1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by Louisiana-Pacific Corporation (LP) to conduct compliance testing at the Sagola, MI facility. Portions of the facility are subject to 40 CFR 63 Subpart DDDDD. The facility operates under the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-N1315-2018. Testing was conducted to determine the emission rates of particulate matter (PM/PM10), nitrogen oxides (NOx), carbon monoxide (CO), hydrogen chloride (HCl), mercury (Hg) and volatile organic compounds (VOC) from the Thermal Oil Heater (TOH) Stack.

1.1 Facility Description

The Louisiana-Pacific Corporation Sagola Plant is an orientated strand board manufacturing facility that produces structural panels used for various construction applications. The facility is identified by the NAICS Code 321219.

The plant purchases small diameter logs that are debarked and fed to a waferizer. The bark removed from the logs is used as fuel for the thermal oil heater. The waferizer flakes the logs into strands, which are approximately three (3) inches long by one (1) inch wide, and 0.03125 (1/32) of an inch thick. The wet flakes go through a rotary dryer, which reduces the flake moisture content from approximately 50% down to 5%. The flakes are then captured by a cyclone and the exhaust gas passes through a wet electrostatic precipitator (WESP) followed by a regenerative thermal oxidizer (RTO).

The flakes collected by the primary cyclone drop into a rotary screen, which separates usable flake and small wood pieces (fines). The material passing through the screen is used as fuel in the dryers, the usable flake is routed to the blenders. Wax and resin are mixed with the flakes in the blenders. Formers then evenly distribute the resinated flakes into a continuous mat of flakes onto moving conveyor. The continuous mat is separated into press size segments by the flying cut-off-saw.

The loader conveys the mats into the press; with the combination of heat (supplied by the thermal oil heater) and pressure, the mats are turned into solid boards of various predetermined thickness. The emissions from the pressing process are captured within an enclosure and routed to a Regenerative Catalytic 4 of 7 Oxidizer (RCO). The boards are unloaded from the press and cut with saw blades into 4' x 8' panels. The dust formed by the sawing process is collected and used for fuel in the wafer dryers. Some panels are subsequently cut with a tongue and groove pattern and sanded; the wood dust formed during the finishing process is collected and used for fuel in the flake dryers.

1.2 Source and Control System Descriptions

The Thermal Oil Heater consists of the following components: a geka bark burning thermal oil heater rated at 40 MMBTU/hour heat output or approximately 60 MM BTU/hour heat input, a mulitclone dust collector and a dry electrostatic precipitator (DESP) particulate removal system.

1.3   Project Team

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

Table 1-1: Project Team

Facility Personnel	Rich Menard
Alliance Personnel	Trent Johnson
	Corbin Godfrey
	Ryan Schuth

1.4   Test Protocol & Notification

Testing was conducted in accordance with the test protocol submitted to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Marquette.

1.5   Test Program Notes

The average spike recovery on the EPA Method 30B sampling QA came in at 117.63% which is slightly elevated above the acceptable range (85-115%). This outcome was discussed with Michigan EGLE. It was concluded that this indicates the testing was biased slightly high, however the final results are still well below the applicable limit. This communication can be found in Appendix F.

2.0   Summary of Results

Alliance conducted compliance testing at the LP facility in Sagola, MI on September 20-21, 2022. Testing consisted of determining the emission rates of PM/PM10, NOx, CO, HCl, Hg and VOC from the TOH Stack.

Tables 2-1 and 2-2 provide a summary of the emission testing results with comparisons to the applicable MDEQ and NESHAP permit limits. The NESHAP limits presented in this report are new upcoming limits published in the Federal Register on October 6th and go into effect on December 5th. These limits are more stringent than the previous Subpart DDDDD limits and therefore show compliance with the limits that were in effect at the time of testing. These tables also provide a summary of the process operating and control system data collected during testing. 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 – 201A/202 & 30B Data

Emission Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**9/21/22**	**9/21/22**	**9/21/22**	**--**
Filterable PM10 Data				
Concentration, grain/dscf	0.00043	0.00044	0.00044	0.00044
Emission Rate, lb/hr	0.053	0.055	0.056	0.054
Condensable PM Data				
Concentration, grain/dscf	0.0021	0.0028	0.0017	0.0022
Emission Rate, lb/hr	0.26	0.34	0.22	0.27
PM10 Data				
Concentration, grain/dscf	0.0025	0.0032	0.0022	0.0026
Emission Rate, lb/hr	0.31	0.40	0.27	0.33
Permit Limit, lb/hr	--	--	--	11.55
Percent of Limit, %	--	--	--	**3**
Mercury Data				
Concentration, ug/dscm	0.58	0.62	0.56	0.59
Emission Factor, lb/TBtu	0.64	0.69	0.64	0.66
NESHAP Limit, lb/TBtu	--	--	--	5.40
Percent of Limit, %	--	--	--	**12**
Process Operating / Control System Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**9/21/22**	**9/21/22**	**9/21/22**	**--**
Wood Species Mixture, %	100% Hardwoods			
Bark Feed, wet ton/hr	4.0	4.1	3.9	4.0
Oxygen Concentration, % dry	7.8	7.9	7.8	7.8

