Introduction

1.0 Introduction

Alliance Source Testing, LLC (AST) was retained by Sumpter Energy Associates, LLC (SEA) to conduct compliance testing at the SEA Pine Tree Acres (PTA) Phase II facility located in Lenox, Michigan. The facility operates under Michigan Department of Environment Great Lakes, and Energy-Air Quality Division (EGLE-AQD), MI-PTI-N5984-2019. Testing was conducted on two (2) engines to demonstrate compliance with the facility's EGLE-AQD permit and 40 CFR 60 Subpart JJJJ.

Compliance testing was conducted to determine the concentration and emission rates of nitrogen oxides (NOx), carbon monoxide (CO) and non-methane-ethane volatile organic compounds (NMEVOC). Testing consisted of three (3) 60-minute test runs for each source. Performance testing was conducted while the engines were operating at the highest achievable load at current site conditions. The Test Report Summary (TRS) provides the results from the compliance testing, including the three (3) run average, with comparisons to the applicable limits. Any difference between the summary results listed in the TRS and the detailed results contained in the appendices is due to rounding for presentation.

1.1 Facility and Process Description

The SEA PTA Phase II facility consists of two (2) Caterpillar (CAT®) Model No. 3520C landfill gas fueled reciprocating internal combustion engines (RICE) that are identified in ROP No. MIROP-N5984-2019 as Emission Unit ID: EU-ICENGINE8 and EU-ICENGINE9 (Flexible Group ID: FG-ICENGINE2).

The CAT G3520C IC engines are operated at base load conditions (i.e., 100% of design capacity). The amount of landfill gas that is used by each engine is dependent on its methane content. At the minimum fuel quality utilization value of 420 Btu/cf (LHV), the maximum fuel use rate of each IC engine is approximately 580 cfm. The CAT® G3520C IC engine will be tested while operations occur at (or near + 10% of design capacity) the following power generation and fuel use rates:

- Engine Power: 2,242 brake horsepower
- Electricity Generation: 1,600 kilowatts
- Heat Input (LHV): 14.67 MMBtu/hr

The CAT® G3520 IC engines use an electronic air-to-fuel ratio controller to fire lean fuel mixtures and produce low combustion by-product emissions. Emissions from the combustion of LFG are released into the ambient air through a stack connected to the IC engine exhaust manifold and noise muffler.

1.2 Project Team

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

Table 1-1
Project Team

Facility Personnel	Rick Covell – Aria Energy
AST Personnel	Aaron Blum Zachary Wood

1.3 Test Protocol and Notification

Testing was conducted in accordance with the test protocol submitted to the EGLE-AQD on October 23, 2020.

Testing Methodology

2.0 Testing Methodology

The emissions testing program was conducted in accordance with the U.S. EPA Reference Test Methods listed in Table 2-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix C.

Table 2-1
Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1 & 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Moisture Content	4	Volumetric / Gravimetric Analysis
Nitrogen Oxides	7E	Instrumental Analysis
Carbon Monoxide	10	Instrumental Analysis
Non-Methane Volatile Organic Compounds	ALT 096	Instrumental Analysis
Gas Dilution System Certification	205	--

2.1 U.S. EPA Reference Test Methods 1 & 2 – Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-2 in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

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

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3A. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, heated Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. The quality control measures are described in Section 2.8.

2.3 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. The impingers were pre and post-measured to determine the amount of moisture condensed during each test run.

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

The nitrogen oxides (NOx) testing was conducted in accordance with U.S. EPA Reference Test Method 7E. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless steel probe, heated Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. The quality control measures are described in Section 2.8.

2.5 U.S. EPA Reference Test Method 10 – Carbon Monoxide

The carbon monoxide (CO) testing was conducted in accordance with U.S. EPA Reference Test Method 10. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless steel probe, heated Teflon sample line(s), gas conditioning system, and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the gas. The quality control measures are described in Section 2.8.

2.6 U.S. EPA Reference Test Method ALT-096 – Non Methane Hydrocarbons

The non-methane volatile organic compounds (NMVOC) testing was conducted in accordance with U.S. EPA Alternate Test Method ALT-096. EPA Method 25A is incorporated by reference. The sampling system consisted of a stainless steel probe, heated Teflon sample line(s) and the Thermo 55i analyzer. The quality control measures are described in Section 2.9.

2.7 U.S. EPA Reference Test Method 205 – Gas Dilution System Certification

A calibration gas dilution system field check was conducted in accordance with U.S. EPA Reference Method 205. Multiple dilution rates and total gas flow rates were utilized to force the dilution system to perform two dilutions on each mass flow controller. The diluted calibration gases were sent directly to the analyzer, and the analyzer response recorded in an electronic field data sheet. The analyzer response agreed within 2% of the actual diluted gas concentration. A second Protocol 1 calibration gas, with a cylinder concentration within 10% of one of the gas divider settings described above, was introduced directly to the analyzer, and the analyzer response recorded in an electronic field data sheet. The cylinder concentration and the analyzer response agreed within 2%. These steps were repeated three (3) times. Copies of the Method 205 data can be found in the Quality Assurance/Quality Control Appendix.

