



# Compliance Test Report

in accordance with the

**40CFR60**

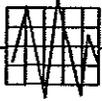
**Midland Cogeneration Venture**

**Midland, Michigan**

**EUBOILER1-EUBOILER6 (Units 16-21)**

**October 2014**

Prepared By:  
Spectrum Systems, Inc.  
3410 W. Nine Mile Rd.  
Pensacola, Fl. 32526  
(850)-944-3392



## I. INTRODUCTION

Midland Cogeneration Venture (MCV) contracted Spectrum Systems, Inc., to perform compliance testing to quantify the Volatile organic compounds emission as VOC lbs/MMBtu in the gaseous effluent from the gas fired Units 16-21 (EUBOILER 1 – EUBOILER 6) located at 100 Progress Place in Midland, Michigan.

Testing was performed to satisfy the requirements contained in the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) No. MI-ROP-B6527-2014.

The testing was conducted October 27-30, 2014 by James Garrett, Rick Artybridge, Sean Myrick, Wayne Smith and Gary Martin of Spectrum Systems, Inc. (SSI). Ms. Barbara Vanderkelen of MCV coordinated the test events and Mr. Jim Lazzaro collected the process data. A representative from MDEQ was on site to observe testing.

Emissions compliance testing was conducted according to the procedures in the Code of Federal Regulations, Title 40, Part 60 (40CFR60), Appendix B, , and using sampling and calibration procedures specified in U.S. EPA Methods 1, 2, 3A, 4 and 25A. This report contains the results of that testing.

Section II of this report, titled Installation and Source Description, gives a brief description of the plant source for emissions and how it was operated during the test program.

Section III of this report, titled Summary of Results, presents a discussion of the test results. A summary of the performance test results appears at the end of this section.

Section IV of this report contains the certification of authenticity for the testing.

Section V of this report describes the test methods and procedures used during the testing.

Section VI of this report gives a description of the Spectrum Systems, Inc. Transportable Continuous Emission Monitoring System (TCEMS) used as the reference method system for the testing.



Section VII contains the mathematical equations used in the data analysis.

Actual test data, materials, and test results are presented in the different appendices of this report. A summary of all test results appears in Appendix A.

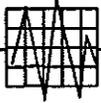
Sampling System Bias Drift is in Appendix A of this report.

The actual run emission calculation results are presented in Appendix B

All the Reference Method Raw DAHS printouts are placed in Appendix C. This includes the gas calibration data and the gas one minute averages

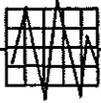
#### Contact Information

Affiliation	Address	Contact Info
Test Facility	Midland Cogeneration Venture 100 Progress Place Midland, Michigan 48640	Ms. Barb Vanderkelen 989-633-7937 <a href="mailto:bavanderkelen@midcogen.com">bavanderkelen@midcogen.com</a>
Test Company Rep.	Spectrum Systems, Inc. 3410 W. Nine Mile Rd. Pensacola, Florida 32526	Mr. James Garrett 850-944-3392 <a href="mailto:jgarrett@spectrumsystems.com">jgarrett@spectrumsystems.com</a>
State Representative	MDEQ Air Quality Division-Technical Programs Unit Constitution Hall, 3 <sup>rd</sup> Floor North 525 West Allegan Street Lansing, Michigan 48933	



## II. INSTALLATION and SOURCE DESCRIPTION

The MCV Units 16-21 (EUBOILER1-EUBOILER6) are operated as a cycling facility, in that they are expected to be brought on-line and off-line several times per day, most often during the summer months. The plant may also be dispatched at other appropriate times whenever system demand, capacity/steam and commercial energy availability, market, and/or as emergency conditions dictate. Each boiler is rated at 370 MMBtu/hr and is fired on natural gas exclusively. Each boiler is equipped with low-NOx burner technology and flue gas recirculation, and is capable of supplying 250,000 pounds per hour of steam at 800 psig and 750 degrees Fahrenheit.



### III. SUMMARY OF RESULTS

The Spectrum Systems sampling probe was inserted into each stack of the MCV Units 16-21. The probe was then connected to the Spectrum Systems, Inc.'s Transportable Continuous Emission Monitoring System (TCEMS). Sampling and analysis of the stack effluent stream was performed by the TCEMS Reference Method analyzer system. O<sub>2</sub> and THC in-line analyzers measured O<sub>2</sub> and THC concentrations. Moisture was measured. Initial calibrations of the analyzers with EPA Protocol I gases were conducted. Appropriate analyzer calibrations and analyzer bias and drift measurements were performed as required before, during, and after testing.