Table 2-2: Summary of Results – CEMS & 5/26A

Emission Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**9/20/22**	**9/20/22**	**9/20/22**	**--**
Filterable Particulate Matter Data				
Concentration, grain/dscf	0.00061	0.00049	0.00028	0.00046
Emission Rate, lb/hr	0.074	0.059	0.032	0.055
Permit Limit, lb/hr	--	--	--	11.55
Percent of Limit, %	--	--	--	**< 1**
Emission Factor, lb/MMBtu	0.0016	0.0014	0.00075	0.0012
NESHAP Limit, lb/MMBtu	--	--	--	0.034
Percent of Limit, %	--	--	--	**4**
Hydrogen Chloride Data				
Emission Factor, lb/MMBtu	8.2E-04	8.5E-04	8.6E-04	8.4E-04
NESHAP Limit, lb/MMBtu	--	--	--	0.020
Percent of Limit, %	--	--	--	**4**
Carbon Monoxide Data				
Concentration, ppmvd @ 3%	486.7	206.8	206.2	299.9
NESHAP Limit, ppmvd @ 3%	--	--	--	1100
Percent of Limit, %	--	--	--	**27**
Emission Rate, lb/hr	18.4	7.3	7.2	11.0
Permit Limit, lb/hr	--	--	--	28.6
Percent of Limit, %	--	--	--	**38**
Nitrogen Oxide Data				
Concentration, ppmvd	104.1	99.5	100.6	101.4
Emission Rate, lb/hr	10.5	10.1	9.8	10.1
Permit Limit, lb/hr	--	--	--	16.8
Percent of Limit, %	--	--	--	**60**
Volatile Organic Compound Data*				
NMHC (as propane) Concentration, ppmvd	4.7	0.47	0.079	1.7
NMHC (as propane) Emission Rate, lb/hr	0.45	0.045	0.0074	0.17
NMHC (as propane) Permit Limit, lb/hr	--	--	--	0.5
Percent of Limit, %	--	--	--	**34**
Process Operating / Control System Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**9/20/22**	**9/20/22**	**9/20/22**	**--**
Wood Species Mixture, %	100 % Hardwoods			
Bark Feed, wet ton/hr	4.1	4.0	3.9	4.0
Oxygen Concentration, %	8.3	9.2	8.8	8.8

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	3A	Instrumental Analysis
Oxygen/Carbon Dioxide	3/3A	Integrated Bag / Instrumental Analysis
Moisture Content	4	Gravimetric Analysis
Particulate Matter / Hydrogen Chloride	5 & 26A	Isokinetic Sampling
Nitrogen Oxides	7E	Instrumental Analysis
Carbon Monoxide	10	Instrumental Analysis
Mass Emission Factors	19	Fuel Factors/Heat Inputs
Volatile Organic Compounds	25A	Instrumental Analysis
Mercury	30B	Sorbent Traps
PM < 10 microns	201A/202	Constant Rate 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 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 on September 21 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 3.12.

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

The oxygen (O_2) and carbon dioxide (CO_2) testing on September 20 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 3.13.

3.4 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.

3.5 U.S. EPA Reference Test Methods 5 and 26A – Particulate Matter/ Hydrogen Chloride

The filterable particulate matter, and hydrogen chloride testing was conducted in accordance with U.S. EPA Reference Test Methods 5 and 26A. The complete sampling system consisted of a glass nozzle, heated glass-lined probe, pre-weighed heated Teflon filter, gas conditioning train, pump and calibrated dry gas meter. The gas conditioning train consisted of four (4) chilled impingers. The first and second impingers contained 100 mL of 0.1 N H_2SO_4, the third was initially empty and the fourth contained 200-300 grams of silica gel. The probe liner and filter heating systems were maintained at 248-273°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 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 pre-weighed Teflon filter was carefully removed and placed in container 1. The probe and nozzle were rinsed and brushed three (3) times with acetone to remove any adhering particulate matter and these rinses placed 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 absorbing solution (0.1 N H_2SO_4) from the first and second impingers was placed into sample container 3. The back-half of the filter holder, first, second and third impingers and all glassware leading to the outlet of the third impinger were rinsed with de-ionized (DI) water. These rinses were also placed in container 3. Containers 1-2 were sealed, labeled and liquid levels marked for transport to the identified laboratory for particulate analysis. Container 3 was sealed, labeled and liquid levels marked for transport to the identified laboratory for halide analysis.

3.6 U.S. EPA Reference Test Method 7E – Nitrogen Oxides

The nitrogen oxides (NOx) testing was conducted in accordance with U.S. EPA Reference Test Method 7E. 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 3.12.

3.7 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 3.12.

3.8   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 based fuel factor (F-Factor) of 9,600 for wood bark was used in the calculations.

3.9   U.S. EPA Reference Test Methods 25A and 18 – Non-Methane Hydrocarbon

The non-methane hydrocarbon (NMHC) testing was conducted in accordance with U.S. EPA Reference Test Methods 25A and 18. The sampling system consisted of a stainless-steel probe, heated Teflon sample line(s) and the identified gas analyzer. Total hydrocarbon data was collected online and reported in one-minute averages. The quality control measures are described in Section 3.14.

Methane concentration was determined by integrated Tedlar bag sampling and offsite lab analysis using U.S. EPA Reference Test Method 18. The average methane concentration was subtracted from the average total hydrocarbon concentration to provide a non-methane VOC concentration.

3.10   U.S. EPA Reference Test Method 30B – Mercury

The total vapor phase mercury (Hg) testing was conducted in accordance with U.S. EPA Reference Test Method 30B. The complete sampling system consisted of a heated pair of in-stack sorbent traps, stainless steel-lined probe, gas conditioning train, pump and calibrated dry gas meter. Sample gas was withdrawn through the paired sorbent traps at a pre-determined sampling rate during each test run. A field recovery test was conducted during three (3) of the test runs in which a known mass of mercury was pre-spiked onto one (1) of the paired sorbent traps.

Prior to starting each test run, the sampling train was leak checked at a vacuum pressure of fifteen inches of mercury. Following the completion of each test run, the sampling train was leak checked at the highest vacuum pressure observed during the test run. Each sorbent trap was removed from the sample probe and sealed to prevent contamination. All samples were sealed and labeled for transport to the identified laboratory for analysis.

