

RECEIVED NOV 1 4 2014 AIR QUALITY DIV.

## J.

Count on Us

## **Compliance Test Report**

## **RAY COMPRESSOR STATION EUENGINE 3-1, 3-2, 3-3, 3-4 & 3-5**

Ray Compressor Station 68536 A Road, Route 1 Ray, Michigan 49099

Test Dates: September 23-25, 2014

Report Submitted: November 13, 2014

**Report Revision 0** 

Test Performed by the Consumers Energy Company Regulatory Compliance Testing Section Laboratory Services Department

## RECEIVED

#### **1.0 INTRODUCTION**

#### Identification, location and dates of tests

AIR QUALITY DIV. This report summarizes the results of testing conducted on September 23-25, 2014 at Consumers Energy Company's (CEC) Ray Compressor Station. CEC's Regulatory Compliance Testing Section (RCTS) conducted performance tests on five (5) 4-stroke lean burn (4SLB) natural gas-fired, reciprocating internal combustion engines (RICE), identified as EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4 and EUENGINE3-5. The engines are located and operating at the Ray Compressor Station in Armada, Michigan.

#### Purpose of testing

(

The purpose of the testing was to evaluate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE), 40 CFR Part 63, Subpart ZZZZ. This testing event represented the second semi-annual performance test for EUENGINE3-5. The remaining four engines were included in this test event to align the engine test schedule.

| Unit   | Parameter to be Tested  | Underlying Regulation |
|--|---|-----------------------|
| EUENGINE3-1,<br>EUENGINE3-2,<br>EUENGINE3-3,<br>EUENGINE3-4 &<br>EUENGINE3-5 | Carbon Monoxide (CO) & diluent gas<br>(Oxygen (O <sub>2</sub> )or Carbon Dioxide (CO <sub>2</sub> )) both<br>upstream and downstream from the oxidation<br>catalyst (% reduction) | Subpart ZZZZ          |

#### Brief description of source

The Ray Compressor Station is a natural gas compressor station. The purpose of the facility is to maintain pressure of natural gas in order to move it in and out of storage reservoirs and along the pipeline system. Each RICE is a 4SLB, Caterpillar Model G3616 engine, designed to exclusively fire natural gas and equipped with oxidation catalysts to reduce CO and VOC emissions.

#### Names, addresses, and telephone numbers of the contacts for information regarding the test and the test report, and names and affiliation of all personnel involved in conducting the testing

The testing was performed by CEC RCTS employees Joe Mason and Brian Miska. MDEQ representatives Mr. Mark Dziadosz and Mr. Robert Elmouchi observed portions of the test. Ray Field Leader, Mr. Charles Kelly, coordinated the test and Station Operator, Branden Collins, collected operating data. The following table contains the test program participant contact information.

NOV 1 4 2014

#### **Test Program Participants** Ray Compressor Station

(

ĺ

(

| Test Program Participants<br>Ray Compressor Station |  |   |  |  |
|---|--|---|--|--|
| a Shara Par   |  |   |  |  |
| Responsible<br>Party                                | Address  | Contact   |  |  |
| Test Facility                                       | Ray Compressor Station<br>69333 Omo Road<br>Armada, Michigan 48005   | Mr. Charles Kelly<br>Compression Field Leader<br>586-784-2096<br>charles.kelly@cmsenergy.co |  |  |
| Corporate<br>Air Quality<br>Contact                 | Consumers Energy Company<br>Environmental Services Department<br>1945 West Parnall Road<br>Jackson, Michigan 49201       | Ms. Amy Kapuga<br>517-788-2201<br>amy.kapuga@cmsenergy.co                                   |  |  |
| Test<br>Representative                              | Consumers Energy Company<br>Regulatory Compliance Testing Section<br>17010 Croswell Street<br>West Olive, Michigan 49460 | Mr. Joe Mason<br>616-738-3385<br>joe.mason@cmsenergy.co                                     |  |  |
| State   | Michigan<br>Department of Environmental Quality  | Mr. Mark Dziadosz<br>586-753-3731<br>dziadoszm@michigan.gov                                 |  |  |
| Representative                                      | 525 W. Allegan, Constitution Hall<br>Lansing, Michigan 48909   | Mr. Robert Elmouchi<br>586-753-3736<br>elmouchir@michigan.gov                               |  |  |

2

#### 2.0 SUMMARY OF RESULTS

#### **Operating Data**

Operating data collected during each test run included catalyst inlet temperature, pressure drop across catalyst, engine load, ambient temperature, barometric pressure, humidity, fuel flow rate, suction pressure, discharge pressure, speed and horsepower. The purpose of documenting engine horsepower is to verify engine load during the performance test, as Subpart ZZZZ § 63.6620 (b) states *the test must be conducted at any load condition within plus or minus 10 percent of 100 percent load*. Engine load was obtained by dividing the recorded horsepower value observed during each test run by the rated engine horse power.

