Regulatory Information

Permit No. Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit No. MI-ROP-N5940-2019A

Source Information

Source Name	*Source ID*	*Target Parameters*
Wood Fuel Boiler 2	EU-WOODBOILER2	PM

Contact Information

Test Location
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Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.

Edward "EJ" Juers
Alliance Technical Group, LLC

March 20, 2024
Date

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1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by PotlatchDeltic Corporation (PotlatchDeltic) to conduct compliance testing at the Gwinn Sawmill in Gwinn, Michigan. The facility operates under the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit No. MI-ROP-N5940-2019A. Testing was conducted to determine the emission rates of particulate matter (PM) from the exhaust of Wood Fuel Boiler No. 2.

1.1 Facility Description

The PotlatchDeltic Corporation owns and operates the Wood Fuel Boiler. No 2 at the Gwinn Sawmill. The Wood Fuel Boiler 2 is a Hurst and Welding Co. Inc. Model No. HYB-4000-150-WF (SN. No. HYB3948-300-1). It has a capacity of 28.7 MMBtu/hr and is controlled by a primary and secondary multiclone.

1.2 Project Team

Personnel involved in this project are identified in the following table.

Table 1-1: Project Team

Facility Personnel	Amy Benson
Alliance Personnel	Ryan Schuth Carl Bender Leo Peters

1.3 Site Specific Test Plan & Notification

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP) approved by EGLE.

2.0 Summary of Results

Alliance conducted compliance testing at the PotlatchDeltic facility in Gwinn, MI on February 27, 2024. Testing consisted of determining the emission rates of PM from the exhaust of Wood Fuel Boiler No. 2.

Table 2-1 provides a summary of the emission testing results with comparisons to the applicable Michigan EGLE permit limits. Any difference between the summary results listed in the following tables and the detailed results contained in appendices is due to rounding for presentation.

Table 2-1: Summary of Results

Run Number	Run 1	Run 2	Run 3	Average
Date	**2/17/24**	**2/17/24**	**2/17/24**	--
Filterable Particulate Matter Data				
Concentration, grain/dscf	0.090	0.091	0.085	0.089
Emission Rate, lb/hr	4.2	4.3	4.0	4.2
Permit Limit, lb/hr	--	--	--	5.7
Percent of Limit, %	--	--	--	**73**
Emission Rate, ton/yr	18.4	18.7	17.6	18.2
Permit Limit, ton/yr	--	--	--	25.1
Percent of Limit, %	--	--	--	**73**
Emission Factor, lb/MMBtu	0.16	0.16	0.14	0.15
Permit Limit, lb/MMBtu	--	--	--	0.2
Percent of Limit, %	--	--	--	**76**

3.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix D.

Table 3-1: Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1 & 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3/3A	Integrated Bag / Instrumental Analysis
Moisture Content	4	Gravimetric Analysis
Particulate Matter	5	Isokinetic Sampling
Mass Emission Factors	19	Fuel Factors/Heat Inputs

3.1 U.S. EPA Reference Test Methods 1 and 2 – Sampling/Traverse Points and Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-1 in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

Stack gas velocity pressure and temperature readings were recorded during each test run. The data collected was utilized to calculate the volumetric flow rate in accordance with U.S. EPA Reference Test Method 2.

3.2 U.S. EPA Reference Test Method 3A – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3A. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.6.

3.3 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content (BWS) was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. Prior to testing, each impinger was filled with a known quantity of water or silica gel. Each impinger was analyzed gravimetrically before and after each test run on the same balance to determine the amount of moisture condensed.

3.4 U.S. EPA Reference Test Method 5 – Particulate Matter

The filterable particulate matter testing was conducted accordance with U.S. EPA Reference Test Method 5. The complete sampling system consisted of a stainless-steel nozzle, heated glass-lined probe, pre-weighed heated quartz filter, gas conditioning train, pump and calibrated dry gas meter. The gas conditioning train consisted of four (4) chilled impingers – the first and second containing 100 mL of H_2O, an empty third impinger and the fourth containing 200-300 grams of silica gel. The probe liner and filter heating systems were maintained at a temperature of 120 ± 14°C (248 ±25°F) and the impinger temperature was maintained at 20°C (68°F) or less throughout the testing.

Following the completion of each test run, the sampling train was leak checked at a vacuum pressure greater than or equal to the highest vacuum pressure observed during the run, and the contents of the impingers were measured for moisture gain. The probe was rinsed and brushed three (3) times and nozzle was rinsed and brushed six (6) times with acetone to remove any adhering particulate matter. This rinse was recovered in container 2. The front half of the filter holder was rinsed three (3) times with acetone and this rinse was added to container 2. The pre-weighed quartz filter was carefully removed and placed in container 1. All containers were sealed, labeled and liquid levels marked for transport to the identified laboratory.

