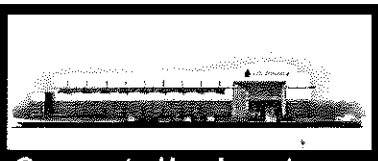
AIR HYGIENE, INC.

Testing Solutions for a Better World

RECEIVED
SEP 13 2016
AIR QUALITY DIV.

EMISSION COMPLIANCE TEST
FOR THE
GENERAL ELECTRIC (GE), FRAME 7FA.05,
UNIT #1
PREPARED FOR
WOLVERINE POWER SUPPLY COOPERATIVE
AND BLUEWATER ENERGY, INC.
AT THE
ALPINE POWER PLANT
ELMIRA TOWNSHIP, OTSEGO COUNTY,
MICHIGAN
JULY 21, 22, AND 25, 2016



Corporate Headquarters
1600 W Tacoma Street
Broken Arrow, Oklahoma 74012

AIR HYGIENE, INC.

(918) 307-8865 or (888) 461-8778
www.airhygiene.com

Remote Testing Offices
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Miami, FL 33101
Pittsburgh, PA 15205

EMISSION COMPLIANCE TEST
FOR THE
GENERAL ELECTRIC (GE), FRAME 7FA.05, UNIT #1
PREPARED FOR
WOLVERINE POWER SUPPLY COOPERATIVE
AND BLUEWATER ENERGY, INC.
AT THE
ALPINE POWER PLANT
ELMIRA TOWNSHIP, OTSEGO COUNTY,
MICHIGAN
JULY 21, 22, AND 25, 2016
Permit No: 206-14
State Registration No: P0582

Prepared and Reviewed by:

Todd R. Sturgeon, QSTI
Senior Project Manager

Aaron Blum
Test Manager

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-CTG1 (Unit #1), located in Elmira Township, Michigan. The fieldwork, performed on July 21, 22 and 25 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 #1
July 21, 22 and 25, 2016

Parameter	Units	Load				Limit
		50%	75%	85%	100%	
Nitrogen Oxides (NOx)	lb/hr	31.97	37.84	40.29	57.67	66.8
	lb/mmbtu	0.025	0.025	0.023	0.028	0.0327
Carbon Monoxide (CO)	lb/hr				1.65	40.9
	lb/mmbtu				0.001	0.020
Volatile Organic Compounds (VOCs)	lb/hr				0.63	2.9
	lb/mmbtu				0.000	0.00140
Particulate Matter (PM_{10})	lb/hr				6.15	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 #1
Wolverine Power Supply Cooperative and Bluewater Energy, Inc.
Alpine Power Plant
Elmira Township, Otsego County, Michigan
July 21, 22, and 25, 2016

1.0 INTRODUCTION

Air Hygiene International, Inc. (Air Hygiene) has completed the stack sampling survey for nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC), particulate matter (PM_{10}), flow, moisture (H_2O), carbon dioxide (CO_2), and oxygen (O_2) from the exhaust of the General Electric (GE), Frame 7FA.05, Unit #1 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 21, 22, and 25, 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 NOx, CO, VOC, PM_{10}, flow, H_2O, CO_2, and O_2 from the exhaust of Wolverine Power Supply Cooperative and Bluewater Energy, Inc.'s General Electric (GE), Frame 7FA.05, Unit #1 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 the 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 Watergate Road, Cadillac, Michigan 49651

1.2.5 Equipment Tested
- General Electric (GE), Frame 7FA.05, Unit #1

1.2.6 Emission Points

- Exhaust from the General Electric (GE), Frame 7FA.05, Unit #1
- For all gases, twelve sample points in the exhaust stack from the General Electric (GE), Frame 7FA.05, Unit #1, 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 #1 (refer to Appendix A)

1.2.7 Emission Parameters Measured

- NOx
- CO
- VOC
- PM_{10}
- Flow
- H_2O
- CO_2
- O_2

1.2.8 Dates of Emission Test

- July 21, 22, and 25, 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 #1 located at the Alpine Power Plant on July 21, 22, and 25, 2016 are summarized in the following table and relate only to the items tested. Testing was briefly delayed because of a broken fuel valve which explains the gap in test dates.

