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 Waste Boiler 1	EU-WOODBOILER1	PM, CO, benzo (a) pyrene

Contact Information

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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

12/19/2023
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. Portions of the facility are subject to provisions of the Michigan EGLE Permit No. MI-ROP-N5940-2019A. Testing was conducted to determine the emission rates of particulate matter (PM), carbon monoxide (CO) and benzo (a) pyrene from the exhaust of Wood Waste Boiler No. 1.

1.1 Facility Description

The PotlatchDeltic Corporation owns and operates the Wood Waste Boiler No. 1 at the Gwinn Sawmill. The Wood Waste Boiler 1 is a Hurst and Welding Co. Inc. Model No. HYB-4000-150-WF (SN. No. HYB3948-300-2). 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 Corbin Godfrey Colin Kelly Leo Peters

1.3 Site Specific Test Plan & Notification

Testing was conducted in accordance with the Site Specific Test Plan (SSTP) approved by EGLE on November 1, 2023.

1.4 Test Program Notes

Testing was originally planned to have both Boiler 1 and Boiler 2 be tested, however due to mechanical issues, only Boiler 1 was tested. Testing for Boiler 2 has been postponed to a future date.

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2.0 Summary of Results

Alliance conducted compliance testing at the PotlatchDeltic facility in Gwinn, MI on November 7, 2023. Testing consisted of determining the emission rates of PM, CO, and benzo (a) pyrene at the exhaust of Wood Waste Boiler No. 1.

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

Table 2-1: Summary of Results - PM and Gases

Run Number	Run 1	Run 2	Run 3	Average
Date	**11/7/23**	**11/7/23**	**11/7/23**	**--**
Filterable Particulate Matter Data				
Concentration, grain/dscf	0.085	0.079	0.078	0.081
Emission Rate, lb/hr	4.2	4.0	3.8	4.0
Permit Limit, lb/hr	--	--	--	5.7
Percent of Limit, %	--	--	--	**70**
Emission Rate, ton/yr	18.3	17.4	16.5	17.4
Permit Limit, ton/yr	--	--	--	25.1
Percent of Limit, %	--	--	--	**69**
Emission Factor, lb/MMBtu	0.14	0.16	0.14	0.15
Permit Limit, lb/MMBtu	--	--	--	0.2
Percent of Limit, %	--	--	--	**74**
Carbon Monoxide Data				
Emission Rate, lb/hr	2.9	3.0	2.9	2.9
Permit Limit, lb/hr	--	--	--	14.35
Percent of Limit, %	--	--	--	**20**
Emission Rate, ton/yr	12.6	13.3	12.5	12.8
Permit Limit, ton/yr	--	--	--	62.85
Percent of Limit, %	--	--	--	**20**
Emission Factor, lb/MMBtu	0.099	0.122	0.107	0.109
Permit Limit, lb/MMBtu	--	--	--	0.50
Percent of Limit, %	--	--	--	**22**

Table 2-2: Summary of Results - Benzo[a]pyrene

Run Number	Run 1	Run 2	Run 3	Average
Date	**11/7/23**	**11/7/23**	**11/7/23**	**--**
Benzo[a]pyrene Data				
Concentration, ug/dscm	1.7	1.6	1.6	1.7
Permit Limit, ug/dscm	--	--	--	9.7
Percent of Limit, %	--	--	--	**17**
Emission Rate, lb/hr	3.8E-05	3.9E-05	3.9E-05	3.8E-05
Permit Limit, lb/hr	--	--	--	0.0006
Percent of Limit, %	--	--	--	**6**
Emission Rate, ton/yr	1.7E-04	1.7E-04	1.7E-04	1.7E-04
Permit Limit, ton/yr	--	--	--	0.0027
Percent of Limit, %	--	--	--	**6**

Note: Underlined results indicate the laboratory results were below the minimum detection limit (MDL). The MDL was reported and used in subsequent calculations.