2.8 Quality Assurance/Quality Control – U.S. EPA Reference Methods 3A, 7E and 10

Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

Low Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low Level gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the Mid Level gas. Next, High Level gas was introduced directly to the analyzer, and the response recorded when it was stable. All values were within 2.0 percent of the Calibration Span or 0.5 ppmv absolute difference.

High or Mid Level gas (whichever was closer to the stack gas concentration) was introduced at the probe and the time required for the analyzer reading to reach 95 percent or 0.5 ppm (whichever was less restrictive) of the gas concentration was recorded. The analyzer reading was observed until it reached a stable value, and this value was recorded. Next, Low Level gas was introduced at the probe and the time required for the analyzer reading to decrease to a value within 5.0 percent or 0.5 ppm (whichever was less restrictive) was recorded. If the Low Level gas was zero gas, the response was 0.5 ppm or 5.0 percent of the upscale gas concentration (whichever was less restrictive). The analyzer reading was observed until it reached a stable value and this value was recorded. The measurement system response time and initial system bias were determined from these data. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv absolute difference

High or Mid Level gas (whichever was closer to the stack gas concentration) was introduced at the probe. After the analyzer response was stable, the value was recorded. Next, Low Level gas was introduced at the probe, and the analyzer value recorded once it reached a stable response. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv absolute difference or the data was invalidated and the Calibration Error Test and System Bias were repeated. Drift between pre- and post-run System Bias was within 0.5 ppmv absolute difference or the Calibration Error Test and System Bias were repeated.

To determine the number of sampling points, a gas stratification check was conducted prior to initiating testing. The pollutant concentrations were measured at three points (16.7, 50.0 and 83.3 percent of the measurement line). Each traverse point was sampled for a minimum of twice the system response time. The pollutant concentration at each traverse point did not differ more than 5% or 0.5 ppm (whichever was less restrictive) of the average pollutant concentration. Therefore, single point sampling was conducted during the test runs. Copies of stratification check data can be found in the Quality Assurance/Quality Control Appendix.

An NO_2 – NO converter check was performed on the analyzer prior to initiating testing. An approximately 50 ppm nitrogen dioxide cylinder gas was introduced directly to the NOx analyzer and the instrument response was recorded in an electronic data sheet. The instrument response was within +/- 10 percent of the cylinder concentration.

A Data Acquisition System with battery backup was used to record the instrument response in one (1) minute averages. The data was continuously stored as a *.CSV file in Excel format on the hard drive of a computer. At the completion of testing, the data was also saved to the AST server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at AST's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.

2.9 Quality Assurance/Quality Control – U.S. EPA Reference Method ALT-096

EPA Protocol 1 Calibration Gases – Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

Zero gas was introduced through the sampling system to the analyzer. After adjusting the analyzer to the Zero gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High Level gas, and the time required for the analyzer reading to reach 95 percent of the gas concentration was recorded to determine the response time. Next, Mid and Low Level gases were introduced through the sampling system to the analyzer, and the response was recorded when it was stable. All values were within +/- 5% of the calibration gas concentrations.

Post Test Drift Checks – Mid Level gas was introduced through the sampling system. After the analyzer response was stable, the value was recorded. Next, Zero gas was introduced through the sampling system, and the analyzer value recorded once it reached a stable response. The Analyzer Drift was less than 3 percent of the Calibration Span.

Data Collection – A Data Acquisition System with battery backup was used to record the instrument response (analog 0-10 volt signal) in one (1) minute averages. The data was continuously stored as a *.CSV file in Excel format on the hard drive of a desktop computer. At the completion of the emissions testing the data was also saved to disk.

Appendix A

Location: Sumpter Energy Associates, LLC - Pine Tree Acres
Source: Engine No. 8
Project No.: 2020-1866
Run No. /Method: Run 1 / Method 10

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

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

where,

C_{obs}	733.1	= average analyzer value during test, ppmvd
C_o	0.2	= average of pretest & posttest zero responses, ppmvd
C_{MA}	1250.0	= actual concentration of calibration gas, ppmvd
C_M	1254.4	= average of pretest & posttest calibration responses, ppmvd
C_{CO}	730.5	= CO Concentration, ppmvd

CO - Outlet Concentration (C_{COc15}), ppmvd @ 15% O_2

$$C_{COc15} = C_{CO} \times \left(\frac{20.9 - 15}{20.9 - O_2} \right)$$

where,

C_{CO}	730.5	= CO - Outlet Concentration, ppmvd
C_{O_2}	8.7	= oxygen concentration, %
C_{COc15}	352.2	= ppmvd @15% O_2

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

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

where,

C_{CO}	730.5	= CO - Outlet Concentration, ppmvd
MW	28.01	= CO molecular weight, g/g-mole
Qs	3,294	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{CO}	10.5	= lb/hr

