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COMPLIANCE TEST REPORT

for

OXIDES OF NITROGEN (NO_X) AND CARBON MONOXIDE (CO) EMISSIONS

CTG's UNITs 12-1, 12-2, and 13-1

Belle River Power Plant
China Township, Michigan

June 1 through June 10, 2017

Prepared By
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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EMR) Field Services Group performed particulate emissions testing at the DTE Energy, Belle River Power Plant, located in China Twp., Michigan. The fieldwork, performed during the period of June 1 - June 10, 2017, was conducted to satisfy testing requirements of Michigan Renewable Operating Permit No. MI-ROP-B2796-2015b. Emissions tests were performed on three natural gas-fired Combustion Turbine Generators (CTG's) (12-1, 12-2, & 13-1) for oxides of nitrogen (NO_x) and carbon monoxide (CO).

The average results of the emissions testing are highlighted below:

Emissions Testing Summary
CTG's 12-1, 12-2, 13-1
Belle River Power Plant
June 1 – June 10, 2017

Unit[1]	Parameter[2] (ppm @ 15% O2)	High Load	Mid-High Load	Mid-Low Load	Low Load
12-1	NO_x	6.4	6.2	6.2	6.2
	CO	11.7	11.3	8.3	8.1
12-2	NO_x	7.0	7.4	7.4	7.2
	CO	18.3	8.1	7.7	7.4
13-1	NO_x	7.1	7.0	7.2	7.5
	CO	2.9	3.5	3.0	1.7

(1) Permit Limits: NOx – 9.0 ppm @ 15% O2
CO – 25.0 ppm @15% O2

(2) Concentration corrected per USEPA Method 7E

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1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EMR) Field Services Group performed particulate emissions testing at the DTE Energy, Belle River Power Plant, located in China Twp., Michigan. The fieldwork, performed during the period of June 1 – June 10, 2017, was conducted to satisfy testing requirements of Michigan Renewable Operating Permit No. MI-ROP-B2796-2015b. Emissions tests were performed on three natural gas-fired Combustion Turbine Generators (CTG's) (12-1, 12-2, & 13-1) for oxides of nitrogen (NO_x) and carbon monoxide (CO).

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 3A, 7E, 10 and 19.

The fieldwork was performed in accordance with EPA Reference Methods and DTE Energy's Intent to Test[1], which was approved in a letter[2] by Mr. Tom Gasloli from the Michigan Department of Environmental Quality – Air Quality Division (MDEQ-AQD). The following DTE Energy personnel participated in the testing program: Mr. Mark Westerberg, Environmental Specialist, Mr. Ken St. Amant, Senior Environmental Technician and Mr. Jacob Maas, Summer Student. Mr. Westerberg was the project leader. Mr. Dennis Farver, with the DTE Energy Peaker Group provided process coordination for the testing program. Mr. Tom Gasloli with the Air Quality Division of the Michigan Department of Environmental Quality (MDEQ) reviewed the Test Plan and observed portions of the testing.

2.0 SOURCE DESCRIPTION

The DTE Energy, Belle River Energy Center, located at 4505 King Road, China Twp., Michigan, employs the use of three General Electric Frame 7, simple-cycle, combustion turbines nominally rated at 82.4 megawatts (MW) each at 100% load (dependent upon ambient conditions). Flue gases from each unit exhaust through a separate rectangular stack (108" x 228") that has an exit height of 56.0 feet above ground level. See Figure 1 for a diagram of the units' sampling locations and stack dimensions.

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:

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[1] DTE Test Plan, Submitted April 24, 2017. (Attached-Appendix A)

[2] MDEQ Approval Letter received May 18, 2017 (Attached-Appendix A)

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Sampling Method	Parameter	Analysis
USEPA Method 3A	Oxygen	Instrumental Analyzer Method
USEPA Method 7E	Oxides of Nitrogen	Chemiluminecent Instrumental Analyzer Method
USEPA Method 10	Carbon Monoxide	NDIR Instrumental Analyzer Method
USEPA Method 19	Exhaust Gas Flow rates	Stoichiometric Calculations
USEPA Method 20	Oxides of Nitrogen	Ref. Method 7E

3.1 OXYGEN AND CARBON DIOXIDE (USEPA METHOD 3A)

3.1.1 Sampling Method

Stack gas Oxygen (O_2) and Carbon Dioxide (CO_2) emissions were evaluated using USEPA Method 3A, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight (Instrumental Analyzer Method)". The O_2/CO_2 analyzers utilize paramagnetic sensors.

