Spectrum SYSTEMS

RELATIVE ACCURACY TEST AUDIT

in accordance with the

40CFR60 and 40CFR75

CLEAN AIR ACT of 1990

Midland Cogeneration Venture
Midland, Michigan

EUBOILER1,2,3,4,5,6 (Units 16,17,18,19,20,21)

November 2017

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

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I. INTRODUCTION

Midland Cogeneration Venture (MCV) contracted Spectrum Systems, Inc., to perform annual relative accuracy testing on the Nitrogen Oxides and Carbon Monoxide Continuous Emissions Monitoring Systems installed on the Units 16-21 (EUBOILER 1 – EUBOILER 6) CEMS 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-B6527-2014a. The tests were conducted according to the procedures outlined in the Code of Federal Regulations, Appendix A of Title 40, Part 75 (40CFR75) and Appendix B of Title 40, Part 60 (40CFR60), including Performance Specifications (PS) 2, 3, and 4A, and using sampling and calibration procedures specified in U.S. EPA Methods 3A, 7E, and 10.

The testing was conducted November 6-9, 2017 by James Garrett and Rick Artybridge 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 not on site to observe testing.

Contact Information

Affiliation	Address	Contact Info
Test Facility	Midland Cogeneration Venture 100 Progress Place Midland, Michigan 48640	Ms. Barb Vanderkelen 989-633-7937 bavanderkelen@midcogen.com
Test Company Rep.	Spectrum Systems, Inc. 3410 W. Nine Mile Rd. Pensacola, Florida 32526	Mr. James Garrett 850-944-3392 jgarrett@spectrumsystems.com
State Representative	MDEQ Air Quality Division 401 Ketchum Street Bay City, Michigan 48708	State did not observe the testing

II. INSTALLATION 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-NO_x 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.

The following serial numbers are associated with each dedicated CEMS.

Emission Unit	Pollutant	Serial Number
Unit 16 EUBOILER 1	NO_x	0809828287
	CO	CM08090018
	O_2	0803292
Unit 17 EUBOILER 2	NO_x	0809828295
	CO	CM08020018
	O_2	0803290
Unit 18 EUBOILER 3	NO_x	0809828290
	CO	CM08020019
	O_2	0803297
Unit 19 EUBOILER 4 (not tested)	NO_x	0809828284
	CO	CM08020017
	O_2	0803298
Unit 20 EUBOILER 5	NO_x	0809828299
	CO	CM08090022
	O_2	0803294
Unit 21 EUBOILER 6	NO_x	0809828292
	CO	CM08090020
	O_2	0803304

III. SUMMARY OF RESULTS

Results of the relative accuracy test audit are presented in Appendix A of this report. These results are based on test data obtained from the affected facility during normal operation of the boilers at low or mid load.

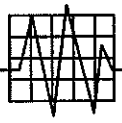
Testing was conducted according to the procedures in the Code of Federal Regulations, Title 40, Part 75 (40CFR75), Appendix A. Reference Methods 3A and 7E, as defined in 40 CFR 60 Appendix A, were used to determine Oxygen and Nitrogen Oxides. The NO_x CEMS Relative Accuracy was performed using 40CFR75 Appendix A Section 6.5. NO_x Relative Accuracy results must meet the criteria of 40CFR75 Appendix A, Section 3.3 and shall not exceed 10.0% (or 7.5% to achieve reduced RATA frequency incentive for annual RATAs). Exceptions are as follows:
Low NO_x emitting units (≤0.2 lb/mmBtu): the difference between the mean value of the CEMS measurements and the reference method mean value is not to exceed ±0.02 lb/mmBtu whenever the Relative Accuracy is greater than 10% (or ±0.015 lb/mmBtu for reduced RATA frequency).

O_2 Relative Accuracy results are also acceptable if the difference of between the mean value of the O_2 monitor measurements and the reference method mean value does not exceed ± 1.0 percent O_2 (or ±0.7% for reduced RATA frequency).

The CO Relative Accuracies were performed using the procedures in 40CFR60, Appendix B, Performance Specification 2. Reference Method 10, as defined in 40 CFR 60 Appendix A, was used to determine Carbon Monoxide. To meet 40CFR60 requirements, Relative Accuracy of the CO monitors must met the criteria of Performance Specification 4A (PS4A) in 40CFR60 Appendix B: CO: Relative Accuracy of CO monitors shall not exceed 10% when the average RM value is used to calculate RA (when average emissions during the test are greater than 50% of the standard), and 5% when the applicable emission standard is used to calculate RA (when average emissions during the test are less than 50% of the standard), or within 5ppmv when RA is calculated as the absolute average difference between RM and CEMS plus the 2.5% confidence coefficient.

