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EMISSIONS COMPLIANCE STUDY

Prepared For
Plains All American Pipeline, LP

Performed At
**Plains Natural Gas, LLP
Bluewater Gas Storage
EU-COMPEAST, EU-COMPWEST, EU-COMP NORTH
Columbus, Michigan**

Test Dates
February 25 and 26, 2015

Report No.
TRC Environmental Corporation Report 229312A

Report Submittal Date
March 26, 2015

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1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed an emissions compliance test program on the EU-COMPEAST, EU-COMPWEST, and EU-COMP NORTH at the Bluewater Gas Storage of Plains Natural Gas, LLP in Columbus, Michigan on February 25 and 26, 2015. The tests were authorized by and performed for Plains All American Pipeline, LP.

The purpose of this test program was to determine compliance with Michigan Department of Environmental Quality – Air Quality Division (MDEQ-AQD) Permit to Install (PTI) 77-14 and United States Environmental Protection Agency (USEPA), Title 40 Code of Federal Regulations Part 63 (40CFR63), Subpart ZZZZ - National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. The test program was conducted according to the Test Protocol 229312 dated December 29, 2014.

1.1 Project Contact Information

Participants		
Test Facility	Plains Natural Gas, LLP Bluewater Gas Storage 333 South Wales Center Road Columbus, Michigan 48063	Ms. Karon McManus Sr. Air Quality Compliance Engineer 713-993-5628 (phone) KGMcManus@paalp.com
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Mr. Paul Coleman Project Manager 312-533-2023 (phone) 312-533-2070 (fax) pcoleman@tresolutions.com

The tests were conducted by Ricardo Nunez and Paul Coleman of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual(s) (QI) can be located in the appendix to this report.

Mr. Sebastian G. Kallumkal and Mr. Mark Dziadosz of the MDEQ-AQD observed the testing on February 25 and 26, 2015.



2.0 SUMMARY OF RESULTS

The results of this test program are summarized in the table below. Detailed individual run results are presented in Section 6.0.

Unit ID	Pollutant Tested	Measured Emissions	Emission Limit	
EU-COMPWEST	Nitrogen Oxide (NO _x)	lb/hr	3.01	7.4
	Carbon Monoxide (CO)	lb/hr	0.61	1.85
		ppmvd @ 15% O ₂	9.8	47
EU-COMPEAST	NO _x	lb/hr	6.16	7.4
	CO	lb/hr	0.67	1.85
		ppmvd @ 15% O ₂	10.1	47
EU-COMP NORTH	NO _x	lb/hr	3.80	4.50
	CO	lb/hr	0.002	0.40
		ppmvd @ 15% O ₂	0.2	47
	Formaldehyde	lb/hr	0.002	0.017



The table below summarizes the test methods used, as well as the number and duration of each at each test location:

Source	Parameter Measured	Test Method	No. of Runs	Run Duration
EU-COMP NORTH	Volumetric Flow Rate, and Fuel Factor (Fd Factor)	USEPA 19	3	15 min
	O ₂	USEPA 3A	3	15 min
	NO _x	USEPA 7E	3	15 min
	CO	USEPA 10	3	15 min
	Formaldehyde	USEPA 323	3	120 min
EU-COMPEAST and EU-COMPWEST	Volumetric Flow Rate, and Fuel Factor (Fd Factor)	USEPA 19	3	15 min
	O ₂	USEPA 3A	3	15 min
	NO _x	USEPA 7E	3	15 min
	CO	USEPA 10	3	15 min

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. Source operation appeared normal during the entire test program.

Unit operating data was recorded by plant personnel. Heat content of the natural gas was determined to support the performance tests. The fuel analysis reports are appended.

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the



following sections. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system.

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol 1 gases. Three-point linearity checks were performed prior to sampling, and in the event of a failing system bias or drift test (and subsequent corrective action). System bias and drift checks were performed using the low-level gas and either the mid- or high-level gas prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

4.1.1 CO₂ Determination by USEPA Method 3A

This method is applicable for the determination of CO₂ concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The CO₂ analyzer was equipped with a non-dispersive infrared (IR) detector.

4.1.2 O₂ Determination by USEPA Method 3A

This method is applicable for the determination of O₂ concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O₂ analyzer was equipped with a paramagnetic-based detector.