TABLE 2.1
SUMMARY OF GENERAL ELECTRIC, 7FA.05, UNIT #1 RESULTS

Parameter	100 Load	85 Load	70 Load	50 Load	Permit Limits
Date (mm/dd/yy)	07/21/16	07/22/16	07/25/16	07/25/16	--
Start Time (hh:mm:ss)	7:40:09	13:20:09	16:00:01	20:15:05	--
End Time (hh:mm:ss)	18:45:53	17:54:39	19:55:35	0:08:35	--
Run Duration (min / run)	74	86	73	72	--
Bar. Pressure (in. Hg)	29.93	30.00	29.97	30.01	--
Amb. Temp. (°F)	79	89	77	68	--
Rel. Humidity (%)	75	38	57	77	--
Spec. Humidity (lb water / lb air)	0.015595	0.011052	0.011330	0.011005	--
Load Designator	100	85	70	50	--
Turbine Fuel Flow (lb/min)	1,492	1,262	1,096	912	--
Stack Flow (M2) (SCFH)	62,056,862	--	--	--	--
Stack Flow (RM19) (SCFH)	48,261,383	43,528,852	36,244,771	30,986,027	--
Stack Moisture (% Calculated)	9.2	--	--	--	--
Power Output (megawatts)	207.5	173.0	142.2	102.7	--
NOx (ppmvd)	10.00	7.75	8.74	8.64	--
NOx (lb/hr)	57.67	40.29	37.84	31.97	66.8
NOx (lb/MMBtu)	0.028	0.023	0.025	0.025	0.0327
CO (ppmvd)	0.47	0.77	0.78	4.59	--
CO (lb/hr)	1.65	2.42	2.06	10.33	40.9
CO (lb/MMBtu)	0.001	0.001	0.001	0.008	0.02
VOC (ppmvd)	0.11	--	--	--	--
VOC (lb/hr)	0.63	--	--	--	2.9
VOC (lb/MMBtu)	0.000	--	--	--	0.0014
Total PM_{10} (mg)	5.47	--	--	--	--
Total PM_{10} (lb/hr)	6.15	--	--	--	13.5
Total PM_{10} (lb/MMBtu)	0.002	--	--	--	0.0066
O_2 (%)	13.17	13.65	13.34	13.53	--

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.

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 1 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_{10} 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_{10} 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 #1 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 21, 22, and 25, 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 FFactor 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_{10} 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. 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 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_{10}). 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 #1 at the maximum test load for NOx, CO, VOC, H_2O, CO_2, and O_2. Three test runs of approximately 60 minutes each were conducted on the General Electric (GE), Frame 7FA.05, Unit #1 at each of the multiple test loads for NOx, CO, and O_2. Three test runs pulling at least 100 dry standard cubic feet of sample were run at 100% load for the PM_{10} testing.

The stack gas analysis for O_2 and CO_2 concentrations was performed in accordance with procedures set forth in EPA Method 3A. The O_2 analyzer uses a paramagnetic cell detector and the CO_2 analyzer uses a continuous nondispersive infrared analyzer.

