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Source Test Report

Louisiana-Pacific Corporation
7299 LP Mill Road
Newberry, MI 49868

Sources Tested: Dryer Regenerative Thermal Oxidizer
(RTO)

Test Dates: October 10-11, 2022

Project No. AST-2022-3122

Prepared By
Alliance Technical Group, LLC
4500 Ball Road NE
Circle Pines, MN 55014

Regulatory Information

Permit Nos. Michigan Renewable Operating Permit Nos. #MI-ROP-N0780-2018a & PTI 43-19A

Source Information

<i>Source Name</i>	<i>Source ID</i>	<i>Target Parameters</i>
Dryer Regenerative Thermal Oxidizer (RTO) Inlet		VOC, Formaldehyde
Dryer Regenerative Thermal Oxidizer (RTO) Outlet	Stack P002 / EUDRYERRC	PM, CO, NOx, VOC, acetaldehyde, acrolein, formaldehyde, phenol, propionaldehyde, methanol and manganese

Contact Information

<i>Test Location</i>	<i>Test Company</i>	<i>Analytical Laboratory</i>
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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

Date

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Introduction

1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by Louisiana-Pacific Corporation (LP) to conduct compliance testing at the Newberry, MI facility. The facility operates under Michigan Renewable Operating Permit Nos. #MI-ROP-N0780-2018a and PTI 43-19A. Testing was conducted to determine the emission rate of particulate matter (PM), carbon monoxide (CO), nitrogen oxide (NOx), volatile organic compounds (VOC-in/out), acetaldehyde, acrolein, formaldehyde (in/out), phenol, propionaldehyde, methanol and manganese from one (1) Dryer regenerative thermal oxidizer (RTO).

1.1 Source and Control System Descriptions

The LP facility owns and operates the Dryer RTO. The Dryer System is a MEC model 1360T Wafer dryer, triple pass drum with flue gas re-circulation controlled by a geoenergy wet electrostatic precipitator and TANN corporation regenerative thermal oxidizer. It has an estimated production capacity of 30,000 pounds of wafers per hour. The primary burner is a McConnell wood fired cyclonic suspension burner rated at 46 MMBtu/hr. The vented platen press emissions are controlled by the Dryer System WESP and RTO and are accounted for in the emission limits under EUDRYERRC.

1.2 Project Team

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

Table 1-1: Project Team

Facility Personnel	Nick Waddell
Alliance Personnel	Trent Johnson Corbin Godfrey Jim Thoma Chris Warneke

1.3 Test Protocol & Notification

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

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Summary of Results

2.0 Summary of Results

Alliance conducted compliance testing at the LP facility in Newberry, MI on October 10-11, 2022. Testing consisted of determining the emission rates of PM, CO, NOx, VOC-in/out, acetaldehyde, acrolein, formaldehyde (in/out), phenol, propionaldehyde, methanol and manganese from the RTO.

Tables 2-1 through 2-3 provide a summary of the emission testing results with comparisons to the applicable MI-ROP 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 – RTO VOC and Formaldehyde DRE Data

Run Number	Run 1	Run 2	Run 3	Average
Date	10/11/22	10/11/22	10/11/22	--
Volatile Organic Compounds Data (NMEHC¹)				
RTO Inlet Concentration, ppmvd	110.5	190.6	138.3	146.5
RTO Inlet Emission Rate, lb/hr	23.2	43.0	30.4	32.2
RTO Outlet Concentration, ppmvd	0.28	0.70	0.41	0.46
RTO Outlet Emission Rate, lb/hr	0.069	0.17	0.10	0.11
Permit Limit, lb/hr	--	--	--	5.12
Percent of Limit, %	--	--	--	2
Reduction Efficiency, %	99.70	99.60	99.67	99.66
Formaldehyde Data				
RTO Inlet Concentration, ppmvd	88.9	156.1	116.5	120.5
RTO Inlet Emission Rate, lb/hr	12.7	24.0	17.4	18.1
RTO Outlet Concentration, ppmvd	0.33	0.36	0.34	0.34
RTO Outlet Emission Rate, lb/hr	0.056	0.060	0.056	0.057
Permit Limit, lb/hr	--	--	--	1.11
Percent of Limit, %	--	--	--	5
Reduction Efficiency, %	99.56	99.75	99.68	99.66

¹ Non-Methane Hydrocarbons (as propane)