Three one-hour runs of O<sub>2</sub> and THC concentration measurements were performed at one load condition. Reference Method O<sub>2</sub> and THC analyzer measurements were recorded on a one-minute continuous basis by the Reference Method TCEMS. An average of the concentrations is calculated for each run. VOC calculations were adjusted for moisture.

A summary of the final emissions results is presented at the end of this section. The summary page displays results for each run as well as calculates the overall VOC emissions as lbs/MMBtu. Average overall results are calculated by averaging the run averages of each parameter.

This report contains a summary of all the testing performed and the supporting data for all tests. Detailed test material is presented in the different appendices of this report. Within each appendix Unit 16 data is presented before Unit 17 data.

Gas analyzer sampling system bias and drift results are placed into Appendix A of this report. These sheets contain the before and after calibration drift data obtained by introducing EPA Protocol 1 gases to the TCEMS analyzers between runs. This verifies that the TCEMS analyzers stay calibrated and operable during each run. This data is transferred to the Calculation of Average Emissions sheets and is used to correct the gas ppm concentrations.

Run emission results are located in Appendix B of this report. There is a Calculation of Average Emissions sheet for each run. Each sheet contains the calibration and drift data and both the uncorrected and corrected the gas concentrations for the run.

Reference Method Raw DAHS data printouts are supplied in this report in Appendix C. This includes raw gas calibration data, raw one-minute Reference Method TCEMS analyzer data readings, raw moisture data and calculated gas run average concentrations.



Reference Method Quality Assurance Data is found in Appendix D of this report. This includes the analyzer calibration error results, the gas interference tests. Before any set of TCEMS analysis, the analyzers are calibrated with EPA Protocol 1 Gases and the Analyzer Calibration error is determined and verified to within specific limits.

All plant process data is supplied in Appendix E of this report.

Appendix F of this report contains copies of the EPA Protocol Gas Certificates for the calibration gases used during VOC and O<sub>2</sub> calibration and calibration bias drift checks during testing.



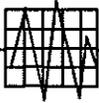
## Midland Cogeneration Venture

### Compliance Testing Emission Results Summary

<b>Unit 16</b>										
#	Run Start		Run Stop		Run Min	O2 %	VOC ppmvd	Fuel		VOC Emission lb/mmBtu
	Date	Time	Date	Time				Factor Fc	Moisture BWS	
1	10/27/2014	23:09	10/28/2014	00:09	60	3.117	2.297	8710	0.163	0.0027
2	10/28/2014	00:40	10/28/2014	01:40	60	3.027	2.558	8710	0.163	0.0030
3	10/28/2014	02:02	10/28/2014	03:02	60	3.034	1.838	8710	0.163	0.0021
<b>Averages:</b>						<b>3.059</b>	<b>2.231</b>	<b>8710</b>	<b>0.163</b>	<b>0.0026</b>
<b>Permit Limit</b>										<b>0.0054</b>

<b>Unit 17</b>										
#	Run Start		Run Stop		Run Min	O2 %	VOC ppmvd	Fuel		VOC Emission lb/mmBtu
	Date	Time	Date	Time				Factor Fc	Moisture BWS	
1	10/27/2014	23:09	10/28/2014	00:09	60	3.254	1.369	8710	0.162	0.0016
2	10/28/2014	00:40	10/28/2014	01:40	60	2.617	2.356	8710	0.162	0.0027
3	10/28/2014	02:02	10/28/2014	03:02	60	2.476	2.669	8710	0.162	0.0030
<b>Averages:</b>						<b>2.782</b>	<b>2.131</b>	<b>8710</b>	<b>0.162</b>	<b>0.0024</b>
<b>Permit Limit</b>										<b>0.0054</b>

<b>Unit 18</b>										
#	Run Start		Run Stop		Run Min	O2 %	VOC ppmvd	Fuel		VOC Emission lb/mmBtu
	Date	Time	Date	Time				Factor Fc	Moisture BWS	
1	10/28/2014	22:30	10/28/2014	23:30	60	3.254	1.369	8710	0.162	0.0016
2	10/28/2014	23:43	10/29/2014	00:43	60	3.178	2.311	8710	0.162	0.0027
3	10/29/2015	01:00	10/29/2015	02:00	60	3.207	1.517	8710	0.162	0.0018
<b>Averages:</b>						<b>3.213</b>	<b>1.732</b>	<b>8710</b>	<b>0.162</b>	<b>0.0020</b>
<b>Permit Limit</b>										<b>0.0054</b>