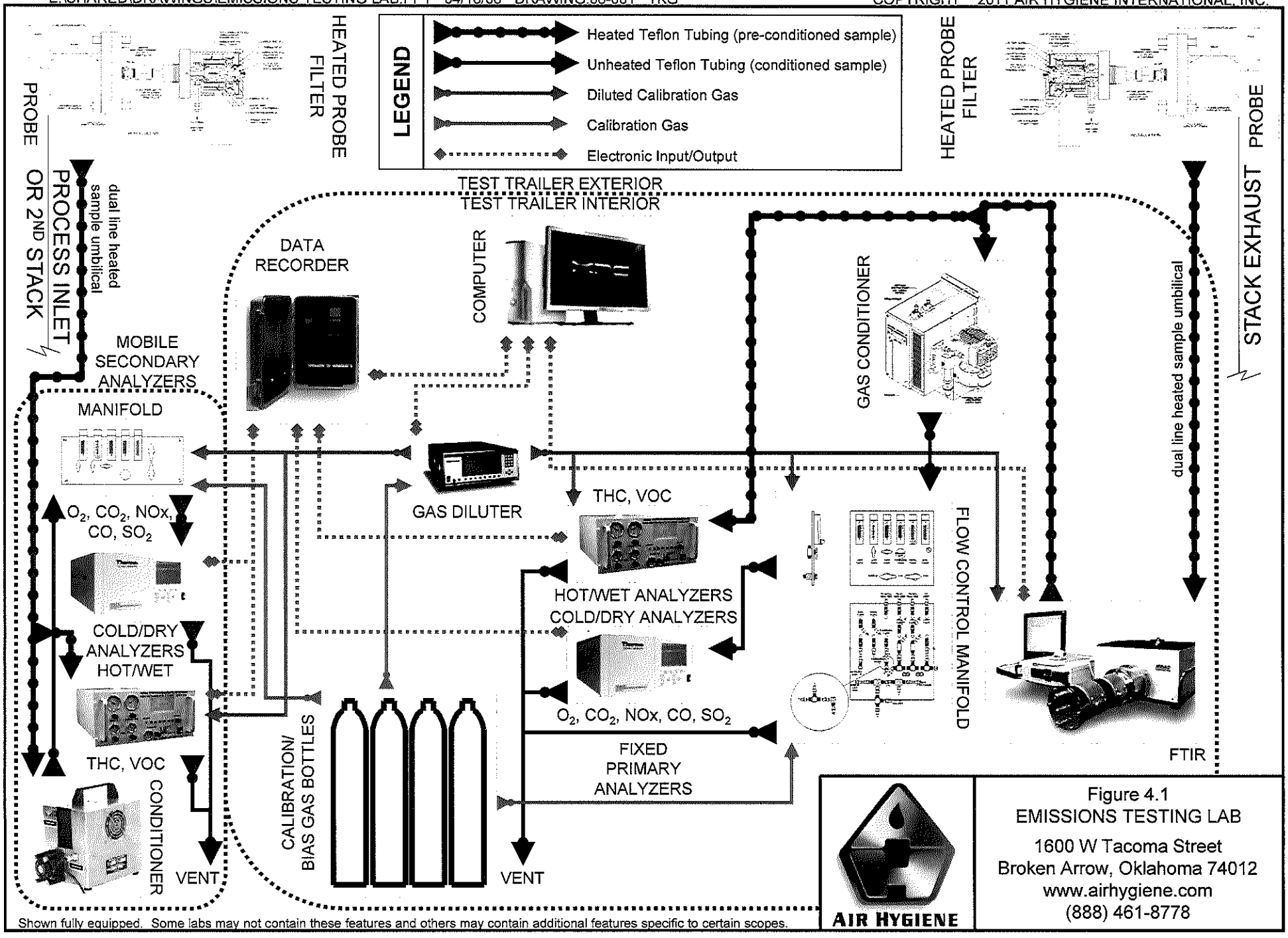
EPA Method 7E was used to determine concentrations of NOx. A chemiluminescent analyzer was used to determine the nitrogen oxides concentration in the gas stream. A NO_2 in nitrogen certified gas cylinder was used to verify at least a 90 percent NO_2 conversion on the day of the test.

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 is 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
NOx	THERMO 42i-HL	User may select up to 5,000 ppm	0.1 ppm	Thermal reduction of NO_2 to NO. Chemiluminescence of reaction of NO with O_3. 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_2	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_2	SERVOMEX 1440	0-25%	0.1%	Paramagnetic cell, inherently linear.

