) between the end of the run and the completion of the post-run system bias or system calibration error check. Note that for all post-run system bias or 2-point system calibration error checks, you may inject the low-level gas first and the upscale gas last, or vice-versa. If conducting a relative accuracy test or relative accuracy test audit, consisting of nine runs or more, you may risk sampling for up to three runs before performing the post-run bias or system calibration error check provided you pass this test at the conclusion of the group of three runs. A failed post-run bias or system calibration error check in this case will invalidate all runs subsequent to the last passed check. When conducting a performance or compliance test, you must perform a post-run system bias or system calibration error check after each individual test run.

(1) If you do not pass the post-run system bias (or system calibration error) check, then the run is invalid. You must diagnose and fix the problem and pass another calibration error test (Section 8.2.3) and system bias (or 2-point system calibration error) check (Section 8.2.5) before

repeating the run. Record the system bias (or system calibration error) results on a form similar to Table 7E-2.

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

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

*8.6 Alternative Interference and System Bias Checks (Dynamic Spike Procedure). If I want to use the dynamic spike procedure to validate my data, what procedure should I follow? Except for applications under part 75 of this chapter, you may use the dynamic spiking procedure and requirements provided in section 16.1 during each test as an alternative to the interference check and the pre- and post-run system bias checks. The calibration error test is still required under this option. Use of the dynamic spiking procedure for Part 75 applications is subject to the approval of the Administrator.*

*8.7 Moisture correction.* You must determine the moisture content of the flue gas and correct the measured gas concentrations to a dry basis using Method 4 or other appropriate methods, subject to the approval of the Administrator, when the moisture basis (wet or dry) of the measurements made with this method is different from the moisture basis of either: (1) The applicable emissions limit; or (2) the CEMS being evaluated for relative accuracy. Moisture correction is also required if the applicable limit is in lb/mmBtu and the moisture basis of the Method 7E NO<sub>x</sub> analyzer is different from the moisture basis of the Method 3A diluent gas (CO<sub>2</sub> or O<sub>2</sub>) analyzer.

## *9.0 Quality Control*

What quality control measures must I take?

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

## SUMMARY TABLE OF AQ/QC

Status	Process or element	QA/QC specification	Acceptance criteria	Checking frequency
S	Identify Data User		Regulatory Agency or other primary end user of data	Before designing test.
S	Analyzer Design	Analyzer resolution or sensitivity	<2.0% of full-scale range	Manufacturer design.
M		Interference gas check	Sum of responses $\leq$ 2.5% of calibration span Alternatively, sum of responses:	
			$\leq$ 0.5 ppmv for calibration spans of 5 to 10 ppmv	
			$\leq$ 0.2 ppmv for calibration spans <5 ppmv	
			See Table 7E-3	
M	Calibration Gases	Traceability protocol (G1, G2)	Valid certificate required Uncertainty $\leq$ 2.0% of tag value	
M		High-level gas	Equal to the calibration span	Each test.
M		Mid-level gas	40 to 60% of calibration span	Each test.
M		Low-level gas	<20% of calibration span	Each test.
S	Data Recorder Design	Data resolution	$\leq$ 0.5% of full-scale range	Manufacturer design.
S	Sample Extraction	Probe material	SS or quartz if stack >500 °F	Each test.
M	Sample Extraction	Probe, filter and sample line temperature	For dry-basis analyzers, keep sample above the dew point by heating, prior to sample conditioning	Each run.
			For wet-basis analyzers, keep sample above dew point at all times, by heating or dilution	

