EXECUTIVE SUMMARY

Chase Young Environmental Testing Inc (CYET) was retained by JBS USA (JBS) [SRN:B7244] to conduct emission testing on four engines at their facility located at 11 11th Street in Plainwell, MI 49080 in Allegan County. The emissions test program was conducted on December 8th, 12th, and 13th, 2023, and was performed in accordance with CYET project number 231650 Emission Test Plan as well as the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD) acceptance letter.

The test program was conducted to determine compliance with Permit to Install (PTI) 111-23 issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE) and 40 CFR 60 Subpart JJJJ. The results of the test program are presented in Table 1.

Table 1
Overall Emission Summary
Test Dates: December 8th, 12th, and 13th, 2023

Source	Pollutant	Reporting Units	Emission Limit	Emission Result
EUBIOGEN1	NOx	ppmvd@ 15% O_2	150	41.4
		lb/hr	3.12	1.79
	CO	ppmvd@ 15% O_2	610	8.8
		lb/hr	7.83	0.23
	VOC	ppmvd@ 15% O_2	80	31.3
		lb/hr	1.5	1.2
	Formaldehyde	lb/hr	0.25	0.11
EUBIOGEN2	NOx	ppmvd@ 15% O_2	150	45.1
		lb/hr	3.12	2.72
	CO	ppmvd@ 15% O_2	610	7.2
		lb/hr	7.83	0.26
	VOC	ppmvd@ 15% O_2	80	1.2
		lb/hr	1.5	0.1
	Formaldehyde	lb/hr	0.25	0.11
EUBIOGEN3	NOx	ppmvd@ 15% O_2	150	40.9
		lb/hr	3.12	2.61
	CO	ppmvd@ 15% O_2	610	5.0
		lb/hr	7.83	0.19
	VOC	ppmvd@ 15% O_2	80	7.4
		lb/hr	1.5	0.4
	Formaldehyde	lb/hr	0.25	0.08
EUBIOGEN4	NOx	ppmvd@ 15% O_2	150	40.4
		lb/hr	3.12	2.69
	CO	ppmvd@ 15% O_2	610	6.0
		lb/hr	7.83	0.25
	VOC	ppmvd@ 15% O_2	80	2.7
		lb/hr	1.5	0.2
	Formaldehyde	lb/hr	0.25	0.09
Source	**Pollutant**	**Reporting Units**	**Limit**	**Result**
BIOGEN Inlet	TRS	ppmvd	≤300	46

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ChaseYoung Environmental Testing

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Appendix D	Equipment Calibration and Span Gas Certification Documentation
Appendix E	Example Calculations
Appendix F	Laboratory Analytical Results
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1. Introduction

Chase Young Environmental Testing Inc (CYET) was retained by JBS USA (JBS) [SRN:B7244] to conduct emission testing on four engines at their facility located at 11 11th Street in Plainwell, MI 49080 in Allegan County. The emissions test program was conducted on December 8th, 12th, and 13th, 2023, and was performed in accordance with CYET project number 231650 Emission Test Plan as well as the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD) acceptance letter.

The test program was conducted to determine compliance with Permit to Install (PTI) 111-23 issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE) and 40 CFR 60 Subpart JJJJ. The results of the test program are presented in Table 1.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on December 6th, 8th, and 12-13th, 2023, at the JBS facility located in Plainwell, MI

1.b Purpose of Testing

AQD issued Permit to Install 111-23 to JBS on September 7, 2023. This permit limits emissions as summarized by Table 1.

1.c Source Description

JBS operates under Permit to Install 111-23 which includes FGBIOGENS. FGBIOGENS include four (4) spark ignition RICE, each rated at 2,788 hp, manufactured after 7/1/2010. The RICE combusts wastewater lagoon gas (biogas) with natural gas backup. The engines are subject to the requirements of 40 CFR 60 Subpart JJJJ.

Figure 1 presents the test port and traverse/sampling point locations used at each site.

1.d Test Program Contacts

The contact for the source and test report is:

Gary Boreham
RNG Power Plant Lead Operator
Tegre
970-828-4732
Gary.boreham@tegrecorp.com

Names and affiliations for personnel who were present during the testing program are summarized by Table 2.

Table 2
Test Personnel

Name, Title, and Email	Affiliation	Telephone
Mr. Gary Boreham RNG Power Plant Lead Operator gary.boreham@tegrecorp.com	Tegre 11 11th Street Plainwell, Michigan 49464	(970) 828-4732
Mr. Brandon Chase Senior Environmental Engineer bchase@cyetinc.com	CYET 28744 Groveland Street Madison Heights, MI 48071	(248) 506-0107
Mr. Matthew Young Senior Project Manager myoung@cyetinc.com	CYET 28744 Groveland Street Madison Heights, MI 48071	(586) 744-9133
Mr. Trevor Drost Environmental Quality Analyst drostt@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(517) 245-5781
Mr. Cody Yazzie Environmental Quality Analyst YazzieC@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(269) 312-2754
Mr. Jared Edgerton Environmental Quality Analyst EdgertonJ1@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(269) 312-1540
Ms. Mariah Scott Environmental Quality Analyst ScottM29@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(517) 899-3519

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

2.a Operating Data

Process data monitored during the emissions test program include:

- Engine load, kW;
- Biogas Methane Content, %; and
- Biogas Fuel Flow, SCFM.

Process operating data is included in Appendix G.

Biogas heat content (BTU) is not measured by the facility. The facility uses an assumed value of 733 BTU/scf.

2.b Applicable Permit

The applicable permit for this emissions test program is PTI 111-23.

2.c Results

The overall results of the emission test program as well as emission limits are summarized by Table 1 (see Section 5.a, and Appendix A). Detailed emission rates are presented in Tables 3-10 in Appendix A.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

JBS operates under Permit to Install 111-23 which includes FGBIOGENS. FGBIOGENS include four (4) spark ignition RICE, each rated at 2,788 hp, manufactured after 7/1/2010. The RICE combusts wastewater lagoon gas (biogas) with natural gas backup. The engines are subject to the requirements of 40 CFR 60 Subpart JJJJ.

3.b Process Flow Diagram

Due to the simplicity of the process, a process flow diagram is not necessary.

3.c Raw and Finished Materials

Raw material used by FGBIOGENS wastewater lagoon digester gas (biogas). The engines are able to run natural gas as a backup, however for this test program only biogas was used. The maximum H_2S in the biogas shall not exceed 300 ppmv.

3.d Process Capacity

The engines in FGBIOGENS are rated at 2,788 HP (2,080 kW) at 100% load.

3.e Process Instrumentation

Process data monitored during the emissions test program include:

- Engine load, kW;
- Biogas Methane Content, %; and
- Biogas Fuel Flow, SCFM.

Process operating data is included in Appendix G.

