Survey of Source Emissions for: Weyerhaeuser

4111 West Four Mile Road
Grayling, MI 49738

Sources:
EUPRESSLINE Biofilter

FGDRYERS RTO

Relative Accuracy Test Audit (RATA)

EGLE Renewable Operating Permit No.
MI-ROP-B7302-2016c

Test Date: November 28-29, 2023
Project ID: 2311520004

ESC

Environmental Services Company, Inc.

Arkansas
Little Rock & Springdale

New Mexico
Carlsbad & Albuquerque

1-888-ESC-First (3477)
www.esclabs.com

REVIEWED AND CERTIFIED BY:

Baxter Woosley — Digitally signed by Baxter Woosley Date: 2024.01.12 09:09:53 -06'00'

BAXTER S. WOOSLEY, AIR PROJECTS MANAGER/QSTI

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the sources tested in the scope of this project.

Table of Contents

1.0 Introduction

1.1 Summary of Test Program

At the request of Mr. Tim Tadlock of Weyerhaeuser, Environmental Services Company, Inc. (ESC) performed a Relative Accuracy Test Audit (RATA) at Weyerhaeuser's Grayling, Michigan facility. The scope of work consisted of testing the EUPRESSLINE Biofilter and FGDRYERS RTO continuous emissions monitoring systems (CEMS). RATAs were conducted on both the EUPRESSLINE Biofilter Volatile Organic Compound monitor (VOC CEMS) and the FGDRYERS RTO VOC and Carbon Monoxide monitor (VOC /CO CEMS).

1.2 Regulatory Information

Permit No.	EGLE Renewable Operating Permit No. MI-ROP-B7302-2016c
Regulatory Citation	40 CF Part 60
Regulatory Information	US EPA Region 5

1.3 Source Information

Source names:	EUPRESSLINE Biofilter	FGDRYERS RTO
Source ID:	SVBIOFILTER	SVRTOSTACK
Target Parameters:	VOC	CO, VOC

1.4 Test Location and Facility Contact

Mr. Tim Tadlcok
timothy.tadlock@weyerhaeuser.com
Weyerhaeuser
4111 West Four Mile Road
Grayling, Michigan 49378
Phone: (989) 348-3411

1.5 Regulatory Contact

Mr. Trevor Drost
drostt@michigan.gov
Michigan Department of Environment, Great Lakes & Energy
(EGLE) Phone: (517) 245-5781

Ms. Sharon LeBlanc
Environmental Quality Analyst
Michigan Department of Environment, Great Lakes, and Energy
Air Quality Division
Phone: (989) 217-0055
Email: LeBlancS@michigan.gov

1.6 Test Company and Personnel

Environmental Services Company, Inc.
13715 West Markham
Little Rock, AR 72211
Phone: (501) 221-2565

Project Manager	Field Team Leader
Steve Woosley	Baxter Woosley
stevew@esclabs.com	tbaxterw@esclabs.com

1.7 Site-Specific Test Plan and Testing Notes

All testing was performed in accordance with the Site-Specific Test Plan (SSTP) submitted to Michigan Department of Environment, Great Lakes and Energy dated October 26, 2023. Prior to sampling ESC Labs and Weyerhaeuser petitioned EGLE for several variances in testing that were originally planned in the SSTP. The variations included not running EPA Method 326 for MDI, the use of EPA Method 320 for determining moisture content on the EUPRESSLINE Biofilter, and utilizing section 8.6 of US EPA Method 2. This section was used to eliminate the use of US EPA Method 3A on EUPRESSLINE Biofilter. Section 8.6 of US EPA Method 2 states, " For processes emitting essentially air, an analysis need not be conducted: use a dry molecular weight of 29.0."

2.0 Summary of Results

2.1 Results Table

On November 28-29, 2023, ESC performed relative accuracy test audits (RATA's) on the EUPRESSLINE Biofilter and FGDRYERS RTO continuous emission monitoring systems (CEMS) at the Weyerhaeuser facility in Grayling, Michigan to determine compliance with EGLE Renewable Operating Permit No. MI-ROP-B7302-2016c, and provisions of the 40 CFR 60.

The summary of results from the testing compared to EGLE permit limits are summarized in the table in section 2.1.1. Section 2.2 of the report contains all field data and calculated results for each run and the calculations used in this sampling program.

2.1.1 Summary of Results

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2.1.2 EUPRESSLINE Biofilter VOC RATA

Summary of Results - VOC RATA

Date:	11/28/23
Customer:	Weyerhaeuser
Emission Unit:	EUPRESSLINE Biofilter Outlet
ESC Personnel:	RSW, RM, TKB, JMTS, NAM
Reference Methods:	25A and 320
Number of Test Runs:	10
t-value (97.5% confidence):	2.262

t-values	
# of runs	**t-value**
9	2.306
10	2.262
11	2.228
12	2.201
13	2.179

		Calculated Data	**CERM Data**	**Differences**
Run #	Run Time	VOC lbs/hr as carbon	VOC lbs/hr as carbon	Differences, lbs/hr
1	1058-1119	8.70	8.83	0.13
2	1120-1141	6.95	7.50	0.55
3	1142-1203	6.89	7.99	1.10
4	1211-1232	5.29	6.58	1.29
5	1300-1321	7.74	6.26	-1.48
6	1322-1343	8.81	7.84	-0.97
7*	1408-1429	7.11	8.44	1.33
8	1430-1451	6.54	7.15	0.61
9	1451-1518	4.82	5.89	1.07
10	1533-1554	4.09	5.20	1.11
	Averages:	**6.65**	**7.03**	**0.38**
			Standard Deviation:	0.99
			Confidence Coefficent	0.70

*Run 7 excluded from RATA

VOC Relative Accuracy		
5.56%	**Based on Applicable Standard**	**Pass**

2.1.3 FGDRYERS RTO VOC RATA

Summary of Results - VOC RATA

Date:	11/29/23
Customer:	Weyerhaeuser
Emission Unit:	FGDRYERS RTO Outlet
ESC Personnel:	RSW, TKB, JMTS, NAM
Reference Methods:	25A and 4
Number of Test Runs:	12
t-value (97.5% confidence):	2.201

t-values	
# of runs	**t-value**
9	2.306
10	2.262
11	2.228
12	2.201
13	2.179

		Calculated Data	**CERM Data**	**Differences**
		VOC lbs/hr as carbon	VOC lbs/hr as carbon	Differences, lbs/hr
Run #	Run Time			
1	1308-1329	0.24	0.90	0.66
2	1330-1351	0.51	1.17	0.66
3	1352-1413	0.79	1.40	0.61
4	1428-1449	1.09	2.52	1.43
5	1450-1511	1.19	2.54	1.35
6	1512-1533	1.11	2.47	1.36
7*	1631-1652	0.72	3.04	2.32
8	1653-1714	0.65	2.69	2.04
9	1715-1736	0.66	2.55	1.89
10	1745-1806	1.37	2.98	1.61
11*	1807-1828	1.47	4.05	2.58
12*	1829-1850	1.40	3.77	2.37
	Averages:	**0.84**	**2.14**	**1.29**
			Standard Deviation:	0.63
			Confidence Coefficent	0.40

* Runs not included in Relative accuracy calculation

VOC Relative Accuracy		
9.11%	**Based on Applicable Standard**	**Pass**

2.1.4 FGDRYERS RTO CO RATA

Summary of Results - CO RATA

Date:	11/29/23
Customer:	Weyerhaeuser
Emission Unit:	FGDRYERS RTO Outlet
ESC Personnel:	RSW, TKB, JMTS, NAM
Reference Methods:	2, 4 and 10
Number of Test Runs:	12
t-value (97.5% confidence):	2.201

t-values	
# of runs	t-value
9	2.306
10	2.262
11	2.228
12	2.201
13	2.179

		Calculated Data	CERM Data	Differences
Run #	Run Time	CO lbs/hr	CO lbs/hr	Differences, lbs/hr
1	1308-1329	9.36	7.33	-2.03
2	1330-1351	18.09	12.47	-5.62
3*	1352-1413	22.27	14.49	-7.78
4	1428-1449	49.93	44.75	-5.18
5	1450-1511	61.07	56.08	-4.99
6	1512-1533	61.59	57.08	-4.51
7*	1631-1652	84.24	78.06	-6.18
8*	1653-1714	73.65	65.61	-8.04
9	1715-1736	58.91	53.50	-5.41
10	1745-1806	60.55	58.88	-1.67
11	1807-1828	68.38	66.85	-1.53
12	1829-1850	69.85	72.90	3.05
	Averages:	**50.86**	**47.76**	**-3.10**
			Standard Deviation:	1.79
			Confidence Coefficent	1.13

* Runs not included in Relative accuracy calculation

CO Relative Accuracy		
2.87%	**Based on Applicable Standard**	**Pass**

2.2 Data Summary

The following provides a detailed summary of the field data, calculated data, and calculations.