S	Sample Extraction	Calibration valve material	SS	Each test.
S	Sample Extraction	Sample pump material	Inert to sample constituents	Each test.
S	Sample Extraction	Manifolding material	Inert to sample constituents	Each test.
S	Moisture Removal	Equipment efficiency	<5% target compound removal	Verified through system bias check.
S	Particulate Removal	Filter inertness	Pass system bias check	Each bias check.
M	Analyzer & Calibration Gas Performance	Analyzer calibration error (of 3-point system calibration error for dilution systems)	Within $\pm 2.0$ percent of the calibration span of the analyzer for the low-, mid-, and high-level calibration gases	Before initial run and after a failed system bias test or drift test.
			Alternative specification: $\leq 0.5$ ppmv absolute difference	
M	System Performance	System bias (or pre- and post-run 2-point system calibration error for dilution (Systems))	Within $\pm 5.0\%$ of the analyzer calibration span for low-scale and upscale calibration gases	Before and after each run.
			Alternative specification: $\leq 0.5$ ppmv absolute difference	
M	System Performance	System response time	Determines minimum sampling time per point	During initial sampling system bias test.
M	System Performance	Drift	$\leq 3.0\%$ of calibration span for low-level and mid- or high-level gases	After each test run.
			Alternative specification: $\leq 0.5$ ppmv absolute difference	
M	System Performance	NO <sub>2</sub> -NO conversion efficiency	$\geq 90\%$ of certified test gas concentration	Before or after each test.
M	System Performance	Purge time	$\geq 2$ times system response time	Before starting the first run and when

				probe is removed from and re-inserted into the stack.
M	System Performance	Minimum sample time at each point	Two times the system response time	Each sample point.
M	System Performance	Stable sample flow rate (surrogate for maintaining system response time)	Within 10% of flow rate established during system response time check	Each run.
M	Sample Point Selection	Stratification test	All points within:	Prior to first run.
			±5% of mean for 1-point sampling	
			±10% of mean for 3-point	
			Alternatively, all points within:	
			±0.5 ppm of mean for 1-point sampling	
			±1.0 ppm of mean for 3-point sampling	
A	Multiple sample points simultaneously	No. of openings in probe	Multi-hole probe with verifiable constant flow through all holes within 10% of mean flow rate (requires Administrative approval for Part 75)	Each run.
M	Data Recording	Frequency	≤1 minute average	During run.
S	Data Parameters	Sample concentration range	All 1-minute averages within calibration span	Each run.
M	Date Parameters	Average concentration for the run	Run average ≤calibration span	Each run.

S = Suggest.

M = Mandatory.

A = Alternative.

### 10.0 Calibration and Standardization

What measurement system calibrations are required?

(1) The initial 3-point calibration error test as described in section 8.2.3 and the system bias (or system calibration error) checks described in section 8.2.5 are required and must meet the specifications in section 13 before you start the test. Make all necessary adjustments to calibrate the gas analyzer and data recorder. Then, after the test commences, the system bias or system calibration error checks described in section 8.5 are required before and after each run. Your analyzer must be calibrated for all species of NO<sub>x</sub> that it detects. Analyzers that measure NO and NO<sub>2</sub> separately without using a converter must be calibrated with both NO and NO<sub>2</sub>.

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

### 11.0 Analytical Procedures

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

### 12.0 Calculations and Data Analysis

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

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

ACE = Analyzer calibration error, percent of calibration span.

B<sub>WS</sub> = Moisture content of sample gas as measured by Method 4 or other approved method, percent/100.

C<sub>Avg</sub> = Average unadjusted gas concentration indicated by data recorder for the test run, ppmv.

C<sub>D</sub> = Pollutant concentration adjusted to dry conditions, ppmv.

C<sub>Dir</sub> = Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode, ppmv.

C<sub>Gas</sub> = Average effluent gas concentration adjusted for bias, ppmv.

C<sub>M</sub> = Average of initial and final system calibration bias (or 2-point system calibration error) check responses for the upscale calibration gas, ppmv.

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

$C_{Native}$  =  $NO_X$  concentration in the stack gas as calculated in section 12.6, ppmv.

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

$C_{OA}$  = Actual concentration of the low-level calibration gas, ppmv.

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

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

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

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

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

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

$CS$  = Calibration span, ppmv.

$D$  = Drift assessment, percent of calibration span.

$DF$  = Dilution system dilution factor or spike gas dilution factor, dimensionless.