Biogas heat content (BTU) is not measured by the facility. The facility uses an assumed value of 733 BTU/scf.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

Sampling and analysis procedures followed the methods codified at 40 CFR 60, Appendix A and 40 CFR 63, Appendix A:

- Method 1 - *"Sample and Velocity Traverses for Stationary Sources"* was used to determine the sampling locations and the stack traverse points.
- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"* was used to determine average exhaust gas velocity.
- Method 3 - *"Gas Analysis for Determination of Dry Molecular Weight"(Fyrite Method)* was used to evaluate the molecular weight of the exhaust gas.
- Method 3A – *"Determination of Oxygen and Carbon Dioxide Concentrations in emissions from stationary sources" (Instrumental Analyzer Procedure)* was used to determine the oxygen of the exhaust gas.
- Method 4 - *"Determination of Moisture Content in Stack Gases"* was used to determine the moisture content of the exhaust gas.
- Method 7E – *"Determination of Nitrogen Oxides Emissions from Stationary Sources"(Instrumental Analyzer Procedure)* was used to determine the nitrogen oxide concentration of the exhaust gas.
- Method 10 – *"Determination of Carbon Monoxide Emissions from Stationary Sources"* was used to determine the carbon monoxide concentration of the exhaust gas.
- Method 25A - *"Determination of Total Gaseous Organic concentration using a flame ionization analyzer" (modified for methane subtraction)* was used to determine the volatile organic compound concentration of the exhaust gas.
- Method 323 - *"Measurement of Formaldehyde Emissions From Natural Gas-Fired Stationary Sources—Acetyl Acetone Derivatization Method"* was used to measure the formaldehyde concentration of the exhaust gas.
- ASTM D5504 - *" Standard Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and*

Chemiluminescence" was used to measure the total reduced sulfur of the biogas inlet.

USEPA Method 1 was utilized to determine the necessary sampling points in which to collect the air pollutants. This method is applicable to sources that are not cyclonic or swirling, and the duct diameter is greater than 12 inches. The sample locations were verified to meet at least 2 duct diameters downstream, and at least 0.5 duct diameters upstream of any flow disturbances.

The test team verified the absence of cyclonic flow in the field. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the direction of flow and the axis of the duct. If the average of the absolute values of the flow angles is greater than 20 degrees, cyclonic flow exists. None of the sources sampled indicated cyclonic flow.

USEPA Method 2 was utilized to measure exhaust gas velocity pressures and temperatures utilizing an S-type pitot tube equipped with a thermocouple, and an inclined manometer.

The S-Type Pitot tube dimensions were verified to be within the specified limits of Method 2 Figure 2-2, Therefore a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned. All thermocouple systems used during testing used the alternative Method 2 thermocouple calibration procedures specified in ALT-011 to ensure that the temperature of each thermocouple and reference thermometer agree to within ± 2 °F.

The sampling apparatus was setup onsite, noting that the manometer is level and zeroed continuously throughout sampling. A pre- and post-test leak check of the system was performed by reaching at least 3" H_2O on both the impact and static pressure sides of the S-type pitot tube, and closing off the system. The system leak check passes when the pressure remains stable for a minimum of 15 seconds. The velocity head and temperature are then measured at each sampling point specified by USEPA Method 1.

Molecular weight determinations were evaluated using the Fyrite® procedure. The equipment used for this evaluation consists of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers (O_2 and CO_2). A grab sample of the exhaust gas was analyzed for each test run.

The Fyrite analyzers are audited monthly by collecting a known concentration of O_2 and CO_2 (protocol 1 gas cylinder) in a tedlar bag and analyzing using the fyrite. Three consecutive samples are measured and must agree with the protocol 1 gas cylinder values within $\pm 0.5\%$.

USEPA Method 4 was utilized to measure the moisture content of the gas utilizing the Method 323 sampling systems.

The O_2 content was continuously measured via gas analyzer. The gas stream is drawn through a stainless-steel probe with an in-line filter to remove any particulate, a heated Teflon® sample line (~250°F), and through a refrigerated gas sample conditioner to remove the moisture from the sample before it enters the gas analyzers. Data is recorded on a PC equipped with data acquisition software.

In accordance with Method 7E, an analyzer calibration error test was performed prior to sampling. Zero-, mid- and high-level gases are introduced directly to the analyzer sequentially and recording the analyzer response. For method 3A, the calibration error must be within 0.5% of each calibration gas. An initial system bias check is determined by introducing zero- and mid-gases into the sampling system and recording the analyzer response for each calibration gas. This check is performed after each test run to determine that both the system bias is 0.5%, and that the analyzer drift does not exceed 0.5% during any run.

The NOx ppm was continuously measured via chemiluminescence gas analyzer. The gas stream is drawn through a stainless-steel probe with an in-line filter to remove any particulate, a heated Teflon® sample line (~250°F), and through a refrigerated gas sample conditioner to remove the moisture from the sample before it enters the gas analyzer. Data is recorded on a PC equipped with data acquisition software.

The CO ppm was continuously measured via gas analyzer. The gas stream is drawn through a stainless-steel probe with an in-line filter to remove any particulate, a heated Teflon® sample line (~250°F), and through a refrigerated gas sample conditioner to remove the moisture from the sample before it enters the gas analyzer. Data is recorded on a PC equipped with data acquisition software.

An analyzer calibration error test was performed prior to sampling. Zero-, mid- and high-level gases are introduced directly to the analyzer sequentially, recording the analyzer response. The calibration error must be within 2% of the calibration span. An initial system bias check is determined by introducing zero- and mid-gases into the sampling system and recording the analyzer response for each calibration gas. This check is performed after each test run to determine that both the system bias is 5% of the calibration span, and that the analyzer drift does not exceed 3% of the calibration span during any run.

Recorded O_2, NOx, and CO concentrations are averaged and reported for the duration of each test (as drift corrected per Method 7E). A drawing of the sampling train used for the testing program is presented as Figure 2.

The THC ppm was continuously measured via a flame ionization analyzer calibrated with propane. The gas stream is drawn through a stainless-steel probe with an in-line filter to remove any particulate, and a heated Teflon® sample line (~250°F) before it enters the gas analyzer. Data is recorded on a PC equipped with data acquisition software.

The JUM Model 109A analyzer utilizes two flame ionization detectors (FIDs) to report the average ppmv for total hydrocarbons (THC), as propane, as well as the average ppmv for methane (as methane). Upon entry, the analyzer splits the gas stream. One FID ionizes all of the hydrocarbons in the gas stream sample into carbon, which is then detected as a concentration of total hydrocarbons. Using an analog signal, specifically voltage, the concentration of THC is then sent to the data acquisition system (DAS), where recordings are taken at 4-second intervals to produce an average based on the overall duration of the test. This average is then used to determine the average ppmv for THC reported as the calibration gas, propane, in equivalent units.

The second FID reports methane only. The sample enters a chamber containing a catalyst that destroys all of the hydrocarbons present in the gas stream other than methane. As with the THC sample, the methane gas concentration is sent to the DAS and recorded. The methane concentration, reported as methane, can then be converted to methane, reported as propane, by dividing the measured methane concentration by the analyzer's response factor.

The analyzer's response factor is obtained by introducing a methane calibration gas to the calibrated J.U.M. 109A. The response of the analyzer's THC FID to the methane calibration gas, in ppmv as propane, is divided by the Methane analyzer's response to the methane calibration gas, in ppmv as methane.

An analyzer calibration error test was performed prior to sampling. Zero-, low-, mid- and high-level gases are introduced to the sampling system sequentially, recording the analyzer response. The calibration error must be within 5% of each calibration gas. A drift determination was performed after each test run by introducing the zero and mid-level calibration gases, to determine that the analyzer drift does not exceed 3% of the calibration span during any run. Recorded THC concentrations are averaged and reported for the duration of each test (as drift corrected per Method 7E). A drawing of the sampling train used for the testing program is presented as Figure 3.

