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EMISSION COMPLIANCE TEST
FOR THE
SIEMENS, SGE-56SL, UNIT #1-6
PREPARED FOR
LIVWELL
AT THE
LIVWELL CULTIVATION BUSINESS CENTER
WARREN, MACOMB COUNTY, MICHIGAN
FEBRUARY 15-21, 2023

Permit No: 10-20A (P1109)
Report Date: April 9, 2023

Corporate Headquarters
1600 W. Tacoma Street
Broken Arrow, OK 74012

AIR HYGIENE, INC.

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www.airhygiene.com

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Prepared and Reviewed by:

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Director of AHU

I, ________________
Greg Vaughn, QSTI
Test Manager
certify that 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.

Greg Vaughn, QSTI
Test Manager
Air Hygiene International, Inc.

March 20, 2023
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
Siemens, SGE-56SL, Unit #1-6
LivWell
Livwell Cultivation Business Center
Warren, Macomb County, Michigan
February 15-21, 2023

1.0 INTRODUCTION

Air Hygiene International, Inc. (Air Hygiene) has completed the Emissions Compliance Test for nitrogen oxides (NOx), carbon monoxide (CO), total hydrocarbons/non-methane hydrocarbons/volatile organic compounds (THC/NMHC/VOC), and ammonia (NH_3) from the exhaust of the Siemens, SGE-56SL, Unit #1-6 for LivWell at the Livwell Cultivation Business Center in Warren, Macomb County, Michigan. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on February 15-21, 2023.

1.1 TEST PURPOSE AND OBJECTIVES

The purpose of the test was to conduct a periodic emission test to document levels of selected pollutants at maximum operation levels of the unit. The information will be used to confirm compliance with the operating permit issued by the Michigan Department of Environment, Great Lakes & Energy (Michigan EGLE) in addition to the requirements of 40 Code of Federal Regulations, Part 60, Subpart JJJJ. The specific objective was to determine the emission concentration of NOx, CO, THC/NMHC/VOC, and NH_3 from the exhaust of LivWell's Siemens, SGE-56SL, Unit #1-6.

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 (Michigan EGLE)
- LivWell
- Air Hygiene

1.2.2 Industry
- Cannabis Cultivation and Production

1.2.3 Air Permit and Federal Requirements
- Permit Number: 10-20A (P1109)
- 40 CFR 60, Subpart JJJJ

1.2.4 Plant Location
- Livwell Cultivation Business Center in Warren, Macomb County, Michigan
  - GPS Coordinates [Latitude 42.455310, Longitude -83.003680]
  - Physical Address: 21550 Hoover Road, CUP Building, Warren, Michigan 48089

1.2.5 Equipment Tested
- Siemens, SGE-56SL, Unit #1-6

1.2.6 Emission Points

- Exhaust from the Siemens, SGE-56SL, Unit #1-6
- For all gases, one to three sample points in the exhaust stacks from the Siemens, SGE-56SL, Unit #1-6, at the point nearest the mean (non-stratified) or 16.7, 50.0, and 83.3 percent of the diameter (minimally stratified)
- For all flow testing, 12 sampling points in the exhaust stacks from the Siemens, SGE-56SL, Unit #1-6

1.2.7 Emission Parameters Measured

- NOx
- CO
- THC/NMHC/VOC
- NH_3
- Flow
- H_2O
- CO_2
- O_2

1.2.8 Dates of Emission Test

- February 15-21, 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

LivWell:	Shannelle Montoya (shannelle.montoya@livwell.com)	720-276-7669
Cultivated Power:	Jim Kelly (jim.kelly@cultivatedpower.net)	303-601-5681
Michigan EGLE:	Lindsey Wells (wellsl8@michigan.gov)	517-282-2345
Air Hygiene:	Greg Vaughn (gvaughn@airhygiene.com)	918-307-8865
Air Hygiene:	Matt McBride	918-307-8865
Air Hygiene:	Garrett Rogers	918-307-8865

2.0 SUMMARY OF TEST RESULTS

Results from the sampling conducted on LivWell's Siemens, SGE-56SL, Unit #1-6 located at the Livwell Cultivation Business Center on February 15-21, 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
SUMMARY OF SIEMENS, SGE-56SL, UNIT #EUGEN1, SERIAL #A9B0018 RESULTS

Parameter	Unit #1 S#A9B0018 (EUGEN1)	Unit #2 S#A9C0007 (EUGEN2)	Unit #3 S#A9A0027 (EUGEN3)	Unit #4 S#A9B0001 (EUGEN4)	Unit #5 S#A9B0011 (EUGEN5)	Unit #6 S#BOD0008 (EUGEN6)	FGCOGEN Emission Limits	40 CFR 60, Subpart JJJJ Limits[5]
Date (mm/dd/yy)	02/21/23	02/16/23	02/20/23	02/18/23	02/19/23	02/15/23	--	--
Power Output (kilowatts)	900.0	906.7	900.0	909.7	906.7	900.0	--	--
Stack Flow (M2) (DSCFH)	142,648	136,509	100,307	141,240	127,263	142,817	--	--
NOx (ppmvd)	4.25	7.60	25.16	17.37	20.67	7.68	--	--
NOx (ppm@15%O_2)	2.04	3.65	11.90	8.53	9.87	3.66	--	82
NOx (g/hp*hr)	0.027	0.046	0.113	0.109	0.118	0.049	0.05[1] / 0.14[2]	1.0
CO (ppmvd)	8.23	0.11	4.72	0.01	3.70	6.46	--	--
CO (ppm@15%O_2)	3.95	0.05	2.23	0.00	1.77	3.08	--	270
CO (g/hp*hr)	0.032	0.000	0.013	0.000	0.013	0.025	0.036[3] / 0.45[4]	2.0
NMHC (as C_3H_8) (ppmvd)	2.18	1.64	28.42	31.84	28.07	18.89	--	--
NMHC (as C_3H_8) (ppm@15%O_2)	1.05	0.78	13.44	15.63	13.41	9.00	--	60
NMHC (as C_3H_8) (g/hp*hr)	0.01	0.01	0.12	0.19	0.15	0.12	0.07[3] / 0.28[4]	0.7
NH_3 (ppmvd)	3.92	4.59	6.78	0.24	6.87	2.42	--	--
NH_3 (ppm@15%O_2)	1.88	2.20	3.21	0.12	3.28	1.15	5[3] / 3.5[4]	--
NH_3 (g/hp*hr)	0.009	0.010	0.011	0.001	0.015	0.006	--	--

Notes: [1]Applicable to Units 1, 2, and 6; [2]Applicable to Units 3, 4, and 5; [3]Applicable to Units 1 and 2; [4]Applicable to Units 3, 4, 5, and 6; [5]Based on 2019 Manufacturing Date

3.0 SOURCE OPERATION

3.1 PROCESS DESCRIPTION

The units tested were Siemens, SGE-56SL, Unit #1-6. The engines are rated at 1,431 horsepower. The engine emissions are vented to the atmosphere through exhaust systems extending from each engine. The lean burn engines use an oxidation catalyst and ammonia injection between the engine and the exhaust stack.

3.2 SAMPLING LOCATION

The stacks are vertical, circular, and measure 1.1 feet (ft) (13.25 inches) in diameter at the test ports which are approximately 37 ft above grade level with an exit elevation of approximately 42 ft above grade level. The test ports are located approximately 7.5 ft (90 inches) [6.8 dia] downstream and approximately 5.2 ft (62.5 inches) [4.7 dia] upstream from the nearest disturbances. Air Hygiene has field verified the measurable dimensions. Non-field verified dimensions are provided by LivWell. All exhaust samples for gaseous emissions were continuously drawn from the exhaust system at the sample ports from one (non-stratified) or three (minimally stratified) sample points determined after conducting stratification tests. During the stratification test six points were traversed from each of the two test ports. The probe was allowed to remain at a point for at least two times the system response time. For flow testing, an initial velocity traverse was performed across the stack from 12 total points. All flow sampling occurred from the same 12 points.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

The emission test on the Siemens, SGE-56SL, Unit #1-6 at the Livwell Cultivation Business Center 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 February 15-21, 2023.

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
Nitrogen Oxides	EPA Method 7E	Chemiluminescent Analyzer
Carbon Monoxide	EPA Method 10	Nondispersive Infrared Analyzer
Ammonia, THC, Methane, Ethane, Carbon Dioxide, and Water	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, 7E, 10; 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 60 seconds. For target compounds measured with the Fourier transform infrared (FTIR) spectrometer, interferograms consisting of 60 co-added scans were recorded continuously during the test periods and provided approximately 60-second average concentrations. Spectral data was analyzed by the MAX Analytical software.

The stack gas analysis for O_2 and CO_2 concentrations was performed in accordance with procedures set forth in EPA Method 3A and 20. 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 air manufacturer-certified gas cylinder was used to verify at least a 90 percent NO_2 conversion on the day of the test.

