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EMISSION TEST REPORT

REGULATION(S): 40 CFR 60 SUBPART JJJJ AND MDEQ PERMIT

POLLUTANT(S): CO, NOX, AND VOCs

ANR TRANSCANADA PIPELINE COMPANY BLUE LAKE 18 KALKASKA COUNTY, MI

RECEIVED

JAN 23 2018

PERMIT NUMBER: MI-ROP-B7198_2014A
FRS # / EPA REGISTRY ID: 110013860526
SOURCE CLASSIFICATION CODE (SCC): 20200254

AIR QUALITY DIVISION

SOURCE ID: BLGEN-B
EMISSION SOURCE: SPARK-IGNITED ENGINE
4-STROKE/2-STROKE: 4-STROKE
RICH/LEAN BURN: LEAN BURN
MAKE & MODEL: CATERPILLAR G3516
UNIT NUMBER: B
SERIAL NUMBER: 3RC00642

TEST DATE: NOVEMBER 28, 2017

Pollutant	pounds / hour		g/BHP-hr		PASS/FAIL
	Permitted	Emitted	Permitted	Emitted	
CO	1.6	< 0.1	1.4	< 0.1	PASS
NOx	5.7	1.1	2	1	PASS
VOCs	0.9	< 0.1	0.55	< 0.01	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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Revision History

Version	Revision Date	Comments
0	<i>original</i>	Original Version of Document.

Project Information

CECO Project No: 20171128-052-2

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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 18 to fulfill the requirements of 40 CFR 60 Subpart JJJJ and MDEQ Permit. This report details the test purpose, objectives, testing procedures, sampling and analysis methodology, and results of the source testing conducted on November 28, 2017.

Process Description

The following source was tested:

- Unit Number B (Source ID BLGEN-B) SN 3RC00642 – 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 an oxidation catalyst with an air-fuel ratio controller for emission control and drives 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. 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

Caterpillar G3516		Test Run			Average
Source ID:BLGEN-B Unit ID: B SN: 3RC00642		1st	2nd	3rd	
Fuel					
HHV (BTU/SCF)	1020				
LHV (BTU/SCF)	923				
F-factor (DSCF/MMBTU)	8616				
Test Date & Time					
Date	11/28/2017	11/28/2017	11/28/2017		
Start Time	1:26 PM	2:35 PM	3:54 PM		
End Time	2:26 PM	3:35 PM	4:54 PM		
Interval (minutes)	60	60	60		60
Measured Concentrations (bias-corrected where applicable)					
O ₂ (%vd)	9.22	9.25	8.96		9.14
CO (ppmvd)	2.1	2.5	3.2		2.6
NO _x (ppmvd)	78.8	75.2	114.6		89.5
VOCs (ppmvd)	-193.6	-215.1	-204.2		-204.3
THC (ppmvd)	480.9	473.7	468.5		474.4
Operating Conditions					
Engine Horsepower (BHP)	655	688	688		677
Engine (Torque) Load (%)	58.1	61.0	61.0		60.0
Engine Speed (RPM)	1203	1202	1203		1203
Fuel Flow Rate (SCFH)	6470	6457	6153		6360
BSFC (BTU/BHP/hr), LHV	9116	8662	8255		8678
Fuel BTU Consumption (MMBTU/hr)	6.60	6.59	6.28		6.49
Exhaust Flow Rate (SCFH)	101756	101808	94669		99411
Exhaust Flow Rate (SCFM)	1695.9	1696.8	1577.8		1656.9
Calculated Emissions					
CO	(lb/hr)	0.0155	0.0185	0.0220	0.0187
	(ton/year)	0.0680	0.0810	0.0964	0.0818
	(g/BHP-hr)	0.0108	0.0122	0.0145	0.0125
	(ppmvd at 15% O ₂)	1.0608	1.2661	1.5812	1.3027
NO _x	(lb/hr)	0.9569	0.9137	1.2947	1.0551
	(ton/year)	4.1913	4.0018	5.6709	4.6213
	(g/BHP-hr)	0.6626	0.6024	0.8537	0.7062
	(ppmvd at 15% O ₂)	39.8048	38.0841	56.6281	44.8390
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)	5.5976	5.5166	5.0734	5.3959
	(ton/year)	24.5175	24.1628	22.2217	23.6340
	(g/BHP-hr)	3.8759	3.6373	3.3451	3.6194
	(ppmvd at 15% O ₂)	242.9204	239.8996	231.5034	238.1078

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 ₂ H 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 calculated from the load percentage displayed on the engine panel and fuel flow was obtained from a fuel flow meter. The Engine Torque Load averaged 60.0% 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, NO_x, 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 15 seconds from the oxygen analyzer and the FTIR during the 60 minute runs.

