



**EXECUTIVE SUMMARY**

Chase Young Environmental Testing Inc (CYET) was retained by Zeeland Farm Services, Incorporated (ZFS) [SRN:M4204] to conduct emission testing on EUPREPEQUIPMENT, EUEXTRACTION, EULF/NGENGINE 1, and EULF/NGENGINE 2 at their facility located at 2468 84<sup>th</sup> Avenue in Zeeland, MI 49464 in Ottawa County. The emissions test program was conducted on June 27-29, 2023, and was performed in accordance with CYET project number 231651 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 MI-ROP M4204-2018b issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE). Method deviations were requested for EPA Methods 1A and 25 and are listed in sections 5.C. The results of the test program are presented in Table 1.

**Table 1  
Overall Emission Summary  
Test Dates: June 27-29, 2023**

Source	Parameter	Reporting Units	Test Result	Limit
EUPREPEQUIPMENT	FPM	lbs/1,000 lbs	0.001 <sup>A</sup>	0.044
	PM <sub>10</sub>	lb/hr	0.18 <sup>A</sup>	5.36
	PM <sub>2.5</sub>	lb/hr	0.18 <sup>A</sup>	4.25
EUEXTRACTION	VOC	lb/hr	0.09	7.12
EULF/NGENGINE 1	NO <sub>x</sub>	lb/hr	2.79	4.56
	CO	lb/hr	13.14	22.44
	VOC	lb/hr	2.12	4.02
	Formaldehyde	lb/hr	1.2 <sup>B</sup>	2.8
	SO <sub>2</sub>	lb/hr	1.69	2.77
EULF/NGENGINE 2	NO <sub>x</sub>	lb/hr	2.71	4.56
	CO	lb/hr	12.55	22.44
	VOC	lb/hr	0.96	4.02
	Formaldehyde	lb/hr	1.1	2.8
	SO <sub>2</sub>	lb/hr	1.69	2.77

A: Result is average of Runs 2-4. Run 1 results are included in Table 3

B: Results is average of Runs 1, 2A, and 2B. Run 3 results are included in Table 6



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## 1. Introduction

Chase Young Environmental Testing Inc (CYET) was retained by Zeeland Farm Services, Incorporated (ZFS) [SRN:M4204] to conduct emission testing on EUPREPEQUIPMENT, EUEXTRACTION, EULF/NGENGINE 1, and EULF/NGENGINE 2 at their facility located at 2468 84<sup>th</sup> Avenue in Zeeland, MI 49464 in Ottawa County. The emissions test program was conducted on June 27-29, 2023 and was performed in accordance with CYET project number 231651 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 MI-ROP-M4204-2018b issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE). Method deviations were requested for EPA Methods 1A and 25 and are listed in section 5.C. 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 June 27-29, 2023, at the ZFS facility Plant located in Zeeland, MI

### 1.b Purpose of Testing

AQD issued Renewable Operating Permit No. MI-ROP- M4204-2018a to ZFS on September 18, 2018. This permit limits emissions as summarized by Table 1.

### 1.c Source Description

ZFS operates under renewable operating permit MI-ROP-M4204-2018b which includes EUPREPEQUIPMENT, EUEXTRACTION, and EULF/NGENGINES 1 and 2.

Soybeans are passed through a processing area (EUPREPEQUIPMENT) to prepare the beans before the oil is extracted. A maximum rated capacity of 1,050 tons of soybeans per day are handled, cleaned, cracked and dehulled, ground, conditioned, and flaked within this area. Emission from the vertical seed conditioner (VSC) are controlled by a cyclone, and all other equipment is controlled by a baghouse. The testing conducted is only on the baghouse exhaust stack, and not the VSC cyclone stack.

Gasses from EUEXTRACTION are sent to the Mineral Oil Absorption System (MOS). The MOS captures most solvent from vent gases and returns the recovered solvent to the work tank to be reused in the process. Gasses enter the bottom of the absorption column and rise through packing to the top of the tower. Cold mineral oil enters the tower at the top and flows down through the packing. The mineral oil absorbs hexane from the gas stream. Desolventized gasses exit through a demister at the top and are vented to the atmosphere at SVMAINVENT.

ZFS Operates two 2,300 BHP Caterpillar 3520C reciprocating internal combustion engines fueled with treated landfill or natural gas. Each engine has its own exhaust stack along with a



shared waste heat boiler stack. Valves can be closed to the engine exhaust stacks to run through the shared waste heat boiler stack to capture any heat from the engine exhaust. The valves were adjusted during the test program to route the exhaust through the shared waste heat boiler stack. Only a single engine was operated at a time. CYET measured the flow rate in the waste heat boiler stack as well as the engine stack after the valves were closed and there was no detectable flow in the engine stacks, therefore sampling was performed from the waste heat boiler stack for each engine.

Figures 1-3 present 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:

Mr. Brandon LaRosa  
 Environmental Engineer  
 Zeeland Farm Services, Incorporated  
 (616) 879-1715

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. Brandon LaRosa Environmental Engineer <a href="mailto:brandonl@zfs.com">brandonl@zfs.com</a>	Zeeland Farm Services, Incorporated 2468 84 <sup>th</sup> Avenue Zeeland, Michigan 49464	(616) 879-1715
Ms. Hannah O'Toole EHS Manager <a href="mailto:hannaho@zfs.com">hannaho@zfs.com</a>	Zeeland Farm Services, Incorporated 2468 84 <sup>th</sup> Avenue Zeeland, Michigan 49464	(616) 748-3961
Mr. Brandon Chase Senior Environmental Engineer <a href="mailto:bchase@cyetinc.com">bchase@cyetinc.com</a>	CYET 28744 Groveland Street Madison Heights, MI 48071	(248) 506-0107
Mr. Matthew Young Senior Project Manager <a href="mailto:myoung@cyetinc.com">myoung@cyetinc.com</a>	CYET 28744 Groveland Street Madison Heights, MI 48071	(586) 744-9133
Mr. Trevor Drost Environmental Quality Analyst <a href="mailto:drostt@michigan.gov">drostt@michigan.gov</a>	Air Quality Division Michigan Dept of Environment, Great Lakes & Energy	(517) 245-5781

## **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:

#### **EUPREPEQUIPMENT**

- Soybeans Processed, tons
- Baghouse differential pressure, inches of water column

#### **EUEXTRACTION**

- Soybeans Processed, tons
- Mineral Oil Flowrate, gpm

#### **EULF/NGENGINE 1 and 2**

- Engine Load, KW
- LFG Heat Content, BTU
- LFG Methane Content, %
- LFG Fuel Flow, scfm

Process operating data is included in Appendix G.

### **2.b Applicable Permit**

The applicable permit for this emissions test program is Renewable Operating Permit (ROP) No. MI-ROP-M4204-2018b.

### **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 3-8 in Appendix A.

## **3. Source Description**

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

### **3.a Process Description**

ZFS operates under renewable operating permit MI-ROP-M4204-2018b which includes EUPREPEQUIPMENT, EUEXTRACTION, and EULF/NGENGINES 1 and 2.

Soybeans are passed through a processing area (EUPREPEQUIPMENT) to prepare the beans before the oil is extracted. A maximum rated capacity of 1,050 tons of soybeans per day are handled, cleaned, cracked and dehulled, ground, conditioned, and flaked within this area. Emission from the vertical seed conditioner (VSC) are controlled by a cyclone, and all other equipment is controlled by a baghouse. The testing conducted is only on the baghouse exhaust stack, and not the VSC cyclone stack.

Gasses from EUEXTRACTION are sent to the Mineral Oil Absorption System (MOS). The MOS captures most solvent from vent gases and returns the recovered solvent to the work tank to be reused in the process. Gasses enter the bottom of the absorption column and rise through packing to the top of the tower. Cold mineral oil enters the tower at the top and flows down through the packing. The mineral oil absorbs hexane from the gas stream. Desolventized gasses exit through a demister at the top and are vented to the atmosphere at SVMAINVENT.