3.11   U.S. EPA Reference Test Methods 201A and 202 – PM <10 microns

The PM10 testing was conducted in accordance with U.S. EPA Reference Test Methods 201A and 202. The complete sampling system consisted of a stainless-steel nozzle, PM10 in-stack cyclone, in-stack filter holder, pre-weighed quartz filter, heated glass-lined probe extension, un-weighed Teflon filter, gas conditioning train, pump and calibrated dry gas meter. The gas conditioning train consisted of a coiled condenser and four (4) chilled impingers. The first and second impingers were initially empty, the third contained 100 mL of de-ionized water and the last impinger contained 200-300 grams of silica gel. The un-weighed 90 mm Teflon filter was placed between the second and third impinger. The probe liner heating system was maintained at a temperature of 248 ±25°F, and the impinger temperature was maintained at 68°F or less throughout testing. The temperature of the Teflon filter was maintained greater than 65°F but less than or equal to 85°F.

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. If condensate was collected in the first dry impinger, then the front-half of the sample train (the nozzle, probe, and heated pre-weighed filter) and the coil condenser were

removed, and a glass bubbler was connected to the first impinger. If needed, de-ionized ultra-filtered (DIUF) water was added to the first impinger to raise the water level above the bubbler. Zero nitrogen was connected to the bubbler, and a 60-minute purge at 14 liters per minute was conducted. After the completion of the nitrogen purge the impinger contents were measured for moisture gain.

The pre-weighed quartz filter was carefully removed and placed in container 1. The front half of the filter holder and back-half of the PM10 cyclone were rinsed six (6) times with acetone to remove any adhering particulate matter, and these rinses were recovered in container 2. All containers were sealed, labeled and liquid levels marked for transport to the identified laboratory for filterable particulate matter analysis.

The contents of impingers 1 and 2 were recovered in container CPM Cont. #1. The back half of the filterable PM filter holder, probe extension, coil condenser, impingers 1 and 2 and all connecting glassware were rinsed with DIUF water and then rinsed with acetone, followed by hexane. The water rinses were added to container CPM Cont. #1 while the solvent rinses were recovered in container CPM Cont. #2. The Teflon filter was removed from the filter holder and placed in container CPM Cont. #3. The front half of the condensable PM filter holder was rinsed with DIUF water and then with acetone, followed by hexane. The water rinse was added to container CPM Cont. #1 while the solvent rinses were added to container CPM Cont. #2. All containers were sealed, labeled and liquid levels marked for transport to the identified laboratory for condensable particulate matter analysis.

3.12   Quality Assurance/Quality Control – U.S. EPA Reference Test Methods 3A, 7E 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.

An $NO_2 - NO$ converter check was performed on the analyzer at the completion of testing. Mid-level nitrogen oxide protocol 1 calibration gas was mixed at a 1:1 ratio with span level protocol 1 oxygen calibration gas in a Tedlar sample bag to form NO_2 gas. The NO_2 gas was delivered to the nitrogen oxides analyzer directly from a Tedlar sample bag. The response of the analyzer was stable for the 30-minute duration of the test with the variation less than 2.0% at the end of the test from the maximum value of the test.

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.

3.13   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.

3.14   Quality Assurance/Quality Control – U.S. EPA Reference Test Method 25A

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.

Within two (2) hours prior to testing, zero gas was introduced through the sampling system to the analyzer. After adjusting the analyzer to the Zero gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas, and the time required for the analyzer reading to reach 95 percent of the gas concentration was recorded to determine the response time. Next, Low and Mid-Level gases were introduced through the sampling system to the analyzer, and the response was recorded when it was stable. All values were less than +/- 5 percent of the calibration gas concentrations.

Mid Level gas was introduced through the sampling system. After the analyzer response was stable, the value was recorded. Next, Zero gas was introduced through the sampling system, and the analyzer value recorded once it reached a stable response. The Analyzer Drift was less than +/- 3 percent of the span value.

As requested by the Michigan EGLE protocol review letter, the VOC measurements for analyzer drift using equation 7E-5 in Method 7E.

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.

Location: Louisiana-Pacific Sagola Plant - Sagola, MI
Source: Thermal Oil Heater (TOH)
Project No.: 2022-2666
Run No.: 1
Parameter: PM/HCl

Meter Pressure (Pm), in. Hg

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

where,

Pb	28.52	= barometric pressure, in. Hg
ΔH	1.400	= pressure differential of orifice, in H_2O
Pm	28.62	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

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

where,

Pb	28.52	= barometric pressure, in. Hg
Pg	-0.30	= static pressure, in. H_2O
Ps	28.50	= in. Hg

Standard Meter Volume (Vmstd), dscf

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

where,

Y	0.9789	= meter correction factor
Vm	81.470	= meter volume, cf
Pm	28.62	= absolute meter pressure, in. Hg
Tm	534.1	= absolute meter temperature, °R
Vmstd	75.377	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04716 \times Vlc$$

where,

Vlc	321.3	= volume of H_2O collected, ml
Vwstd	15.153	= scf

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

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

where,

Ts	470.5	= stack temperature, °F
Ps	28.50	= absolute stack gas pressure, in. Hg
BWSsat	33.840	= dimensionless

Moisture Fraction (BWS), dimensionless (measured)

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

where,

Vwstd	15.153	= standard wet volume, scf
Vmstd	75.377	= standard meter volume, dscf
BWS	0.167	= dimensionless

Moisture Fraction (BWS), dimensionless

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

where,

BWSsat	33.840	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.167	= moisture fraction (measured)
BWS	0.167	