3.5 U.S. EPA Reference Test Method 19 – Mass Emission Factors

The pollutant concentrations were converted to mass emission factors (lb/MMBtu) using procedures outlined in U.S. EPA Reference Test Method 19. The published dry O_2, wet O_2 or CO_2 based fuel factor (F-Factor) of 9,600 dscf/MMBtu for wood bark was used in the calculations.

3.6 Quality Assurance/Quality Control – U.S. EPA Reference Test Method 3/3A

Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

Low-Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low-Level gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas. For the Calibration Error Test, Low, Mid, and High-Level calibration gases were sequentially introduced directly to the analyzer. All values were within 2.0 percent of the Calibration Span or 0.5% absolute difference.

At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.

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Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 2
Project No.: AST-2024-1279
Run No.: 1
Parameter: PM

Meter Pressure (Pm), in. Hg

$$Pm = Pb + \frac{\Delta H}{13.6}$$

where,

Pb	28.10	= barometric pressure, in. Hg
ΔH	1.192	= pressure differential of orifice, in H_2O
Pm	28.19	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

$$Ps = Pb + \frac{Pg}{13.6}$$

where,

Pb	28.10	= barometric pressure, in. Hg
Pg	-0.40	= static pressure, in. H_2O
Ps	28.07	= in. Hg

Standard Meter Volume (Vmstd), dscf

$$Vmstd = \frac{17.636 \times Y \times Vm \times Pm}{Tm}$$

where,

Y	0.995	= meter correction factor
Vm	36.400	= meter volume, cf
Pm	28.19	= absolute meter pressure, in. Hg
Tm	529.2	= absolute meter temperature, °R
Vmstd	34.021	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04716 \times Vlc$$

where,

Vlc	161.7	= weight of H_2O collected, g
Vwstd	7.626	= scf

Moisture Fraction (BWSsat), dimensionless (theoretical at saturated conditions)

$$BWSsat = \frac{10^{6.37-\left(\frac{2,827}{Ts+365}\right)}}{Ps}$$

where,

Ts	341.5	= stack temperature, °F
Ps	28.07	= absolute stack gas pressure, in. Hg
BWSsat	8.267	= dimensionless

Moisture Fraction (BWS), dimensionless (measured)

$$BWS = \frac{Vwstd}{(Vwstd + Vmstd)}$$

where,

Vwstd	7.626	= standard wet volume, scf
Vmstd	34.021	= standard meter volume, dscf
BWS	0.183	= dimensionless

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 2
Project No.: AST-2024-1279
Run No.: 1
Parameter: PM

Moisture Fraction (BWS), dimensionless

$$BWS = BWSmsd \text{ unless } BWSsat < BWSmsd$$

where,

BWSsat	8.267	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.183	= moisture fraction (measured)
BWS	0.183	

Molecular Weight (DRY) (Md), lb/lb-mole

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O2) + (0.28\,(100 - \%CO_2 - \%O2))$$

where,

CO_2	15.4	= carbon dioxide concentration, %
O_2	4.6	= oxygen concentration, %
Md	30.65	= lb/lb mol

Molecular Weight (WET) (Ms), lb/lb-mole

$$Ms = Md\ (1 - BWS) + 18.015\,(BWS)$$

where,

Md	30.65	= molecular weight (DRY), lb/lb mol
BWS	0.183	= moisture fraction, dimensionless
Ms	28.33	= lb/lb mol

Average Velocity (Vs), ft/sec

$$Vs = 85.49 \times Cp \times (\Delta P^{1/2})\,avg \times \sqrt{\frac{Ts}{Ps \times Ms}}$$

where,

Cp	0.840	= pitot tube coefficient
$\Delta P^{1/2}$	0.526	= velocity head of stack gas, $(\text{in. } H_2O)^{1/2}$
Ts	801.2	= absolute stack temperature, °R
Ps	28.07	= absolute stack gas pressure, in. Hg
Ms	28.33	= molecular weight of stack gas, lb/lb mol
Vs	37.9	= ft/sec

Average Stack Gas Flow at Stack Conditions (Qa), acfm

$$Qa = 60 \times Vs \times As$$

where,

Vs	37.9	= stack gas velocity, ft/sec
As	4.75	= cross-sectional area of stack, ft^2
Qa	10,787	= acfm

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 2
Project No.: AST-2024-1279
Run No.: 1
Parameter: PM

Average Stack Gas Flow at Standard Conditions (Qs), dscfm

$$Qs = 17.636 \times Qa \times (1 - BWS) \times \frac{Ps}{Ts}$$

where,

Qa	10,787	= average stack gas flow at stack conditions, acfm
BWS	0.183	= moisture fraction, dimensionless
Ps	28.07	= absolute stack gas pressure, in. Hg
Ts	801.2	= absolute stack temperature, °R
Qs	5,445	= dscfm

