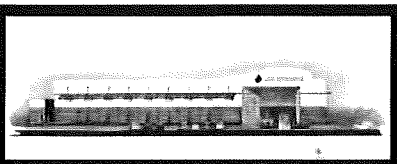
AIR HYGIENE, INC.

Testing Solutions for a Better World

EMISSION COMPLIANCE TEST
FOR THE
GENERAL ELECTRIC, 7FA.05, UNIT #EU-CTG2
PREPARED FOR
WOLVERINE POWER SUPPLY
COOPERATIVE, INC.
AT THE
ALPINE POWER PLANT
ELMIRA, OTSEGO COUNTY, MICHIGAN
AUGUST 3-5, 2021

Permit No: MI-ROP-P0582-2019
Report Date: October 5, 2021



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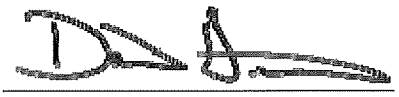
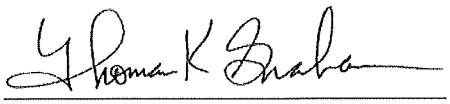
Prepared and Reviewed by:



Darin Grimes
Sr. Testing Solutions Specialist



Thomas K. Graham, PE, QSTI
Director of AHU

I, 

Michael Stockwell, QSTI
Sr. Regional Manager-Broken Arrow, OK
certify this testing was conducted and
this report was created in conformance
with the requirements of ASTM D7036

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CERTIFICATION OF INFORMATION

I certify under penalty of law that I believe the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for submitting false, inaccurate or incomplete information.

Michael Stockwell, QSTI
Sr. Regional Manager-Broken Arrow, OK
Air Hygiene International, Inc.

August 19, 2021
Date

FACILITY CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attached documents and, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for submitting false, inaccurate or incomplete information.

I am the responsible official with direct knowledge and overall responsibility for the information contained in this report.

Name

Title

Signature

Date

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APPENDICES

Emissions Compliance Test
General Electric, 7FA.05, Unit #EU-CTG2
Wolverine Power Supply Cooperative, Inc.
Alpine Power Plant
Elmira, Otsego County, Michigan
August 3-5, 2021

1.0 INTRODUCTION

Air Hygiene International, Inc. (Air Hygiene) has completed the Emissions Compliance Test for nitrogen oxides (NOx), carbon monoxide (CO), total hydrocarbons/volatile organic compounds (THC/VOC), particulate matter (PM), and formaldehyde (HCHO) from the exhaust of the General Electric, 7FA.05, Unit #EU-CTG2 for Wolverine Power Supply Cooperative, Inc. at the Alpine Power Plant in Elmira, Otsego County, Michigan. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on August 3-5, 2021.

1.1 TEST PURPOSE AND OBJECTIVES

The purpose of the test was to conduct a periodic compliance emission test to document levels of selected pollutants at four test loads (high, mid-high, mid-low, and low) for NOx and CO, with additional testing at high load for THC/VOC, PM, and HCHO. The information will be used to confirm compliance with the operating permit issued by the Michigan Department of Environment, Great Lakes and Energy (EGLE). The specific objective was to determine the emission concentration of NOx, CO, THC/VOC, PM, and HCHO from the exhaust of Wolverine Power Supply Cooperative, Inc.'s General Electric, 7FA.05, Unit #EU-CTG2.

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 and Energy (EGLE)
- Wolverine Power Supply Cooperative, Inc.
- Air Hygiene

1.2.2 Industry
- Electric Utility / Electric Services

1.2.3 Air Permit Requirements
- Permit Number: MI-ROP-P0582-2019

1.2.4 Plant Location
- Alpine Power Plant in Elmira, Otsego County, Michigan
  - GPS Coordinates [Latitude 45.0639, Longitude -84.8271]
  - Physical Address: 7432 M-32, Elmira, Michigan 49730
  - Federal Registry System / Facility Registry Service (FRS) No. – 110070082175
  - Source Classification Code (SCC) – 20100209

1.2.5 Equipment Tested
- General Electric, 7FA.05, Unit #EU-CTG2

1.2.6 Emission Points

- Exhaust from the General Electric, 7FA.05, Unit #EU-CTG2
- For all gases, twelve sample points in the exhaust stack from the General Electric, 7FA.05, Unit #EU-CTG2, located according to 40 CFR 60, Appendix A, Method 1
- For all PM testing, 24 sampling points in the exhaust duct from the General Electric, 7FA.05, Unit #EU-CTG2

1.2.7 Emission Parameters Measured

- NOx
- CO
- THC/VOC – high load only
- PM – high load only
- HCHO – high load only
- Flow
- H_2O
- CO_2
- O_2

