



AIR HYGIENE, INC.

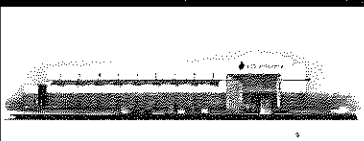
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**AIR QUALITY DIV.**

EMISSION COMPLIANCE TEST  
FOR THE  
GENERAL ELECTRIC (GE), FRAME 7FA.05,  
UNIT #2  
PREPARED FOR  
WOLVERINE POWER SUPPLY COOPERATIVE  
AND BLUEWATER ENERGY, INC.  
AT THE  
ALPINE POWER PLANT  
ELMIRA TOWNSHIP, OTSEGO COUNTY,  
MICHIGAN  
JULY 19, 20, AND 21, 2016



**Corporate Headquarters**  
1600 W Tacoma Street  
Broken Arrow, Oklahoma 74012



AIR HYGIENE, INC.


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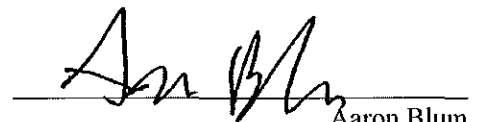
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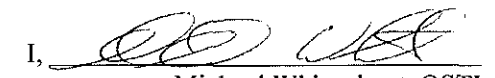
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ELMIRA TOWNSHIP, OTSEGO COUNTY,  
MICHIGAN  
JULY 19, 20, AND 21, 2016  
Permit No: 206-14  
State Registration No: P0582**

Prepared and Reviewed by:

  
Todd R. Sturgeon, QSTI  
Senior Project Manager

  
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I,   
Michael Whisenhunt, QSTI  
Project Manager  
certify that this testing was conducted and  
this report was created in conformance  
with the requirements of ASTM D7036

**EXECUTIVE SUMMARY**

Air Hygiene International, Inc. (Air Hygiene) performed emissions testing at the Alpine Power Plant, EU-CTG2 (Unit #2), located in Elmira Township, Michigan. The fieldwork, performed on July 19, 20 and 21 was conducted to satisfy requirements of Michigan Permit-to-Install (PTI) 206-14. The results of the emissions testing are highlighted below:

**Test Summary  
Alpine Power Plant, Unit #2  
July 19, 20 and 21, 2016**

Parameter	Units	Load				Limit
		50%	75%	85%	100%	
Nitrogen Oxides (NOx)	lb/hr	31.76	34.87	37.09	45.22	66.8
	lb/mmbtu	0.025	0.023	0.021	0.022	0.0327
Carbon Monoxide (CO)	lb/hr				2.11	40.9
	lb/mmbtu				0.001	0.020
Volatile Organic Compounds (VOCs)	lb/hr				0.27	2.9
	lb/mmbtu				0.000	0.00140
Particulate Matter (PM <sub>10</sub> )	lb/hr				6.48	13.5
	lb/mmbtu				0.002	0.0066

Compliance was demonstrated for all pollutants under all operating conditions as this table shows.

**Emissions Compliance Test  
General Electric (GE), Frame 7FA.05, Unit #2  
Wolverine Power Supply Cooperative and Bluewater Energy, Inc.  
Alpine Power Plant  
Elmira Township, Otsego County, Michigan  
July 19, 20, and 21, 2016**

## **1.0 INTRODUCTION**

Air Hygiene International, Inc. (Air Hygiene) has completed the stack sampling survey for nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), volatile organic compounds (VOC), particulate matter (PM<sub>10</sub>), flow, moisture (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), and oxygen (O<sub>2</sub>) from the exhaust of the General Electric (GE), Frame 7FA.05, Unit #2 for Wolverine Power Supply Cooperative and Bluewater Energy, Inc. at the Alpine Power Plant near Elmira Township, Otsego County, Michigan. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on July 19, 20, and 21, 2016.