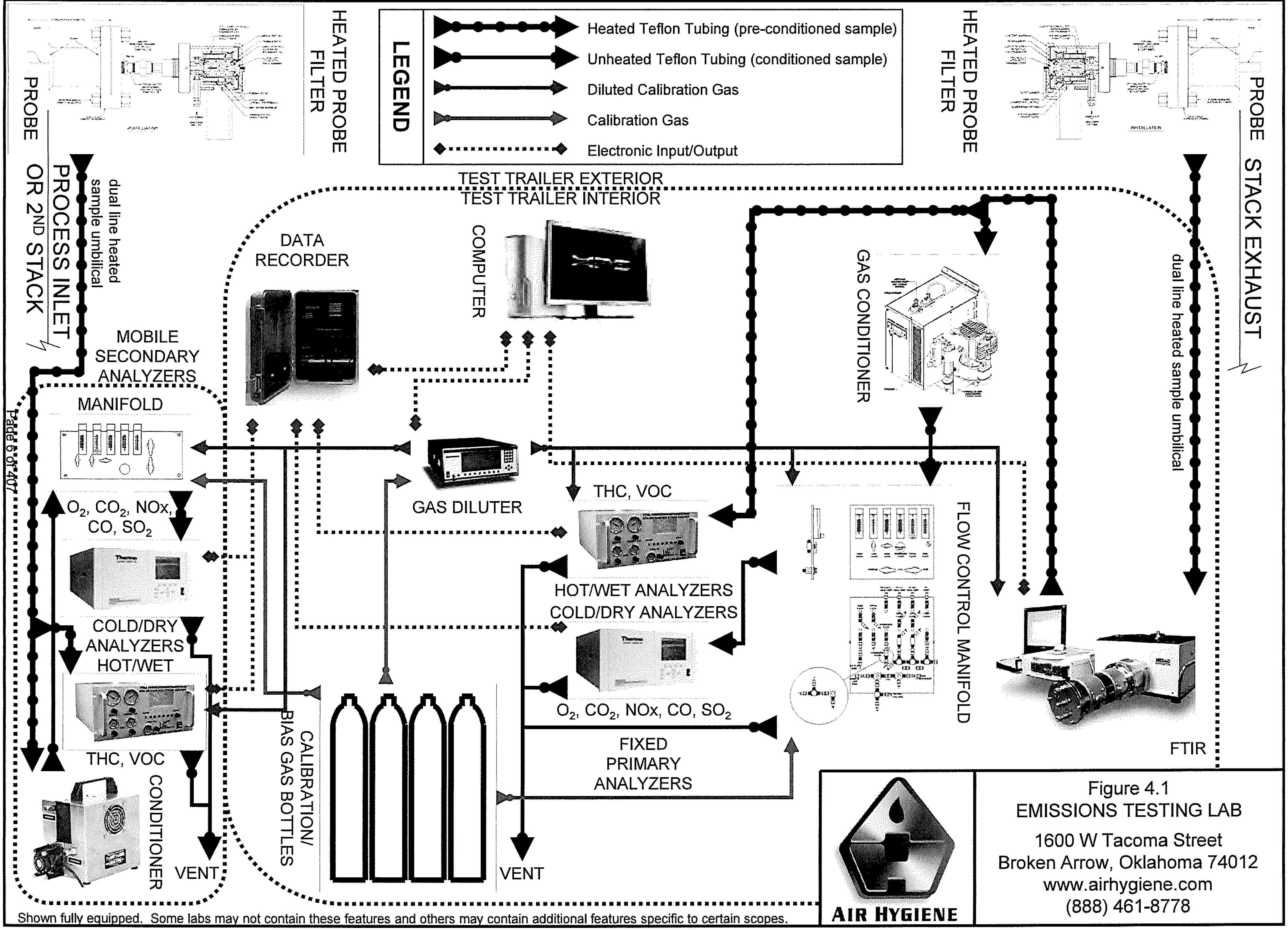
CO emission concentrations were quantified in accordance with procedures set forth in EPA Method 10. A continuous nondispersive infrared (NDIR) analyzer was used for this purpose.

A MKS Instruments - MultiGas™ Fourier Transform Infrared (FTIR) spectrometer was used for ammonia, total hydrocarbon, methane, ethane, carbon dioxide, and moisture 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 60 co-added scans were recorded continuously during the test periods and provided approximately 60-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
NH_3, CH_4, CO_2, H_2O	MKS 2030	User may select from multiple ranges	0.1 ppm	Fourier Transform Infrared – FTIR
O_2	SERVOMEX 1440	0-25%	0.1%	Paramagnetic cell, inherently linear.

Figure 4.2 represents the sample system used for the flow tests. Flow rates were monitored with manometers.



Shown fully equipped. Some labels 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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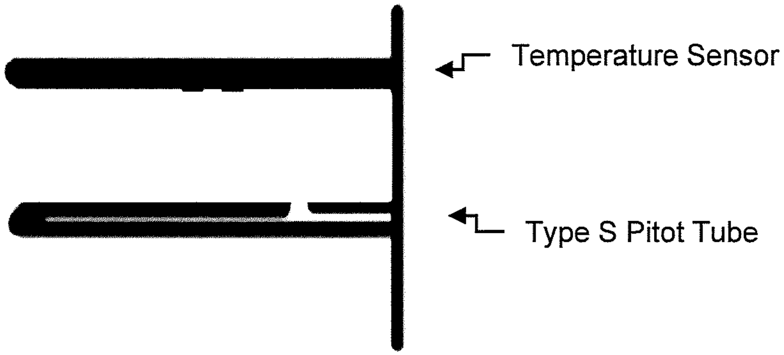