$Eff_{NO_2}$  =  $NO_2$  to  $NO$  converter efficiency, percent.

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

$NO_{XFinal}$  = The final  $NO_X$  concentration observed during the converter efficiency test in section 16.2.2, ppmv.

$NO_{XPeak}$  = The highest  $NO_X$  concentration observed during the converter efficiency test in section 16.2.2, ppmv.

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

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

$R$  = Spike recovery, percent.

$SB$  = System bias, percent of calibration span.

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

$SB_{final}$  = Post-run system bias, percent of calibration span.

$SCE$  = System calibration error, percent of calibration span.

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

$SCE_{\text{Final}}$  = Post-run system calibration error, percent of calibration span.

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

$$ACE = \frac{C_{Dir} - C_V}{CS} \times 100 \quad \text{Eq. 7E-1}$$

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

$$SB = \frac{C_S - C_{Dir}}{CS} \times 100 \quad \text{Eq. 7E-2}$$

*12.4 System Calibration Error.* Use Equation 7E-3 to calculate the system calibration error for dilution systems. Equation 7E-3 applies to both the initial 3-point system calibration error test and the subsequent 2-point calibration error checks between test runs. In this equation, the term “ $C_s$ ” refers to the diluted calibration gas concentration measured by the analyzer.

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

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

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

*12.6 Effluent Gas Concentration.* For each test run, calculate  $C_{\text{avg}}$ , the arithmetic average of all valid  $\text{NO}_x$  concentration values (e.g., 1-minute averages). Then adjust the value of  $C_{\text{avg}}$  for bias using Equation 7E-5a if you use a non-zero gas as your low-level calibration gas, or Equation 7E-5b if you use a zero gas as your low-level calibration gas.

$$C_{\text{Gas}} = (C_{\text{avg}} - C_M) \frac{C_{MA} - C_{OA}}{C_M - C_O} + C_{MA} \quad \text{Eq. 7E-5a}$$

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

*12.7  $\text{NO}_2$ — $\text{NO}$  Conversion Efficiency.* If the  $\text{NO}_x$  converter efficiency test described in section 8.2.4.1 is performed, calculate the efficiency using Equation 7E-7.

$$Eff_{\text{NO}_2} = \frac{C_{Dir}}{C_V} \times 100 \quad \text{Eq. 7E-7}$$

*12.8  $\text{NO}_2$ — $\text{NO}$  Conversion Efficiency Correction.* If desired, calculate the total  $\text{NO}_x$  concentration with a correction for converter efficiency using Equation 7E-8.

$$NO_{XCorr} = NO + \left( \frac{(NO_X - NO)}{Eff_{NO_2}} \times 100 \right) \quad \text{Eq. 7E-8}$$

*12.9 Alternative NO<sub>2</sub> Converter Efficiency.* If the alternative procedure of section 16.2.2 is used, determine the NO<sub>X</sub> concentration decrease from NO<sub>XPeak</sub> after the minimum 30-minute test interval using Equation 7E-9. This decrease from NO<sub>XPeak</sub> must meet the requirement in section 13.5 for the converter to be acceptable.

$$\% \text{ Decrease} = \frac{NO_{XPeak} - NO_{XFinal}}{NO_{XPeak}} \times 100 \quad \text{Eq. 7E-9}$$

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

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

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

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

$$R = \frac{DF(C_{SS} - C_{native}) + C_{native}}{C_{Spike}} \times 100 \quad \text{Eq. 7E-12}$$

### 13.0 Method Performance

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

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

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

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

*13.5 NO<sub>2</sub> to NO Conversion Efficiency Test (as applicable).* The NO<sub>2</sub> to NO conversion efficiency, calculated according to Equation 7E-7, must be greater than or equal to 90 percent. The alternative conversion efficiency check, described in section 16.2.2 and calculated according to Equation 7E-9, must not result in a decrease from NO<sub>XPeak</sub> by more than 2.0 percent.

