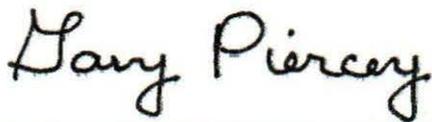


EMISSION COMPLIANCE TEST  
FOR THE  
CATERPILLAR, G3516B, UNIT #EUGENERATOR3,  
SERIAL #PBR00193  
PREPARED FOR  
MICHIGAN TECHNICAL UNIVERSITY  
AT THE  
MICHIGAN TECHNICAL UNIVERSITY CAMPUS  
HOUGHTON, MICHIGAN  
SEPTEMBER 8, 2023

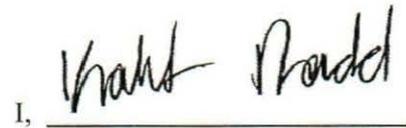
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certify that this testing was conducted and  
this report was created in conformance  
with the requirements of ASTM D7036

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**Emissions Compliance Test  
Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193  
Michigan Technical University  
Michigan Technical University Campus  
Houghton, Michigan  
September 8, 2023**

## **1.0 INTRODUCTION**

Air Hygiene International, Inc. (Air Hygiene) has completed the Emissions Compliance Test for carbon monoxide (CO) and oxygen (O<sub>2</sub>) from the exhaust of the Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193 for Michigan Technical University at the Michigan Technical University Campus in Houghton, Michigan. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on September 8, 2023.

## **1.1 TEST PURPOSE AND OBJECTIVES**

The purpose of the test was to conduct a compliance emission test to document levels of selected pollutants with the unit operating at the maximum rated capacity, or as near as practicable. The information will be used to confirm compliance with the Michigan Department of Environment, Great Lakes, & Energy Permit (Michigan EGLE), United States Environmental Protection Agency (EPA), and 40 Code of Federal Regulations (CFR) 63 Subpart ZZZZ requirements. The specific objective was to determine the emission concentration of CO and O<sub>2</sub> from the exhaust of Michigan Technical University's Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193.

## **1.2 SUMMARY OF TEST PROGRAM**

The following list details pertinent information related to this specific project:

- 1.2.1 Participating Organizations
  - Michigan Department of Environment, Great Lakes, & Energy Permit (Michigan EGLE)
  - Michigan Technical University
  - Air Hygiene
- 1.2.2 Industry
  - Natural Gas Transport and Processing
- 1.2.3 Air Permit and Federal Requirements
  - Permit to Install: 91-04A
  - 40 CFR 63 Subpart ZZZZ
- 1.2.4 Plant Location
  - Michigan Technical University Campus in Houghton, Michigan
    - 1400 Townsend Dr, Houghton, MI 49931
- 1.2.5 Equipment Tested
  - Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193
  - End of Test Engine Run Time Hours: 742

- 1.2.6 Emission Points
  - Exhaust from the Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193
  - For all gases, one sample point in the exhaust duct from the Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193
- 1.2.7 Emission Parameters Measured
  - CO
  - O<sub>2</sub>
- 1.2.8 Date of Emission Test
  - September 8, 2023
- 1.2.9 Federal and State Certifications
  - Stack Testing Accreditation Council AETB Certificate No. 3796.02
  - International Standard ISO/IEC 17025:2005 Certificate No. 3796.01

**1.3 KEY PERSONNEL**

Michigan Technical University:	Dave Krings (dwkrings@mtu.edu)	906-487-2829
Air Hygiene:	Kaleb Dodd (kdodd@airhygiene.com)	918-307-8865
Air Hygiene:	Trevor Thompson	918-307-8865

**2.0 SUMMARY OF TEST RESULTS**

Results from the sampling conducted on Michigan Technical University’s Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193 located at the Michigan Technical University Campus on September 8, 2023 are summarized in the following table and relate only to the items tested.

The results of all measured pollutant emissions were below the required limits. All testing was performed without any real or apparent errors. All testing was conducted according to the approved testing protocol.

**TABLE 2.1: ENGINE EMISSIONS REPORT  
MICHIGAN TECHNICAL UNIVERSITY  
CATERPILLAR , 3516B, UNIT #EU GENERATOR 3, SERIAL #PBR00193**