CO - Outlet Emission Rate (ER_{COTPY}), ton/yr

$$ER_{COTPY} = \frac{ER_{CO} \times 8{,}760 \frac{hr}{yr}}{2{,}000 \frac{lb}{ton}}$$

where,

ER_{CO}	10.5	= CO - Outlet Emission Rate, lb/hr
ER_{COTPY}	46.0	= ton/yr

CO - Outlet Emission Factor (EF_{CO}), g/hp-hr

$$EF_{CO} = \frac{ER_{CO} \times 454 \frac{g}{lb}}{EBW}$$

where,

ER_{CO}	10.5	= CO - Outlet Emission Rate, lb/hr
EBW	2,197	= engine brake work, HP
EF_{CO}	2.2	= g/hp-hr

Alliance SOURCE TESTING

Location: Sumpter Energy Associates, LLC - Pine Tree Acres
Source: Engine No. 8
Project No.: 2020-1866
Run No. /Method: Run 1 / Method 7E

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

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

where,

C_{obs}	36.6	= average analyzer value during test, ppmvd
C_o	0.1	= average of pretest & posttest zero responses, ppmvd
C_{MA}	100.0	= actual concentration of calibration gas, ppmvd
C_M	99.9	= average of pretest & posttest calibration responses, ppmvd
C_{NOx}	36.6	= NOx Concentration, ppmvd

NOx - Outlet Concentration (C_{NOxc15}), ppmvd @ 15% O_2

$$C_{NOxc15} = C_{NOx} \times \left(\frac{20.9 - 15}{20.9 - O_2} \right)$$

where,

C_{NOx}	36.6	= NOx - Outlet Concentration, ppmvd
C_{O_2}	8.7	= oxygen concentration, %
C_{NOxc15}	17.7	= ppmvd @15% O_2

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

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

where,

C_{NOx}	36.6	= NOx - Outlet Concentration, ppmvd
MW	46.055	= NOx molecular weight, g/g-mole
Qs	3,294	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{NOx}	0.86	= lb/hr

NOx - Outlet Emission Rate (ER_{NOxTPY}), ton/yr

$$ER_{NOxTPY} = \frac{ER_{NOx} \times 8{,}760 \frac{hr}{yr}}{2{,}000 \frac{lb}{ton}}$$

where,

ER_{NOx}	0.86	= NOx - Outlet Emission Rate, lb/hr
ER_{NOxTPY}	3.8	= ton/yr

NOx - Outlet Emission Factor (EF_{NOx}), g/hp-hr

$$EF_{NOx} = \frac{ER_{NOx} \times 454 \frac{g}{lb}}{EBW}$$

where,

ER_{NOx}	0.86	= NOx - Outlet Emission Rate, lb/hr
EBW	2,197	= engine brake work, HP
EF_{NOx}	0.18	= g/hp-hr

Alliance SOURCE TESTING

Location: Sumpter Energy Associates, LLC - Pine Tree Acres
Source: Engine No. 8
Project No.: 2020-1866
Run No. /Method: Run 1 / Method Alt-096

NMHC - Outlet Concentration (CNMHC), ppmvd

$$CNMHC = \frac{CNMHCw}{1 - BWS}$$

where,

CNMHCw	25.9	= NMHC - Outlet Concentration, ppmvw
BWS	0.114	= moisture fraction, unitless
CNMHC	29.3	= ppmvd

NMHC - Outlet Concentration (CNMHCc15), ppmvd @ 15% O_2

$$CNMHCc15 = CNMHC \times \left(\frac{20.9 - 15}{20.9 - O_2}\right)$$

where,

CNMHC	29.3	= NMHC - Outlet Concentration, ppmvd
C_{O_2}	8.7	= oxygen concentration, %
CNMHCc15	14.1	= ppmvd @15% O_2

NMHC - Outlet Emission Rate (ERNMHC), lb/hr

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

where,

CNMHC	29.3	= NMHC - Outlet Concentration, ppmvd
MW	44.1	= NMHC molecular weight, g/g-mole
Qs	3,294	= stack gas volumetric flow rate at standard conditions
ERNMHC	0.66	= lb/hr

NMHC - Outlet Emission Rate (ERNMHCTPY), ton/yr

$$ERNMHCTPY = \frac{ERNMHC \times 8,760\frac{hr}{yr}}{2,000\frac{lb}{ton}}$$

where,

ERNMHC	0.66	= NMHC - Outlet Emission Rate, lb/hr
ERNMHCTPY	2.9	= ton/yr

NMHC - Outlet Emission Factor (EFNMHC), g/hp-hr

$$EFNMHC = \frac{ERNMHC \times 454\frac{g}{lb}}{EBW}$$

where,

ERNMHC	0.66	= NMHC - Outlet Emission Rate, lb/hr
EBW	2,197	= engine brake work, HP
EFNMHC	0.14	= g/hp-hr

Alliance SOURCE TESTING

Location	Sumpter Energy Associates, LLC - Pine Tree Acres
Source	Engine No. 8
Project No.	2020-1866
Run No.	1
Parameter(s)	VFR