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
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Moisture Content	4	Gravimetric Analysis
Particulate Matter	5	Isokinetic Sampling
Carbon Monoxide	10	Instrumental Analysis
Mass Emission Factors	19	Fuel Factors/Heat Inputs
Benzo (a) Pyrene	SW 846-0010	Isokinetic Sampling

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 (for isokinetic sampling) and/or Figure 1-2 (measuring velocity alone) 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 3/3A – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3/3A. One (1) integrated Tedlar bag sample was collected during each test run. The bag samples were analyzed on site with a gas analyzer. The remaining stack gas constituent was assumed to be nitrogen for the stack gas molecular weight determination. The quality control measures are described in Section 3.9.

3.3 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 3.10.

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

The stack gas moisture content 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.

3.5 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 and nozzle were 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.

3.6 U.S. EPA Reference Test Method 10 – Carbon Monoxide

The carbon monoxide (CO) testing was conducted in accordance with U.S. EPA Reference Test Method 10. 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 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 3.10.

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

Fuel samples were procured and sent to the identified analytical laboratory. The laboratory analysis was used to calculate a dry O_2 based F-Factor in accordance with U.S. EPA Reference Test Method 19. The mass emission factor (lb/MMBtu) was calculated using the pollutant concentration, O_2 concentration and the calculated F-Factor.

3.8 SW-846 Test Method 0010 – Beno (a) Pyrene

The benzo (a) pyrene testing was conducted in accordance with SW-846 Test Method 0010. The sampling system consisted of a stainless steel or glass nozzle, heated glass or quartz-lined probe, glass filter holder with pre-cleaned glass-fiber filter, condenser coil, XAD sorbent module, gas conditioning train, pump and calibrated dry gas meter. The gas conditioning system consisted of four (4) chilled impingers. The first impinger (shortened stem) was empty and used for moisture knockout. The next two (2) impingers each contained 100 mL of water. The fourth impinger was charged with 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 below at 20°C (68°F) or less throughout testing.

All glassware leading to the XAD adsorbing resin trap was cleaned and sealed before mobilizing to the site. The sampling train was assembled in the sample recovery area. The pre-cleaned quartz filter was placed in a glass filter holder with a Teflon filter support and connected to the condenser coil. All open ends of the sampling train were sealed with Teflon tape prior to complete assembly at the sampling location.

Following the completion of each test run, the sampling train was leak checked at vacuum pressure greater than or equal to the highest vacuum pressure observed during the run. The XAD sorbent module was sealed on both ends and placed on ice. The filter was removed from the filter holder and placed in container 1. The nozzle, probe liner and front half of the filter holder were triple-rinsed and brushed with methanol/methylene chloride (1:1 v/v), and these rinses were recovered in container 2. The contents of the impingers were measured for moisture gain along with any moisture collected in the back half of the filter housing and the gas-conditioning section of the organic module. The impinger contents and condensate were then be transferred to container 3. The back half of the filter holder and coil condenser glassware were triple-rinsed with methanol/methylene chloride and recovered in container 4. All samples were sealed, labeled and liquid levels marked for transport to the identified laboratory for analysis.

3.9 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.

3.10 Quality Assurance/Quality Control – U.S. EPA Reference Test Methods 3A and 10

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 ppmv/% absolute difference.

High or Mid Level gas (whichever was closer to the stack gas concentration) was introduced at the probe and the time required for the analyzer reading to reach 95 percent or 0.5 ppmv/% (whichever was less restrictive) of the gas concentration was recorded. The analyzer reading was observed until it reached a stable value, and this value was recorded. Next, Low Level gas was introduced at the probe and the time required for the analyzer reading to decrease to a value within 5.0 percent or 0.5 ppmv/% (whichever was less restrictive) was recorded. If the Low-Level gas was zero gas, the response was 0.5 ppmv/% or 5.0 percent of the upscale gas concentration (whichever was less restrictive). The analyzer reading was observed until it reached a stable value and this value was recorded. The measurement system response time and initial system bias were determined from these data. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

High or Mid Level gas (whichever was closer to the stack gas concentration) was introduced at the probe. After the analyzer response was stable, the value was recorded. Next, Low Level gas was introduced at the probe, and the analyzer value recorded once it reached a stable response. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference or the data was invalidated and the Calibration Error Test and System Bias were repeated.

