North Dakota Department of Environmental Quality
Division of Air Quality
Use of Portable Analyzer for Title V Semi-Annual Testing
Standard Operating Procedure

A. **Date**:

April 20, 2021

B. **General**:

The North Dakota Department of Environmental Quality, Division of Air Quality (Department) approves the use of portable analyzers to measure NO_x and CO emissions with quality assurance procedures equivalent to Environmental Protection Agency (EPA) Test Methods in 40 CFR 60, Appendix A or the following minimum Standard Operating Procedure (SOP), which is strongly based on EPA's Conditional Test Method (CTM) - 030. The purpose of the SOP is not to replace the Reference Methods of 40 CFR 60, Appendix A, but to facilitate the measurement of emissions from sources that require periodic emissions testing. The SOP is limited to measurements of NO_x (NO and NO_2) and CO.

The tester may submit other quality assurance procedures/protocol for Department approval. The protocol must comply with the minimum requirements of this SOP and must address all pertinent information regarding the analyzer as well as all requirements listed in the following sections to be considered for approval. It is the Department's discretion to determine if approval is warranted.

C. **Pre-Test Measurement System Performance Specifications**:

I. **Calibration Gas Standards**

Calibration Gases – Three calibration gases (zero, mid-level, and span) for O_2, CO, NO and NO_2 shall be used.

1) Zero Gas –The zero-gas concentration shall be less than 0.25% of the span gas for each constituent. Purified ambient air may be used as the zero gas.

2) Mid-Level Gas – The mid-level gas concentration shall be 40% to 60% of the span calibration gas.

3) Span Gas – The span gas concentration shall be no higher than 125% of the expected concentration and no less than 90% of the expected concentration. The span gas is equal to the calibration span.

All gas used as calibration standards must be certified by the supplier to ±2% accuracy.

II. Pre-Test Calibration Error Check

The pre-test calibration error check requires the use of the zero and span gases. Analyzer calibration error shall be no more than 5% of the calibration span value for the span CO, NO, and NO_2 calibration gases and no more than 0.5% O_2 for the span O_2 calibration gas. The analyzer calibration error shall be no more than 3% of the calibration span value for the zero CO, NO, and NO_2 calibration gases and no more than 0.3% O_2 for the zero O_2 calibration gas. The calibration errors shall be calculated as follows:

$$\%Error_{CO,NO,NO_2} = \frac{|Analyzer\ Response - Gas\ Concentration|}{Calibration\ Span} \times 100$$

$$\%Error_{O_2} = Analyzer\ Response - Gas\ Concentration$$

III. Linearity Check

The linearity check requires the use of the zero, mid-level, and span gases. The absolute value of the difference between the calibration gas value and the analyzer response shall be no greater than 2.5% of the calibration span for the O_2, CO and NO zero, mid-level and span gases. The absolute value of the difference between the calibration gas value and the analyzer response shall be no greater than 3.0% of the calibration span for the NO_2 zero, mid-level and span gases. A linearity check shall be repeated before each five days of analyzer operation.

IV. Cross Interference Check

While performing the pre-test calibration, check for and record any response noted on one sensor while calibrating another cell. Interference shall be calculated using the following equation:

$$\%\ Interference = \frac{Analyzer\ Interferant\ Response}{Stack\ Gas\ Interferant\ Concentration} \times 100$$

Interference shall be no greater than 5% of the average stack concentration for each test run.

V. Stability Check Response

The analyzer response to CO, NO and NO_2 span gas values shall not vary more than 2.0% of the span gas value over a 30-minute period or more than 1.0% of the span gas value over a 15-minute period. A stability check response shall be repeated before each five days of analyzer operation.