ZFS Operates two 2,300 BHP Caterpillar 3520C reciprocating internal combustion engines fueled with treated landfill or natural gas. Each engine has its own exhaust stack along with a shared waste heat boiler stack. Valves can be closed to the engine exhaust stacks to run through the shared waste heat boiler stack to capture any heat from the engine exhaust. Only a single engine was operated at a time. CYET measured the flow rate in the waste heat boiler stack as well as the engine stack after the valves were closed and there was no detectable flow in the engine stacks, therefore sampling was performed from the waste heat boiler stack for each engine.

### **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 materials associated with EUPREPEQUIPMENT are soybeans. EUEXTRACTION uses hexane to extract soybean oil. EULF/NGENGINES 1 and 2 typically use landfill gas as fuel, however they are also able to run using natural gas. The engines were tested while using landfill gas.

### **3.d Process Capacity**

The facility is permitted to process a maximum of 1,050 tons of soybeans per day through EUPREPEQUIPMENT and EUEXTRACTION. EULF/NGENGINES 1 and 2 are both rated at 2,300 bhp (1600 kW) at 100% load.

### **3.e Process Instrumentation**

Process data monitored during the emissions test program include:

#### **EUPREPEQUIPMENT**

- Soybeans Processed, tons
- Baghouse differential pressure, inches of water column

#### **EUEXTRACTION**

- Soybeans Processed, tons
- Mineral Oil Flowrate, gpm

#### **EULF/NGENGINE 1 and 2**

- Engine Load, KW
- LFG Heat Content, BTU
- LFG Methane Content, %
- LFG Fuel Flow, scfm

Process operating data is included in Appendix G.

### **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 1A - *“Sample and Velocity Traverses for Stationary Sources with Small Stacks or Ducts”* 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 5 - *“Determination of Particulate Emissions from Stationary Sources”* was used to determine the concentration of particulate in the exhaust gas.
- Method 6C - *“Determination of Sulfur Dioxide Emissions from Stationary Sources” (Instrumental Analyzer Procedure)* was used to determine the sulfur dioxide concentration 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 25 - *“Determination of Total Gaseous Non-Methane Organic emissions as carbon”* was used to determine the TGNMO 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 202 - *“Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources Stationary Sources”* was used to determine the concentration of particulate in 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.

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 location was verified to meet at least 2 duct diameters downstream, and at least 0.5 duct diameters upstream of any flow disturbances.

USEPA Method 1A was utilized to determine the necessary sampling points for flow rates on EU EXTRACTION. This method is applicable to sources that are not cyclonic or swirling, and the duct diameter is greater than 4 inches but less than 12 inches. The sample location was verified to meet at least 2 duct diameters downstream, and at least 0.5 duct diameters upstream of any flow disturbances.

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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  $\pm 2$  °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<sub>2</sub>O 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<sub>2</sub> and CO<sub>2</sub>). 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<sub>2</sub> and CO<sub>2</sub> (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 5/202 and Method 323 sampling systems.

On the EUEXTRACTION SVMAINVENT, moisture content was determined using wet bulb/dry bulb measurements and pressure saturation tables.

The O<sub>2</sub> 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 SO<sub>2</sub> 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.

The NO<sub>x</sub> 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 SO<sub>2</sub>, NO<sub>x</sub>, 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 4.

USEPA Methods 5/202 was used to measure both Filterable Particulate Matter (FPM) and Condensable Particulate Matter (CPM) to determine the Total Particulate Matter (TPM). A Nutech® Model 2010 modular isokinetic stack sampling system consisting of (1) a stainless steel nozzle, (2) a glass probe, (3) a tared 90mm glass fiber filter, (4) a vertical condenser, (5) an empty potbellied impinger, (6) an empty Greenburg-Smith (GS) impinger, (7) an unheated filter holder with 47mm Teflon filter (CPM Filter), (8) a second Greenburg-Smith (GS) impinger with 100 ml of H<sub>2</sub>O, (9) and an impinger filled with approximately 300 grams of silica gel.

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  $\pm 0.5$ g of the certified mass.

The sampling system was set up onsite, noting that the manometer is level and zeroed continuously throughout sampling. A pre- and post-test leak check of the system were performed by plugging the end of the sample probe and reaching a vacuum of 15 in. Hg. The system passes when the leakage rate of the dry gas meter is no greater than 0.020 cfm. A sample of the gas is obtained by inserting the probe and nozzle to each sampling point as per Method 1 and extracting the sample at isokinetic conditions ( $\pm 10\%$ ). Probe and filter temperatures are maintained  $248 \pm 25$  F for the duration of each test. The CPM filter is maintained between 68-85 F during the testing.

After the post-test leak check, the sampling train is disassembled, and the filter is collected into a petri dish. The nozzle, probe, and the front half of the filter holder assembly are brushed, and triple rinsed with acetone and collected in a sample container. The impinger train is weighed, and then purged with nitrogen at 14 lpm for 1 hour. The back half of the filter holder and connecting lines, the vertical condenser, the potbelly impinger, the 1<sup>st</sup> GS impinger, and the front half of the CPM filter are then double rinsed with high purity deionized water and collected (container 1, aqueous liquid impinger contents). The same components are then single rinsed with acetone, and double rinsed with hexane and collected (container 2, organic rinses). The CPM filter is collected into a petri dish (container 3, CPM filter sample) Each container is labeled with the client, test location, test number, and test date. The container is sealed, and the liquid level is marked on the outside of the container. 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 6.

The TGNMO was measured utilizing the procedures of Method 25. TGNMO was analyzed by gas chromatography/flame ionization detector (GC/FID) at AAC Labs in Ventura, California and reported as carbon. The gas stream is drawn through a length of teflon line, an inline filter assembly, a straight trap condenser cooled with dry ice, a flow controller, a vacuum gage, and an 8-liter evacuated summa canister.

The sampling system is modified from the typical Method 25 train since the probe and filter will not be heated during testing due to safety concerns. Additionally, the trap used in this train will be constructed using the provisions of SCAQMD 25.1 which utilizes a straight condensate trap, rather than a U condensate trap described in Method 25.

A drawing of the sampling train used for the testing program is presented as Figure 7.

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 ( $\sim 250^\circ\text{F}$ ) 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 5.

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. 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 Engine 1 and Engine 2 were 15% and 19%, respectively.

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  $\pm 0.5\text{g}$  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 ( $\sim 0.4\text{ L/min}$ ). 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.

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 midjet 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 8.

#### **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 Figures 1-3.

#### **4.d Traverse Points**

A diagram of the stacks indicating traverse point and sampling locations and stack dimensions is included as Figures 1-3.

### **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 3-8 in Appendix A.

**Table 1  
Overall Emission Summary  
Test Dates: June 27-29, 2023**

Source	Parameter	Reporting Units	Test Result	Limit
EUPREPEQUIPMENT	FPM	lbs/1,000 lbs	0.001 <sup>A</sup>	0.044
	PM <sub>10</sub>	lb/hr	0.18 <sup>A</sup>	5.36
	PM <sub>2.5</sub>	lb/hr	0.18 <sup>A</sup>	4.25
EUEXTRACTION	VOC	lb/hr	0.09	7.12
EULF/NGENGINE 1	NO <sub>x</sub>	lb/hr	2.79	4.56
	CO	lb/hr	13.14	22.44
	VOC	lb/hr	2.12	4.02
	Formaldehyde	lb/hr	1.2 <sup>B</sup>	2.8
	SO <sub>2</sub>	lb/hr	1.69	2.77
EULF/NGENGINE 2	NO <sub>x</sub>	lb/hr	2.71	4.56
	CO	lb/hr	12.55	22.44
	VOC	lb/hr	0.96	4.02
	Formaldehyde	lb/hr	1.1	2.8
	SO <sub>2</sub>	lb/hr	1.69	2.77

A: Result is average of Runs 2-4. Run 1 results are included in Table 3

B: Results is average of Runs 1, 2A, and 2B. Run 3 results are included in Table 6

**5.b Discussion of Results**

All test results are in compliance with permit limits.