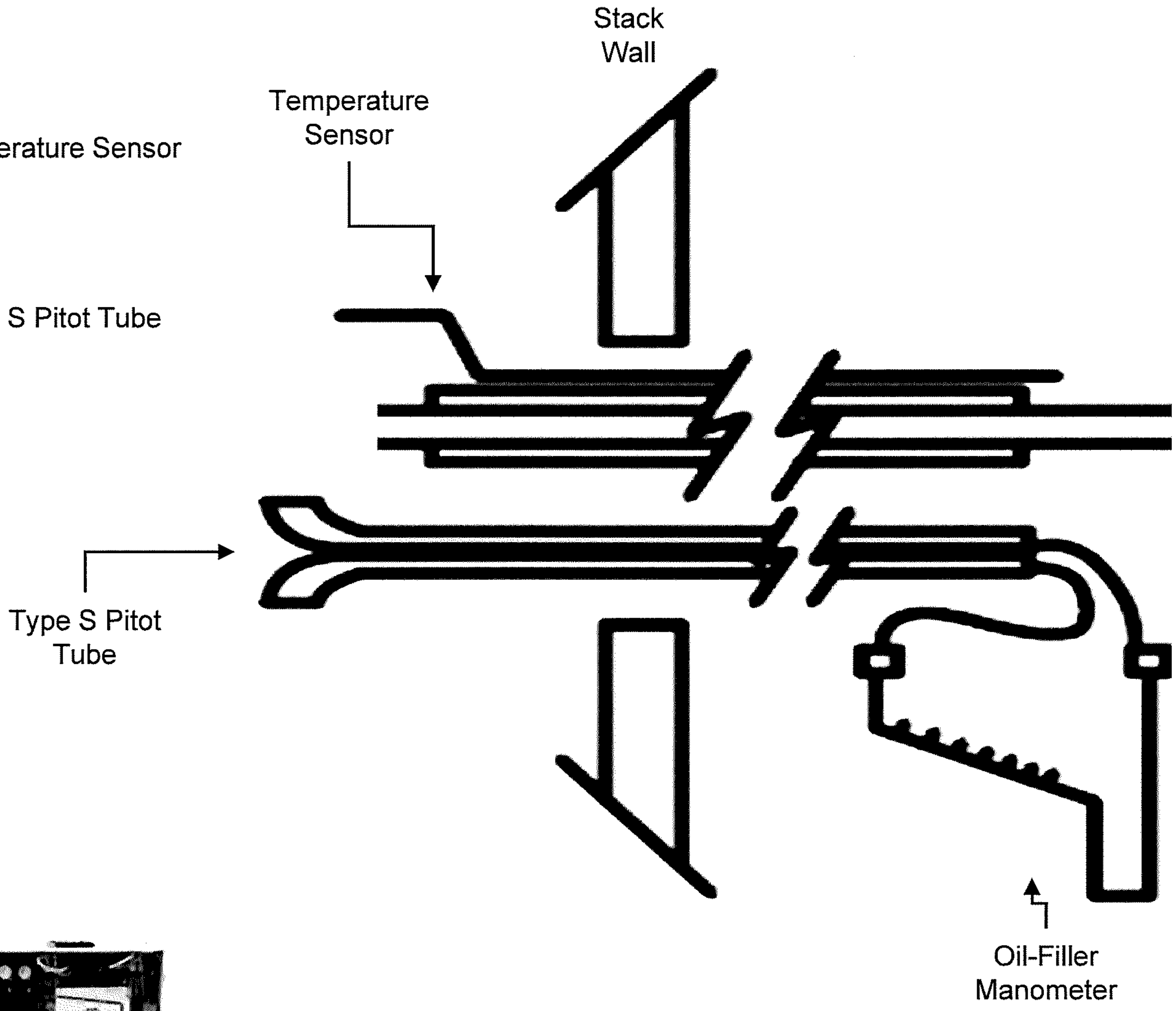

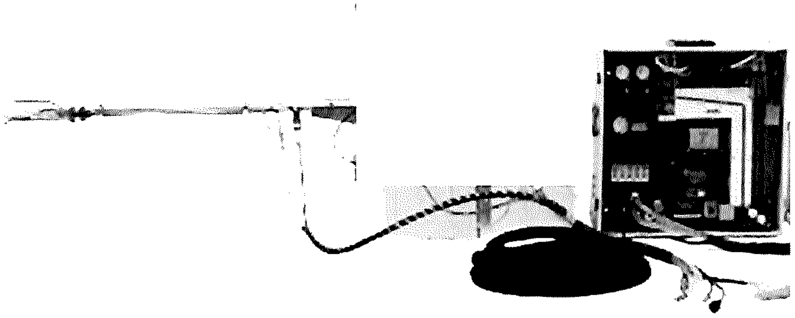

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Figure 4.2
FLOW ASSEMBLY

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APPENDIX A

TEST RESULTS AND CALCULATIONS

TABLE A.1: EMISSIONS TESTING SCHEDULE

Unit	Load	Component	Run	Date	Start	Stop	Time Sync	Duration
1	> 90%	Stratification Test	1	02/21/23	11:18	11:48	DAHS	00:31
1	> 90%	NOx, CO, VOC, NH_3	1-1	02/21/23	12:18	13:17	DAHS	01:00
1	> 90%	NOx, CO, VOC, NH_3	1-2	02/21/23	13:28	14:27	DAHS	01:00
1	> 90%	NOx, CO, VOC, NH_3	1-3	02/21/23	14:39	15:38	DAHS	01:00
1	> 90%	Flow	Flow-U1-V1	02/21/23	12:20	12:35	DAHS	00:15
1	> 90%	Flow	Flow-U1-V2	02/21/23	13:30	13:40	DAHS	00:10
1	> 90%	Flow	Flow-U1-V3	02/21/23	14:40	14:51	DAHS	00:11
2	> 90%	Stratification Test	1	02/16/23	13:53	14:29	DAHS	00:36
2	> 90%	NOx, CO, VOC, NH_3	1-1	02/16/23	14:36	15:35	DAHS	01:00
2	> 90%	NOx, CO, VOC, NH_3	1-2	02/16/23	15:44	16:43	DAHS	01:00
2	> 90%	NOx, CO, VOC, NH_3	1-3	02/16/23	16:55	17:54	DAHS	01:00
2	> 90%	Flow	Flow-U2-V1	02/16/23	14:42	14:59	DAHS	00:17
2	> 90%	Flow	Flow-U2-V2	02/16/23	15:37	15:49	DAHS	00:12
2	> 90%	Flow	Flow-U2-V3	02/16/23	16:49	17:02	DAHS	00:13
3	> 90%	Stratification Test	1	02/20/23	13:14	13:45	DAHS	00:32
3	> 90%	NOx, CO, VOC, NH_3	1-1	02/20/23	18:17	19:16	DAHS	01:00
3	> 90%	NOx, CO, VOC, NH_3	1-2	02/20/23	19:29	20:28	DAHS	01:00
3	> 90%	NOx, CO, VOC, NH_3	1-3	02/20/23	20:43	21:42	DAHS	01:00
3	> 90%	Flow	Flow-U3-V1	02/20/23	18:17	18:30	DAHS	00:13
3	> 90%	Flow	Flow-U3-V2	02/20/23	19:29	19:39	DAHS	00:10
3	> 90%	Flow	Flow-U3-V3	02/20/23	20:43	20:53	DAHS	00:10
4	> 90%	Stratification Test	1	02/18/23	17:17	17:48	DAHS	00:32
4	> 90%	NOx, CO, VOC, NH_3	1-1	02/18/23	18:40	19:39	DAHS	01:00
4	> 90%	NOx, CO, VOC, NH_3	1-2	02/18/23	19:57	20:56	DAHS	01:00
4	> 90%	NOx, CO, VOC, NH_3	1-3	02/18/23	21:10	22:09	DAHS	01:00
4	> 90%	Flow	Flow-U4-V1	02/18/23	18:26	18:42	DAHS	00:16
4	> 90%	Flow	Flow-U4-V2	02/18/23	20:12	20:27	DAHS	00:15
4	> 90%	Flow	Flow-U4-V3	02/18/23	21:20	21:35	DAHS	00:15
5	> 90%	Stratification Test	1	02/19/23	09:53	10:39	DAHS	00:46
5	> 90%	NOx, CO, VOC, NH_3	1-1	02/19/23	12:34	13:33	DAHS	01:00
5	> 90%	NOx, CO, VOC, NH_3	1-2	02/19/23	15:46	16:45	DAHS	01:00
5	> 90%	NOx, CO, VOC, NH_3	1-3	02/19/23	17:43	18:42	DAHS	01:00
5	> 90%	Flow	Flow-U5-V1	02/19/23	12:15	12:30	DAHS	00:15
5	> 90%	Flow	Flow-U5-V2	02/19/23	16:10	16:20	DAHS	00:10
5	> 90%	Flow	Flow-U5-V3	02/19/23	17:00	17:15	DAHS	00:15
6	> 90%	Stratification Test	1	02/15/23	13:44	14:22	DAHS	00:38
6	> 90%	NOx, CO, VOC, NH_3	1-1	02/15/23	16:51	17:50	DAHS	01:00
6	> 90%	NOx, CO, VOC, NH_3	1-2	02/15/23	18:02	19:01	DAHS	01:00
6	> 90%	NOx, CO, VOC, NH_3	1-3	02/15/23	19:07	20:06	DAHS	01:00
6	> 90%	Flow	Flow-U5-V1	02/15/23	16:33	16:47	DAHS	00:14
6	> 90%	Flow	Flow-U5-V2	02/15/23	18:27	18:40	DAHS	00:13
6	> 90%	Flow	Flow-U5-V3	02/15/23	19:15	19:27	DAHS	00:12

TEST RESULTS AND CALCULATIONS

Unit #1 Emissions Data

SIEMENS, SGE-56SL, UNIT #EUGEN1, SERIAL #A9B0018 ≥90% LOAD DATA SUMMARY

Parameter	≥90% Load, Run - 1-1	≥90% Load, Run - 1-2	≥90% Load, Run - 1-3	Average
Date (mm/dd/yy)	02/21/23	02/21/23	02/21/23	02/21/23
Start Time (hh:mm:ss)	12:18:22	13:28:23	14:39:24	12:18:22
End Time (hh:mm:ss)	13:17:52	14:27:53	15:38:54	15:38:54
Run Duration (min / run)	60	60	60	60
Bar. Pressure (in. Hg)	29.05	28.98	29.00	29.01
Amb. Temp. (°F)	56	38	40	44
Rel. Humidity (%)	50	50	48	49
Spec. Humidity (lb water / lb air)	0.004859	0.002416	0.002548	0.003274
Power Output (kilowatts)	900.0	900.0	900.0	900.0
Stack Flow (M2) (DSCFH)	144,278	142,661	141,004	142,648
Stack Moisture (% Method 320)	11.1	11.2	11.2	11.2
NOx (ppmvd)	4.14	4.25	4.36	4.25
NOx (ppm@15%O_2)	1.99	2.04	2.09	2.04
NOx (g/hp*hr)	0.027	0.027	0.028	0.027
CO (ppmvd)	8.09	8.27	8.35	8.23
CO (ppm@15%O_2)	3.88	3.96	4.00	3.95
CO (g/hp*hr)	0.032	0.032	0.032	0.032
THC (as C_3H_8) (ppmvd)	406.51	410.20	405.26	407.32
THC (as C_3H_8) (ppm@15%O_2)	195.07	196.50	194.26	195.28
THC (as C_3H_8) (g/hp*hr)	2.518	2.512	2.453	2.494
CH_4 (ppmvd)	404.31	408.05	403.05	405.14
NMHC (as C_3H_8) (ppmvd)	2.20	2.15	2.21	2.18
NMHC (as C_3H_8) (ppm@15%O_2)	1.06	1.03	1.06	1.05
NMHC (as C_3H_8) (g/hp*hr)	0.014	0.013	0.013	0.013
NH_3 (ppmvd)	3.65	3.91	4.21	3.92
NH_3 (ppm@15%O_2)	1.75	1.88	2.02	1.88
NH_3 (g/hp*hr)	0.0087	0.0093	0.0099	0.0093
CO_2 (%)	6.88	6.87	6.88	6.88
O_2 (%)	8.60	8.58	8.59	8.59

RM 7E, (08-15-06), 12.1 Nomenclature. The terms used in the equations are defined as follows:

ACE = Analyzer calibration error, percent of calibration span.
B_{WS} = Moisture content of sample gas as measured by Method 4 or other approved method, percent/100.
C_{Avg} = Average unadjusted gas concentration indicated by data recorder for the test run.
C_D = Pollutant concentration adjusted to dry conditions.
C_{Dir} = Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode.
C_{Gas} = Average effluent gas concentration adjusted for bias.
C_M = Average of initial and final system calibration bias (or 2-point system calibration error) check responses for the upscale calibration gas.
C_{MA} = Actual concentration of the upscale calibration gas, ppmv.
C_O = Average of the initial and final system calibration bias (or 2-point system calibration error) check responses from the low-level (or zero) calibration gas.
C_S = Measured concentration of a calibration gas (low, mid, or high) when introduced in system calibration mode.
C_{SS} = Concentration of NOx measured in the spiked sample.
C_{Spike} = Concentration of NOx in the undiluted spike gas.
C_{Calc} = Calculated concentration of NOx in the spike gas diluted in the sample.
C_V = Manufacturer certified concentration of a calibration gas (low, mid, or high).
C_W = Pollutant concentration measured under moist sample conditions, wet basis.
CS = Calibration span.
D = Drift assessment, percent of calibration span.
E_p = The predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response.
Eff_{NO2} = NO_2 to NO converter efficiency, percent.
H = High calibration gas, designator.
L = Low calibration gas, designator.
M = Mid calibration gas, designator.
NOFinal = The average NO concentration observed with the analyzer in the NO mode during the converter efficiency test in Section 16.2.2.
NOxCorr = The NOx concentration corrected for the converter efficiency.
NOxFinal = The final NOx concentration observed during the converter efficiency test in Section 16.2.2.
NOxPeak = The highest NOx concentration observed during the converter efficiency test in Section 16.2.2.
Q_{Spike} = Flow rate of spike gas introduced in system calibration mode, L/min.
Q_{Total} = Total sample flow rate during the spike test, L/min.
R = Spike recovery, percent.
SB = System bias, percent of calibration span.
SB_i = Pre-run system bias, percent of calibration span.
SB_f = Post-run system bias, percent of calibration span.
SB / D_{Alt} = Alternative absolute difference criteria to pass bias and/or drift checks.
SCE = System calibration error, percent of calibration span.
SCE_i = Pre-run system calibration error, percent of calibration span.
SCE_{final} = Post-run system calibration error, percent of calibration span.
Z = Zero calibration gas, designator.

40CFR60.355(b)(1), (09-20-06), Nomenclature. The terms used in the equations are defined as follows:

P_r = reference combustor inlet absolute pressure at 101.3 kilopascals ambient pressure, mm Hg
P_o = observed combustor inlet absolute pressure at test, mm Hg
H_o = observed humidity of ambient air, g H_2O/g air
e = transcendental constant, 2.718
T_a = ambient temperature, K

Small Engine and FTIR Nomenclature. The terms used in the equations are defined as follows:

bhp = brake horsepower
hp = horsepower
Q_{sys} = system flow (lpm)
Q_m = matrix spike flow (lpm)

RM 19, (07-29-06), 12.1 Nomenclature. The terms used in the equations are defined as follows:

AdjFactor = Percent oxygen or carbon dioxide adjustment applied to a target pollutant
B_{wa} = Moisture fraction of ambient air, percent.
Btu = British thermal unit
$\%_C$ = Concentration of carbon from an ultimate analysis of fuel, weight percent.
$\%_{CO2d}$,$\%_{CO2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.
CIP / CDP = Combustor inlet pressure / compressor discharge pressure (mm Hg); note, some manufactures reference as PCD.
E = Pollutant emission rate, ng/J (lb/million Btu).
E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).
E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).
E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu).
E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).
E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).
E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).
E_d = Average pollutant rate for each sampling period (e.g.,24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (e.g., amount of fuel bunkered), ng/J (lb/million Btu).
E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu).
E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).
E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.
E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.
E_h = Hourly average pollutant, ng/J (lb/million Btu).
E_{hj} = Hourly arithmetic average pollutant rate for hour "j," ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.
EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.
Fc = Ratio of the volume of carbon dioxide produced to the gross calorific value of the fuel from Method 19
F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).
ft^3 = cubic feet
G = ideal gas conversion factor
(385.23 SCF/lb-mol at 68 deg F & 14.696 psia)
GCM = gross Btu per SCF (constant, compound based)
GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).
GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).
$\%_H$ = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.
H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).
H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).
$\%_{H2O}$ = Concentration of water from an ultimate analysis of fuel, weight percent.
H_r = Total numbers of hours in the performance test period (e.g., 720 hours for 30-day performance test period).
K = volume of combustion component per pound of component (constant)
K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].
K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].
K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].
K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].
K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].
K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].
K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].
K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].
K_{sulfur} = 2x10^4 Btu/wt%-MMBtu
K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].
lb = pound
ln = Natural log of indicated value.
L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).
$\%_N$ = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.
$M_{\%}$ = mole percent
mol = mole
MW = molecular weight (lb/lb-mol)
MW_{AIR} = molecular weight of air (28.9625 lb/lb-mole)[1]
NCM = net Btu per SCF (constant based on compound)
$\%_O$ = Concentration of oxygen from an ultimate analysis of fuel, weight percent.
$\%_{O2d}$, $\%_{O2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.
P_B = barometric pressure, in Hg
P_s = Potential SO2 emissions, percent.
$\%_S$ = Sulfur content of as-fired fuel lot, dry basis, weight percent.
S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).
$\%_{Sf}$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.
S(wt%) = weight percent of sulfur, per lab analysis by appropriate ASTM standard
S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).
S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).
$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.
SCF = standard cubic feet
SH = specific humidity, pounds of water per pound of air
$t_{0.95}$ = Values shown in Table 19-3 for the indicated number of data points n.
T_{amb} = ambient temperature, °F
W/D Factor = 1.0236 = conv. at 14.696 psia and
68 deg F (ref. Civil Eng. Ref. Manual, 7th Ed.)
X_{CO2}=CO_2 Correction factor, percent.
X_k = Fraction of total heat input from each type of fuel k.

Calculations, Formulas, and Constants

The following information supports the spreadsheets for this testing project.

Given Data:

Ideal Gas Conversion Factor = 385.23 SCF/lb-mol at 68 deg F & 14.696 psia

Fuel Heating Value is based upon Air Hygiene's fuel gas calculation sheet. All calculations are based upon a correction to 68 deg F & 14.696 psia

High Heating Values (HHV) are used for the Fuel Heating Value, F-Factor, and Fuel Flow Data per EPA requirements.

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Molecular Weight of NOx (lb/lb-mole) = 46.01
Molecular Weight of CO (lb/lb-mole) = 28.00
Molecular Weight of SO_2 (lb/lb-mole) = 64.00
Molecular Weight of THC (propane) (lb/lb-mole) = 44.00
Molecular Weight of VOC (methane) (lb/lb-mole) = 16.00
Molecular Weight of NH_3 (lb/lb-mole) = 17.03
Molecular Weight of HCHO (lb/lb-mole) = 30.03
Molecular Weight of CO_2 (lb/lb-mole) = 44.01

40CFR60, App. A., RM 19, Table 19-1

Conversion Constant for NOx = 0.0000001194351
Conversion Constant for CO = 0.0000000726839
Conversion Constant for SO_2 = 0.0000001661345
Conversion Constant for THC = 0.0000001142175
Conversion Constant for VOC (methane) = 0.0000000415336
Conversion Constant for NH_3 = 0.0000000442074
Conversion Constant for HCHO = 0.0000000779534
Conversion Constant for CO_2 = 0.0000001142434

NOTE: units are lb/ppm*ft^3

Formulas:

1. Corrected Raw Average (C_{Gas}), 40CFR60, App. A, RM 7E, Eq. 7E-5 (08/15/06)

$$C_{Gas} = \left(C_{Avg} - C_O\right) \times \left(\frac{C_{MA}}{C_M - C_O}\right)$$

2. Correction to % O_2, 40CFR60, App. A, RM 20, Eq. 20-5 (11/26/02)

$$C_{adj} = C_{Gas(Target)} \times \left(\frac{20.9\% - AdjFactor}{20.9\% - C_{Gas(O2)}}\right)$$

3. Correction to % O_2 and ISO Conditions

$$C_{ISO} = C_{Adj} \times \sqrt{\frac{P_r}{P_o}} \times e^{(19\times(H_o - 0.00633))} \times \left(\frac{288}{T_a}\right)^{1.53}$$

4. Method 19 stack exhaust flow (scfh) [ref. EPA EMC FAQ Method 19]

$$Q_S = \left(\frac{FFactor \times Q_f \times HHV}{1{,}000{,}000}\right) \times \left(\frac{20.9\%}{20.9\% - C_{Gas(O2)}}\right)$$

5. Emission Rate in lb/hr

$$E_{lb/hr} = \frac{C_{Gas}}{10^6} \times \frac{Q_S \times MW}{G}$$

6. Emission Rate in tons per year

$$E_{ton/yr} = \frac{E_{lb/hr} \times hr_{year}}{2000}$$

7. Emission Concentration in lb/MMBtu (O_2 based)

$$E_{lb/MMBtu} = \frac{C_{Gas} \times F_d Factor \times Conv_C \times 20.9\%}{20.9\% - C_{Gas(O2)}}$$

8. Emission Concentration in g/hp*hr

$$E_{g/hp\cdot hr} = \frac{E_{lb/hr} \times 453.6}{mw \times 1341.022} \text{ or } \frac{E_{lb/hr} \times 453.6}{hp}$$

Nomenclature

- $\%CO$ = carbon monoxide concentration (%)
- $\%CO_2$ = carbon dioxide concentration (%)
- $\%N_2$ = nitrogen concentration (%)
- $\%O_2$ = oxygen concentration (%)
- $\%O_{2,wet}$ = Oxygen content of gas stream, % by volume of wet gas. (Note: The oxygen percentage used in Method 201A, Equation 3 is on a wet gas basis. That means that since oxygen is typically measured on a dry gas basis, the measured percent O2 must be multiplied by the quantity (1 - B_{ws}) to convert to the actual volume fraction. Therefore, $\%O_{2,wet} = (1 - B_{ws}) * \%O_{2,\,dry}$)
- $(\%EA)_{avg}$ = average excess air (%)
- $(F_o)_{avg}$ = average calculated fuel factor
- $[(\Delta p)^{0.5}]_{avg}$ = Average of square roots of the velocity pressures measured during the preliminary traverse, inches W.C.
- μ = Gas viscosity, micropoise
- 12.0 = Constant calculated as 60 percent of 20.5 square inch cross-sectional area of combined cyclone head, square inches
- 17.03 = mg/milliequivalents for ammonium ion
- 22.4 = liters of ideal gas per lb-mol of substance at 0^oC and 1 atm (ref. Civil Engineering Reference Manual, 7th ed. - Michael R. Lindeburg)
- 24.04 = liters of ideal gas per lb-mol of substance at 20^oC and 1 atm (ref. Civil Engineering Reference Manual, 7th ed. - Michael R. Lindeburg)
- 5.02×10^4 = constant derived from the molecular weight and correcting standard temperature and pressure (ref. Bay Area Air Quality Management District, Source Test Procedure ST-1B, Ammonia Integrated Sampling, Adopted January 20, 1982, Regulation 7-303)
- A = distance upstream (in.)
- A_D = stack diameters upstream (dia.)
- An = Area of nozzle, square feet
- A_s = area of stack (ft^2)
- B = distance downstream (in.)
- B_D = stack diameters downstream (dia.)
- b_f = Average blockage factor calculated in Equation 26, dimensionless
- B_{wm} = meter moisture content (%)
- B_{ws} = stack moisture content (%)
- C = Cunningham correction factor for particle diameter, Dp, and calculated using the actual stack gas temperature, dimensionless
- C_1 = -150.3162 (micropoise)
- C_2 = 18.0614 (micropoise/$K^{0.5}$) = 13.4622 (micropoise/$R^{0.5}$)
- $C_3 = 1.19183 \times 10^6$ (micropoise/K^2) = 3.86153×10^6 (micropoise/R^2)
- C_4 = 0.591123 (micropoise)
- C_5 = 91.9723 (micropoise)
- $C_6 = 4.91705 \times 10^{-5}$ (micropoise/K^2) = 1.51761×10^{-5} (micropoise/R^2)
- C_a = Acetone blank concentration, mg/mg
- C_b = Concentration of NH3 ion in the back half of train (breakthrough)
- C_f = Concentration of NH3 ion in the front half of train (main catch)
- C_{fPM10} = Conc. of filterable PM_{10}, gr/dscf
- $C_{fPM2.5}$ = Conc. of filterable $PM_{2.5}$, gr/dscf
- C_k = K Factor Constant, 849.8

Nomenclature

- C_n = nozzle diameter constant, 0.03575
- C_p' = Coefficient for the pitot used in the preliminary traverse, dimensionless
- C_p = Pitot coefficient for the combined cyclone pitot, dimensionless
- C_{cpm} = Concentration of the condensable PM in the stack gas, dry basis, corrected to standard conditions, milligrams/dry standard cubic foot.
- C_r = Re-estimated Cunningham correction factor for particle diameter equivalent to the actual cut size diameter and calculated using the actual stack gas temperature, dimensionless
- D_{50} = Particle cut diameter, micrometers
- $D_{50(N+1)}$ = D_{50} value for cyclone IV calculated during the N+1 iterative step, micrometers
- D_{50-1} = Re-calculated particle cut diameters based on re-estimated C_r, micrometers
- D_{50LL} = Cut diameter for cyclone I corresponding to the 2.25 micrometer cut diameter for cyclone IV, micrometer
- D_{50N} = D_{50} value for cyclone IV calculated during the Nth iterative step, micrometers
- D_{50T} = Cyclone I cut diameter corresponding to the middle of the overlap zone shown in Method 201A, Figure 10 of Section 17, micrometers
- D_e = equivalent stack diameter (in.)
- $\Delta H@$ = ΔH @ 0.75 scfm (in. H2O)
- ΔH_{avg} = average orifice pressure (in. H_2O)
- D_n = Inner diameter of sampling nozzle mounted on Cyclone I, inches
- D_{na} = actual nozzle diameter (in.)
- D_p = Physical particle size, micrometers
- Δp = velocity head (in. H_2O)
- Δp_1 = velocity head at first current traverse point (in. H_2O)
- $\Delta p'_1$ = velocity head at first preliminary traverse point (in. H_2O)
- Δp_{avg} = average pitot tube differential pressure (in. H_2O)
- Δp_n = velocity head at subsequent current traverse point (in. H_2O)
- Δp_{RM2} = method 2 velocity head (in. H_2O)
- D_s = diameter of stack (in.)
- F_d = fuel f-factor (dscf/MMBtu)
- f_{O2} = stack gas fraction of O_2, by volume, dry basis
- I = Percent isokinetic sampling, dimensionless
- K_1 = standard volume correction, 17.65°R/in. Hg
- K_4 = isokinetic conversion constant, 0.0945min•in.Hg/sec•°R
- K_5 = water mass to std water vapor, 0.04715 ft^3/g
- K_p = 85.49, ((ft/sec)/(pounds/mole -°R))
- L = length of stack (in.)
- L_{fw} = distance to far wall of stack (in.)
- L_{nw} = distance to near wall of stack (in.) [reference]
- $m_{\#x}$ = weight measurements (g)
- M_1 = Milligrams of PM collected on the filter, less than or equal to 2.5 micrometers
- M_2 = Milligrams of PM recovered from Container #2 (acetone blank corrected), greater than 10 micrometers
- M_3 = Milligrams of PM recovered from Container #3 (acetone blank corrected), less than or equal to 10 and greater than 2.5 micrometers
- M_4 = Milligrams of PM recovered from Container #4 (acetone blank corrected), less than or equal to 2.5 micrometers