VI. NO Cell Temperature Monitoring

A thermocouple, thermistor, or other device must be used to monitor the temperature of the NO electrochemical cell. NO cell temperature reporting is not required when temperature monitoring and the ability to control for temperature fluctuations is incorporated in the portable analyzer *if* the Department is provided proper documentation illustrating that the portable analyzer can control temperature fluctuations *and* Department approval is provided. If Department approval is *not* provided, NO cell temperature reporting is required, which consists of recording the initial NO cell temperature during the pre-test calibration error check and recording the temperature at least once every five minutes during sample collection. If the NO cell temperature is 85°F or greater during sample collection and has changed more than 5°F since the pre-test calibration, sampling must be stopped immediately, and a post-test calibration error check must be conducted. The analyzer must then be re-zeroed, and another pre-test calibration error check must be conducted before continuing.

D. Testing Procedures:

A test shall consist of three runs, with each run at least 20 minutes in length. Prior to beginning the test, allow the analyzer to purge the calibration gases from the system. Place the analyzer probe inside the stack and allow it to pull gas through the system. The analyzer has been properly purged when the analyzer measurements have stabilized. Record the readings for CO, NO, and NO_2 at 2-minute intervals during each 20-minute run.

The stack gas volumetric flow and moisture content may be determined using 40 CFR 60, Appendix A, Methods 1 through 4 or by knowledge of fuel gas composition and combustion stoichiometry. Combustion stoichiometry may be used to determine stack flow only if quality assurance procedures are submitted to the Department and approved prior to use in the field.

E. Post-Test Measurement System Performance Specifications:

I. Post-Test Calibration Error Check

After a maximum of three valid 20-minute runs, conduct a post-test calibration as follows for the O_2, CO, NO and NO_2 calibration gases:

1. Allow the analyzer to purge the gas sample until a stable zero reading is observed. Record the zero reading.

2. Introduce the span gas to the analyzer and allow it to reach a stable reading. Record the analyzer reading.

3. Introduce the zero gas to the analyzer and allow it to reach a stable reading. Record the analyzer reading.

Use the equations below to calculate the post-test calibration error:

$$\%Error_{CO,NO,NO_2} = \frac{|(Pre - Test\ Reading) - (Post - Test\ Reading)|}{Calibration\ Span} \times 100$$

$$\%\ Error_{O_2} = |(Pre - Test\ Reading) - (Post - Test\ Reading)|$$

The emission test runs are invalid and must be repeated if either of the following are true:

1. The calibration span error is greater than 5% for the CO, NO and NO_2 calibration gases or greater than 0.5% O_2 for the O_2 calibration gas.

2. The calibration zero error is greater than 3% for the CO, NO and NO_2 calibration gases or greater than 0.3% O_2 for the O_2 calibration gas.

The Department will not accept any portable analyzer test unless all the above conditions are met, or a separate testing protocol has been approved in advance by the Department.

The Department reserves the right to withdraw or modify this SOP without advance notice.
Approved by:

James L. Semerad
Director
Division of Air Quality

Date: 4/22/2021

Emission Test Worksheet

Test Date(s) _____ Permit No. _____
Tested By _____
Source _____
Company _____
Location _____
Engine Serial No. _____ Emission Unit No. _____
Analyzer Model # _____ Analyzer Serial # _____

NO Calibration Error and Linearity Check

	NO Calibration Gas	Calibration Span (ppm)	Gas Concentration (ppm)	Analyzer Response (ppm)	Difference
Pre-Test Calibration Error	Zero				% [A]
	Span				% [B]
Post-Test Calibration Error	Zero				% [A]
	Span				% [B]
Linearity Check	Zero				% [C]
	Mid-Level				% [C]
	Span				% [C]

[A] May not be greater than ±3.0% of the calibration span
[B] May not be greater than ±5.0% of the calibration span
[C] May not be greater than ±2.5% of the calibration span

NO_2 Calibration Error and Linearity Check

	NO_2 Calibration Gas	Calibration Span (ppm)	Gas Concentration (ppm)	Analyzer Response (ppm)	Difference
Pre-Test Calibration Error	Zero				% [A]
	Span				% [B]
Post-Test Calibration Error	Zero				% [A]
	Span				% [B]
Linearity Check	Zero				% [C]
	Mid-Level				% [C]
	Span				% [C]