Table 2-2: Summary of Results – RTO PM, Manganese and HAP Data

Run Number	Run 1	Run 2	Run 3	Average
Date	10/11/22	10/11/22	10/11/22	--
Total Particulate Matter Data				
Concentration, grain/dscf	0.0041	0.0025	0.0026	0.0030
Emission Rate, lb/hr	1.2	0.76	0.78	0.93
Permit Limit, lb/hr	--	--	--	7.9
Percent of Limit, %	--	--	--	12
Acetaldehyde Data				
Concentration, ppmvd	< 0.13	< 0.15	< 0.13	< 0.14
Emission Rate, lb/hr	< 0.031	< 0.038	< 0.032	< 0.034
Permit Limit, lb/hr	--	--	--	1.17
Percent of Limit, %	--	--	--	3
Acrolein Data				
Concentration, ppmvd	< 0.061	< 0.073	< 0.063	< 0.066
Emission Rate, lb/hr	< 0.019	< 0.023	< 0.020	< 0.020
Permit Limit, lb/hr	--	--	--	0.195
Percent of Limit, %	--	--	--	10
Phenol Data				
Concentration, ppmvd	< 0.18	< 0.22	< 0.19	< 0.20
Emission Rate, lb/hr	< 0.10	< 0.11	< 0.10	< 0.10
Propionaldehyde Data				
Concentration, ppmvd	< 0.16	< 0.19	< 0.16	< 0.17
Emission Rate, lb/hr	< 0.051	< 0.061	< 0.053	< 0.055
Methanol Data				
Concentration, ppmvd	< 0.22	< 0.27	< 0.23	< 0.24
Emission Rate, lb/hr	< 0.040	< 0.048	< 0.041	< 0.043
Manganese Data				
Concentration, ug/dscm	9.0	8.2	6.9	8.0
Emission Rate, lb/hr	0.0012	0.0010	0.0009	0.0010
Permit Limit, lb/hr	--	--	--	0.03
Percent of Limit, %	--	--	--	3

Table 2-3: Summary of Results – RTO CO and NOx Outlet Data

Run Number	Run 1	Run 2	Run 3	Average
Date	10/10/22	10/10/22	10/10/22	--
Carbon Monoxide Data				
Concentration, ppmvd	62.3	108.7	80.4	83.8
Emission Rate, lb/hr	9.7	17.0	12.5	13.1
Permit Limit, lb/hr	--	--	--	23.98
Percent of Limit, %	--	--	--	54
Nitrogen Oxide Data				
Concentration, ppmvd	8.8	10.0	9.3	9.4
Emission Rate, lb/hr	2.3	2.6	2.4	2.4
Permit Limit, lb/hr	--	--	--	14.8
Percent of Limit, %	--	--	--	16

Testing Methodology

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
Moisture Content	4	Gravimetric Analysis
Particulate Matter	5/202	Isokinetic Sampling
Nitrogen Oxides	7E	Instrumental Analysis
Carbon Monoxide	10	Instrumental Analysis
Volatile Organic Compounds ¹	18 / 25A	Instrumental Analysis
Manganese	29	Isokinetic Testing
Formaldehyde	320	FTIR – Continuous Sampling
Acetaldehyde, Acrolein, Methanol, Phenol, Propionaldehyde	NCASI 99.02	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 (O₂) and carbon dioxide (CO₂) 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 3.13.

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 Methods 5 and 202 – Total Particulate Matter

The total particulate matter (filterable and condensable PM) testing was conducted in accordance with U.S. EPA Reference Test Methods 5 and 202. The complete sampling system consisted of a stainless-steel nozzle, glass-lined probe, pre-weighed quartz filter, coil condenser, 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 impingers. The probe liner heating system was maintained at a temperature of $248 \pm 25^\circ\text{F}$, 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. Condensate was collected in the first dry impinger, therefore the front-half of the sample train (the nozzle, probe, and heated pre-weighed filter) was removed in order to purge the back-half of the sample train (coil condenser, first and second impingers and CPM filter). A glass bubbler was inserted into 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, then the coil condenser was replaced. Zero nitrogen was connected to the condenser, 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 probe, nozzle and front half of the filter holder 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, the 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.

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

The nitrogen oxides (NO_x) 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 3.13.

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 3.13.

3.7 U.S. EPA Reference Test Methods 25A and 18 –Volatile Organic Compounds

The volatile organic compounds (VOC) 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.