Alliance
SOURCE TESTING

Location:	**Louisiana-Pacific Sagola Plant - Sagola, MI**
Source:	**Thermal Oil Heater (TOH)**
Project No.:	**2022-2666**
Run No.:	**1**
Parameter:	**PM/HCl**

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	11.1	= carbon dioxide concentration, %
O_2	9.9	= oxygen concentration, %
Md	30.17	= lb/lb mol

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

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

where,

Md	30.17	= molecular weight (DRY), lb/lb mol
BWS	0.167	= moisture fraction, dimensionless
Ms	28.13	= 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
$\Delta P^{1/2}$	0.561	= velocity head of stack gas, (in. $H_2O)^{1/2}$
Ts	930.2	= absolute stack temperature, °R
Ps	28.50	= absolute stack gas pressure, in. Hg
Ms	28.13	= molecular weight of stack gas, lb/lb mol
Vs	43.4	= ft/sec

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

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

where,

Vs	43.4	= stack gas velocity, ft/sec
As	12.05	= cross-sectional area of stack, ft^2
Qa	31,395	= acfm

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

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

where,

Qa	31,395	= average stack gas flow at stack conditions, acfm
BWS	0.167	= moisture fraction, dimensionless
Ps	28.50	= absolute stack gas pressure, in. Hg
Ts	930.2	= absolute stack temperature, °R
Qs	14,124	= 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	0.9789	= meter correction factor, dimensionless
Θ	120	= run time, min.
Vm	81.47	= total meter volume, dcf
Tm	534.1	= absolute meter temperature, °R
$\Delta H@$	1.81	= orifice meter calibration coefficient, in. H_2O
Pb	28.52	= barometric pressure, in. Hg
ΔH avg	1.400	= average pressure differential of orifice, in H_2O
Md	30.17	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.180	= average squareroot pressure differential of orifice, (in. $H2O)^{1/2}$
Yqa	0.1	= dimensionless

Alliance
SOURCE TESTING

Location:	**Louisiana-Pacific Sagola Plant - Sagola, MI**
Source:	**Thermal Oil Heater (TOH)**
Project No.:	**2022-2666**
Run No.:	**1**
Parameter:	**PM/HCl**

Volume of Nozzle (Vn), ft³

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

where,

Ts	930.2	= absolute stack temperature, °R
Ps	28.50	= absolute stack gas pressure, in. Hg
Vlc	321.3	= volume of H_2O collected, ml
Vm	81.470	= meter volume, cf
Pm	28.62	= absolute meter pressure, in. Hg
Y	0.979	= meter correction factor, unitless
Tm	534.1	= absolute meter temperature, °R
Vn	167.495	= volume of nozzle, ft³

Isokinetic Sampling Rate (I), %

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

where,

Vn	167.495	= nozzle volume, ft3
θ	120.0	= run time, minutes
An	0.00053	= area of nozzle, ft²
Vs	43.4	= average velocity, ft/sec
I	100.2	= %

Filterable PM Concentration (Cₛ), grain/dscf

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

where,

Mn	3.0	= filterable PM mass, mg
Vmstd	75.377	= standard meter volume, dscf
Cₛ	0.00061	= grain/dscf

Filterable PM Emission Rate (PMR), lb/hr

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

where,

Cₛ	0.0006	= filterable PM concentration, grain/dscf
Qs	14,124	= average stack gas flow at standard conditions, dscfm
PMR	0.074	= lb/hr

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	3.0	= filterable PM mass, mg
Fd	9,600	= oxygen based fuel factor, dscf/MMBtu
Vmstd	75.377	= standard meter volume, dscf
O_2	9.9	= oxygen concentration, %
EF$_{PM\ O2d}$	0.0016	= lb/MMBtu

Alliance
SOURCE TESTING

Location:	**Louisiana-Pacific Sagola Plant - Sagola, MI**
Source:	**Thermal Oil Heater (TOH)**
Project No.:	**2022-2666**
Run No.:	**1**
Parameter:	**PM/HCl**

Hydrogen Chloride Concentration (C_{HCl}), mg/dscm

$$C_{HCl} = \frac{M_{HCl} \times 35.313}{Vmstd \times 1.0E + 03}$$

where,

M_{HCl}	1,530	= hydrogen chloride mass, ug
Vmstd	75.377	= standard meter volume, dscf
C_{HCl}	0.72	= mg/dscm

Hydrogen Chloride Concentration (C_{HClp}), ppmvd

$$C_{HClp} = \frac{M_{HCl} \times 24.04 \frac{L}{mol}}{MW \times Vmstd \times 28.32}$$

where,

M_{HCl}	1,530	= hydrogen chloride mass, ug
MW	36.5	= molecular weight, g/g mol
Vmstd	75.377	= standard meter volume, dscf
C_{HClp}	0.47	= ppmvd

Hydrogen Chloride Emission Rate (ER_{HCl}), lb/hr

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

where,

M_{HCl}	1,530	= hydrogen chloride mass, ug
Qs	14,124	= average stack gas flow at standard conditions, dscfm
Vmstd	75.377	= standard meter volume, dscf
ER_{HCl}	0.038	= lb/hr

Hydrogen Chloride Emission Factor (EF_{HCl O2d}), lb/MMBtu

$$EF_{HClO2d} = \frac{M_{HCl} \times Fd}{Vmstd \times 4.54E + 08} \times \frac{20.9\% \, O_2}{20.9\% \, O_2 - O_2}$$

where,

M_{HCl}	1,530	= hydrogen chloride mass, ug
Fd	9,600	= oxygen based fuel factor, dscf/MMBtu
Vmstd	75.377	= standard meter volume, dscf
O_2	9.9	= oxygen concentration, %
EF_{HCl O2d}	8.2E-04	= lb/MMBtu