[A] May not be greater than ±3.0% of the calibration span
[B] May not be greater than ±5.0% of the calibration span
[C] May not be greater than ±3.0% of the calibration span

CO Calibration Error and Linearity Check

	NO_2 Calibration Gas	Calibration Span (ppm)	Gas Concentration (ppm)	Analyzer Response (ppm)	Difference
Pre-Test Calibration Error	Zero				% [A]
	Span				% [B]
Post-Test Calibration Error	Zero				% [A]
	Span				% [B]
Linearity Check	Zero				% [C]
	Mid-Level				% [C]
	Span				% [C]

A May not be greater than ±3% of the calibration span

B May not be greater than ±5% of the calibration span

C May not be greater than ±2.5% of the calibration span

O_2 Calibration Error and Linearity Check

	NO_2 Calibration Gas	Calibration Span (%)	Gas Concentration (%)	Analyzer Response (%)	Difference
Pre-Test Calibration Error	Zero				% [A]
	Span				% [B]
Post-Test Calibration Error	Zero				% [A]
	Span				% [B]
Linearity Check	Zero				% [C]
	Mid-Level				% [C]
	Span				% [C]

A May not be greater than ±0.3% of the calibration span

B May not be greater than ±0.5% of the calibration span

C May not be greater than ±2.5% of the calibration span

Cross Interference Check

Gas (Span)	Calibration Span	CO Response	NO Response	NO_2 Response	% Interference *	
CO		--				
NO			--			
NO_2				--		

* May not exceed 5%.

Stability Check

Elapsed Time (min)	Analyzer Response (ppm NO_2)	Analyzer Response (ppm NO)	Analyzer Response (ppm CO)	Elapsed Time (min)	Analyzer Response (ppm NO_2)	Analyzer Response (ppm NO)	Analyzer Response (ppm CO)
1				19			
2				20			
3				21			
4				22			
5				23			
6				24			
7				25			
8				26			
9				27			
10				28			
11				29			
12				30			
13				31			
14				32			
15				33			
16				34			
17				35			
18				36			

Time to Stability (minutes)

NO_2: _____

NO: _____

CO: _____

Test Time: _____

Gas (Span)	Calibration Span (ppm)	Maximum Value	Minimum Value	Difference
CO				% *
NO				% *
NO_2				% *

* May not exceed 2.0% of span gas value over a 30-minute period or 1.0% over a 15-minute period.

Operating Information

	Engine Fuel Consumption (MMBtu/hr)	Fuel Gas Flow (scf/hr)	Engine Specific Fuel Consumption (Btu/bhp-hr)	Fuel Heat Content (Btu/scf)
Run 1				
Run 2				
Run 3				

Emission Test Raw Data

Run	Time	NO Cell Temperature (°F)	CO (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm) *
1	Pre-test calibration		--	--	--	--
	0:02	--				
	0:04	--				
	0:05		--	--	--	--
	0:06	--				
	0:08	--				
	0:10					
	0:12	--				
	0:14	--				
	0:15		--	--	--	--
	0:16	--				
	0:18	--				
	0:20					
	average					
2	Pre-test calibration		--	--	--	--
	0:02	--				
	0:04	--				
	0:05		--	--	--	--
	0:06	--				
	0:08	--				
	0:10					
	0:12	--				
	0:14	--				
	0:15		--	--	--	--
	0:16	--				
	0:18	--				
	0:20					
	average					
3	Pre-test calibration		--	--	--	--
	0:02	--				
	0:04	--				
	0:05		--	--	--	--
	0:06	--				
	0:08	--				
	0:10					
	0:12	--				
	0:14	--				
	0:15		--	--	--	--
	0:16	--				
	0:18	--				
	0:20					
	average					

* NO_x (ppm) = NO (ppm) + NO_2 (ppm)