3.1.2 O_2 / CO_2 Sampling Train

The EPA Method 3A sampling system (Figure 2) consisted of the following:

(1) Stainless Steel sampling probe (traversed across 12 points of each stack)
(2) Heated Teflon™ sampling line
(3) MAK® gas conditioner with particulate filter
(4) Flexible unheated Teflon™ sampling line
(5) Servomex O_2/CO_2 gas analyzer
(6) Appropriate USEPA Protocol 1 calibration gases
(7) Data Acquisition System.

3.1.3 Sampling Train Calibration

The sampling train was calibrated per procedures outlined in USEPA Method 7E. Zero, span, and mid-range calibration gases were introduced directly into the analyzer to determine the instruments linearity. A zero and mid-range span gas for each pollutant was then introduced through the entire sampling system to determine sampling system bias for the analyzer at the completion of each test.

3.2 OXIDES OF NITROGEN AND CARBON MONOXIDE (USEPA METHODS 7E AND 10)

3.2.1 Sampling Method

Oxides of nitrogen (NO_x) emissions were evaluated using USEPA Method 7E, "Determination of Oxides of Nitrogen Emissions from Stationary Sources". The NO_x analyzer utilizes a Chemiluminecent detector. Carbon monoxide (CO) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources". The CO analyzer utilizes an NDIR detector.

The EPA Methods 7E and 10 sampling system (Figure 2) consisted of the following:

(1) Stainless Steel sampling probe (traversed across 12 points of each stack)
(2) Heated Teflon™ sampling line
(3) MAK® gas conditioner with particulate filter
(4) Flexible unheated Teflon™ sampling line
(5) 42i Chemiluminecent NO/NO_x gas analyzer and TECO 48i NDIR CO gas analyzer
(6) Appropriate USEPA Protocol 1 calibration gases
(7) Data Acquisition System.

Oxides of Nitrogen and carbon monoxide emissions testing were performed per Method 20, and Sub-Part GG. Testing at each of four loads (equally spaced between max load and 50 MW) was performed. Each load was tested in triplicate with a run consisting of sampling for 1-minute at each of 12 points. The probe was moved to each point with sufficient time to allow for sampling system response per the guidelines of Sub-Part GG. Diluent (O_2) concentrations were measured simultaneously during all sampling.

3.2.2 Quality Control and Assurance

All sampling and analytical equipment were calibrated per the guidelines referenced in Methods 7E and 10. Calibration gases were EPA Protocol 1 gases and the concentrations

were within the acceptable ranges (40-60% mid-range and span) specified in Method 7E. Calibration gas certification sheets are in Appendix C.

Zero, span, and mid-range calibration gases were introduced directly into the analyzer to determine the instruments linearity. A zero and mid-range span gas for each pollutant was then introduced through the entire sampling system to determine sampling system bias for each analyzer at the completion of each test.

DTE performed NO_x converter efficiency testing by directly challenging the NO_x analyzer with a nitrogen dioxide (NO_2) calibration gas of 15.60 ppm. Results from the converter efficiency test demonstrated that the analyzer met the requirements of Method 7E (Eq-1).

Eq. 1

$$Eff_{NO2} = \frac{C_{Dir}}{C_v} = \frac{14.4}{15.6} = 92.3\%$$

3.2.3 Data Reduction

Data was recorded at 10-second intervals and averaged in 1-minute increments. The NO_x and CO emissions were reported in parts per million corrected to 15% oxygen (ppm @ 15% O_2). The 1-minute readings collected can be found in Appendix B.

4.0 OPERATING PARAMETERS

The test program included the collection of turbine operating data during each test run. Parameters recorded included fuel flowrate (pounds per second), power generation (MW), inlet guide vane angle (%), compressor discharge temperature (°F), compressor discharge pressure (psi), and exhaust temperature (°F). Unit operational data collected during each test can be found in Appendix E.

Natural gas samples were collected once during the testing of each unit and analyzed for heat content. The results of the fuel analysis can be found in Appendix E.

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5.0 DISCUSSION OF RESULTS

Unit 12-1:

Table No. 1 presents the nitrogen oxides (NO_x) and carbon monoxide (CO) emission testing results for CTG 12-1 at four (4) operating loads between 50 MW and the highest load attainable. The NO_x and CO emissions are presented in parts per million corrected to fifteen percent oxygen (ppm @ 15% O_2). The NO_x and CO emissions for each of the 4 loads were below the permit limits of 9 ppm @15% O_2 and 25 ppm @ 15% O_2 respectively.

Unit 12-2:

Table No. 2 presents the nitrogen oxides (NO_x) and carbon monoxide (CO) emission testing results for CTG 12-2 at four (4) operating loads between 50 MW and the highest load attainable. The NO_x and CO emissions are presented in parts per million corrected to fifteen percent oxygen (ppm @ 15% O_2). The NO_x and CO emissions for each of the 4 loads were below the permit limits of 9 ppm @15% O_2 and 25 ppm @ 15% O_2 respectively.