Meter Pressure (Pm), in. Hg

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

where,

Pb	30.07	= barometric pressure, in. Hg
ΔH	1.000	= pressure differential of orifice, in H_2O
Pm	30.14	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

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

where,

Pb	30.07	= barometric pressure, in. Hg
Pg	9.50	= static pressure, in. H_2O
Ps	30.77	= in. Hg

Standard Meter Volume (Vmstd), dscf

$$Vmstd = \frac{17.647 \times Vm \times Pm}{Tm}$$

where,

Y	1.002	= meter correction factor
Vm	31.790	= meter volume, cf
Pm	30.14	= absolute meter pressure, in. Hg
Tm	518.8	= absolute meter temperature, °R
Vmstd	32.658	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04707 \times Vlc$$

where,

Vlc	89.4	= volume of H2O collected, ml
Vwstd	4.215	= scf

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

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

where,

Ts	908.3	= stack temperature, °F
Ps	30.8	= absolute stack gas pressure, in. Hg
BWSsat	458.4	= dimensionless

Moisture Fraction (BWS), dimensionless

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

where,

Vwstd	4.215	= standard wet volume, scf
Vmstd	32.658	= standard meter volume, dscf
BWS	0.114	= dimensionless

Moisture Fraction (BWS), dimensionless

$$BWS = BWSmsd \ \ unless \ \ BWSsat < BWSmsd$$

where,

BWSsat	458.397	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.114	= moisture fraction (measured)
BWS	0.114	

Molecular Weight (DRY) (Md), lb/lb-mole

$$Md = (0.44 \times \% CO_2) + (0.32 \times \% O_2) + (0.28 (100 - \% CO_2 - \% O_2))$$

where,

CO2	9.9	= carbon dioxide concentration, %
O2	8.7	= oxygen concentration, %
Md	29.93	= lb/lb mol

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

$$Ms = Md (1 - BWS) + 18 (BWS)$$

where,

Md	29.93	= molecular weight (DRY), lb/lb mol
BWS	0.114	= moisture fraction, dimensionless
Ms	28.57	= lb/lb mol

Alliance SOURCE TESTING

Location	**Sumpter Energy Associates, LLC - Pine Tree Acres**
Source	**Engine No. 8**
Project No.	**2020-1866**
Run No.	**1**
Parameter(s)	**VFR**

Average Velocity (Vs), ft/sec

$$Vs = 85.49 \times Cp \times (\Delta P^{1/2})\,avg \times \sqrt{\frac{Ts}{Ps \times Ms}}$$

where,

Cp	0.84	= pitot tube coefficient
$\Delta P^{1/2}$	1.891	= average pre/post test velocity head of stack gas, $(in.\ H2O)^{1/2}$
Ts	1368.3	= average pre/post test absolute stack temperature, °R
Ps	30.77	= absolute stack gas pressure, in. Hg
Ms	28.57	= molecular weight of stack gas, lb/lb mol
Vs	169.4	= ft/sec

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

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

where,

Vs	169.4	= stack gas velocity, ft/sec
As	0.92	= cross-sectional area of stack, ft^2
Qa	9,371	= acfm

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

$$Qsd = 17.647 \times Qa \times (1 - BWS) \times \frac{Ps}{Ts}$$

where,

Qa	9,371	= average stack gas flow at stack conditions, acfm
BWS	0.114	= moisture fraction, dimensionless
Ps	30.77	= absolute stack gas pressure, in. Hg
Ts	1368.3	= average pre/post test absolute stack temperature, °R
Qs	3,294	= dscfm

Dry Gas Meter Calibration Check (Yqa), dimensionless

$$Yqa = \frac{Y - \left(\frac{\Theta}{Vm} \sqrt{\frac{0.0319 \times Tm \times 29}{\Delta H@ \times \left(Pb + \frac{\Delta H\ avg.}{13.6} \right) \times Md}} \sqrt{\Delta H}\ avg. \right)}{Y} \times 100$$

where,

Y	1.002	= meter correction factor, dimensionless
Θ	60	= run time, min.
Vm	31.79	= total meter volume, dcf
Tm	518.8	= absolute meter temperature, °R
ΔH@	1.93	= orifice meter calibration coefficient, in. H_2O
Pb	30.07	= barometric pressure, in. Hg
ΔH avg	1.000	= average pressure differential of orifice, in H_2O
Md	29.93	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.000	= average squareroot pressure differential of orifice, $(in.\ H_2O)^{1/2}$
Yqa	1.1	= dimensionless

Appendix B

Location Sumpter Energy Associates, LLC - Pine Tree Acres
Source Engine No. 8
Project No. 2020-1866