Run 1 of the M5/202 sampling on EUPREPEQUIPMENT had a lot of loose particulate matter on the filter. CYET believes that while performing the sampling at the sample point closest to the stack wall, that the edge of the stack was inadvertently scraped with the nozzle resulting in the loose particulate being collected and is not representative of the true emission rate. An additional sample run (Run 4) was conducted. EUPREPEQUIPMENT FPM Results presented in Table 1 exclude the flagged Run 1 results. Table 3 in Appendix A includes the results of Run 1. It should be noted that while EUPREPEQUIPMENT FPM emission rates for the flagged Run 1 are biased high, they are still below the permit limits for all parameters.

Formaldehyde results for Run 3 of the M323 sampling on EULF/NGENGINE 1 are much lower than expected and have been flagged. EULF/NGENGINE 1 formaldehyde results presented in Table 1 exclude the flagged Run 3 results. Table 6 in Appendix A includes the results of Run 3 and presents the overall average emission rates two ways; Including Run 3 and excluding Run 3. It should be noted that EULF/NGENGINE 1 formaldehyde emission rates are below the limit

whether Run 3 is included in the overall average or not. It should also be noted that field duplicates were performed concurrently during Run 2 on each engine (see section 4a), giving a total of 4 independent sampling runs on each engine (Run 1, Run 2A, Run 2B, and Run 3).

Results for the test program are presented as the average of 4 sample runs for each source to include the results of the duplicate samples, as per USEPA method 323 section 8.4.1. Results for EULF/NGENGINE 1 are presented as the average of 3 sample runs due to the flagged Run 3 results.

The overall average moisture results from the Method 323 sampling were used to calculate molecular weight and flow rates for each engine. The overall average moisture for EULF/NGENGINE 1 was 13.12%, and the overall average moisture for EULF/NGENGINE 2 was 13.38%.

### **5.c Sampling Procedure Variations**

The following method variations were granted for the test program:

The EUEXTRACTION vent measured 3.75 inches in diameter. This source is also equipped with only one sample port. EGLE approved sampling from a single sample port using 8 points to take velocity measurements across the diameter of the stack utilizing a standard pitot tube. A standard pitot was unable to fit into the sampling port, so a small s-type pitot was used instead. Measurements were taken before and after each sample, and the average of the two measurements were used to calculate emissions rates for each test run.

The Method 25 sampling system is modified from the typical Method 25 train since the probe and filter were not heated during testing due to safety concerns (EUEXTRACTION is a Class 1, Division 1 hazardous location and electrical equipment must be avoided or be “intrinsically safe”). Additionally, the trap used in this train was constructed using the provisions of SCAQMD 25.1 which utilizes a straight condensate trap, rather than a U condensate trap described in Method 25.

The aforementioned method deviations were approved for use in the test plan acceptance letter dated June 23, 2023. The approval letter from EGLE is provided in Appendix H.

### **5.d Process or Control Device Upsets**

No upset conditions occurred during testing.

### **5.e Control Device Maintenance**

There was no control equipment maintenance performed during the emissions test program.

### **5.f Re-Test**

The emissions test program was not a re-test.



#### **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  
Brandon Chase  
Senior Environmental Engineer

This report was reviewed by: Matthew Young  
Matthew Young  
Senior Project Manager

## Appendix A – Emission Results Tables

**Table 1**  
**Overall Emission Summary**  
**Test Dates: June 27-29, 2023**

Source	Parameter	Reporting Units	Test Result	Limit
EUPREPEQUIPMENT	FPM	lbs/1,000 lbs	0.001 <sup>A</sup>	0.044
	PM <sub>10</sub>	lb/hr	0.18 <sup>A</sup>	5.36
	PM <sub>2.5</sub>	lb/hr	0.18 <sup>A</sup>	4.25
EUEXTRACTION	VOC	lb/hr	0.09	7.12
EULF/NGENGINE 1	NO <sub>x</sub>	lb/hr	2.79	4.56
	CO	lb/hr	13.14	22.44
	VOC	lb/hr	2.12	4.02
	Formaldehyde	lb/hr	1.2 <sup>B</sup>	2.8
	SO <sub>2</sub>	lb/hr	1.69	2.77
EULF/NGENGINE 2	NO <sub>x</sub>	lb/hr	2.71	4.56
	CO	lb/hr	12.55	22.44
	VOC	lb/hr	0.96	4.02
	Formaldehyde	lb/hr	1.1	2.8
	SO <sub>2</sub>	lb/hr	1.69	2.77

A: Result is average of Runs 2-4. Run 1 results are included in Table 3

B: Results is average of Runs 1, 2A, and 2B. Run 3 results are included in Table 6

**Table 2  
Test Personnel**

Name, Title, and Email	Affiliation	Telephone
Mr. Brandon LaRosa Environmental Engineer brandonl@zfs.com	Zeeland Farm Services, Incorporated 2468 84 <sup>th</sup> Avenue Zeeland, Michigan 49464	(616) 879-1715
Ms. Hannah O'Toole EHS Manager hannaho@zfs.com	Zeeland Farm Services, Incorporated 2468 84 <sup>th</sup> Avenue Zeeland, Michigan 49464	(616) 748-3961
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