4.1.3 NO_x Determination by USEPA Method 7E

This method is applicable for the determination of NO_x concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The NO_x analyzer utilized a photomultiplier tube to measure the linear and proportional luminescence caused by the reaction of nitric oxide and ozone.



4.1.4 CO Determination by USEPA Method 10

This method is applicable for the determination of CO concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The non-dispersive infrared analyzer (NDIR) CO analyzer was equipped with an internal gas correlation filter wheel, which eliminates potential detector interference. As such, use of an interference removal trap was not required.

4.2 Formaldehyde Determination By USEPA Method 323

This method is applicable to the determination of emissions of formaldehyde from natural gas-fired stationary sources.

Flue gas is withdrawn at a constant rate from the source at a single sample point. Sample is drawn through a midget impinger train containing chilled reagent water to absorb formaldehyde. The formaldehyde concentration in the impingers is determined by reaction with acetyl acetone to form a colored derivative that is measured colorimetrically.

4.3 Determination of F-Factors by USEPA Method 19

This method is applicable for the determination of the pollutant emission rate using oxygen (O₂) or carbon dioxide (CO₂) concentrations and the appropriate F factor (the ratio of combustion gas volumes to heat inputs) and the pollutant concentration. The appropriate F-Factor was calculated from fuel analyses using the equations in Section 12.3.3.1 of Method 19.



5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Louisiana Environmental Lab Accreditation Program (LELAP) accreditation;
- Interim accreditation from the Stack Testing Accreditation Council (STAC) that our operations conform with the requirements of ASTM D 7036-04

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: *“AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of uncertainty for test methods may be found.”* TRC conforms with this section by using approved test protocols for all tests.



6.0 TEST RESULTS SUMMARY



GASEOUS TEST RESULTS SUMMARY

Project Number:	229312	Start Date:	2/25/15
Customer:	Plains All American Pipeline	End Date:	2/25/15
Unit Identification:	EU-COMPWEST	Facility:	Bluewater Gas Storage
Sample Location:	Stack	Recorded by:	P. Coleman
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	70%	Fd Factor:	8657

Reference Method Results, As Measured Moisture Basis							
Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO ₂ % v/v dry	O ₂ % v/v dry
1	2/25/15	10:00	10:15	42.6	13.9	4.7	12.3
2	2/25/15	10:35	10:50	41.6	14.6	4.7	12.3
3	2/25/15	11:15	11:30	45.0	14.5	4.7	12.3
Average				43.1	14.3	4.7	12.3

Emission Rate Calculation Summary					
Run #	NOX lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Heat Input MMBtu/Hr
1	0.107	0.021	2.99	0.59	27.87
2	0.104	0.022	2.90	0.62	27.87
3	0.113	0.022	3.15	0.62	27.87
Average	0.108	0.022	3.01	0.61	27.87

Results Corrected to a Reference O ₂ Concentration		Emission Rate Test Calculation Summary g/HP-hr Determined Using lb/hr and horsepower-hour		
Run #	CO ppmvd corrected to 15% Oxygen	BHP HP-hr	NO _x g/HP-hr	CO g/HP-hr
1	9.6	3301	0.41	0.08
2	10.0	3301	0.40	0.09
3	9.9	3301	0.43	0.08
Average	9.8	3301	0.41	0.08



GASEOUS TEST RESULTS SUMMARY

Project Number:	229312	Start Date:	2/25/15
Customer:	Plains All American Pipeline	End Date:	2/25/15
Unit Identification:	EU-COMPEAST	Facility:	Bluewater Gas Storage
Sample Location:	Stack	Recorded by:	P. Coleman
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	83%	Fd Factor:	8656

Reference Method Results, As Measured Moisture Basis							
Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO ₂ % v/v dry	O ₂ % v/v dry
1	2/25/15	12:45	13:00	82.9	16.2	5.0	11.8
2	2/25/15	13:20	13:35	88.9	15.1	5.0	11.9
3	2/25/15	13:55	14:10	87.7	15.2	5.0	11.8
Average				86.5	15.5	5.0	11.8

Emission Rate Calculation Summary					
Run #	NOx lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Heat Input MMBtu/Hr
1	0.196	0.023	5.86	0.70	29.90
2	0.212	0.022	6.35	0.66	29.90
3	0.209	0.022	6.26	0.66	29.90
Average	0.206	0.022	6.16	0.67	29.90