2.2.1 Data Summary – EUPRESSLINE Biofilter

USEPA Method 25A
Data Summary
Volatile Organic Compounds

VOC's		Run #1	Run #2	Run #3	Run #4	Run #5	Run #6	Run #7	Run #8	Run #9	Run #10
	Emission Unit:	EUPRESSLINE Biofilter Outlet									
	Date:	11/28/23	11/28/23	11/28/23	11/28/23	11/28/23	11/28/23	11/28/23	11/28/23	11/28/23	11/28/23
	Start Time:	1058	1120	1142	1211	1233	1255	1408	1430	1451	1533
	Stop Time:	1119	1141	1203	1232	1254	1316	1429	1451	1518	1554
$C_{c3h8(wet)}$	Average VOC concentration as propane indicated by the gas analyzer, ppmvw	15.01	13.57	14.32	11.70	15.58	17.45	14.86	12.87	9.89	8.90
C_o	Average of initial and final system calibration bias check responses for the zero VOC's calibration gas, ppmvd	1.02	1.02	1.02	1.45	1.45	1.45	1.44	1.44	1.44	1.47
C_m	Average of initial and final system calibration bias check responses for the upscale VOC's calibration gas, ppmvd	51.58	51.58	51.58	51.25	51.25	51.25	50.66	50.66	50.66	50.66
C_{ma}	Actual concentration of the upscale VOC's calibration gas, ppmvd	50.10	50.10	50.10	50.10	50.10	50.10	50.10	50.10	50.10	50.10
$C_{c3h8(corrected)}$	VOC concentration as carbon, ppmvw	13.86	12.44	13.18	10.31	14.22	16.10	13.66	11.64	8.60	7.58
B_{ws}	Water vapor in the gas stream, proportion by volume	0.0060	0.0054	0.0056	0.0057	0.0054	0.0057	0.0056	0.0055	0.0055	0.0060
$C_{c3h8(dry)}$	VOC concentration as propane, ppmvd	13.95	12.50	13.25	10.37	14.30	16.19	13.73	11.70	8.64	7.62
C_{voc}	VOC concentration as carbon, ppmvd	41.84	37.51	39.76	31.11	42.89	48.57	41.20	35.11	25.93	22.86
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	6,673,789.01	5,947,323.30	5,563,949.04	5,458,419.62	5,789,912.58	5,819,312.09	5,539,771.10	5,974,083.60	5,962,536.93	5,738,266.50
E_{voc}	VOC emission rate as carbon, lbs/hr	8.70	6.95	6.89	5.29	7.74	8.81	7.11	6.54	4.82	4.09

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #1	Run #2	Run #3
	Identification:		EUPRESSLINE Biofilter Outlet	
	Date:	11/28/23	11/28/23	11/28/23
	Start Time:	1015	1030	1145
	Stop Time:	1020	1035	1150
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.8899	0.7927	0.7416
D_s	Stack diameter, ft.	7.0000	7.0000	7.0000
T_s	Average stack temperature, °F	77	77	77
P_{bar}	Barometric pressure at sampling site, in. Hg	28.68	28.68	28.68
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.0060	0.0054	0.0056
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.0000	29.0000	29.0000
P_s	Absolute stack gas pressure, in. Hg	28.6825	28.6825	28.6825
M_s	Wet molecular weight of stack gasses, lb/lb-mole	28.9340	28.9406	28.9384
A	Area of the stack, ft^2	38.4846	38.4846	38.4846
V_s	Velocity in the stack, ft/sec	51.3961	45.7845	42.8268
V_{acfm}	Velocity in the stack, acfm	118,677.55	105,719.89	98,890.36
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	6,673,789.01	5,947,323.30	5,563,949.04

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #4	Run #5	Run #6
	Identification:		EUPRESSLINE Biofilter Outlet	
	Date:	11/28/23	11/28/23	11/28/23
	Start Time:	1225	1300	1345
	Stop Time:	1230	1305	1350
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.7268	0.7704	0.7756
D_s	Stack diameter, ft.	7.0000	7.0000	7.0000
T_s	Average stack temperature, °F	76	75	77
P_{bar}	Barometric pressure at sampling site, in. Hg	28.68	28.68	28.68
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.0057	0.0054	0.0057
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.0000	29.0000	29.0000
P_s	Absolute stack gas pressure, in. Hg	28.6825	28.6825	28.6825
M_s	Wet molecular weight of stack gasses, lb/lb-mole	28.9378	28.9411	28.9378
A	Area of the stack, ft^2	38.4846	38.4846	38.4846
V_s	Velocity in the stack, ft/sec	41.9240	44.4151	44.7791
V_{acfm}	Velocity in the stack, acfm	96,805.62	102,557.79	103,398.38
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	5,458,419.62	5,789,912.58	5,819,312.09

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #7	Run #8	Run #9
	Identification:		EUPRESSLINE Biofilter Outlet	
	Date:	11/28/23	11/28/23	11/28/23
	Start Time:	1415	1440	1510
	Stop Time:	1420	1445	1515
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.7375	0.7951	0.7940
D_s	Stack diameter, ft.	7.0000	7.0000	7.0000
T_s	Average stack temperature, °F	76	75	76
P_{bar}	Barometric pressure at sampling site, in. Hg	28.68	28.68	28.68
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.0056	0.0055	0.0055
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.0000	29.0000	29.0000
P_s	Absolute stack gas pressure, in. Hg	28.6825	28.6825	28.6825
M_s	Wet molecular weight of stack gasses, lb/lb-mole	28.9382	28.9392	28.9394
A	Area of the stack, ft^2	38.4846	38.4846	38.4846
V_s	Velocity in the stack, ft/sec	42.5423	45.8465	45.8104
V_{acfm}	Velocity in the stack, acfm	98,233.48	105,862.96	105,779.60
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	5,539,771.10	5,974,083.60	5,962,536.93

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #10	Run #11	Run #12
	Identification:		EUPRESSLINE Biofilter Outlet	
	Date:	11/28/23	--	--
	Start Time:	1555	--	--
	Stop Time:	1600	--	--
C_p	Pitot correction factor, dimensionless	0.84	--	--
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.7625	--	--
D_s	Stack diameter, ft.	7.0000	--	--
T_s	Average stack temperature, °F	73	--	--
P_{bar}	Barometric pressure at sampling site, in. Hg	28.68	--	--
P_g	Stack static pressure, in. Hg	0.00	--	--
B_{ws}	Water vapor in the gas stream, proportion by volume	0.0060	--	--
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.0000	--	--
P_s	Absolute stack gas pressure, in. Hg	28.6825	--	--
M_s	Wet molecular weight of stack gasses, lb/lb-mole	28.9342	--	--
A	Area of the stack, ft^2	38.4846	--	--
V_s	Velocity in the stack, ft/sec	43.8818	--	--
V_{acfm}	Velocity in the stack, acfm	101,326.45	--	--
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	5,738,266.50	--	--