Nomenclature

- m_a = Mass of residue of acetone after evaporation, mg
- m_c = Mass of the NH4+ added to sample to form ammonium sulfate, mg
- m_{cpm} = Mass of the total condensable PM, mg
- M_d = Molecular weight of dry gas, pounds/pound mole
- m_{fb} = Mass of total CPM in field train recovery blank, mg
- m_{fx} = final weight, avg of last two measurements (g)
- mg = Milligram
- mg/L = Milligram per liter
- m_i = Mass of inorganic CPM, mg
- m_{ib} = Mass of inorganic CPM in field train recovery blank, mg
- M_n = total particulates (mg)
- m_o = Mass of organic CPM, mg
- m_{ob} = Mass of organic CPM in field train blank, mg
- m_r = Mass of dried sample from inorganic fraction, mg
- m_{tx} = tare weight (g)
- MW = molecular weight (lb/lb-mole)
- M_w = Molecular weight of wet gas, pounds/pound mole
- N = Normality of ammonium hydroxide titrant
- N_a = null angle (deg.)
- N_{re} = Reynolds number, dimensionless
- N_{tp} = Number of iterative steps or total traverse points
- P_b = P_{bar} = barometric pressure (in. Hg)
- P_{bar} = barometric pressure (in. Hg)
- ppmCO = carbon monoxide concentration (ppm)
- ppmv = Parts per million by volume
- ppmw = Parts per million by weight
- P_s = absolute stack pressure (in. Hg)
- P_{static} = static pressure (in. H_2O)
- P_{std} = standard pressure, 29.92 in. Hg
- Θ = total sampling time (min)
- Q_{aw} = average stack wet flow rate (ascf/min)
- Q_I = Sampling rate for cyclone I to achieve specified D_{50}
- Q_m = estimated orifice flow rate, 0.750 acfm, else Vm/Q from previous run
- Q_s = Sampling rate for cyclone I to achieve specified D_{50}
- $Q_{s(std)}$ = total cyclone flow rate at standard conditions (dscf/min)
- Q_{sd} = dry standard stack flow rate (dscfm)
- Q_{sST} = Dry gas sampling rate through the sampling assembly, dscfm
- Q_{sw} = wet standard stack flow rate (ascfm)
- R_{max} = Nozzle/stack velocity ratio parameter, dimensionless
- R_{min} = Nozzle/stack velocity ratio parameter, dimensionless
- t_1 = Sampling time at point 1, min
- t_m = average gas meter temperature (^oF)
- t_m = average meter temperature (^oF)
- T_m = Meter box and orifice gas temperature, ^oR
- t_n = Sampling time at point n, min

Nomenclature

- t_r = Total projected run time, min
- T_s = Absolute stack gas temperature, °R
- T_{std} = standard temperature, 68°F, 528°R
- T_u = absolute temperature offset, 460°R
- V_a = Volume of acetone blank, ml
- V_{aw} = Volume of acetone used in sample recovery wash, ml
- V_b = Volume of aliquot taken for IC analysis, ml
- V_c = Quantity of water captured in impingers and silica gel, ml
- V_f = final impinger volume (ml)
- V_i = initial impinger volume (ml)
- V_{ic} = Volume of impinger contents sample, ml
- V_m = Dry gas meter volume sampled, acf
- $V_{m(std)}$ = standard meter volume (dscf)
- v_{max} = Maximum gas velocity calculated from Equations 18 or 19, ft/sec
- v_{max} = maximum nozzle velocity (ft/sec)
- V_{mf} = final dry gas meter reading (dcf)
- V_{mi} = initial dry gas meter reading (dcf)
- v_{min} = Minimum gas velocity calculated from Method 201A, Equations 16 or 17, ft/sec
- V_{ms} = Dry gas meter volume sampled, corrected to standard conditions, dscf
- v_n = Sample gas velocity in the nozzle, ft/sec
- v_{org} = organics wash volume (ml)
- V_p = Volume of water added during train purge
- v_s = average stack gas velocity (ft/sec)
- v_{sl} = local velocity (ft/sec)
- V_t = total impinger volume (ml) = ;(V_f-V_i)
- V_t = Volume of NH4OH titrant, ml
- $V_{w(std)}$ = volume of water vapor in gas sample at standard conditions (scf)
- v_x = blank volume (ml)
- W = width of stack (in.)
- $W_{2,3,4}$ = Weight of PM recovered from Containers #2, #3, and #4, mg
- W_a = Weight of blank residue in acetone used to recover samples, mg
- W_f = final impinger weight (g)
- W_i = initial impinger weight (g)
- W_t = total impinger weight (g) = ;(W_f-W_i)
- w_x = blank weight of solids (g)
- Y = meter calibration factor (a.k.a gamma)
- Z = Ratio between estimated cyclone IV D_{50} values, dimensionless
- γ = Dry gas meter gamma value, dimensionless
- ΔH = Meter box orifice pressure drop, inches W.C.
- $\Delta H@$ = Pressure drop across orifice at flow rate of 0.75 scfm at standard conditions, inches W.C.
  (Note: Specific to each orifice and meter box.)
- Δp_1 = Velocity pressure measured at point 1, inches W.C.
- Δp_{avg} = Average velocity pressure, inches W.C.
- Δp_m = Observed velocity pressure using S-type pitot tube in preliminary traverse, inches W.C.
- Δp_{max} = Maximum velocity pressure, inches W.C.

Nomenclature

- Δp_{min} = Minimum velocity pressure, inches W.C.
- Δp_n = Velocity pressure measured at point n during the test run, inches W.C.
- Δp_s = Velocity pressure calculated in Method 201a, Equation 25, inches W.C.
- Δp_{s1} = Velocity pressure adjusted for combined cyclone pitot tube, inches W.C.
- Δp_{s2} = Velocity pressure corrected for blockage, inches W.C.
- θ = Total run time, min
- ρ_a = Density of acetone, mg/ml (see label on bottle)
- Σ_n = total number of sampling points

EXAMPLE CALCULATIONS (Reference Method 1 - Circular Stack)

Diameter of Stack (in.)

$$D(in.) = L_{fw} - L_{nw}$$

D (in.) = 19.00 in. - 5.75 in. = 13.25 in.

Stack Diameters Downstream

$$B_D(dia.) = \frac{B}{D}$$

$$B_D \text{ (dia.)} = \frac{90.00 \text{ in.}}{13.25 \text{ in.}} = 6.79 \text{ diameters}$$

Area of Stack (ft^2)

$$A_s(ft^2) = \pi \times \left(\frac{D}{2 \times 12}\right)^2$$

$$A_s \text{ (ft}^2\text{)} = 3.14 \times \left(\frac{13.25 \text{ in.}}{2 \times 12\text{in./ft}}\right)^2 = 0.96 \text{ ft}^2$$

Stack Diameters Upstream

$$A_D(dia.) = \frac{A}{D}$$

$$A_D \text{ (dia.)} = \frac{62.50 \text{ in.}}{13.25 \text{ in.}} = 4.72 \text{ diameters}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Reference Method 3a) [Values from Preliminary test]

Carbon Monoxide Concentration (%)

$$\%CO = \frac{ppmCO}{10{,}000}$$

$$\%CO\ (\%) = \frac{8.09 \quad ppm}{10{,}000\ ppm/\%} = 0.0008 \quad \%$$

Nitrogen Concentration (%)

$$\%N_2 = 100 - \%CO_2 - \%O_2 - \%CO$$

$\%N_2$ (%) = 100 - 6.88 % - 8.60 % - 8.09 / 10,000 % = 84.52 %

Stack Dry Molecular Weight (lb/lb-mole)

$$M_d\,(lb/lb-mol) = \sum\left(\frac{MW_{comp}}{100} \times \%component\right)$$

$$M_d\ (lb/lb\text{-}mol) = \left(\frac{44\ lb/lb\text{-}mol}{100} \times 6.88 \quad \%\right) + \left(\frac{32\ lb/lb\text{-}mol}{100} \times 8.60 \quad \%\right) + \left(\frac{28\ lb/lb\text{-}mol}{100} \times \left[\frac{8.09}{10{,}000} + 84.52\right]\right) = \frac{29.44\ lb}{lb\text{-}mol}$$

Stack Wet Molecular Weight (lb/lb-mole)

$$M_S\,(lb/lb-mol) = \left[M_d \times \left(1 - \frac{B_{WS}}{100}\right)\right] + \left[MW_{H_2O} \times \frac{B_{WS}}{100}\right]$$

$$M_S\ (lb/lb\text{-}mol) = \left\{\frac{29.44\ lb}{lb\text{-}mol} \times \left(1 - \frac{11.14\ \%}{100}\right)\right\} + \left\{\frac{18\ lb}{lb\text{-}mol} \times \frac{11.14\ \%}{100}\right\} = \frac{28.17\ lb}{lb\text{-}mol}$$

Average Calculated Fuel Factor (F_o)

$$F_{o(avg)} = \frac{\left[20.9 - (\%O_2)_{avg} - \left(0.5 \times (\%CO)_{avg}\right)\right]}{(\%CO_2)_{avg} + (\%CO)_{avg}}$$

$$F_{o(avg)} = \frac{20.9\% - 8.60 \quad \% - (0.5 \times 0.001 \quad \%)}{6.88 \quad \% + 0.001 \quad \%} = 1.788$$