All monitors tested for Relative Accuracy meet the required criteria.

Relative Accuracy Sheets show the comparisons of the monitor and reference method data on a run-by-run basis with confidence intervals and relative accuracy's calculated. Relative Accuracy is detailed in tables at the end of this section.



All results were entered into the EPA Emissions Collection and Monitoring Plan System (ECMPS). A copy of the detailed testing report is found in Appendix A of this report.

Effluent samples are obtained from a three point traverse of the stack during sampling runs with duration's of 7 minutes, per 40CFR60, Appendix A Reference Method 7E. The total run time of 21 minutes precludes, by at least twice, the TCEMS response time.

The zero calibration drift checks are conducted for each test run. Each final zero and calibration drift data value also serves as the initial zero and calibration drift data value for the following run. The analyzer measurements are recorded on a continuous basis. A NOx emission rate is computed for each set of NOx and CO_2 analyzer measurements after specified correction of pre-cal and post-cal drift data.

The Sampling System Bias Checks and the Calculation of Average Emissions are located in Appendix B and Appendix C, respectively, of this report.

Spectrum Systems, Inc. raw reference method DAHS data is supplied in Appendix D of this procedure. The corresponding CEMS data is supplied in Appendix E of this report.

Quality assurance reference method Analyzer Performance Results are in Appendix F of this report and the EPA Protocol One Gas Certificates in Appendix G of this report.

IV. STATEMENT OF AUTHENTICITY

The sampling and analysis for this report was carried out under my direction and supervision. I hereby certify that the details and results contained in this report are authentic and accurate to the best of my knowledge

Date: December 4, 2017

Signature:

James Garrett, QSTI
Testing Team Leader

V. MATHEMATICAL EXPLANATION

Emission Calculations

The reference method TCEMS and the NOx CEMS utilize both NOx and O_2 monitor concentration results for calculating emissions rates. Emissions are calculated using 40CFR75, Appendix F, equation F-6 for NOx emissions in pounds per million BTU. The equation using a O_2 diluent is:

NOx (Lbs/mmBtu) = (NOx (ppm dry) * F * K * 20.9) / (20.9 x O2%dry)

Where,

NOx (Lbs/MMBtu)	=	NOx Emission Rate
NOx PPM (dry)	=	Pollutant Concentration in dry ppm
% O2 dry	=	Dry Oxygen in Flue Gas in % by volume dry
K	=	Conversion Factor for NOx:
		K = 1.194 E10-7 (lb / dscf)/ ppm NOx
F	=	Fuel Factor for Natural Gas:
		F = 8710 (lbs/dscf) / mmBtu

Relative Accuracy Comparison Calculations

The formulas used in calculating the relative accuracy comparisons are directly from 40CFR75, Appendix A and appear below:

Arithmetic Mean:

$$\bar{d} = \frac{1}{n} \sum_{i=1}^{n} d_i$$

Where,

- n = Number of data points
- d = Arithmetic Mean
- di = The individual difference between the reference method and corresponding CEMS value for an individual data point.
- Σ = The summation of all the individual differences di for all points

Standard Deviation:

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \left[\frac{\left(\sum_{i=1}^{n} d_i\right)^2}{n}\right]}{n-1}}$$

Where,

n = Number of data points

di = The individual difference between the reference method and corresponding CEMS value for an individual data point.

Σ = The summation of all the individual differences di for all points

Confidence Coefficient:

$$CC = t_{0.025} \frac{S_d}{\sqrt{n}}$$

Where,

$t_{0.025}$ = T value from the table below:

n-1	$t_{0.025}$	n-1	$t_{0.025}$	n-1	$t_{0.025}$
1	12.706	12	2.179	23	2.069
2	4.303	13	2.160	24	2.064
3	3.182	14	2.145	25	2.060
4	2.776	15	2.131	26	2.056
5	2.571	16	2.120	27	2.052
6	2.447	17	2.110	28	2.048
7	2.365	18	2.101	29	2.045
8	2.306	19	2.093	30	2.042
9	2.262	20	2.086	40	2.021
10	2.228	21	2.080	60	2.000
11	2.201	22	2.074	>80	1.980