Dry Gas Meter Calibration Check (Yqa), dimensionless

$$Yqa = \frac{Y - \left(\frac{\Theta}{Vm} \sqrt{\frac{0.0319 \times Tm \times 29}{\Delta H@ \times \left(Pb + \frac{\Delta Havg.}{13.6} \right) \times Md}} \sqrt{\Delta H}\ avg. \right)}{Y} \times 100$$

where,

Y	0.995	= meter correction factor, dimensionless
Θ	60	= run time, min.
Vm	36.4	= total meter volume, dcf
Tm	529.2	= absolute meter temperature, °R
ΔH@	1.764	= orifice meter calibration coefficient, in. H_2O
Pb	28.10	= barometric pressure, in. Hg
ΔH avg	1.192	= average pressure differential of orifice, in H_2O
Md	30.65	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.084	= average squareroot pressure differential of orifice, $(in. H2O)^{1/2}$
Yqa	-1.8	= percent

Volume of Nozzle (Vn), ft^3

$$Vn = \frac{Ts}{Ps} \left(0.002669 \times Vlc + \frac{Vm \times Pm \times Y}{Tm} \right)$$

where,

Ts	801.2	= absolute stack temperature, °R
Ps	28.07	= absolute stack gas pressure, in. Hg
Vlc	161.7	= volume of H_2O collected, ml
Vm	36.400	= meter volume, cf
Pm	28.19	= absolute meter pressure, in. Hg
Y	0.995	= meter correction factor, unitless
Tm	529.2	= absolute meter temperature, °R
Vn	67.376	= volume of nozzle, ft^3

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 2
Project No.: AST-2024-1279
Run No.: 1
Parameter: PM

Isokinetic Sampling Rate (I), %

$$I = \left(\frac{Vn}{\theta \times 60 \times An \times Vs}\right) \times 100$$

where,

Vn	67.376	= nozzle volume, ft3
θ	60.0	= run time, minutes
An	0.00049	= area of nozzle, ft^2
Vs	37.9	= average velocity, ft/sec
I	100.7	= %

Filterable PM Concentration (C_s), grain/dscf

$$C_s = \frac{M_n \times 0.0154}{Vmstd}$$

where,

Mn	198.4	= filterable PM mass, mg
Vmstd	34.021	= standard meter volume, dscf
C_s	0.090	= grain/dscf

Filterable PM Emission Rate (PMR), lb/hr

$$PMR = \frac{C_s \times Qs \times 60}{7.0E+03}$$

where,

C_s	0.0900	= filterable PM concentration, grain/dscf
Qs	5,445	= average stack gas flow at standard conditions, dscfm
PMR	4.2	= lb/hr

Filterable PM Emission Rate (ER_{PMTPY}), ton/yr

$$ER_{PMTPY} = \frac{PMR \times 8{,}760}{2.0E+03}$$

where,

PMR	4.2	= filterable PM emission rate, lb/hr
ER_{PMTPY}	18.4	= ton/yr

Filterable PM Emission Factor ($EF_{PM\ O2d}$), lb/MMBtu

$$EF_{PMO2d} = \frac{M_n \times Fd}{Vmstd \times 4.54E+05} \times \frac{20.9}{20.9 - O_2}$$

where,

Mn	198.4	= filterable PM mass, mg
Fd	9,600	= oxygen based fuel factor, dscf/MMBtu
Vmstd	34.021	= standard meter volume, dscf
O_2	4.6	= oxygen concentration, %
$EF_{PM\ O2d}$	0.16	= lb/MMBtu