#### Applicable Permit Number

The Ray Compressor Station is currently operating pursuant to the terms and conditions of Renewable Operating Permit (ROP) No. MI-ROP-B6636-2010 and PTI No. 206-09. Performance tests were conducted, as required, on five (5) 4SLB natural gas-fired RICE, identified as EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4 and EUENGINE3-5.

#### Results

The purpose of the testing was to evaluate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE), 40 CFR Part 63, Subpart ZZZZ. This testing event represented the second semiannual performance test for EUENGINE3-5. The remaining four engines were included in this test event to align the engine test schedule. A summary of the test results are presented below.

| Source      | CO<br>Reduction Efficiency<br>(%)<br>[ZZZZ Limit = ≥93%] | Catalyst Pressure<br>Drop<br>(Inches Water<br>Gauge) | Catalyst<br>Inlet<br>Temperature<br>(°F) |
|-------------|--|--|--|
| EUENGINE3-1 | 98.8   | 2.47   | 834.8                                    |
| EUENGINE3-2 | 98.9   | 2.28   | 869.5                                    |
| EUENGINE3-3 | 98.7   | 2.05   | 852.4                                    |
| EUENGINE3-4 | 99.3   | 2.21   | 843.8                                    |
| EUENGINE3-5 | 99.2   | 2.23   | 809.8                                    |

#### Summary of 40 CFR 63 Subpart ZZZZ RICE Carbon Monoxide Reduction, Catalyst Pressure Drop & Catalyst Inlet Temperature Results

Based on the dry CO concentrations measured at the oxidation catalyst inlet and outlet corrected to  $15\% O_2$ , the above results indicate the oxidation catalysts are operating at a CO reduction efficiency greater than the 93 percentage requirement in Subpart ZZZZ.

#### **3.0 SOURCE DESCRIPTION**

#### **Description of Process**

The Ray Compressor Station is a natural gas compressor station. The purpose of the facility is to maintain pressure of natural gas in order to move it in and out of storage reservoirs and along the pipeline system. Five (5) natural gas-fired reciprocating engine driven compressor units, designated at EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4 and EUENGINE3-5, were installed in 2013 to maintain station reliability, working in conjunction with several other RICE located at the facility.

The  $NO_x$  emissions from each of the engines are minimized through the use of lean-burn combustion technology. Lean-burn combustion refers to a high level of excess air (generally 50% to 100% relative to the stoichiometric amount) in the combustion chamber. The excess air absorbs heat during the combustion process, thereby reducing the combustion temperature and pressure and resulting in lower  $NO_x$  emissions.

Each of the engines is also equipped with oxidation catalysts. The catalysts are designed in a modular manner, and each engine is equipped with four catalyst modules. The catalysts use proprietary materials in order to lower the temperature at which the oxidation process occurs for CO and other organic compounds. As a result, the oxidation process will occur at the exhaust gas temperatures generated by the engines. The catalyst vendor has guaranteed a minimum CO destruction efficiency of 93%. The estimated formaldehyde and non-methane, non-ethane hydrocarbon (NMNEHC) destruction efficiencies are 85% and 75%, respectively.

(

í

**Process Flow Sheet or Diagram** NA

Type and Quantity of Raw Material Processed During the Tests NA

#### Maximum and Normal Rated Capacity of the Process

The Ray Compressor Station operates five (5) natural gas-fired, 4SLB Caterpillar engines equipped with oxidation catalysts for CO and formaldehyde reduction. These Model 3616's are operated to maintain pressure of natural gas in order to move it in and out of storage reservoirs and along the pipeline system. The facility also includes one natural gas-fired, 4SLB Caterpillar engine, without add-on controls, which supplies emergency power. The following table contains pertinent engine specifications.

| Parameter <sup>1</sup>       | EUENGINE3-1 through<br>EUENGINE3-5 |  |  |
|------------------------------|------------------------------------|--|--|
| Make                         | Caterpillar                        |  |  |
| Model                        | G3616                              |  |  |
| Output (brake-horsepower)    | 4,735                              |  |  |
| Heat Input, LHV (mmBtu/hour) | 32.0                               |  |  |
| Exhaust Gas Temp. (°F)       | 856                                |  |  |

#### Summary of Specifications for EUENGINE3-1 through EUENGINE3-5

<sup>1</sup> All engine specifications are based upon vendor data for operation at 100% of rated engine capacity.