USEPA Method 323 was used to measure formaldehyde utilizing a dual Dry Gas Meter sampling system consisting of (1) a stainless steel probe (2) a set of three midget impingers with the first serving as an empty knockout, the second containing 20 ml of DI water, and a third containing silica gel (3) a length of sample line, and (4) a dry gas meter control case equipped with 2 pumps, 2 dry gas meters, and calibrated orifices.

Method 323 field duplicates were performed on each engine as per Method 323 section 8.4.1. A pair of independent sample trains were operated concurrently during Run 2 (Run 3 for EUBIOGEN1). The duplicate sample trains were recovered and reported as independent sample runs (Run 2A and Run 2B). The percent difference in stack exhaust concentration indicated by the field duplicates should be within 20% of their mean concentration. The percent difference for the field duplicates on all sources were less than 20%.

The metering system is calibrated before and after the field test to confirm that the DGM calibration factor (Y) value has not changed by more than 5%. The field balance used onsite is checked daily using a certified 500g weight to ensure that the balance measures within $\pm$0.5g of the certified mass.

A pre- and post-test leak check of the system were performed by plugging the end of the sample probe and observing the leak rate. The system passes when the leakage rate of the dry gas meter is no greater than 2 percent of the sample rate (~0.4 L/min). A sample of the gas is obtained by inserting the probe into the stack and sampling from a single point. Sample flowrate, dry gas meter exhaust temperature and other necessary information were logged every 5 minutes during each run. Duplicate sample trains were performed simultaneously during Run 2 on each engine (Run 3 on EUBIOGEN1).

After the post-test leak check, the sampling train is disassembled. The impinger train is weighed for moisture determination. The impinger catch is transferred to an amber 40-mL VOA bottle with a Teflon-lined cap. The probe, connecting line, first two midget impinges and connecting glassware are rinsed with high purity deionized water which is added to the VOA bottle. The VOA bottle is filled so no headspace remains before being sealed.

Blank samples of each reagent are collected onsite as per the method. All samples are logged using standard Chain of Custody procedures, and then transported to CYET's office and/or the contracted laboratory for analysis. A drawing of the sampling train used for the testing program is presented as Figure 4.

Total reduced sulfurs were determined according to ASTM D5504. The equipment used for this evaluation consisted of evacuated summa canisters and a flow control unit to deliver samples of the biogas to the tanks. Triplicate ~21-minute test runs were conducted on BIOGEN Inlet. A schematic of the sampling train used for the testing program is presented as Figure 5.

4.b Recovery and Analytical Procedures

Recovery and analytical procedures are included in section 4.a.

4.c Sampling Ports

A diagram of the stacks indicating traverse point and sampling locations and stack dimensions is included as Figure 1.

4.d Traverse Points

A diagram of the stacks indicating traverse point and sampling locations and stack dimensions is included as Figure 1.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 1. Detailed results for the emissions test program are summarized by Tables 3-10 in Appendix A.

Table 1
Overall Emission Summary
Test Dates: December 8th, 12th, and 13th, 2023

Source	Pollutant	Reporting Units	Emission Limit	Emission Result
EUBIOGEN1	NOx	ppmvd@ 15% O_2	150	41.4
		lb/hr	3.12	1.79
	CO	ppmvd@ 15% O_2	610	8.8
		lb/hr	7.83	0.23
	VOC	ppmvd@ 15% O_2	80	31.3
		lb/hr	1.5	1.2
	Formaldehyde	lb/hr	0.25	0.11
EUBIOGEN2	NOx	ppmvd@ 15% O_2	150	45.1
		lb/hr	3.12	2.72
	CO	ppmvd@ 15% O_2	610	7.2
		lb/hr	7.83	0.26
	VOC	ppmvd@ 15% O_2	80	1.2
		lb/hr	1.5	0.1
	Formaldehyde	lb/hr	0.25	0.11
EUBIOGEN3	NOx	ppmvd@ 15% O_2	150	40.9
		lb/hr	3.12	2.61
	CO	ppmvd@ 15% O_2	610	5.0
		lb/hr	7.83	0.19
	VOC	ppmvd@ 15% O_2	80	7.4
		lb/hr	1.5	0.4
	Formaldehyde	lb/hr	0.25	0.08
EUBIOGEN4	NOx	ppmvd@ 15% O_2	150	40.4
		lb/hr	3.12	2.69
	CO	ppmvd@ 15% O_2	610	6.0
		lb/hr	7.83	0.25
	VOC	ppmvd@ 15% O_2	80	2.7
		lb/hr	1.5	0.2
	Formaldehyde	lb/hr	0.25	0.09
Source	**Pollutant**	**Reporting Units**	**Limit**	**Result**
BIOGEN Inlet	TRS	ppmvd	≤300	46

5.b Discussion of Results

All test results are in compliance with permit limits.

A flowrate was performed before and after each test run. The average of the pre/post flowrate was used to calculate the emission rates for each test run.

The overall average moisture result from the M323 sampling for each source was used to calculate molecular weights and flowrates.

5.c Sampling Procedure Variations

There were no sampling procedure variations for the test program.

5.d Process or Control Device Upsets

Testing was initially conducted on EUBIOGEN1 on December 6th, 2023. One run was performed, and preliminary results indicated the NOx lb/hr emission rate exceeded the permitted limit of 3.12 lb/hr. Run 1 was voided and the test program was halted until the facility could get a CAT technician to tune all the engines. The test program resumed on December 8th, 2023 when testing was conducted on EUBIOGEN3 and EUBIOGEN4. EUBIOGEN2 was tested on December 12th and EUBIOGEN1 was tested on December 13th. Results for the voided run 1 on EUBIOGEN1 are available in appendix C.

5.e Control Device Maintenance

All engines were tuned by a CAT technician on December 7, 2023. See section 5.d.

5.f Re-Test

The emissions test program was an initial performance test of the Biogens.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix D.

5.i Sample Calculations

Sample calculations are provided in Appendix E.

5.j Field Data Sheets

Field documents and raw CEM data relevant to the emissions test program are presented in Appendix C.

5.k Laboratory Data

Laboratory analytical data is provided electronically in Appendix F.

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, CYET personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, CYET 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 our Quality Manual and ASTM D 7036-04. 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.

REPORT SIGNATURES

CYET operated in conformance with the requirements of ASTM D7036-04 during this emissions test project and this emissions test report:

This report was prepared by: ______________________

Brandon Chase
Senior Environmental Engineer

This report was reviewed by: ______________________

Matthew Young
Senior Project Manager

Appendix A – Emission Results Tables

Table 1
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Test Dates: December 8th, 12th, and 13th, 2023

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Source	**Pollutant**	**Reporting Units**	**Limit**	**Result**
BIOGEN Inlet	TRS	ppmvd	≤300	46

Table 2
Test Personnel

Name, Title, and Email	Affiliation	Telephone
Mr. Gary Boreham RNG Power Plant Lead Operator gary.boreham@tegrecorp.com	Tegre 11 11th Street Plainwell, Michigan 49464	(970) 828-4732
Mr. Brandon Chase Senior Environmental Engineer bchase@cyetinc.com	CYET 28744 Groveland Street Madison Heights, MI 48071	(248) 506-0107
Mr. Matthew Young Senior Project Manager myoung@cyetinc.com	CYET 28744 Groveland Street Madison Heights, MI 48071	(586) 744-9133
Mr. Trevor Drost Environmental Quality Analyst drostt@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(517) 245-5781
Mr. Cody Yazzie Environmental Quality Analyst YazzieC@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(269) 312-2754
Mr. Jared Edgerton Environmental Quality Analyst EdgertonJ1@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(269) 312-1540
Ms. Mariah Scott Environmental Quality Analyst ScottM29@michigan.gov	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(517) 899-3519

