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COMPLIANCE TEST REPORT

for

CARBON MONOXIDE EMISSIONS

UNIT 1

**Belle River Power Plant
China Township, Michigan**

September 25th & November 9th, 2018

Prepared By
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DTE Energy®



B2796-TEST-20180925



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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed carbon monoxide emissions testing on the exhaust of Unit 1 at the DTE Electric, Belle River Power Plant, located in China Township, Michigan. The fieldwork, performed on September 25 & November 9, 2018, satisfies requirements of the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) No. ROP-MI-B2796-2015b. Testing was performed for carbon monoxide (CO) at two loads (high & intermediate loads) as required by permit conditions.

The results of the emissions testing are highlighted below:

CO Emissions Test Results Belle River Power Plant - Unit 1 September 25 & November 9, 2018

Boiler Operating Condition	Average CO Concentration (ppm)	Average CO Concentration (lb/MMBtu)
High Load (11/9)	209.6	0.2733
Mid Load (9/25)	0.4	0.0007



1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed carbon monoxide emissions testing on the exhaust of Unit 1 at the DTE Electric, Belle River Power Plant, located in China Township, Michigan. The fieldwork, performed on September 25 & November 9, 2018, satisfies requirements of the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) No. ROP-MI-B2796-2015b. Testing was performed for carbon monoxide (CO) at two loads (high & intermediate loads) as required by permit conditions.

The testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Method 3A and ASTM Method D6348.

The fieldwork was performed in accordance with EPA Reference Methods and EM&R's Intent to Test¹, submitted July 21, 2018. The following EM&R personnel participated in the testing program: Mr. Mark Grigereit, Principal Engineer, Mr. Thomas Snyder, Environmental Specialist and Mr. Fred Meinecke, Senior Environmental Technician. Mr. Snyder was the project leader. Mr. Jason Roggenbuck, Senior Environmental Engineer at the plant provided process coordination for the testing program.

2.0 SOURCE DESCRIPTION

The Belle River Power Plant (BRPP) located at 4505 King Road in China Township, Michigan, employs the use of two (2) Babcock and Wilcox coal-fired boilers (Units 1 & 2) each capable of producing 4,550,000 pounds per hour of steam. Each Unit has a Siemens Power Corporation turbine generator with a nominally rated capability of 635 (Unit 1) and 645 (Unit 2) megawatts (MW).

A schematic representation of the Boiler exhaust and sampling locations is presented in Figure 1.

¹ MDEQ, Test Plan, Submitted July 21, 2018, (Attached-Appendix A)



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
ASTM Method D6348	CO and CO ₂	FTIR

3.1 CARBON MONOXIDE AND CARBON DIOXIDE (ASTM METHOD D6348)

3.2.1 *Sampling Method*

Carbon Monoxide and Carbon Dioxide emissions were evaluated using ASTM Method D6348, "Measurement of Vapor Phase Organic Emissions by Extractive Fourier Transform Infrared (FTIR)". Single point sampling was performed. Triplicate 60-minute test runs were performed.

The Method D6348 sampling system (Figure 2) consisted of the following:

- (1) Single-point sampling probe
- (2) Flexible heated PTFE sampling line
- (3) Air Dimensions Heated Head Diaphragm Pump
- (4) MKS MultiGas 2030 FTIR spectrometer
- (5) Appropriate calibration gases
- (6) Data Acquisition System

The FTIR was equipped with a temperature controlled, 5.11 meter multipass gas cell maintained at 191°C. Gas flows and sampling system pressures were monitored using a rotometer and pressure transducer. All data was collected at 0.5 cm⁻¹ resolution.

3.2.2 *Sampling Train Calibration*

The FTIR was calibrated per procedures outlined in ASTM Method D6348. Direct measurements of nitrogen, carbon monoxide (CO), carbon dioxide (CO₂), and ethylene (C₂H₄) gas standards were made at the test location to confirm concentrations.



A calibration transfer standard (CTS) was analyzed before and after testing at each location. The concentration determined for all CTS runs were within $\pm 5\%$ of the certified value of the standard. Ethylene was passed through the entire system to determine the sampling system response time and to ensure that the entire sampling system was leak-free.

Nitrogen was purged through the sampling system at each test location to confirm the system was free of contaminants.

Carbon Monoxide gas standards were passed through the sampling system at each test location to determine the response time and confirm recovery.

Spiking was performed to verify the ability of the sampling system to quantitatively deliver a sample containing CO from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR to quantify CO in the presence of effluent gas.