## **1.1 TEST PURPOSE AND OBJECTIVES**

The purpose of the test was to conduct an initial compliance emission test to document levels of selected pollutants at four test loads (50%, 70%, 85%, and 100%). The information will be used to confirm compliance with the Permit-to-Install 206-14 issued by the Michigan Department of Environmental Quality (MDEQ). The specific objective was to determine the emission concentration of NO<sub>x</sub>, CO, VOC, PM<sub>10</sub>, flow, H<sub>2</sub>O, CO<sub>2</sub>, and O<sub>2</sub> from the exhaust of Wolverine Power Supply Cooperative and Bluewater Energy, Inc.'s General Electric (GE), Frame 7FA.05, Unit #2 at 50%, 70%, 85%, and 100% of total capacity (50%, 70%, 85%, and 100% of operating capacity). Testing was done in conformance with the test protocol dated April 1, 2016, except for some minor changes discussed with MDEQ. A copy of the test protocol and changes is included in Appendix G.

## **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 Environmental Quality (MDEQ)
  - Wolverine Power Supply Cooperative and Bluewater Energy, Inc.
  - Air Hygiene
- 1.2.2 Industry
  - Electric Utility / Electric Services
- 1.2.3 Air Permit and Federal Requirements
  - Permit Number: 206-14
  - State Registration No: P0582
  - 40 CFR 75, Appendix E
- 1.2.4 Plant Location
  - Alpine Power Plant near Elmira Township, Otsego County, Michigan
  - 10125 West Watagate Road, Cadillac, Michigan 49651
- 1.2.5 Equipment Tested
  - General Electric (GE), Frame 7FA.05, Unit #2

1.2.6 Emission Points

- Exhaust from the General Electric (GE), Frame 7FA.05, Unit #2
- For all gases, twelve sample points in the exhaust stack from the General Electric (GE), Frame 7FA.05, Unit #2, at 16.7, 50.0, and 83.3 percent of the diameter
- For all wet chemistry testing, 24 sampling points in the exhaust duct from the General Electric (GE), Frame 7FA.05, Unit #2 (refer to Appendix A)

1.2.7 Emission Parameters Measured

- |                    |                    |
|--------------------|--------------------|
| • NO <sub>x</sub>  | • Flow             |
| • CO               | • H <sub>2</sub> O |
| • VOC              | • CO <sub>2</sub>  |
| • PM <sub>10</sub> | • O <sub>2</sub>   |

1.2.8 Dates of Emission Test

- July 19, 20, and 21, 2016

1.2.9 Federal Certifications

- Stack Testing Accreditation Council AETB Certificate No. 3796.02
- International Standard ISO/IEC 17025:2005 Certificate No. 3796.01

**1.3 KEY PERSONNEL**

Wolverine Power Supply Cooperative:	Laura Hoisington	231-429-9783
Bluewater Energy, Inc.:	Bret Bernhardt	207-680-6774
MDEQ:	Tom Gasloli	517-284-6778
Air Hygiene:	Michael Whisenhunt	918-307-8865
Air Hygiene:	Swanson Bierman	918-307-8865

**2.0 SUMMARY OF TEST RESULTS**

Results from the sampling conducted on Wolverine Power Supply Cooperative and Bluewater Energy, Inc.'s General Electric (GE), Frame 7FA.05, Unit #2 located at the Alpine Power Plant on July 19, 20, and 21, 2016 are summarized in the following table and relate only to the items tested.

**TABLE 2.1  
SUMMARY OF GENERAL ELECTRIC, 7FA.05, UNIT #2 RESULTS**

Parameter	100 Load	85 Load	70 Load	50 Load	Permit Limits
Date (mm/dd/yy)	07/19/16	07/20/16	07/20/16	07/21/16	--
Start Time (hh:mm:ss)	10:24:12	13:20:21	17:35:21	6:30:00	--
End Time (hh:mm:ss)	18:54:42	17:25:51	21:34:34	10:30:30	--
Run Duration (min / run)	99	75	74	74	--
Bar. Pressure (in. Hg)	30.29	30.19	30.14	30.03	--
Amb. Temp. (°F)	79	88	84	78	--
Rel. Humidity (%)	34	40	54	75	--
Spec. Humidity (lb water / lb air)	0.007140	0.011102	0.013259	0.015229	--
Load Designator	100	85	70	50	--
Turbine Fuel Flow (lb/min)	1,515	1,267	1,107	918	--
Stack Flow (RM19) (SCFH)	50,273,631	44,039,566	36,873,035	30,833,036	--
Stack Moisture (% Calculated)	8.3	--	--	--	--
Power Output (megawatts)	210.5	173.0	142.0	104.0	--
NOx (ppmvd)	7.53	7.05	7.92	8.62	--
NOx (lb/hr)	45.22	37.09	34.87	31.76	66.8
NOx (lb/MMBtu)	0.022	0.021	0.023	0.025	0.0327
CO (ppmvd)	0.58	0.87	0.75	5.84	--
CO (lb/hr)	2.11	2.79	2.02	13.10	40.9
CO (lb/MMBtu)	0.001	0.002	0.001	0.010	0.02
VOC (ppmvd)	0.05	--	--	--	--
VOC (lb/hr)	0.27	--	--	--	2.9
VOC (lb/MMBtu)	0.000	--	--	--	0.0014
Total PM <sub>10</sub> (mg)	5.82	--	--	--	--
Total PM <sub>10</sub> (lb/hr)	6.48	--	--	--	13.5
Total PM <sub>10</sub> (lb/MMBtu)	0.002	--	--	--	0.0066
O <sub>2</sub> (%)	13.36	13.70	13.39	13.46	--