Alliance TECHNICAL GROUP

Emission Calculations

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279
Parameter PM

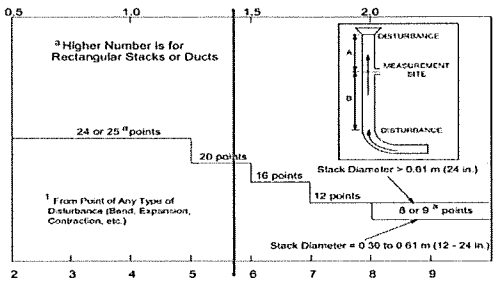
Run Number		Run 1	Run 2	Run 3	Average
Date		2/27/24	2/27/24	2/27/24	--
Start Time		8:10	10:10	12:10	--
Stop Time		9:17	11:14	13:12	--
Run Time, min	(θ)	60.0	60.0	60.0	60.0
INPUT DATA					
Fuel Factor (O2 dry), dscf/MMBtu	(Fd)	9,600	9,600	9,600	9,600
Barometric Pressure, in. Hg	(Pb)	28.10	28.10	28.10	28.10
Meter Correction Factor	(Y)	0.995	0.995	0.995	0.995
Orifice Calibration Value	(ΔH @)	1.764	1.764	1.764	1.764
Meter Volume, ft^3	(Vm)	36.400	36.750	35.850	36.333
Meter Temperature, °F	(Tm)	69.6	73.9	72.8	72.1
Meter Temperature, °R	(Tm)	529.2	533.6	532.4	531.7
Meter Orifice Pressure, in. WC	(ΔH)	1.192	1.197	1.131	1.173
Volume H_2O Collected, mL	(Vlc)	161.7	163.4	139.9	155.0
Nozzle Diameter, in	(Dn)	0.300	0.300	0.300	0.300
Area of Nozzle, ft^2	(An)	0.0005	0.0005	0.0005	0.0005
Filterable PM Mass, mg	(Mn)	198.4	200.8	183.4	194.2
ISOKINETIC DATA					
Standard Meter Volume, ft^3	(Vmstd)	34.021	34.069	33.300	33.797
Standard Water Volume, ft^3	(Vwstd)	7.626	7.706	6.598	7.310
Moisture Fraction Measured	(BWSmsd)	0.183	0.184	0.165	0.178
Moisture Fraction @ Saturation	(BWSsat)	8.267	8.529	8.386	8.394
Moisture Fraction	(BWS)	0.183	0.184	0.165	0.178
Meter Pressure, in Hg	(Pm)	28.19	28.19	28.18	28.19
Volume at Nozzle, ft^3	(Vn)	67.376	67.785	64.637	66.60
Isokinetic Sampling Rate, (%)	(I)	100.7	100.0	97.4	99.3
DGM Calibration Check Value, (+/- 5%)	(Y_{qa})	-1.8	-1.4	-0.8	-1.3
EMISSION CALCULATIONS					
Filterable PM Concentration, grain/dscf	(C_s)	0.090	0.091	0.085	0.089
Filterable PM Emission Rate, lb/hr	(PMR)	4.2	4.3	4.0	4.2
Filterable PM Emission Rate, ton/yr	(ER_{FPM})	18.4	18.7	17.6	18.2
Filterable PM Emission Factor, lb/MMBtu (O2)	($EF_{PM\ O2d}$)	0.16	0.16	0.14	0.15

Method 1 Data

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279
Date: 02/26/24

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	34.00	in
Nipple Length:	4.50	in
Depth of Duct:	29.50	in
Cross Sectional Area of Duct:	4.75	ft^2
No. of Test Ports:	2	
Distance A:	15.0	ft
Distance A Duct Diameters:	6.1	(must be ≥ 0.5)
Distance B:	14.0	ft
Distance B Duct Diameters:	5.7	(must be ≥ 2)
Minimum Number of Traverse Points:	20	
Actual Number of Traverse Points:	20	
Number of Readings per Point:	1	
Measurer (Initial and Date):	LP 2/26	
Reviewer (Initial and Date):	RA 2/26	