Drift between pre- and post-run System Bias was within 3 percent of the Calibration Span or 0.5 ppmv/% absolute difference. If the drift exceeded 3 percent or 0.5 ppmv/%, the Calibration Error Test and System Bias were repeated.

To determine the number of sampling points, a gas stratification check was conducted prior to initiating testing. The pollutant concentrations were measured at three points (16.7, 50.0 and 83.3 percent of the measurement line). Each traverse point was sampled for a minimum of twice the system response time.

If the pollutant concentration at each traverse point did not differ more than 5 percent or 0.5 ppmv/0.3% (whichever was less restrictive) of the average pollutant concentration, then single point sampling was conducted during the test runs. If the pollutant concentration did not meet these specifications but differed less than 10 percent or 1.0 ppmv/0.5% from the average concentration, then three (3) point sampling was conducted (stacks less than 7.8 feet in diameter - 16.7, 50.0 and 83.3 percent of the measurement line; stacks greater than 7.8 feet in diameter – 0.4, 1.0, and 2.0 meters from the stack wall). If the pollutant concentration differed by more than 10 percent or 1.0 ppmv/0.5% from the average concentration, then sampling was conducted at a minimum of twelve (12) traverse points. Copies of stratification check data can be found in the Quality Assurance/Quality Control Appendix.

A Data Acquisition System with battery backup was used to record the instrument response in one (1) minute averages. The data was continuously stored as a *.CSV file in Excel format on the hard drive of a computer. 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.

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No.: 1
Parameter: PM

Meter Pressure (Pm), in. Hg

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

where,

Pb	28.80	= barometric pressure, in. Hg
ΔH	1.330	= pressure differential of orifice, in H_2O
Pm	28.90	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

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

where,

Pb	28.80	= barometric pressure, in. Hg
Pg	-0.36	= static pressure, in. H_2O
Ps	28.77	= in. Hg

Standard Meter Volume (Vmstd), dscf

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

where,

Y	0.9843	= meter correction factor
Vm	37.850	= meter volume, cf
Pm	28.90	= absolute meter pressure, in. Hg
Tm	528.3	= absolute meter temperature, °R
Vmstd	35.942	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04716 \times Vlc$$

where,

Vlc	202.9	= weight of H_2O collected, g
Vwstd	9.569	= scf

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

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

where,

Ts	332.4	= stack temperature, °F
Ps	28.77	= absolute stack gas pressure, in. Hg
BWSsat	7.150	= dimensionless

Moisture Fraction (BWS), dimensionless (measured)

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

where,

Vwstd	9.569	= standard wet volume, scf
Vmstd	35.942	= standard meter volume, dscf
BWS	0.210	= dimensionless

Moisture Fraction (BWS), dimensionless

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

where,

BWSsat	7.150	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.210	= moisture fraction (measured)
BWS	0.210	

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No.: 1
Parameter: PM

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	15.7	= carbon dioxide concentration, %
O_2	5.3	= oxygen concentration, %
Md	30.73	= lb/lb mol

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

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

where,

Md	30.73	= molecular weight (DRY), lb/lb mol
BWS	0.210	= moisture fraction, dimensionless
Ms	28.06	= 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
$\Delta P^{1/2}$	0.557	= velocity head of stack gas, $(in.\ H_2O)^{1/2}$
Ts	792.1	= absolute stack temperature, °R
Ps	28.77	= absolute stack gas pressure, in. Hg
Ms	28.06	= molecular weight of stack gas, lb/lb mol
Vs	39.6	= ft/sec

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

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

where,

Vs	39.6	= stack gas velocity, ft/sec
As	4.75	= cross-sectional area of stack, ft^2
Qa	11,281	= acfm