Table 3  
EUPRE-EQUIPMENT Particulate Matter Emission Rates

Client	ZFS				
Source	EUPRE-EQUIPMENT				
<b>Test Information</b>					
Test Number:	1	2	3	4	Average
Test Date:	6/27/2023	6/27/2023	6/27/2023	6/27/2023	Run 2-4 only
Run Start Time:	8:13	10:32	12:48	15:33	
Run Finish Time:	9:39	11:56	14:10	16:56	
Net Traverse Points:	24	24	24	24	
Net Run Time, Minutes:	72	72	72	72	
<b>Meter/Nozzle Information</b>					
Meter Temperature Tm (F)	76.0	85.4	91.2	95.0	90.5
Meter Pressure - Pm (in. Hg)	29.2	29.2	29.2	29.2	29.2
Measured Sample Volume (Vm)	52.8	56.5	56.1	55.5	56.0
Sample Volume (Vm-Std ft <sup>3</sup> )	50.2	52.9	52.0	51.1	52.0
Sample Volume (Vm-Std m <sup>3</sup> )	1.42	1.50	1.47	1.45	1.47
Condensate Volume (Vw-std)	1.377	1.811	1.693	1.815	1.773
Gas Density (Ps(std) lbs/ft <sup>3</sup> ) (wet)	0.0738	0.0736	0.0736	0.0736	0.0736
Gas Density (Ps(std) lbs/ft <sup>3</sup> ) (dry)	0.0745	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.81	4.03	3.95	3.89	3.96
Total weight of sampled gas (m g lbs) (dry)	3.74	3.94	3.87	3.81	3.88
Nozzle Size - An (sq. ft.)	0.000197	0.000187	0.000187	0.000187	0.000187
Isokinetic Variation - I	97.4	101.0	100.8	101.0	100.9
<b>Stack Data</b>					
Average Stack Temperature - Ts (F)	114.5	119.8	121.0	126.0	122.0
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.5	28.5	28.5	28.5	28.5
Stack Gas Specific Gravity (Gs)	0.986	0.986	0.986	0.983	0.985
Percent Moisture (Bws)	2.67	3.31	3.15	3.43	3.30
Water Vapor Volume (fraction)	0.0267	0.0331	0.0315	0.0343	0.0330
Pressure - Ps ("Hg)	29.0	29.0	29.0	29.0	29.0
Average Stack Velocity -Vs (ft/sec)	73.8	76.1	74.9	74.3	75.1
Area of Stack (ft <sup>2</sup> )	4.9	4.9	4.9	4.9	4.9
<b>Exhaust Gas Flowrate</b>					
Flowrate ft <sup>3</sup> (Actual)	21,734	22,401	22,055	21,876	22,111
Flowrate ft <sup>3</sup> (Standard Wet)	19,350	19,778	19,437	19,128	19,448
Flowrate ft <sup>3</sup> (Standard Dry)	18,834	19,123	18,824	18,472	18,806
Flowrate m <sup>3</sup> (standard dry)	533	542	533	523	533
<b>Total Particulate Weights (mg)</b>					
Total Nozzle/Probe/Filter	28.0	1.7	2.2	1.8	1.9
Organic Condensable Particulate	1.0	1.9	1.3	1.0	1.4
Inorganic Condensable Particulate	1.7	1.8	2.1	1.7	1.9
Condensable Blank Correction	1.5	1.5	1.5	1.5	1.5
Total Condensable Particulate	1.2	2.2	1.9	1.2	1.8
Total Filterable and Condensable Particulate	29.2	3.9	4.1	3.0	3.7
<b>Filterable Particulate Concentration</b>					
lb/1000 lb (wet)	0.016	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.016	0.001	0.001	0.001	0.001
mg/dscm (dry)	19.7	1.1	1.5	1.2	1.3
gr/dscf	0.0086	0.0005	0.0007	0.0005	0.0006
<b>Filterable Particulate Emission Rate</b>					
lb/ hr	1.39	0.08	0.11	0.09	0.09
<b>Condensable Particulate Concentration</b>					
lb/1000 lb (wet)	0.001	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.001	0.001	0.001
mg/dscm (dry)	0.8	1.5	1.3	0.8	1.2
gr/dscf	0.0004	0.0006	0.0006	0.0004	0.0005
<b>Condensable Particulate Emission Rate</b>					
lb/ hr	0.06	0.11	0.09	0.06	0.08
<b>Total Particulate Concentration</b>					
lb/1000 lb (wet)	0.017	0.002	0.002	0.002	0.002
lb/1000 lb (dry)	0.017	0.002	0.002	0.002	0.002
mg/dscm (dry)	20.5	2.6	2.8	2.1	2.5
gr/dscf	0.0090	0.0011	0.0012	0.0009	0.0011
<b>Total Particulate Emission Rate</b>					
lb/ hr	1.45	0.19	0.20	0.14	0.18

Run 1 results are presented, but excluded from the average  
Average is Run2, Run 3, and Run 4 only

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**Table 4**  
**EULF/NGENGINE 1 NOx, CO, VOC, and SO<sub>2</sub> Emission Rates**  
**Zeeland Farm Services**  
**Zeeland, Michigan**  
**CYET Project No. 231651**  
**Sampling Dates: June 28, 2023**

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	6/28/2023	6/28/2023	6/28/2023	
Test Run Time	15:35-16:35	17:11-18:11	18:45-19:45	
Outlet Flowrate (dscfm)	4,664	4,624	4,599	4,629
Outlet Flowrate (scfm)	5,369	5,322	5,293	5,328
Oxygen Concentration (%. drift corrected as per USEPA 7E)	8.23	8.22	8.20	8.22
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	83.43	84.45	84.75	84.21
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	2.79	2.80	2.79	2.79
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	644.91	651.80	655.79	650.83
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	13.12	13.15	13.16	13.14
Outlet SO <sub>2</sub> Concentration (ppmv, corrected as per USEPA 7E)	36.44	37.00	36.24	36.56
SO <sub>2</sub> Emission Rate (lb/hr) (corrected as per USEPA 7E)	1.70	1.71	1.66	1.69
Outlet VOC Concentration (ppmv propane, corrected as per USEPA 7E)	548.31	558.81	573.86	560.33
Outlet Methane Concentration (ppmv methane, corrected as per USEPA 7E)	1,113.29	1,147.42	1,176.26	1,145.66
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)	60.02	55.56	57.96	57.85
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	2.21	2.03	2.11	2.12

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<sub>2</sub> = 64.05, C<sub>3</sub>H<sub>8</sub> = 44.10)

24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)

35.31 = ft<sup>3</sup> per m<sup>3</sup>

453600 = mg per lb

Response factor obtained from introducing propane into methane analyzer:

**2.28**

VOC concentrations are measured on a wet basis, all other pollutants are measured on a dry basis

**Equations**

lb/hr = ppmv \* MW/24.055 \* 1/35.31 \* 1/453,600 \* scfm \* 60 for VOC

lb/hr = ppmv \* MW/24.055 \* 1/35.31 \* 1/453,600 \* dscfm \* 60

Conc<sub>(15%O<sub>2</sub>)</sub> = Conc \* (20.9 - 15)/(20.9 - %O<sub>2</sub>)

Eq. 25A-1 C<sub>c</sub> = K \* C<sub>mess</sub>

where C<sub>c</sub> = Concentration as Carbon (ppmv), K = Carbon equivalent correction factor (3 for Propane)

and C<sub>mess</sub> = concentration as measured (as propane)

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CYET Project Number 231651  
August 15, 2023

**Table 5**  
**EULF/NGENGINE 2 NOx, CO, VOC, and SO<sub>2</sub> Emission Rates**  
**Zeeland Farm Services**  
**Zeeland, Michigan**  
**CYET Project No. 231651**  
**Sampling Dates: June 28, 2023**

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	6/28/2023	6/28/2023	6/28/2023	
Test Run Time	9:50-10:50	12:00-13:00	13:42-14:42	
Outlet Flowrate (dscfm)	4,738	4,657	4,654	4,683
Outlet Flowrate (scfm)	5,469	5,376	5,373	5,406
Oxygen Concentration (%. drift corrected as per USEPA 7E)	7.70	7.77	7.83	7.77
Outlet NO <sub>x</sub> Concentration (ppmv, corrected as per USEPA 7E)	76.94	80.32	85.34	80.87
NO <sub>x</sub> Emission Rate (lb/hr) (corrected as per USEPA 7E)	2.61	2.68	2.85	2.71
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	615.56	615.67	611.76	614.33
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	12.72	12.51	12.42	12.55
Outlet SO <sub>2</sub> Concentration (ppmv, corrected as per USEPA 7E)	35.72	36.16	36.39	36.09
SO <sub>2</sub> Emission Rate (lb/hr) (corrected as per USEPA 7E)	1.69	1.68	1.69	1.69
Outlet VOC Concentration (ppmv propane, corrected as per USEPA 7E)	397.19	384.76	376.40	386.12
Outlet Methane Concentration (ppmv methane, corrected as per USEPA 7E)	863.95	807.71	792.20	821.29
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)	18.26	30.50	28.94	25.90
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	0.69	1.13	1.07	0.96

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<sub>x</sub> = 46.01, SO<sub>2</sub> = 64.05, C<sub>3</sub>H<sub>8</sub> = 44.10)

24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)

35.31 = ft<sup>3</sup> per m<sup>3</sup>

453600 = mg per lb

Response factor obtained from introducing propane into methane analyzer:

**2.28**

VOC concentrations are measured on a wet basis; all other pollutants are measured on a dry basis