Average Excess Air (%)

$$\%EA_{avg}\,(\%) = \frac{100 \times \left[(\%O_2)_{avg} - \left(0.5 \times (\%CO)_{avg}\right)\right]}{\left(0.264 \times (N_2)_{avg}\right) - \left[(\%O_2)_{avg} - \left(0.5 \times (\%CO)_{avg}\right)\right]}$$

$$(\%EA)_{AVG} = \frac{100 \times \{\ 8.60 \quad \% - (0.5 \times 0.001 \quad \%)\ \}}{(0.264 \times 84.52 \quad \%) - \{\ 8.60 \quad \% - (0.5 \times 0.001 \quad \%)\}} = 62.77 \quad \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Reference Method 2) [Values from Preliminary test]

Absolute Stack Pressure (in. Hg)

$$P_s\,(in.Hg) = P_b + \frac{P_{static}}{13.6}$$

$$P_s \text{ (in. Hg)} = 29.05 \text{ in. Hg} + \frac{-0.47 \text{ in. } H_2O}{13.6 \text{ in. } H_2O\text{/in. Hg}} = 29.02 \text{ in. Hg}$$

Average Stack Gas Velocity (ft/sec)

$$v_s\,(ft/\sec) = K_p \times C_p \times \left(\sqrt{\Delta p}\right)_{avg} \times \sqrt{\frac{(t_s)_{avg} + T_u}{P_s \times M_s}}$$

v_{sl} (ft/sec) =

$$\left(\frac{85.49 \text{ ft} \quad \text{(lb/lb-mol)(in. Hg)}}{\text{sec} \quad (^{o}\text{R})(\text{in. } H_2O)}\right)^{1/2} \times 0.81 \times 0.96 \text{ in.}H_2O^{1/2} \times \sqrt{\frac{184.00 + 460\ ^{o}\text{R}}{29.02 \text{ in. Hg} \times 28.17 \text{ lb/lb-mol}}} = \frac{59.2 \text{ ft}}{\text{sec}}$$

Average Stack Dry Standard Flow Rate (dscfh)

$$Q_{sd}(dscfh) = \frac{60 \times 60 \times \left(1 - \frac{B_{ws}}{100}\right) \times v_s \times A_s \times T_{std} \times P_s}{(t_s + T_u) \times P_{std}}$$

$$Q_{sd} \text{ (dscf/hr)} = \frac{3600 \text{ sec}}{\text{hr}} \times \left(1 - \frac{11.14\ \%}{100}\right) \times \frac{59.24 \text{ ft}}{\text{sec}} \times 0.96 \text{ ft}^2 \times$$

$$\frac{68.00 + 460\ ^{o}\text{R}}{184.00 + 460\ ^{o}\text{R}} \times \frac{29.02 \text{ in. Hg}}{29.92 \text{ in. Hg}} = \frac{144{,}277.57 \text{ dscf}}{\text{hr}}$$

Average Stack Wet Flow Rate (acfm)

$$Q_{aw}(acfm) = 60 \times v_s \times A_s$$

$$Q_{aw} \text{ (acf/min)} = \frac{60 \text{ sec}}{\text{min}} \times \frac{59.24 \text{ ft}}{\text{sec}} \times 0.96 \text{ ft}^2 = \frac{3{,}403.33 \text{ acf}}{\text{min}}$$

Average Stack Wet Standard Flow Rate (ascfh)

$$Q_{sw}(ascfh) = \frac{60 \times Q_{aw} \times T_{std} \times P_s}{(t_s + T_u) \times P_{std}}$$

$$Q_{sw} \text{ (ascf/hr)} = \frac{60 \text{ min}}{\text{hr}} \times \frac{3{,}403.33 \text{ acf}}{\text{min}} \times$$

$$\frac{68.00 + 460\ ^{o}\text{R}}{184.00 + 460\ ^{o}\text{R}} \times \frac{29.02 \text{ in. Hg}}{29.92 \text{ in. Hg}} = \frac{162{,}356.99 \text{ ascf}}{\text{hr}}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (INFORMATION)

Specific Humidity (RH_{sp})

Note: RHsp (gr/lb) calculated using temperature, relative humidity, and barometric pressure with psychrometric chart, psychrometric calculator, or built in psychrometric algorithm.

$$RH_{sp}(lb/lb)=\left[\left(\frac{gr}{lb}\right)\times\frac{lb}{7000\ gr}\right]$$

$$RH_{sp}=\frac{34.02\ \text{gr}}{\text{lb}}\ \text{x}\ \frac{1\ \text{lb}}{7000\ \text{gr}}=0.004859\frac{\text{lb}\ H_2O}{\text{lb Air}}$$

EXAMPLE CALCULATIONS (CALIBRATION)

Analyzer Calibration Error

RM 7E, (02-27-14), 12.2 Analyzer Calibration Error. For non-dilution systems, use Equation 7E-1 to calculate the analyzer calibration error for the low-, mid-, and high-level calibration gases. (calc for NOx analyzer mid gas, if applicable)

$$ACE=\left(\frac{C_{Dir}-C_V}{CS}\right)\times 100$$

Eq. 7E-1

$$\text{ACE}=\frac{9.28\ \text{ppm}-8.87\ \text{ppm}}{18.10\ \text{ppm}}\ \text{x}\ 100=2.27\ \%$$

EXAMPLE CALCULATIONS (BIAS, DRIFT, AND CORRECTED RAW AVERAGE)

System Bias

RM 7E, (02-27-14), 12.3 System Bias. For non-dilution systems, use Equation 7E-2 to calculate the system bias separately for the low-level and upscale calibration gases. (calc for NOx analyzer upscale gas, Run 1 initial bias, if applicable)

$$SB=\left(\frac{C_S-C_{Dir}}{CS}\right)\times 100$$

Eq. 7E-2

$$\text{SB}=\frac{8.83\ \text{ppm}-9.28\ \text{ppm}}{18.10\ \text{ppm}}\ \text{x}\ 100=-2.49\ \%$$

Drift Assessment

RM 7E, (02-27-14), 12.5 Drift Assessment. Use Equation 7E-4 to separately calculate the low-level and upscale drift over each test run. (calc for NOx analyzer upscale drift, Run 1, if applicable)

$$D=\left|SB_{final}-SB_i\right|$$

Eq. 7E-4

$$\text{D}=\left|\ -2.38\ \%\ -\ -2.49\ \%\ \right|=0.11\ \%$$

Alternative Drift and Bias

RM 7E, (02-27-14), 13.2 / 13.3 System Bias and Drift. Alternatively, the results are acceptable if |Cs – Cdir| is ≤ 0.5 ppmv or if |Cs – Cv| is ≤ 0.5 ppmv (as applicable). (calc for NOx analyzer initial upscale, Run 1, if applicable)

$$SB/D_{Alt}=\left|C_S-C_{Dir}\right|$$

Eq. Section 13.2 and 13.3

$$\text{SB}/D_{Alt}=\left|\ 8.83\ \text{ppm}-9.28\ \text{ppm}\ \right|=0.45\ \text{ppm}$$

Bias Adjusted Average

RM 7E, (02-27-14), 12.6 Effluent Gas Concentration. For each test run, calculate Cavg, the arithmetic average of all valid NOx concentration values (e.g., 1-minute averages). Then adjust the value of Cavg for bias, using Equation 7E-5b. (calc for NOx analyzer, Run 1, if applicable)

$$C_{Gas}=\left(C_{Avg}-C_O\right)\times\left(\frac{C_{MA}}{C_M-C_O}\right)$$

Eq. 7E-5b

$$C_{Gas}=\left(4.25\ \text{ppm}-0.22\ \text{ppm}\right)\left(\frac{8.87\ \text{ppm}}{8.84\ \text{ppm}-0.22\ \text{ppm}}\right)=4.14\ \text{ppm}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (RUNS)

Moisture Correction

RM 7E, (02-27-14), 12.10 Moisture Correction. Use Equation 7E-10 if your measurements need to be corrected to a dry basis. (calc for NOx analyzer, Run 1, if applicable) Note: Calculations may not match as Run 1 results are typically also bias adjusted

$$C_W = C_D \times (1 - B_{WS})$$

$$C_D = \frac{C_W}{1 - B_{WS}}$$ Eq. 7E-10 $C_D = \frac{3.68 \text{ ppmvw}}{1 - 0.11} = 4.14$ ppmvd or inversely, $C_W = 4.14 \text{ ppmvd} \times \left(1 - 0.11\right) = 3.68$ ppmvw

Diluent-Corrected Pollutant Concentration, O_2 Based

RM 20, (11-26-02), 7.3.1 Correction of Pollutant Concentration Using O_2 Concentration. Calculate the O_2 corrected pollutant concentration, as follows: (calc for NOx gas, Run 1, if applicable) [now contained in applicable Subpart]

$$C_{adj} = C_{Gas(Target)} \times \left(\frac{20.9\% - AdjFactor}{20.9\% - C_{Gas(O2)}}\right)$$ Eq. 20-4 $C_{adj} = 4.14 \text{ ppm} \times \left(\frac{20.9\% - 15.00\ \%}{20.9\% - 8.60\ \%}\right) = 1.99$ ppm@15%O_2

Emissions Rate (lb/hr)

Calculation for pound per hour emission rate. Calculate, as follows: (calc for NOx gas Run 1, if applicable)

$$E_{lb/hr} = \frac{C_{Gas}}{10^6} \times \frac{Q_S \times MW}{G}$$

$$E_{lb/hr} = \frac{4.14 \text{ ppmvd}}{10^6 \text{ ppm/part}} \times \frac{144{,}278 \text{ DSCFH} \times 46.01 \text{ lb/lb-mol}}{385.23 \text{ SCF/lb-mol}} = \frac{0.07 \text{ lb}}{\text{hr}}$$

Emissions Rate (g/hp-hr)

Calculation for grams per horsepower-hour. Calculate, as follows: (calc for NOx gas Run 1, if applicable)

$$E_{g/hp\text{-}hr} = \frac{E_{lb/hr} \times 453.6}{mw \times 1341.022} \text{ or } \frac{E_{lb/hr} \times 453.6}{hp}$$

$$E_{g/hp\text{-}hr} = \frac{0.07 \text{ lb}}{\text{hr}} \times \frac{453.6 \text{ g}}{\text{lb}} \times \frac{1}{0.90 \text{ mw}} \times \frac{\text{mw}}{1341.022 \text{ hp}} = \frac{0.03 \text{ g}}{\text{hp*hr}}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