2.2.2 Run 1 Calculations – EUPRESSLINE Biofilter

VOC RATA AS Calculations

CEM VOC concentrations (CEM_{avg}), lbs/hr = CEM_{avg}

where,

CEM_{avg} 8.830 = Average of client VOC data over a given run time, lbs/hr

VOC concentration as carbon ($C_{c(dry)}$), ppmvd =

$$\frac{3C_{c3h8(wet)}}{(1 - B_{ws})}$$

where,

$C_{c3h8(wet)}$ 15.01 = VOC concentration as propane, ppmvw

B_{ws} 0.0060 = Water vapor in the gas stream, proportion by volume

$C_{c(dry)}$ 41.84 = VOC concentration as carbon, ppmvd

VOC emission rate as carbon (E_{voc}), lbs/hr =

$$\frac{C_{c(dry)}\ x\ 12\ x\ Q_{std}}{385.1E06}$$

where,

$C_{c(dry)}$ 41.84 = VOC concentration as carbon, ppmvd

Q_{std} 6,673,789.01 = Volume of metered gas sample, dscf

E_{voc} 8.70 = VOC emission rate as carbon, lbs/hr

Confidence coefficient (CC) =

$$t_{0.975}\frac{S_d}{\sqrt{n}}$$

where,

$T_{0.975}$ 2.262 = t-value for n-1 degrees of freedom

S_d 0.99 = Standard deviation of the difference of the reference method and CEM

$\sqrt{n}$ 3.2 = square root of the number of data points (runs)

CC 0.70 = Confidence coefficient

Relative accuracy (RA), % =

$$\frac{|\bar{d}| + |CC|}{\overline{RM}}$$

where,

$|\bar{d}|$ 0.38 = Absolute value of the mean of the differences

$|CC|$ 0.70 = Absolute value of the confidence coefficient

$\overline{AS}$ 19.50 = Applicable standard

RA 5.56 = Relative accuracy of CEM CO monitor, percent of applicable standard

Method 2

Absolute stack gas pressure (P_s), in. Hg = $P_{bar} + P_g$

where,

P_{bar}	28.68	= Barometric pressure at sampling site, in. Hg
P_g	0.00	= Stack static pressure, in. Hg
P_s	28.68	= Absolute stack gas pressure, in. Hg

Wet molecular weight of stack gasses (M_s), lb/lb-mole = $M_d(1 - B_{ws}) + 18.0B_{ws}$

where,

M_d	29.0000	= Dry molecular weight of stack gasses, lb/lb-mole
B_{ws}	0.0060	= Water vapor in the gas stream, proportion by volume
M_s	28.9340	= Wet molecular weight of stack gasses, lb/lb-mole

Area of stack (A), ft^2 = $\left(\frac{D_s}{2}\right)^2 \times 3.1416$

where,

D_s	7.0000	= Stack diameter or dimensions, ft
A	38.4846	= Area of stack, ft^2

Velocity in the stack (V_s), ft/sec = $85.49C_p\sqrt{\Delta P_{avg}}\sqrt{\frac{460 + T_s}{P_s M_s}}$

where,

C_p	0.84	= Pitot correction factor, dimensionless
$\sqrt{\Delta P}$	0.8899	= Average of the square roots of the pressure heads, in. H2O
T_s	77	= Average stack temperature, °F
P_s	28.68	= Absolute stack gas pressure, in. Hg
M_s	28.9340	= Wet molecular weight of stack gasses, lb/lb-mole
V_s	51.40	= Velocity in the stack, ft/sec

Velocity in the stack (V_{acfm}), acfm = $60 \times A \times V_s$

where,

A	38.4846	= Area of stack, ft^2
V_s	51.40	= Velocity in the stack, ft/sec
V_{acfm}	118,677.55	= Velocity in the stack, acfm

Stack gas dry volumetric flow rate (Q_{std}), dscf/hr =

$$3600\left(1 - B_{ws}\right)V_s A\left[\frac{528}{460 + T_s} \times \frac{P_s}{29.92}\right]$$

where,

B_{ws}	0.0060	= Water vapor in the gas stream, proportion by volume
V_s	51.40	= Velocity in the stack, ft/sec
A	38.4846	= Area of stack, ft^2
T_s	77	= Average stack temperature, °F
P_s	28.68	= Absolute stack gas pressure, in. Hg
Q_{std}	6,673,789.01	= Stack gas dry volumetric flow rate, dscf/hr

2.2.3 Data Summary – FGDRYERS RTO

USEPA Methodology
Data Summary

Methods 2-4		Run #1	Run #2	Run #3	Run #4
	Emission Unit:			FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1315	1435	1635	1745
	Stop Time:	1355	1515	1715	1825
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84	0.840
D_s	Stack diameter, ft.	8.7500	8.7500	8.7500	8.7500
T_m	Average meter temperature	55	66	65	65
ΔH	Average pressure differential across the orifice meter, in. H_2O	1.8000	1.8000	1.7000	1.7000
P_{bar}	Barometric pressure at sampling site, in. Hg	28.26	28.26	28.26	28.26
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00	0.00
V_{ic}	Total volume of liquid collected in the impingers and silica gel, mls	168.6	308.5	237.6	314.1
V_m	Volume of gas sample as measured by the dry gas meter	28.518	28.600	27.610	28.715
T_{min}	Total sampling time, minutes	40.00	40.00	40.00	40.00
Y	Dry gas meter calibration factor, dimensionless	0.991	0.991	0.991	0.991
$\%O_2$	Percent O_2 by volume, dry basis	16.23	13.67	13.76	13.72
$\%CO_2$	Percent CO_2 by volume, dry basis	4.29	6.89	6.74	6.79
$\%CO+N_2$	Percent $CO+N_2$ by volume, dry basis	79.49	79.44	79.50	79.49
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.3348	29.6487	29.6292	29.6352
$V_{w(std)}$	Volume of water vapor in the gas sample, dry gas meter, cf	7.9360	14.5211	11.1838	14.7847
P_s	Absolute stack gas pressure, in. Hg	28.2615	28.2615	28.2615	28.2600
$V_{m(std)}$	Volume of metered gas sample, dry standard	27.5051	27.0069	26.0777	27.1401
B_{ws}	Water vapor in the gas stream, proportion by volume	0.2239	0.3497	0.3001	0.3526

USEPA Method 3A
Data Summary
Oxygen and Carbon Dioxide

Oxygen		**Run #1**	**Run #2**	**Run #3**	**Run #4**
	Emission Unit:			FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1308	1428	1631	1745
	Stop Time:	1413	1533	1736	1840
C	Average oxygen concentration indicated by the gas analyzer, % dry	16.01	13.39	13.49	13.56
C_o	Average of initial and final system the zero oxygen calibration gas, % dry	0.11	0.08	0.26	0.21
C_m	Average of initial and final system calibration bias check responses for the upscale oxygen calibration gas, % dry	9.97	9.88	9.93	10.00
C_{ma}	Actual concentration of the upscale oxygen calibration gas, % dry	10.06	10.06	10.06	10.06
C_{o2}	Oxygen concentration, % dry	16.23	13.67	13.76	13.72

Carbon Dioxide		**Run #1**	**Run #2**	**Run #3**	**Run #4**
C	Average carbon dioxide concentration indicated by the gas analyzer, % dry	4.31	6.86	6.69	6.72
C_o	Average of initial and final system calibration bias check responses for the zero carbon dioxide calibration gas, % dry	0.11	0.17	0.16	0.16
C_m	Average of initial and final system calibration bias check responses for the upscalecarbon dioxide calibration gas, % dry	8.20	8.19	8.16	8.13
C_{ma}	Actual concentration of the upscale carbon dioxide calibration gas, % dry	8.25	8.25	8.25	8.25
C_{co2}	Carbon dioxide concentration, % dry	4.29	6.89	6.74	6.79

