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EMISSION TEST REPORT

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

TRANSCANADA US PIPELINE BLUE LAKE GAS STORAGE COMPANY KALKASKA COUNTY, MI

RECEIVED

OCT 16 2017

AIR QUALITY DIVISION

PERMIT NUMBER: MI-ROP-B7198-2014A
FACILITY ID: B7198
FRS # / EPA REGISTRY ID: 110013860526
SOURCE CLASSIFICATION CODE (SCC): 20200252
SOURCE ID: BLCMPR-A
EMISSION SOURCE: SPARK-IGNITED ENGINE
4-STROKE/2-STROKE: 2-STROKE
RICH/LEAN BURN: LEAN BURN
MAKE & MODEL: DRESSER RAND TCVD-12
UNIT NUMBER: CMPR-A
SERIAL NUMBER: 12TCVD104AP
TEST DATE: AUGUST 29, 2017

Pollutant	Permitted Limits				PASS/FAIL
	pounds / hour		g/BHP-hr		
	Permitted	Emitted	Permitted	Emitted	
CO	37.0	28.73	2.8	2.4	PASS
NOx	26.4	14.71	2	1	PASS
VOCs	9.7	3.33	0.73	0.28	PASS

Limits obtained from Permit MI-ROP-B7198-2014a and 40 CFR 60, Subpart JJJJ

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: 20170829-051-1

Contact Information

Facility Information

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Introduction

CECO Training & Technical Services, a division of Compressor Engineering Corporation, conducted source emission testing at TransCanada US Pipeline, Blue Lake Gas Storage Company 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 August 29, 2017.

Process Description

The following sources were tested:

- Unit CMPR-A (BLCMPR-A) SN 12TCVD104AP – one (1) Dresser Rand TCVD-12 natural gas-fired, 2-stroke, lean burn internal combustion engine, rated to 6000 brake horsepower (BHP) at 330 revolutions per minute (RPM). This source is equipped with a NSCR with an air-fuel ratio controller for emission control and drive a natural gas compressor.

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

Dresser Rand TCVD-12 ID: CMPR-A SN: 12TCVD104AP		Test Run			Average
		1st	2nd	3rd	
Fuel					
HHV (BTU/SCF)		1011			
LHV (BTU/SCF)		915			
F-factor (DSCF/MMBTU)		8616			
Test Date & Time					
Date		8/29/2017	8/29/2017	8/29/2017	
Start Time		7:44 AM	8:56 AM	10:03 AM	
End Time		8:44 AM	9:56 AM	11:03 AM	
Interval (minutes)		60	60	60	60
Measured Concentrations					
O ₂ (%vd)		15.67	15.78	15.68	15.71
CO (ppmvd)		262.1	264.3	266.7	264.4
NO _x (ppmvd)		87.4	79.7	80.1	82.4
VOCs (ppmvd)		19.0	19.6	19.8	19.5
THC (ppmvd)		543.1	521.8	524.0	529.6
Operating Conditions (Rated BHP: 6000 @ 330 RPM)					
Engine Horsepower (BHP)		5352	5296	5371	5340
Engine (Torque) Load (%)		91.6	90.7	92.1	91.5
Engine Speed (RPM)		321	321	321	321
Fuel Flow Rate (SCFH)		42893	42340	42670	42634
BSFC (BTU/BHP/hr), LHV		7330	7312	7266	7303
Fuel BTU Consumption (MMBTU/hr)		43.37	42.81	43.15	43.11
Exhaust Flow Rate (SCFH)		1493297	1505702	1488368	1495789
Exhaust Flow Rate (SCFM)		24888.3	25095.0	24806.1	24929.8
Calculated Emissions					
CO	(lb/hr)	28.4384	28.9153	28.8420	28.7319
	(ton/year)	124.5602	126.6491	126.3279	125.8457
	(g/BHP-hr)	2.4101	2.4764	2.4356	2.4407
	(ppmvd at 15% O ₂)	295.6769	304.5645	301.4425	300.5613
NO _x	(lb/hr)	15.5756	14.3213	14.2275	14.7081
	(ton/year)	68.2210	62.7275	62.3165	64.4217
	(g/BHP-hr)	1.3200	1.2265	1.2015	1.2493
	(ppmvd at 15% O ₂)	98.5966	91.8418	90.5345	93.6576
VOCs	(lb/hr)	3.2455	3.3758	3.3710	3.3308
	(ton/year)	14.2155	14.7862	14.7651	14.5889
	(g/BHP-hr)	0.2750	0.2891	0.2847	0.2829
	(ppmvd at 15% O ₂)	21.4340	22.5859	22.3793	22.1331
THC	(lb/hr)	92.7711	89.8731	89.2130	90.6191
	(ton/year)	406.3375	393.6443	390.7531	396.9116
	(g/BHP-hr)	7.8620	7.6970	7.5338	7.6976
	(ppmvd at 15% O ₂)	612.6750	601.2930	592.2605	602.0762

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
Volatile Organic Compounds (VOCs)	ASTM D6348

VOCs via ASTM D6348

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)
Acrolein (RF 3)	Benzene (RF 6)			

Horsepower and Fuel Flow Determination

For this test, horsepower was obtained from engine panel and fuel flow was obtained from the engine panel. The Engine Torque Load averaged 91.5% 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.