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

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

where,

Qa	11,281	= average stack gas flow at stack conditions, acfm
BWS	0.210	= moisture fraction, dimensionless
Ps	28.77	= absolute stack gas pressure, in. Hg
Ts	792.1	= absolute stack temperature, °R
Qs	5,708	= 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	0.9843	= meter correction factor, dimensionless
Θ	60	= run time, min.
Vm	37.85	= total meter volume, dcf
Tm	528.3	= absolute meter temperature, °R
ΔH@	1.84	= orifice meter calibration coefficient, in. H_2O
Pb	28.80	= barometric pressure, in. Hg
ΔH avg	1.330	= average pressure differential of orifice, in H_2O
Md	30.73	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.145	= average squareroot pressure differential of orifice, $(in.\ H2O)^{1/2}$
Yqa	-0.9	= percent

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Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No.: 1
Parameter: PM

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	792.1	= absolute stack temperature, °R
Ps	28.77	= absolute stack gas pressure, in. Hg
Vlc	202.9	= volume of H_2O collected, ml
Vm	37.850	= meter volume, cf
Pm	28.90	= absolute meter pressure, in. Hg
Y	0.984	= meter correction factor, unitless
Tm	528.3	= absolute meter temperature, °R
Vn	71.009	= volume of nozzle, ft^3

Isokinetic Sampling Rate (I), %

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

where,

Vn	71.009	= nozzle volume, ft3
θ	60.0	= run time, minutes
An	0.00049	= area of nozzle, ft^2
Vs	39.6	= average velocity, ft/sec
I	100.8	= %

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No. /Method Run 1 / Method 3A

O_2 - Outlet Concentration (C_{O_2}), % dry

$$C_{O_2} = (C_{obs} - C_0) \times \left(\frac{C_{MA}}{(C_M - C_0)} \right)$$

where,

C_{obs}	5.27	= average analyzer value during test, % dry
C_o	-0.05	= average of pretest & posttest zero responses, % dry
C_{MA}	11.08	= actual concentration of calibration gas, % dry
C_M	10.99	= average of pretest & posttest calibration responses, % dry
C_{O_2}	5.3	= O_2 Concentration, % dry

CO_2 - Outlet Concentration (C_{CO_2}), % dry

$$C_{CO_2} = (C_{obs} - C_0) \times \left(\frac{C_{MA}}{(C_M - C_0)} \right)$$

where,

C_{obs}	15.02	= average analyzer value during test, % dry
C_o	0.09	= average of pretest & posttest zero responses, % dry
C_{MA}	8.51	= actual concentration of calibration gas, % dry
C_M	8.17	= average of pretest & posttest calibration responses, % dry
C_{CO_2}	15.7	= CO_2 Concentration, % dry

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No. /Method Run 1 / Method 10

CO - Outlet Concentration (C_{CO}), ppmvd

$$C_{CO} = (C_{obs} - C_0) \times \left(\frac{C_{MA}}{(C_M - C_0)} \right)$$

where,

C_{obs}	113.30	= average analyzer value during test, ppmvd
C_o	-0.44	= average of pretest & posttest zero responses, ppmvd
C_{MA}	251.00	= actual concentration of calibration gas, ppmvd
C_M	247.39	= average of pretest & posttest calibration responses, ppmvd
C_{CO}	115.2	= CO Concentration, ppmvd

CO - Outlet Emission Rate (ER_{CO}), lb/hr

$$ER_{CO} = \frac{C_{CO} \times MW \times Qs \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 453.592 \frac{g}{lb}}$$

where,

C_{CO}	115.2	= CO - Outlet Concentration, ppmvd
MW	28.01	= CO molecular weight, g/g-mole
Qs	5,708	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{CO}	2.9	= lb/hr

CO - Outlet Emission Rate (ER_{COTPY}), ton/yr

$$ER_{COTPY} = \frac{ER_{CO} \times 8{,}760 \frac{hr}{yr}}{2{,}000 \frac{lb}{ton}}$$

where,

ER_{CO}	2.9	= CO - Outlet Emission Rate, lb/hr
ER_{COTPY}	12.6	= ton/yr

CO - Outlet Emission Factor (EF_{CO_2d}), lb/MMBtu

$$EF_{CO_2d} = ER_{CO} \times K \times Fd \times \left(\frac{20.9}{20.9 - C_{O_2}} \right)$$

where,

C_{CO}	115.2	= CO - Outlet Concentration, ppmvd
K	7.27456E-08	= constant, lb/dscf · ppmvd
F_d	8,825	= fuel factor, dscf/MMBtu
C_{O_2}	5.3	= oxygen concentration, %
EF_{CO_2d}	0.099	= lb/MMBtu