Relative Accuracy:

$$RA = \frac{|\overline{d}| + |\overline{cc}|}{\overline{RM}} \times 100$$

Where,

$|\overline{d}|$ = The absolute value of the mean difference between reference and monitor values

$|cc|$ = The absolute value of the confidence coefficient

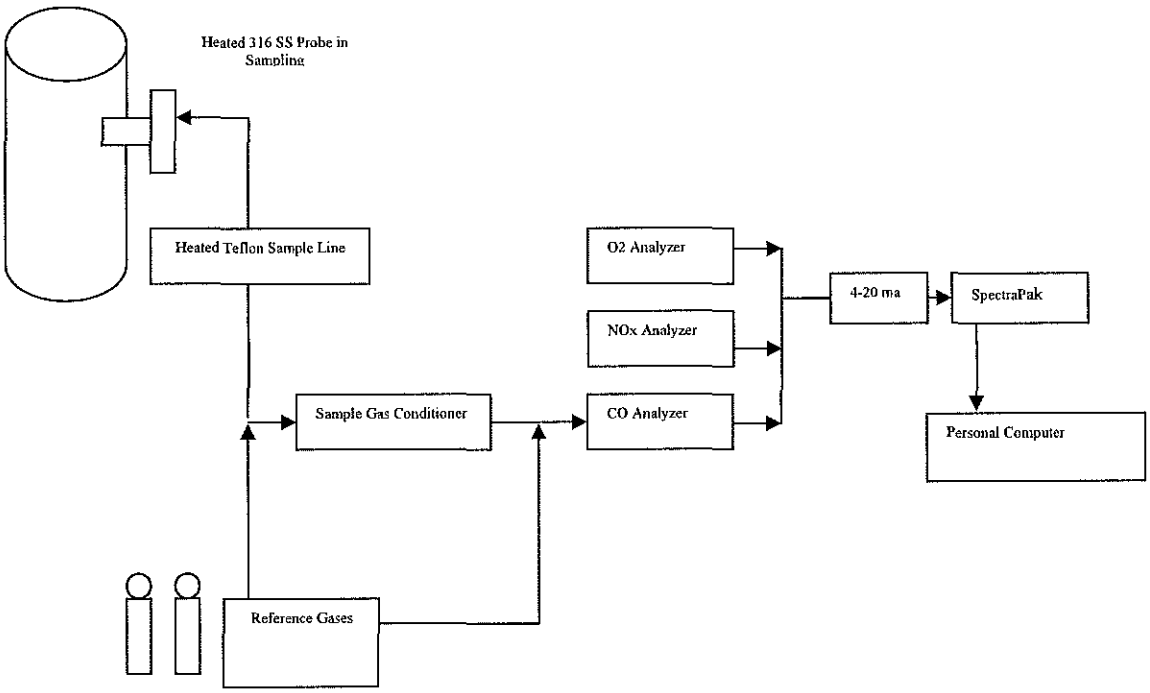
$\overline{RM}$ = The average reference method value or applicable standard

VI. REFERENCE METHODOLOGY

The sampling followed procedures as detailed in U.S. Environmental Protection Agency (EPA) Reference Methods as described in the Code of Federal Regulations 40CFR60, Appendix A. Discussions of these sampling, recovery, and analytical procedures are presented on the following pages.

Sampling point locations, or traverse points, were determined in accordance with 40CFR60, Appendix A Reference Methods 1-2H and 40CFR60, Appendix B, Performance Specification 2.

A general schematic of the Spectrum Systems, Inc. reference method testing transportable CEMS (TCEMS) appears below.



EPA Protocol One Standard Gas Concentrations

EPA Protocol One gas concentration levels are defined by 40CFR60, Method 7E Paragraph 3.3 A low-level concentration gas has a concentration less than 20.0 percent of the calibration span and may be a zero gas. A mid-level concentration gas has a concentration between 40.0 and 60.0 percent of the calibration span. A high-level concentration gas sets the calibration span and results in measurements being 20 to 100 percent of the calibration span. The Tester then chooses the reference gases that most closely approximate the plant effluent concentrations. Plant effluent concentrations change with different plant power levels.