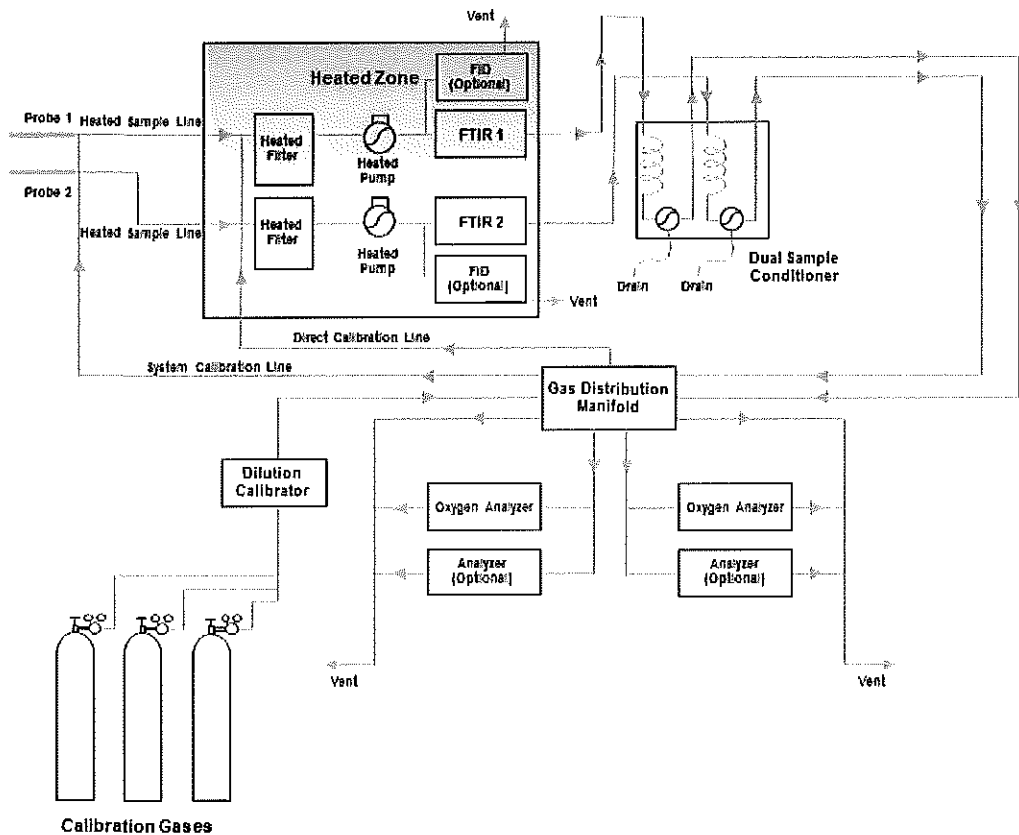


Figure 1: Sampling System Schematic

Instrument Specifications

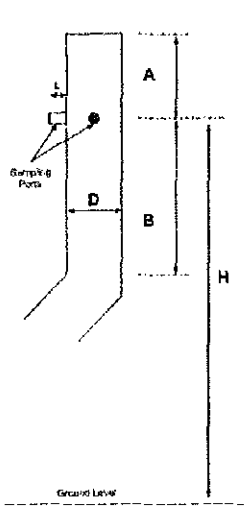
Description: Oxygen Analyzer
Manufacturer: Servomex
Model: 1440C
Serial Number: 2593
Technology Type: Paramagnetic
Range: 0-25%
Repeatability: +/- 0.1% O2
Response Time (90%): Typically less than 10 sec
Linearity: +/- 0.1% O2

Description: FTIR Analyzer
Manufacturer: MKS Instruments
Model: 2030
Serial Number: 017978321
Technology Type: FTIR Spectrometry
Range: between 10ppb and 100% 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: 20LPM, 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 of Sampling Location

Physical Duct Parameters



D =	48	in	Duct Diameter
L =	4	in	Port Length
A =	144	in	Distance to Downstream Disturbance
B =	360	in	Distance to Upstream Disturbance
H =	56	ft	Approximate Height Above Grade
	3.0	D	Distance to Downstream Disturbance (A)
	0.5	D	EPA M1 Requirement
	TRUE		EPA M1 Requirement Met?
	7.5	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/ZZZ Sampling Point Requirements

Duct Diameter	Ports
D ≤ 6 inches	N/A
6 < D ≤ 12 inches	N/A
D > 12 inches	M1 Ports
D > 12 inches	no M1 Ports

Sampling Strategy

Single Point Located at Duct Centroid
 3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
 3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
 Stratification Check Required

REQUIRED SAMPLING STRATEGY:

40.0 in	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
24.0 in	Point 1
8.0 in	Point 2
44.0 in	Point 3
28.0 in	Point 1 Probe Mark (Includes port length)
12.0 in	Point 2 Probe Mark (Includes port length)
	Point 3 Probe Mark (Includes port length)

STRATIFICATION CHECK REQUIREMENTS

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

- Da < 5 %
- 5% ≤ Da < 10 %
- Otherwise

Single Point Located at Duct Centroid
 3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
 Full M1 Points Required

STRATIFICATION CHECK RESULTS

Point 1	Point 2	Point 3
15.52	15.48	15.51
15.52	15.50	15.53
15.48	15.51	15.52
15.51	15.52	15.56
15.46	15.49	15.54
15.48	15.52	15.53
15.50	15.53	15.53
15.51	15.53	15.54
15.44	15.53	15.54
15.48	15.53	15.56
15.48	15.52	15.55
15.49	15.56	15.56

Point Average (% O2)	15.49	15.52	15.54
Point Deviation from Average (%)	- 0.17	0.02	0.15
Point Deviation from Average (% O2)	- 0.03	0.00	0.02
Average of Point Averages (% O2)	15.52		

STRATIFICATION CHECK RESULTANT STRATEGY

Single Point Located at Duct Centroid