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No.: 1
Parameter: PM

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	35.942	= standard meter volume, dscf
C_s	0.0852	= grain/dscf

Filterable PM Emission Rate (PMR), lb/hr

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

where,

C_s	0.085	= filterable PM concentration, grain/dscf
Qs	5,708	= 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}	18.3	= 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	8,825	= oxygen based fuel factor, dscf/MMBtu
Vmstd	35.942	= standard meter volume, dscf
O_2	5.3	= oxygen concentration, %
$EF_{PM\,O2d}$	0.14	= lb/MMBtu

Alliance TECHNICAL GROUP

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Run No.: 1
Parameter: EPA 0010

Benzo[a]pyrene Concentration (C_{C20H12}), ug/dscm

$$C_{C20H12} = \frac{M_{C20H12} \times 35.313}{Vmstd}$$

where,

M_{C20H12}	1.70	= benzo[a]pyrene mass, ug
Vmstd	34.859	= standard meter volume, dscf
C_{C20H12}	1.7	= ug/dscm

Benzo[a]pyrene Emission Rate (ER_{C20H12}), lb/hr

$$ER_{C20H12} = \frac{M_{C20H12} \times Qs \times 60}{Vmstd \times 4.54E+08}$$

where,

M_{C20H12}	1.7	= benzo[a]pyrene mass, ug
Qs	5,859	= average stack gas flow at standard conditions, dscfm
Vmstd	34.859	= standard meter volume, dscf
ER_{C20H12}	3.8E-05	= lb/hr

Benzo[a]pyrene Emission Rate (ER_{C20H12}), ton/yr

$$ER_{C20H12TPY} = \frac{ER_{C20H12} \times 8{,}760\frac{hr}{yr}}{2.0E+03}$$

where,

ER_{C20H12}	3.8E-05	= benzo[a]pyrene emission rate, lb/hr
$ER_{C20H12TPY}$	1.7E-04	= ton/yr

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Emission Calculations

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 1
Project No. AST-2023-3744
Parameter PM

Run Number		Run 1	Run 2	Run 3	Average
Date		11/7/23	11/7/23	11/7/23	--
Start Time		8:50	10:30	12:10	--
Stop Time		9:50	11:30	13:10	--
Run Time, min	(θ)	60.0	60.0	60.0	60.0
INPUT DATA					
Fuel Factor (O2 dry), dscf/MMBtu	(Fd)	8,825	10,173	9,734	9,577
Barometric Pressure, in. Hg	(Pb)	28.80	28.80	28.80	28.80
Meter Correction Factor	(Y)	0.9843	0.9843	0.9843	0.9843
Orifice Calibration Value	(ΔH @)	1.84	1.84	1.84	1.84
Meter Volume, ft^3	(Vm)	37.850	38.790	37.430	38.023
Meter Temperature, °F	(Tm)	68.6	70.5	70.7	69.9
Meter Temperature, °R	(Tm)	528.3	530.2	530.3	529.6
Meter Orifice Pressure, in. WC	(ΔH)	1.330	1.373	1.280	1.328
Volume H_2O Collected, mL	(Vlc)	202.9	202.0	195.7	200.2
Nozzle Diameter, in	(Dn)	0.301	0.301	0.301	0.301
Area of Nozzle, ft^2	(An)	0.0005	0.0005	0.0005	0.0005
Filterable PM Mass, mg	(Mn)	198.4	188.9	179.1	188.8
ISOKINETIC DATA					
Standard Meter Volume, ft^3	(Vmstd)	35.942	36.707	35.401	36.017
Standard Water Volume, ft^3	(Vwstd)	9.569	9.526	9.229	9.441
Moisture Fraction Measured	(BWSmsd)	0.210	0.206	0.207	0.208
Moisture Fraction @ Saturation	(BWSsat)	7.150	7.174	7.427	7.250
Moisture Fraction	(BWS)	0.210	0.206	0.207	0.208
Meter Pressure, in Hg	(Pm)	28.90	28.90	28.89	28.90
Volume at Nozzle, ft^3	(Vn)	71.009	72.159	69.886	71.02
Isokinetic Sampling Rate, (%)	(I)	100.8	100.6	100.7	100.7
DGM Calibration Check Value, (+/- 5%)	(Y_{qa})	-0.9	-0.4	-0.2	-0.5
EMISSION CALCULATIONS					
Filterable PM Concentration, grain/dscf	(C_s)	0.085	0.079	0.078	0.081
Filterable PM Emission Rate, lb/hr	(PMR)	4.2	4.0	3.8	4.0
Filterable PM Emission Rate, ton/yr	(ER_{FPM})	18.3	17.4	16.5	17.4
Filterable PM Emission Factor, lb/MMBtu (O2)	($EF_{PM\ O2d}$)	0.14	0.16	0.14	0.15

