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EMISSION TEST REPORT

REGULATION(S): 40 CFR 60 SUBPART JJJ AND MDEQ PERMIT
POLLUTANT(S): CO, NOX, AND VOCS

ANR TRANSCANADA PIPELINE COMPANY
BLUE LAKE STORAGE COMPANY
KALKASKA COUNTY, MI

PERMIT NUMBER: MI-ROP-B7198-2014A
FRS# /EPA REGISTRY ID: 110013860526
SOURCE CLASSIFICATION CODE (SCC): 20200254

EMISSION SOURCE: SPARK-IGNITED ENGINE
4-STROKE/2-STROKE: 4-STROKE
RICH/LEAN BURN: LEAN BURN
MAKE & MODEL: CATERPILLAR G3516
UNIT NUMBER: BLGEN-A
SERIAL NUMBER: 3RC00646

RECEIVED
DEC 04 2017
AIR QUALITY DIVISION

TEST DATE: OCTOBER 4, 2017

	Permitted Limits				
	pounds / hour		g/BHP-hr		
Pollutant	Permitted	Emitted	Permitted	Emitted	PASS/FAIL
CO	1.6	0.01	1.4	0.01	PASS
NOx	5.7	1.94	2	1.4	PASS
VOCs	0.9	< 0.10	0.55	<0.100	PASS

Limits obtained from Permit MI-ROP-B7198-2014a.

The contents of this document relate only to the items tested. I certify under penalty of law that I believe the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for submitting false, inaccurate or incomplete information.

CECO TEST LEADER:

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724-961-3583

Revision History

Version	Revision Date	Comments
0	*original*	Original Version of Document.

Project Information

CECO Project No: 20171004-051-1

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Introduction

CECO Training & Technical Services, a division of Compressor Engineering Corporation, conducted source emission testing at ANR TransCanada Pipeline Company, Blue Lake Storage Company to fulfill the requirements of 40 CFR 60 Subpart JJJJ and MDEQ Permit No. MI-ROP-B7198-2014A. This report details the test purpose, objectives, testing procedures, sampling and analysis methodology, and results of the source testing conducted on October 4, 2017.

Process Description

The following source was tested:

- Unit Number (BLGEN-A) SN 3RC00646 – one (1) Caterpillar G3516 natural gas-fired, 4-Stroke, Lean Burn internal combustion engine, rated to 1125 brake horsepower (BHP) at 1200 revolutions per minute (RPM). This source is equipped with Oxidation Catalyst w/AFR for emission control and drive a generator.

Test Purpose and Objectives

The purpose of this test was to fulfill the requirements of 40 CFR 60 Subpart JJJJ and MDEQ Permit No. The objective of this test was to conduct the required three (3) 60-minute test runs to measure the applicable emission species at the maximum achievable load.

Results

		Test Run			
		1st	2nd	3rd	Average
Fuel					
HHV (BTU/SCF)		1012			
LHV (BTU/SCF)		915			
F-factor (DSCF/MMBTU)		8613			
Test Date & Time					
Date		10/4/2017	10/4/2017	10/4/2017	
Start Time		2:51 PM	4:13 PM	5:26 PM	
End Time		3:51 PM	5:13 PM	6:26 PM	
Interval (minutes)		60	60	60	60
Measured Concentrations (bias-corrected where applicable)					
O_2 (%vd)		8.27	8.02	8.27	8.19
CO (ppmvd)		2.9	0.1	0.8	1.3
NOx (ppmvd)		214.7	212.6	159.0	195.4
VOCs (ppmvd)		-37.6	-49.1	-43.9	-43.5
THC (ppmvd)		412.8	403.0	419.4	411.7
Operating Conditions					
Engine Horsepower (BHP)		656	621	666	647
Torque Load (%)		58.3	55.2	59.2	57.6
Engine Speed (RPM)		1200	1200	1200	1200
Fuel Flow Rate (SCFH)		5610	5593	6373	5859
BSFC (BTU/BHP/hr), LHV		7835	8244	8763	8281
Fuel BTU Consumption (MMBTU/hr)		5.68	5.66	6.45	5.93
Exhaust Flow Rate (SCFH)		80930	79123	91942	83998
Exhaust Flow Rate (SCFM)		1348.8	1318.7	1532.4	1400.0
Calculated Emissions					
CO	(lb/hr)	0.0171	0.0006	0.0053	0.0077
	(ton/year)	0.0747	0.0025	0.0234	0.0335
	(g/BHP-hr)	0.0118	0.0004	0.0036	0.0053
	(ppmvd at 15% O_2)	1.3547	0.0458	0.3737	0.5914
NOx	(lb/hr)	2.0736	2.0075	1.7446	1.9419
	(ton/year)	9.0824	8.7928	7.6414	8.5055
	(g/BHP-hr)	1.4348	1.4661	1.1885	1.3631
	(ppmvd at 15% O_2)	100.2953	97.3866	74.2755	90.6525
VOCs	(lb/hr)	< 0.1000	< 0.1000	< 0.1000	< 0.1000
	(ton/year)	< 1.0000	< 1.0000	< 1.0000	< 1.0000
	(g/BHP-hr)	< 0.1000	< 0.1000	< 0.1000	< 0.1000
	(ppmvd at 15% O_2)	< 1.0000	< 1.0000	< 1.0000	< 1.0000
THC	(lb/hr)	3.8215	3.6475	4.4109	3.9600
	(ton/year)	16.7382	15.9761	19.3198	17.3447
	(g/BHP-hr)	2.6442	2.6638	3.0050	2.7710
	(ppmvd at 15% O_2)	192.8361	184.6040	195.9192	191.1198