Table 3
EUBIOGEN1 NOx, CO, and VOC Emission Rates
JBS USA
Plainwell MI

Parameter	Run 2	Run 3	Run 4	Average
Test Run Date	12/13/2023	12/13/2023	12/13/2023	
Test Run Time	814-914	940-1040	1100-1200	
Engine Load (kW)	1,840.8	1,840.3	1,842.7	
Outlet Flowrate (dscfm)	5,438	5,386	5,380	**5,401**
Outlet Flowrate (scfm)	6,252	6,191	6,185	**6,209**
Oxygen Concentration (%)	14.0	14.0	14.6	**14.2**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	14.0	14.1	14.8	**14.3**
Carbon Dioxide Concentration (%)	9.0	9.0	9.0	**9.0**
Outlet Oxides of Nitrogen Concentration (ppmv)	49.5	45.8	45.8	**47.0**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	49.3	45.2	44.4	**46.3**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**1.91**	**1.74**	**1.70**	**1.79**
Outlet NOx Concentration (ppmv, corrected to 15% O_2)	**42.0**	**39.1**	**43.1**	**41.4**
Outlet Carbon Monoxide Concentration (ppmv)	11.0	9.8	9.6	**10.1**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	10.2	9.4	9.7	**9.8**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**0.24**	**0.22**	**0.23**	**0.23**
Outlet CO Concentration (ppmv, corrected to 15% O_2)	**8.7**	**8.1**	**9.5**	**8.8**
Outlet VOC Concentration (ppmv as propane)	554.6	525.8	529.6	**536.6**
Outlet Methane Concentration (ppmv as methane)	1,383.8	1,263.1	1,169.0	**1,272.0**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	560.6	537.6	541.8	**546.7**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1,362.8	1,236.7	1,157.3	**1,252.3**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)	2.1	30.8	67.5	**33.4**
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	**0.1**	**1.1**	**2.5**	**1.2**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E, corrected to 15% O_2)	**1.8**	**26.6**	**65.6**	**31.3**

All concentrations reported on a dry basis

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
MW = molecular weight (CO = 28.01, NOx = 46.01, SO_2 = 64.05, C_3H_8 = 44.10, carbon = 12.01)
24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
Response factor obtained from introducing propane into methane analyzer **2.44**

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60
$Conc_{@15\%O2}$ = Conc * (20.9 -15)/(20.9 - %O_2)

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Table 4
EUBIOGEN2 NOx, CO, and VOC Emission Rates
JBS USA
Plainwell MI

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	12/12/2023	12/12/2023	12/12/2023	
Test Run Time	1215-1315	1336-1436	1501-1601	
Engine Load (kW)	1,844.2	1,846.3	1,846.2	
Outlet Flowrate (dscfm)	5,445	5,362	5,350	**5,386**
Outlet Flowrate (scfm)	6,145	6,050	6,037	**6,077**
Oxygen Concentration (%)	11.5	11.1	11.3	**11.3**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	11.8	11.5	11.7	**11.7**
Carbon Dioxide Concentration (%)	9.0	9.0	9.0	**9.0**
Outlet Oxides of Nitrogen Concentration (ppmv)	70.8	74.9	73.5	**73.1**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	69.6	72.0	70.6	**70.7**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**2.71**	**2.76**	**2.70**	**2.72**
Outlet NOx Concentration (ppmv, corrected to 15% O_2)	**45.2**	**45.0**	**45.3**	**45.1**
Outlet Carbon Monoxide Concentration (ppmv)	11.1	11.4	11.6	**11.4**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	11.3	11.2	11.2	**11.2**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**0.27**	**0.26**	**0.26**	**0.26**
Outlet CO Concentration (ppmv, corrected to 15% O_2)	**7.3**	**7.0**	**7.2**	**7.2**
Outlet VOC Concentration (ppmv as propane)	543.3	581.8	593.0	**572.7**
Outlet Methane Concentration (ppmv as methane)	1,280.7	1,372.6	1,402.3	**1,351.8**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	545.3	588.4	591.6	**575.1**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1,265.9	1,345.5	1,372.0	**1,327.8**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)*	*0.0*	5.9	*0.0*	**2.0**
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	***0.0***	**0.2**	***0.0***	**0.1**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E, corrected to 15% O_2)	***0.0***	**3.7**	***0.0***	**1.2**

**All concentrations reported on a dry basis*

**VOC concentrations for Run 1 and Run 3 were negative after subtracting methane and have been reported as zero ppmvd.*

All concentrations reported on a dry basis

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
MW = molecular weight (CO = 28.01, NOx = 46.01, SO_2 = 64.05, C_3H_8 = 44.10, carbon = 12.01)
24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
Response factor obtained from introducing propane into methane analyzer **2.31**

Equations

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60

$Conc_{@15\%O2}$ = Conc * (20.9 - 15)/(20.9 - %O_2)

Table 5
EUBIOGEN3 NOx, CO, and VOC Emission Rates
JBS USA
Plainwell MI

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	12/8/2023	12/8/2023	12/8/2023	
Test Run Time	1407-1507	1541-1641	1658-1758	
Engine Load (kW)	1,837.4	1,838.1	1,837.7	
Outlet Flowrate (dscfm)	5,163	5,144	5,134	**5,147**
Outlet Flowrate (scfm)	5,955	5,934	5,922	**5,937**
Oxygen Concentration (%)	10.7	9.5	11.4	**10.5**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	10.8	9.6	11.5	**10.7**
Carbon Dioxide Concentration (%)	9.0	9.0	9.0	**9.0**
Outlet Oxides of Nitrogen Concentration (ppmv)	73.1	78.1	66.0	**72.4**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	73.6	76.4	63.1	**71.0**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**2.71**	**2.81**	**2.31**	**2.61**
Outlet NOx Concentration (ppmv, corrected to 15% O_2)	**43.1**	**40.0**	**39.7**	**40.9**
Outlet Carbon Monoxide Concentration (ppmv)	9.7	8.6	8.5	**8.9**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	9.1	8.2	8.4	**8.6**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**0.20**	**0.18**	**0.19**	**0.19**
Outlet CO Concentration (ppmv, corrected to 15% O_2)	**5.3**	**4.3**	**5.3**	**5.0**
Outlet VOC Concentration (ppmv as propane)	538.3	609.6	550.6	**566.2**
Outlet Methane Concentration (ppmv as methane)	1,270.9	1,389.1	1,230.1	**1,296.7**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	555.2	622.3	558.2	**578.6**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1,284.5	1,385.9	1,220.1	**1,296.8**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)*	*0.0*	14.4	23.1	**12.5**
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	***0.0***	**0.5**	**0.8**	**0.4**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E, corrected to 15% O_2)	***0.0***	**7.6**	**14.6**	**7.4**

**VOC concentration for Run 1 was negative after subtracting methane and has been reported as zero ppmvd.*

All concentrations reported on a dry basis

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
MW = molecular weight (CO = 28.01, NOx = 46.01, SO_2 = 64.05, C_3H_8 = 44.10, carbon = 12.01)
24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
Response factor obtained from introducing propane into methane analyzer: **2.28**

