

**TEST REPORT  
COMPLIANCE EMISSION TEST  
POET BIOREFINING  
REGENERATIVE THERMAL OXIDIZER  
THERMAL OXIDIZER  
FLUIDIZED BED BAGHOUSE  
CARO, MICHIGAN**

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**JUN 04 2018**

**AIR QUALITY DIVISION**

Prepared For:

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Document No.: 024AS-330458-RT-66  
Test Dates: April 10 through 12, 2018



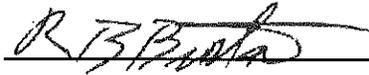
POET Biorefining: Caro, Michigan  
RTO, TO, & Fluidized Bed Baghouse Compliance Test  
Test Dates: 4/10 – 4/12/18

## REPORT CERTIFICATION

### STATEMENT OF CONFORMANCE AND TEST REPORT CERTIFICATION

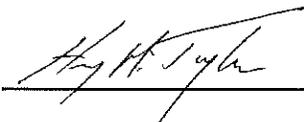
I certify, to the best of my knowledge, that this test program was conducted in a manner conforming to the criteria set forth in ASTM D7036-12: Standard Practice for Competence of Air Emission Testing Bodies, and that project management and supervision of all project related activities were performed by qualified individuals as defined by this practice.

I further certify that this test report and all attachments were prepared under my direction or supervision in accordance with the Montrose Air Quality Services, LLC quality management system designed to ensure that qualified personnel gathered and evaluated the test information submitted. Based on my inquiry of the person or persons who performed the sampling and analysis relating to this performance test, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete.



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Rob Burton, QI  
Client Project Manager  
Montrose Air Quality Services, LLC



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Henry M. Taylor, QSTO  
Quality Assurance Manager  
Montrose Air Quality Services, LLC

## 1.0 INTRODUCTION AND SUMMARY

Montrose Air Quality Services, LLC (Montrose) was retained by POET Biorefining (POET) to conduct a compliance emission test at their facility in Caro, Michigan.

The purpose of the testing was to determine the concentrations and mass emission rates of particulate matter (PM), condensable PM (CPM), nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (VOC), and acetaldehyde.

The compliance test consisted of three 60-minute test runs conducted on the following sources for the listed parameters:

Test Date	Source	Parameters	Test Methods
4/10/18	Regenerative Thermal Oxidizer (RTO) Stack	PM, NO <sub>x</sub> , VOC, Acetaldehyde	1, 2, 3A, 4, 5, 7E, 19, 202, 320
4/11/18	Thermal Oxidizer (TO) Stack	PM, NO <sub>x</sub> , VOC, Acetaldehyde	1, 2, 3A, 4, 5, 7E, 19, 202, 320
4/12/18	Fluidized Bed Baghouse Stack	PM, VOC, Acetaldehyde	1, 2, 4, 5, 202, 320

The CO<sub>2</sub>, VOC, and acetaldehyde concentrations were determined using Fourier transform infrared (FTIR) instrumentation in accordance with USEPA Method 320 and ASTM Method D6348-03. The following compounds were determined by FTIR analysis to calculate the total VOC:

Ethanol	Ethyl Acetate	Methanol
Acetic Acid	Formaldehyde	Acetaldehyde
Formic Acid	2-Furaldehyde	Acrolein

Testing was conducted in accordance with the sampling and analytical procedures presented in Test Plan No. 024AS-330458-PP-7R1 dated March 2, 2018. Specifically, where applicable, testing was conducted pursuant to the following procedures:

- Code of Federal Regulations, Title 40, Part 60 (40 CFR 60), Appendix A, USEPA Methods 1, 2, 3A, 4, 5, 7E, and 19
- 40 CFR 51, Appendix M, USEPA Methods 202 and 205
- 40 CFR 63, Appendix A, USEPA Method 320
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods
- ASTM Method D6348-03 – Determination of Gaseous Compounds by Extractive Direct Interface FTIR Spectroscopy

Mr. Jacob Mackowski of POET coordinated the test and monitored all pertinent process operations. Messrs. Rob Burton, Bryan Fotos, Vannak Khy, and Daniel Stork of Montrose performed the compliance test. Mr. Rob Burton was the onsite field test supervisor and qualified individual for the test. Mr. Tom Gasloli of the Michigan Department of Environmental Quality (MDEQ) witnessed the testing on all sources. Ms. Gina McCann of the MDEQ witnessed the RTO testing, and Mr. Matt Karl of the MDEQ witnessed the Fluidized Bed Baghouse testing.

This report summarizes the test procedures and results of the test. Included, as appendices, is complete documentation of all calculation summaries, field data, laboratory data, reference method monitoring data, FTIR data, process data, calibration data, and test program qualifications.

The test results are detailed in Section 3 of this document. A summary of the average test results is presented in Table 1-1.

**TABLE 1-1  
 SUMMARY OF AVERAGE TEST RESULTS**

Source	Test Date	Parameter	Units	Average Result	Compliance Limit
RTO Stack	4/10/18	Total PM	lb/hr	2.48	6.00
		Total VOC	lb/hr	< 0.91	9.00*
		Acetaldehyde	lb/hr	< 0.07	
		NO <sub>x</sub>	lb/MMBtu	0.079	0.10
TO Stack	4/11/18	Total PM	lb/hr	1.22	6.00
		Total VOC	lb/hr	< 0.79	9.00*
		Acetaldehyde	lb/hr	< 0.08	
		NO <sub>x</sub>	lb/MMBtu	0.055	0.10
Fluidized Bed Stack	4/12/18	Total PM	lb/hr	0.30	0.65
		Total PM	lb/1,000 lb gas	0.0037	0.006
		Total VOC	lb/hr	< 5.26	6.60
		Acetaldehyde	lb/hr	0.14	

\*Combined RTO and TO compliance limit.

Note: Average values labeled as 'less than' identify emission rates which include one or more compounds reported at the method detection limit.

## 2.0 TEST METHODOLOGY AND PROCEDURES

### 2.1 OVERVIEW

Montrose was retained by POET to conduct a compliance emission test at their facility in Caro, Michigan. Testing was conducted on April 10 through 12, 2018.