Alliance
SOURCE TESTING

Location:	**Louisiana-Pacific Sagola Plant - Sagola, MI**
Source:	**Thermal Oil Heater (TOH)**
Project No.:	**2022-2666**
Run No./Method:	Run 1/Method 201A

Filterable PM10 Concentration (C_{FPM10}), grain/dscf

$$C_{FPM10} = \frac{M_{FPM10} \times 0.0154}{Vmstd}$$

where,

M_{FPM10}	0.5	= FPM10 mass, mg
Vmstd	35.862	= standard meter volume, dscf
C_{FPM10}	0.00043	= grain/dscf

Filterable PM10 Emission Rate (ER_{FPM10}), lb/hr

$$ER_{FPM10} = \frac{C_{FPM10} \times Qs \times 60}{7.0E + 03}$$

where,

C_{FPM10}	0.0004	= FPM10 concentration, grain/dscf
Qs	14,330	= average stack gas flow at standard conditions, dscfm
ER_{FPM10}	0.053	= lb/hr

Condensable PM Concentration (C_{CPM}), grain/dscf

$$C_{CPM} = \frac{M_{CPM} \times 0.0154}{Vmstd}$$

where,

M_{CPM}	4.9	= condensable PM mass, mg
Vmstd	35.862	= standard meter volume, dscf
C_{CPM}	0.0021	= grain/dscf

Condensable PM Emission Rate (ER_{CPM}), lb/hr

$$ER_{CPM} = \frac{C_{CPM} \times Qs \times 60}{7.0E + 03}$$

where,

C_{CPM}	0.0021	= condensable PM concentration, grain/dscf
Qs	14,330	= average stack gas flow at standard conditions, dscfm
ER_{CPM}	0.26	= lb/hr

Alliance
SOURCE TESTING

Location:	**Louisiana-Pacific Sagola Plant - Sagola, MI**	
Source:	**Thermal Oil Heater (TOH)**	
Project No.:	**2022-2666**	
Run No./Method:	Run 1/Method 201A	

PM10 Concentration (C_{PM10}), grain/dscf

$$C_{PM10} = \frac{M_{PM10} \times 0.0154}{Vmstd}$$

where,

M_{PM10}	5.9	= PM10 mass, mg
Vmstd	35.862	= standard meter volume, dscf
C_{PM10}	0.0025	= grain/dscf

PM10 Emission Rate (ER_{PM10}), lb/hr

$$ER_{PM10} = \frac{C_{PM10} \times Qs \times 60}{7.0E + 03}$$

where,

C_{PM10}	0.0025	= PM10 concentration, grain/dscf
Qs	14,330	= average stack gas flow at standard conditions, dscfm
ER_{PM10}	0.31	= lb/hr

Alliance SOURCE TESTING

Location: Louisiana-Pacific Sagola Plant - Sagola, MI
Source: Thermal Oil Heater (TOH)
Project No.: 2022-2666
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}	300.6	= average analyzer value during test, ppmvd
C_o	-0.4	= average of pretest & posttest zero responses, ppmvd
C_{MA}	501.0	= actual concentration of calibration gas, ppmvd
C_M	503.7	= average of pretest & posttest calibration responses, ppmvd
C_{CO}	299.2	= CO Concentration, ppmvd

CO - Outlet Concentration (C_{COc3}), ppmvd @ 3% O_2

$$C_{COc3} = C_{CO} \times \left(\frac{20.9 - 3}{20.9 - O_2} \right)$$

where,

C_{CO}	299.2	= CO - Outlet Concentration, ppmvd
C_{O_2}	9.9	= oxygen concentration, %
C_{COc3}	486.7	= ppmvd @3% O_2

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}	299.2	= CO - Outlet Concentration, ppmvd
MW	28.01	= CO molecular weight, g/g-mole
Qs	14,124	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{CO}	18.444	= lb/hr

Alliance
SOURCE TESTING

Location: Louisiana-Pacific Sagola Plant - Sagola, MI
Source: Thermal Oil Heater (TOH)
Project No.: 2022-2666
Run No. /Method Run 1 / Method 7E

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

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

where,

C_{obs}	103.9	= average analyzer value during test, ppmvd
C_o	0.1	= average of pretest & posttest zero responses, ppmvd
C_{MA}	116.0	= actual concentration of calibration gas, ppmvd
C_M	115.8	= average of pretest & posttest calibration responses, ppmvd
C_{NOx}	104.1	= NOx Concentration, ppmvd

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

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

where,

C_{NOx}	104.1	= NOx - Outlet Concentration, ppmvd
MW	46.0055	= NOx molecular weight, g/g-mole
Qs	14,124	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{NOx}	10.5	= lb/hr

Alliance
SOURCE TESTING

Location:	Louisiana-Pacific Sagola Plant - Sagola, MI
Source:	Thermal Oil Heater (TOH)
Project No.:	2022-2666
Run No. /Method	Run 1 / Method 25A

THC - Outlet Concentration (as C3H8) (C_{THC}), ppmvd

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

where,

C_{obs}	6.8	= average analyzer value during test, ppmvd
C_o	-0.1	= average of pretest & posttest zero responses, ppmvd
C_{MA}	30.2	= actual concentration of calibration gas, ppmvd
C_M	30.4	= average of pretest & posttest calibration responses, ppmvd
C_{THC}	6.8	= THC Concentration (as C3H8), ppmvd

THC - Outlet Concentration (as C3H8) (C_{THC}), ppmvd

$$C_{THC} = \frac{C_{THCw}}{1 - BWS}$$

where,

C_{THCw}	6.8	= THC - Outlet Concentration (as C3H8), ppmvw
BWS	0.167	= moisture fraction, unitless
C_{THC}	8.2	= ppmvd