Test Period:	Qtr 3 - 2023		Manufacturing or Rebuild Date		Air Permit Number:	91-04A
Location:	Michigan Technical University campus				Unit Number:	EU GENERATOR 3
Date:	September 8, 2023		03/03/06		Suction Pressure (psi):	--
Project Number:	mtu-23-houghton.mi-eng#1				Discharge Pressure (psi):	--
Engine Manufacturer:	caterpillar		Federal Regulatory Citation		Stack Exhaust Temperature (°F):	--
Engine Model:	3516B				Rated Horsepower (hp <sub>r</sub> ):	2,250
Engine Serial Number:	PBR00193				Brake Horsepower (bhp):	2,250
Analyzer Manufacturers:	TECO(CO), SERV(O2)		Subpart ZZZZ		Engine Fuel Flow (SCFH):	--
Analyzer Model Numbers:	48 series, 1440				Specific Gravity:	
Date Analyzers Calibrated:	September 8, 2023		§63.6620		Fuel Heating Value [HHV] (Btu/SCF):	
Test Results and Calculations:	Appendix A				BSFC (Btu/hp*hr):	--
Emission Data Records:	Appendix B				Annual Hours Allowed to Operate:	8,760
Calibration Gas Certifications:	Appendix C				Engine Speed (rpm):	1,800
Quality Assurance and QC Data:	Appendix D				Air Manifold Temp (°F):	--
Fuel Analysis Records:	Appendix E				Air Manifold Pressure (psi):	--
Ambient Temperature (°F):	53.0				End of Test (hrs):	742
Barometric Pressure (in. Hg):	29.50				Available Horsepower (hp <sub>a</sub> ):	2,250
Relative Humidity (%):	79				Rated Engine Speed (rpm):	1,800
<b>Emission Test Results</b>					Rated Manifold Pressure (in. Hg (abs)):	--
<b>Pollutant (units)</b>	<b>Stack Test Results</b>	<b>State Limits</b>	<b>Federal Limits</b>	<b>Passing</b>	Engine Load (%):	100
O <sub>2</sub> (%)	9.97	--	--	--	Differential Pressure (in H <sub>2</sub> O):	--
CO (ppmvd)	15.39	--	--	--	-Brake horsepower based on available horsepower multiplied by load.	
CO (ppmvd@15%O <sub>2</sub> )	8.31	--	47.00	YES		
All testing conducted according to United States Environmental Protection Agency (EPA), Methods: 1, 3a, 10 and 19.					Tested By: Air Hygiene International, Inc. Tester(s) / Test Unit(s): KD/TT/216	

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### 3.0 SOURCE OPERATION

#### 3.1 PROCESS DESCRIPTION

The unit tested was a Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193. The engine is rated at 2,250 horsepower. The engine emissions are vented to the atmosphere through an exhaust system extending from the engine. The lean burn engine uses an oxidation catalyst between the engine and the exhaust stack.

#### 3.2 SAMPLING LOCATION

The probe extended at least 0.5 stack diameters from the exit to the atmosphere and at least 2.0 stack diameters from the upstream disturbance. All exhaust samples for gaseous emissions were continuously drawn from the exhaust system at the sample ports from a single point.

### 4.0 SAMPLING AND ANALYTICAL PROCEDURES

#### 4.1 TEST METHODS

The emission test on the Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193 at the Michigan Technical University Campus was performed following United States Environmental Protection Agency (EPA) methods described by the Code of Federal Regulations (CFR). Table 4.1 outlines the specific methods performed on September 8, 2023.

**TABLE 4.1  
SUMMARY OF SAMPLING METHODS**

Pollutant or Parameter	Sampling Method	Analysis Method
Sample Point Location	EPA Method 1	Equal Area Method
Oxygen	EPA Method 3A	Paramagnetic Cell
Carbon Monoxide	EPA Method 10	Nondispersive Infrared Analyzer
Stack Flow Rate	EPA Method 19	Dry Oxygen F Factor

#### 4.2 INSTRUMENT CONFIGURATION AND OPERATIONS FOR GAS ANALYSIS

The sampling and analysis procedures used during these tests conform with the methods outlined in the Code of Federal Regulations (CFR), Title 40, Part 60, Appendix A, Methods 1, 3A, 10, and 19.

Figure 4.1 depicts the sample system used for the real-time gas analyzer tests. The gas sample was continuously pulled through the probe and transported, via heat-traced Teflon® tubing, to a stainless-steel minimum-contact condenser designed to dry the sample. Transportation of the sample, through Teflon® tubing, continued into the sample manifold within the mobile laboratory via a stainless steel/Teflon® diaphragm pump. From the manifold,

the sample was partitioned to the real-time analyzers through rotameters that controlled the flow rate of the sample.

Figure 4.1 shows that the sample system was also equipped with a separate path through which a calibration gas could be delivered to the probe and back through the entire sampling system. This allowed for convenient performance of system bias checks as required by the testing methods.

All instruments were housed in a climate controlled, trailer-mounted mobile laboratory. Gaseous calibration standards were provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 was used to determine the cylinder concentrations where applicable (i.e., NOx calibration gases).

Table 4.2 provides a description of the analyzers used for the instrument portion of the tests. All data from the continuous monitoring instruments were recorded on a Logic Beach Portable Data Logging System which retrieves calibrated electronic data from each instrument every one second and reports an average of the collected data every 30 seconds.