Three 60-minute test runs were conducted on the RTO and TO stacks for PM, CPM, NO<sub>x</sub>, VOC, and acetaldehyde determination. Three 60-minute test runs were conducted on the Fluidized Bed Baghouse stack for PM, CPM, VOC, and acetaldehyde determination.

### 2.2 METHODOLOGY

Where applicable, test procedures and sampling methodology followed 40 CFR 60, Appendix A, USEPA Methods 1, 2, 3A, 4, 5, 7E, and 19; 40 CFR 51, Appendix M, USEPA Methods 202 and 205; 40 CFR 63, Appendix A, USEPA Method 320; ASTM Method D6348-03 (FTIR); and the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods.

#### 2.2.1 Sampling Locations (USEPA Method 1)

The velocity sampling points were determined following USEPA Method 1. The sampling locations and number of velocity sampling points were as follows:

Stack Sampling Location	Stack Diameter (inches)	Port Location Upstream from Disturbance (inches)	Port Location Downstream from Disturbance (inches)	No. of Ports	Velocity Points per Port	Total Points
RTO	44.0	393	462	2	6	12
TO	79.25	480	240	2	12	24
Fluidized Bed Baghouse	36.0	110	72	2	12	24

#### 2.2.2 Gas Velocity and Volumetric Flow Rate Determination (USEPA Method 2)

Gas velocity and volumetric flow rate were determined following USEPA Method 2 procedures. Velocity traverses were performed using a Type-S pitot tube with the velocity head pressure measured on a Dwyer oil gauge inclined manometer to the nearest 0.01-inch H<sub>2</sub>O. Temperature measurements were performed with a chromel-alumel thermocouple connected to a digital direct read-out potentiometer.

The Fluidized Bed Baghouse stack gas composition is equivalent to ambient air; therefore, a dry molecular weight of 29.0 lb/lb-mole was used for the gas density and flow calculations as stated in USEPA Method 2.

#### 2.2.3 O<sub>2</sub> and NO<sub>x</sub> (USEPA Methods 3A and 7E)

Oxygen (O<sub>2</sub>) sampling was conducted in accordance with USEPA Method 3A using a Servomex, Inc. Model 1440 paramagnetic O<sub>2</sub> analyzer.

NO<sub>x</sub> sampling was conducted in accordance with USEPA Method 7E using a California Analytical Instruments, Inc. Model 600CLD chemiluminescent NO<sub>x</sub> analyzer. The NO<sub>x</sub> converter check was performed following USEPA Method 7E. This procedure uses a nitrogen dioxide (NO<sub>2</sub>) cylinder gas (40-60 ppm) to provide direct measurement of the converter efficiency. The converter is acceptable if the NO<sub>2</sub> to nitric oxide (NO) conversion rate is greater than 90%.

As shown in Figure 2-1, the sampling system consisted of a heated probe with an in-stack filter followed by a calibration tee assembly. The probe system was connected to a heated Teflon sampling line that transported the gas sample through an ice-cooled condenser and an electronic chiller to remove moisture. The dry sample gas was then transported to a manifold system by a Teflon-lined sample pump and Teflon sample line. The manifold was connected with sample gas intake lines for the analyzers.

The sampling system was calibrated with applicable zero, mid, and high-range gases as specified in the applicable USEPA methods. The calibration gases were generated from Protocol 1 calibration gases using an Environics Model 4040 Gas Dilution System. The gas dilution system was verified on site in accordance with USEPA Method 205.

A response time test, calibration error test, and measurement system bias test were performed prior to testing, and a pre/post calibration drift test was performed after each test repetition on each analyzer. The average zero and calibration drift values were used to correct each analyzer's raw data for instrument zero and drift for each respective test run.

The data were collected at 15-second intervals, and one-minute averages were calculated by a data acquisition system consisting of an Omega OMB-DAQ-56 data acquisition module connected to a computer for digital data storage and reduction.

#### **2.2.4 Moisture Content (USEPA Method 4)**

The stack gas moisture content was determined in accordance with USEPA Method 4 and combined with the PM sampling trains.

#### **2.2.5 Particulate Matter Determination (USEPA Methods 5 and 202)**

PM was determined following the procedures described in USEPA Method 5. The back-half impinger catch was analyzed in accordance with USEPA Method 202 for CPM determination.

##### **2.2.5.1 Sampling Apparatus**

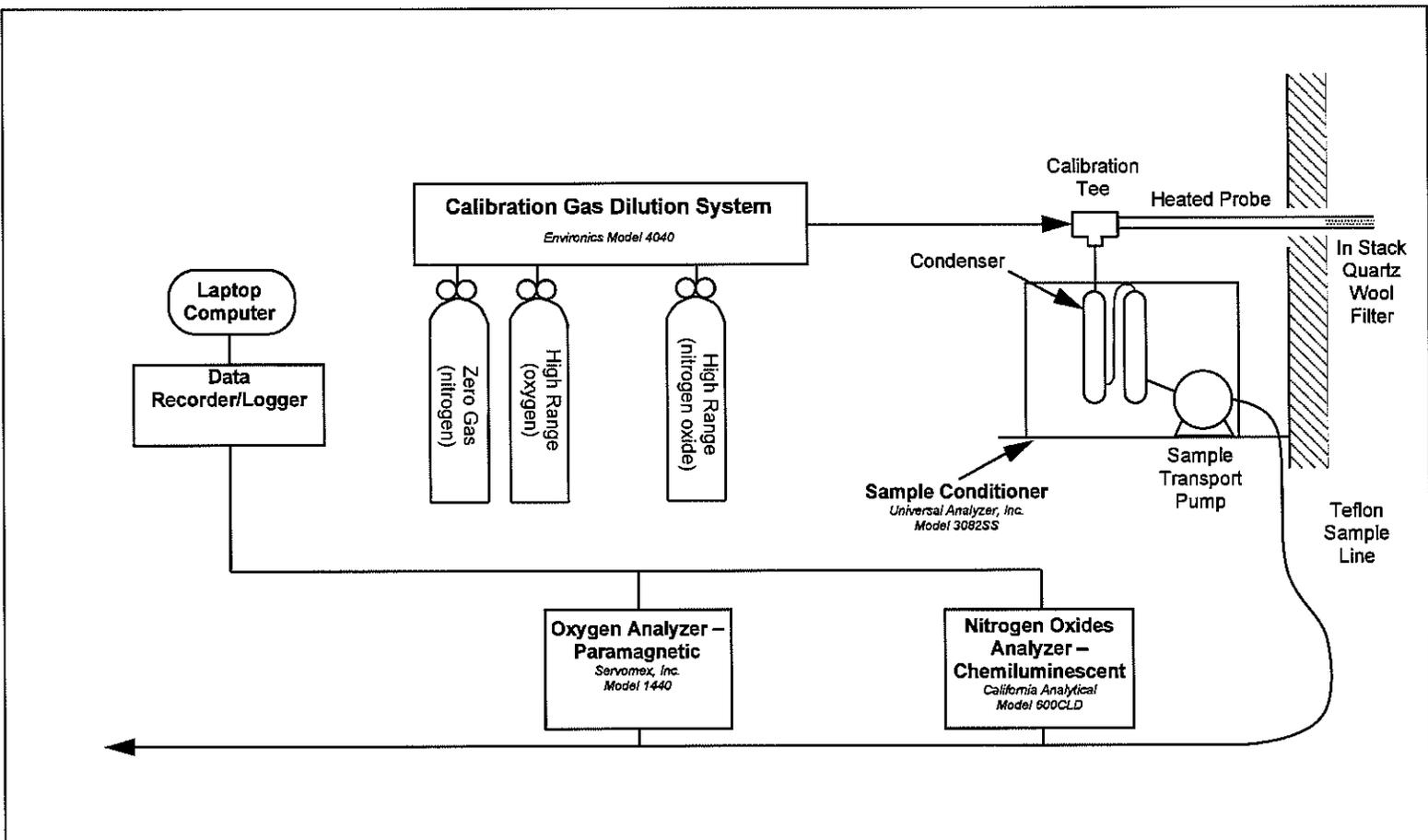
Assembled by Montrose personnel, the sampling train consisted of the following:

Nozzle – Stainless steel with sharp, tapered leading edge.

Probe - Borosilicate glass with a heating system capable of maintaining a probe exit temperature of 248 °F ± 25 °F.

Pitot Tube - Type-S, attached to probe for monitoring stack gas velocity.

FIGURE 2-1  
REFERENCE METHOD O<sub>2</sub> AND NO<sub>x</sub> SAMPLING SYSTEM



Heated Filter Holder - Borosilicate glass with a four-inch Teflon frit filter support and a silicone rubber gasket. The holder design provided a positive seal against leakage from the outside or around the filter. The filter holder was heated to 248 °F ± 25 °F during sampling. A thermocouple was placed in the back half of the filter support in direct contact with the sample stream.

Ambient Filter Holder - Unheated borosilicate glass with a three-inch Teflon frit filter support and a silicone rubber gasket. A thermocouple was placed in the back half of the filter holder to measure sample gas temperature by direct contact with the sample stream. Temperature was maintained between 65 and 85 °F. A Teflon filter disc was placed in the filter holder.

Draft Gauge - Inclined manometer with a readability of 0.01-inch H<sub>2</sub>O in the 0 to 10-inch range.

Condenser - Glass, coil type with compatible fittings.

Impingers - Four impingers connected in series with glass ball joints. The first impinger was a custom glass jar designed with a shortened stem to act as a moisture knockout and allowed the condenser coil to set atop the inlet in a vertical position. The second, third, and fourth impingers were of the Greenburg-Smith design but modified by replacing the standard tip with a ½-inch I.D. glass tube extending to within ½-inch of the bottom of the impinger flask. The second and third impingers were connected using the ambient filter holder.

Metering System - Apex Model 522. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5 °F, dry gas meter with ± 2 percent accuracy, and related equipment as required to maintain an isokinetic sampling rate and to determine sample volume.

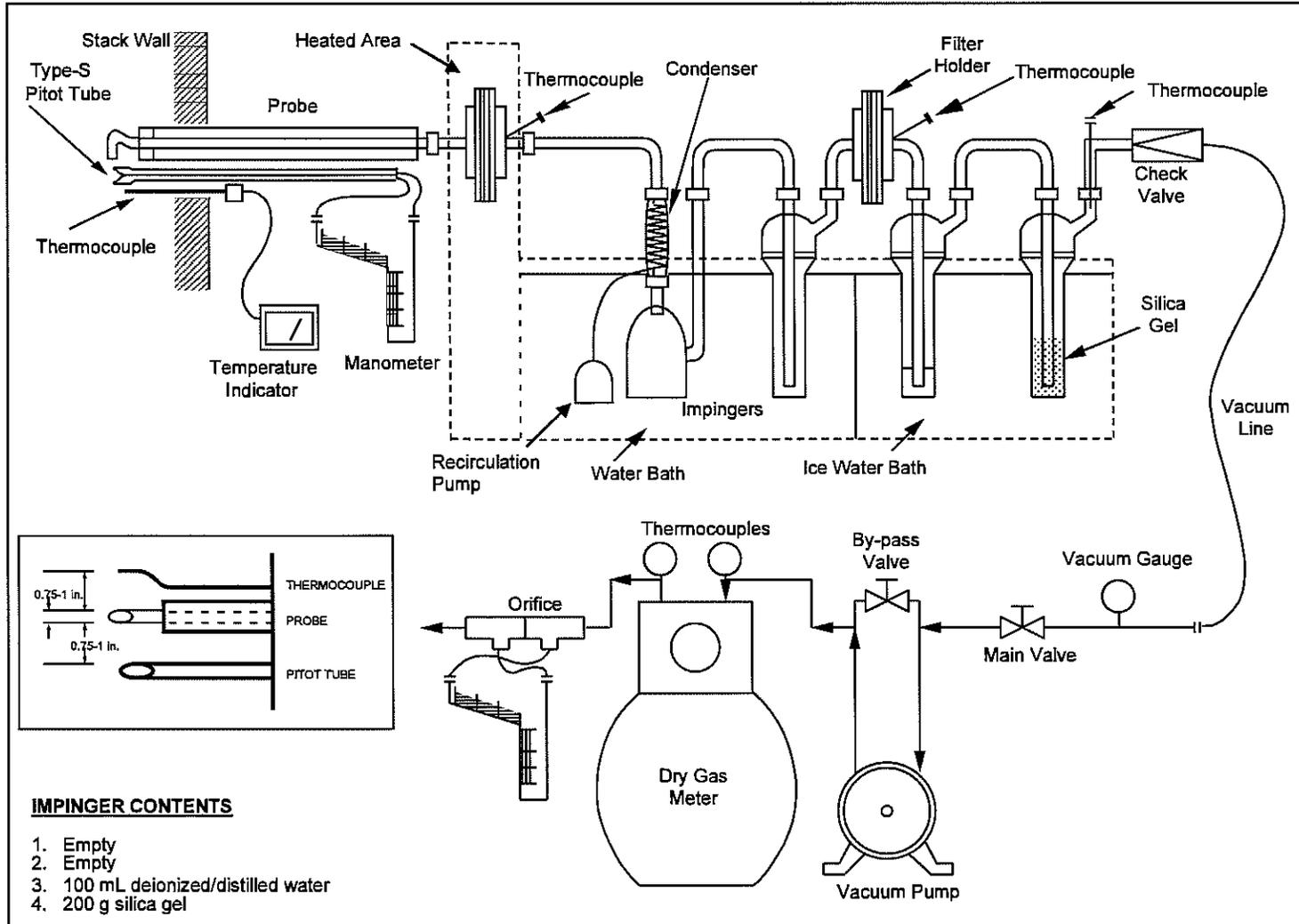
Barometer - Mercury barometer capable of measuring atmospheric pressure to within ± 0.1-inch Hg.