Method 320 Equation 3, Dilution Factor (DF)

(example calculation for Pre-Trial, where applicable)

$$DF = \frac{SF_{6\,(spk)}}{SF_{6\,(dir)}} = \frac{(SF_{6\,(spk+native)} - SF_{6\,(native)})}{SF_{6\,(dir)}}\ OR\ \frac{(CO_{2(native)} - CO_{2(spk+native)})}{CO_{2(native)}}$$

$$DF\ (SF_6) = \frac{0.8416\ -\ 0.0120\ \text{ppmvw}}{9.99\ \text{ppmvw}} = \quad 0.0830$$

Test Method 320, Section 9.0 Quality Control

Where,

$SF_{6(dir)}$ = SF_6 (or tracer gas) concentration measured directly in undiluted spike gas

$SF_{6(spk)}$ = Diluted SF_6 (or tracer gas) concentration measured in a spiked sample

$SF_{6(spk)} = SF_{6(spk+native)} - SF_{6(native)}$

$SF_{6(spk+native)}$ = Diluted SF_6 (or tracer gas) concentration measured in a spiked sample in stack gas

$SF_{6(native)}$ = SF_6 (or tracer gas) concentration measured in a native stack gas sample

Dilution Factor Ratio

(example calculation for Pre-Trial, where applicable)

$$DF\ Ratio = \frac{SF_{6\,(dir)}}{SF_{6\,(spk)}} = \frac{SF_{6\,(dir)}}{(SF_{6\,(spk+native)} - SF_{6\,(native)})}\ OR\ \frac{CO_{2(native)}}{CO_{2(native)} - CO_{2(spk+native}} \geq 10$$

$$DF\ Ratio = \frac{9.99\ \text{ppmvw}}{0.8416\ -\ 0.0120\ \text{ppmvw}} =$$

Spike Ratio = 12.0 : 1 ≥ 10

Unspike = Native concentration of analytes in unspiked samples

$Spike_{dir}$ = Concentration of the analyte in the spike standard measured by filling the FTIR cell directly

Method 320 Equation 4 [Method 321 Equation 2], Excepted Concentration of the Spiked Samples

Ideal Spike Yield

(example calculation for Pre-Trial (SF_6), where applicable)

$$CS = DF \times Spike_{dir} + Unspike\ (1 - DF)$$

$$CS = 0.0830 \times 9.9925\ \text{ppmvw} + 0.0120\ \text{ppmvw} \times \left(1 - 0.0830\right) = 0.8406\ \text{ppmvw}$$

Method 320 Spiked vs Expected

$$Spiked\ vs\ Expected = \frac{Actual\ Spike\ Yield}{Ideal\ Spike\ Yield} \times 100$$

(example calculation for Pre-Trial (SF_6), where applicable)

$$\%\ Recovery = \frac{0.8416\ \text{ppmvw}}{0.8406\ \text{ppmvw}} \times 100 = 100.118\ \%$$

Method 320 Equation 4 [Method 321 Equation 2], Excepted Concentration of the Spiked Samples

Ideal Spike Yield

(example calculation for Pre-Trial (NH_3), where applicable)

$$CS = DF \times Spike_{dir} + Unspike\ (1 - DF)$$

$$CS = 0.0830 \times 47.6968\ \text{ppmvw} + 2.5519\ \text{ppmvw} \times \left(1 - 0.0830\right) = 6.3001\ \text{ppmvw}$$

Method 320 Spiked vs Expected

$$Spiked\ vs\ Expected = \frac{Actual\ Spike\ Yield}{Ideal\ Spike\ Yield} \times 100$$

(example calculation for Pre-Trial (NH_3), where applicable)

$$\%\ Recovery = \frac{7.1369\ \text{ppmvw}}{6.3001\ \text{ppmvw}} \times 100 = 113.283\ \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

Method 320 Equation 3, Dilution Factor (DF)

(example calculation for Post-Trial, where applicable)

$$DF = \frac{SF_{6\,(spk)}}{SF_{6\,(dir)}} = \frac{(SF_{6\,(spk+native)} - SF_{6\,(native)})}{SF_{6\,(dir)}}\ OR\ \frac{(CO_{2(native)} - CO_{2(spk+native)})}{CO_{2(native)}}$$

$$DF\ (SF_6) = \frac{0.8318 \quad - \quad 0.0133 \quad ppmvw}{9.99 \quad ppmvw} = 0.0819$$

Test Method 320, Section 9.0 Quality Control

Where,

$SF_{6(dir)}$ = SF_6 (or tracer gas) concentration measured directly in undiluted spike gas

$SF_{6(spk)}$ = Diluted SF_6 (or tracer gas) concentration measured in a spiked sample

$SF_{6(spk)} = SF_{6(spk+native)} - SF_{6(native)}$

$SF_{6(spk+native)}$ = Diluted SF_6 (or tracer gas) concentration measured in a spiked sample in stack gas

$SF_{6(native)}$ = SF_6 (or tracer gas) concentration measured in a native stack gas sample

Dilution Factor Ratio

(example calculation for Post-Trial, where applicable)

$$DF\ Ratio = \frac{SF_{6\,(dir)}}{SF_{6\,(spk)}} = \frac{SF_{6\,(dir)}}{(SF_{6\,(spk+native)} - SF_{6\,(native)})}\ OR\ \frac{CO_{2(native)}}{CO_{2(native)} - CO_{2(spk+native}} \geq 10$$

$$\text{DF Ratio} = \frac{9.99 \quad ppmvw}{0.8318 \quad - \quad 0.0133 \quad ppmvw} =$$

Spike Ratio = 12.2 : 1 ≥ 10

Unspike = Native concentration of analytes in unspiked samples

$Spike_{dir}$ = Concentration of the analyte in the spike standard measured by filling the FTIR cell directly

Method 320 Equation 4 [Method 321 Equation 2], Excepted Concentration of the Spiked Samples

Ideal Spike Yield

(example calculation for Post-Trial (SF_6), where applicable)

$$CS = DF \times Spike_{dir} + Unspike\ (1 - DF)$$

$$CS = 0.0819 \quad X \quad 9.9925 \quad ppmvw \quad + \quad 0.0133 \quad ppmvw \quad X \left(1 - \quad 0.0819\right) = \quad 0.8307 \quad ppmvw$$

Method 320 Spiked vs Expected

$$Spiked\ vs\ Expected = \frac{Actual\ Spike\ Yield}{Ideal\ Spike\ Yield} \times 100$$

(example calculation for Post-Trial (SF_6), where applicable)

$$\%\ Recovery = \frac{0.8318 \quad ppmvw}{0.8307 \quad ppmvw} \times 100 = \quad 100.131 \quad \%$$

Method 320 Equation 4 [Method 321 Equation 2], Excepted Concentration of the Spiked Samples

Ideal Spike Yield

(example calculation for Post-Trial (NH_3), where applicable)

$$CS = DF \times Spike_{dir} + Unspike\ (1 - DF)$$

$$CS = 0.0819 \quad X \quad 47.6968 \quad ppmvw \quad + \quad 3.9577 \quad ppmvw \quad X \left(1 - \quad 0.0819\right) = \quad 7.5405 \quad ppmvw$$

Method 320 Spiked vs Expected

$$Spiked\ vs\ Expected = \frac{Actual\ Spike\ Yield}{Ideal\ Spike\ Yield} \times 100$$

(example calculation for Post-Trial (NH_3), where applicable)

$$\%\ Recovery = \frac{8.2625 \quad ppmvw}{7.5405 \quad ppmvw} \times 100 = \quad 109.575 \quad \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

TEST RESULTS AND CALCULATIONS

Unit #2 Emissions Data

SIEMENS, SGE-56SL, UNIT #EUGEN2, SERIAL #A9C0007 ≥90% LOAD DATA SUMMARY

Parameter	≥90% Load, Run - 1-1	≥90% Load, Run - 1-2	≥90% Load, Run - 1-3	Average
Date (mm/dd/yy)	02/16/23	02/16/23	02/16/23	02/16/23
Start Time (hh:mm:ss)	14:36:23	15:44:23	16:55:28	14:36:23
End Time (hh:mm:ss)	15:35:53	16:43:53	17:54:58	17:54:58
Run Duration (min / run)	60	60	60	60
Bar. Pressure (in. Hg)	29.17	29.13	29.08	29.13
Amb. Temp. (°F)	37	33	31	34
Rel. Humidity (%)	71	77	90	79
Spec. Humidity (lb water / lb air)	0.003354	0.003105	0.003332	0.003264
Power Output (kilowatts)	920.0	900.0	900.0	906.7
Stack Flow (M2) (DSCFH)	136,843	136,618	136,067	136,509
Stack Moisture (% Method 320)	11.2	11.4	11.4	11.3
NOx (ppmvd)	7.35	7.62	7.84	7.60
NOx (ppm@15%O_2)	3.53	3.65	3.76	3.65
NOx (g/hp*hr)	0.044	0.047	0.048	0.046
CO (ppmvd)	0.09	0.11	0.13	0.11
CO (ppm@15%O_2)	0.05	0.05	0.06	0.05
CO (g/hp*hr)	0.000	0.000	0.000	0.000
THC (as C_3H_8) (ppmvd)	362.74	356.82	346.26	355.27
THC (as C_3H_8) (ppm@15%O_2)	173.90	170.94	166.07	170.30
THC (as C_3H_8) (g/hp*hr)	2.084	2.093	2.022	2.067
CH_4 (ppmvd)	361.15	355.16	344.61	353.64
NMHC (as C_3H_8) (ppmvd)	1.59	1.66	1.66	1.64
NMHC (as C_3H_8) (ppm@15%O_2)	0.76	0.80	0.80	0.78
NMHC (as C_3H_8) (g/hp*hr)	0.009	0.010	0.010	0.010
NH_3 (ppmvd)	4.56	4.69	4.50	4.59
NH_3 (ppm@15%O_2)	2.19	2.25	2.16	2.20
NH_3 (g/hp*hr)	0.0102	0.0106	0.0102	0.0103
CO_2 (%)	6.63	6.82	6.79	6.74
O_2 (%)	8.59	8.58	8.60	8.59