USEPA Method 25A
Data Summary
Volatile Organic Compounds

VOC's		Run #1	Run #2	Run #3	Run #4	Run #5	Run #6
	Emission Unit:					FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1308	1330	1352	1428	1450	1512
	Stop Time:	1329	1351	1413	1449	1511	1533
$C_{c3h8(wet)}$	Average VOC concentration as propane indicated by the gas analyzer, ppmvw	0.84	1.39	1.99	2.20	2.34	2.28
C_o	Average of initial and final system calibration bias check responses for the zero VOC's calibration gas, ppmvd	0.36	0.36	0.36	0.33	0.33	0.33
C_m	Average of initial and final system calibration bias check responses for the upscale VOC's calibration gas, ppmvd	50.96	50.96	50.96	51.77	51.77	51.77
C_{ma}	Actual concentration of the upscale VOC's calibration gas, ppmvd	50.10	50.10	50.10	50.10	50.10	50.10
$C_{c3h8(corrected)}$	VOC concentration as carbon, ppmvw	0.48	1.02	1.61	1.82	1.96	1.90
B_{ws}	Water vapor in the gas stream, proportion by volume	0.2239	0.2239	0.2239	0.3497	0.3497	0.3497
$C_{c3h8(dry)}$	VOC concentration as propane, ppmvd	0.62	1.32	2.08	2.80	3.01	2.92
C_{voc}	VOC concentration as carbon, ppmvd	1.85	3.95	6.23	8.40	9.03	8.76
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,082,272.42	4,119,795.24	4,058,760.64	4,176,461.32	4,222,029.80	4,055,518.22
E_{voc}	VOC emission rate as carbon, lbs/hr	0.24	0.51	0.79	1.09	1.19	1.11

USEPA Method 25A
Data Summary
Volatile Organic Compounds

VOC's		Run #7	Run #8	Run #9	Run #10	Run #11	Run #12
	Emission Unit:					FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1631	1653	1715	1745	1807	1829
	Stop Time:	1652	1714	1736	1806	1828	1850
$C_{c3h8(wet)}$	Average VOC concentration as propane indicated by the gas analyzer, ppmvw	1.43	1.33	1.36	2.69	2.90	2.87
C_o	Average of initial and final system calibration bias check responses for the zero VOC's calibration gas, ppmvd	0.21	0.21	0.21	0.36	0.36	0.36
C_m	Average of initial and final system calibration bias check responses for the upscale VOC's calibration gas, ppmvd	52.25	52.25	52.25	51.00	51.00	51.00
C_{ma}	Actual concentration of the upscale VOC's calibration gas, ppmvd	50.10	50.10	50.10	50.10	50.10	50.10
$C_{c3h8(corrected)}$	VOC concentration as carbon, ppmvw	1.18	1.08	1.10	2.31	2.51	2.48
B_{ws}	Water vapor in the gas stream, proportion by volume	0.3001	0.3001	0.3001	0.3526	0.3526	0.3526
$C_{c3h8(dry)}$	VOC concentration as propane, ppmvd	1.68	1.54	1.58	3.57	3.88	3.83
C_{voc}	VOC concentration as carbon, ppmvd	5.05	4.61	4.73	10.70	11.65	11.50
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,579,812.72	4,527,875.67	4,447,403.73	4,101,165.18	4,044,346.65	3,891,575.27
E_{voc}	VOC emission rate as carbon, lbs/hr	0.72	0.65	0.66	1.37	1.47	1.40

USEPA Method 10
Data Summary
Carbon Monoxide

CO		Run #1	Run #2	Run #3	Run #4	Run #5	Run #6
	Emission Unit:						FGDRYERS RTO Outlet
	Date:	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1308	1330	1352	1428	1450	1512
	Stop Time:	1329	1351	1413	1449	1511	1533
C	Average carbon monoxide concentration indicated by the gas analyzer, ppmvd	57.37	85.53	100.23	194.53	228.27	237.99
C_o	Average of initial and final system calibration bias check responses for the zero carbon monoxide calibration gas, ppmvd	26.59	26.59	26.59	33.80	33.80	33.80
C_m	Average of initial and final system calibration bias check responses for the upscale carbon monoxide calibration gas, ppmvd	524.28	524.28	524.28	532.38	532.38	532.38
C_{ma}	Actual concentration of the upscale carbon monoxide calibration gas, ppmvd	510.00	510.00	510.00	510.00	510.00	510.00
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,082,272.42	4,119,795.24	4,058,760.64	4,176,461.32	4,222,029.80	4,055,518.22
C_{co}	Carbon monoxide concentration, ppmvd	31.54	60.40	75.47	164.41	198.93	208.87
E_{co}	Carbon monoxide emission rate, lbs/hr	9.36	18.09	22.27	49.93	61.07	61.59

USEPA Method 10
Data Summary
Carbon Monoxide

CO		Run #1	Run #2	Run #3	Run #4	Run #5	Run #6
	Emission Unit:					FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1308	1330	1352	1428	1450	1512
	Stop Time:	1329	1351	1413	1449	1511	1533
C	Average carbon monoxide concentration indicated by the gas analyzer, ppmvd	57.37	85.53	100.23	194.53	228.27	237.99
C_o	Average of initial and final system calibration bias check responses for the zero carbon monoxide calibration gas, ppmvd	26.59	26.59	26.59	33.80	33.80	33.80
C_m	Average of initial and final system calibration bias check responses for the upscale carbon monoxide calibration gas, ppmvd	524.28	524.28	524.28	532.38	532.38	532.38
C_{ma}	Actual concentration of the upscale carbon monoxide calibration gas, ppmvd	510.00	510.00	510.00	510.00	510.00	510.00
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,082,272.42	4,119,795.24	4,058,760.64	4,176,461.32	4,222,029.80	4,055,518.22
C_{co}	Carbon monoxide concentration, ppmvd	31.54	60.40	75.47	164.41	198.93	208.87
E_{co}	Carbon monoxide emission rate, lbs/hr	9.36	18.09	22.27	49.93	61.07	61.59

USEPA Method 10
Data Summary
Carbon Monoxide

CO		Run #7	Run #8	Run #9	Run #10	Run #11	Run #12
	Emission Unit:					FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23	11/29/23
	Start Time:	1631	1653	1715	1745	1807	1829
	Stop Time:	1652	1714	1736	1806	1828	1850
C	Average carbon monoxide concentration indicated by the gas analyzer, ppmvd	275.47	246.91	206.37	224.50	253.33	267.34
C_o	Average of initial and final system calibration bias check responses for the zero carbon monoxide calibration gas, ppmvd	28.60	28.60	28.60	26.08	26.08	26.08
C_m	Average of initial and final system calibration bias check responses for the upscale carbon monoxide calibration gas, ppmvd	526.28	526.28	526.28	524.49	524.49	524.49
C_{ma}	Actual concentration of the upscale carbon monoxide calibration gas, ppmvd	510.00	510.00	510.00	510.00	510.00	510.00
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,579,812.72	4,527,875.67	4,447,403.73	4,101,165.18	4,044,346.65	3,891,575.27
C_{co}	Carbon monoxide concentration, ppmvd	252.98	223.71	182.17	203.04	232.54	246.87
E_{co}	Carbon monoxide emission rate, lbs/hr	84.24	73.65	58.91	60.55	68.38	69.85

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #1	Run #2	Run #3
	Identification:		FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23
	Start Time:	1321	1335	1355
	Stop Time:	1326	1340	1400
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.4734	0.4757	0.4697
D_s	Stack diameter, ft.	8.7500	8.7500	8.7500
T_s	Average stack temperature, °F	183	177	180
P_{bar}	Barometric pressure at sampling site, in. Hg	28.26	28.26	28.26
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.2239	0.2239	0.2239
$\%O_2$	Percent O_2 by volume, dry basis	16.23	16.23	16.23
$\%CO_2$	Percent CO_2 by volume, dry basis	4.29	4.29	4.29
$\%CO+N_2$	Percent $CO+N_2$ by volume, dry basis	79.49	79.49	79.49
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.3348	29.3348	29.3348
P_s	Absolute stack gas pressure, in. Hg	28.2615	28.2615	28.2615
M_s	Wet molecular weight of stack gasses, lb/lb-mole	26.7967	26.7967	26.7967
A	Area of the stack, ft^2	60.1322	60.1322	60.1322
V_s	Velocity in the stack, ft/sec	31.3217	31.3392	31.0112
V_{acfm}	Velocity in the stack, acfm	113,006.70	113,069.73	111,886.15
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,082,272.42	4,119,795.24	4,058,760.64