**Equations**

$$\text{lb/hr} = \text{ppmv} * \text{MW}/24.055 * 1/35.31 * 1/453,600 * \text{scfm} * 60 \text{ for VOC}$$

$$\text{lb/hr} = \text{ppmv} * \text{MW}/24.055 * 1/35.31 * 1/453,600 * \text{dscfm} * 60$$

$$\text{Conc}_{\text{CO}_2, \text{SO}_2} = \text{Conc} * (20.9 - 15)/(20.9 - \% \text{O}_2)$$

$$\text{Eq. 25A-1 } C_c = K * C_{\text{meas}}$$

where C<sub>c</sub> = Concentration as Carbon (ppmv), K = Carbon equivalent correction factor (3 for Propane)

and C<sub>meas</sub> = concentration as measured (as propane)

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Table 6  
EULF/NGENGINE 1 Formaldehyde Emission Rates

Client Source		ZFS EUENGINE1					
<b>Test Information</b>							
Test Number		R1	R2A	R2B	R3		
Test Date		6/28/2023	6/28/2023	6/28/2023	6/28/2023		
Run Start Time		15:35	17:11	17:11	18:45		
Run Finish Time		16:35	18:11	18:11	19:45		
Net Run Time, Minutes		60	60	60	60		
<b>Sampling Information</b>							
Dry Gas Meter Calibration Factor, Y		1.0099	1.0099	1.0009	1.0099		
Meter Temperature Tm (F)		97.1	100.6	100.6	94.9	98.3	
Barometric Pressure - Pbar (in. Hg)		29.27	29.27	29.27	29.27	29.27	
Measured Sample Volume, Vm (L)		20.238	20.634	20.601	21.137	20.653	
Measured Sample Volume, Vmstd (L)		18.960	19.212	19.011	19.884	19.267	
Sample Volume (Vm-Std ft <sup>3</sup> )		0.67	0.68	0.67	0.70	0.68	
Condensate Volume (Vw-std)		0.137	0.094	0.132	0.052	0.104	
Percent Moisture (Bws)		16.96	12.20	16.43	6.88	13.12	
%R		92.0	92.0	92.0	92.0	92.0	
<b>Exhaust Gas Flowrate</b>							
Flowrate ft <sup>3</sup> (Standard Wet)		5,369	5,322	5,322	5,293	5,328	
Flowrate ft <sup>3</sup> (Standard Dry)		4,664	4,624	4,624	4,599	4,629	
<b>Total Formaldehyde Weights (mg)</b>							
Sample Catch		1.5	1.3	1.5	0.1	1.1	Average Excluding Run 3 1.4
<b>Total Formaldehyde Concentration</b>							
ppmv, dry		58.3	49.9	58.2	4.5	42.7	55.5
<b>Total Formaldehyde Emission Rate</b>							
lb/ hr		1.3	1.1	1.3	0.1	0.9	1.2
Field duplicate		$\bar{x}_1$ , Run 2A concentration (ppmv)	49.9	PD =	15		
Eg. 323-2, PD = $100 * (\bar{x}_1 - \bar{x}_2) / ((\bar{x}_1 + \bar{x}_2) / 2)$		$\bar{x}_2$ , Run 2B concentration (ppmv)	58.2				



**Table 8**  
**EUEXTRACTION TGNMO Emission Rates**  
**Zeeland Farm Services**  
**Zeeland, Michigan**  
**CYET Project No. 231651**  
**Sampling Dates: June 29, 2023**

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	6/29/2023	6/29/2023	6/29/2023	
Test Run Time	9:03-10:00	10:12-11:12	11:28-12:28	
Outlet Flowrate (dscfm)	25.6	27.3	26.5	26.5
Outlet Flowrate (scfm)	26.0	27.7	26.9	26.9
TGNMO Concentration (ppmv as carbon)	2,127	1,501	1,790	1,806
TGNMO Emission Rate (lb/hr)	0.10	0.08	0.09	0.09

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 (Carbon = 12.01)

24.055 = molar volume of air at standard conditions (68°F, 29.92" Hg)

35.31 = ft<sup>3</sup> per m<sup>3</sup>

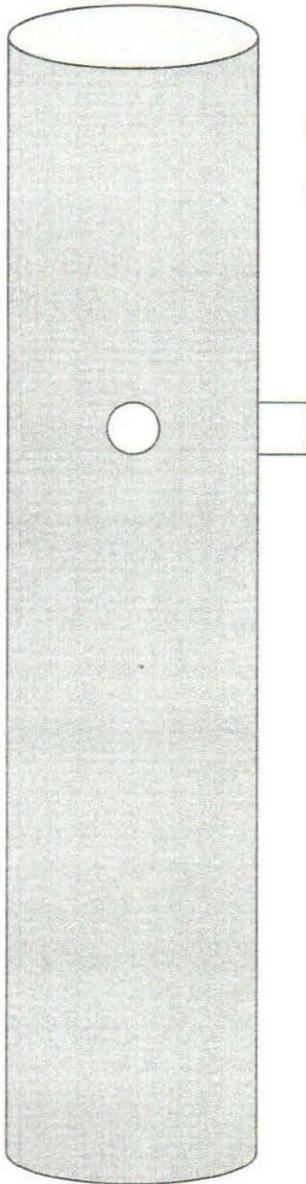
453600 = mg per lb

**Equations**

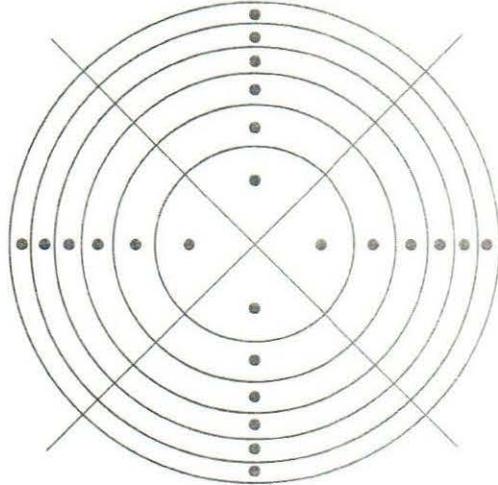
lb/hr = ppmv \* MW/24.055 \* 1/35.31 \* 1/453,600 \* scfm \* 60 for TGNMO

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# Appendix B – Figures

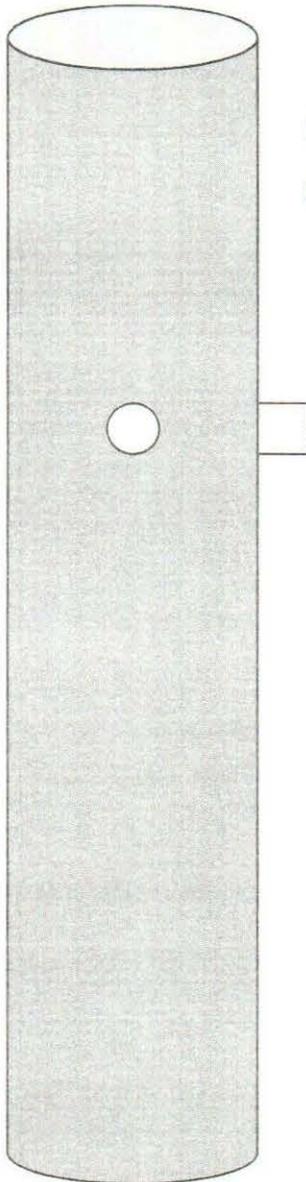


Diameter 30 inches  
 Upstream 48 inches  
 Downstream 144 inches  
 Upstream 1.6 diameters  
 Downstream 4.8 diameters