Unit 13-1:

Table No. 3 presents the nitrogen oxides (NO_x) and carbon monoxide (CO) emission testing results for CTG 13-1 at four (4) operating loads between 50 MW and the highest load attainable. The NO_x and CO emissions are presented in parts per million corrected to fifteen percent oxygen (ppm @ 15% O_2). The NO_x and CO emissions for each of the 4 loads were below the permit limits of 9 ppm @15% O_2 and 25 ppm @ 15% O_2 respectively.

The Auxiliary test data presented in each NO_x/CO Emissions Table for each test includes the Unit Load in gross megawatts (GMW), stack temperature in degrees Fahrenheit (°F), fuel flow in pounds per second (lbs/sec), inlet guide vane angle in degrees (°), Compressor discharge temperature in degrees Fahrenheit (°F), Compressor discharge pressure in pounds per square inch (PSI), and heat input in Million British Thermal units per hour (MMBtu/hr).

The results of the testing indicate that Units 12-1, 12-2, & 13-1 are in compliance with the sources Permit Requirements for NO_x & CO.

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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."

Mark R. Grigerelt, QSTI

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TABLE NO. 1

NO_x & CO EMISSIONS TESTING RESULTS

Belle River Power Plant - Unit 12-1

June 1 & 2, 2017

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Fuel Flow (lb/sec)	Inlet Guide Vane Angle	Compressor Discharge Temperature	Compressor Discharge Pressure	Heat Input (MMBtu/hr)	NOx Emissions (ppm@15%O_2)[1]	CO Emissions (ppm@15%O_2)[2]
High	1-Jun-17	7:40-9:22	83.7	1016.1	12.1	84.0	669.7	165.7	1,055.2	6.4	11.7
Mid-High		9:50-11:33	72.1	1036.8	11.0	79.0	672.8	149.4	956.7	6.2	11.3
Mid-Low	2-Jun-17	7:30-9:15	62.0	1061.9	10.1	71.2	659.3	134.2	878.4	6.2	8.3
Low		9:39-11:19	52.1	1099.9	8.9	57.4	636.3	115.3	774.0	6.2	8.1
	Average:		*67.5*	*1053.7*	*10.5*	*72.9*	*659.5*	*141.2*	*916.1*	*6.3*	*9.9*

(1) Permit Limit = 9 ppm@15%O2

(2) Permit Limit = 25 ppm@15%O2

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TABLE NO. 2

NO_x & CO EMISSIONS TESTING RESULTS

Belle River Power Plant - Unit 12-2

June 7 & 8, 2017

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Fuel Flow (lb/sec)	Inlet Guide Vane Angle	Compressor Discharge Temperature	Compressor Discharge Pressure	Heat Input (MMBtu/hr)	NOx Emissions (ppm@15%O2)[1]	CO Emissions (ppm@15%O2)[2]
High	7-Jun-17	7:09-8:51	80.4	1008.5	10.4	84.0	668.4	165.0	901.5	7.0	18.3
Mid-High		9:40-11:23	70.0	1035.8	9.5	79.4	675.2	149.5	826.1	7.4	8.1
Mid-Low	8-Jun-17	7:00-8:42	61.0	1059.4	8.8	72.3	667.8	135.2	762.4	7.4	7.7
Low		9:09-10:57	52.0	1092.5	7.8	61.2	656.2	118.9	678.3	7.2	7.4
	Average:		*65.9*	*1049.1*	*9.1*	*74.2*	*666.9*	*142.2*	*792.1*	*7.3*	*10.4*

(1) Permit Limit = 9 ppm@15%O2

(2) Permit Limit = 25 ppm@15%O2

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TABLE NO. 3
NO_x & CO EMISSIONS TESTING RESULTS
Belle River Power Plant - Unit 13-1
June 10, 2017

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Fuel Flow (lb/sec)	Inlet Guide Vane Angle	Compressor Discharge Temperature	Compressor Discharge Pressure	Heat Input (MMBtu/hr)	NOx Emissions (ppm@15%O2)[1]	CO Emissions (ppm@15%O2)[2]
High	10-Jun-17	11:15-12:56	73.5	1024.1	10.9	84.3	691.3	153.9	950.8	7.1	2.9
Mid-High		13:29-15:07	67.0	1031.5	10.3	81.5	694.4	145.0	895.7	7.0	3.5
Mid-Low		15:28-17:10	60.0	1051.5	9.6	77.0	693.9	134.6	834.8	7.2	3.0
Low		17:35-19:18	52.0	1081.5	8.8	69.6	688.9	121.9	768.2	7.5	1.7
	Average:		*63.1*	*1047.2*	*9.9*	*78.1*	*692.1*	*138.9*	*862.4*	*7.2*	*2.8*