Run Number		Run 1	Run 2	Run 3	Average
Date		12/8/20	12/8/20	12/8/20	--
Start Time		8:18	9:48	11:28	--
Stop Time		9:18	10:48	12:28	--
Engine Data					
Engine Manufacturer		Caterpillar			
Engine Model		G3520C			
Engine Serial Number		GZJ00189			
Engine Type		Spark Ignition - 4SLB			
Engine Date of Manufacturer	DOM	7/25/2005			
Engine Hour Meter Reading	EMR	86,199			
Generator Output, Hz	Gen OP	60	60	60	60
Engine Speed, RPM	ES	1,200	1,200	1,200	1,200
Engine Brake Work, HP	EBW	2,197	2,197	2,197	2,197
Maximum Engine Brake Work, HP	MaxEBW	2,242	2,242	2,242	2,242
Engine Load, %	EL	98	98	98	98
Fuel Factor (O2 dry), dscf/MMBtu	Fd	8,710	8,710	8,710	8,710
Fuel Rate, scfh	F_R	34,956	35,244	34,932	35,044
Ambient Temperature	T_{Amb}	21	28	34	28
Realtive Humidity, %	RH	98	81	74	84
Barometric Pressure, in. Hg	Pb	30.07	30.07	30.05	30.06
Input Data - Outlet					
Moisture Fraction, dimensionless	BWS	0.114	0.104	0.097	0.105
Volumetric Flow Rate (M1-4), dscfm	Qs	3,294	3,095	3,152	3,180
Calculated Data - Outlet					
O_2 Concentration, % dry	C_{O_2}	8.66	8.54	8.61	8.61
CO_2 Concentration, % dry	C_{CO_2}	9.87	9.52	11.09	10.16
CO Concentration, ppmvd	C_{CO}	730.5	797.7	786.0	771.4
CO Concentration, ppmvd @ 15 % O_2	C_{COc15}	352.2	380.7	377.5	370.1
CO Emission Rate, lb/hr	ER_{CO}	10.5	10.8	10.8	10.7
CO Emission Rate, ton/yr	ER_{COTPY}	46.0	47.2	47.3	46.8
CO Emission Factor, g/HP-hr	EF_{CO}	2.2	2.2	2.2	2.2
NOx Concentration, ppmvd	C_{NOx}	36.6	44.0	38.9	39.8
NOx Concentration, ppmvd @ 15 % O_2	C_{NOxc15}	17.7	21.0	18.7	19.1
NOx Emission Rate, lb/hr	ER_{NOx}	0.86	0.98	0.88	0.91
NOx Emission Rate, ton/yr	ER_{NOxTPY}	3.8	4.3	3.9	4.0
NOx Emission Factor, g/HP-hr	EF_{NOx}	0.18	0.20	0.18	0.19
NMHC (as C3H8) Concentration, ppmvd	C_{NMHC}	29.3	29.4	28.3	29.0
NMHC (as C3H8) Concentration, ppmvw	C_{NMHCw}	25.9	26.1	25.1	25.7
NMHC (as C3H8) Concentration, ppmvd @ 15 % O_2	$C_{NMHCc15}$	14.1	14.0	13.6	13.9
NMHC (as C3H8) Emission Rate, lb/hr	ER_{NMHC}	0.66	0.63	0.61	0.63
NMHC (as C3H8) Emission Rate, ton/yr	$ER_{NMHCTPY}$	2.9	2.7	2.7	2.8
NMHC (as C3H8) Emission Factor, g/HP-hr	EF_{NMHC}	0.14	0.13	0.13	0.13

Run 1 - CEMS Data

Location: Sumpter Energy Associates, LLC - Pine Tree Acres
Source: Engine No. 8
Project No.: 2020-1866
Date: 12/8/20