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

*14.0 Pollution Prevention [Reserved]*

*15.0 Waste Management [Reserved]*

*16.0 Alternative Procedures*

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

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

*16.1.2 Spiking Procedure Requirements.* The spikes must be prepared from EPA Traceability Protocol gases. Your procedure must be designed to spike field samples at two target levels both before and after the test. Your target spike levels should bracket the average sample NO<sub>X</sub> concentrations. The higher target concentration must be less than the calibration span. You must collect at least 5 data points for each target concentration. The spiking procedure must be performed before the first run and repeated after the last run of the test program.

*16.1.3 Example Spiking Procedure.* Determine the NO concentration needed to generate concentrations that are 50 and 150 percent of the anticipated NO<sub>X</sub> concentration in the stack at the total sampling flow rate while keeping the spike flow rate at or below 10 percent of this total. Use a mass flow meter (accurate within 2.0 percent) to generate these NO spike gas

concentrations at a constant flow rate. Use Equation 7E-11 in section 12.11 to determine the calculated spike concentration in the collected sample.

(1) Prepare the measurement system and conduct the analyzer calibration error test as described in sections 8.2.2 and 8.2.3. Following the sampling procedures in section 8.1, determine the stack  $\text{NO}_x$  concentration and use this concentration as the average stack concentration ( $C_{\text{avg}}$ ) for the first spike level, or if desired, for both pre-test spike levels. Introduce the first level spike gas into the system in system calibration mode and begin sample collection. Wait for at least two times the system response time before measuring the spiked sample concentration. Then record at least five successive 1-minute averages of the spiked sample gas. Monitor the spike gas flow rate and maintain at the determined addition rate. Average the five 1-minute averages and determine the spike recovery using Equation 7E-12. Repeat this procedure for the other pre-test spike level. The recovery at each level must be within the limits in section 13.6 before proceeding with the test.

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

*16.2 Alternative  $\text{NO}_2$  to  $\text{NO}$  Conversion Efficiency Procedures.* You may use either of the following procedures to determine converter efficiency in place of the procedure in section 8.2.4.1.

16.2.1 The procedure for determining conversion efficiency using  $\text{NO}$  in 40 CFR 86.123-78.

16.2.2 Bag Procedure. Perform the analyzer calibration error test to document the calibration (both  $\text{NO}$  and  $\text{NO}_x$  modes, as applicable). Fill a Tedlar or equivalent bag approximately half full with either ambient air, pure oxygen, or an oxygen standard gas with at least 19.5 percent by volume oxygen content. Fill the remainder of the bag with mid- to high-level  $\text{NO}$  in  $\text{N}_2$  (or other appropriate concentration) calibration gas. (Note that the concentration of the  $\text{NO}$  standard should be sufficiently high enough for the diluted concentration to be easily and accurately measured on the scale used. The size of the bag should be large enough to accommodate the procedure and time required. Verify through the manufacturer that the Tedlar alternative is suitable for  $\text{NO}$  and make this verified information available for inspection.)

(1) Immediately attach the bag to the inlet of the  $\text{NO}_x$  analyzer (or external converter if used). In the case of a dilution-system, introduce the gas at a point upstream of the dilution assembly. Measure the  $\text{NO}_x$  concentration for a period of 30 minutes. If the  $\text{NO}_x$  concentration drops more than 2 percent absolute from the peak value observed, then the  $\text{NO}_2$  converter has failed to meet the criteria of this test. Take corrective action. The highest  $\text{NO}_x$  value observed is considered to be  $\text{NO}_{x\text{Peak}}$ . The final  $\text{NO}_x$  value observed is considered to be  $\text{NO}_{x\text{final}}$ .