TEST RESULTS AND CALCULATIONS

Unit #3 Emissions Data

SIEMENS, SGE-56SL, UNIT #EUGEN3, SERIAL #A9A0027 ≥90% LOAD DATA SUMMARY

Parameter	≥90% Load, Run - 1-1	≥90% Load, Run - 1-2	≥90% Load, Run - 1-3	Average
Date (mm/dd/yy)	02/20/23	02/20/23	02/20/23	02/20/23
Start Time (hh:mm:ss)	18:17:24	19:29:24	20:43:24	18:17:24
End Time (hh:mm:ss)	19:16:54	20:28:54	21:42:54	21:42:54
Run Duration (min / run)	60	60	60	60
Bar. Pressure (in. Hg)	29.00	28.99	28.96	28.98
Amb. Temp. (°F)	41	38	35	38
Rel. Humidity (%)	47	51	70	56
Spec. Humidity (lb water / lb air)	0.002572	0.002533	0.003072	0.002726
Power Output (kilowatts)	900.0	900.0	900.0	900.0
Stack Flow (M2) (DSCFH)	98,233	100,535	102,152	100,307
Stack Moisture (% Method 320)	11.5	11.4	11.4	11.4
NOx (ppmvd)	25.62	24.89	24.97	25.16
NOx (ppm@15%O_2)	12.13	11.78	11.80	11.90
NOx (g/hp*hr)	0.113	0.112	0.114	0.113
CO (ppmvd)	4.73	4.72	4.72	4.72
CO (ppm@15%O_2)	2.24	2.23	2.23	2.23
CO (g/hp*hr)	0.013	0.013	0.013	0.013
THC (as C_3H_8) (ppmvd)	384.13	382.87	384.30	383.77
THC (as C_3H_8) (ppm@15%O_2)	181.89	181.16	181.56	181.54
THC (as C_3H_8) (g/hp*hr)	1.620	1.652	1.685	1.652
CH_4 (ppmvd)	355.72	354.41	355.92	355.35
NMHC (as C_3H_8) (ppmvd)	28.41	28.46	28.39	28.42
NMHC (as C_3H_8) (ppm@15%O_2)	13.45	13.47	13.41	13.44
NMHC (as C_3H_8) (g/hp*hr)	0.120	0.123	0.124	0.122
NH_3 (ppmvd)	6.48	6.86	6.99	6.78
NH_3 (ppm@15%O_2)	3.07	3.25	3.30	3.21
NH_3 (g/hp*hr)	0.0106	0.0115	0.0119	0.0113
CO_2 (%)	6.88	6.88	6.89	6.88
O_2 (%)	8.44	8.43	8.41	8.43

TEST RESULTS AND CALCULATIONS

Unit #4 Emissions Data

SIEMENS, SGE-56SL, UNIT #EUGEN4, SERIAL #A9B0001 ≥90% LOAD DATA SUMMARY

Parameter	≥90% Load, Run - 1-1	≥90% Load, Run - 1-2	≥90% Load, Run - 1-3	Average
Date (mm/dd/yy)	02/18/23	02/18/23	02/18/23	02/18/23
Start Time (hh:mm:ss)	18:40:12	19:57:12	21:10:12	18:40:12
End Time (hh:mm:ss)	19:39:42	20:56:42	22:09:42	22:09:42
Run Duration (min / run)	60	60	60	60
Bar. Pressure (in. Hg)	29.48	29.49	29.48	29.48
Amb. Temp. (°F)	40	39	39	39
Rel. Humidity (%)	53	57	58	56
Spec. Humidity (lb water / lb air)	0.002784	0.002879	0.002930	0.002864
Power Output (kilowatts)	920.0	909.0	900.0	909.7
Stack Flow (M2) (DSCFH)	144,002	135,641	144,076	141,240
Stack Moisture (% Method 320)	11.0	11.0	11.0	11.0
NOx (ppmvd)	17.75	17.23	17.14	17.37
NOx (ppm@15%O_2)	8.71	8.46	8.41	8.53
NOx (g/hp*hr)	0.112	0.104	0.111	0.109
CO (ppmvd)	0.02	0.00	0.00	0.01
CO (ppm@15%O_2)	0.01	0.00	0.00	0.00
CO (g/hp*hr)	0.000	0.000	0.000	0.000
THC (as C_3H_8) (ppmvd)	446.45	447.58	448.48	447.50
THC (as C_3H_8) (ppm@15%O_2)	219.16	219.79	220.20	219.72
THC (as C_3H_8) (g/hp*hr)	2.700	2.580	2.774	2.685
CH_4 (ppmvd)	414.69	415.86	416.44	415.66
NMHC (as C_3H_8) (ppmvd)	31.76	31.72	32.04	31.84
NMHC (as C_3H_8) (ppm@15%O_2)	15.59	15.58	15.73	15.63
NMHC (as C_3H_8) (g/hp*hr)	0.192	0.183	0.198	0.191
NH_3 (ppmvd)	0.43	0.17	0.13	0.24
NH_3 (ppm@15%O_2)	0.21	0.08	0.06	0.12
NH_3 (g/hp*hr)	0.0010	0.0004	0.0003	0.0006
CO_2 (%)	6.60	6.65	6.67	6.64
O_2 (%)	8.88	8.88	8.88	8.88

TEST RESULTS AND CALCULATIONS

Unit #5 Emissions Data

SIEMENS, SGE-56SL, UNIT #EUGEN5, SERIAL #A9B0011 ≥90% LOAD DATA SUMMARY

Parameter	≥90% Load, Run - 1-1	≥90% Load, Run - 1-2	≥90% Load, Run - 1-3	Average
Date (mm/dd/yy)	02/19/23	02/19/23	02/19/23	02/19/23
Start Time (hh:mm:ss)	12:34:02	15:46:02	17:43:02	12:34:02
End Time (hh:mm:ss)	13:33:32	16:45:32	18:42:32	18:42:32
Run Duration (min / run)	60	60	60	60
Bar. Pressure (in. Hg)	29.13	29.04	29.04	29.07
Amb. Temp. (°F)	52	56	55	54
Rel. Humidity (%)	43	40	41	41
Spec. Humidity (lb water / lb air)	0.003545	0.003886	0.003823	0.003751
Power Output (kilowatts)	920.0	900.0	900.0	906.7
Stack Flow (M2) (DSCFH)	126,593	128,531	126,666	127,263
Stack Moisture (% Method 320)	11.3	11.3	11.3	11.3
NOx (ppmvd)	19.70	20.57	21.73	20.67
NOx (ppm@15%O_2)	9.41	9.84	10.38	9.87
NOx (g/hp*hr)	0.112	0.119	0.124	0.118
CO (ppmvd)	3.66	3.68	3.77	3.70
CO (ppm@15%O_2)	1.75	1.76	1.80	1.77
CO (g/hp*hr)	0.013	0.013	0.013	0.013
THC (as C_3H_8) (ppmvd)	397.63	398.28	403.02	399.64
THC (as C_3H_8) (ppm@15%O_2)	189.98	190.43	192.43	190.95
THC (as C_3H_8) (g/hp*hr)	2.161	2.197	2.191	2.183
CH_4 (ppmvd)	369.42	370.14	375.16	371.57
NMHC (as C_3H_8) (ppmvd)	28.21	28.14	27.86	28.07
NMHC (as C_3H_8) (ppm@15%O_2)	13.48	13.46	13.30	13.41
NMHC (as C_3H_8) (g/hp*hr)	0.153	0.155	0.151	0.153
NH_3 (ppmvd)	7.69	7.52	5.41	6.87
NH_3 (ppm@15%O_2)	3.68	3.59	2.59	3.28
NH_3 (g/hp*hr)	0.0162	0.0160	0.0114	0.0145
CO_2 (%)	6.87	6.88	6.92	6.89
O_2 (%)	8.55	8.56	8.54	8.55

TEST RESULTS AND CALCULATIONS

Unit #6 Emissions Data

SIEMENS, SGE-56SL, UNIT #EUGEN6, SERIAL #BOD0008 ≥90% LOAD DATA SUMMARY

Parameter	≥90% Load, Run - 1-1	≥90% Load, Run - 1-2	≥90% Load, Run - 1-3	Average
Date (mm/dd/yy)	02/15/23	02/15/23	02/15/23	02/15/23
Start Time (hh:mm:ss)	16:51:17	18:02:17	19:07:17	16:51:17
End Time (hh:mm:ss)	17:50:47	19:01:47	20:06:47	20:06:47
Run Duration (min / run)	60	60	60	60
Bar. Pressure (in. Hg)	29.05	29.14	29.18	29.12
Amb. Temp. (°F)	56	54	50	53
Rel. Humidity (%)	50	56	60	55
Spec. Humidity (lb water / lb air)	0.004859	0.005065	0.004638	0.004854
Power Output (kilowatts)	900.0	900.0	900.0	900.0
Stack Flow (M2) (DSCFH)	142,848	141,941	143,664	142,817
Stack Moisture (% Method 320)	11.7	11.7	11.6	11.7
NOx (ppmvd)	7.61	7.71	7.71	7.68
NOx (ppm@15%O_2)	3.63	3.67	3.67	3.66
NOx (g/hp*hr)	0.049	0.049	0.050	0.049
CO (ppmvd)	6.40	6.44	6.53	6.46
CO (ppm@15%O_2)	3.05	3.07	3.11	3.08
CO (g/hp*hr)	0.025	0.025	0.026	0.025
THC (as C_3H_8) (ppmvd)	362.82	363.74	362.09	362.88
THC (as C_3H_8) (ppm@15%O_2)	172.88	173.22	172.49	172.86
THC (as C_3H_8) (g/hp*hr)	2.225	2.216	2.233	2.225
CH_4 (ppmvd)	344.27	344.99	342.73	343.99
NMHC (as C_3H_8) (ppmvd)	18.55	18.76	19.37	18.89
NMHC (as C_3H_8) (ppm@15%O_2)	8.84	8.93	9.23	9.00
NMHC (as C_3H_8) (g/hp*hr)	0.114	0.114	0.119	0.116
NH_3 (ppmvd)	2.98	2.28	2.01	2.42
NH_3 (ppm@15%O_2)	1.42	1.09	0.96	1.15
NH_3 (g/hp*hr)	0.0071	0.0054	0.0048	0.0057
CO_2 (%)	6.06	6.85	6.84	6.58
O_2 (%)	8.52	8.51	8.51	8.51

APPENDIX B

EMISSION DATA RECORDS