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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 Date

September 30, 2015

Report No.

TRC Environmental Corporation Report 241561A

Report Submittal Date

October 14, 2015

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EMISSIONS COMPLIANCE STUDY

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 September 30, 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 241561 dated August 6, 2015.

1.1 Project Contact Information

| Participants | | |
|-----------------------------------|---|---|
| Test Facility | Plains Natural Gas, LLP Bluewater Gas Storage 333 South Wales Center Road Columbus, Michigan 48063 Facility No. B7551 | 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. Ben Cacao Field Team Leader 312-533-2042 (phone) 312-533-2070 (fax) bcacao@trcsolutions.com |

The tests were conducted by Ted Kalisz and Ben Cacao of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual(s) (QI) can be located in the appendix to this report.

Mr. David Patterson of the MDEQ-AQD observed the testing on September 30, 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-COMPEAST | Nitrogen Oxide (NO _x) | lb/hr | 4.72 | 7.4 |
| | Carbon Monoxide (CO) | lb/hr | 1.23 | 1.85 |
| | | ppmvd @ 15% O ₂ | 18.0 | 47 |
| EU-COMPWEST | NO _x | lb/hr | 5.49 | 7.4 |
| | CO | lb/hr | 1.13 | 1.85 |
| | | ppmvd @ 15% O ₂ | 16.5 | 47 |
| EU-COMP NORTH | NO _x | lb/hr | 3.61 | 4.50 |
| | CO | lb/hr | 0.02 | 0.40 |
| | | ppmvd @ 15% O ₂ | 1.1 | 47 |

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-COMEAST, EU-COMPWEST, 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 |



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 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.



4.1.2 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.

4.1.3 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 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 12.3.2.1 of Method 19.



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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;
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

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: | <u>241561</u> | Start Date: | <u>9/30/15</u> |
| Customer: | <u>Plains All American Pipeline</u> | End Date: | <u>9/30/15</u> |
| Unit Identification: | <u>EU-COMPEAST</u> | Facility: | <u>Bluewater Gas Storage</u> |
| Sample Location: | <u>Stack</u> | Recorded by: | <u>Ben Cacao</u> |
| RM Probe Type: | <u>Extractive (Dry)</u> | Fc Factor: | <u>-</u> |
| Load Level/Condition: | <u>85 Percent</u> | Fd Factor: | <u>8664</u> |

| Reference Method Results, As Measured Moisture Basis | | | | | | |
|--|---------|------------|----------|-------------|-------------|--------------------------|
| Run # | Date | Start Time | End Time | NOx ppmvd | CO ppmvd | O ₂ % v/v dry |
| 1 | 9/30/15 | 14:09 | 14:23 | 64.1 | 27.9 | 11.9 |
| 2 | 9/30/15 | 14:45 | 14:59 | 64.3 | 27.5 | 11.9 |
| 3 | 9/30/15 | 15:18 | 15:32 | 64.2 | 27.2 | 11.9 |
| Average | | | | 64.2 | 27.5 | 11.9 |

| Emission Rate Calculation Summary | | | | | |
|-----------------------------------|--------------|--------------|-------------|-------------|---------------------|
| Run # | NOx lb/MMBtu | CO lb/MMBtu | NOx lb/hr | CO lb/hr | Heat Input MMBtu/hr |
| 1 | 0.154 | 0.041 | 4.72 | 1.25 | 30.68 |
| 2 | 0.154 | 0.040 | 4.72 | 1.23 | 30.68 |
| 3 | 0.154 | 0.040 | 4.72 | 1.22 | 30.68 |
| Average | 0.154 | 0.040 | 4.72 | 1.23 | 30.68 |

| 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 | 18.2 | 3,905 | 0.55 | 0.145 |
| 2 | 18.0 | 3,905 | 0.55 | 0.143 |
| 3 | 17.8 | 3,905 | 0.55 | 0.141 |
| Average | 18.0 | 3,905 | 0.55 | 0.143 |