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LOCATION OF TRAVERSE POINTS

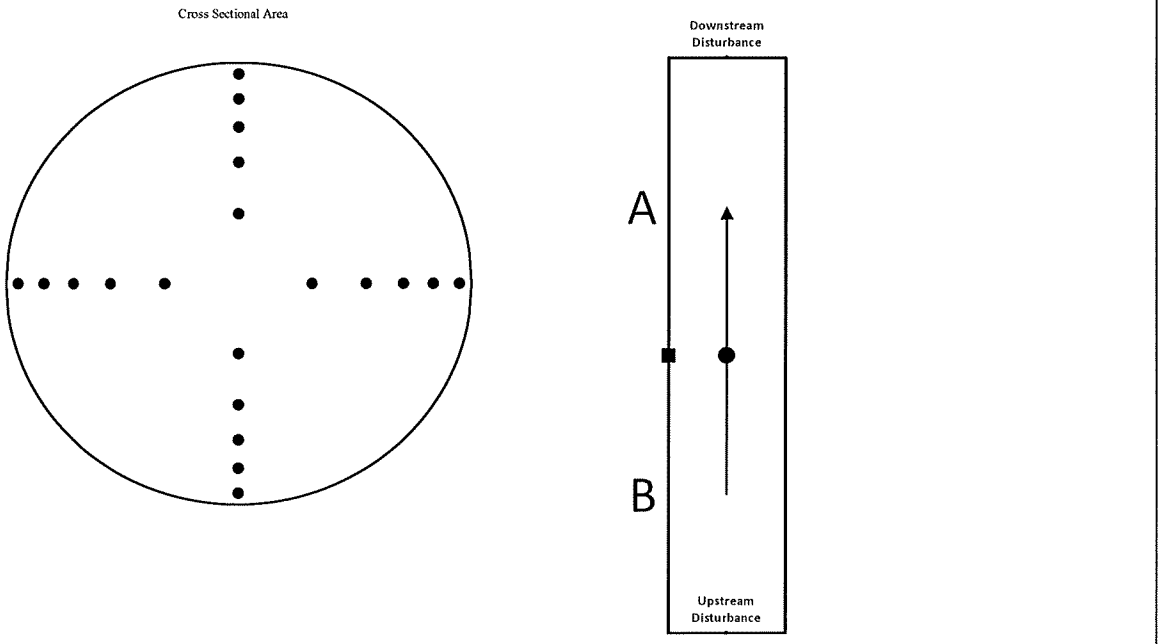
Number of traverse points on a diameter

	2	3	4	5	6	7	8	9	10	11	12
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

**Percent of stack diameter from inside wall to traverse point.*

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	2.6	1.00	5 1/2
2	8.2	2.42	6 15/16
3	14.6	4.31	8 13/16
4	22.6	6.67	11 3/16
5	34.2	10.09	14 9/16
6	65.8	19.41	23 15/16
7	77.4	22.83	27 5/16
8	85.4	25.19	29 11/16
9	91.8	27.08	31 9/16
10	97.4	28.50	33
11	--	--	--
12	--	--	--

Stack Diagram
A = 15 ft.
B = 14 ft.
Depth of Duct = 29.5 in.



Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279
Parameter PM

Run Number		Run 1	Run 2	Run 3	Average
Date		2/27/24	2/27/24	2/27/24	--
Start Time		8:10	10:10	12:10	--
Stop Time		9:17	11:14	13:12	--
Run Time, min		60.0	60.0	60.0	60.0
VELOCITY HEAD, in. WC					
Point 1		0.18	0.23	0.17	0.19
Point 2		0.20	0.25	0.19	0.21
Point 3		0.21	0.27	0.21	0.23
Point 4		0.22	0.29	0.23	0.25
Point 5		0.26	0.35	0.25	0.29
Point 6		0.34	0.43	0.32	0.36
Point 7		0.35	0.40	0.35	0.37
Point 8		0.34	0.38	0.31	0.34
Point 9		0.27	0.30	0.25	0.27
Point 10		0.26	0.27	0.17	0.23
Point 11		0.19	0.16	0.23	0.19
Point 12		0.22	0.20	0.27	0.23
Point 13		0.26	0.22	0.28	0.25
Point 14		0.30	0.24	0.29	0.28
Point 15		0.31	0.26	0.32	0.30
Point 16		0.40	0.34	0.41	0.38
Point 17		0.40	0.35	0.40	0.38
Point 18		0.35	0.33	0.35	0.34
Point 19		0.28	0.24	0.29	0.27
Point 20		0.26	0.22	0.27	0.25
CALCULATED DATA					
Square Root of ΔP, $(\text{in. WC})^{1/2}$	(ΔP)	0.526	0.531	0.523	0.527
Pitot Tube Coefficient	(Cp)	0.840	0.840	0.840	0.840
Barometric Pressure, in. Hg	(Pb)	28.10	28.10	28.10	28.10
Static Pressure, in. WC	(Pg)	-0.40	-0.40	-0.40	-0.40
Stack Pressure, in. Hg	(Ps)	28.07	28.07	28.07	28.07
Stack Cross-sectional Area, ft^2	(As)	4.75	4.75	4.75	4.75
Temperature, °F	(Ts)	341.5	343.9	342.6	342.7
Temperature, °R	(Ts)	801.2	803.6	802.3	802.3
Moisture Fraction Measured	(BWSmsd)	0.183	0.184	0.165	0.178
Moisture Fraction @ Saturation	(BWSsat)	8.267	8.529	8.386	8.394
Moisture Fraction	(BWS)	0.183	0.184	0.165	0.178
O_2 Concentration, %	(O_2)	4.6	4.3	3.8	4.23
CO_2 Concentration, %	(CO_2)	15.4	15.5	16	15.63
Molecular Weight, lb/lb-mole (dry)	(Md)	30.65	30.65	30.71	30.67
Molecular Weight, lb/lb-mole (wet)	(Ms)	28.33	28.32	28.61	28.42
Velocity, ft/sec	(Vs)	37.9	38.4	37.6	37.9
VOLUMETRIC FLOW RATE					
At Stack Conditions, acfm	(Qa)	10,787	10,924	10,698	10,803
At Standard Conditions, scfm	(Qsw)	6,665	6,730	6,601	6,665
At Standard Conditions, dscfm	(Qs)	5,445	5,488	5,510	5,481

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Method 2 Data

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279
Date 2/27/24

Saturation Moisture Content Check		
Stack Temperature (Ts):	363.0	°F
Moisture Fraction @ Sat.:	10.574	

Stack Parameters		
Pitot Tube ID#:		
Pitot Tube Coefficient (Cp):	0.840	
Barometric Pressure (Pb):	28.85	in. Hg
Static Pressure(Pg):	-0.40	in. WC
Stack Pressure (Ps):	28.82	in. Hg