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60
$Conc_{@15\%O_2}$ = Conc * (20.9 -15)/(20.9 - %O_2)

Table 6
EUBIOGEN4 NOx, CO, and VOC Emission Rates
JBS USA
Plainwell MI

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	12/8/2023	12/8/2023	12/8/2023	
Test Run Time	900-1000	1034-1134	1201-1301	
Engine Load (kW)	1,844.2	1,843.9	1,845.5	
Outlet Flowrate (dscfm)	5,257	5,288	5,342	**5,296**
Outlet Flowrate (scfm)	6,040	6,076	6,138	**6,084**
Oxygen Concentration (%)	9.9	10.7	10.6	**10.4**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	10.0	10.8	10.7	**10.5**
Carbon Dioxide Concentration (%)	9.0	9.0	9.0	**9.0**
Outlet Oxides of Nitrogen Concentration (ppmv)	74.5	70.2	71.1	**71.9**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	73.8	69.0	70.8	**71.2**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**2.77**	**2.60**	**2.70**	**2.69**
Outlet NOx Concentration (ppmv, corrected to 15% O_2)	**39.9**	**40.2**	**41.0**	**40.4**
Outlet Carbon Monoxide Concentration (ppmv)	11.3	10.4	10.7	**10.8**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	11.0	10.5	10.5	**10.7**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**0.25**	**0.24**	**0.24**	**0.25**
Outlet CO Concentration (ppmv, corrected to 15% O_2)	**5.9**	**6.1**	**6.1**	**6.0**
Outlet VOC Concentration (ppmv as propane)	558.6	555.7	626.7	**580.4**
Outlet Methane Concentration (ppmv as methane)	1,286.6	1,262.3	1,440.9	**1,329.9**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	569.1	573.9	643.8	**595.6**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1,308.6	1,283.2	1,449.2	**1,347.0**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)*	*0.0*	8.6	5.3	**4.7**
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	***0.0***	**0.3**	**0.2**	**0.2**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E, corrected to 15% O_2)	***0.0***	**5.0**	**3.1**	**2.7**

**VOC concentration for Run 1 was negative after subtracting methane and has been reported as zero ppmvd.*

All concentrations reported on a dry basis

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
MW = molecular weight (CO = 28.01, NO_x = 46.01, SO_2 = 64.05, C_3H_8 = 44.10, carbon = 12.01)
24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
Response factor obtained from introducing propane into methane analyzer: 2.27

Equations

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60

$Conc_{@15\%O_2} = Conc * (20.9 - 15)/(20.9 - \%O_2)$

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Table 7
EUBIOGEN1 Formaldehyde Emission Rates

Client	**JBS USA**				
Source	**EUBIOGEN1**				
Test Information					
Test Number	R2	R3A	R3B	R4	
Test Date	12/13/2023	12/13/2023	12/13/2023	12/13/2023	
Run Start Time	8:14	9:40	9:40	11:00	
Run Finish Time	9:14	10:40	10:40	12:00	
Net Run Time, Minutes	60	60	60	60	
Sampling Information					
Dry Gas Meter Calibration Factor, Y	1.0099	1.0099	1.0009	1.0099	
Meter Temperature Tm (F)	45.6	54.7	58.7	61.0	55.0
Barometric Pressure - Pbar (in. Hg)	29.89	29.89	29.89	29.89	29.89
Measured Sample Volume, Vm (L)	21.948	21.250	21.202	22.017	21.604
Measured Sample Volume, Vmstd (L)	23.137	22.003	21.589	22.522	22.313
Sample Volume (Vm-Std ft^3)	0.82	0.78	0.76	0.80	0.79
Condensate Volume (Vw-std)	0.113	0.118	0.108	0.132	0.118
Percent Moisture (Bws)	12.16	13.17	12.45	14.24	13.01
Exhaust Gas Flowrate					
Flowrate ft^3 (Standard Wet)	6,252	6,191	6,191	6,185	6,209
Flowrate ft^3 (Standard Dry)	5,438	5,386	5,386	5,380	5,401
Total Formaldehyde Weights (mg)					
Sample Catch	0.12	0.13	0.12	0.11	0.12
Total Formaldehyde Concentration					
ppmv, dry	4.2	4.7	4.5	3.9	4.3
Total Formaldehyde Emission Rate					
lb/ hr	0.11	0.12	0.11	0.10	0.11

Field duplicate	$\bar{x}_1$, Run 3A concentration (ppmv):	4.74	PD =	6
Eq. 323-2, PD = 100 * ($\bar{x}_1$-$\bar{x}_2$) / (($\bar{x}_1$+$\bar{x}_2$)/2)	$\bar{x}_2$, Run 3B concentration (ppmv):	4.46		

Table 8
EUBIOGEN2 Formaldehyde Emission Rates

Client	**JBS USA**				
Source	**EUBIOGEN2**				
Test Information					
Test Number	R1	R2A	R2B	R3	
Test Date	12/12/2023	12/12/2023	12/12/2023	12/12/2023	
Run Start Time	12:15	13:36	13:36	15:01	
Run Finish Time	13:15	14:36	14:36	16:01	
Net Run Time, Minutes	60	60	60	60	
Sampling Information					
Dry Gas Meter Calibration Factor, Y	1.0099	1.0099	1.0009	1.0099	
Meter Temperature Tm (F)	51.4	54.3	51.3	53.0	52.5
Barometric Pressure - Pbar (in. Hg)	29.52	29.52	29.52	29.52	29.52
Measured Sample Volume, Vm (L)	20.720	20.782	21.006	21.461	20.992
Measured Sample Volume, Vmstd (L)	21.324	21.269	21.432	22.019	21.511
Sample Volume (Vm-Std ft^3)	0.75	0.75	0.76	0.78	0.76
Condensate Volume (Vw-std)	0.075	0.108	0.094	0.113	0.098
Percent Moisture (Bws)	9.11	12.62	11.08	12.70	11.38
Exhaust Gas Flowrate					
Flowrate ft^3 (Standard Wet)	6,145	6,050	6,050	6,037	6,077
Flowrate ft^3 (Standard Dry)	5,445	5,362	5,362	5,350	5,386
Total Formaldehyde Weights (mg)					
Sample Catch	0.10	0.12	0.12	0.12	0.11
Total Formaldehyde Concentration					
ppmv, dry	3.6	4.5	4.5	4.4	4.3
Total Formaldehyde Emission Rate					
lb/ hr	0.09	0.11	0.11	0.11	0.11

Field duplicate	$\bar{x}_1$, Run 2A concentration (ppmv):	4.5	PD =	1
Eq. 323-2, PD = 100 * ($\bar{x}_1$-$\bar{x}_2$) / (($\bar{x}_1$+$\bar{x}_2$)/2)	$\bar{x}_2$, Run 2B concentration (ppmv):	4.5		