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Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 1
Project No. AST-2023-3744

Run Number		Run 1	Run 2	Run 3	Average
Date		11/7/23	11/7/23	11/7/23	--
Start Time		8:50	10:30	12:10	--
Stop Time		9:50	11:30	13:10	--
Source Data					
Fuel Factor (O2 dry), dscf/MMBtu	Fd	8,825	10,173	9,734	9,577
Input Data - Outlet					
Volumetric Flow Rate (M1-4), dscfm	Qs	5,708	5,840	5,628	5,725
Calculated Data - Outlet					
O_2 Concentration, % dry	C_{O_2}	5.3	5.7	4.8	5.3
CO_2 Concentration, % dry	C_{CO_2}	15.7	15.5	16.6	15.3
CO Concentration, ppmvd	C_{CO}	115.2	119.1	116.5	116.9
CO Emission Rate, lb/hr	ER_{CO}	2.9	3.0	2.9	2.9
CO Emission Rate, ton/yr	ER_{COTPY}	12.6	13.3	12.5	12.8
CO Emission Factor, lb/MMBtu (O2d)	$EF_{CO\ O2d}$	0.099	0.122	0.107	0.109

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Emission Calculations

Location PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source Boiler No. 1
Project No. AST-2023-3744
Parameter EPA 0010

Run Number		Run 1	Run 2	Run 3	Average
Date		11/7/23	11/7/23	11/7/23	--
Start Time		14:10	16:00	17:45	--
Stop Time		15:11	17:01	18:46	--
Run Time, min	(θ)	60.0	60.0	60.0	60.0
INPUT DATA					
Barometric Pressure, in. Hg	(Pb)	28.89	28.90	28.95	28.91
Meter Correction Factor	(Y)	0.9979	0.9979	0.9979	0.9979
Orifice Calibration Value	(ΔH @)	1.83	1.83	1.83	1.83
Meter Volume, ft^3	(Vm)	35.770	37.400	38.100	37.090
Meter Temperature, °F	(Tm)	63.7	64.1	65.0	64.2
Meter Temperature, °R	(Tm)	523.3	523.8	524.6	523.9
Meter Orifice Pressure, in. WC	(ΔH)	1.209	1.316	1.388	1.304
Volume H_2O Collected, mL	(Vlc)	191.8	185.5	176.5	184.6
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
Benzo[a]pyrene Mass, ug	(M_{C20H12})	1.70	1.70	1.70	1.70
ISOKINETIC DATA					
Standard Meter Volume, ft^3	(Vmstd)	34.859	36.439	37.132	36.143
Standard Water Volume, ft^3	(Vwstd)	9.045	8.748	8.324	8.706
Moisture Fraction Measured	(BWSmsd)	0.206	0.194	0.183	0.194
Moisture Fraction @ Saturation	(BWSsat)	8.225	7.696	7.046	7.656
Moisture Fraction	(BWS)	0.206	0.194	0.183	0.194
Meter Pressure, in Hg	(Pm)	28.98	29.00	29.05	29.01
Volume at Nozzle, ft^3	(Vn)	69.225	70.776	70.496	70.17
Isokinetic Sampling Rate, (%)	(I)	100.6	98.8	98.6	99.3
DGM Calibration Check Value, (+/- 5%)	(Y_{qa})	-0.1	0.0	-0.8	-0.3
EMISSION CALCULATIONS					
Benzo[a]pyrene Concentration, ug/dscm	(C_{C20H12})	1.7	1.6	1.6	1.7
Benzo[a]pyrene Emission Rate, lb/hr	(ER_{C20H12})	3.8E-05	3.9E-05	3.9E-05	3.8E-05
Benzo[a]pyrene Emission Rate, ton/yr	(ER_{C20H12})	1.7E-04	1.7E-04	1.7E-04	1.7E-04