Calculations	
Square Root of ΔP, (in. W.C.) $^{1/2}$	0.575
Average ΔP, (in. W.C.)	0.33
Average Temperature (Ts), °F	363.0
Average Temperature (Ts), °R	822.7
Moisture (BWS), % (enter as percent)	16.0
O_2 Concentration, %	6.0
CO_2 Concentration, %	12.0
Molecular Weight (Md), lb/lb-mole (dry)	30.16
Molecular Weight (Ms), lb/lb-mole (wet)	28.21
Velocity (Vs), ft/sec	41.5
VFR at stack conditions (Qa), acfm	11,832
VFR at standard conditions (Qs), dscfm	6,141

Traverse Point	Δ P (in. WC)	Ts (°F)
1	0.24	363
2	0.27	363
3	0.31	363
4	0.32	363
5	0.32	363
6	0.46	363
7	0.42	363
8	0.41	363
9	0.40	363
10	0.36	363
11	0.23	363
12	0.24	363
13	0.27	363
14	0.29	363
15	0.37	363
16	0.38	363
17	0.40	363
18	0.36	363
19	0.33	363
20	0.30	363

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Cyclonic Flow Check

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279
Date 02/27/24

Sample Point	Angle (ΔP=0)
1	5
2	5
3	5
4	0
5	0
6	0
7	0
8	5
9	0
10	5
11	10
12	10
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
Average	2

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Method 3/3A Data

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279

	O_2 Data			CO_2 Data		
	Date/Time	2/28/24	14:30	Date/Time	2/28/24	14:30
Make/Model/SN	Servomex	1420C	TR16	Servomex	1420C	2553-0144001
Parameter	Cylinder ID	Cylinder Concentration, %	Analyzer Concentration, %	Cylinder ID	Cylinder Concentration, %	Analyzer Concentration, %
Zero Gas		0.00	0.00		0.00	0.00
High Range Gas	CC458895	20.90	20.95	CC458895	16.90	16.91
Mid Range Gas	CC480335	10.95	11.03	CC480335	8.43	8.33
Concentration Span, %	20.9			16.9		
Required Accuracy, %	0.42			0.34		

Run No.	Run 1		Run 2		Run 3	
Analysis Date/Time	2/28/2024	15:00	2/28/2024	15:15	2/28/2024	15:30
Parameter	O_2 %	CO_2 %	O_2 %	CO_2 %	O_2 %	CO_2 %
Analysis #1	4.60	15.40	4.30	15.50	3.80	16.00
Analysis #2	4.60	15.40	4.30	15.50	3.80	16.00
Analysis #3	4.60	15.40	4.30	15.50	3.80	16.00
Average	4.6	15.4	4.3	15.5	3.8	16.0

The remaining consistuent is assumed to be nitrogen.

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Method 4 Data

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 2
Project No. AST-2024-1279
Parameter PM
Analysis Gravimetric

Run 1	Date:	2/27/24			
Impinger No.	1	2	3	4	Total
Contents	H2O	H2O	Empty	Silica	--
Initial Mass, g	749.7	769.4	608.9	1590.6	3718.6
Final Mass, g	829.4	830.6	616.5	1603.8	3880.3
Gain	79.7	61.2	7.6	13.2	161.7
Run 2	**Date:**	2/27/24			
Impinger No.	1	2	3	4	Total
Contents	H2O	H2O	Empty	Silica	--
Initial Mass, g	761.1	806.0	616.5	1566.0	3749.6
Final Mass, g	856.9	840.7	635.3	1580.1	3913.0
Gain	95.8	34.7	18.8	14.1	163.4
Run 3	**Date:**	2/27/24			
Impinger No.	1	2	3	4	Total
Contents	H2O	H2O	Empty	Silica	--
Initial Mass, g	742.6	795.6	635.3	1580.1	3753.6
Final Mass, g	841.6	823.5	639.9	1588.5	3893.5
Gain	99.0	27.9	4.6	8.4	139.9

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Isokinetic Field Data

Location:	PotlatchDeltic / Gwinn Sawmill - Gwinn, MI	Start Time:	8:10	Source:	Boiler No. 2
Date:	2/27/24	Run 1	VALID	End Time:	9:17	Project No.:	AST-2024-1279	Parameter:	PM