Table 9
EUBIOGEN3 Formaldehyde Emission Rates

Client	**JBS USA**				
Source	**EUBIOGEN3**				
Test Information					
Test Number	R1	R2A	R2B	R3	
Test Date	12/8/2023	12/8/2023	12/8/2023	12/8/2023	
Run Start Time	14:07	15:41	15:41	16:58	
Run Finish Time	15:07	16:41	16:41	17:58	
Net Run Time, Minutes	60	60	60	60	
Sampling Information					
Dry Gas Meter Calibration Factor, Y	1.0099	1.0099	1.0009	1.0099	
Meter Temperature Tm (F)	62.0	63.4	63.9	64.0	63.3
Barometric Pressure - Pbar (in. Hg)	29.01	29.01	29.01	29.01	29.01
Measured Sample Volume, Vm (L)	20.505	21.036	21.484	20.750	20.944
Measured Sample Volume, Vmstd (L)	20.318	20.788	21.024	20.483	20.653
Sample Volume (Vm-Std ft^3)	0.72	0.73	0.74	0.72	0.73
Condensate Volume (Vw-std)	0.108	0.118	0.104	0.118	0.112
Percent Moisture (Bws)	13.13	13.84	12.26	14.01	13.31
Exhaust Gas Flowrate					
Flowrate ft^3 (Standard Wet)	5,955	5,934	5,934	5,922	5,937
Flowrate ft^3 (Standard Dry)	5,163	5,144	5,144	5,134	5,147
Total Formaldehyde Weights (mg)					
Sample Catch	0.08	0.09	0.08	0.09	0.08
Total Formaldehyde Concentration					
ppmv, dry	3.0	3.4	3.1	3.4	3.2
Total Formaldehyde Emission Rate					
lb/ hr	0.07	0.08	0.07	0.08	0.08

Field duplicate	$\bar{x}_1$, Run 2A concentration (ppmv):	3.4	PD =	12
Eq. 323-2, PD = 100 * $(\bar{x}_1-\bar{x}_2) / ((\bar{x}_1+\bar{x}_2)/2)$	$\bar{x}_2$, Run 2B concentration (ppmv):	3.1		

Table 10
EUBIOGEN4 Formaldehyde Emission Rates

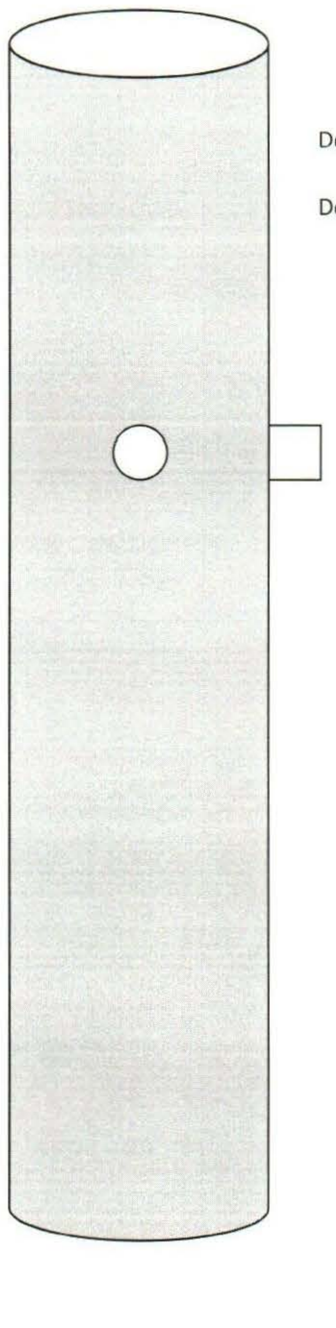
Client	**JBS USA**				
Source	**EUBIOGEN4**				
Test Information					
Test Number	R1	R2A	R2B	R3	
Test Date	12/8/2023	12/8/2023	12/8/2023	12/8/2023	
Run Start Time	9:00	10:34	10:34	12:01	
Run Finish Time	10:00	11:34	11:34	13:01	
Net Run Time, Minutes	60	60	60	60	
Sampling Information					
Dry Gas Meter Calibration Factor, Y	1.0099	1.0099	1.0009	1.0099	
Meter Temperature Tm (F)	53.4	62.6	63.3	65.6	61.2
Barometric Pressure - Pbar (in. Hg)	29.01	29.01	29.01	29.01	29.01
Measured Sample Volume, Vm (L)	19.574	19.667	20.132	21.234	20.152
Measured Sample Volume, Vmstd (L)	19.720	19.467	19.722	20.898	19.952
Sample Volume (Vm-Std ft^3)	0.70	0.69	0.70	0.74	0.70
Condensate Volume (Vw-std)	0.090	0.094	0.090	0.151	0.106
Percent Moisture (Bws)	11.40	12.06	11.40	16.97	12.96
Exhaust Gas Flowrate					
Flowrate ft^3 (Standard Wet)	6,040	6,076	6,076	6,138	6,084
Flowrate ft^3 (Standard Dry)	5,257	5,288	5,288	5,342	5,296
Total Formaldehyde Weights (mg)					
Sample Catch	0.08	0.09	0.09	0.10	0.09
Total Formaldehyde Concentration					
ppmv, dry	3.3	3.5	3.8	3.8	3.6
Total Formaldehyde Emission Rate					
lb/ hr	0.08	0.09	0.09	0.10	0.09

Field duplicate
Eq. 323-2, PD = 100 * $(\bar{x}_1-\bar{x}_2) / ((\bar{x}_1+\bar{x}_2)/2)$

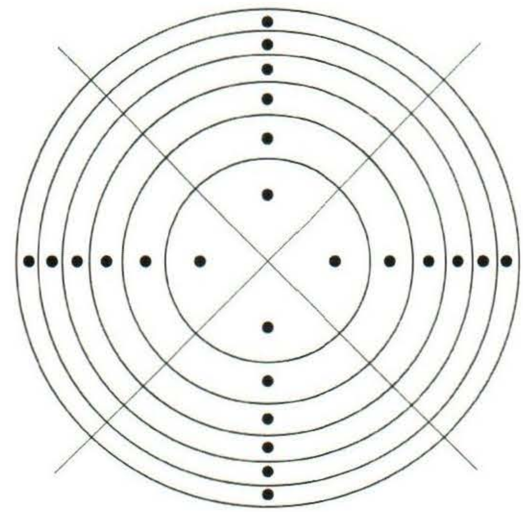
$\bar{x}_1$, Run 2A concentration (ppmv): 3.5 PD = 7
$\bar{x}_2$, Run 2B concentration (ppmv): 3.8

Appendix B – Figures

ChaseYoung Environmental Testing



Diameter	19.5 inches
Upstream	26 inches
Downstream	62 inches
Upstream	1.333 diameters
Downstream	3.179 diameters



Traverse Point #	Distance (inches)
1	0.41
2	1.31
3	2.30
4	3.45
5	4.88
6	6.94
7	12.56
8	14.63
9	16.05
10	17.20
11	18.19
12	19.09