(2) [Reserved]

*16.3 Manufacturer's Stability Test.* A manufacturer's stability test is required for all analyzers that routinely measure emissions below 20 ppmv and is optional but recommended for other analyzers. This test evaluates each analyzer model by subjecting it to the tests listed in Table 7E-5 following procedures similar to those in 40 CFR 53.23 for thermal stability and insensitivity to supply voltage variations. If the analyzer will be used under temperature conditions that are outside the test conditions in Table B-4 of Part 53.23, alternative test temperatures that better reflect the analyzer field environment should be used. Alternative procedures or documentation that establish the analyzer's stability over the appropriate line voltages and temperatures are acceptable.

### 17.0 References

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

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

Figure 7E-1. Measurement System

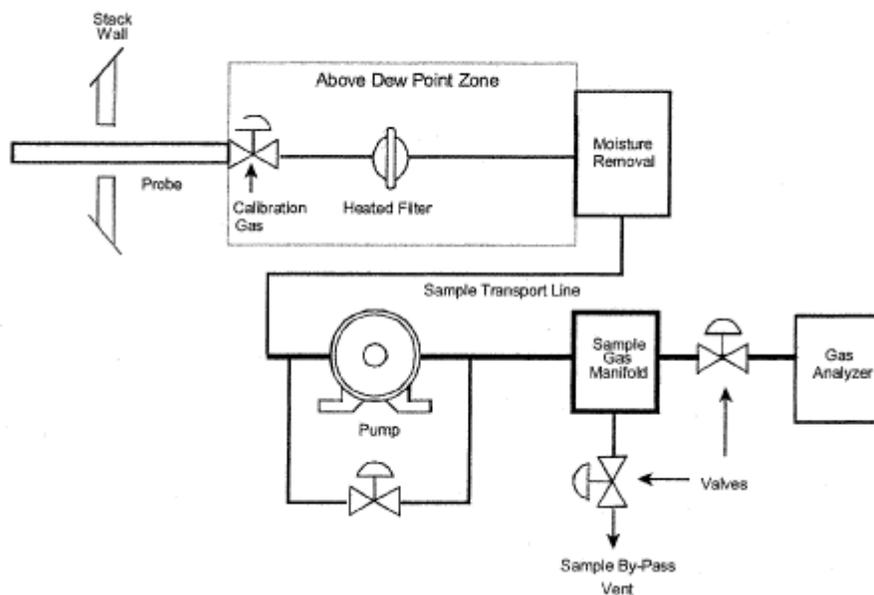
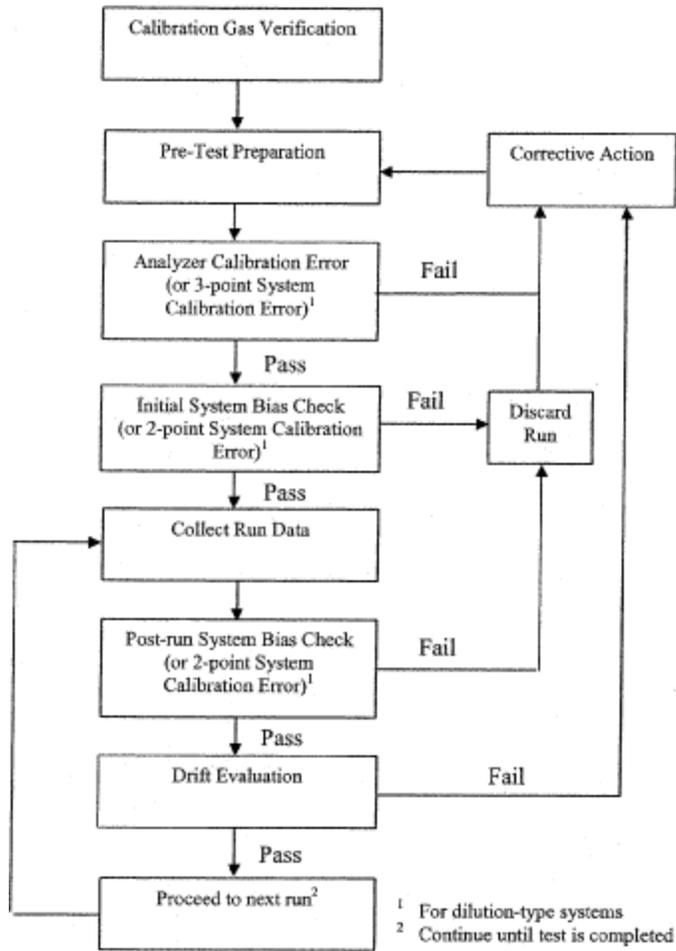