#### 2.2.5.2 Sampling Procedures

After the minimum number of traverse points was selected, the stack pressure, temperature, moisture, and range of velocity head were measured according to procedures described in USEPA Methods 1 through 4. The sampling train was set up with the probe, heated filter holder, condenser, ambient filter holder, and impingers as shown in Figure 2-2. The first and second impingers were initially empty. The third impinger contained 100 milliliters (mL) of deionized/distilled water. The fourth impinger contained 200 grams of silica gel.

The impingers were placed in a container that had two compartments. The first two impingers were placed in the first compartment, and the third and fourth impingers were placed in the second compartment. The first compartment contained water that was circulated through the condenser to reduce the sample gas to between 65 and 85 °F at the exit of the ambient filter. The second compartment contained ice water to reduce the sample gas to ≤ 68 °F upon exiting the last impinger. Both temperatures were recorded at each traverse point interval throughout each test run.

**FIGURE 2-2  
USEPA METHODS 5/202 PARTICULATE MATTER SAMPLING TRAIN**



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The sampling train was leak-checked at the sampling site by plugging the inlet to the nozzle and pulling a vacuum of 15 inches Hg. Leak rates of less than 0.02 ft<sup>3</sup>/min at a vacuum of 15 inches Hg are considered acceptable. At the completion of each test run, the sampling train was again leak-checked by the same procedure, but at the highest vacuum attained during the test run. Both pre and post-test leak checks of the pitot tube were made for each test run. Ice was placed around the impingers to keep the temperature of the gases leaving the last impinger at less than 68 °F.

During sampling, stack gas and sampling train data were recorded at specified intervals. Isokinetic sampling rates were set throughout the sampling period with the aid of a programmable calculator.

### 2.2.5.3 Sample Recovery Procedures (Including Recovery Blank Train)

After sampling was completed, a post-test nitrogen purge was conducted with the impingers still on ice at the meter  $\Delta H@$  for 60 minutes. Before the purge step began, the short stem of the first impinger was replaced with a long stem that was within ½-inch of the bottom of the impinger. If the stem did not extend below the water level in the impinger by at least 1 cm, a measured amount of degassed, deionized/distilled water was added to adjust the level.

The sample fractions were recovered as follows:

Container 1 - The heated filter was removed from the holder and placed in a petri dish.

Container 2 - PM was removed from the probe with the aid of a brush and acetone rinsing. Loose PM and acetone washings from all sample-exposed surfaces prior to the filter were placed in a glass bottle, sealed, and labeled. The container was sealed, and the liquid level was marked.

Container 3 - The contents from the first two impingers were placed into a glass container. The impingers (including the short stem), connecting glassware, and front half of the ambient filter holder were quantitatively rinsed twice with deionized/distilled water, and the rinse was added to this container. The container was sealed, and the liquid level was marked.

Container 4 - The first two impingers (including the short stem), connecting glassware, and front half of the ambient filter holder were then rinsed with acetone followed by two rinses with hexane and placed in a glass container. The container was sealed, and the liquid level was marked.

Container 5 - The ambient filter was removed and placed in a petri dish.

Containers 6, 7, & 8 - 200 mL each of acetone, deionized/distilled water, and hexane were taken for blank analysis. The blanks were obtained and treated in a similar manner as the contents of Containers 2, 3, and 4.

The contents of the third impinger were weighed and discarded. The contents of the fourth impinger (silica gel) were weighed to the nearest gram.

#### 2.2.5.4 Analytical Procedures (Including Recovery Blank Train)

The analytical procedures followed those described in USEPA Methods 5 and 202.

Container 1 - The filter and any loose PM from this sample container were placed in a weighing dish, dried at 105 °C for two to three hours, desiccated for 24 hours to a constant weight, and weighed to the nearest 0.1 mg.

Container 2 - The acetone washings were transferred to a tared beaker and evaporated to dryness at ambient temperature and pressure. Then the contents were desiccated for 24 hours and weighed to a constant weight to the nearest 0.1 mg.

Container 3 - The liquid in this container was measured volumetrically and placed into a separatory funnel. Approximately 30 mL of hexane was added, mixed well, and the lower organic phase drained off. This procedure was repeated twice, leaving a small amount of the organic/hexane phase in the separatory funnel each time to yield approximately 90 mL of organic extract. This organic extract was combined with Container 4. The aqueous fraction from Container 3 was transferred to a tared Teflon beaker liner, evaporated in an oven at 105 °C to no less than 10 mL, and allowed to air dry at ambient temperature. If a dried constant weight could not be achieved, the residue was redissolved in 100 mL of water and titrated with 0.1N ammonium hydroxide to a pH of 7.0. The aqueous phase was then evaporated in an oven at 105 °C to approximately 10 mL, evaporated to dryness in a fume hood at ambient temperature and pressure, placed in a desiccator for 24 hours, and weighed to a constant weight to the nearest 0.1 mg. The gain in mass represents the inorganic PM collected in the sampling train back-half.