1.2.8 Dates of Emission Test

- August 3-5, 2021

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, Inc.:	Joe Hazewinkel (jhazewinkel@wpsci.com)	231-577-8721
Wolverine Power Supply Cooperative, Inc.:	Daniel Boulter (dboulter@wpsci.com)	989-619-4059
Fishbeck:	Stephanie Jarrett (sajarrett@ftch.com)	248-324-2146
EGLE:	Jeremy Howe (HoweJ1@michigan.gov)	231-876-4416
Air Hygiene:	Michael Stockwell (mstockwell@airhygiene.com)	918-307-8865
Air Hygiene:	Atlas Melchert	918-307-8865
Air Hygiene:	Jeff Wollrab	918-307-8865
Air Hygiene:	Cade Cavender	918-307-8865
Air Hygiene:	Connor Copeland	918-307-8865

2.0 SUMMARY OF TEST RESULTS

Results from the sampling conducted on Wolverine Power Supply Cooperative, Inc.'s General Electric, 7FA.05, Unit #EU-CTG2 located at the Alpine Power Plant on August 3-5, 2021 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
SUMMARY OF GENERAL ELECTRIC, 7FA.05, UNIT #EU-CTG2 RESULTS

Parameter	Low Load	Mid-Low Load	Mid-High Load	High Load	Permit Limits
Date (mm/dd/yy)	08/05/21	08/04/21	08/04/21	08/03/21	--
Comb. Discharge Pres. (psig)	144.8	172.5	200.3	238.9	--
Turbine Fuel Flow (lb/min)	926	1,095	1,245	1,481	--
Heat Input (MMBtu/hr)	1,286.7	1,522.7	1,730.1	2,058.8	--
Power Output (megawatts)	104.9	140.7	170.0	207.4	--
NOx (ppmvd)	10.23	10.03	9.42	10.23	--
NOx (ppm@15%O_2)	7.93	7.84	7.45	7.77	--
NOx (ppm@15%O_2&ISO)	8.46	8.27	8.05	8.05	--
NOx (lb/hr)	37.29	43.67	47.15	58.47	66.8
NOx (lb/MMBtu)	0.029	0.029	0.027	0.028	0.0327
CO (ppmvd)	2.32	0.86	1.44	0.32	--
CO (ppm@15%O_2)	1.80	0.68	1.13	0.25	--
CO (ppm@15%O_2&ISO)	1.92	0.71	1.23	0.25	--
CO (lb/hr)	5.15	2.29	4.37	1.12	40.9
CO (lb/MMBtu)	0.0040	0.0015	0.0025	0.0005	0.020
VOC (as CH_4) (ppmvd)	--	--	--	0.025	--
VOC (as CH_4) (ppm@15%O_2)				0.019	--
VOC (as CH_4) (ppm@15%O_2&ISO)				0.020	--
VOC (as CH_4) (lb/hr)	--	--	--	0.050	2.9
VOC (as CH_4) (lb/MMBtu)	--	--	--	0.00002	0.00140
HCHO (ppmvd)	--	--	--	0.33	--
HCHO (ppm@15%O_2)				0.25	--
HCHO (ppm@15%O_2&ISO)				0.26	--
HCHO (lb/hr)	--	--	--	1.23	--
HCHO (lb/MMBtu)	--	--	--	0.001	--
Total PM_{10} (mg)				8.54	--
Total PM_{10} (gr/dscf)				1.56E-03	--
Total PM_{10} (lb/hr)				12.06	13.5
Total PM_{10} (lb/MMBtu)				0.0051	0.0066

3.0 SOURCE OPERATION

3.1 PROCESS DESCRIPTION

Wolverine Power Supply Cooperative, Inc. owns and operates the Alpine Power Plant located in Elmira, Otsego County, Michigan. The station consists of two General Electric Frame 7FA.05 simple cycle combustion turbines, designated as EU-CTG1 and EU-CTG2. Each CTG has a nominal rating of 203 megawatts (MW), with a peak heat input of 2,045 million British thermal units per hour (MMBtu/hr), an exhaust flow rate of approximately 800,000 standard cubic feet per minute (scfm) (at 100 percent load), and an exhaust gas temperature of approximately 1,100 degrees Fahrenheit (°F).