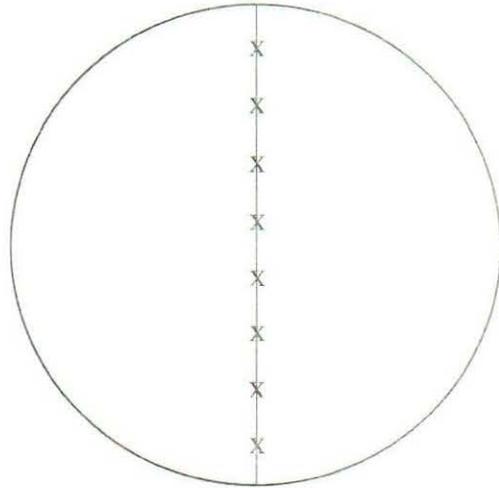


Traverse Point #	Distance (inches)
1	0.63
2	2.01
3	3.54
4	5.31
5	7.50
6	10.68
7	19.32
8	22.50
9	24.69
10	26.46
11	27.99
12	29.37

**Figure 1**  
**EUPREPEQUIPMENT Exhaust Stack Diagram**

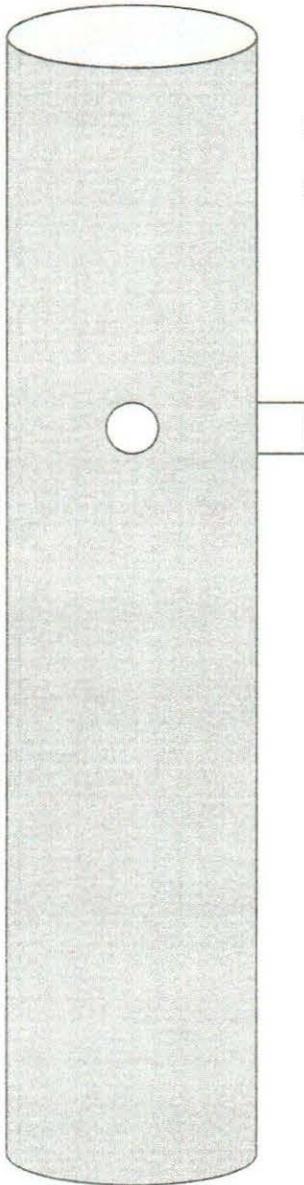


Diameter 3.75 inches  
 Upstream 120 inches  
 Downstream 4 inches  
 Upstream 32 diameters  
 Downstream 1.067 diameters

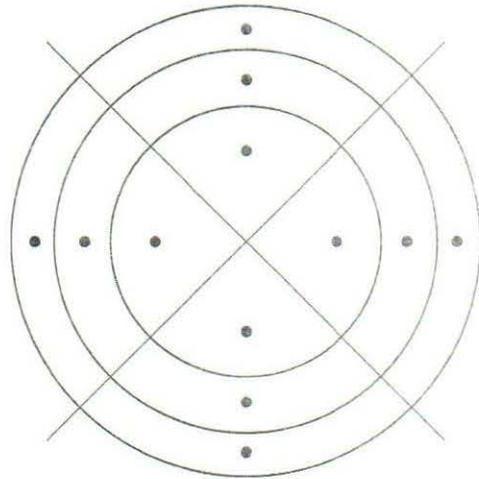


Traverse Point #	Distance (inches)
1	0.12
2	0.39
3	0.73
4	1.21
5	2.54
6	3.02
7	3.36
8	3.63

**Figure 2**  
 EUEXTRACTION Exhaust Stack Diagram



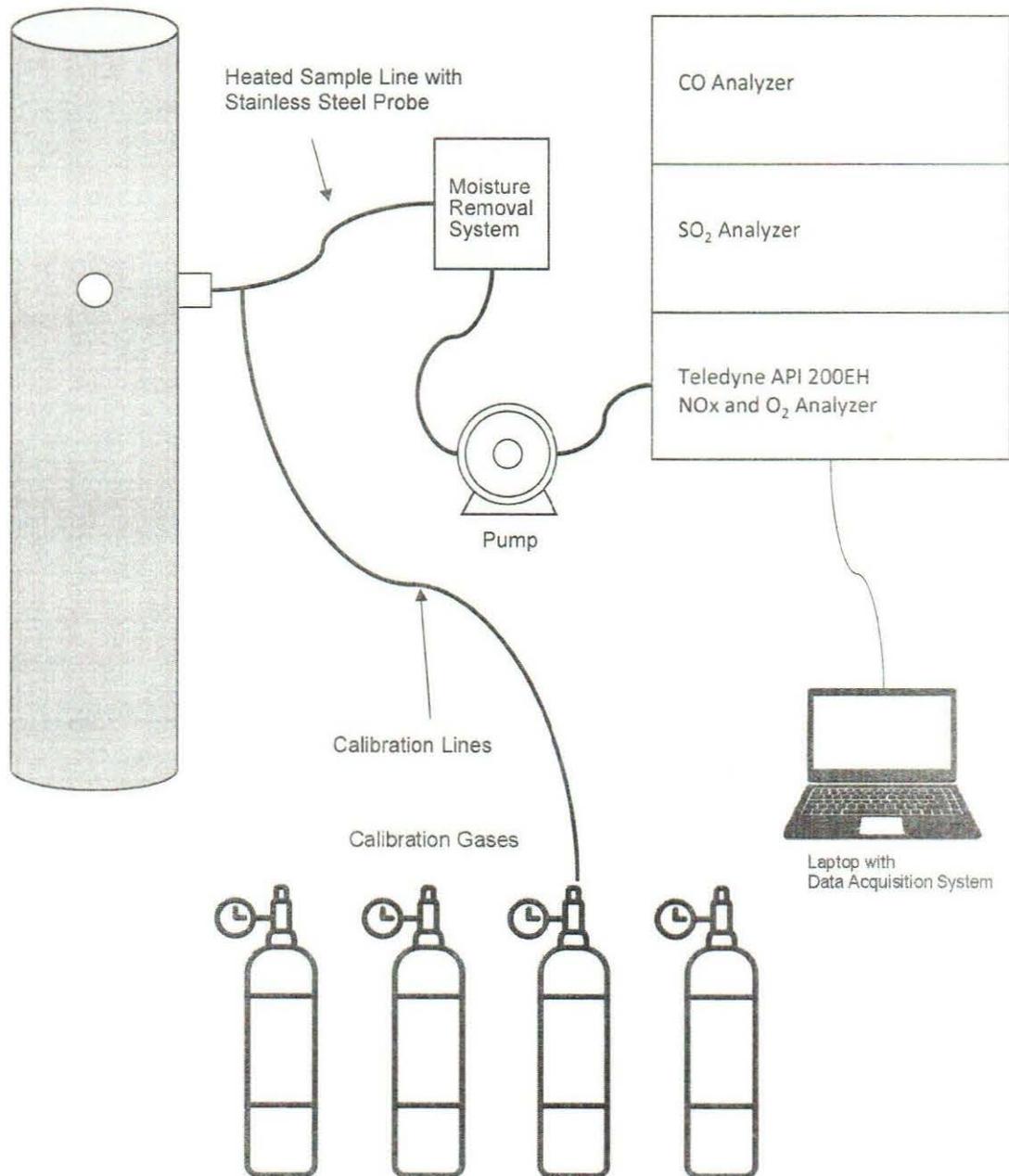
Diameter 28 inches  
 Upstream 96 inches  
 Downstream 240 inches  
 Upstream 3.429 diameters  
 Downstream 8.571 diameters