Container 4 - The contents of this container were combined with the organic extract from Container 3, placed in a tared Teflon beaker liner, evaporated to dryness at ambient temperature and pressure in a fume hood, placed in a desiccator for 24 hours, and weighed to a constant weight to the nearest 0.1 mg. The gain in mass represents the organic PM collected in the sampling train back-half.

Container 5 - The ambient filter was folded in quarters and placed into a 50 mL extraction tube. Sufficient deionized/distilled water was used to cover the filter. The extraction tube was placed in a sonication bath and the water soluble material extracted for a minimum of two minutes. The aqueous extract was combined with the contents of Container 3. This step was completed a total of three times. After completion of the aqueous extraction, the filter was covered with a sufficient amount of hexane. The extraction tube was then placed in a sonication bath, and the organic material was extracted for a minimum of two minutes. The organic extract was combined with the contents of Container 4. This step was completed a total of three times. The procedures for Container 5 were completed prior to any procedures for Containers 3 and 4.

Container 6 - The acetone blank was transferred to a tared Teflon beaker liner, evaporated to dryness at ambient temperature and pressure in a fume hood, placed in a desiccator for 24 hours, and weighed to a constant weight to the nearest 0.1 mg.

Container 7 - The water blank was transferred to a tared Teflon beaker liner, evaporated to approximately 10 mL in an oven at 105 °C, evaporated to dryness at ambient temperature and pressure in a fume hood, placed in a desiccator for 24 hours, and weighed to a constant weight to the nearest 0.1 mg.

Container 8 - The hexane blank was transferred to a tared Teflon beaker liner, evaporated to dryness at ambient temperature and pressure in a fume hood, placed in a desiccator for 24 hours, and weighed to a constant weight to the nearest 0.1 mg.

The term “constant weight” means a difference of no more than 0.5 mg or one percent of the total weight less tare weight, whichever is greater between two consecutive readings, with no less than six hours of desiccation between weighings.

#### 2.2.6 NO<sub>x</sub> Emission Rate Calculation (USEPA Method 19)

The NO<sub>x</sub> emission rate in pounds per million British thermal units (lb/MMBtu) was determined in accordance with USEPA Method 19 procedures. The emission rate was calculated using the oxygen-based F-factor (F<sub>d</sub>) method. The published F<sub>d</sub> of 8,710 dry standard cubic feet (dscf) per million Btu (MMBtu) for natural gas was used for calculations. The following equation presented in Section 12.2.1 of USEPA Method 19 was used to calculate the emission rate:

$$E = C_d F_d \left( \frac{20.9}{20.9 - O_{2d}} \right)$$

Where:

- E = Pollutant emission rate, lb/MMBtu
- C<sub>d</sub> = Pollutant concentration, lb/dscf
- F<sub>d</sub> = Oxygen-based F-factor, dscf/MMBtu
- O<sub>2d</sub> = Stack gas oxygen content, percent dry basis

#### 2.2.7 Gas Dilution System Verification (USEPA Method 205)

All applicable calibration gases were certified by USEPA Protocol 1 procedures. All diluted calibration standards were prepared using an Environics Model 4040 gas dilution system that was verified by a field evaluation following the requirements of USEPA Method 205.

The Servomex, Inc. Model 1440 paramagnetic O<sub>2</sub> analyzer was used for this procedure. It was initially calibrated following USEPA Method 3A procedures. After the calibration procedure was complete, two diluted standards and a USEPA Protocol 1 standard were alternately introduced in triplicate, and an average instrument response was calculated for each standard. No single response differed by more than ± 2% from the average response for each standard. The

difference between the instrument average and the predicted concentration was less than  $\pm 2\%$  for each diluted standard. The difference between the certified gas concentration and the average instrument response for the USEPA Protocol 1 standard was less than  $\pm 2\%$ .

### **2.2.8 FTIR Single Instrument Spiking Validation (USEPA Method 301)**

Montrose has performed several USEPA Method 301 spiking studies to validate the use of FTIR techniques to accurately measure the concentrations of the specific compounds from RTO, TO, and baghouse stacks.

The results of the validation studies were used to determine if the FTIR procedures are valid for these types of stationary sources. USEPA Method 320 allows the validation of FTIR-based measurements by a pair-wise comparison between the results of a single FTIR system.

The results of the validation studies indicated an accuracy of  $< \pm 2\%$  for the specific compounds; therefore, a bias correction factor is not needed. All of the statistical criteria in the method were met. The validation studies are on file at Montrose.

### **2.2.9 CO<sub>2</sub>, VOC, and Acetaldehyde Determination using FTIR Spectroscopy (USEPA Method 320)**

CO<sub>2</sub>, VOC, and acetaldehyde sampling was conducted using FTIR instrumentation following USEPA Method 320 and ASTM Method D6348-03.

An MKS Model MultiGas 2030 FTIR was used to measure the concentrations of the specific compounds. The MultiGas 2030 analyzer is composed of a 2102 process FTIR spectrometer, a high optical throughput sampling cell, analysis software, and a quantitative spectral library. The analyzer collects high resolution spectra in the mid infrared spectral region (400 to 4,000 cm<sup>-1</sup>), which are analyzed using the quantitative spectral library. This provides an accurate, highly sensitive measurement of gases and vapors.

As shown in Figure 2-3, the sample delivery system consisted of a stainless steel sampling probe, calibration tee, Teflon sampling line, fast loop bypass pump, dilution system, and sample manifold. The gas sample was continuously extracted from the source at approximately four liters per minute.