(1) Permit Limit = 9 ppm@15%O2
(2) Permit Limit = 25 ppm@15%O2

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Figure 1 – Sampling Location
DTE Energy– BRPP CTGs
June 1 – June 10, 2017

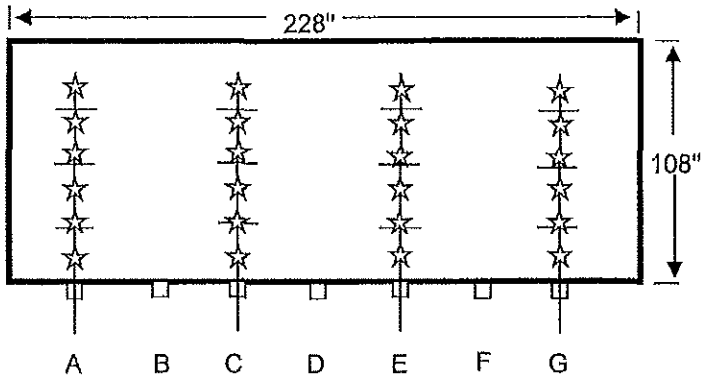
—— NOx & CO sampling points

Point	Distance (in.)
3	18
2	54
1	90

PM sampling points

☆

Point	Distance (in.)
6	4.75
5	15.77
4	31.97
3	76.03
2	92.23
1	103.25



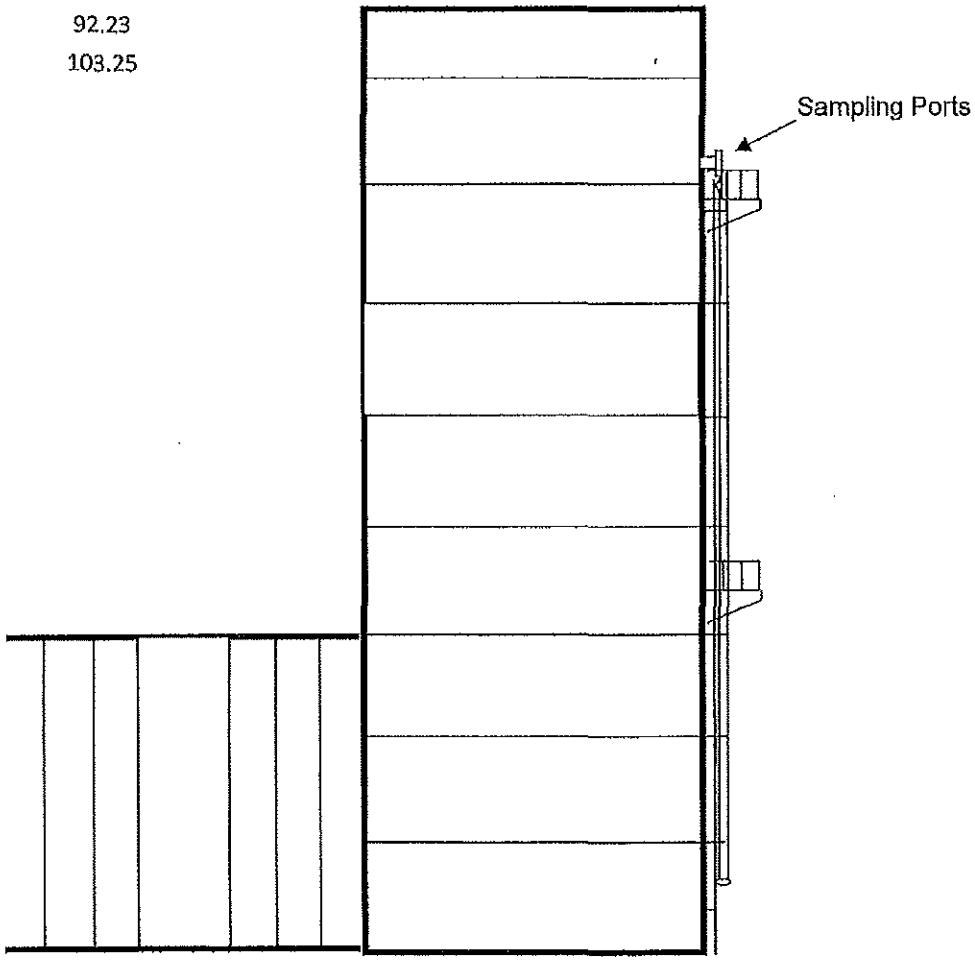


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Figure 2 – EPA Methods 3A/7E/10
DTE Energy – BRPP CTGs
June 1 – June 10, 2017