3.2 SAMPLING LOCATION

The stacks are vertical, circular and measure 24 feet (ft) (288 inches) in diameter at the test ports which are approximately 74 ft above grade level with an exit elevation of approximately 85 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. Air Hygiene has field verified the measurable dimensions. Non-field verified dimensions are provided by Wolverine Power Supply Cooperative, Inc. The stacks were sampled from a minimum of twelve sampling points during each run with the sampling time at each point in compliance with 40 CFR 75, Appendix E Section 2.1.2.3. Prior to the first run for Appendix E testing, the system response time was determined to ensure sufficient sampling time for each sample point. For PM testing, an initial velocity traverse was performed across the stack to confirm the absence of cyclonic flow (also confirmed by a 2016 40-point traverse, see Appendix G). All sampling occurred from the same 24 points.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

The emission test on the General Electric, 7FA.05, Unit #EU-CTG2 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 August 3-5, 2021.

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
Oxygen	EPA Method 3A	Paramagnetic Cell
Carbon Dioxide	EPA Method 3A	Nondispersive Infrared Analyzer
Stack Moisture Content	EPA Method 4	Gravimetric Analysis
Particulate Matter	EPA Method 5	Front Half Filterables
Nitrogen Oxides	EPA Method 7E	Chemiluminescent Analyzer
Carbon Monoxide	EPA Method 10	Nondispersive Infrared Analyzer
Stack Flow Rate	EPA Method 19	Dry Oxygen F Factor
Total Hydrocarbons / Volatile Organic Compounds	EPA Method 25A	Flame Ionization Detector
Particulate Matter	EPA Method 202	Back Half Condensables
Formaldehyde, Methane, Ethylene, CO_2, H_2O	EPA Method 320	Fourier Transform Infrared

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, 2, 3A, 4, 5, 7E, 10, 19, 25A; 40 CFR 51, Appendix M, Method 202; and 40 CFR 63, Appendix A, Method 320.

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 heated head pump and into the FTIR then 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 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. For target compounds measured with the Fourier transform infrared (FTIR) spectrometer, interferograms consisting of 30 co-added scans were recorded continuously during the test periods, and provided approximately 30-second average concentrations. Spectral data was analyzed by the MKS MG2000 software.

Figure 4.2 represents the sample system used for the PM tests. A heated stainless-steel probe with a glass liner and 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.

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.

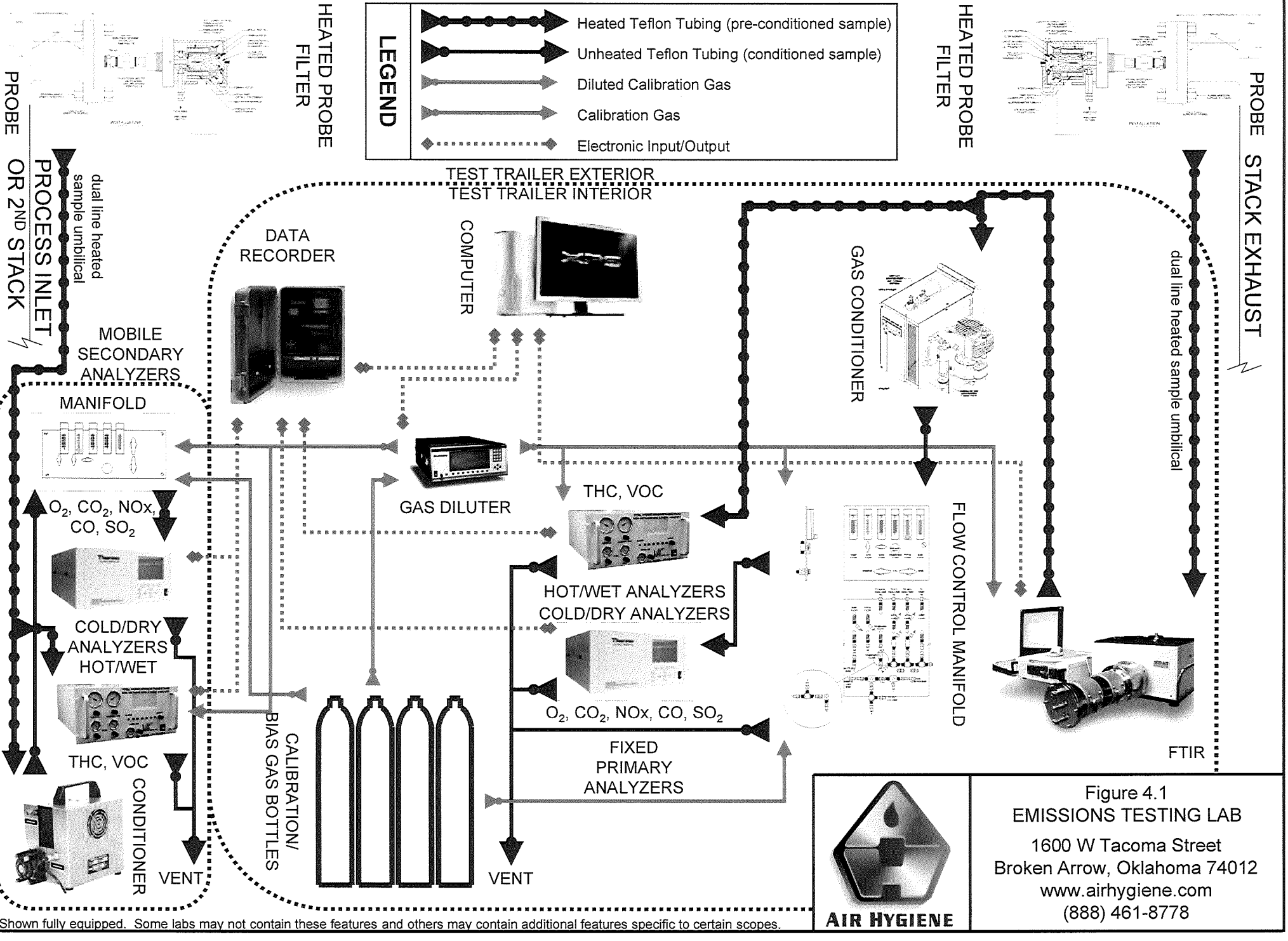
CO emission concentrations were quantified in accordance with procedures set forth in EPA Method 10. A continuous nondispersive infrared (NDIR) analyzer was used for this purpose.