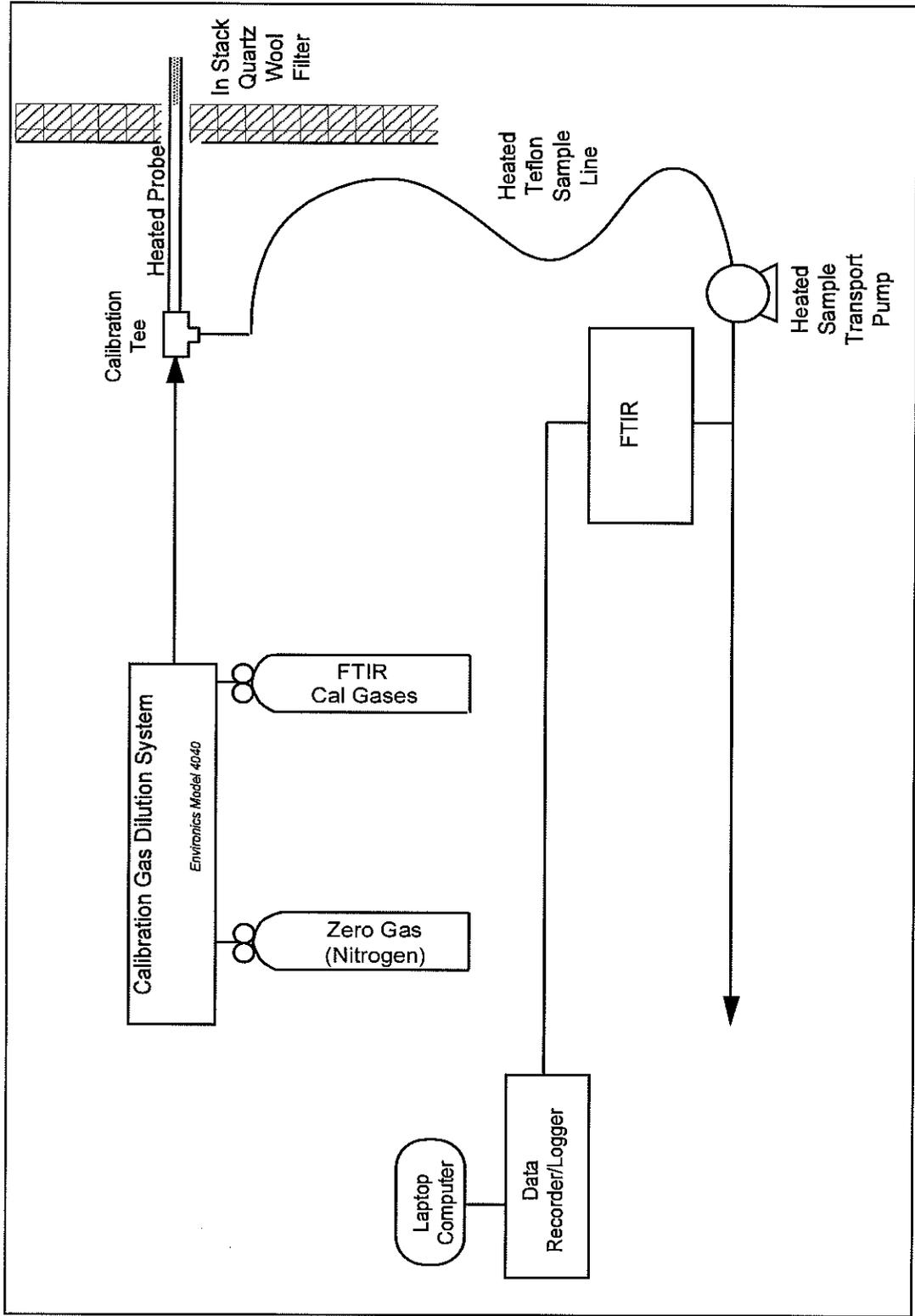
It should be noted that the main principles and calibration procedures of USEPA Method 320 were followed. USEPA Method 320 specifies a number of analytical uncertainty parameters that the analyst calculated to characterize the FTIR system performance. However, this did not provide analytical detection limits. To calculate the method detection limit (MDL) for the target compounds, the guidelines in Appendix B of 40 CFR 136 were followed. With this, the Student t-test is used to calculate the MDL for each analyte at a 99% confidence level. This follows USEPA guidelines for reporting of zeroes or non-detects and also meets the NELAC requirements for determination of MDL values.

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FIGURE 2-3  
FTIR SAMPLING SYSTEM



The MKS software calculates the analytical error of the FTIR measurement which includes the root mean standard deviation (RMSD). The concentration uncertainty reported by MKS is called the standard error of estimated concentration (SEC) and is also known as the marginal standard deviation. The uncertainties in the concentration are proportional to the square root of the sums of the squares of the residual. After the residual spectrum is obtained, which is called R, the error variance for the case of a single reference spectrum is calculated by the software.

Independent calculations of optical path length were not performed because the instrument has a fixed path of 5.11 meters. A signal to noise ratio test (S/N) was performed using MKS software to verify instrument performance.

Performance parameters measured included signal to noise tests, noise equivalent absorbance (NEA), detector linearity, background spectra, potential interferences, and cell and system leakage.

Quality assurance procedures included baseline measurement with ultra-high purity nitrogen, measurement of a calibration transfer standard (~100 ppm ethylene), direct analyte calibration measurements, and measurements to determine baseline shift. SF<sub>6</sub> was also used as a tracer gas in the calibration gases to evaluate dilution ratios and verify the sample delivery system integrity. A dynamic matrix spike was performed using acetaldehyde and SF<sub>6</sub> as a tracer gas.

The general FTIR field sampling procedure was as follows:

#### **PRE-TEST**

- 1) Background spectrum
  - Evaluate diagnostics of the instrumentation
- 2) Baseline (cylinder UHP-N<sub>2</sub> for zero check)
  - Determine the level of background noise
  - Observe spectrum for baseline tilt, i.e., indicates vibrations/perturbations affecting instrument
- 3) Calibration transfer standard (cylinder 100 ppm ethylene for span check)
  - Determine level of response to evaluate the spectral response and stability of the instrument
  - Create a field reference spectrum
- 4) Baseline evaluation
  - Note baseline flush/clean out FTIR sample cell
  - Observe spectrum for baseline tilt
- 5) Collection of spectra stack gas
  - Determine stack gas analyte concentrations
- 6) Measurement of analyte calibration gas
- 7) Perform dynamic spiking recovery study (recovery must be  $0.7 \leq R \leq 1.3$ )

#### **TEST (REPEAT EACH RUN)**

- 1) Baseline Determination
- 2) Measurement of Calibration Transfer Standard
- 3) Collect sequential spectra of stack gas
- 4) Baseline Determination
- 5) Measurement of Calibration Transfer Standard

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**POST-TEST**

- 1) Baseline Determination
- 2) Measurement of Calibration Transfer Standard (i.e. span check)
- 3) Measurement of analyte calibration gas (optional)

### 3.0 TEST RESULTS

The compliance emission test results are presented in Tables 3-1 through 3-6<sup>1</sup>.