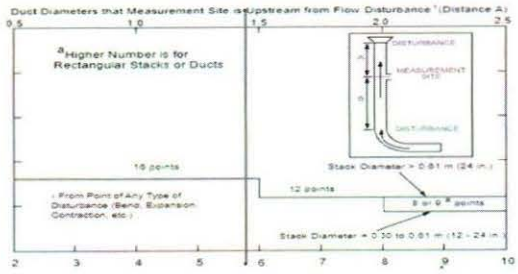
Underlined values indicate that the results were below detection limits; the minimum detection limit (MDL) was used in the calculations.

Method 1 Data

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Date: 11/07/23

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	33.50	in
Nipple Length:	4.00	in
Depth of Duct:	29.50	in
Cross Sectional Area of Duct:	4.75	ft^2
No. of Test Ports:	2	
Number of Readings per Point:	1	
Distance A:	12.0	ft
Distance A Duct Diameters:	4.9	(must be ≥ 0.5)
Distance B:	14.0	ft
Distance B Duct Diameters:	5.7	(must be ≥ 2)
Actual Number of Traverse Points:	3	
Measurer (Initial and Date):	COG 11/7	
Reviewer (Initial and Date):	RA 11/7	



CIRCULAR DUCT

LOCATION OF TRAVERSE POINTS

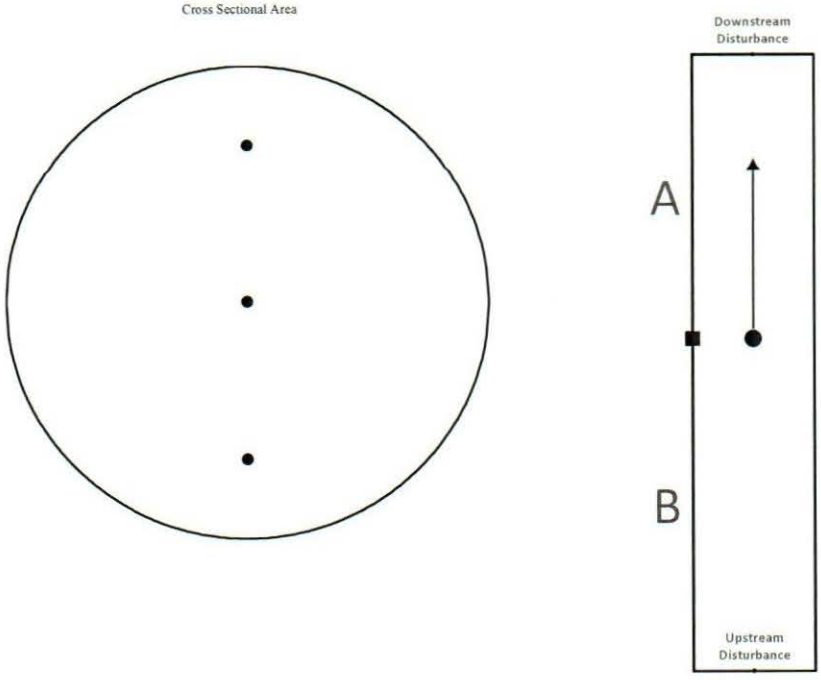
Number of traverse points on a diameter

	2	3	4	5	6	7	8	9	10	11	12
1	14.6	16.7	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	50.0	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	83.3	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	16.7	4.93	8.93
2	50.0	14.75	18.75
3	83.3	24.57	28.57
4	--	--	--
5	--	--	--
6	--	--	--
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 12 ft.
B = 14 ft.
Depth of Duct = 29.5 in.