The results of all measured pollutant emissions were below the required limits. Run 1 PM<sub>10</sub> test failed post-test leak check and was discarded. All testing was conducted according to the approved testing protocol.

### 3.0 SOURCE OPERATION

#### 3.1 PROCESS DESCRIPTION

Wolverine Power Supply Cooperative (Wolverine Power) owns and operates the Alpine Power Plant located at 10125 West Watergate Road in Elmira Township, Michigan. The Alpine Power Plant includes two simple-cycle, 203 megawatt (MW), General Electric (GE) Frame 7FA.05 combustion turbine generators (CTGs), fired on natural gas, and designated as EU-CTG1 and EU-CTG2. Each turbine is rated with a nominal maximum peak heat input of 2,045 million British thermal units per hour (MMBtu/hr). Each unit is capable of operating at multiple test loads, but operations are continuous, not cyclical or batch, pending approval from dispatchers controlling the local electrical grid. The turbines use Dry-Low NOx burners and good combustion practices as controls.

### 3.2 SAMPLING LOCATION

The Turbine 2 stack is vertical, circular and measures 24 feet (ft) (288 inches) in diameter at the test ports which are approximately 110 ft above grade level with an exit elevation of approximately 130 ft above grade level. The test ports are located approximately 39.2 ft (470.5 inches) downstream and approximately 11 ft (132 inches) upstream from the nearest disturbances. All exhaust samples for gaseous emissions were continuously drawn from 12 points located throughout the stack. For PM<sub>10</sub> testing, an initial velocity traverse using EPA method 2g was performed across the stack from 40 total points due to the stack not meeting Method 1 criteria. All PM<sub>10</sub> occurred from 24 points by leaving the probe at each point for a constant volume in order to draw at least 100 dry standard cubic feet of gas through the sample train.

### 4.0 SAMPLING AND ANALYTICAL PROCEDURES

#### 4.1 TEST METHODS

The emission test on the General Electric (GE), Frame 7FA.05, Unit #2 at the Alpine Power Plant 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 July 19, 20, and 21, 2016.

**TABLE 4.1  
SUMMARY OF SAMPLING METHODS**

Pollutant or Parameter	Sampling Method	Analysis Method
Sample Point Location	EPA Method 1	Equal Area Method
Stack Flow Rate	EPA Method 2*	S-Type Pitot Tube
Preliminary Cyclonic Flow Measurement	EPA Method 2G	2-D Probe
Oxygen	EPA Method 3A	Paramagnetic Cell
Carbon Dioxide	EPA Method 3A	Nondispersive Infrared Analyzer
Stack Moisture Content	EPA Method 4	Section 16.4 F Factor Based Calculation
Particulate Matter	EPA Method 5	Front Half Filterables
Nitrogen Oxides	EPA Method 7E	Chemiluminescent Analyzer
Carbon Monoxide	EPA Method 10	Nondispersive Infrared Analyzer
Volatile Organic Compounds	EPA Method 18/25A	Gas Chromatograph and Flame Ionization Detector
Stack Flow Rate	EPA Method 19*	Dry Oxygen F Factor
Particulate Matter	EPA Method 202	Back Half Condensables

\* - M2 calcs used for PM<sub>10</sub> and M19 calcs used for gases

## 4.2 INSTRUMENT CONFIGURATION AND OPERATIONS FOR EMISSIONS 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, 2, 3A, 4, 5, 7E, 10, 18, 19, and 25A; 40 CFR 51, Appendix M, 202.