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #4	Run #5	Run #6
	Identification:		FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23
	Start Time:	1435	1505	1520
	Stop Time:	1440	1510	1525
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.5740	0.5870	0.5579
D_s	Stack diameter, ft.	8.7500	8.7500	8.7500
T_s	Average stack temperature, °F	204	220	206
P_{bar}	Barometric pressure at sampling site, in. Hg	28.26	28.26	28.26
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.3497	0.3497	0.3497
$\%O_2$	Percent O_2 by volume, dry basis	13.67	13.67	13.67
$\%CO_2$	Percent CO_2 by volume, dry basis	6.89	6.89	6.89
$\%CO+N_2$	Percent $CO+N_2$ by volume, dry basis	79.44	79.44	79.44
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.6487	29.6487	29.6487
P_s	Absolute stack gas pressure, in. Hg	28.2615	28.2615	28.2615
M_s	Wet molecular weight of stack gasses, lb/lb-mole	25.5755	25.5755	25.5755
A	Area of the stack, ft^2	60.1322	60.1322	60.1322
V_s	Velocity in the stack, ft/sec	39.5195	40.8827	38.4509
V_{acfm}	Velocity in the stack, acfm	142,583.60	147,502.10	138,728.15
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,176,461.32	4,222,029.80	4,055,518.22

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #7	Run #8	Run #9
	Identification:		FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23
	Start Time:	1640	1700	1725
	Stop Time:	1645	1705	1730
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.6048	0.5976	0.5855
D_s	Stack diameter, ft.	8.7500	8.7500	8.7500
T_s	Average stack temperature, °F	235	234	231
P_{bar}	Barometric pressure at sampling site, in. Hg	28.26	28.26	28.26
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.3001	0.3001	0.3001
$\%O_2$	Percent O_2 by volume, dry basis	13.76	13.76	13.76
$\%CO_2$	Percent CO_2 by volume, dry basis	6.74	6.74	6.74
$\%CO+N_2$	Percent $CO+N_2$ by volume, dry basis	79.50	79.50	79.50
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.6292	29.6292	29.6292
P_s	Absolute stack gas pressure, in. Hg	28.2615	28.2615	28.2615
M_s	Wet molecular weight of stack gasses, lb/lb-mole	26.1388	26.1388	26.1388
A	Area of the stack, ft^2	60.1322	60.1322	60.1322
V_s	Velocity in the stack, ft/sec	42.1257	41.6031	40.6613
V_{acfm}	Velocity in the stack, acfm	151,986.70	150,100.95	146,703.27
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,579,812.72	4,527,875.67	4,447,403.73

USEPA Method 2
Data Summary
Volumetric Flow Rate

		Run #10	Run #11	Run #12
	Identification:		FGDRYERS RTO Outlet	
	Date:	11/29/23	11/29/23	11/29/23
	Start Time:	1800	1815	1835
	Stop Time:	1805	1820	1840
C_p	Pitot correction factor, dimensionless	0.84	0.84	0.84
$\sqrt{\Delta P}$	Average of the square roots of the pressure heads, in. H_2O	0.5795	0.5727	0.5487
D_s	Stack diameter, ft.	8.7500	8.7500	8.7500
T_s	Average stack temperature, °F	237	240	234
P_{bar}	Barometric pressure at sampling site, in. Hg	28.26	28.26	28.26
P_g	Stack static pressure, in. Hg	0.00	0.00	0.00
B_{ws}	Water vapor in the gas stream, proportion by volume	0.3526	0.3526	0.3526
$\%O_2$	Percent O_2 by volume, dry basis	13.72	13.72	13.72
$\%CO_2$	Percent CO_2 by volume, dry basis	6.79	6.79	6.79
$\%CO+N_2$	Percent $CO+N_2$ by volume, dry basis	79.49	79.49	79.49
M_d	Dry molecular weight of stack gasses, lb/lb-mole	29.6354	29.6354	29.6354
P_s	Absolute stack gas pressure, in. Hg	28.2615	28.2615	28.2615
M_s	Wet molecular weight of stack gasses, lb/lb-mole	25.5322	25.5322	25.5322
A	Area of the stack, ft^2	60.1322	60.1322	60.1322
V_s	Velocity in the stack, ft/sec	40.9000	40.5069	38.6427
V_{acfm}	Velocity in the stack, acfm	147,564.33	146,146.28	139,420.38
Q_{std}	Stack gas dry volumetric flow rate, dscf/hr	4,101,165.18	4,044,346.65	3,891,575.27

2.2.4 Run 1 Calculations – FGDRYERS RTO

CO RATA AS Calculations

CEM CO concentrations (CEM_{avg}), lbs/hr = CEM_{avg}

where,

CEM_{avg} 7.330 = Average of client CO data over a given run time, lbs/hr

Oxygen concentration (C_{o2}), % =

$$(C_{a(o2)} - C_{0(o2)})\left(\frac{C_{ma(o2)}}{C_{m(o2)} - C_{0(o2)}}\right)$$

where,

$C_{a(o2)}$ 16.01 = Average oxygen concentration indicated by the gas analyzer, % dry

$C_{0(o2)}$ 0.11 = Average of the initial and final system calibration bias check responses for the zero calibration gas, % dry

$C_{ma(o2)}$ 10.06 = Actual concentration of the upscale calibration gas, % dry

$C_{m(o2)}$ 9.97 = Average of the initial and final system calibration bias check responses for the upscale calibration gas, % dry

C_{o2} 16.23 = Oxygen concentration, % dry

Carbon dioxide concentration (C_{co2}), % =

$$(C_{a(co2)} - C_{0(co2)})\left(\frac{C_{ma(co2)}}{C_{m(co2)} - C_{0(co2)}}\right)$$

where,

$C_{a(co2)}$ 4.31 = Average carbon dioxide concentration indicated by the gas analyzer, % dry

$C_{0(co2)}$ 0.11 = Average of the initial and final system calibration bias check responses for the zero calibration gas, % dry

$C_{ma(co2)}$ 8.25 = Actual concentration of the upscale calibration gas, % dry

$C_{m(co2)}$ 8.20 = Average of the initial and final system calibration bias check responses for the upscale calibration gas, % dry

C_{co2} 4.29 = Carbon dioxide concentration, % dry

Carbon monoxide concentration (C_{co}), ppmvd =

$$(C_{a(co)} - C_{0(co)})\left(\frac{C_{ma(co)}}{C_{m(co)} - C_{0(co)}}\right)$$

where,

$C_{a(co)}$ 57.37 = Average carbon monoxide concentration indicated by the gas analyzer, ppm

$C_{0(co)}$ 26.59 = Average of the initial and final system calibration bias check responses for the zero calibration gas, ppmvd

$C_{ma(co)}$ 510.00 = Actual concentration of the upscale calibration gas, ppmvd

$C_{m(co)}$ 524.28 = Average of the initial and final system calibration bias check responses for the upscale calibration gas, ppmvd

C_{co} 31.54 = Carbon monoxide concentration, ppmvd

Carbon monoxide emission rate (E_{co}), lbs/hr = $\left(\frac{C_{co} \; x \; 28 \; x \; Q_{std}}{385100000}\right)$

where,

C_{co}	31.54	= Carbon monoxide concentration, ppmvd
Q_{std}	4,082,272.42	= Stack gas dry volumetric flow rate, dscf/hr
E_{co}	9.36	= Carbon monoxide emission rate, lbs/hr

Confidence coefficient (CC) = $t_{0.975}\frac{S_d}{\sqrt{n}}$

where,

$T_{0.975}$	2.201	= t-value for n-1 degrees of freedom
S_d	1.79	= Standard deviation of the difference of the reference method and CEM
$\sqrt{n}$	3.5	= square root of the number of data points (runs)
CC	1.13	= Confidence coefficient

Relative accuracy (RA), % = $\frac{|\bar{d}| + |CC|}{\overline{RM}}$

where,

$\lvert\bar{d}\rvert$	3.10	= Absolute value of the mean of the differences
$\lvert CC\rvert$	1.13	= Absolute value of the confidence coefficient
$\overline{AS}$	147.30	= Applicable standard
RA	2.87	= Relative accuracy of CEM CO monitor, percent of applicable standard

Methods 2 and 4

Dry molecular weight of stack gasses (M_d), lb/lb-mole = $0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO + N_2)$

where,

C_{co2}	16.23	= Carbon dioxide concentration, % dry
C_{o2}	4.29	= Oxygen concentration, % dry
C_{co+n2}	79.49	= Carbon monoxide plus nitrogen concentrations, % dry
M_d	29.3348	= Dry molecular weight of stack gasses, lb/lb-mole