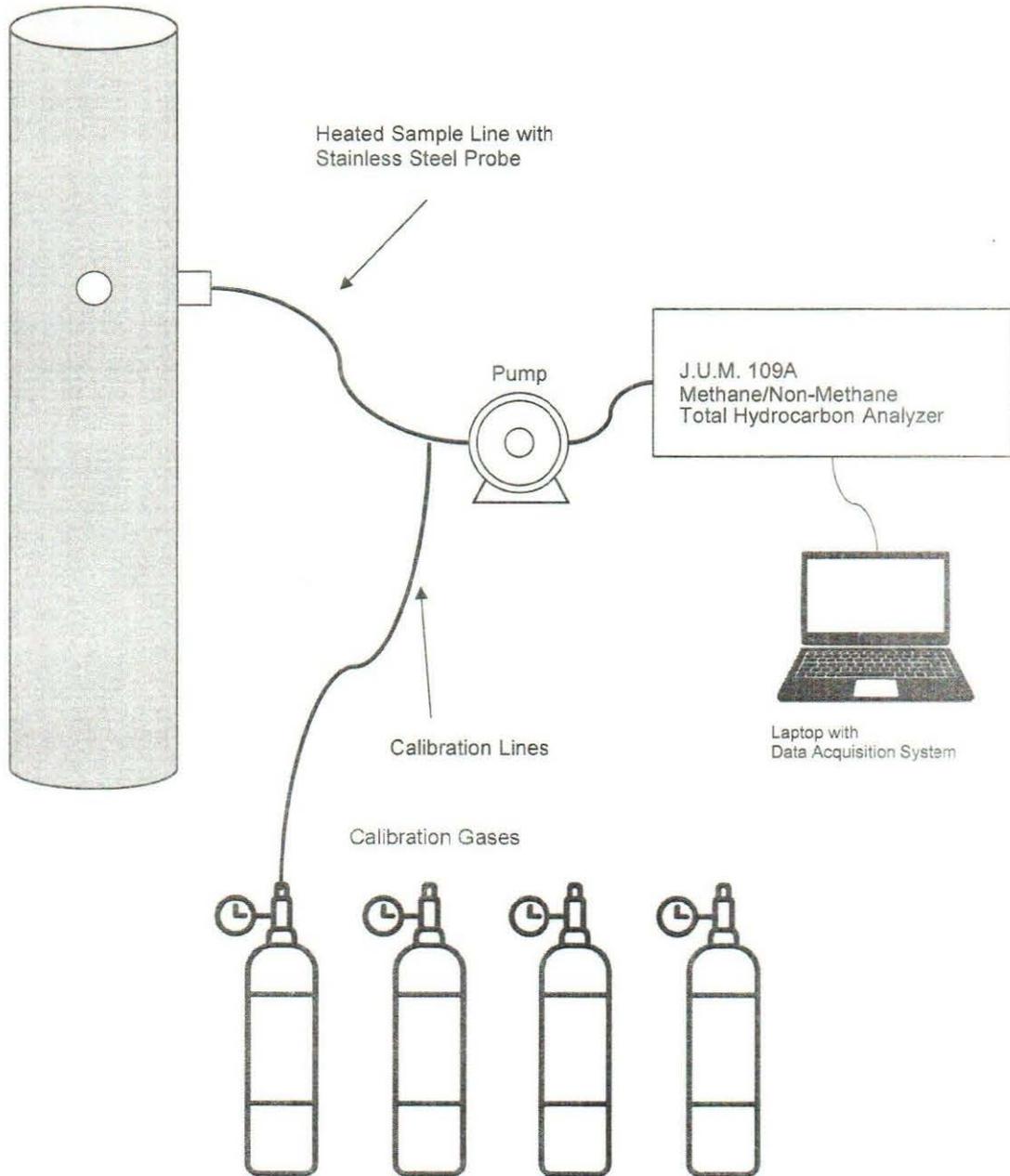
Traverse Point #	Distance (inches)
1	1.23
2	4.09
3	8.29
4	19.71
5	23.91
6	26.77

EULF/NGENGINE 1 and EULF/NGENGINE 2 were each tested out of the combined boiler stack. See section 1.c in the report for more details

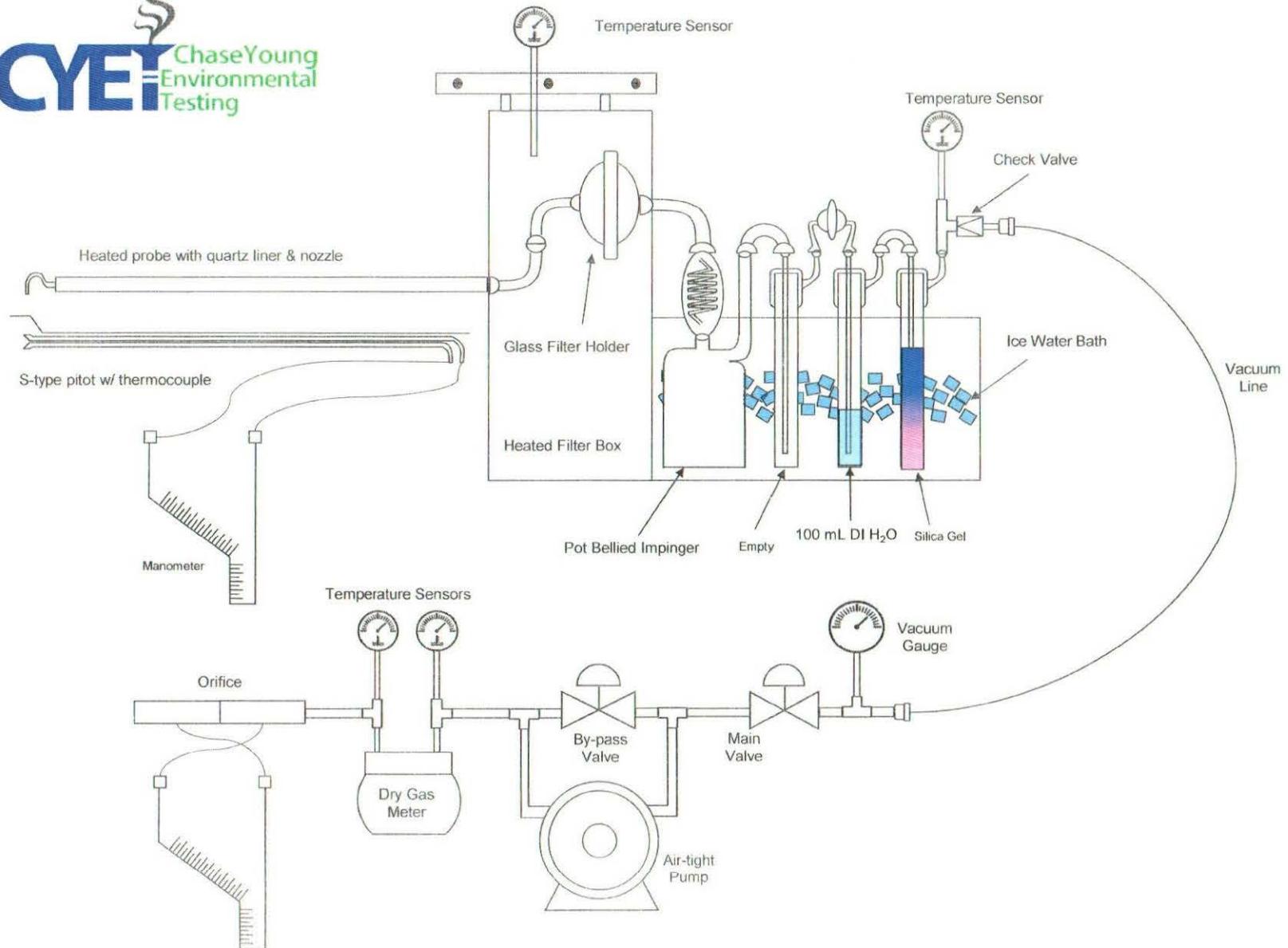
**Figure 3**  
**Combined Boiler Stack Exhaust Stack Diagram**