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. Exhaust samples were routed to the wet based analyzer prior to gas conditioning.

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 an air-conditioned, 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. NO<sub>x</sub> 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 Hyperlogger which retrieves calibrated electronic data from each instrument every one second and reports an average of the collected data every 30 seconds. Data records can be found in Appendix A and B of this report.

Figure 4.2 represents the sample system used for the wet chemistry tests (PM<sub>10</sub>). A heated stainless steel probe with a glass liner and glass nozzle was inserted into the sample ports of the stack to extract gas measurements from the emission stream through a filter and glass impinger train. Flow rates are monitored with oil filled manometers and total sample volumes are measured with a dry gas meter. Glassware that is used to collect and analyze Method 202 condensable particulate samples is cleaned prior to the test with soap and water, and rinsed using tap water, deionized water, acetone, and finally, hexane. After cleaning, Air Hygiene incorporates a glassware bake at 300°C for six hours rather than the alternative of collecting a field train proof blank.

Three test runs of approximately 60 minutes each were conducted on the General Electric (GE), Frame 7FA.05, Unit #2 at the maximum test load for NO<sub>x</sub>, CO, VOC, H<sub>2</sub>O, CO<sub>2</sub>, and O<sub>2</sub>. Three test runs of approximately 60 minutes each were conducted on the General Electric (GE), Frame 7FA.05, Unit #2 at each of the multiple test loads for NO<sub>x</sub>, CO, and O<sub>2</sub>. Three test runs pulling at least 100 dry standard cubic feet of sample were run at 100% load for the PM<sub>10</sub> testing.

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

EPA Method 7E was used to determine concentrations of NO<sub>x</sub>. A chemiluminescent analyzer was used to determine the nitrogen oxides concentration in the gas stream. A NO<sub>2</sub> in nitrogen certified gas cylinder was used to verify at least a 90 percent NO<sub>2</sub> conversion on the day of the test.