GASEOUS TEST RESULTS SUMMARY

| | | | |
|-----------------------|-------------------------------------|--------------|------------------------------|
| Project Number: | <u>241561</u> | Start Date: | <u>9/30/15</u> |
| Customer: | <u>Plains All American Pipeline</u> | End Date: | <u>9/30/15</u> |
| Unit Identification: | <u>EU-COMPWEST</u> | Facility: | <u>Bluewater Gas Storage</u> |
| Sample Location: | <u>Stack</u> | Recorded by: | <u>Ben Cacao</u> |
| RM Probe Type: | <u>Extractive (Dry)</u> | Fc Factor: | <u>-</u> |
| Load Level/Condition: | <u>85 Percent</u> | Fd Factor: | <u>8664</u> |

| Reference Method Results, As Measured Moisture Basis | | | | | | |
|--|---------|------------|----------|-------------|-------------|--------------------------|
| Run # | Date | Start Time | End Time | NOx ppmvd | CO ppmvd | O ₂ % v/v dry |
| 1 | 9/30/15 | 11:31 | 11:45 | 75.3 | 26.3 | 11.7 |
| 2 | 9/30/15 | 12:07 | 12:21 | 76.9 | 25.5 | 11.7 |
| 3 | 9/30/15 | 12:46 | 13:00 | 76.7 | 25.4 | 11.7 |
| Average | | | | 76.3 | 25.8 | 11.7 |

| Emission Rate Calculation Summary | | | | | |
|-----------------------------------|--------------|--------------|-------------|-------------|---------------------|
| Run # | NOX lb/MMBtu | CO lb/MMBtu | NOx lb/hr | CO lb/hr | Heat Input MMBtu/hr |
| 1 | 0.176 | 0.037 | 5.40 | 1.15 | 30.68 |
| 2 | 0.181 | 0.037 | 5.54 | 1.12 | 30.68 |
| 3 | 0.180 | 0.036 | 5.53 | 1.11 | 30.68 |
| Average | 0.179 | 0.037 | 5.49 | 1.13 | 30.68 |

| 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 | 16.8 | 3,914 | 0.63 | 0.133 |
| 2 | 16.4 | 3,914 | 0.64 | 0.130 |
| 3 | 16.3 | 3,914 | 0.64 | 0.129 |
| Average | 16.5 | 3,914 | 0.64 | 0.131 |



GASEOUS TEST RESULTS SUMMARY

| | | | |
|-----------------------|-------------------------------------|--------------|------------------------------|
| Project Number: | <u>241561</u> | Start Date: | <u>9/30/15</u> |
| Customer: | <u>Plains All American Pipeline</u> | End Date: | <u>9/30/15</u> |
| Unit Identification: | <u>EU-COMP NORTH</u> | Facility: | <u>Bluewater Gas Storage</u> |
| Sample Location: | <u>Stack</u> | Recorded by: | <u>Ben Cacao</u> |
| RM Probe Type: | <u>Extractive (Dry)</u> | Fc Factor: | <u>-</u> |
| Load Level/Condition: | <u>63%</u> | Fd Factor: | <u>8664</u> |

| Reference Method Results, As Measured Moisture Basis | | | | | | |
|--|---------|------------|----------|--------------|------------|--------------------------|
| Run # | Date | Start Time | End Time | NOx ppmvd | CO ppmvd | O ₂ % v/v dry |
| 1 | 9/30/15 | 8:38 | 8:52 | 353.5 | 3.0 | 7.5 |
| 2 | 9/30/15 | 9:23 | 9:37 | 351.0 | 2.5 | 7.5 |
| 3 | 9/30/15 | 10:03 | 10:17 | 341.7 | 2.3 | 7.5 |
| Average | | | | 348.8 | 2.6 | 7.5 |

| Emission Rate Calculation Summary | | | | | |
|-----------------------------------|--------------|--------------|-------------|-------------|---------------------|
| Run # | NOx lb/MMBtu | CO lb/MMBtu | NOx lb/hr | CO lb/hr | Heat Input MMBtu/hr |
| 1 | 0.571 | 0.003 | 3.65 | 0.02 | 6.40 |
| 2 | 0.567 | 0.002 | 3.63 | 0.02 | 6.40 |
| 3 | 0.553 | 0.002 | 3.54 | 0.01 | 6.40 |
| Average | 0.563 | 0.003 | 3.61 | 0.02 | 6.40 |

| 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 | 1.3 | 667 | 2.48 | 0.013 |
| 2 | 1.1 | 667 | 2.47 | 0.011 |
| 3 | 1.0 | 667 | 2.41 | 0.010 |
| Average | 1.1 | 667 | 2.45 | 0.011 |