Time Unit Status	O_2 - Outlet % dry Valid	CO_2 - Outlet % dry Valid	CO - Outlet ppmvd Valid	NOx - Outlet ppmvd Valid	NMHC - Outlet ppmvw Valid
8:18	8.75	9.99	744.50	37.45	23.42
8:19	8.73	10.01	744.44	37.58	25.60
8:20	8.75	10.00	743.97	37.53	25.08
8:21	8.75	9.99	743.31	36.73	24.69
8:22	8.78	9.97	742.90	33.75	26.74
8:23	8.73	10.00	741.54	36.50	25.41
8:24	8.71	10.01	740.08	37.18	24.37
8:25	8.74	9.99	739.49	37.11	27.02
8:26	8.74	9.98	739.41	36.04	26.55
8:27	8.74	9.98	739.30	36.41	27.93
8:28	8.74	9.97	739.57	35.86	26.18
8:29	8.73	9.98	740.26	37.40	26.70
8:30	8.75	9.96	740.64	35.36	27.57
8:31	8.72	9.97	739.09	33.96	25.89
8:32	8.68	9.99	737.54	38.09	26.99
8:33	8.68	9.99	737.40	38.47	26.46
8:34	8.71	9.98	736.36	36.85	25.30
8:35	8.69	9.98	734.40	37.47	25.83
8:36	8.69	9.99	734.35	37.83	26.20
8:37	8.71	9.97	734.49	36.77	26.18
8:38	8.69	9.99	732.51	37.66	25.97
8:39	8.68	9.98	731.51	38.31	25.65
8:40	8.71	9.96	731.83	39.38	25.43
8:41	8.71	9.96	732.83	38.18	25.58
8:42	8.71	9.96	733.58	38.27	26.16
8:43	8.70	9.96	735.20	37.08	26.61
8:44	8.64	10.00	735.85	36.30	25.50
8:45	8.63	10.00	733.66	37.24	24.11
8:46	8.65	9.99	731.78	36.16	25.32
8:47	8.63	10.00	730.46	35.49	25.73
8:48	8.70	9.95	727.67	33.00	26.32
8:49	8.68	9.95	726.08	32.28	25.25
8:50	8.64	9.97	725.68	33.59	26.39
8:51	8.58	10.01	724.79	35.73	26.14
8:52	8.58	10.02	724.51	36.24	26.52
8:53	8.57	10.01	725.18	37.30	25.44
8:54	8.59	9.99	726.99	36.86	25.50
8:55	8.59	9.99	728.82	37.52	25.41
8:56	8.64	9.95	730.86	36.70	25.67
8:57	8.61	9.96	732.14	39.07	25.77
8:58	8.58	9.97	733.58	38.47	26.30
8:59	8.62	9.95	732.95	36.08	26.19
9:00	8.65	9.92	732.41	36.04	26.25
9:01	8.62	9.93	732.56	36.96	26.61
9:02	8.65	9.91	732.92	34.07	26.40
9:03	8.64	9.91	732.38	36.19	26.08
9:04	8.62	9.91	734.66	37.18	26.57
9:05	8.59	9.92	735.19	37.59	27.05
9:06	8.62	9.91	733.74	36.87	26.30
9:07	8.61	9.90	732.19	36.82	25.28
9:08	8.66	9.86	730.51	35.30	25.66
9:09	8.62	9.87	727.12	38.59	25.54
9:10	8.68	9.83	726.11	36.35	26.89
9:11	8.69	9.82	724.85	35.85	25.38
9:12	8.71	9.80	724.45	36.63	25.51
9:13	8.69	9.80	725.19	36.02	25.89
9:14	8.68	9.80	726.28	36.62	26.38
9:15	8.72	9.77	724.77	35.81	25.14
9:16	8.76	9.74	725.00	35.55	25.55
9:17	8.72	9.75	726.21	37.13	26.46

Parameter	O_2 - Outlet	CO_2 - Outlet	CO - Outlet	NOx - Outlet	NMHC - Outlet
Uncorrected Run Average (C_{obs})	8.7	9.9	733.1	36.6	25.9
Cal Gas Concentration (C_{MA})	10.0	10.0	1,250.0	100.0	40.0
Pretest System Zero Response	0.07	0.04	0.21	0.11	0.00
Posttest System Zero Response	0.07	0.04	0.21	0.11	0.00
Average Zero Response (Co)	0.1	0.0	0.2	0.1	0.0
Pretest System Cal Response	10.02	10.07	1,251.20	99.81	39.97
Posttest System Cal Response	10.02	10.07	1,251.20	99.81	39.97
Average Cal Response (C_M)	10.0	10.1	1,254.4	99.9	39.9
Corrected Run Average (Corr)	8.7	9.9	730.5	36.6	NA

Alliance SOURCE TESTING

Location: Sumpter Energy Associates, LLC - Pine Tree Acres
Source: Engine No. 8
Project No.: 2020-1866
Date: 12/8/20