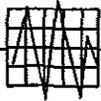
## Midland Cogeneration Venture

### Compliance Testing Emission Results Summary

<b>Unit 19</b>										
#	Run Start		Run Stop		Run Min	O2 %	VOC ppmvd	Fuel		VOC
	Date	Time	Date	Time				Factor Fc	Moisture BWS	Emission lb/mmBtu
1	10/27/2014	23:09	10/28/2014	00:09	60	3.117	2.297	8710	0.163	0.0027
2	10/28/2014	00:40	10/28/2014	01:40	60	3.027	2.558	8710	0.163	0.0030
3	10/28/2014	02:02	10/28/2014	03:02	60	3.034	1.838	8710	0.163	0.0021
<b>Averages:</b>						<b>3.059</b>	<b>2.231</b>	<b>8710</b>	<b>0.163</b>	<b>0.0026</b>
<b>Permit Limit</b>										<b>0.0054</b>

<b>Unit 20</b>										
#	Run Start		Run Stop		Run Min	O2 %	VOC ppmvd	Fuel		VOC
	Date	Time	Date	Time				Factor Fc	Moisture BWS	Emission lb/mmBtu
1	10/27/2014	23:09	10/28/2014	00:09	60	3.254	1.369	8710	0.162	0.0016
2	10/28/2014	00:40	10/28/2014	01:40	60	2.617	2.356	8710	0.162	0.0027
3	10/28/2014	02:02	10/28/2014	03:02	60	2.476	2.669	8710	0.162	0.0030
<b>Averages:</b>						<b>2.782</b>	<b>2.131</b>	<b>8710</b>	<b>0.162</b>	<b>0.0024</b>
<b>Permit Limit</b>										<b>0.0054</b>

<b>Unit 21</b>										
#	Run Start		Run Stop		Run Min	O2 %	VOC ppmvd	Fuel		VOC
	Date	Time	Date	Time				Factor Fc	Moisture BWS	Emission lb/mmBtu
1	10/28/2014	22:30	10/28/2014	23:30	60	3.254	1.369	8710	0.162	0.0016
2	10/28/2014	23:43	10/29/2014	00:43	60	3.178	2.311	8710	0.162	0.0027
3	10/29/2015	01:00	10/29/2015	02:00	60	3.207	1.517	8710	0.162	0.0018
<b>Averages:</b>						<b>3.213</b>	<b>1.732</b>	<b>8710</b>	<b>0.162</b>	<b>0.0020</b>
<b>Permit Limit</b>										<b>0.0054</b>



#### IV. STATEMENT OF AUTHENTICITY

The sampling and analysis for this report was carried out under my direction

I have reviewed the testing details and results of this report and hereby certify that the data contained within is authentic and accurate to the best of my knowledge.

Date: January 9, 2015

Signature: \_\_\_\_\_



James Garrett QSTI  
Testing Department



## V. TEST PROCEDURES

Volatile Organic Compounds is measured using 40CFR60 Appendix A Reference Method 25A. Reference Method analyzer measurements are recorded on a continuous basis.

Using formulas and fuel factors from 40 CFR 60, Appendix B Reference Method 19, lbs/MMBtu were computed from each set of VOC and O<sub>2</sub> analyzer measurements after specified correction of pre-calibration and post-calibration drift data.

### Initial Analyzer Calibrations

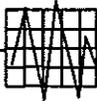
Analyzer calibrations are required prior to a set of analysis or when conditions change or when sampling bias and drift (performed between analysis runs) drifts out of spec. The reference method analyzers are calibrated by introducing zero, mid, and high range EPA Protocol 1 gases into the analyzers to verify the accuracy of the reference method analyzers.

### Sampling Bias and Drift

There is a difference in injecting gases directly into the TCEMS analyzer inlet and injecting gases at the stack connected by a long sampling umbilical cord to the TCEMS inlet. This difference is measured by performing the Sampling System Bias and Drift checks. This sampling system bias is then applied to correct the analyzer reading values.

Prior to pollutant emission sample analysis, a Sampling System Bias Check is performed by injecting both a zero gas and a higher range gas with a concentration close to the sample effluent concentration. Each EPA Protocol 1 gas is introduced at the outlet of the sampling probe in the stack and directly to the inlet of the reference gas analyzers. Their concentration is recorded once the system stabilizes. The sampling system bias must stay within 5% of the span throughout the test to ensure the sampling system conditions do not change during the test. Sampling System Bias checks are performed before and after each run.

To verify that the reference method analyzers continue to stay within their calibration, zero and mid Calibration Drift checks are conducted by introducing zero and mid range gases between each test run. Each final zero and calibration value also serves as the initial zero and calibration value for the following run. The difference between the pre run values and the post run values are calculated and the error in percent is calculated for each run. The zero and calibration drift error must stay within 3% of the span or the system is recalibrated.