THC emission concentrations were quantified in accordance with procedures set forth in EPA Method 25A. A continuous flame ionization (FID) analyzer was used for this purpose. THC emission concentrations were less than the permitted VOC limit, thus all THCs were assumed as VOC.

An MKS Instruments - MultiGas™ Fourier Transform Infrared (FTIR) spectrometer was used for HCHO, CH_4, C_2H_4, CO_2, and H_2O analysis per EPA Method 320. The FTIR spectrometer spectral resolution was 0.5 cm^{-1}. The system employed a silicon carbide infrared source at 1200°C, a helium neon reference laser, beam splitters, potassium bromide (KBr) cell window, front-surface optical transfer mirrors, and multi-pass absorption cells. MCT detectors were used and cooled with liquid nitrogen in order to maintain a constant temperature of 77 Kelvin. The approximately 5.11-meter multi-pass path cells incorporated aspheric, aberration-correcting mirrors to increase the optical throughput and the detection sensitivity. Transducers and thermocouples were connected directly to the insulated sample cells that provide the pressure and temperatures of the sample streams. During testing, the temperature of the absorption cells was set at 191°C. Elevated temperature prevented gas condensation within the cell and minimized compound adhesion to the cell walls and mirrors. The volume of the absorption cell was 0.5 liters, so at a sample gas flow rate of 4.0 liters per minute, the sample gas in the cell is refreshed approximately four times each minute. Interferograms consisting of 30 co-added scans were recorded continuously during the test periods, and provided approximately 30-second average concentrations.

TABLE 4.2
ANALYTICAL INSTRUMENTATION

Parameter	Manufacturer and Model	Range	Sensitivity	Detection Principle
NOx	THERMO 42 series	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 48 series	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
HCHO, CH_4, C_2H_4, CO_2, H_2O	MKS 2030	User may select from multiple ranges	0.1 ppm	Fourier Transform Infrared – FTIR
THC/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.



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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

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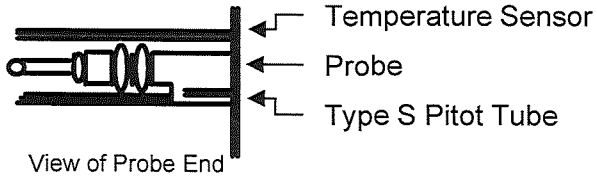
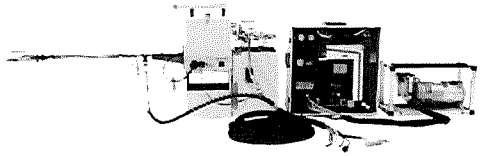


View of Probe End
(from the bottom)



Wet Chemistry Assembly
(photo)

Temperature Sensor (here and multiple locations)

Temperature Sensor

Stack Wall

Liner (glass)

Probe Sheath (heated)

Vertical Condenser With Dropout

CPM Filter Holder

Nozzle

Type S Pitot Tube

Glass Filter Holder

Heated Area

Vacuum Line

Ice Water Bath

Oil-Filler Manometer

Hot Box

Recirc. pump

Impingers

Split Cold Box

Vacuum Gauge

Orifice

By-pass Valve

Main Valve

Dry Gas Meter

Air-Tight Pump

Oil-Filler Manometer

AIR HYGIENE

Figure 4.2
RM5 / 202 ASSEMBLY

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