Results Corrected to a Reference O ₂ Concentration		Emission Rate Test Calculation Summary g/HP-hr Determined Using lb/hr and horsepower-hour		
Run #	CO ppmvd corrected to 15% Oxygen	BHP HP-hr	NO _x g/HP-hr	CO g/HP-hr
1	10.5	3925	0.68	0.08
2	9.8	3925	0.73	0.08
3	9.9	3925	0.72	0.08
Average	10.1	3925	0.71	0.08



GASEOUS TEST RESULTS SUMMARY

Project Number:	229312	Start Date:	2/26/15
Customer:	Plains All American Pipeline	End Date:	2/26/15
Unit Identification:	EU-COMP NORTH	Facility:	Bluewater Gas Storage
Sample Location:	Stack	Recorded by:	P. Coleman
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	43%	Fd Factor:	8656

Reference Method Results, As Measured Moisture Basis							
Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO ₂ % v/v dry	O ₂ % v/v dry
1	2/26/15	8:30	8:45	379.1	0.4	7.7	7.3
2	2/26/15	9:10	9:25	440.3	0.1	7.8	7.1
3	2/26/15	9:45	10:00	387.3	0.7	7.6	7.6
Average				402.2	0.4	7.7	7.3

Emission Rate Calculation Summary					
Run #	NOx lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Heat Input MMBtu/Hr
1	0.602	0.0004	3.58	0.003	5.94
2	0.688	0.0001	4.09	0.001	5.94
3	0.627	0.0007	3.73	0.004	5.94
Average	0.639	0.0004	3.80	0.002	5.94

Results Corrected to a Reference O ₂ Concentration		Emission Rate Test Calculation Summary g/HP-hr Determined Using lb/hr and horsepower-hour		
Run #	CO ppmvd corrected to 15% Oxygen	BHP HP-hr	NO _x g/HP-hr	CO g/HP-hr
1	0.2	540	3.01	0.002
2	0.1	540	3.44	0.001
3	0.3	540	3.13	0.003
Average	0.2	540	3.19	0.002



FORMALDEHYDE TEST RESULTS SUMMARY (METHOD 323)

Company: Plains All American Pipeline
 Plant: Bluewater Gas Storage
 Unit: EU-COMP NORTH
 Location: Stack

Test Run Number	1	2	3	Average
Source Condition	43%	43%	43%	
Date	2/26/15	2/26/15	2/26/15	
Start Time	10:45	13:15	15:35	
End Time	12:45	15:15	17:35	
Sample Duration (min):	120.0	120.0	120.0	120.0
Gas CO ₂ Content (%v/v dry):	7.7	7.6	7.6	7.6
Gas O ₂ Content (%v/v dry):	7.3	7.4	7.4	7.4
Gas Dry MW, M _d (lb/lb-mole):	29.53	29.51	29.50	29.51
Barometric Pressure, P _{bar} ("Hg)	29.34	29.34	29.37	29.35
Meter Volume, V _{m(std)} (dscf):	1.711	1.736	1.742	1.730
Fractional Moisture Content, B _{ws} :	0.146	0.115	0.134	0.132
O ₂ -Based Fuel Factor, F _d (dscf/MMBtu):	8657	8657	8657	8657
Heat Input (MMBtu/hr)	6.54	6.33	6.53	6.47
BHP (HP-hr)	547	552	554	551
Formaldehyde				
Net Mass Collected (mg):	0.02	0.02	0.02	0.02 ADL
Concentration (lb/dscf):	2.99E-08	2.77E-08	2.67E-08	2.81E-08 ADL
Concentration (ppmvd):	0.38	0.36	0.34	0.36 ADL
Concentration (ppmw):	0.33	0.31	0.30	0.31 ADL
Emission Rate (lb/hr):	0.003	0.002	0.002	0.002 ADL
O ₂ -Based Emission Rate (lb/MMBtu):	0.0004	0.0004	0.0004	0.0004 ADL
Concentration Corrected to 15% O ₂ (ppmvd)	0.17	0.15	0.15	0.16 ADL
Emission Rate (g/HP-hr):	0.002	0.002	0.002	0.002

ADL - all analytical values used to calculate and report an In-stack emissions value are greater than the laboratory's reported detection level(s)