THC - Outlet Emission Rate (as C3H8) (ER_{THC}), lb/hr

$$ER_{THC} = \frac{C_{THC} \times MW \times Qs \times 60\frac{min}{hr} \times 28.32\frac{L}{ft^3}}{24.04\frac{L}{g-mole} \times 1.0E06 \times 454\frac{g}{lb}}$$

where,

C_{THC}	8.2	= THC - Outlet Concentration (as C3H8), ppmvd
MW	44.1	= THC molecular weight, g/g-mole
Qs	14,124	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{THC}	0.79	= lb/hr

NMEHC Concentration (as C3H8) (C_{NMEHC}), ppmvd

$$C_{NMEHC} = C_{THC} - C_{CH4} - C_{C2H6}$$

where,

C_{THC}	8.17	= THC Concentration (as C3H8), ppmvd
C_{CH4}	3.20	= CH4 Concentration (as C3H8), ppmvd
C_{C2H6}	--	= C2H6 Concentration (as C3H8), ppmvd
C_{NMEHC}	4.7	= ppmvd

NMEHC Emission Rate (as C3H8) (ER_{NMEHC}), lb/hr

$$ER_{NMEHC} = \frac{C_{NMEHC} \times MW \times Qs \times 60\frac{min}{hr} \times 28.32\frac{L}{ft^3}}{24.04\frac{L}{g-mole} \times 1.0E06 \times 454\frac{g}{lb}}$$

where,

C_{NMEHC}	4.69	= NMEHC Concentration (as C3H8), ppmvd
MW	44.1	= NMEHC molecular weight, g/g-mole
Qs	14,124	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{NMEHC}	0.45	= lb/hr

Alliance
SOURCE TESTING

Location Louisiana-Pacific Sagola Plant - Sagola, MI
Source Thermal Oil Heater (TOH)
Project No. 2022-2666
Method/Run No. Method 30B/Run 1

Mercury Concentration (unspiked) (Ca), ug/dscm

$$C_a = \frac{m_u \times 1.0E + 03}{Vmstd_{DGM1} \times 1.0E + 03}$$

where,

m_u	40.52	= mercury mass (unspiked), ng
Vmstd	79.1458681	= standard meter volume (unspiked), dsL
Ca	0.51	= ug/dscm

Mercury Mass (without spike) (mb), ng

$$m_b = m_s - m_{spiked}$$

where,

m_s	101.81	= mercury mass (with spike), ng
m_{spiked}	50	= spike mass, ng
m_b	51.81	= ng

Mercury Concentration (C_{Hgdry}), ug/dscm

$$C_{Hg} = \frac{Ca + Cb}{2}$$

where,

Ca	0.51	= mercury concentration (unspiked), ug/dscm
Cb	0.65	= mercury concentration (duplicate/spiked), ug/dscm
C_{Hgdry}	0.58	= ug/dscm

Mercury Emission Factor ($EF_{Hg\,O2d}$), lb/MMBtu

$$EF_{HgO2d} = \frac{C_{Hg} \times Fd}{35.313 \times 454E + 08} \times \frac{20.9}{20.9 - O_2}$$

where,

C_{Hg}	0.58	= mercury concentration dry, ug/dscm
Fd	9,600	= oxygen based fuel factor, dscf/MMBtu
O_2	9.50	= oxygen concentration, %
$EF_{Hg\,O2d}$	6.37E-07	= lb/MMBtu

Mercury Emission Factor ($EF_{Hg\,O2d}$), lb/TBtu

$$EF_{HgO2d} = \frac{C_{Hg} \times Fd}{35.313 \times 454} \times \frac{20.9}{20.9 - O_2}$$

where,

C_{Hg}	0.58	= mercury concentration dry, ug/dscm
Fd	9,600	= oxygen based fuel factor, dscf/MMBtu
O_2	9.50	= oxygen concentration, %

Emissions Data

Location: **Louisiana-Pacific Sagola Plant - Sagola, MI**
Source: **Thermal Oil Heater (TOH)**
Project No.: **2022-2666**
Parmater: **PM/CPM**