Figure 1

EUBIOGEN 1-4 Exhaust Stack Traverse Point Diagram

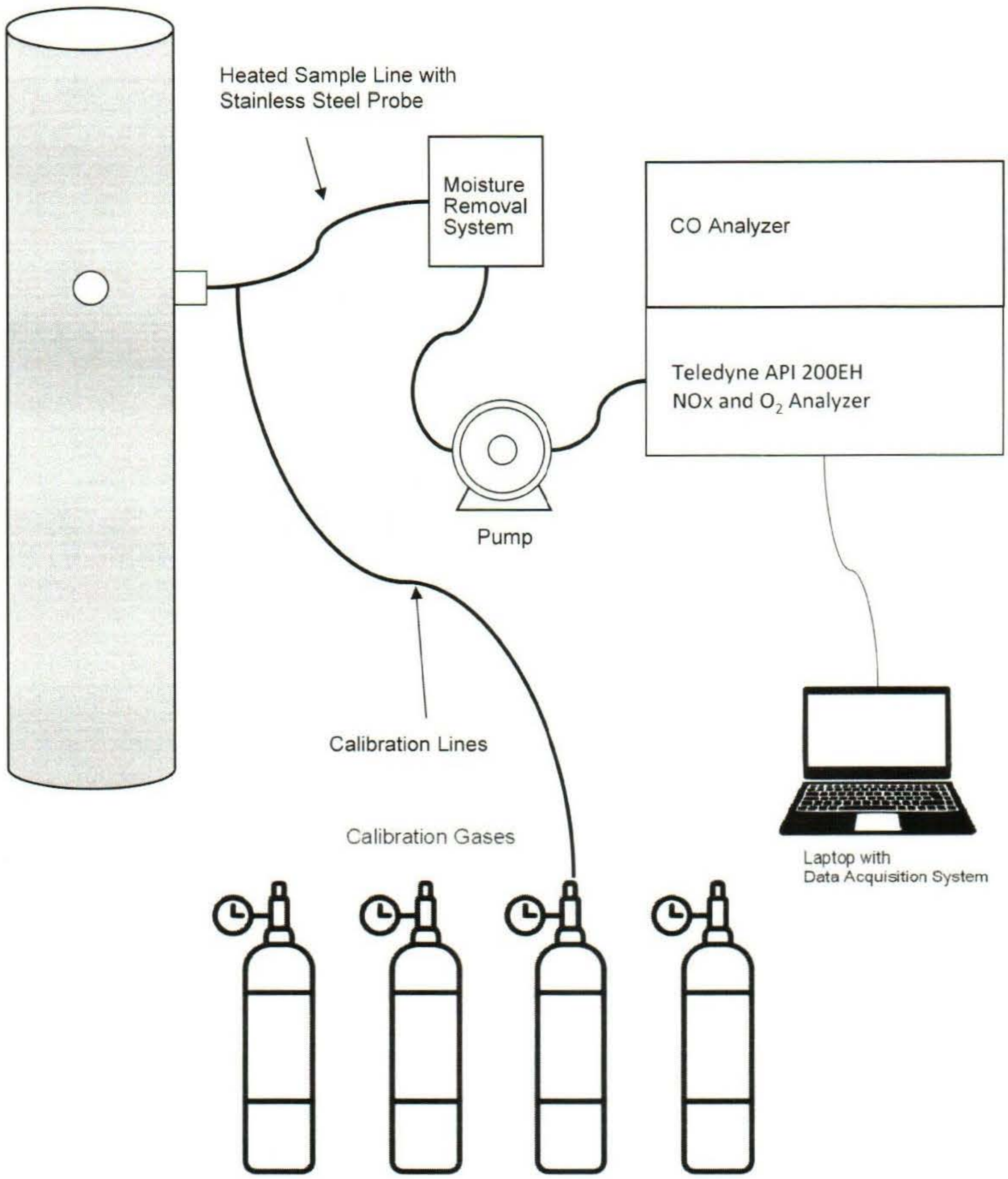


Figure 2

USEPA Method 3A/7E/10 Sampling Train

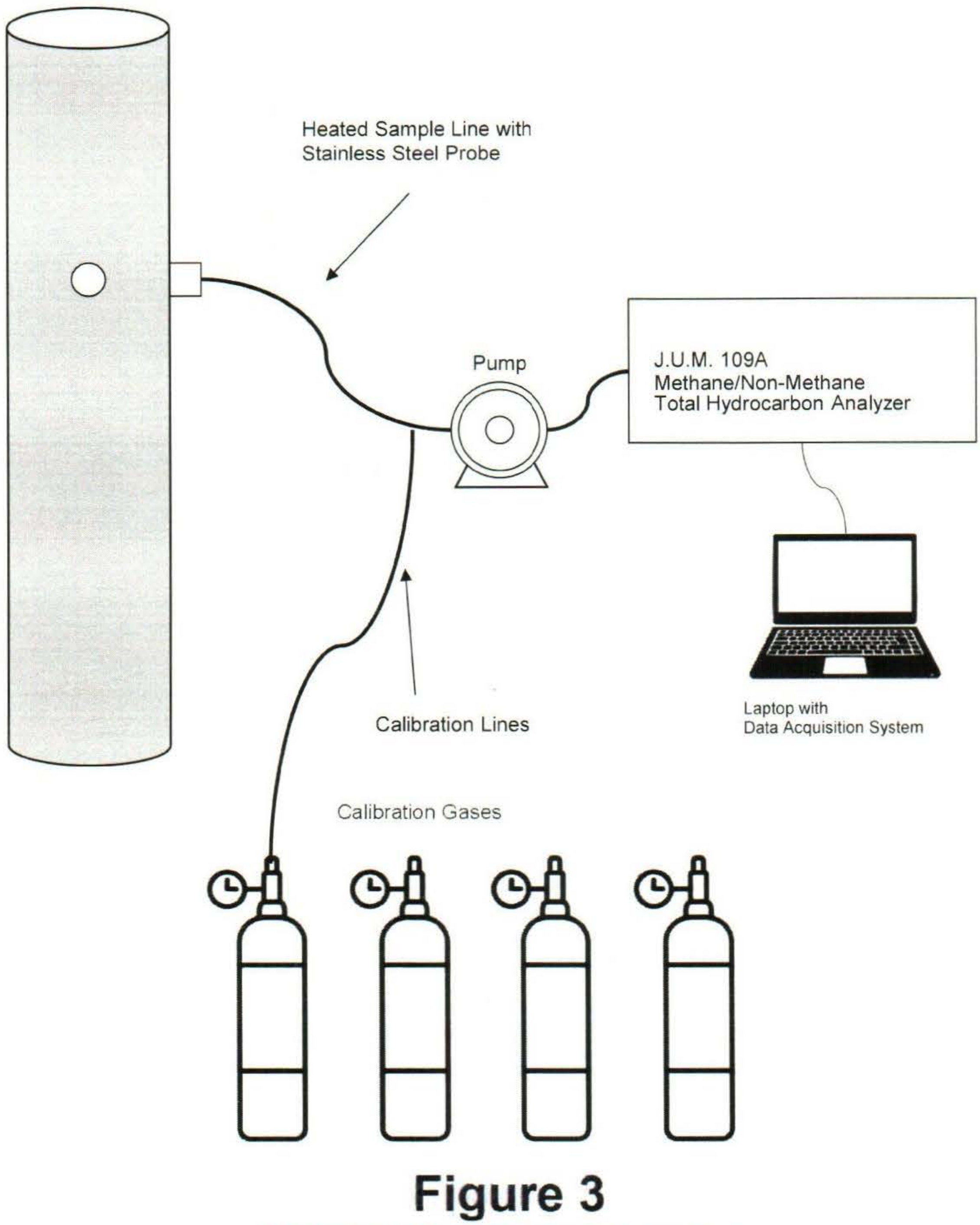


Figure 3