3.8 U.S. EPA Reference Test Method 29 – Manganese

The metals testing was conducted in accordance with U.S. EPA Reference Test Method 29. The complete sampling system consisted of a glass nozzle, heated glass-lined probe, pre-cleaned quartz filter, gas conditioning system, 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 HNO₃/H₂O₂, the third was empty and the fourth impinger contained 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 testing. Prior to testing, all glassware was cleaned and sealed in a controlled environment as outlined in the test method.

Following the completion of each test run, the sample train was leak checked at a vacuum pressure equal to or greater than the highest vacuum pressure observed during the run and the contents of the impingers were measured for moisture gain. The quartz filter was carefully removed and placed into container 1. The probe and nozzle were rinsed and brushed three (3) times with 0.1 N HNO₃ using a non-metallic brush and these rinses were placed in container 3. The front half of the filter holder was rinsed three (3) times with 0.1 N HNO₃ and these rinses were added to container 3. The contents of impingers 1, 2, and 3 were placed in container 4. Impingers 1, 2, and 3 along with the filter support, back half of the filter holder and all connecting glassware were triple rinsed with 0.1 N HNO₃ and these rinses were added to container 4. All containers were sealed, labeled and liquid levels marked for transport to the identified laboratory for analysis.

3.9 U.S. EPA Reference Test Method 320 – Formaldehyde

The concentrations of formaldehyde at each inlet and outlet were determined in accordance with U.S. EPA Reference Test Method 320. Each source gas stream was extracted at a constant rate through a heated probe, heated filter and heated sample line and analyzed with a MKS MultiGas 2030 FTIR operated by a portable computer. The computer has FTIR spectra of calibration gases stored on the hard drive. These single component calibration spectra are used to

analyze the measured sample spectra. The gas components to be measured were selected from the spectra library and incorporated into the analytical method. The signal amplitude, linearity, and signal to noise ratio were measured and recorded to document analyzer performance. A leak check was performed on the sample cell. The instrument path length was verified using ethylene as the Calibration Transfer Standard. Dynamic spiking was performed using a certified standard of the target compound or appropriate surrogate in nitrogen with sulfur hexafluoride blended as a tracer to calculate the dilution factor. All test spectra, interferograms, and analytical method information are recorded and stored with the calculated analytical results. The quality control measures are described in Section 3.15.

3.10 National Council for Air and Stream Improvement Method 99.02 – RTO HAPs

The HAPs testing on the RTO was conducted in accordance with NCASI Methods 99.02. The source gas was withdrawn at a constant sampling rate through a glass probe and midjet impinger train with a portion evacuated to a stainless-steel canister. Constant rate sampling was assured by using a critical orifice and maintaining constant system pressure, verified with a rotameter. A heated filter was inserted upstream of the midjet impingers to prevent clogging by particulate. The actual sampling rates were verified with a bubble flow meter.

3.11 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 NO₂ – NO converter check was performed on the analyzer prior to initiating 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 NO₂ gas. The NO₂ 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.

3.12 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.

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 Method 320

EPA Protocol 1 Calibration Gases – 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.

After providing ample time for the FTIR to reach the desired temperature and to stabilize, zero gas (nitrogen) was introduced directly to the instrument sample port. While flowing nitrogen the signal amplitude was recorded, a background spectra was taken, a linearity check was performed and recorded, the peak-to-peak noise and the root mean square in the spectral region of interest was measured and a screenshot was recorded.

Following the zero gas checks, room air was pulled through the sample chamber and the line width and resolution was verified to be at 1879 cm⁻¹, the peak position was entered and the FWHH was recorded (screenshot). Following these checks, another background spectra was recorded, and the calibration transfer standard (CTS) was introduced directly to the instrument sample port. The CTS instrument recovery was recorded, and the instrument mechanical response time was measured.

Next, stack gas was introduced to the FTIR through the sampling system and several scans were taken until a stable reading was achieved. The native concentration of our surrogate spiking analyte acetaldehyde was recorded. Spike gas was introduced to the sampling system at a constant flow rate $\leq 10\%$ of the total sample flow rate and a corresponding dilution ratio was calculated along with a system response time. Matrix spike recovery spectra were recorded and were within the $\pm 30\%$ of the calculated value of the spike concentration that the method requires.

The matrix spike recovery was conducted once at the beginning of the testing and the CTS recovery procedures were repeated following each test run. The corresponding values were recorded.