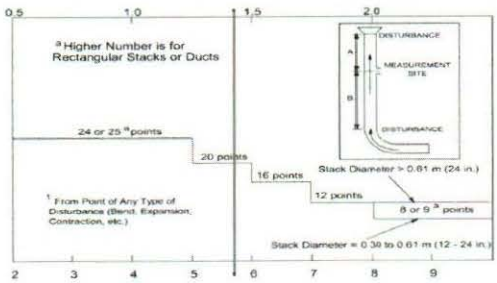


Method 1 Data

Location: PotlatchDeltic / Gwinn Sawmill - Gwinn, MI
Source: Boiler No. 1
Project No.: AST-2023-3744
Date: 11/07/23

Stack Parameters

Duct Orientation:	Vertical		
Duct Design:	Circular		
Distance from Far Wall to Outside of Port:	33.50	in	33.5
Nipple Length:	4.00	in	4
Depth of Duct:	29.50	in	
Cross Sectional Area of Duct:	4.75	ft^2	
No. of Test Ports:	2		
Distance A:	12.0	ft	
Distance A Duct Diameters:	4.9	(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):	COG 11/6		
Reviewer (Initial and Date):	RA 11/6		



CIRCULAR DUCT

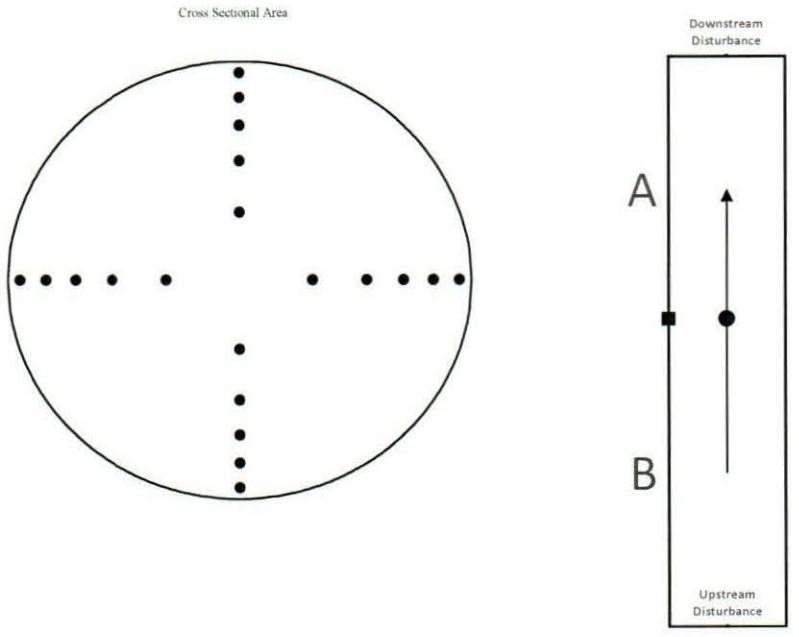
LOCATION OF TRAVERSE POINTS
Number of traverse points on a diameter

	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
2	8.2	2.42	6 7/16
3	14.6	4.31	8 5/16
4	22.6	6.67	10 11/16
5	34.2	10.09	14 1/16
6	65.8	19.41	23 7/16
7	77.4	22.83	26 13/16
8	85.4	25.19	29 3/16
9	91.8	27.08	31 1/16
10	97.4	28.50	32 1/2
11	--	--	--
12	--	--	--

Stack Diagram
A = 12 ft.
B = 14 ft.
Depth of Duct = 29.5 in.



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