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

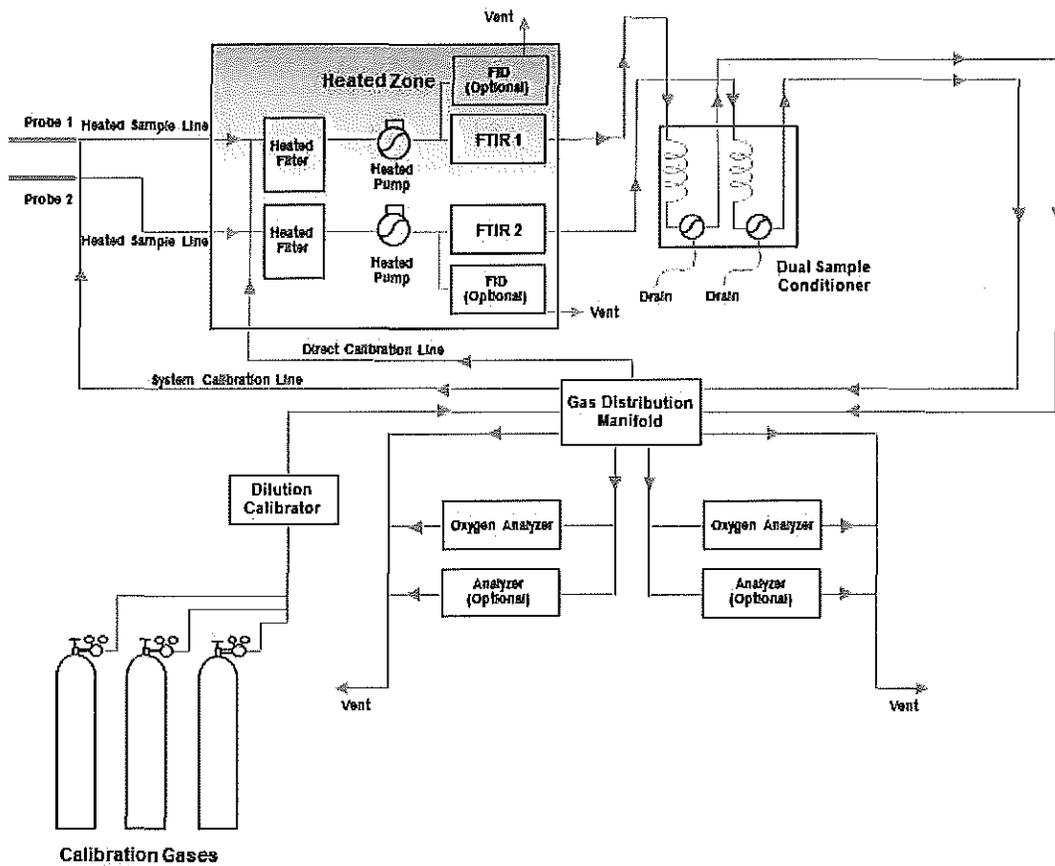


Figure 1: Sampling System Schematic

Instrument Specifications

Description: Oxygen Analyzer
 Manufacturer: Servomex
 Model: 1440C
 Serial Number: 01440C1STO-2594
 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: 017979534
 Technology Type: FTIR Spectrometry
 Range: between 10ppb and 100% fullscale
 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: 70
 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: serial number 8
 Outputs: 0-10V, 4 - 20mA.
 Detection Method: Flame Ionization Detector.

Detection Limit:	1ppm CH ₄ 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

Calibrator Validation

Make: Telydyne Date: 11/28/17
 Model: T700
 Serial No.: 70

Diluent High Calibration Gas		Oxygen	
	Target	12.60	
	Reading	Check	Check
Check 1	12.65	PASS	PASS
Check 2	12.65	PASS	PASS
Check 3	12.67	PASS	PASS
Average	12.66		
Deviation	0.4%	PASS	

Diluent Mid Calibration Gas		Oxygen	
	Target	6.30	
	Reading	Check	Check
Check 1	6.41	PASS	PASS
Check 2	6.31	PASS	PASS
Check 3	6.33	PASS	PASS
Average	6.35		
Deviation	0.8%	PASS	

Validation Calibration Gas		Oxygen	
	Concentration	12.47	
	Reading	Check	
Check 1	12.54		
Check 2	12.56		
Check 3	12.52		
Average	12.54		
Deviation	0.6%	PASS	