Time Unit Status	O_2 - Outlet % dry Valid	CO_2 - Outlet % dry Valid	CO - Outlet ppmvd Valid	NOx - Outlet ppmvd Valid	NMHC - Outlet ppmvw Valid
9:48	8.50	9.61	792.87	41.62	23.83
9:49	8.52	9.60	792.31	41.29	25.26
9:50	8.50	9.60	793.00	41.40	25.31
9:51	8.53	9.58	792.42	39.21	25.45
9:52	8.51	9.59	792.48	40.46	25.16
9:53	8.49	9.60	793.43	42.35	25.53
9:54	8.56	9.56	795.17	39.42	25.76
9:55	8.52	9.58	794.37	42.03	25.25
9:56	8.50	9.59	793.84	43.28	25.50
9:57	8.56	9.55	795.07	41.74	25.62
9:58	8.52	9.57	794.62	39.61	25.10
9:59	8.49	9.59	793.11	42.63	26.44
10:00	8.49	9.59	794.02	41.20	25.95
10:01	8.53	9.56	794.46	40.04	25.55
10:02	8.51	9.57	793.40	41.44	25.68
10:03	8.63	9.50	794.32	36.29	25.62
10:04	8.54	9.54	795.20	38.39	26.87
10:05	8.53	9.55	795.20	38.20	26.95
10:06	8.56	9.53	794.57	40.34	25.96
10:07	8.58	9.52	795.17	43.70	26.12
10:08	8.62	9.49	796.10	41.15	26.28
10:09	8.53	9.53	797.15	45.35	26.44
10:10	8.53	9.53	797.84	44.78	26.61
10:11	8.50	9.56	798.83	42.70	25.99
10:12	8.47	9.58	798.61	42.08	25.90
10:13	8.46	9.59	795.77	43.05	25.88
10:14	8.47	9.58	793.22	43.47	25.64
10:15	8.49	9.56	792.02	41.49	25.65
10:16	8.50	9.55	791.37	43.81	25.25
10:17	8.56	9.51	791.25	41.96	26.48
10:18	8.51	9.53	792.18	43.91	25.73
10:19	8.56	9.50	793.11	44.13	26.07
10:20	8.51	9.52	794.72	45.73	25.53
10:21	8.51	9.51	796.46	45.20	26.05
10:22	8.49	9.51	798.18	46.35	26.10
10:23	8.50	9.50	800.35	47.78	25.85
10:24	8.53	9.48	802.42	45.89	25.47
10:25	8.52	9.47	803.06	46.60	25.47
10:26	8.52	9.47	804.66	47.64	26.09
10:27	8.58	9.44	805.54	46.42	26.13
10:28	8.52	9.47	806.62	48.41	26.36
10:29	8.54	9.46	807.64	48.63	27.05
10:30	8.55	9.45	809.37	47.16	26.44
10:31	8.56	9.45	809.53	45.79	26.84
10:32	8.57	9.44	811.06	46.64	26.82
10:33	8.60	9.43	813.16	44.02	26.39
10:34	8.52	9.47	814.53	46.26	26.44
10:35	8.58	9.44	813.77	43.28	27.77
10:36	8.54	9.46	813.38	46.54	26.28
10:37	8.64	9.41	812.84	41.62	26.53
10:38	8.51	9.48	813.02	44.53	26.30
10:39	8.49	9.49	811.32	46.26	27.57
10:40	8.52	9.48	810.35	44.52	25.74
10:41	8.49	9.50	809.98	46.68	26.21
10:42	8.69	9.38	809.30	39.06	25.83
10:43	8.54	9.46	809.23	46.41	28.30
10:44	8.52	9.48	808.72	47.11	27.90
10:45	8.51	9.49	809.62	49.32	26.44
10:46	8.53	9.48	809.91	49.74	26.03
10:47	8.51	9.49	811.92	49.87	26.08

Parameter	O_2 - Outlet	CO_2 - Outlet	CO - Outlet	NOx - Outlet	NMHC - Outlet
Uncorrected Run Average (C_{obs})	8.5	9.5	800.6	43.8	26.1
Cal Gas Concentration (C_{MA})	10.0	10.0	1,250.0	100.0	40.0
Pretest System Zero Response	0.05	0.04	0.09	0.02	0.00
Posttest System Zero Response	0.04	0.06	0.17	0.10	0.00
Average Zero Response (Co)	0.0	0.1	0.1	0.1	0.0
Pretest System Cal Response	9.99	10.07	1,257.51	99.96	39.73
Posttest System Cal Response	9.98	9.92	1,251.46	99.00	39.71
Average Cal Response (C_M)	10.0	10.0	1,254.5	99.5	39.7
Corrected Run Average (Corr)	8.5	9.5	797.7	44.0	NA

Run 3 - CEMS Data

Location: Sumpter Energy Associates, LLC - Pine Tree Acres
Source: Engine No. 8
Project No.: 2020-1866
Date: 12/8/20