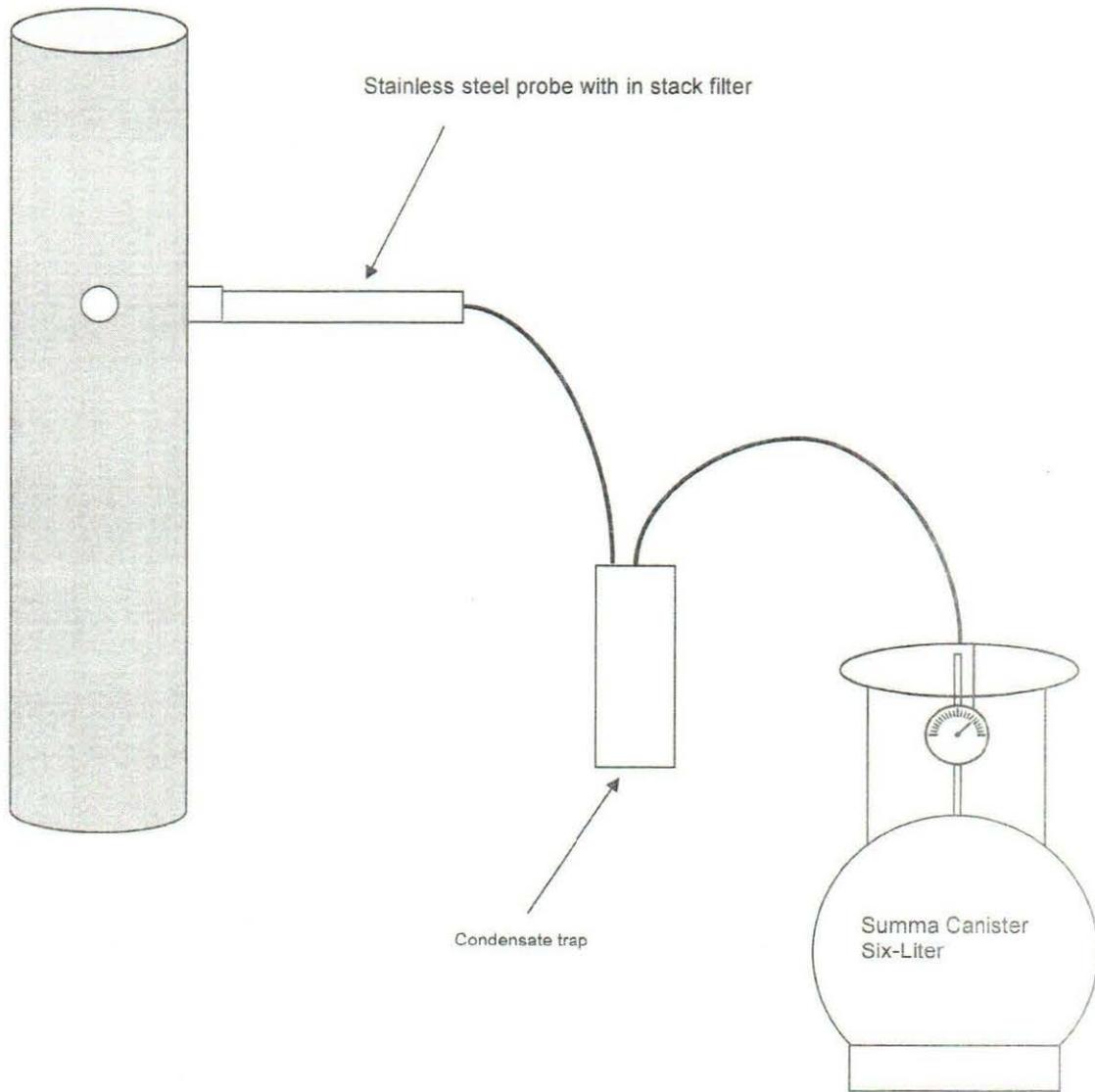
**Figure 4**  
USEPA Method 3A/6C/7E/10 Sampling Train



**Figure 5**  
**USEPA Method 25A Sampling Train**

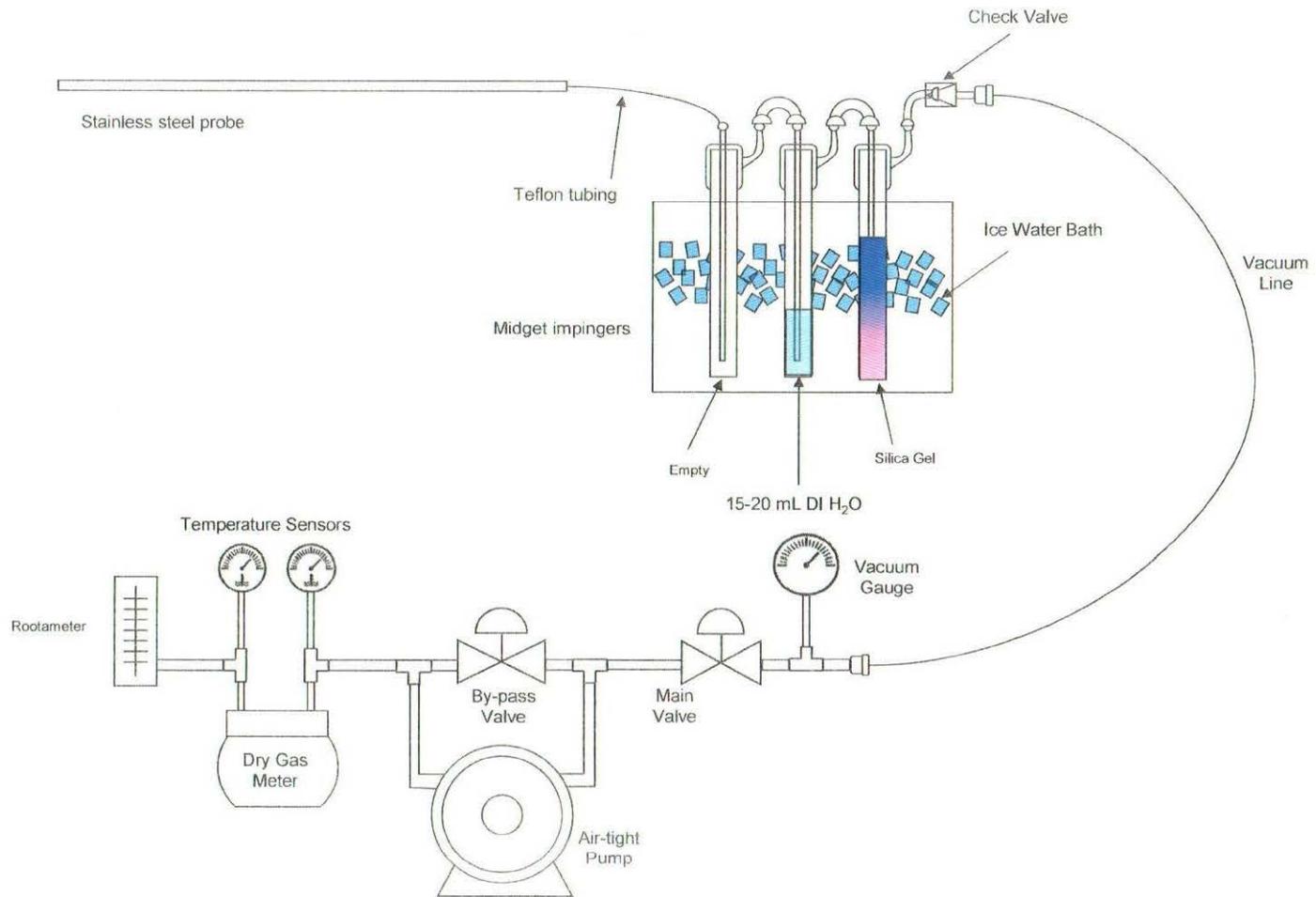


**Figure 6**  
USEPA Method 5/202 Sampling Train



Not to scale

**Figure 7**  
USEPA Method 25 Sampling Train



**Figure 8**  
USEPA Method 323 Sampling Train