Volume of water vapor in the gas sample ($V_{w(std)}$), dscf = $0.04707 * V_{ic}$

where,

V_{ic}	168.6	= Total volume of liquid collected in impingers and silica gel, mls
$V_{w(std)}$	7.9360	= Volume of water vapor in the gas sample, dscf

Volume of metered gas sample ($V_{m(std)}$), dscf =

$$17.64 V_m Y \frac{P_{bar} + \left(\frac{\Delta H}{13.6}\right)}{460 + T_m}$$

where,

V_m	28.518	= Volume of gas sample as measured by dry gas meter, cf
Y	0.991	= Dry gas meter calibration factor, dimensionless
P_{bar}	28.26	= Barometric pressure at sampling site, in. Hg
ΔH	1.800	= Average pressure differential across the orifice meter, in. H2O
T_m	55	= Average meter temperature, °F
$V_{m(std)}$	27.5051	= Volume of metered gas sample, dscf

Water vapor in the gas stream (B_{ws}), proportion by volume =

$$\frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

where,

$V_{w(std)}$	7.9360	= Volume of water vapor in the gas sample, dscf
$V_{m(std)}$	27.5051	= Volume of metered gas sample, dscf
B_{ws}	0.2239	= Water vapor in the gas stream, proportion by volume

Absolute stack gas pressure (P_s), in. Hg =

$$P_{bar} + P_g$$

where,

P_{bar}	28.26	= Barometric pressure at sampling site, in. Hg
P_g	0.00	= Stack static pressure, in. Hg
P_s	28.26	= Absolute stack gas pressure, in. Hg

Wet molecular weight of stack gasses (M_s), lb/lb-mole =

$$M_d(1 - B_{ws}) + 18.0 B_{ws}$$

where,

M_d	29.3348	= Dry molecular weight of stack gasses, lb/lb-mole
B_{ws}	0.2239	= Water vapor in the gas stream, proportion by volume
M_s	26.7967	= Wet molecular weight of stack gasses, lb/lb-mole

Area of stack (A), ft^2 =

$$\left(\frac{D_s}{2}\right)^2 \times 3.1416$$

where,

D_s	8.7500	= Stack diameter or dimensions, ft
A	60.1322	= Area of stack, ft^2

Velocity in the stack (V_s), ft/sec =

$$85.49 C_p \sqrt{\Delta P_{avg}} \sqrt{\frac{460 + T_s}{P_s M_s}}$$

where,

C_p	0.84	= Pitot correction factor, dimensionless
$\sqrt{\Delta P}$	0.4734	= Average of the square roots of the pressure heads, in. H2O
T_s	183	= Average stack temperature, °F
P_s	28.26	= Absolute stack gas pressure, in. Hg
M_s	26.7967	= Wet molecular weight of stack gasses, lb/lb-mole
V_s	31.32	= Velocity in the stack, ft/sec

Velocity in the stack (V_{acfm}), acfm =

$$60 \times A \times V_s$$

where,

A	60.1322	= Area of stack, ft^2
V_s	31.32	= Velocity in the stack, ft/sec
V_{acfm}	113,006.70	= Velocity in the stack, acfm

Stack gas dry volumetric flow rate (Q_{std}), dscf/hr =

$$3600 (1 - B_{ws}) V_s A \left[\frac{528}{460 + T_s} \times \frac{P_s}{29.92} \right]$$

where,

B_{ws}	0.2239	= Water vapor in the gas stream, proportion by volume
V_s	31.32	= Velocity in the stack, ft/sec
A	60.1322	= Area of stack, ft^2
T_s	183	= Average stack temperature, °F
P_s	28.26	= Absolute stack gas pressure, in. Hg
Q_{std}	4,082,272.42	= Stack gas dry volumetric flow rate, dscf/hr

VOC RATA AS Calculations

CEM VOC concentrations (CEM_{avg}), lbs/hr = CEM_{avg}

where,

CEM_{avg} 7.330 = Average of client VOC data over a given run time, lbs/hr

Oxygen concentration (C_{o2}), % =

$$(C_{a(o2)} - C_{0(o2)})\left(\frac{C_{ma(o2)}}{C_{m(o2)} - C_{0(o2)}}\right)$$

where,

$C_{a(o2)}$ 16.01 = Average oxygen concentration indicated by the gas analyzer, % dry

$C_{0(o2)}$ 0.11 = Average of the initial and final system calibration bias check responses for the zero calibration gas, % dry

$C_{ma(o2)}$ 10.06 = Actual concentration of the upscale calibration gas, % dry

$C_{m(o2)}$ 9.97 = Average of the initial and final system calibration bias check responses for the upscale calibration gas, % dry

C_{o2} 16.23 = Oxygen concentration, % dry

Carbon dioxide concentration (C_{co2}), % =

$$(C_{a(co2)} - C_{0(co2)})\left(\frac{C_{ma(co2)}}{C_{m(co2)} - C_{0(co2)}}\right)$$

where,

$C_{a(co2)}$ 4.31 = Average carbon dioxide concentration indicated by the gas analyzer, % dry

$C_{0(co2)}$ 0.11 = Average of the initial and final system calibration bias check responses for the zero calibration gas, % dry

$C_{ma(co2)}$ 8.25 = Actual concentration of the upscale calibration gas, % dry

$C_{m(co2)}$ 8.20 = Average of the initial and final system calibration bias check responses for the upscale calibration gas, % dry

C_{co2} 4.29 = Carbon dioxide concentration, % dry

VOC concentration as carbon ($C_{c(dry)}$), ppmvd =

$$\frac{3C_{c3h8(wet)}}{(1 - B_{ws})}$$

where,

$C_{c3h8(wet)}$ 0.62 = VOC concentration as propane, ppmvw

B_{ws} 0.2239 = Water vapor in the gas stream, proportion by volume

$C_{c(dry)}$ 1.85 = VOC concentration as carbon, ppmvd

VOC emission rate as carbon (E_{voc}), lbs/hr =

$$\frac{C_{c(dry)} \times 12 \times Q_{std}}{385.1E06}$$

where,

$C_{c(dry)}$ 1.85 = VOC concentration as carbon, ppmvd

Q_{std} 4,082,272.42 = Volume of metered gas sample, dscf

E_{voc} 0.24 = VOC emission rate as carbon, lbs/hr

Confidence coefficient (CC) = $t_{0.975} \frac{S_d}{\sqrt{n}}$

where,

$T_{0.975}$ 2.201 = t-value for n-1 degrees of freedom
S_d 0.63 = Standard deviation of the difference of the reference method and CEM
$\sqrt{n}$ 3.5 = square root of the number of data points (runs)
CC 0.40 = Confidence coefficient

Relative accuracy (RA), % = $\frac{|\bar{d}| + |CC|}{\overline{RM}}$

where,

$|\bar{d}|$ 1.29 = Absolute value of the mean of the differences
|CC| 0.40 = Absolute value of the confidence coefficient
$\overline{AS}$ 18.60 = Applicable standard
RA 9.11 = Relative accuracy of CEM CO monitor, percent of applicable standard

Methods 2 and 4

Dry molecular weight of stack gasses (M_d), lb/lb-mole = $0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO + N_2)$

where,

C_{co2} 16.23 = Carbon dioxide concentration, % dry
C_{o2} 4.29 = Oxygen concentration, % dry
C_{co+n2} 79.49 = Carbon monoxide plus nitrogen concentrations, % dry
M_d 29.3348 = Dry molecular weight of stack gasses, lb/lb-mole

Volume of water vapor in the gas sample ($V_{w(std)}$), dscf = $0.04707 * V_{ic}$

where,

V_{ic} 168.6 = Total volume of liquid collected in impingers and silica gel, mls
$V_{w(std)}$ 7.9360 = Volume of water vapor in the gas sample, dscf

Volume of metered gas sample ($V_{m(std)}$), dscf =

$$17.64 V_m Y \frac{P_{bar} + \left(\frac{\Delta H}{13.6}\right)}{460 + T_m}$$

where,

V_m 28.518 = Volume of gas sample as measured by dry gas meter, cf
Y 0.991 = Dry gas meter calibration factor, dimensionless
P_{bar} 28.26 = Barometric pressure at sampling site, in. Hg
ΔH 1.800 = Average pressure differential across the orifice meter, in. H2O
T_m 55 = Average meter temperature, °F
$V_{m(std)}$ 27.5051 = Volume of metered gas sample, dscf