TCEMS Quality Assurance Analyzer Performance Tests

TCEMS Analyzer Calibration Error Test

Prior to calibration of the TCEMS analyzers, an Analyzer Calibration Error test is performed on each analyzer. Each TCEMS analyzer is challenged with a zero concentration reference gas and one or more known higher concentration reference gases in the ranges of the plant gas concentrations to be seen in testing. The analyzer's response for each gas used is recorded and a Calibration Error (CE) in percent is computed using the equation:

Calibration Error (%) = ((Monitor Response) – (Reference Gas)) / Monitor Span x 100

Calibration Error values are used to adjust reference gas concentrations in the Sampling System's Bias and Drift test and in pollutant emission calculations from the reference method TCEMS analyzer system.

TCEMS Interference Checks

Each individual TCEMS analyzer is checked for chemical contaminants that may mask or alter the detection of the substance the monitor is measuring. The interference test is performed by periodically performing three runs on the TCEMS analyzers to verify the presence or absence of interferences. If the analyzer system is altered, interference tests are performed. If interferences are found to affect the readings of the analyzer, samples may need pretreatment processing to remove the interferences prior to analysis by the analyzer. Mechanisms for pretreatment may require use of impingers, absorbers, heating, filtration, chemical washing, etc. Treatment methods differ based on the chemicals involved. 40CFR60 Reference Methods discuss the specific sample pretreatment available. The results are retained and reported with each use of the analyzer.

TCEMS NOx Converter Efficiency Test

Both nitrogen oxide (NO) and N=nitrogen dioxide (NO) gases can both be present in the effluent gases. The analyzers are designed to measure nitrogen oxide (NO) concentrations. To ensure measurement of both types of gas, a NO_2 to NO converter is used, if needed, to convert all the nitrogen dioxide (NO_2) to nitrogen oxide (NO) for measurement. NOx converter efficiencies are performed after each test and reported with TCEMS testing.

TCEMS Analyzer Calibration

Prior to plant sample analysis, the TCEMS analyzers are calibrated. EPA Protocol One reference gases are introduced into the TCEMS monitors. When stable, the analyzer responses are recorded and verified to be within the limits set forth in 40CFR60, Appendix A specific reference methods. Zero and higher EPA Protocol One reference gases are chosen for use based on the plant specific power levels and plant monitor full-scale spans. Refer to 40CFR60, Method 7E Paragraph 3.3 to choose the appropriate gas concentrations for use in testing.

TCEMS Sampling System Bias and Drift Check

Once TCEMS analyzer calibration error and analyzer calibrations are completed, the TCEMS is connected into the plant effluent sample traverse points. Effluent samples are obtained from a three-point traverse of the stack during sampling runs with durations of 7 minutes, per 40CFR60, Appendix B reference methods. The total run time of 21 minutes precludes, by at least twice, the Reference Method TCEMS response time. At least nine runs are conducted.

Sampling bias and drift checks are conducted before and after each sampling run using the zero reference gas and the appropriate higher reference gases. Each final zero and final higher reference gas calibration drift data values also serves as the initial zero and initial reference gas calibration drift data value for the following run.