#### Description of Process Instrumentation Monitored During the Test

Engine process data collected included catalyst inlet temperature, pressure drop across the catalyst, engine load, horsepower, ambient temperature, barometric pressure, humidity, fuel flow rate, suction pressure and discharge pressure. The preceding data was logged at least once every clock minute and then averaged to determine the per-test run values.

Ĺ

#### 4.0 SAMPLING AND ANALYTICAL PROCEDURES

#### Description of sampling train(s) and field procedures

Triplicate one-hour runs were performed on each engine to determine CO reduction efficiency by concurrently measuring  $O_2$  and CO concentrations at the oxidation catalyst inlet and outlet (engine exhaust). The U.S. EPA Test Methods were used exclusively, as described within the test protocol. The CO reduction efficiency test methods and calculations were consistent with those specified in 40 CFR Part 63, Subpart ZZZZ §63.6620 Equation 1 and Table 4. ĺ

Ĺ

The sampling locations are a-typical (relative to U.S. EPA Method 1 "Sample and Velocity Traverses for Stationary Sources" criteria) at the oxidation catalyst inlet, due to the proprietary nature and design of that abatement equipment. Figure 2 of this report illustrates the path of engine effluent as it enters and exits the oxidation catalyst. In an attempt to meet the gas stratification requirements of U.S. EPA Method 7E, measurements at each engine catalyst inlet were performed by selecting and traversing 2 points within each of the two catalyst inlet "ducts". The design and dimension of these ducts precluded the use of more than 2 traverse points. Conversely, the engine exhaust traverse points were typical from a U.S. EPA Method 1 perspective. As illustrated in Figure 2, each engine exhausts via a single duct, so the initial engine exhaust traverses included 12 traverse points, meeting U.S. EPA Method 7E requirements. While performing initial stratification traverses at each location, it was apparent the gas stream concentrations varied significantly at each traverse point, rather than at consecutive traverse points. These findings essentially indicated the engine exhaust varied temporally at each traverse point such that the intent of the stratification test could not be satisfied, thus negating the purpose of the exercise. Subsequently, after establishing similarly varying effluent existed at each of the other engine sample locations, all test runs performed thereafter utilized a single traverse point, located as close to the middle of the duct as practicable.

All components of the  $O_2$  and CO extractive sample systems in contact with flue gas were constructed of Type 316 stainless steel and/or Teflon. Engine exhaust gas was drawn from the stack via a sample probe and line and routed through an ice bath gas dryer for moisture removal prior to be distributed from a gas manifold into individual analyzers. The output signal from each analyzer was connected to a computerized data acquisition system (DAS). The analyzers were calibrated with U.S. EPA Protocol calibration gases at a minimum of three points: low (0-20% of calibration span), mid-level (40-60% of calibration span) and highlevel gas (equal to the calibration span) and operated to insure that zero drift, calibration gas drift, bias and calibration error met the specified method requirements. The extractive sample system apparatus diagram is shown in Figure 1.

The data measured from the pollutant and diluent analyzers was averaged for each run and corrected for drift and bias. The inlet and outlet CO concentrations in part per million by volume (ppmv) used for determining CO reduction efficiency were also corrected to 15 percent  $O_2$  using Equation 19-1 in 40 CFR 60, Appendix A, Method 19. The percent CO reduction efficiency was then calculated using Equation 1 in 40 CFR 63, Subpart ZZZZ § 63.6620(e)(1). The extractive sample system apparatus diagram is shown in Figure 1.

O<sub>2</sub> diluent concentrations were monitored using a non-dispersive infrared (NDIR) and paramagnetic analyzer, respectively, following the guidelines of U.S. EPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from a Stationary Source (Instrumental Analyzer Procedure)*.

The CO concentrations were measured using an NDIR analyzer following the guidelines of U.S. EPA Reference Method 10, *Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure).* 

#### **Quality Assurance Procedures**

Each U.S. EPA reference method performed during this test contains specific language stating that to obtain reliable results, persons using these methods should have a thorough knowledge of the techniques associated with each method. To that end, CEC RCTS attempts to minimize any factors which could cause sampling errors by implementing a quality assurance (QA) program into every component of field testing, including the following information.