Water vapor in the gas stream (B_{ws}), proportion by volume =

$$\frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

where,

$V_{w(std)}$	7.9360	= Volume of water vapor in the gas sample, dscf
$V_{m(std)}$	27.5051	= Volume of metered gas sample, dscf
B_{ws}	0.2239	= Water vapor in the gas stream, proportion by volume

Absolute stack gas pressure (P_s), in. Hg =

$$P_{bar} + P_g$$

where,

P_{bar}	28.26	= Barometric pressure at sampling site, in. Hg
P_g	0.00	= Stack static pressure, in. Hg
P_s	28.26	= Absolute stack gas pressure, in. Hg

Wet molecular weight of stack gasses (M_s), lb/lb-mole =

$$M_d(1 - B_{ws}) + 18.0B_{ws}$$

where,

M_d	29.3348	= Dry molecular weight of stack gasses, lb/lb-mole
B_{ws}	0.2239	= Water vapor in the gas stream, proportion by volume
M_s	26.7967	= Wet molecular weight of stack gasses, lb/lb-mole

Area of stack (A), ft^2 =

$$\left(\frac{D_s}{2}\right)^2 \times 3.1416$$

where,

D_s	8.7500	= Stack diameter or dimensions, ft
A	60.1322	= Area of stack, ft^2

Velocity in the stack (V_s), ft/sec =

$$85.49C_p\sqrt{\Delta P_{avg}}\sqrt{\frac{460 + T_s}{P_s M_s}}$$

where,

C_p	0.84	= Pitot correction factor, dimensionless
$\sqrt{\Delta P}$	0.4734	= Average of the square roots of the pressure heads, in. H2O
T_s	183	= Average stack temperature, °F
P_s	28.26	= Absolute stack gas pressure, in. Hg
M_s	26.7967	= Wet molecular weight of stack gasses, lb/lb-mole
V_s	31.32	= Velocity in the stack, ft/sec

Velocity in the stack (V_{acfm}), acfm = $60 \times A \times V_s$

where,

A	60.1322	= Area of stack, ft^2
V_s	31.32	= Velocity in the stack, ft/sec
V_{acfm}	113,006.70	= Velocity in the stack, acfm

Stack gas dry volumetric flow rate (Q_{std}), dscf/hr =

$$3600\,(1 - B_{ws})V_s A\left[\frac{528}{460 + T_s} \times \frac{P_s}{29.92}\right]$$

where,

B_{ws}	0.2239	= Water vapor in the gas stream, proportion by volume
V_s	31.32	= Velocity in the stack, ft/sec
A	60.1322	= Area of stack, ft^2
T_s	183	= Average stack temperature, °F
P_s	28.26	= Absolute stack gas pressure, in. Hg
Q_{std}	4,082,272.42	= Stack gas dry volumetric flow rate, dscf/hr

3.0 Facility and Sampling Location Descriptions

3.1 Process Description and Operation

Weyerhaeuser manufactures oriented-strand board (OSB) at its facility in Grayling, Michigan. Wood logs are sorted by species and stored in the wood yard. Logs are transferred to heated vats to clean and thaw (in winter months) the wood. The wood logs are conveyed from the vats to a debarking machine that removes the other layers of the logs. A ring-strander cuts the logs into thin wood chips (strands). The strands are conveyed to a storage bin where they are fed into four wood-fired dryers. The dryers remove moisture from the strands to product-specific content. The strands exit the dryers and are sorted according to size using shaker screens.

The fine strands are collected and used as fuel in the dryers and RTOs. The larger strands are conveyed to a blending area where wax and resins are added for adhesion purposes. The strands are then layered, at different angles for strength, onto an 8-foot-wide conveyor belt. The layered strands are cut into 8-foot-by-24-foot sections and formed into mats. The mats are stacked and the press is used to heat and compact the strands to form OSB. Depending on the thickness of the product (i.e.,7/16 or 3/8 inch) up to 16 mats can be compacted in less than 4 minutes. The OSB is cut, labeled, and prepared for shipment.

As part of the manufacturing process, emissions are generated by wood debarking and stranding, conveyance, drying, binding, pressing, milling, and painting (sides of wood). Weyerhaeuser operates pollution control equipment to control the discharge of pollutants to the atmosphere. The biofilter, wet electrostatic precipitator (WESP), and RTOs control emissions from the drying and pressing operations.

The VOC CERMS installed on the EUPRESSLINE Biofilter, and the VOC and CO CERMS and COMS on the FGDRYERS RTO exhaust stacks are used to evaluate continuous compliance with permit limits.

The pages included in Section 3.4 of this report detail the production/throughput data maintained by the facility during the testing program, which were provided to ESC after the completion of the sampling event.

3.2 CEMS Description

EUPRESSLINE Biofilter Outlet

The VOC monitor is a California Analytical Instruments, Inc., Model 600 HFID, Serial Number B05010. The system extracts sample gas through a heated sample probe and heated filter connected to the monitor by a heated sample line. The VOC analyzer measures total hydrocarbons using a flame ionization detector (FID). The VOC monitor operates on a single range/span of 0 to 100 parts per million (ppm).

The flowrate monitor is a Teledyne UltraFlow Model 150, Serial number 1501355. The air flowrate is measured by ultrasonic methods. The flow monitoring system uses 20% oxygen and 0% carbon dioxide for the flowrate calculations.

FGDRYERS RTO Outlet

The VOC monitor is a California Analytical Instruments, Inc., Model 600 HFID, Serial Number B05011. The system extracts sample gas through a heated sample probe and heated filter connected to the monitor by a heated sample line. The VOC analyzer measures total hydrocarbons using a FID. The VOC monitor operates on a dual range span: 0 to 100 ppm and 1 to 1,000 ppm.

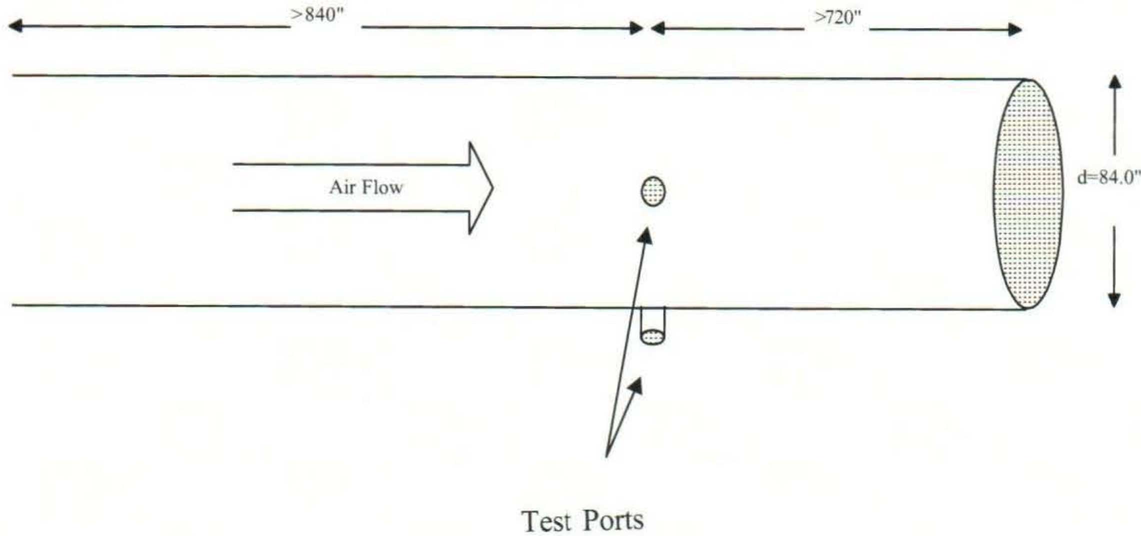
The CO monitor is a California Analytical Instruments, Inc., Model 601, Serial Number B06014-M. The system extracts sample gas through a heated sample probe and heated filter connected to the gas conditioning system by a heated sample line. Moisture is removed from the sample before the sample is analyzed. The CO analyzer measures carbon monoxide concentration by non-dispersive infrared analysis. The analyzer has a span of 1 to 1,000 ppm.

