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EMISSIONS TEST REPORT

for

CARBON MONOXIDE (CO) EMISSIONS

UNIT 1

**DTE-Gas, Willow Compressor Station
Ypsilanti, Michigan**

June 4, 2014

Prepared By
Environmental Management & Resources
Environmental Field Services Group
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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed emissions testing at the DTE-Gas, Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork, performed on June 4, 2014 was conducted to satisfy requirements of the Michigan Permit to Install No. 246-07 and 40CFR Part 63 Subpart ZZZZ. The permit requires annual catalyst efficiency testing (permit allows annual testing after demonstrating two (2) successful semi-annual tests, which were completed in 2010). Emission tests were performed on Unit 1 for carbon monoxide (CO) emission rate and destruction efficiency.

The results of the emissions testing are highlighted below:

**CO Emissions Test Results
Willow Compressor Station - Unit 1
June 4, 2014**

Unit 1 – Operating Load (Brake Horsepower)	Average CO Emission Rate (gram/BHp-Hr)	Average CO Destruction Efficiency (%)
4,324	2.16	98.5

Permit Limits: CO = 2.5 grams/BHp-Hr
CO-DE = 93%

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1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed emissions testing at the DTE-Gas, Willow Compressor Station, located in Ypsilanti, Michigan. The fieldwork, performed on June 4, 2014, was conducted to satisfy requirements of the Michigan Air Permit to Install No. 246-07 and 40CFR Part 63 Subpart ZZZZ. The permit requires annual catalyst efficiency testing (permit allows annual testing after demonstrating two (2) successful semi-annual tests, which were completed in 2010). Emission tests were performed on Unit 1 for carbon monoxide (CO) emission rate and destruction efficiency.

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 3A and 10.

The fieldwork was performed in accordance with EPA Reference Methods and EM&R's Intent to Test¹, Test Plan Submittal. The following DECS personnel participated in the testing program: Mark Grigereit, Senior Environmental Specialist and Fred Meinecke, Senior Engineering Technician-EM&R. Mr. Grigereit was the project leader. Mr. Nathan Hude (MDEQ) approved the Test Plan².

2.0 SOURCE DESCRIPTION

The Willow Compressor Station located at 3020 East Michigan Avenue, Ypsilanti, Michigan, employs the use of a Caterpillar 3616 natural gas-fired 4,735 Horse Power reciprocating engine (Unit 1). The engine generates line pressure assisting the transmission of natural gas throughout the pipeline transmission system in SE Michigan.

The emissions from the engine are exhausted through a catalyst bed and to the atmosphere through an individual exhaust stack. The composition of the emissions from the engine depends both upon the speed of the engine and the torque delivered to the compressor. Ambient atmospheric conditions, as it affects the density of air, limit the speed and torque at which the engine can effectively operate.

During the emissions testing the engine was operated at 91.4% load conditions. There was no demand for gas on the system, therefore, the gas was run in a loop. This caused the line pressure to be low making it difficult to get the differential needed to run the engine at a higher load. A higher load on the engine was tried multiple times throughout the day but a high temperature alarm on the cylinders threatened engine shut down.

¹ MDEQ, Test Plan, Submitted April 14, 2014. (Attached-Appendix A)

² MDEQ, Approval Letter, Received April 21, 2014. (Attached-Appendix A)



A schematic representation of the engine exhaust and sampling locations are presented in Figure 1. Sampling was performed in the duct prior to and immediately following the catalyst bed.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

DTE Energy obtained emissions measurements in accordance with procedures specified in the USEPA *Standards of Performance for New Stationary Sources*. The sampling and analytical methods used in the testing program are indicated in the table below

Sampling Method	Parameter	Analysis
USEPA Method 3A	Oxygen	Instrumental Analyzer Method
USEPA Method 10	Carbon Monoxide	NDIR Instrumental Analyzer Method

3.1 OXYGEN AND CARBON MONOXIDE (USEPA METHODS 3A AND 10)

3.1.1 Sampling Method

Oxygen (O₂) emissions were evaluated using USEPA Method 3A, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight (Instrumental Analyzer Method)". The O₂ analyzer utilizes a paramagnetic sensor.

Carbon monoxide (CO) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources". The CO analyzer utilizes a NDIR detector.

3.1.2 O₂ and CO Sampling Train

The EPA Methods 3A and 10 sampling system (Figure 2) consisted of the following components:

- (1) Single-point stainless steel sampling probe.
- (2) Heated Teflon™ sampling line.
- (3) Universal® gas conditioner with particulate filter.
- (4) Flexible unheated Teflon™ sampling line.