U.S. EPA Protocol gas standards certified according to the U.S. EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997 or May, 2012 version and certified to have a total relative uncertainty of  $\pm 1$  percent were used to calibrate the analyzers during the test program. Although not required in the context of this Parts 60 and 63 test program, the vendors providing the calibration gases also participate in the Protocol Gas Verification Program (PGVP), an EPA audited program recently developed for 40 CFR Part 75.

The extractive sample system instruments were calibrated and operated following the appropriate method guidelines, based on specifications contained in Method 7E (as referenced in Methods 3A and 10). Before daily testing began, an analyzer calibration error (ACE) test was conducted by introducing the calibration gases directly into each analyzer. If the measured response didn't meet the  $\pm 2$  percent of instrument span specification, or within 0.5 ppmv absolute difference to pass the ACE check, appropriate action was taken and the ACE was repeated. Prior to beginning the first run, an initial system bias check was conducted by introducing the low and upscale calibration gases into the sampling system at the probe outlet and drawing them through the sample conditioning system in the same manner as the exhaust gas sample, while measuring the instrument response. Each instrument response must meet a specification of  $\leq 5.0$  percent of instrument span.

Low and upscale bias calibrations were performed after each run thereafter to quantify system calibration drift and bias. During the initial system bias tests, system response time was measured and the sample flow rate throughout the remainder of the test was monitored to maintain the sample flow rate within 10 percent of the average flow rate observed during the response time test. Sampling for each run was started after twice the system response time had elapsed.

**Description of recovery and analytical procedures** NA

Dimensioned sketch showing all sampling ports in relation to breeching and to upstream and downstream disturbances or obstructions of gas flow and a sketch of cross-sectional view of stack indicating traverse point locations and exact stack dimensions The exhaust stack configuration, including hand markups which are intended to provide an illustration of the flue gas path through the stack, is shown in Figure 2.

#### 5.0 TEST RESULTS AND DISCUSSION

## Detailed tabulation of results, including process operating conditions and flue gas conditions

Tables 1-5 contain a summary of the CO percent reductions for each of the units during testing conducted September 23-25, 2014. RICE operating data, calculation spreadsheets, field data sheets and calibration information are contained in Attachments 1 - 4.

## Discussion of significance of results relative to operating parameters and emission regulations

The average percent reduction of CO for each of the engines was greater than the minimum required destruction efficiency. Thus, EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4 and EUENGINE3-5 are in compliance with the CO percent reduction across the catalyst. In addition, the catalyst inlet temperatures and pressure drop across the catalyst were monitored continuously throughout testing and were shown to be within the required ranges.

Discussion of any variations from normal sampling procedures or operating conditions, which could have affected the results NA

Documentation of any process or control equipment upset condition which occurred during the testing NA

Description of any major maintenance performed on the air pollution control device(s) during the three month period prior to testing NA

In the event of a re-test, a description of any changes made to the process or air pollution control device(s) NA

*Results of any quality assurance audit sample analyses required by the reference method* NA

#### Calibration sheets for the dry gas meter, orifice meter, pitot tube, and any other equipment or analytical procedures which require calibration

Attachment 4 contains the analyzer calibration data, response time test results and calibration gas Certificates of Analysis. The results of stratification testing are not included as they ultimately were not used to determine the appropriate number of traverse points. The stratification test requirements in Method 7E do not lend themselves well to the small-diameter stacks of stationary combustion engines, which are noted for well-mixed yet temporally varying effluent. These exhaust gas attributes rarely result in a meaningful stratification test because any measured stratification using Method 7E techniques is indistinguishable from the

natural temporal "stratification" created by the process. Therefore, RCTS performed initial stratification tests at each source in an attempt to corroborate any stratification beyond existing temporal variations.

1

{

Ĭ.

#### Sample calculations of all the formulas used to calculate the results

Sample calculations for all formulas used in the test report are contained in Attachment 5.

## Copies of all field data sheets, including any pre-testing, aborted tests, and/or repeat attempts

Please refer to Attachment 1 for process data collected during the test runs; Attachment 2 for calculation spreadsheets for each of the test runs; and Attachment 3 for data sheets with the measured concentrations for each test run.