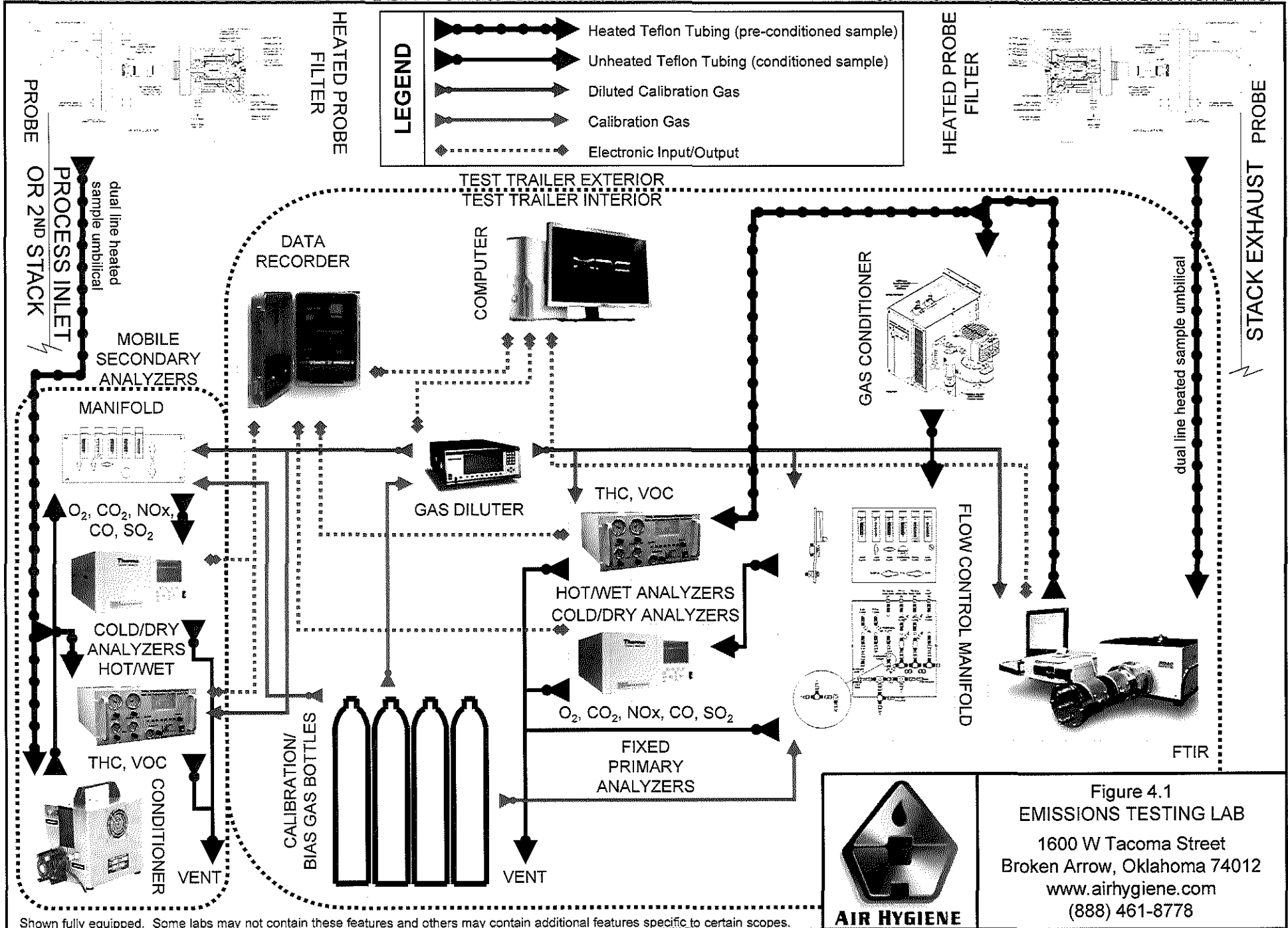


CO emission concentrations were quantified in accordance with procedures set forth in EPA Method 10. A continuous nondispersive infrared (NDIR) analyzer was used for this purpose.

VOC emission concentrations were quantified in accordance with principles set forth in EPA Method 18 and 25A. A VIG 210 was used for this purpose. The VIG 210 includes both a conventional total hydrocarbon (THC) analyzer and an automated gas chromatograph (GC) for determining VOCs. Two FIDs (flame ionization detectors) were used for the measurements: one for the THC channel and the other for the automated GC which measured methane, ethane, and residual (VOCs). During each sample period gas sample is injected directly to the first FID. This detector responded to all hydrocarbons in the sample and is used as a traditional FID as needed. For VOC sampling, a heated gas sampling valve is used for direct injection of the gas on the GC column per Method 18, Section 8.2.2. The GC column separates hydrocarbon components based on their molecular configurations, weights, and boiling points. In this application, the analyzer used the gas chromatograph column to separate methane and ethane from the heavier residual hydrocarbons (i.e. VOCs). Methane eluted from the sample first, it was immediately detected by the second FID; ethane eluted from the column second and was also detected by the second FID. The flow in the GC column was reversed (back-flushed) and the residual components were recombined and detected by the second FID as residual VOCs. Peak residual (VOC) values are reported by the analyzer between each sample period. EPA Method 7E bias and drift check criterion was used to validate data instead of EPA Method 18 recovery studies as it has more stringent and comprehensive quality assurance procedures. EPA Protocol No. 1 traceable propane calibration gas was used to calibrate the residual channel of the analyzer and the calibration procedure followed the requirements of EPA Method 25A. In this application, the target compound was VOC (non methane, non ethane hydrocarbon); therefore, the methane, ethane, and total hydrocarbon channels of the analyzer were not formally calibrated. To confirm the GC column was working properly, a blended bottle of propane and ethane was also injected to confirm the calibration.