Run Number		Run 1	Run 2	Run 3	Average
Date		9/21/22	9/21/22	9/21/22	-
Start Time		7:25	9:40	11:50	-
Stop Time		9:15	11:28	13:39	-
INPUT DATA					
Run Time, min	(θ)	108.5	106.2	106.5	107.0
Barometric Pressure, in. Hg	(Pb)	28.40	28.40	28.40	28.40
Meter Correction Factor	(Y)	0.979	0.979	0.979	0.979
Orifice Calibration Value	$(\Delta H@)$	1.810	1.810	1.810	1.810
Meter Volume, ft^3	(Vm)	39.110	38.150	38.120	38.460
Meter Temperature, °F	(Tm)	75.6	77.3	77.3	76.8
Meter Temperature, °R	(Tm)	535.3	537.0	537.0	536.4
Meter Orifice Pressure, in. WC	(ΔH)	0.398	0.387	0.398	0.394
Volume H2O Collected, mL	(Vlc)	166.0	162.9	152.9	160.6
Nozzle Diameter, in	(Dn)	0.221	0.221	0.221	0.221
Area of Nozzle, ft^2	(An)	0.00027	0.00027	0.00027	0.00027
Filterable <PM10 (Filter) Mass, mg	$(M_{FPM2.5})$	<u>0.5</u>	<u>0.5</u>	<u>0.5</u>	0.5
Filterable <PM10 Mass, mg	(M_{FPM10})	<u>0.5</u>	<u>0.5</u>	0.5	0.5
Filterable >PM10 Mass, mg	(M_{FPM})	<u>0.5</u>	<u>0.5</u>	0.9	0.6
Condensable PM Mass, mg	(M_{CPM})	4.9	6.3	3.9	5.0
Filterable PM10 Mass, mg	(M_{FPM10})	1.0	1.0	1.0	1.0
PM10 Mass, mg (FPM10 + CPM)	(M_{PM10})	5.9	7.3	4.9	6.0
CALCULATED DATA					
Standard Meter Volume, ft^3	$(Vmstd)$	35.862	34.867	34.840	35.190
Standard Water Volume, ft^3	$(Vwstd)$	7.829	7.682	7.211	7.574
Sampling Rate, acfm	(Qs)	0.75	0.75	0.74	0.75
Moisture Fraction Measured	$(BWSmsd)$	0.179	0.181	0.171	0.177
Moisture Fraction @ Saturation	$(BWSsat)$	33.799	36.509	36.231	35.513
Moisture Fraction	(BWS)	0.179	0.181	0.171	0.177
Meter Pressure, in Hg	(Pm)	28.43	28.43	28.43	28.429
Volume at Nozzle, ft^3	(Vn)	81.124	79.712	78.710	79.849
Isokinetic Sampling Rate, % (+/- 20%)	(I)	104.3	103.2	100.4	102.6
DGM Calibration Check Value, % (+/- 5%)	(Y_{qa})	-1.1	0.0	-1.8	-1.0
Particle Cut Diameter (PM2.5), um (+/-0.25 um)	(D_{50IV})	2.48	2.50	2.55	2.51
Particle Cut Diameter (PM10), um (+/-1 um)	(D_{50})	10.1	10.1	10.3	10.2
Reynolds Number	(Nre)	2,161	2,136	2,106	2134
Cunningham Correction Factor	(C)	1.119	1.120	1.120	1.120
Gas Viscosity, mpoise	(μ)	255.08	256.81	257.55	256.48
RECALCULATED DATA					
Cunningham Correction Factor	(Cr)	1.119	1.120	1.118	1.119
Particle Cut Diameter, um	(D_{50-1})	2.48	2.50	2.55	2.51
Ratio of D_{50} and D_{50-1} (+/- 0.01)	(Z)	1.00	1.00	1.00	1.00
EMISSION CALCULATIONS					
Filterable PM10 Concentration, grain/dscf	(C_{FPM10})	0.00043	0.00044	0.00044	0.00044
Filterable PM10 Emission Rate, lb/hr	(ER_{FPM10})	0.053	0.055	0.056	0.054
Condensable PM Concentration, grain/dscf	(C_{CPM})	0.0021	0.0028	0.0017	0.0022
Condensable PM Emission Rate, lb/hr	(ER_{CPM})	0.26	0.34	0.22	0.27
PM10 Concentration, grain/dscf	(C_{PM10})	0.0025	0.0032	0.0022	0.0026
PM10 Emission Rate, lb/hr	(ER_{PM10})	0.31	0.40	0.27	0.33

Location: **Louisiana-Pacific Sagola Plant - Sagola, MI**
Source: **Thermal Oil Heater (TOH)**
Project No.: **2022-2666**
Parameter: **PM/CPM**

Run Number		Run 1	Run 2	Run 3	Average
Date		9/21/22	9/21/22	9/21/22	-
Start Time		7:25	9:40	11:50	-
Stop Time		9:15	11:28	13:39	-
Run Time, min		108.5	106.2	106.5	107.0
VELOCITY HEAD, in. WC					
Point 1		0.33	0.32	0.34	0.33
Point 2		0.34	0.34	0.34	0.34
Point 3		0.35	0.33	0.35	0.34
Point 4		0.35	0.35	0.36	0.35
Point 5		0.36	0.36	0.37	0.36
Point 6		0.37	0.37	0.36	0.37
Point 7		0.29	0.28	0.35	0.31
Point 8		0.31	0.32	0.32	0.32
Point 9		0.32	0.35	0.34	0.34
Point 10		0.33	0.36	0.36	0.35
Point 11		0.32	0.36	0.35	0.34
Point 12		0.33	0.35	0.36	0.35
CALCULATED DATA					
Square Root of ΔP	(in. WC)$^{1/2}$	0.577	0.583	0.592	0.584
Pitot Tube Coefficient	(Cp)	0.84	0.84	0.84	0.84
Barometric Pressure, in. Hg	(Pb)	28.40	28.40	28.40	28.40
Static Pressure, in. WC	(Pg)	-0.30	-0.30	-0.30	-0.30
Stack Pressure, in. Hg	(Ps)	28.38	28.38	28.38	28.38
Stack Cross-sectional Area, ft^2	(As)	12.05	12.05	12.05	12.05
Temperature, °F	(Ts)	469.9	478.3	477.4	475.2
Temperature, °R	(Ts)	929.6	937.9	937.1	934.9
Moisture Fraction Measured	(BWSmsd)	0.179	0.181	0.171	0.177
Moisture Fraction @ Saturation	(BWSsat)	33.799	36.509	36.231	35.513
Moisture Fraction	(BWS)	0.179	0.181	0.171	0.177
O2 Concentration, %	(O2)	9.5	9.6	9.9	9.7
CO2 Concentration, %	(CO2)	10.9	11.0	10.8	10.9
Molecular Weight, lb/lb-mole (dry)	(Md)	30.12	30.14	30.12	30.13
Molecular Weight, lb/lb-mole (wet)	(Ms)	27.95	27.95	28.05	27.99
Velocity, ft/sec	(Vs)	44.9	45.6	46.1	45.5
VOLUMETRIC FLOW RATE					
At Stack Conditions, acfm	(Qa)	32,428	32,933	33,318	32,893
At Standard Conditions, dscfm	(Qs)	14,330	14,400	14,743	14,491