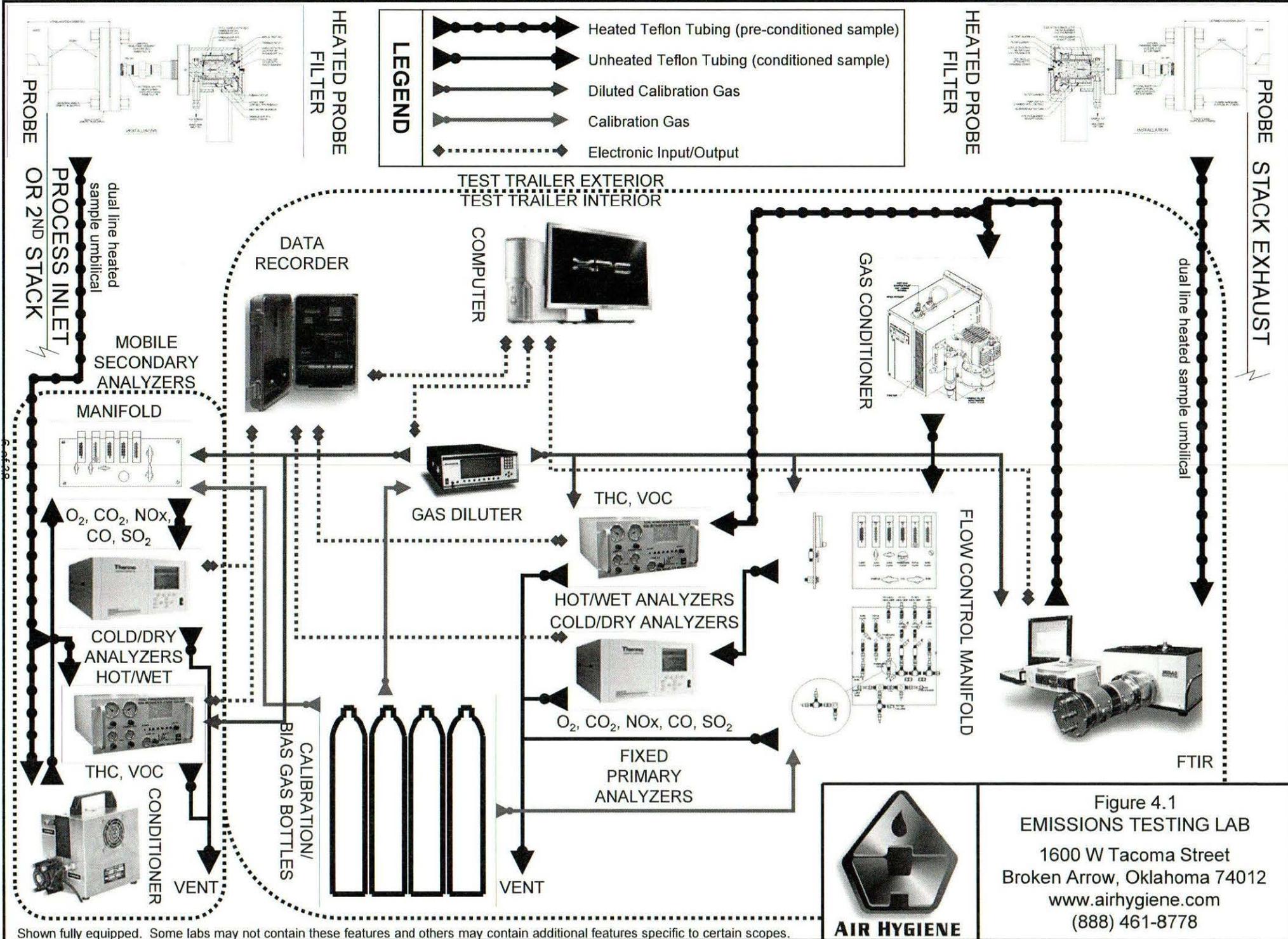
Three test runs of approximately 60 minutes each were conducted on the Caterpillar, G3516B, Unit #EUGENERATOR3, Serial #PBR00193 with the unit operating at the maximum rated capacity, or as near as practicable for CO and O<sub>2</sub>.

The stack gas analysis for O<sub>2</sub> and concentrations was performed in accordance with procedures set forth in EPA Method 3A. The O<sub>2</sub> analyzer uses a paramagnetic cell detector.

CO emission concentrations were quantified in accordance with procedures set forth in EPA Method 10. A continuous nondispersive infrared (NDIR) analyzer was used for this purpose.

**TABLE 4.2  
ANALYTICAL INSTRUMENTATION**

<b>Parameter</b>	<b>Manufacturer and Model</b>	<b>Range</b>	<b>Sensitivity</b>	<b>Detection Principle</b>
CO	THERMO 48 series	User may select up to 10,000 ppm	0.1 ppm	Infrared absorption, gas filter correlation detector, microprocessor-based linearization.
O <sub>2</sub>	SERVOMEX 1440	0-25%	0.1%	Paramagnetic cell, inherently linear.



Shown fully equipped. Some labs may not contain these features and others may contain additional features specific to certain scopes.

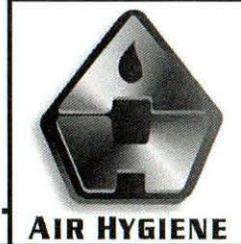


Figure 4.1  
**EMISSIONS TESTING LAB**  
 1600 W Tacoma Street  
 Broken Arrow, Oklahoma 74012  
 www.airhygiene.com  
 (888) 461-8778

**APPENDIX A**  
**TEST RESULTS AND CALCULATIONS**