**TABLE 4.2  
ANALYTICAL INSTRUMENTATION**

Parameter	Manufacturer and Model	Range	Sensitivity	Detection Principle
NO <sub>x</sub>	THERMO 42i-HL	User may select up to 5,000 ppm	0.1 ppm	Thermal reduction of NO <sub>2</sub> to NO. Chemiluminescence of reaction of NO with O <sub>3</sub> . Detection by PMT. Inherently linear for listed ranges.
CO	THERMO 48C	User may select up to 10,000 ppm	0.1 ppm	Infrared absorption, gas filter correlation detector, microprocessor based linearization.
CO <sub>2</sub>	SERVOMEX 1440	0-20%	0.1%	Nondispersive infrared
VOC	VIG 210	User may select up to 10,000 ppm	0.1 ppm	GC Column and Flame Ionization Detector
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

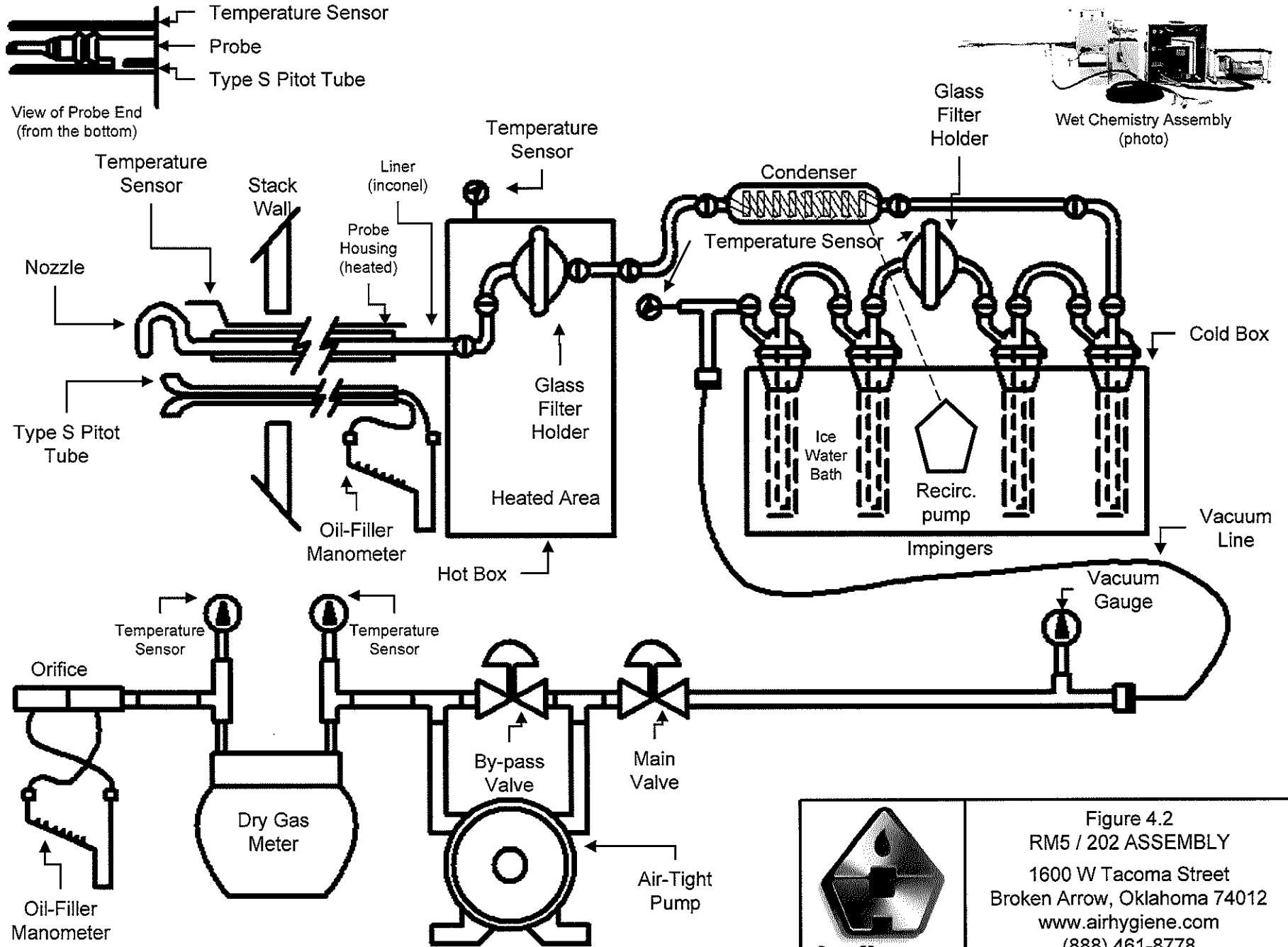


Figure 4.2  
RM5 / 202 ASSEMBLY  
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