*Copies of all laboratory data including QA/QC* NA

# TABLE 1SUMMARY OF CO REDUCTION EFFICIENCYRAY COMPRESSOR STATIONEUENGINE3-1September 24, 2014

í

| Time Davied   | Run 1     | Run 2     | Run 3     | Average |
|---|-----------|-----------|-----------|---------|
|   | 0919-1019 | 1031-1131 | 1145-1245 | s       |
| Process Conditions  |           |           |           |         |
| Engine Speed, Revolutions Per Minute:                                     | 967.9     | 970.6     | 974.1     | 970.9   |
| Brake Horsepower:   | 4730      | 4727      | 4721      | 4726    |
| Load, Percent:  | 103.2     | 102.8     | 102.3     | 102.8   |
| Fuel Flow, SCFM   | 568.6     | 566.1     | 565.8     | 566.8   |
| Suction Pressure, PSIG:   | 573.9     | 574.0     | 573.9     | 573.9   |
| Catalyst Delta P, Inches of Water:  | 2.47      | 2.47      | 2.47      | 2.47    |
| Catalyst Inlet Temperature, degrees F:                                    | 836.8     | 834.1     | 833.5     | 834.8   |
| Inlet Gas Conditions  |           |           |           |         |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 12.1      | 12.1      | 12.2      | 12.1    |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 370.8     | 388.3     | 391.9     | 383.7   |
| Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):                 | 247.7     | 260.4     | 265.0     | 257.7   |
| Outlet Gas Conditions   |           |           |           |         |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 12.0      | 12.1      | 12.1      | 12.1    |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 4.6       | 4.9       | 4.0       | 4.51    |
| Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):           | 3.0       | 3.3       | 2.7       | 3.0     |
| CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ): | 98.8      | 98.7      | 99.0      | 98.8    |

## TABLE 2SUMMARY OF CO REDUCTION EFFICIENCYRAY COMPRESSOR STATIONEUENGINE3-2

September 24, 2014

| The Deviced   |           | Run 2     | Run 3     |                          |
|---|-----------|-----------|-----------|--------------------------|
| I ime Period  | 1331-1431 | 1440-1540 | 1550-1650 | Averages                 |
| Process Conditions  |           |           |           |                          |
| Engine Speed, Revolutions Per Minute:                                     | 944.9     | 957.0     | 950.4     | 950.8                    |
| Brake Horsepower:   | 4518      | 4520      | 4547      | 4528                     |
| Load, Percent:  | 101.0     | 99.7      | 101.0     | 100.6                    |
| Fuel Flow, SCFM   | 553.7     | 555.7     | 558.1     | 555.9                    |
| Suction Pressure, PSIG:   | 573.5     | 573.5     | 572.2     | 573.1                    |
| Catalyst Delta P, Inches of Water:  | 2.28      | 2.28      | 2.29      | 2.28                     |
| Catalyst Inlet Temperature, degrees F:                                    | 868,8     | 871.2     | 868.5     | 869.5                    |
| Inlet Gas Conditions  |           |           |           |                          |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 11.9      | 11.9      | 11.9      | 11.9                     |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 315.2     | 318.7     | 317.6     | 317.1                    |
| Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):                 | 207.0     | 209.0     | 208.3     | 208.2                    |
| Outlet Gas Conditions   |           |           |           | ſ                        |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 11.7      | 11.7      | 11.7      | <b>11.7</b> <sup>\</sup> |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 3.4       | 4.0       | 3.8       | 3.75                     |
| Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):           | 2.2       | 2.6       | 2.5       | 2.4                      |
| CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ): | 99.0      | 98.8      | 98.8      | 98.9                     |

i

#### TABLE 3 SUMMARY OF CO REDUCTION EFFICIENCY RAY COMPRESSOR STATION EUENGINE3-3

Í

September 25, 2014

| Time Davied   |           | Run 2     | Run 3     | Attonages |
|---|-----------|-----------|-----------|-----------|
|   | 1331-1431 | 1440-1540 | 1550-1650 | Averages  |
| Process Conditions  |           |           |           |           |
| Engine Speed, Revolutions Per Minute:                                     | 936.2     | 931.2     | 931.8     | 933.1     |
| Brake Horsepower:   | 4453      | 4453      | 4449      | 4452      |
| Load, Percent:  | 100.4     | 101.0     | 100.8     | 100.7     |
| Fuel Flow, SCFM   | 546.1     | 541.4     | 541.9     | 543.1     |
| Suction Pressure, PSIG:   | 574.7     | 574.5     | 574.3     | 574.5     |
| Catalyst Delta P, Inches of Water:  | 2.05      | 2.05      | 2.05      | 2.05      |
| Catalyst Inlet Temperature, degrees F:                                    | 853.5     | 852.3     | 851.4     | 852.4     |
| Inlet Gas Conditions  |           |           |           |           |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 11.8      | 11.9      | 11.9      | 11.9      |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 323.7     | 322.4     | 324.6     | 323.6     |
| Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):                 | 210.8     | 211.2     | 211.5     | 211.1     |
| Outlet Gas Conditions   |           |           |           |           |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 11.9      | 11.9      | 11.9      | 11.9      |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 4.1       | 4.7       | 3.8       | 4.2       |
| Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):           | 2.7       | 3.1       | 2.5       | 2.7       |
| CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ): | 98.7      | 98.6      | 98.8      | 98.7      |