The calculation summaries, field data, laboratory data, reference method monitoring data, FTIR data, process data, calibration data, and test program qualifications are included in the appendices.

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#### <sup>1</sup>MEASUREMENT UNCERTAINTY STATEMENT

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, Montrose personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of the Montrose Quality Manual and ASTM D7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

**TABLE 3-1  
RTO STACK PM TEST RESULTS**

TEST RUN NO. :	1	2	3	Average
TEST DATE :	4/10/2018	4/10/2018	4/10/2018	
TEST TIME :	10:45-11:52	12:37-13:57	14:40-15:46	
<b>Stack Gas Parameters</b>				
Temperature, °F	319.9	320.2	317.3	319.1
Velocity, av. ft/sec	64.8	64.5	63.6	64.3
Volumetric flow, acfm	41,041	40,834	40,295	40,723
Volumetric flow, scfm	27,360	27,212	26,952	27,175
Volumetric flow, dscfh	891,822	888,033	877,953	885,936
Moisture, av. % vol.	45.7	45.6	45.7	45.7
Carbon dioxide, av. % vol.	4.3	4.4	4.4	4.4
Oxygen, av. % vol.	11.7	11.6	12.0	11.8
<b>Particulate Sample</b>				
Time, min.	60.0	60.0	60.0	60.0
Volume, dscf	41.307	42.986	42.327	42.207
Filterable PM, mg	7.5	8.2	6.8	7.5
CPM, mg	38.1	66.4	34.5	46.3
Isokinetic ratio, %	96.4	100.8	100.4	99.2
<b>Filterable PM (Sample Train Front-Half)</b>				
Concentration, grains/dscf	0.003	0.003	0.002	0.003
Concentration, x10 <sup>-6</sup> lb/dscf	0.400	0.421	0.354	0.392
Emission rate, lb/hr	0.36	0.37	0.31	0.35
<b>CPM (Sample Train Back-Half)</b>				
Concentration, grains/dscf	0.014	0.024	0.013	0.017
Concentration, x10 <sup>-6</sup> lb/dscf	2.034	3.403	1.795	2.411
Emission rate, lb/hr	1.81	3.02	1.58	2.14
<b>Total PM</b>				
Concentration, grains/dscf	0.017	0.027	0.015	0.020
Concentration, x10 <sup>-6</sup> lb/dscf	2.434	3.824	2.149	2.802
Emission rate, lb/hr	2.17	3.39	1.89	2.48

**TABLE 3-2  
RTO STACK VOC, ACETALDEHYDE, AND NO<sub>x</sub> TEST RESULTS**

TEST RUN NO. :	1	2	3	
TEST DATE :	4/10/2018	4/10/2018	4/10/2018	
TEST TIME :	10:45-11:52	12:37-13:57	14:40-15:46	Average
<b>Stack Gas Parameters</b>				
Temperature, °F	319.9	320.2	317.3	319.1
Velocity, av. ft/sec	64.8	64.5	63.6	64.3
Volumetric flow, acfm	41,041	40,834	40,295	40,723
Volumetric flow, scfm	27,360	27,212	26,952	27,175
Volumetric flow, dscfh	891,822	888,033	877,953	885,936
Moisture, av. % vol.	45.7	45.6	45.7	45.7
Carbon dioxide, av. % vol.	4.3	4.4	4.4	4.4
Oxygen, av. % vol.	11.7	11.6	12.0	11.8
<b>Total VOC (FTIR)</b>				
Emission rate, lb/hr	< 0.90	< 0.93	< 0.91	< 0.91
<b>HAP – Acetaldehyde</b>				
Concentration, ppmv wb	< 0.28	0.35	0.44	< 0.36
Concentration, x10 <sup>-6</sup> lb/scf	< 0.032	0.041	0.050	< 0.041
Emission rate, lb/hr	< 0.05	0.07	0.08	< 0.07
<b>Nitrogen Oxides as NO<sub>2</sub></b>				
Concentration, ppmv db	33.2	34.5	31.7	33.2
Concentration, x10 <sup>-6</sup> lb/dscf	3.967	4.126	3.785	3.959
Emission rate, lb/MMBtu	0.079	0.081	0.078	0.079

**TABLE 3-3  
TO STACK PM TEST RESULTS**

TEST RUN NO. :	1	2	3	Average
TEST DATE :	4/11/2018	4/11/2018	4/11/2018	
TEST TIME :	09:35-11:15	12:15-13:19	14:25-15:32	
<b>Stack Gas Parameters</b>				
Temperature, °F	332.8	332.8	333.7	333.1
Velocity, av. ft/sec	22.7	22.7	22.9	22.8
Volumetric flow, acfm	46,665	46,584	47,030	46,759
Volumetric flow, scfm	30,614	30,561	30,819	30,665
Volumetric flow, dscfh	1,039,446	1,036,056	1,044,848	1,040,116
Moisture, av. % vol.	43.4	43.5	43.5	43.5
Carbon dioxide, av. % vol.	13.3	13.5	13.5	13.4
Oxygen, av. % vol.	3.7	3.7	3.6	3.7
<b>Particulate Sample</b>				
Time, min.	60.0	60.0	60.0	60.0
Volume, dscf	41.705	41.942	40.609	41.419
Filterable PM, mg	9.6	31.4	8.7	16.5
CPM, mg	6.8	4.4	5.7	5.6
Isokinetic ratio, %	103.3	104.2	100.1	102.5
<b>Filterable PM (Sample Train Front-Half)</b>				
Concentration, grains/dscf	0.004	0.012	0.003	0.006
Concentration, x10 <sup>-6</sup> lb/dscf	0.505	1.648	0.470	0.874
Emission rate, lb/hr	0.52	1.71	0.49	0.91
<b>CPM (Sample Train Back-Half)</b>				
Concentration, grains/dscf	0.003	0.002	0.002	0.002
Concentration, x10 <sup>-6</sup> lb/dscf	0.360	0.231	0.309	0.300
Emission rate, lb/hr	0.37	0.24	0.32	0.31
<b>Total PM</b>				
Concentration, grains/dscf	0.006	0.013	0.005	0.008
Concentration, x10 <sup>-6</sup> lb/dscf	0.864	1.879	0.779	1.174
Emission rate, lb/hr	0.90	1.95	0.81	1.22