The flowrate monitor is a Teledyne Ultraflow Model 150, Serial Number 1501354. The air flowrate is measured by ultrasonic methods. The flowrate monitoring system uses 20% oxygen and 1% carbon dioxide for the flowrate calculations.

3.3 Flue Gas Sampling Locations

Gas stream sampling was conducted in accordance with U.S. EPA Method 1 for the sources tested. Attached in Section 3.3 are the schematics of the sampling locations and traverse points that provide a representative sample of the sources.

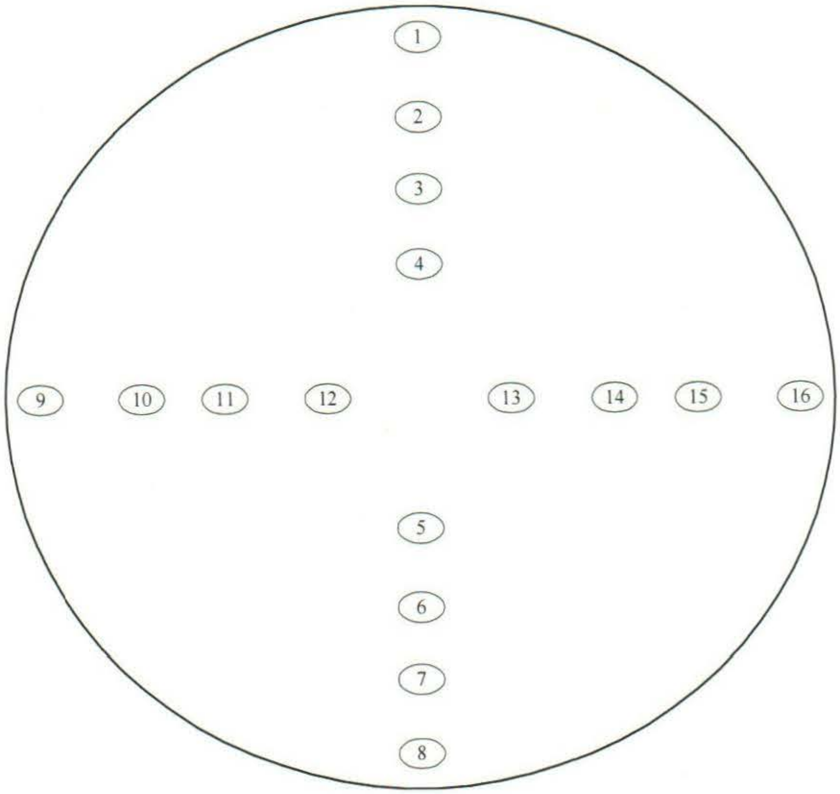
3.4 Stack Schematics



Weyerhaeuser - Grayling, MI

EUPRESSLINE Biofilter

Side View

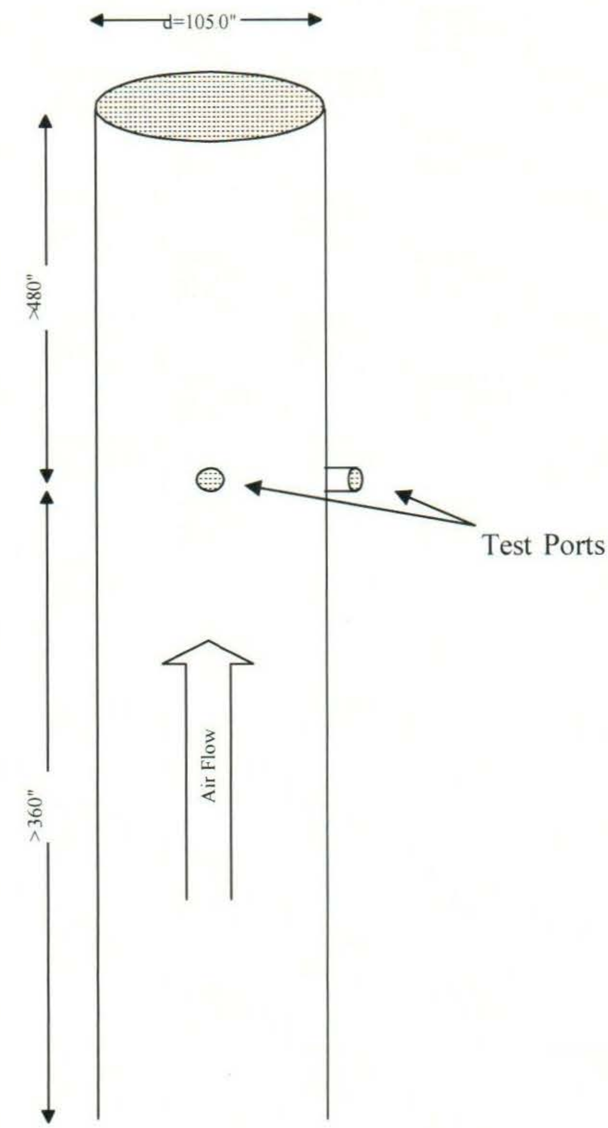


Sample Point	Location
1 and 9	5.7"
2 and 10	11.8"
3 and 11	19.3"
4 and 12	30.1"
5 and 13	59.9"
6 and 14	70.7"
7 and 15	78.2"
8 and 16	84.3"

Weyerhaeuser - Grayling, MI

EUPRESSLINE Biofilter

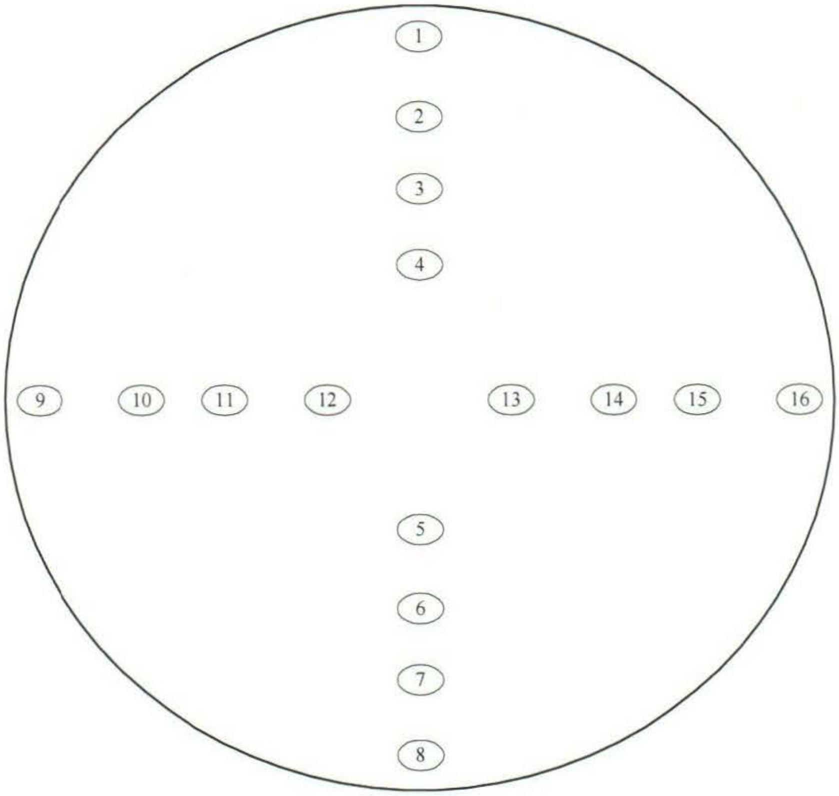
Sample Points



Weyerhaeuser - Grayling, MI

FGDRYERS RTO

Side View



Sample Point	Location
1, 8, 9 and 16	9.9"
2, 7, 10 and 15	17.5"
3, 6, 11 and 14	26.9"
4, 5, 12 and 13	40.4"

Weyerhaeuser - Grayling, MI

FGDRYERS RTO

Sample Points