USEPA Method 25A Sampling Train

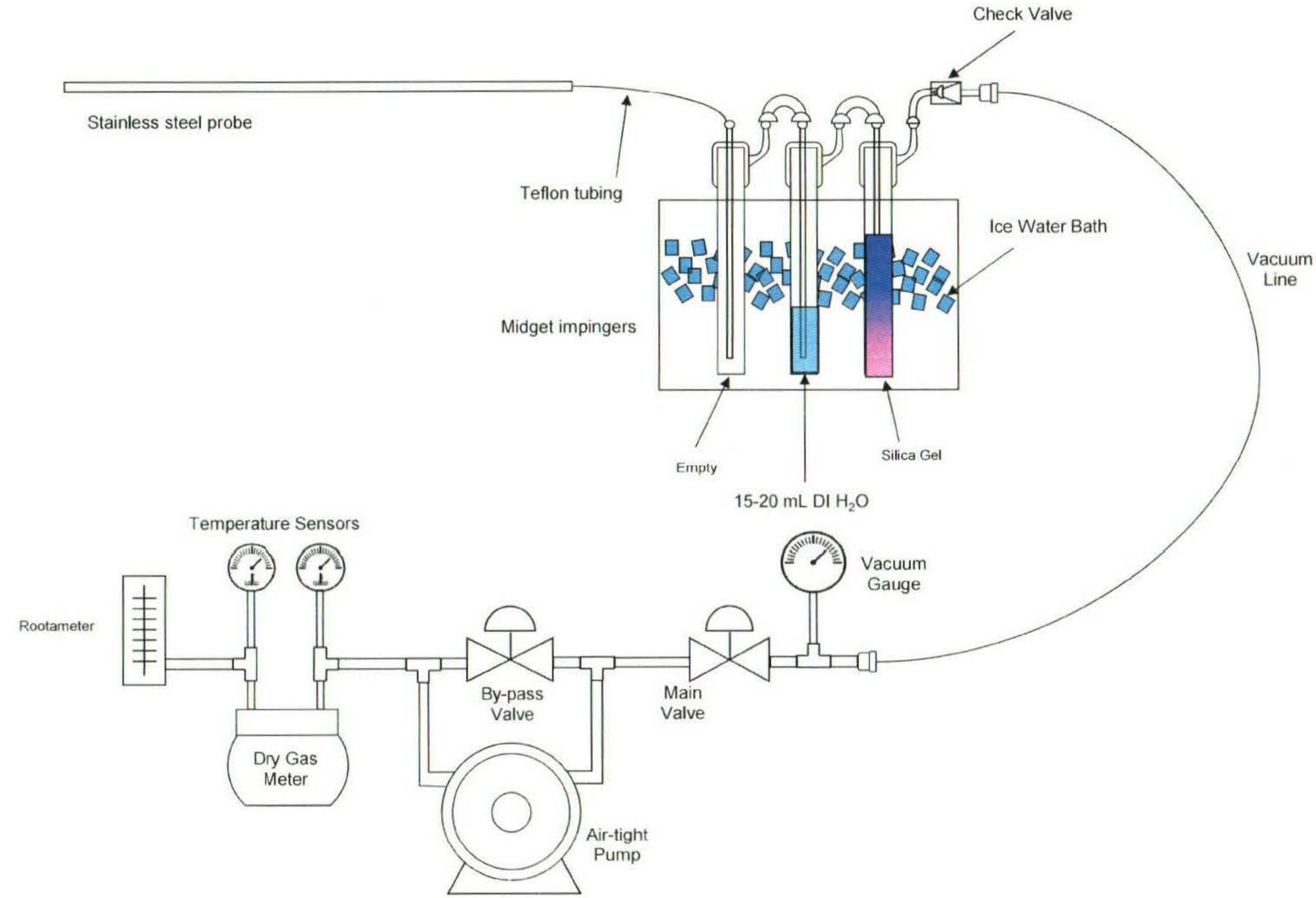
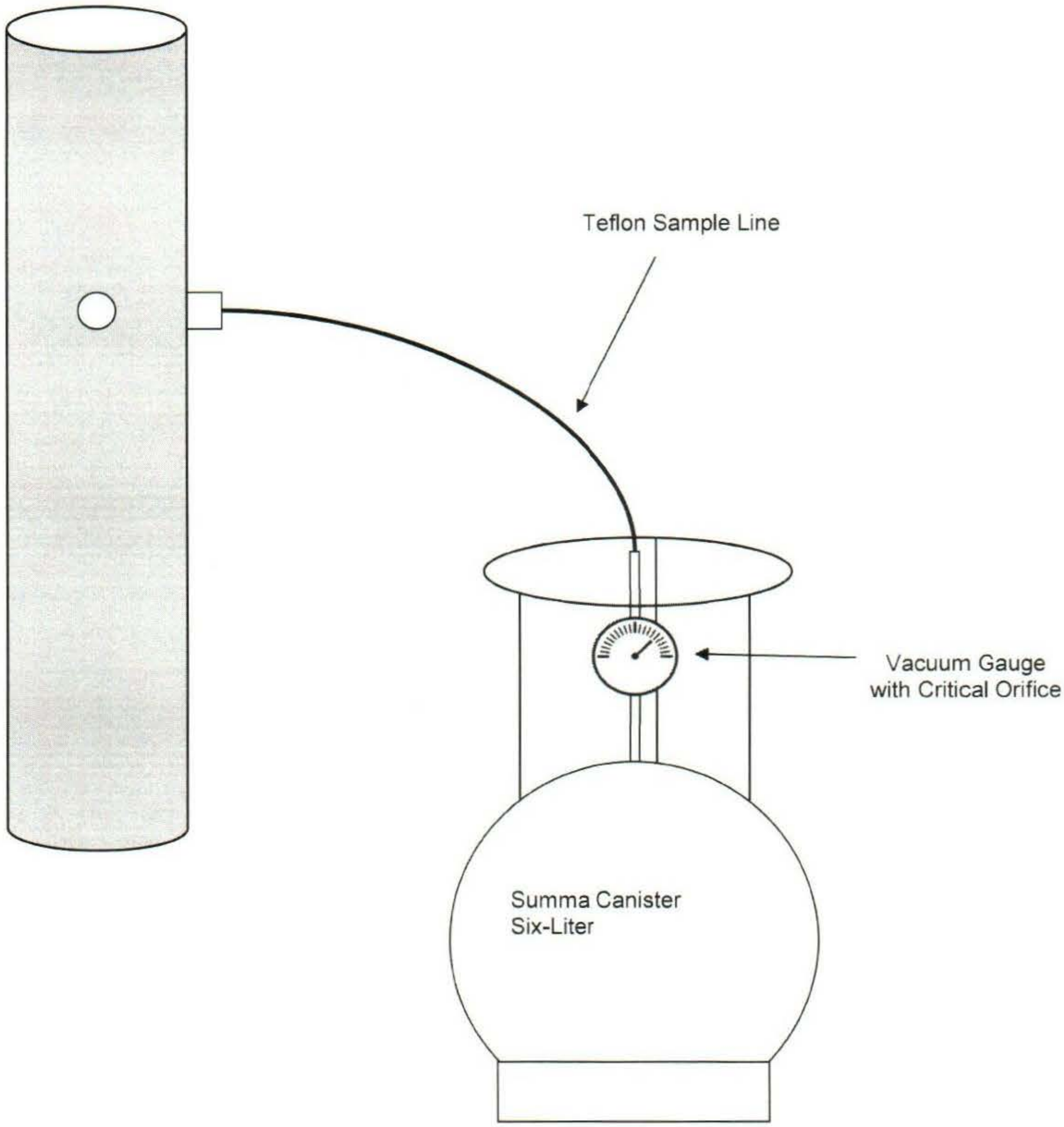


Figure 4

USEPA Method 323 Sampling Train



Not to scale

Figure 5
ASTM D5504 Sampling Train