POET Biorefining: Caro, Michigan  
 RTO, TO, & Fluidized Bed Baghouse Compliance Test  
 Test Dates: 4/10 – 4/12/18

**TABLE 3-4  
 TO STACK VOC, ACETALDEHYDE, AND NO<sub>x</sub> TEST RESULTS**

TEST RUN NO. :	1	2	3	
TEST DATE :	4/11/2018	4/11/2018	4/11/2018	
TEST TIME :	09:35-11:15	12:15-13:19	14:25-15:32	Average
<b>Stack Gas Parameters</b>				
Temperature, °F	332.8	332.8	333.7	333.1
Velocity, av. ft/sec	22.7	22.7	22.9	22.8
Volumetric flow, acfm	46,665	46,584	47,030	46,759
Volumetric flow, scfm	30,614	30,561	30,819	30,665
Volumetric flow, dscfh	1,039,446	1,036,056	1,044,848	1,040,116
Moisture, av. % vol.	43.4	43.5	43.5	43.5
Carbon dioxide, av. % vol.	13.3	13.5	13.5	13.4
Oxygen, av. % vol.	3.7	3.7	3.6	3.7
<b>Total VOC (FTIR)</b>				
Emission rate, lb/hr	< 0.82	< 0.77	< 0.77	< 0.79
<b>HAP – Acetaldehyde</b>				
Concentration, ppmv wb	0.44	0.36	0.35	< 0.39
Concentration, x10 <sup>-6</sup> lb/scf	0.051	0.041	0.040	< 0.044
Emission rate, lb/hr	0.09	0.08	0.07	< 0.08
<b>Nitrogen Oxides as NO<sub>2</sub></b>				
Concentration, ppmv db	41.9	45.8	42.8	43.5
Concentration, x10 <sup>-6</sup> lb/dscf	5.006	5.475	5.115	5.199
Emission rate, lb/MMBtu	0.053	0.058	0.054	0.055

**TABLE 3-5  
FLUIDIZED BED BAGHOUSE STACK PM TEST RESULTS**

TEST RUN NO. :	1	2	3	
TEST DATE :	4/12/2018	4/12/2018	4/12/2018	
TEST TIME :	09:05-10:20	11:00-12:22	12:55-14:14	Average
<b>Stack Gas Parameters</b>				
Temperature, °F	105.8	105.7	105.4	105.6
Velocity, av. ft/sec	45.1	47.3	49.1	47.1
Volumetric flow, acfm	19,130	20,040	20,808	19,993
Volumetric flow, scfm	17,351	18,180	18,887	18,139
Volumetric flow, dscfh	993,647	1,044,506	1,080,835	1,039,663
Moisture, av. % vol.	4.6	4.2	4.6	4.5
Carbon dioxide, av. % vol.	0.0	0.0	0.0	0.0
Oxygen, av. % vol.	20.9	20.9	20.9	20.9
<b>Particulate Sample</b>				
Time, min.	60.0	60.0	60.0	60.0
Volume, dscf	37.079	38.673	40.791	38.848
Filterable PM, mg	0.2	0.8	1.0	0.6
CPM, mg	5.5	2.9	5.1	4.5
Isokinetic ratio, %	99.9	99.1	101.1	100.0
<b>Filterable PM (Sample Train Front-Half)</b>				
Concentration, grains/dscf	0.0001	0.0003	0.0004	0.0002
Concentration, x10 <sup>-6</sup> lb/dscf	0.009	0.046	0.051	0.035
Emission rate, lb/hr	0.01	0.05	0.06	0.04
<b>CPM (Sample Train Back-Half)</b>				
Concentration, grains/dscf	0.002	0.001	0.002	0.002
Concentration, x10 <sup>-6</sup> lb/dscf	0.327	0.162	0.276	0.255
Emission rate, lb/hr	0.32	0.17	0.30	0.26
<b>Total PM</b>				
Concentration, grains/dscf	0.002	0.001	0.002	0.002
Concentration, x10 <sup>-6</sup> lb/dscf	0.336	0.208	0.327	0.290
Emission rate, lb/hr	0.33	0.22	0.35	0.30
Emission rate, lb/1,000 lb gas	0.0043	0.0027	0.0042	0.0037

POET Biorefining: Caro, Michigan  
 RTO, TO, & Fluidized Bed Baghouse Compliance Test  
 Test Dates: 4/10 – 4/12/18

**TABLE 3-6  
 FLUIDIZED BED BAGHOUSE STACK VOC AND ACETALDEHYDE TEST RESULTS**

TEST RUN NO. :	1	2	3	
TEST DATE :	4/12/2018	4/12/2018	4/12/2018	
TEST TIME :	09:05-10:20	11:00-11:22	12:55-14:14	Average
<b>Stack Gas Parameters</b>				
Temperature, °F	105.8	105.7	105.4	105.6
Velocity, av. ft/sec	45.1	47.3	49.1	47.1
Volumetric flow, acfm	19,130	20,040	20,808	19,993
Volumetric flow, scfm	17,351	18,180	18,887	18,139
Volumetric flow, dscfh	993,647	1,044,506	1,080,835	1,039,663
Moisture, av. % vol.	4.6	4.2	4.6	4.5
Carbon dioxide, av. % vol.	0.0	0.0	0.0	0.0
Oxygen, av. % vol.	20.9	20.9	20.9	20.9
<b>Total VOC (FTIR)</b>				
Emission rate, lb/hr	< 6.52	< 5.15	< 4.09	< 5.26
<b>HAP – Acetaldehyde</b>				
Concentration, ppmv wb	0.71	2.40	0.39	1.16
Concentration, x10 <sup>-6</sup> lb/scf	0.081	0.274	0.044	0.133
Emission rate, lb/hr	0.08	0.30	0.05	0.14