Methodology and Sampling Procedures

Methodology

Parameter	Sampling Method
Oxygen (O_2)	40 CFR 60, Appendix A, Method 3A
Oxides of Nitrogen (NO_X)	40 CFR 60, Appendix A, Method 7E
Carbon Monoxide (CO)	40 CFR 60, Appendix A, Method 10
Volumetric Exhaust Flow Rate	40 CFR 60, Appendix A, Method 19
Gas Dilution System	40 CFR 60, Appendix A, Method 205
Methane (CH_4) & Ethane (C_2H_6)	ASTM D6348
Total Hydrocarbons (THC)	40 CFR 60, Appendix A, Method 25A
Volatile Organic Compounds (VOCs)	40 CFR 60, Appendix A, Method 25A & ASTM F6348 Subtraction

VOCs via Method 25A

The following gasses were individually quantified on the Fourier Transfer Infrared Spectroscopy (FTIR) analyzer and summed on a propane basis to calculate total hydrocarbons (THC). Methane response factors (based on carbon number) are listed after each compound. Methane and Ethane were subtracted from the total hydrocarbons to calculate Non-methane/Non-ethane (NM/NE) VOCs, reported as propane. Formaldehyde was specifically excluded per 60.4244 (f).

Methane (RF 1)	Ethylene (RF 2)	Propane (RF 3)	Butane (RF 4)	Acetaldehyde (RF 2)
Ethane (RF 2)	Acetylene (RF 2)	Propylene (RF 3)	Methanol (RF 1)	Formic Acid (RF 1)

Horsepower and Fuel Flow Determination

For this test, horsepower was obtained from automation display and fuel flow was obtained from automation display. The Engine Torque Load averaged 57.6% for the test. This was the highest achievable load based on the operating parameters during the test, which are included in Appendix A.

Sampling System

Compressor Engineering Corporation designed and assembled a versatile, emission testing unit (ETU), which houses all analyzers, computers and auxiliary equipment. Effluent stack gas enters the ETU through a heated Teflon sample line. A heated head pump with a Teflon diaphragm pulls the sample into the trailer, through a heated filter, and sends the wet gas directly to the inlet of the FTIR. The heated pump, sample lines, and filter have their temperatures maintained at approximately 191 °C. The FTIR analyzer gas cell and gas inlet temperatures are also maintained at approximately 191 °C. The sample is routed from the exit of the FTIR through a heated Teflon line to a gas conditioner for moisture removal. The dry gas exiting the gas conditioner is routed to a gas distribution panel which sends a portion of the gas to the paramagnetic oxygen analyzer.

The MKS Instruments MultiGas 2030 FTIR analyzer is used to determine the CO, NOx, and VOCs emission concentrations. The FTIR serves as the instrument for Methods 7E and 10, and meets the requirements of Section 13 of Method 7E. All measured concentrations are corrected to a dry basis via the MKS MG2000 operating software. The FTIR analyzer is configured with

a fixed optical pathlength of 5.11 meters. The measured concentrations are collected at a 0.5 cm^{-1} resolution. Each spectrum is derived from the co-addition of 60 scans. Data is collected continuously during each test run. A new data point is generated every 60 seconds.