## VI. REFERENCE METHOD TCEMS

The following descriptions briefly outline the operational principles of the reference method train of Analyzers called a Transportable Continuous Emission Monitoring System or TCEMS. See Figure 1 for a simplified diagram of the TCEMS arrangement and layout. Additional information on instrument operation may be found in the individual instrument manuals provided by the manufacturers.

### **Servomex Model 1420 O2 Analyzer**

The Servomex Model 1420 Oxygen Analyzer determines the concentration of oxygen in the extracted sample by taking advantage of the paramagnetic properties of the oxygen molecule. A measuring cell or dumb-bell containing the gas in question is suspended in a strong, non-linear, magnetic field. The dumb-bell is deflected in proportion to the concentration of the oxygen present in the sample. This deflection is detected by an optical system containing twin photo cells and an amplifier. A coil of wire surrounding the dumb-bell is utilized to pass a controlled current. The necessary amperage required to return the dumb-bell to its rest position provides an accurate measure of the oxygen. Quality is assured by utilization of a combination automatic flow control device and particulate filter.

### **California Analytical Total Hydrocarbon Analyzer**

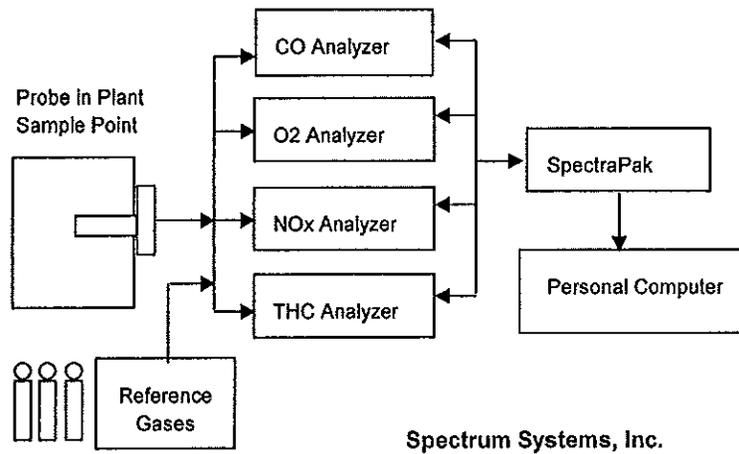
Volatile organic compound concentrations are measured with a California Analytical Total Hydrocarbon Model 300 Flame Ionization Analyzer (FIA).

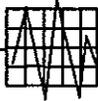
### **Data Acquisition Handling System or DAHS (Recorder)**

The data acquisition handling system (DAHS) used by Spectrum is a Spectra-Pak connected to a Dell Personal computer over a RS-232 line. The software is written by Spectrum System's software department. All data is captured and one (1) minute averages are calculated and printed out as well as stored to disk. All data captured is included in this report. Data reduction is automatically completed in accordance with 40 CFR 60, Appendix B, Performance Specification 2.



**FIGURE 1**  
Spectrum Systems, Inc. Transportable CEMS (TCEMS)





## VII. REFERENCE METHODS AND CALCULATIONS

### Emission Calculations

Reference method testing data analysis is performed using Title 40 of the Code of Federal Regulations, Part 60, Appendix A, Method 19. Measurements of pollutants and diluent gases in any combination of wet and dry instrument responses are detailed. "F" factor analysis techniques are used on both the CEMS and the TCEMS wherever possible. Plug values for moisture are applied when necessary, to compensate for ambient or added moisture gas phase dilution.

#### Emission Calculation

For VOC measured by the Reference Method TCEMS with a dry O<sub>2</sub> measurement, the following formula is used:

$$\text{Emission in lb/mmbtu} = K \times MW \times \text{PPM} \times FF \times (20.9/(20.9-O_2))$$

Where:

PPM	=	Pollutant Concentration in dry ppm
MW	=	Molecular Weight of Pollutant VOC (measured as Propane) = 44.096
K	=	.00000000259
FF	=	8710 Natral Gas

All PPM values entered into the above formulas are corrected values (see below), dry basis.



### Corrected Gas Pollutant Concentration in PPM

Calculate the correction for the gas analyzer measured gas concentrations in ppm, using sampling bias and drift measurements of EPA Protocol 1 zero and higher calibration gas concentrations.

$$C_{\text{gas}} = C_{\text{ma}} * ( C_{\text{avg}} - C_{\text{o}} ) / ( C_{\text{m}} - C_{\text{o}} )$$

Where:

- C gas = Corrected effluent gas concentration in ppm
- Cma = Actual upscale calibration gas concentration in ppm
- Cavg = Gas analyzer reading in ppm
- Co = Average of initial and final system calibration bias check response for the zero gas
- Cm = Average of initial and final system calibration bias check response for the upscale gas