STACK DATA (EST)			EQUIPMENT			STACK DATA (EST)			FILTER NO.	STACK DATA (FINAL)			MOIST. DATA
Moisture:	16.0	% est.	Meter Box ID:	17		Est. Tm:	70	°F	KQ82-23-045	Pb:	28.10	in. Hg	Vlc (ml)
Barometric:	28.85	in. Hg	Y:	0.995		Est. Ts:	363	°F		Pg:	-0.40	in. WC	161.7
Static Press:	-0.40	in. WC	ΔH @ (in.WC):	1.764		Est. ΔP:	0.33	in. WC		O_2:	4.6	%	K-FACTOR
Stack Press:	28.82	in. Hg	Probe ID:	05-04-G1		Est. Dn:	0.276	in.		CO_2:	15.4	%	4.123
CO_2:	12.0	%	Liner Material:	glass		Target Rate:	0.56	scfm					
O_2:	6.0	%	Pitot ID:	05-04-G1		LEAK CHECK!	Pre	Mid 1	Mid 2	Mid 3	Post	Check Pt.	Initial	Final	Corr.
N_2/CO:	82.0	%	Pitot Cp/Type:	0.840	S-type	Leak Rate (cfm):	0.000	--	--	--	0.000	Mid 1 (cf)			--
Md:	30.16	lb/lb-mole	Nozzle ID:	ss	SS	Vacuum (in Hg):	16	--	--	--	15	Mid 2 (cf)			--
Ms:	28.21	lb/lb-mole	Nozzle Dn (in.):	0.300		Pitot Tube:	Pass	--	--	--	Pass	Mid 3 (cf)			--
												Mid-Point Leak Check Vol (cf):			--

Sample Pt.	Sample Time (minutes)		Dry Gas Meter Reading (ft^3)	Pitot Tube ΔP (in WC)	Gas Temperatures (°F)		Orifice Press. ΔH (in. WC)		Pump Vac (in. Hg)	Gas Temperatures (°F)				% ISO	Vs (fps)
					DGM Average	Stack				Probe	Filter	Imp Exit	Aux		
					Amb.	Amb.				Amb.	Amb.	Amb.	Amb.		
	Begin	End			60	34	Ideal	Actual		34	34	34	-		
1	0.00	3.00	387.610	0.18	63	336	0.76	0.76	2	253	247	42	-	103.9	30.14
2	3.00	6.00	389.140	0.20	64	338	0.84	0.84	2	251	248	42	-	100.5	31.81
3	6.00	9.00	390.700	0.21	65	342	0.88	0.88	2	251	246	42	-	97.5	32.67
4	9.00	12.00	392.250	0.22	65	342	0.92	0.92	2	252	247	42	-	99.6	33.44
5	12.00	15.00	393.870	0.26	66	341	1.09	1.10	3	253	248	42	-	97.6	36.33
6	15.00	18.00	395.600	0.34	67	348	1.42	1.40	5	251	249	43	-	95.0	41.73
7	18.00	21.00	397.520	0.35	67	344	1.47	1.50	5	255	244	43	-	97.3	42.24
8	21.00	24.00	399.520	0.34	68	334	1.45	1.50	5	251	247	43	-	97.5	41.37
9	24.00	27.00	401.510	0.27	70	340	1.15	1.20	6	254	249	43	-	103.8	37.00
10	27.00	30.00	403.400	0.26	71	339	1.11	1.10	5	251	250	43	-	101.0	36.29
1	30.00	33.00	405.210	0.19	71	334	0.82	0.80	5	251	252	44	-	98.2	30.92
2	33.00	36.00	406.720	0.22	71	338	0.94	0.94	5	251	253	43	-	100.0	33.36
3	36.00	39.00	408.370	0.26	72	340	1.11	1.10	6	250	256	43	-	99.8	36.31
4	39.00	42.00	410.160	0.30	72	345	1.27	1.30	7	251	256	44	-	101.0	39.13
5	42.00	45.00	412.100	0.31	72	346	1.31	1.30	7	252	257	44	-	96.4	39.80
6	45.00	48.00	413.980	0.40	72	349	1.68	1.70	9	251	256	44	-	96.0	45.29
7	48.00	51.00	416.100	0.40	72	353	1.68	1.70	11	253	255	44	-	97.5	45.40
8	51.00	54.00	418.250	0.35	74	344	1.49	1.50	11	254	260	44	-	98.0	42.24
9	54.00	57.00	420.290	0.28	74	339	1.20	1.20	10	256	258	44	-	102.2	37.66
10	57.00	60.00	422.200	0.26	75	338	1.12	1.10	10	258	260	44	-	100.2	36.27
	Final DGM:		424.010												

RESULTS	Run Time		Vm		ΔP		Tm		Ts		Max Vac	ΔH		%ISO	BWS	Y_{qs}
	60.0	min	36.400	ft^3	0.28	in. WC	69.6	°F	341.5	°F	11	1.192	in. WC	100.7	0.183	-1.8

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Isokinetic Field Data

Location:	PotlatchDeltic / Gwinn Sawmill - Gwinn, MI		Start Time:	10:10	Source:	Boiler No. 2	
Date:	2/27/24	Run 2 VALID	End Time:	11:14	Project No.:	AST-2024-1279	Parameter: PM