A software package (CECOTest) is used to collect and processes data. CECOTest continually logs data every 10 seconds from the oxygen analyzer and the FTIR during the 60 minute runs.

Refer to **FIGURE 1** for a schematic of the sampling system.

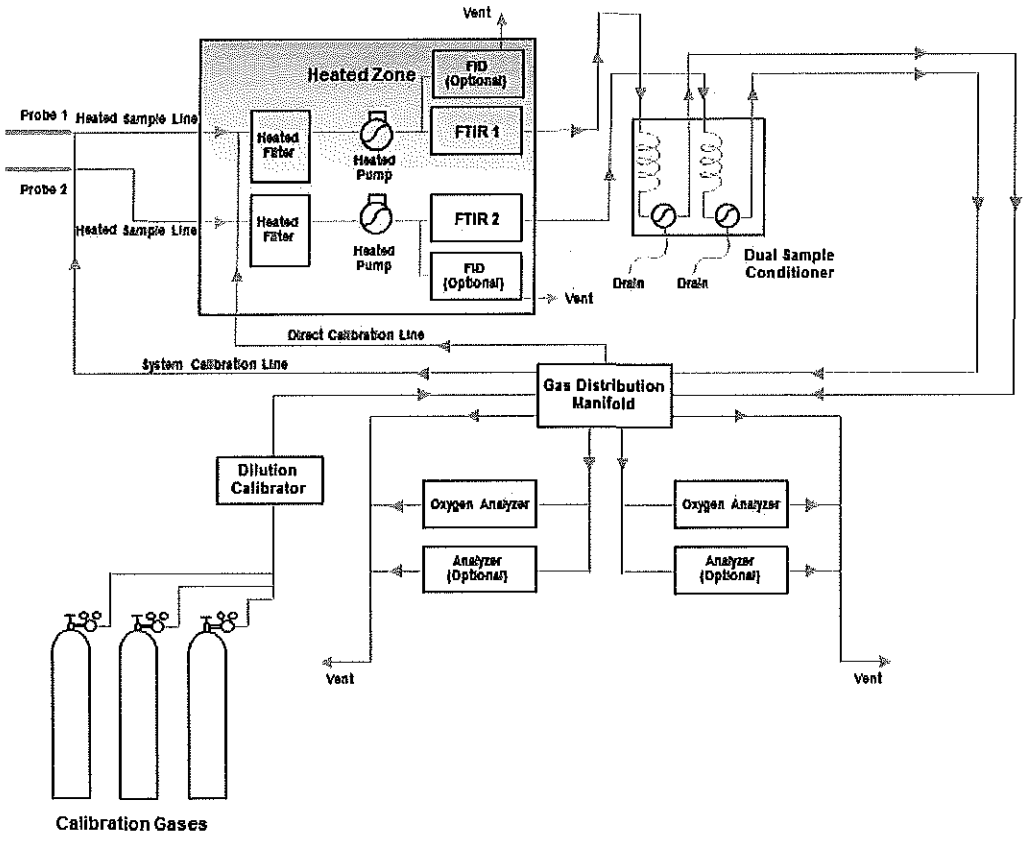


Figure 1: Sampling System Schematic

Instrument Specifications

Description:	Oxygen Analyzer
Manufacturer:	Servomex
Model:	1440C
Serial Number:	2593
Technology Type:	Paramagnetic
Range:	0-25%
Repeatability:	+/- 0.1% O2
Response Time (90%):	Typically less than 10 sec
Linearity:	+/- 0.1% O2

Description:	FTIR Analyzer
Manufacturer:	MKS Instruments
Model:	2030
Serial Number:	017978321
Technology Type:	FTIR Spectrometry
Range:	between 10ppb and 100% full scale
Spectral Resolution:	0.5-128 1/cm
Scan Speed:	1/sec @ 0.5 1/cm
Detector Type:	LN2-cooled MCT