Figure 7E-2. Testing Flow Chart



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

Source Identification:		Analyzer <sup>1</sup> or System <sup>2</sup> calibration error data for sampling runs: _____		
Test personnel: _____		Analyzer Model No. _____		
Date: _____		Serial No. _____		
Time: _____		Calibration Span (CS): _____		
	Manufacturer Certified Cylinder Value (indicate units)	Analyzer calibration response (indicate units)	Absolute difference (indicate units)	Calibration Error (percent of calibration span)
	A	B	A-B	$\frac{A-B}{CS} \times 100$
Low-level (or zero) calibration gas	.....	.....	.....	.....
Mid-level calibration gas .....	.....	.....	.....	.....
High-level calibration gas .....	.....	.....	.....	.....

<sup>1</sup> Refers to data from the analyzer calibration error test of a non-dilution system.  
<sup>2</sup> Refers to data from a 3-point system calibration error test of a dilution system.

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

Source Identification: \_\_\_\_\_ Run Number: \_\_\_\_\_  
 Test personnel: \_\_\_\_\_ Calibration Span: \_\_\_\_\_  
 Date: \_\_\_\_\_ Response Time: \_\_\_\_\_  
 Analyzer Model No. \_\_\_\_\_ Serial No. \_\_\_\_\_

Calibration Gas Level	Initial values			Final values		
	Certified Calibration gas value (indicate units)	System Response (indicate units)	System Bias <sup>1</sup> or Calibration Error <sup>2</sup> (% of calibration span)	System response (indicate units)	System Bias <sup>1</sup> or Calibration Error <sup>2</sup> (% of calibration span)	Drift (% of calibration span)
Low-level gas.....	.....	.....	.....	.....	.....	.....
Upscale (high- or mid-) level gas.....	.....	.....	.....	.....	.....	.....

<sup>1</sup> Refers to the pre- and post-run system bias checks of a non-dilution system.  
<sup>2</sup> Refers to the pre- and post-run system calibration error checks of a dilution system.

**TABLE 7E-3—EXAMPLE INTERFERENCE CHECK GAS CONCENTRATIONS**

<b>Potential interferent gas<sup>1</sup></b>	<b>Concentrations<sup>2</sup> sample conditioning type</b>	
	<b>Hot wet</b>	<b>Dried</b>
CO <sub>2</sub>	5 and 15%	5 and 15%
H <sub>2</sub> O	25%	1%
NO	15 ppmv	15 ppmv
NO <sub>2</sub>	15 ppmv	15 ppmv
N <sub>2</sub> O	10 ppmv	10 ppmv
CO	50 ppmv	50 ppmv
NH <sub>3</sub>	10 ppmv	10 ppmv
CH <sub>4</sub>	50 ppmv	50 ppmv
SO <sub>2</sub>	20 ppmv	20 ppmv
H <sub>2</sub>	50 ppmv	50 ppmv
HCl	10 ppmv	10 ppmv

<sup>1</sup>Any applicable gas may be eliminated or tested at a reduced level if the manufacturer has provided reliable means for limiting or scrubbing that gas to a specified level.

<sup>2</sup>As practicable, gas concentrations should be the highest expected at test sites.

TABLE 7E-4—INTERFERENCE RESPONSE

Date of Test:  
 Analyzer Type:  
 Model No.:  
 Serial No:  
 Calibration Span:

Test gas type	Concentration (ppm)	Analyzer response
Sum of Responses		
% of Calibration Span		

TABLE 7E-5—MANUFACTURER STABILITY TEST

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

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