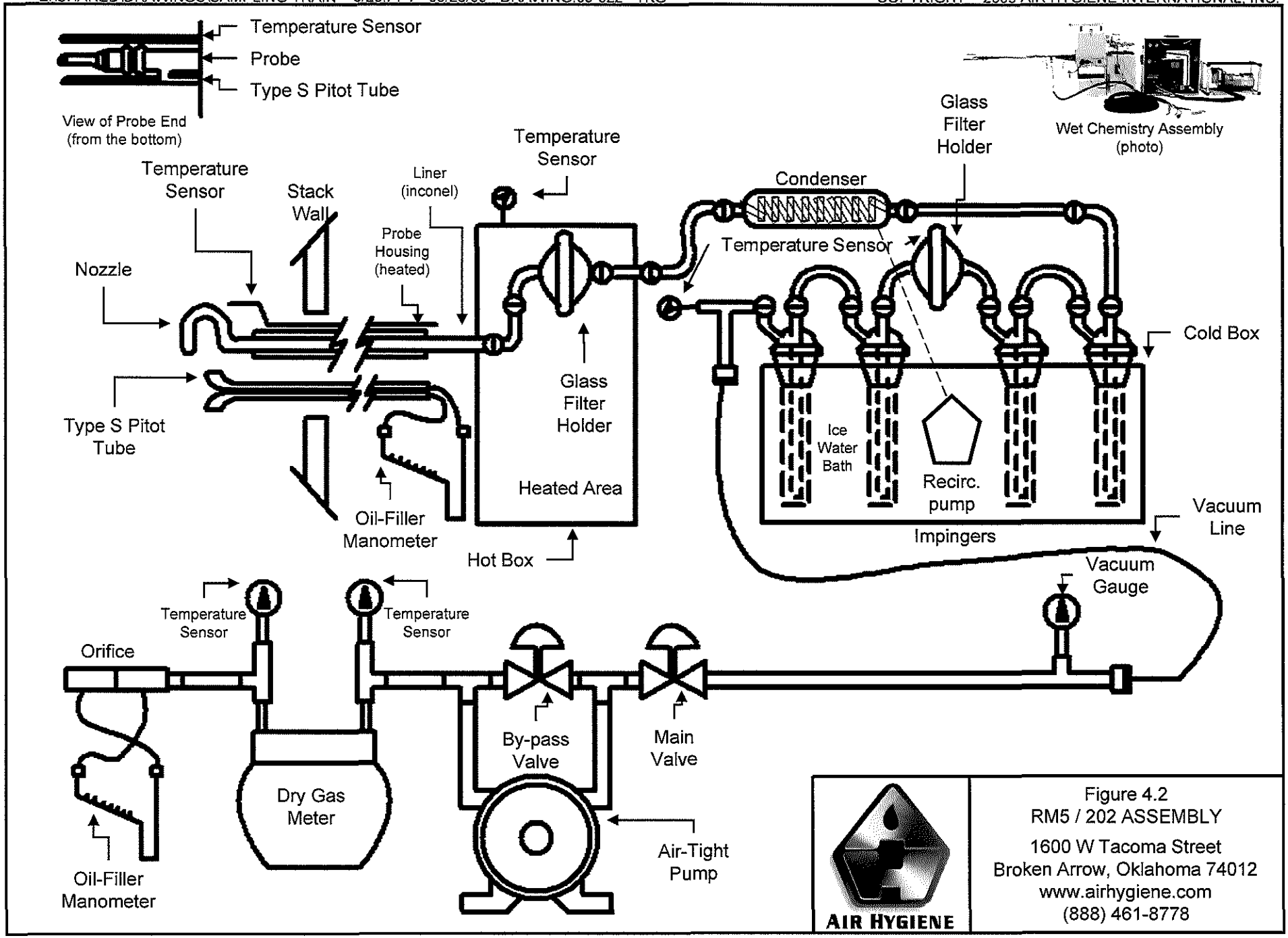


Shown fully equipped. Some labs may not contain these features and others may contain additional features specific to certain scopes.

AIR HYGIENE

Figure 4.1
EMISSIONS TESTING LAB

1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
www.airhygiene.com
(888) 461-8778



AIR HYGIENE

Figure 4.2
RM5 / 202 ASSEMBLY

1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
www.airhygiene.com
(888) 461-8778