Time Unit Status	O_2 - Outlet % dry Valid	CO_2 - Outlet % dry Valid	CO - Outlet ppmvd Valid	NOx - Outlet ppmvd Valid	NMHC - Outlet ppmvw Valid
11:28	8.59	10.87	798.52	38.85	25.03
11:29	8.58	10.87	797.97	39.53	25.26
11:30	8.58	10.86	797.53	38.06	25.36
11:31	8.57	10.87	795.70	38.20	25.54
11:32	8.57	10.87	792.55	36.75	25.31
11:33	8.59	10.86	789.91	36.83	25.17
11:34	8.57	10.88	788.74	39.41	25.29
11:35	8.59	10.87	787.48	37.22	25.27
11:36	8.60	10.86	786.85	37.67	24.86
11:37	8.60	10.86	787.36	36.48	25.49
11:38	8.57	10.89	787.24	36.97	25.24
11:39	8.56	10.90	786.80	38.32	24.87
11:40	8.56	10.90	786.10	37.58	24.59
11:41	8.58	10.89	784.57	35.12	24.61
11:42	8.56	10.90	781.25	36.21	24.72
11:43	8.54	10.92	780.34	36.82	25.40
11:44	8.54	10.92	779.61	36.09	24.78
11:45	8.54	10.92	778.88	37.26	24.60
11:46	8.56	10.91	779.94	37.10	25.14
11:47	8.55	10.92	781.09	36.29	24.97
11:48	8.52	10.94	781.10	38.23	24.73
11:49	8.56	10.92	781.21	36.77	24.67
11:50	8.57	10.91	781.41	37.16	24.73
11:51	8.61	10.88	781.15	37.26	24.85
11:52	8.61	10.87	780.85	34.83	25.08
11:53	8.58	10.90	779.56	36.19	25.52
11:54	8.56	10.91	779.02	39.15	25.47
11:55	8.53	10.93	779.56	36.63	24.74
11:56	8.55	10.93	778.60	38.37	24.71
11:57	8.58	10.90	780.89	39.35	24.58
11:58	8.60	10.88	783.85	36.77	24.55
11:59	8.58	10.90	784.65	38.52	25.14
12:00	8.56	10.91	784.79	39.63	25.26
12:01	8.57	10.90	787.32	39.26	25.12
12:02	8.58	10.89	786.81	38.04	24.37
12:03	8.58	10.89	786.56	37.90	25.05
12:04	8.61	10.87	787.44	39.94	25.14
12:05	8.64	10.84	789.06	38.34	24.70
12:06	8.66	10.82	790.66	38.38	25.19
12:07	8.67	10.81	792.32	40.43	25.57
12:08	8.68	10.80	795.13	38.96	25.22
12:09	8.61	10.84	796.43	40.53	25.69
12:10	8.64	10.83	796.58	39.41	25.24
12:11	8.61	10.85	795.92	39.75	24.53
12:12	8.62	10.84	794.27	37.11	24.83
12:13	8.62	10.84	790.68	39.26	25.33
12:14	8.63	10.84	788.70	40.14	25.46
12:15	8.61	10.85	787.47	37.93	25.05
12:16	8.61	10.85	785.42	38.23	24.90
12:17	8.62	10.84	784.62	38.77	25.06
12:18	8.58	10.87	787.40	40.01	25.31
12:19	8.58	10.86	789.16	41.63	25.44
12:20	8.57	10.87	790.81	43.25	24.76
12:21	8.59	10.85	793.49	41.29	25.39
12:22	8.58	10.85	794.88	42.12	25.12
12:23	8.59	10.84	794.93	43.57	25.48
12:24	8.58	10.85	795.30	44.25	24.69
12:25	8.62	10.82	795.14	44.57	24.94
12:26	8.64	10.79	794.81	44.81	25.00
12:27	8.66	10.78	795.13	42.91	25.20

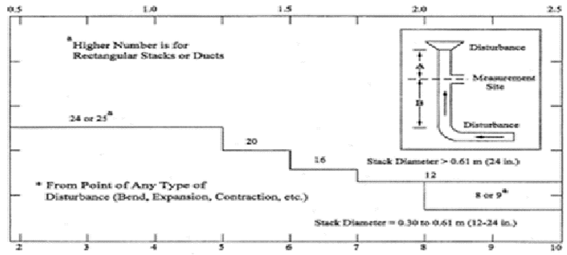
Parameter	O_2 - Outlet	CO_2 - Outlet	CO - Outlet	NOx - Outlet	NMHC - Outlet
Uncorrected Run Average (C_{obs})	8.6	10.9	787.9	38.8	25.1
Cal Gas Concentration (C_{MA})	10.0	10.0	1,250.0	100.0	40.0
Pretest System Zero Response	0.04	0.06	0.17	0.10	0.00
Posttest System Zero Response	0.04	0.01	0.08	0.18	0.00
Average Zero Response (Co)	0.0	0.0	0.1	0.1	0.0
Pretest System Cal Response	9.98	9.92	1,251.46	99.00	39.71
Posttest System Cal Response	9.95	9.70	1,254.15	99.87	39.84
Average Cal Response (C_M)	10.0	9.8	1,252.8	99.4	39.8
Corrected Run Average (Corr)	8.6	11.1	786.0	38.9	NA

Method 1 Data

Location	**Sumpter Energy Associates, LLC - Pine Tree Acres**
Source	**Engine No. 8**
Project No.	**2020-1866**
Date:	**12/08/20**

Stack Parameters

Duct Orientation:	Vertical		
Duct Design:	Circular		
Distance from Far Wall to Outside of Port:	16.00	in	
Nipple Length:	3.00	in	
Depth of Duct:	13.00	in	
Cross Sectional Area of Duct:	0.92	ft^2	
No. of Test Ports:	2		
Distance A:	5.5	ft	
Distance A Duct Diameters:	5.1	(must be > 0.5)	
Distance B:	12.0	ft	
Distance B Duct Diameters:	11.1	(must be > 2)	
Minimum Number of Traverse Points:	3		
Actual Number of Traverse Points:	3		
Measurer (Initial and Date):	ZGW		
Reviewer (Initial and Date):	AMB		



CIRCULAR DUCT

LOCATION OF STRATIFICATION POINTS											
	Number of traverse points on a diameter										
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

**Percent of stack diameter from inside wall to traverse point.*

Traverse Point	**% of Diameter**	**Distance from inside wall**	**Distance from outside of port**
1	16.7	2.17	5.17
2	50.0	6.50	9.50
3	83.3	10.83	13.83
4	--	--	--
5	--	--	--
6	--	--	--
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 5.5 ft.
B = 12 ft.
Depth of Duct = 13 in.

Cross Sectional Area