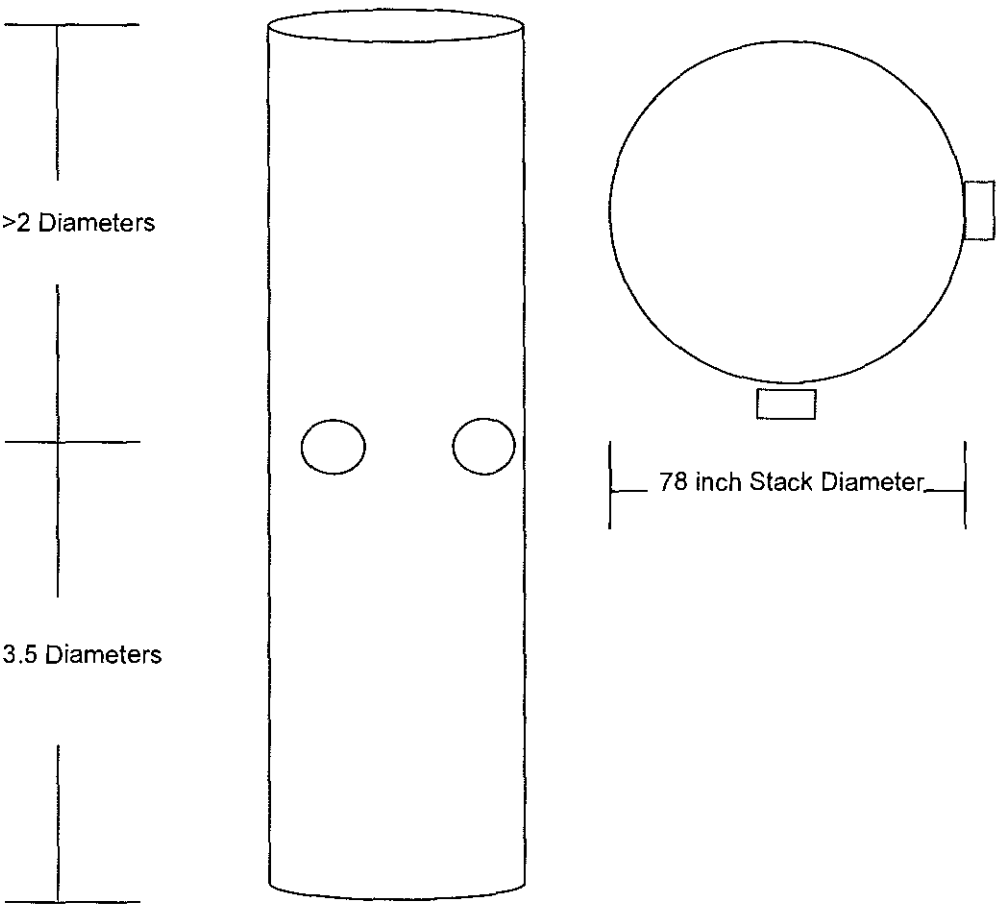
The analyzer measurements are recorded on a continuous basis. Emission rates are computed for each parameter and diluent analyzer measurements after correction of pre-calibration and post-calibration drift data.

If something in the sampling or plant processes change, the system is recalibrated, sampling bias and drift is performed and the sampling test runs are restarted.

Plant Emission Sampling and Analysis

Plant Effluent Sampling (Traverse) Point Selection

Sampling point locations called traverse points, in the plant effluent stack for Continuous Emission Monitoring Systems are determined in accordance with 40CFR60, Appendix B, Performance Specification 2, Section 3. Each stack is built with a series of sample ports that allow a sample probe to be inserted. The TCEMS sampling probe is inserted into a sample port and moved into different positions called traverse points along the path across the stack. At each traverse position in the port, gas samples are collected and fed into the TCEMS analyzer train for analysis. The number of sample ports and traverse sample point locations in a port are chosen based on the size and shape of the effluent stack, flow rates, stack flow disturbances like elbows and bends, stack stratification, and, most importantly, representative stack emissions being released. The points were located at 16.7, 50.0, and 83.3 percent of the measurement line..



Plant Sample Analysis and Relative Accuracy and Emission Calculations

Samples are pulled from the effluent stack of the plant and fed into the Spectrum Systems, Inc. Reference Method TCEMS train of analyzers. Simultaneously, the plant CEMS reads the plant monitors being tested. After testing and calculations are performed, a comparison of emissions is made between the Reference Method (TCEMS) readings and the plant CEMS readings. Relative accuracy calculations determine if the plant monitors meet the specifications outlined in either, 40CFR75 or 40CFR60 for the testing being performed.

The Relative Accuracy Test Audit, or RATA, is conducted in accordance with 40CFR75, Appendix A utilizing the appropriate reference methods in 40CFR60, Appendix B. For NOx and CO testing, the test team used an extractive system for the test with NO_X and CO as the pollutants and O_2 as the diluent. Pollutant concentrations and emission rates were calculated using 40CFR75 Appendix A formulas and. 40CFR75 Appendix F, Section 3, conversion procedures. Raw NO_X and O_2 readings are converted to NO_X lbs/MMBtu for relative accuracy comparison with the CEMS lbs/MMBtu readings.

Stack effluent samples are obtained from a three point traverse of the stack during sampling runs with durations of 7 minutes, per 40CFR60 Appendix A, Reference Method 7E. The total run time of 21 minutes precludes, by at least twice, the TCEMS response time. At least nine runs are conducted.

The zero calibration drift checks are conducted for each test run. Each final zero and calibration drift data value also serves as the initial zero and calibration drift data value for the following run. The analyzer measurements are recorded on a continuous basis. A NO_X emission rate is computed for each set of NOx and O_2 analyzer measurements after specified correction of pre-cal and post-cal drift data.