As part of the spiking procedure, samples from the source were measured to determine CO concentrations to be used in the spike recovery calculations. The determined sulfur hexafluoride (SF_6) concentration in the spiked and unspiked samples was used to calculate the dilution factor of the spike and thus used to calculate the concentration of the spiked CO. The following equation illustrates the percent recovery calculation.

$$DF = \frac{SF_{6(spiked)}}{SF_{6(direct)}} \quad (\text{Sec. 9.2.3 (3) ASTM Method D6348})$$

$$CS = DF * Spike_{dir} + Unspike(1 - DF) \quad (\text{Sec. 9.2.3 (4) ASTM Method D6348})$$

DF = Dilution factor of the spike gas

$SF_{6(direct)}$ = SF_6 concentration measured directly in undiluted spike gas

$SF_{6(spiked)}$ = Diluted SF_6 concentration measured in a spiked sample

$Spike_{dir}$ = Concentration of the analyte in the spike standard measured by the FTIR directly

CS = Expected concentration of the spiked samples

Unspike = Native concentration of analytes in unspiked samples

All analyte spikes were introduced using an instrument grade stainless steel rotometer. The spike target dilution ratio was 1:10 or less. The CO spike recovery during the mid-load testing was within the Method D6348 allowance of $\pm 30\%$. The CO spike recovery during the high-load testing did not meet the requirements of Method D6348. Carbon monoxide levels were higher than expected and the CO calibration gas concentration was insufficient to accurately determine the spike recovery percentage.



3.2.3 Quality Control and Assurance

As part of the data validation procedure, reference spectra are manually fit to that of the sample spectra and a concentration is determined. The reference spectra are scaled to match the peak amplitude of the sample, thus providing a scale factor. The scale factor multiplied by the reference spectra concentration is used to determine the concentration value for the sample spectra. Sample pressure and temperature corrections are then applied to compute the final sample concentration. The manually calculated results are then compared with the software-generated results. The data is then validated if the two concentrations are within $\pm 5\%$ agreement. If there is a difference greater than $\pm 5\%$, the spectra are reviewed for possible spectral interferences or any other possible causes that might lead to inaccurately quantified data. PRISM Analytical Technologies, Inc. validated the FTIR data. The data validation reports are in Appendix B.

3.2.4 Data Reduction

Each spectrum was derived from the coaddition of 64 scans, with a new data point generated approximately every one minute. The CO and CO₂ emissions were recorded in parts per million (ppm) wet volume basis.

Emissions calculations (lb/MMBtu) are based on calculations located in USEPA Method 19. Coal samples were collected during the testing and analyzed to determine the F_c factor. Laboratory results from the coal analysis are presented in Appendix D.

4.0 OPERATING PARAMETERS

The test program included the collection of boiler emissions and operating data during each test run. Parameters recorded included CO₂, SO₂, and NO_x emissions, and opacity as well as boiler load. Operational data can be referred to in Appendix D.

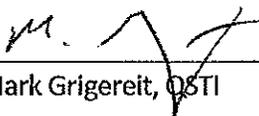
5.0 RESULTS

The results from the CO testing on Unit 1 are displayed in Table No. 1. The results table presents the CO emissions in terms of parts per million (ppm) and pounds per million British thermal unit (lbs/MMBtu) for both the high and intermediate loads tested. The carbon dioxide (CO₂) in percent (%) is also presented. The CO₂ concentrations were corrected for analyzer drift per USEPA Method 7E procedures. Example calculations are presented in Appendix D.

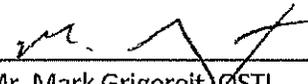


6.0 CERTIFICATION STATEMENT

"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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RESULTS TABLES

Carbon Monoxide Emissions Testing Results
Unit 1
September 25 & November 9, 2018
Belle River Power Plant

Parameter	Run 1	Run 2	Run 3	Average
November 9, 2018				
Date				
Sampling Time (DAHS)	8:10-9:10	9:28-10:28	10:41-11:41	
Load (MW _{gross})	637.0	636.6	636.8	636.8
Average CO ₂ Content (% wet)	10.5	10.6	10.5	10.5
Average CO ₂ Content (% wet, corrected) ¹	10.5	10.4	10.4	10.4
Average CO Concentration (ppmv, wet)	228.5	289.5	110.9	209.6
Average CO Concentration (lb/MMBtu)	0.2968	0.3780	0.1452	0.2733