Alliance SOURCE TESTING

Location **Louisiana-Pacific Sagola Plant - Sagola, MI**
Source **Thermal Oil Heater (TOH)**
Project No. **2022-2666**
Date: **09/19/22**

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	51.25	in
Nipple Length:	4.25	in
Depth of Duct:	47.00	in
Cross Sectional Area of Duct:	12.05	ft^2
No. of Test Ports:	2	
Number of Readings per Point:	1	
Distance A:	30.0	ft
Distance A Duct Diameters:	7.7	(must be > 0.5)
Distance B:	32.0	ft
Distance B Duct Diameters:	8.2	(must be > 2)
Minimum Number of Traverse Points:	12	
Actual Number of Traverse Points:	12	
Measurer:	COG 9/19/22	
Reviewer:	TAJ 9/19/22	

* HIGHER NUMBER IS FOR RECTANGULAR STACKS OR DUCTS

DISTURBANCE
MEASUREMENT SITE
DISTURBANCE
12 points
8 or 9* points
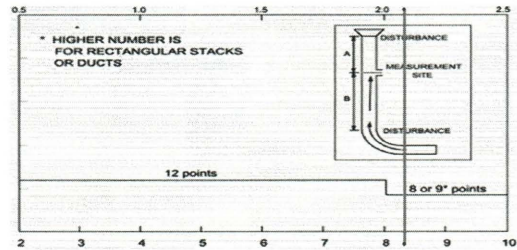
CIRCULAR DUCT

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	4.4	2.07	6.32
2	14.6	6.86	11.11
3	29.6	13.91	18.16
4	70.4	33.09	37.34
5	85.4	40.14	44.39
6	95.6	44.93	49.18
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 30 ft.
B = 32 ft.
Depth of Duct = 47 in.

Cross Sectional Area
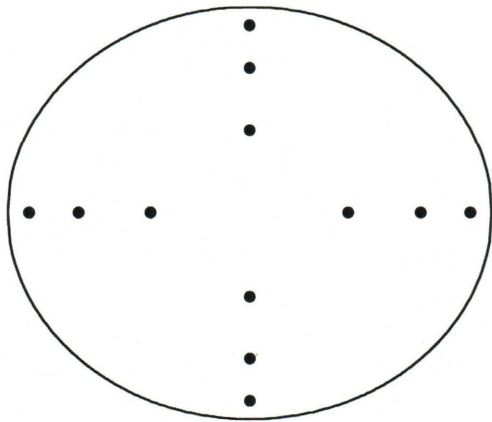
Downstream Disturbance

A

B

Upstream Disturbance

Cyclonic Flow Check

Alliance SOURCE TESTING

Location	**Louisiana-Pacific Sagola Plant - Sagola, MI**
Source	**Thermal Oil Heater (TOH)**
Project No.	**2022-2666**
Date	**9/20/22**

Sample Point	Angle (ΔP=0)
1	-3
2	-1
3	-2
4	-1
5	-3
6	-2
7	0
8	1
9	0
10	1
11	2
12	2
Average	-1

Alliance SOURCE TESTING

Location Louisiana-Pacific Sagola Plant - Sagola, MI

Source Thermal Oil Heater (TOH)

Project No. 2022-2666

Parameter	O₂ Data			CO₂ Data		
	Date/Time	9/21/22	14:30	Date/Time	9/21/22	14:30
Make/Model/SN	Servomex	1440D	693	Servomex	1440D	4043
Parameter	Cylinder ID	Cylinder Concentration, %	Analyzer Concentration, %	Cylinder ID	Cylinder Concentration, %	Analyzer Concentration, %
Zero Gas		0.05	0.11		0.00	0.08
High Range Gas	CC461827	20.80	20.89	CC461827	16.60	16.65
Mid Range Gas	CC461787	10.90	10.92	CC461787	8.50	8.53
Concentration Span, %	20.8			16.6		
Required Accuracy, %	0.42			0.33		

Run No.	Run 1		Run 2		Run 3	
Parameter	O₂ %	CO₂ %	O₂ %	CO₂ %	O₂ %	CO₂ %
Date/Time	9/21/2022	14:35	9/21/2022	14:40	9/21/2022	14:45
Analysis #1	9.5	10.9	9.6	11.0	9.9	10.8
Analysis #2	9.5	10.9	9.6	11.0	9.9	10.8
Analysis #3	9.5	10.9	9.6	11.0	9.9	10.8
Average	9.5	10.9	9.6	11.0	9.9	10.8

Alliance SOURCE TESTING

Location	Louisiana-Pacific Sagola Plant - Sagola, MI
Source	Thermal Oil Heater (TOH)
Project No.	2022-2666
Parameter:	PM/CPM

Run 1		Date:	9/21/22			
	Impinger No.	1	2	3	4	Total
	Contents	empty	empty	water	silica	--
	Initial Mass, g	474.2	640.7	792.2	1568.8	3475.9
	Final Mass, g	629.2	641.5	785.3	1585.9	3641.9
	Gain, g	155.0	0.8	-6.9	17.1	166.0
Run 2		Date:	9/21/22			
	Impinger No.	1	2	3	4	Total
	Contents	empty	empty	water	silica	--
	Initial Mass, g	527.3	622.9	728.4	1538.3	3416.9
	Final Mass, g	676.7	623.3	724.9	1554.9	3579.8
	Gain, g	149.4	0.4	-3.5	16.6	162.9
Run 3		Date:	9/21/22			
	Impinger No.	1	2	3	4	Total
	Contents	empty	empty	water	silica	--
	Initial Mass, g	474.2	640.7	785.3	1585.9	3486.1
	Final Mass, g	620.1	642.6	776.3	1600.0	3639.0
	Gain, g	145.9	1.9	-9.0	14.1	152.9