- (5) Servomex 1400 O₂/CO₂ gas analyzer and TECO 48i NDIR CO gas analyzer.
- (6) Data Acquisition System.

Refer to Figure 2 for a schematic of the O₂ and CO sampling train.

3.1.3 Sampling Train Calibration

The O₂ / CO sampling trains were calibrated according to procedures outlined in USEPA Methods 3A & 10. Zero, span, and mid range calibration gases were introduced directly into the CO and O₂ analyzers to determine the instruments linearity. A zero and mid range span gas was then introduced through the entire sampling system to determine sampling system bias for each analyzer. Additional system calibrations were performed at the completion of each test.

3.1.4 Sampling Duration & Frequency

The emissions testing of the engine consisted of triplicate 60-minute samples at the inlet and exhaust of the catalyst. Testing was conducted at three points across the diameter of the duct during each run. Sampling was performed simultaneously for O₂ and CO. Data was recorded as 1-minute averages.

3.1.5 Quality Control and Assurance (O₂ and CO)

All sampling and analytical equipment was calibrated according to the guidelines referenced in Methods 3A and 10. Calibration gases were EPA Protocol 1 gases. The CO analyzers spans were 0-966.1 ppm and 0-49.3 ppm ranges. The O₂ analyzers spans were 0-17.8% and 0-18.3% ranges.

Calibration gas certification sheets are located in Appendix C.

3.1.6 Data Reduction

The O₂ and CO emission readings in percent (%) and parts per million (ppm) respectively were recorded at 10-second intervals and averaged to 1-minute increments. The CO emissions were reported in grams per Brake Horsepower Hour (g/BHp-Hr) and percent Destruction Efficiency (DE) as required by PTI No. 246-07. Emission calculations are based upon calculations found in USEPA Methods 3A, 7E, 10 and 19. Example calculations are located in Appendix D.

The 1-minute readings collected are located in Appendix B.



4.0 OPERATING PARAMETERS

The test program included the collection of engine speed (RPM), engine load (%), fuel flow (scfh), catalyst inlet and outlet temperature ($^{\circ}$ F), catalyst pressure drop ($^{\prime\prime}$ H₂O), and generator operating hours (kW-hour) along with other engine data. Operational data collected during the testing is located in Appendix E.

5.0 RESULTS

Table 1 presents the CO emission testing results from Unit 1. The CO emissions are presented in grams per brake horsepower hour (g/Bhp-Hr), prior to and after the catalyst, and the destruction efficiency in percent (%). Also presented are the Unit load in percent (%), speed (rpm), brake horsepower, and heat input (MMBtu/Hr) for each test. The Results of the testing indicate that Unit 1 is in compliance with permit requirements for CO of 2.5 g/Bhp-Hr and 93% destruction efficiency.



6.0 CERTIFICATION STATEMENT

"I certify that I believe the information provided in this document is true, accurate, and complete. Results of testing are based on the good faith application of sound professional judgment, using techniques, factors, or standards approved by the Local, State, or Federal Governing body, or generally accepted in the trade."



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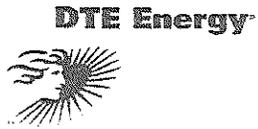


TABLE NO. 1
CARBON MONOXIDE (CO) EMISSION TESTING RESULTS
 Unit 1 - Willow Run Compressor Station
 June 4, 2014

Test	Time	Load (%)	Speed (RPM)	Brake-HP	Heat Input (MMBtu/Hr)	Oxygen ⁽¹⁾		CO Emissions ⁽¹⁾		Destruction Efficiency (%)
						Inlet (%)	Outlet (%)	Inlet (g/BHp-Hr)	Outlet (g/BHp-Hr)	
Run - 1	8:41-9:41	91.7	999.0	4,336	33.41	11.9	11.7	2.15	0.03	98.6
Run - 2	9:55-10:55	91.3	998.7	4,319	33.26	11.9	11.8	2.17	0.04	98.4
Run - 3	11:10-12:10	<u>91.3</u>	<u>998.3</u>	<u>4,317</u>	<u>33.22</u>	<u>11.8</u>	<u>11.7</u>	<u>2.16</u>	<u>0.03</u>	<u>98.6</u>
	<i>Avg:</i>	<i>91.4</i>	<i>998.7</i>	<i>4,324</i>	<i>33.30</i>	<i>11.9</i>	<i>11.7</i>	<i>2.16</i>	<i>0.03</i>	<i>98.5</i>

⁽¹⁾ Corrected for analyzer drift per USEPA method 7E

CO Permit Limits:

2.5 g/BHp-Hr

93% DE

**Figure 1 – Sampling Location
Willow Compressor Station
June 4, 2014**

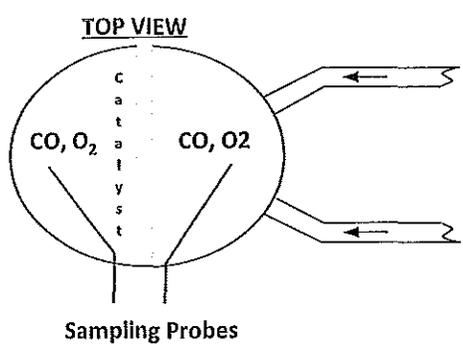
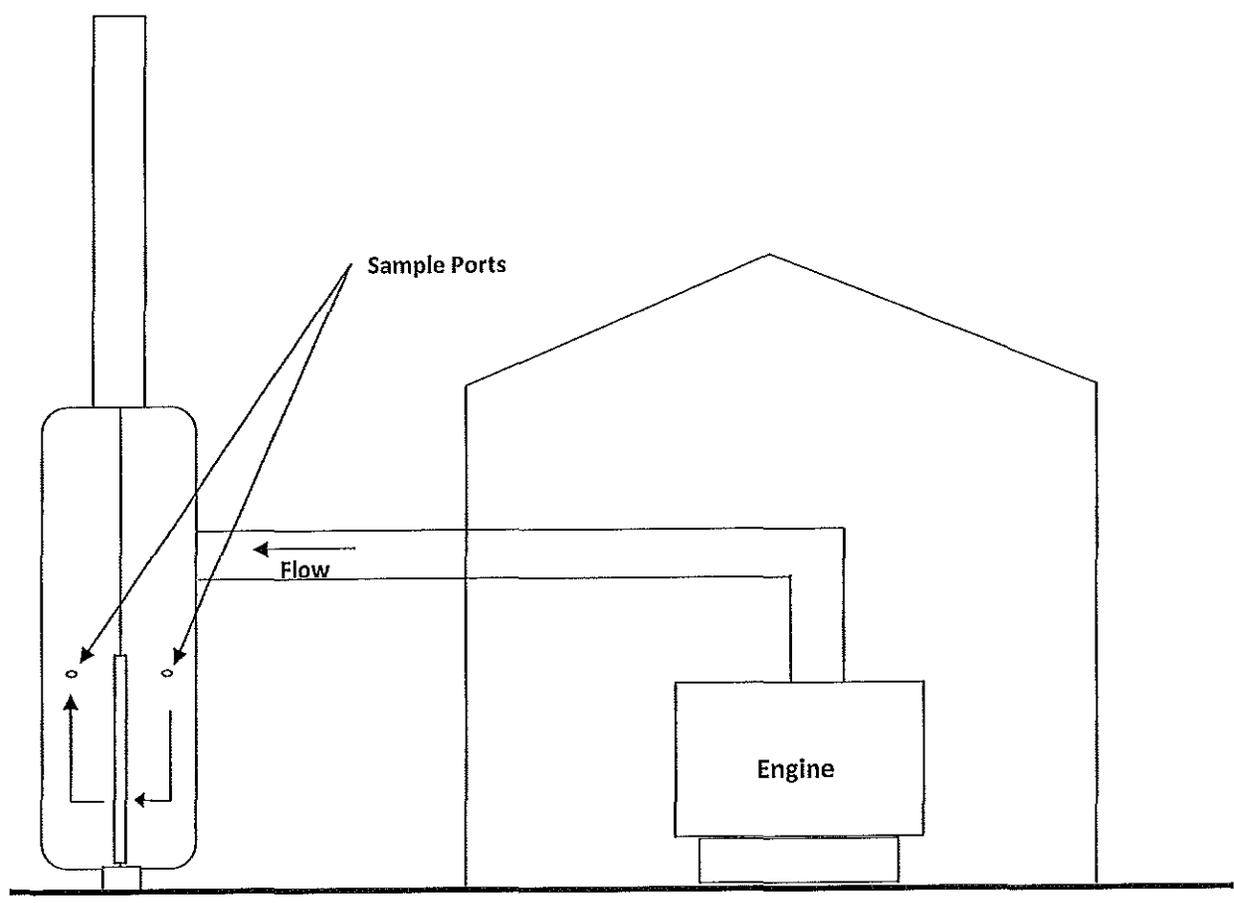




Figure 2 – EPA Methods 3A/10
Willow Compressor Station
June 4, 2014