# TABLE 4SUMMARY OF CO REDUCTION EFFICIENCYRAY COMPRESSOR STATIONEUENGINE3-4September 23, 2014

| Time Period   | Run 1     | Run 2     | Run 3     | Averages |
|---|-----------|-----------|-----------|----------|
| Process Conditions  | 1347-1447 | 1430-1330 | 1009-1709 |          |
| Engine Sneed Develutions Dev Minuter                                      | 802.7     | 201.2     | 007 0     | 000 0    |
| Eligine Speed, Revolutions Fei Winnite.                                   | 092.7     | 091.2     | 002.0     | 000.7    |
| Brake Horsepower:   | 4240      | 4238      | 4197      | 4225     |
| Load, Percent:  | 100.3     | 100.4     | 100,4     | 100.4    |
| Fuel Flow, SCFM   | 494.4     | 494.9     | 488.9     | 492.7    |
| Suction Pressure, PSIG:   | 574.4     | 574.4     | 574.4     | 574.4    |
| Catalyst Delta P, Inches of Water:  | 2.21      | 2.21      | 2.21      | 2.21     |
| Catalyst Inlet Temperature, degrees F:                                    | 842.7     | 844.0     | 844.6     | 843.8    |
| Inlet Gas Conditions  |           |           |           |          |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 12.0      | 12.0      | 12.0      | 12.0     |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 308.7     | 313.8     | 306.9     | 309.8    |
| Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):                 | 203.6     | 207.3     | 202.1     | 204.4    |
| Outlet Gas Conditions   |           |           |           | i`       |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 12.0      | 12.1      | 12.1      | 12.1     |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 2.6       | 0.9       | 2.7       | 2.1      |
| Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):           | 1.7       | 0.6       | 1.8       | 1.4      |
| CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ): | 99.2      | 99.7      | 99.1      | 99.3     |

#### TABLE 5 SUMMARY OF CO REDUCTION EFFICIENCY RAY COMPRESSOR STATION EUENGINE3-5

September 23, 2014

|   |           | Run 2     | Run 3     |          |
|---|-----------|-----------|-----------|----------|
| lime Period   | 0917-1017 | 1027-1127 | 1144-1244 | Averages |
| Process Conditions  |           |           |           |          |
| Engine Speed, Revolutions Per Minute:                                     | 951.1     | 951.7     | 956.3     | 953.1    |
| Brake Horsepower:   | 4737      | 4737      | 4735      | 4736     |
| Load, Percent:  | 105.2     | 105.1     | 104.6     | 105.0    |
| Fuel Flow, SCFM   | 543.8     | 544.7     | 547.1     | 545.2    |
| Suction Pressure, PSIG:   | 573.6     | 573.9     | 574.2     | 573.9    |
| Catalyst Delta P, Inches of Water:  | 2.23      | 2.23      | 2.23      | 2,23     |
| Catalyst Inlet Temperature, degrees F:                                    | 809.6     | 808.8     | 811.0     | 809.8    |
| Inlet Gas Conditions  |           |           |           |          |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 13.7      | 13.7      | 13.7      | 13.7     |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 363.9     | 360.7     | 343.5     | 356.1    |
| Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):                 | 296.1     | 293.7     | 280.2     | 290.0    |
| Outlet Gas Conditions   |           |           |           |          |
| Drift Corrected Oxygen Concentration, Dry (Percent):                      | 12.4      | 12.4      | 12.4      | 12.4     |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):               | 3.1       | 3.6       | 3.4       | 3.4      |
| Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):           | 2.1       | 2.5       | 2.4       | 2.3      |
| CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ): | 99.3      | 99.1      | 99.2      | 99.2     |

### FIGURE 1

## Sampling Apparatus Schematic



\_

### FIGURE 2 Caterpillar Model G3616 Stack Schematic

. ....

## RECEIVED

NOV 1 4 2014

AIR QUALITY DIV.



ĺ

Í