Parameter	Run 1	Run 2	Run 3	Average
September 25, 2018				
Date				
Sampling Time (DAHS)	9:02-10:02	10:22-11:22	11:43-12:43	
Load (MW _{gross})	329.8	329.9	330.1	329.9
Average CO ₂ Content (% wet)	8.0	8.0	8.0	8.0
Average CO ₂ Content (% wet, corrected) ¹	7.8	7.8	7.9	7.9
Average CO Concentration (ppmv, wet)	0.3	0.4	0.5	0.4
Average CO Concentration (lb/MMBtu)	0.0006	0.0006	0.0009	0.0007

¹corrected for analyzer drift as per USEPA Method 7E

CO₂ : Carbon dioxide

CO : carbon monoxide

ppmv : parts per million on a volume-to-volume basis

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FIGURES



Figure 1 – Sampling Location
Belle River Power Plant – Unit 1
September 25 & November 9, 2018

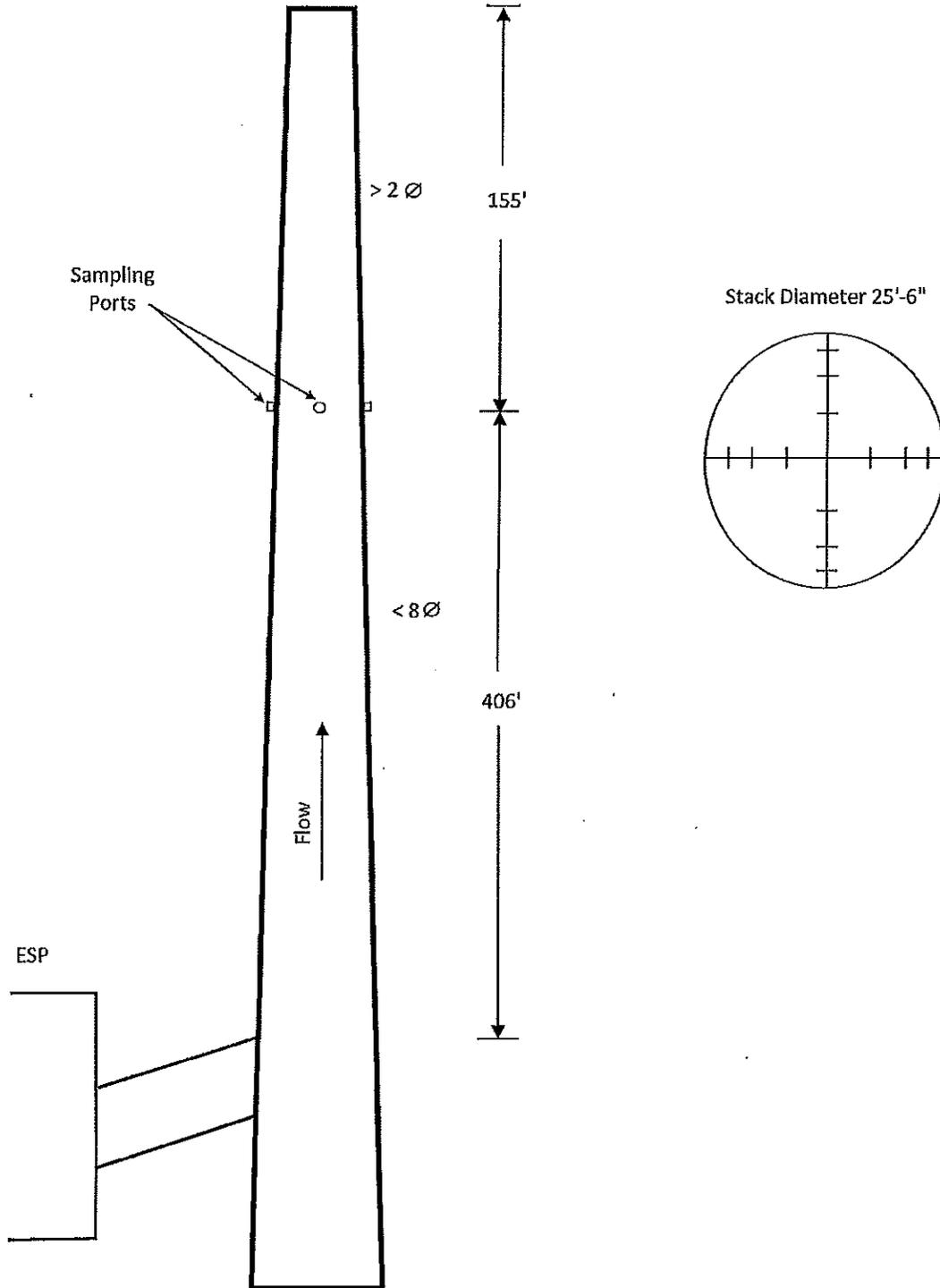
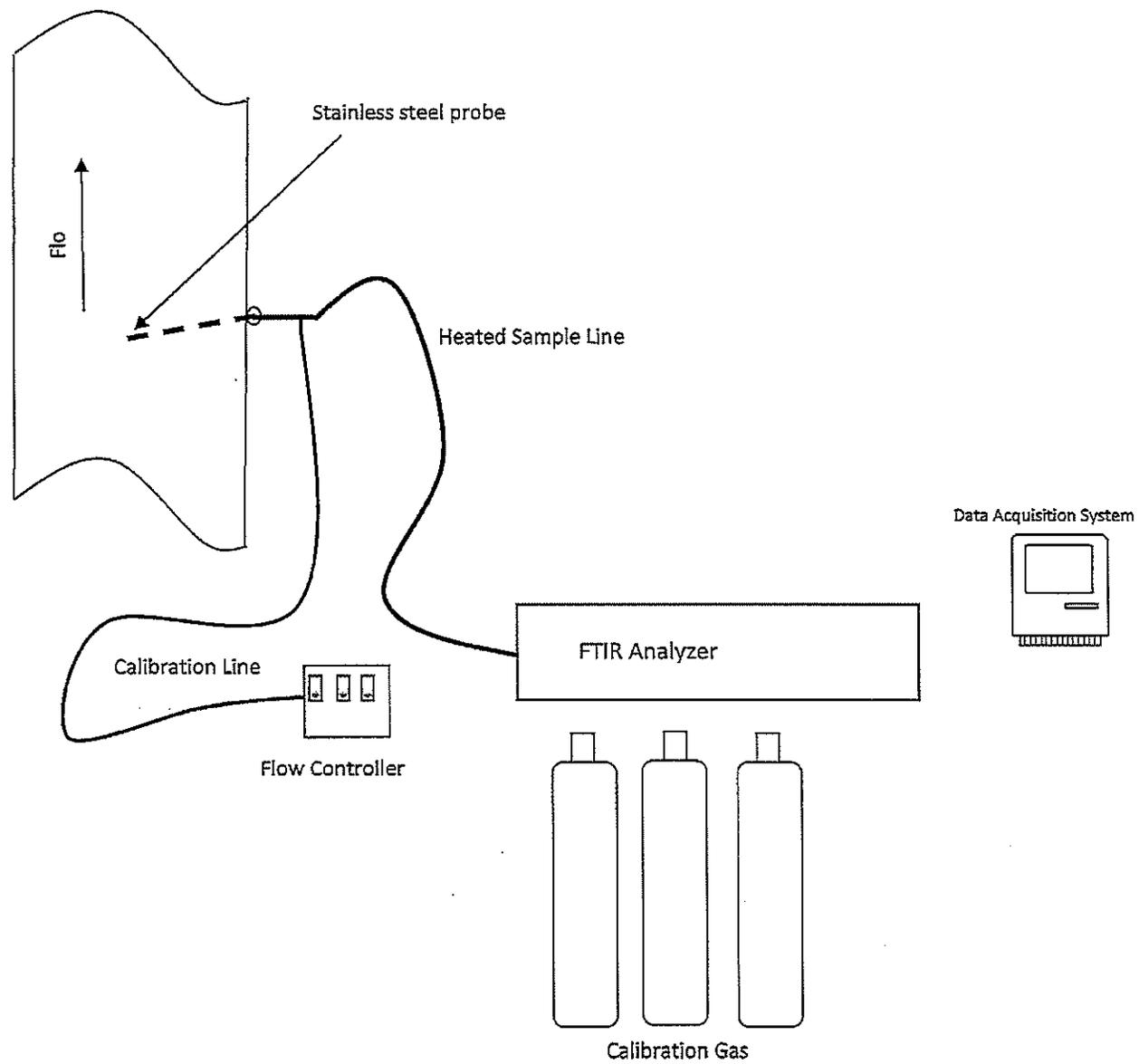




Figure 2 – ASTM D6348
Belle River Power Plant
September 25 & November 9, 2018



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APPENDIX A
MDEQ TEST PLAN