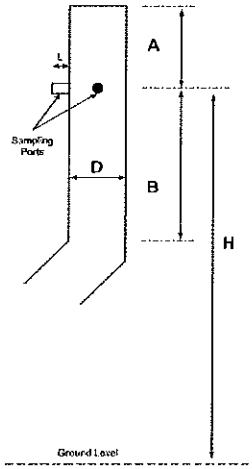
Manufacturer:	Teledyne
Model:	T700
Serial Number:	1364
Technology Type:	Mass Flow Controller
MFC's:	0LPM, 2LPM, and 200ccm
Flow Measurement Accuracy	+/-1.0% of Full Scale
Repeatability of Flow Control	+/-0.2% of full Scale
Linearity of Flow Measurement	+/-0.5% of Full Scale
Flow Range of Diluent Air	0 to 10 SLPM
Optional Ranges:	0 to 5 SLPM; 0 to 20 SLPM
Flow Range of Cylinder Gasses	0 to 100 cc/min
Optional Ranges:	0 to 50 cc/min; 0 to 200 cc/min
Zero Air Required:	10 SLPM @ 30 PSIG
Optional	20 SLPM @ 30 PSIG
CAL Gas Input Ports	4 (configurable)
Diluent Gas Input Ports	1
Response Time	60 Seconds (98%)

Description:	Flame Ionization Analyzer
Manufacturer:	J.U.M. Engineering
Model:	1440C
Serial Number:	6NB05009
Outputs:	0-10V, 4 - 20mA.
Detection Method:	Flame Ionization Detector.

Detection Limit:	1ppm CH4 at full scale.
Ranges:	0-10, 0-100, 0-1,000, 0-10,000, 0-100,000ppm.
Response Time:	0.2 sec.
Sample Flow Rate:	2.5 L/min.
Drift:	Span (24 hours): <1%. Zero (24 hours): <1%.
Linearity:	within 1% of full scale

Description of Sampling Location

Physical Duct Parameters



D =	10	in	Duct Diameter
L =	4	in	Port Length
A =	144	in	Distance to Downstream Disturbance
B =	132	in	Distance to Upstream Disturbance
H =	30	ft	Approximate Height Above Grade
	14.4	D	Distance to Downstream Disturbance (A)
	0.5	D	EPA M1 Requirement
	TRUE		EPA M1 Requirement Met?
	13.2	D	Distance to Upstream Disturbance (B)
	2.0	D	EPA M1 Requirement
	TRUE		EPA M1 Requirement Met?
	TRUE		**EPA M1 Requirements Met for Distances to Up/Downstream Disturbances**

EPA JJJJ/ZZZZ Sampling Point Requirements

Duct Diameter	Ports	Sampling Strategy
D ≤ 6 inches	N/A	Single Point Located at Duct Centroid
6 < D ≤ 12 inches	N/A	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
D > 12 inches	M1 Ports	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
D > 12 inches	no M1 Ports	Stratification Check Required

REQUIRED SAMPLING STRATEGY: **3 Traverse Points (16.7, 50.0, and 83.3%) across the duct**

8.3 in	Point 1
5.0 in	Point 2
1.7 in	Point 3
12.3 in	Point 1 Probe Mark (Includes port length)
9.0 in	Point 2 Probe Mark (Includes port length)
5.7 in	Point 3 Probe Mark (Includes port length)

STRATIFICATION CHECK REQUIREMENTS

For every point (where Da=Deviation from Average (%) for a given point.)

Da < 5 %	Single Point Located at Duct Centroid
5% ≤ Da < 10 %	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
Otherwise	Full M1 Points Required

STRATIFICATION CHECK RESULTS

	Point 1	Point 2	Point 3
	8.69	8.21	8.58
	8.56	8.21	8.50
	8.63	8.17	8.59
	8.50	8.18	8.56
	8.63	8.20	8.60
	8.57	8.17	8.57
	8.60	8.17	8.62
	8.51	8.11	8.43
	8.12	8.15	8.10
	8.24	8.29	8.22
	8.25	8.74	8.16
	8.25	8.57	8.17
Point Average (% O2)	8.46	8.26	8.43
Point Deviation from Average (%)	0.94	- 1.43	0.49
Point Deviation from Average (% O2)	0.08	- 0.12	0.04
Average of Point Averages (% O2)	8.38		
STRATIFICATION CHECK RESULTANT STRATEGY			**Single Point Located at Duct Centroid**