STACK DATA (EST)		EQUIPMENT		STACK DATA (EST)		FILTER NO.	STACK DATA (FINAL)		MOIST. DATA
Moisture:	17.0 % est.	Meter Box ID:	17	Est. Tm:	70 °F	KQ82-23-046	Pb:	28.10 in. Hg	Vlc (ml)
Barometric:	28.85 in. Hg	Y:	0.995	Est. Ts:	342 °F		Pg:	-0.40 in. WC	163.4
Static Press:	-0.40 in. WC	ΔH @ (in.WC):	1.764	Est. ΔP:	0.28 in. WC		O_2:	4.3 %	K-FACTOR
Stack Press:	28.82 in. Hg	Probe ID:	05-04-A1	Est. Dn:	0.288 in.		CO_2:	15.5 %	4.15
CO_2:	12.0 %	Liner Material:	glass	Target Rate:	0.56 scfm				
O_2:	6.0 %	Pitot ID:	05-04-A1	LEAK CHECKS	Pre / Mid 1 / Mid 2 / Mid 3 / Post		Check Pt.	Initial / Final / Corr.	
N_2/CO:	82.0 %	Pitot Cp/Type:	0.840 S-type	Leak Rate (cfm):	0.000 / -- / -- / -- / 0.000		Mid 1 (cf)		--
Md:	30.16 lb/lb-mole	Nozzle ID:	ss SS	Vacuum (in Hg):	16 / -- / -- / -- / 15		Mid 2 (cf)		--
Ms:	28.09 lb/lb-mole	Nozzle Dn (in.):	0.300	Pitot Tube:	Pass / -- / -- / --		Mid 3 (cf)		--
							Mid-Point Leak Check Vol (cf):		--

Sample Pt.	Sample Time (minutes) Begin	End	Dry Gas Meter Reading (ft^3)	Pitot Tube ΔP (in WC)	Gas Temperatures (°F) DGM Average Amb.	Stack Amb.	Orifice Press. ΔH (in. WC) Ideal	Actual	Pump Vac (in. Hg)	Gas Temperatures (°F) Probe Amb.	Filter Amb.	Imp Exit Amb.	Aux Amb.	% ISO	Vs (fps)
1	0.00	3.00	424.450	0.23	72	340	0.96	0.96	2	242	245	41	-	102.3	34.23
2	3.00	6.00	426.160	0.25	72	343	1.04	1.00	2	251	252	44	-	100.0	35.75
3	6.00	9.00	427.900	0.27	73	347	1.12	1.10	3	256	253	44	-	98.0	37.25
4	9.00	12.00	429.670	0.29	73	349	1.20	1.20	3	258	260	45	-	99.0	38.65
5	12.00	15.00	431.520	0.35	73	350	1.45	1.50	5	260	256	45	-	99.0	42.48
6	15.00	18.00	433.550	0.43	73	352	1.77	1.70	6	258	258	45	-	97.0	47.15
7	18.00	21.00	435.750	0.40	74	346	1.66	1.70	7	256	254	45	-	96.8	45.31
8	21.00	24.00	437.880	0.38	75	348	1.58	1.60	7	255	258	45	-	98.8	44.21
9	24.00	27.00	440.000	0.30	75	340	1.26	1.30	7	256	256	45	-	101.7	39.09
10	27.00	30.00	441.950	0.27	76	344	1.13	1.10	6	255	257	45	-	99.5	37.18
1	30.00	33.00	443.760	0.16	77	341	0.68	0.67	5	254	256	45	-	103.7	28.56
2	33.00	36.00	445.220	0.20	76	345	0.84	0.84	5	255	258	45	-	99.0	32.02
3	36.00	39.00	446.770	0.22	76	343	0.92	0.92	5	254	258	45	-	97.3	33.54
4	39.00	42.00	448.370	0.24	75	343	1.01	1.00	6	252	256	43	-	98.6	35.03
5	42.00	45.00	450.060	0.26	73	348	1.08	1.10	8	251	255	44	-	99.9	36.57
6	45.00	48.00	451.830	0.34	73	348	1.41	1.40	10	255	258	44	-	96.9	41.82
7	48.00	51.00	453.790	0.35	73	349	1.45	1.50	10	255	254	44	-	96.5	42.46
8	51.00	54.00	455.770	0.33	73	339	1.38	1.40	11	253	255	44	-	100.3	40.97
9	54.00	57.00	457.780	0.24	73	335	1.01	1.00	10	254	256	44	-	103.2	34.85
10	57.00	60.00	459.550	0.22	73	328	0.94	0.94	10	253	255	44	-	100.0	33.22
	Final DGM:		461.200												

RESULTS	Run Time		Vm		ΔP		Tm		Ts		Max Vac	ΔH		%ISO	BWS	Y_{qs}
	60.0	min	36.750	ft^3	0.29	in. WC	73.9	°F	343.9	°F	11	1.197	in. WC	100.0	0.184	-1.4