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COMPLIANCE TEST REPORT

for

PARTICULATE MATTER LESS THAN 10 MICRONS (PM_{10}) EMISSIONS

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

Belle River Power Plant
China Township, Michigan

May 23 through June 5, 2017

Prepared By
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DTE Energy

DTE Energy

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 May 23 – June 5, 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 Particulate Matter compounds, less than 10 microns (PM_{10}).

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
May 23 – June 5, 2017

Unit / Load	Date	Average PM_{10} Emissions (lbs/hr)[1]
12-1 (100% Load)	May 24, 2017	4.11
12-1 (70% Load)	May 23, 2017	4.15
12-2 (100% Load)	June 5, 2017	4.29
12-2 (70% Load)	June 1, 2017	4.82
13-1 (100% Load)	May 31, 2017	5.72
13-1 (70% Load)	May 25, 2017	5.33

(1) Permit limit: 9.0 lbs/hr

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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 May 23 – June 5, 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 Particulate Matter, less than 10 micron (PM_{10}).

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 3A, and 5/202.

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. Thomas Snyder and Mr. Mark Westerberg, Environmental Specialists, Mr. Fred Meinecke Senior Environmental Technician and Mr. Jacob Maas, Summer Student. Mr. Snyder 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)

Sampling Method	Parameter	Analysis
USEPA Methods 1-2	Exhaust Gas Flow Rates	Field data analysis and reduction
USEPA Method 3A	Oxygen & CO2	Instrumental Analyzer Method
USEPA Method 4	Moisture Content	Field data analysis and reduction
USEPA Method 5	Particulate Matter	Gravimetric Analysis
USEPA Method 202	PM Condensables	Gravimetric Analysis

3.1 STACK GAS VELOCITY AND FLOWRATES (USEPA METHODS 1-2)

3.1.1 Sampling Method

Stack gas velocity traverses during the PM_{10} testing were conducted in accordance with the procedures outlined in USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," and Method 2, "Determination of Stack Gas Velocity and Volumetric Flowrate." Four (4) sampling ports were utilized, sampling at six (6) points per port for a total of twenty-four (24) sampling points. Velocity traverses were conducted in conjunction with the PM_{10} sample collection. See Figure 1 for a diagram of the traverse/sampling points used.

Previous compliance testing of the exhaust stacks demonstrated an absence of cyclonic flow. When DTE performed static pressure checks the null angle was 0° demonstrating that there has been no change in the flow dynamics of the stack.

3.1.2 Method 2 Sampling Equipment

The EPA Method 2 sampling equipment consisted of a 0-10" incline manometer, S-type Pitot tube (C_p = 0.84) and a type-K calibrated thermocouple.

3.2 OXYGEN AND CARBON DIOXIDE (USEPA METHOD 3A)

3.2.1 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.

3.2.2 O_2 / CO_2 Sampling Train

The EPA Method 3A sampling system consisted of the following:

(1) Un-Heated Teflon™ sampling line (collecting sample at the Method 5 console)
(2) Universal® gas conditioner with particulate filter
(3) Flexible unheated Teflon™ sampling line
(4) Servomex O_2/CO_2 gas analyzer
(5) Appropriate USEPA Protocol 1 calibration gases
(6) Data Acquisition System.

3.2.3 Sampling Train Calibration

The sampling train was calibrated according to 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.

3.3 MOISTURE DETERMINATION (USEPA METHOD 4)

3.3.1 Sampling Method

Determination of the moisture content of the exhaust gas was performed using the method described in USEPA Method 4, "Determination of Moisture Content in Stack Gases". The moisture was collected in glass impingers (PM sampling train) and the percentage of moisture was then derived from calculations outlined in USEPA Method 4.

3.4 PARTICULATE MATTER (USEPA METHOD 5/METHOD 202)

3.4.1 Filterable Particulate Sampling Method

USEPA Method 5, "Determination of Particulate Emissions from Stationary Sources" was used to measure the filterable (front-half) particulate emissions. The back-half of the Method 5 train consisted of Method 202 glassware to collect condensable particulate matter. The results from the Method 5 sampling was considered to be filterable PM_{10} emissions.

The Method 5 isokinetic stack sampling system (Figure 2) consisted of the following:

(1) Stainless steel button-hook nozzle
(2) Un-Heated Inconel probe (traversed across 24 points of each stack)
(3) Heated 3" glass filter holder with a quartz filter (maintained at a temperature of 250 $\pm$ 25°F)
(4) Set of Method 202 impingers for the collection of condensable particulate matter and moisture determination
(5) Length of sample line
(6) Environmental Supply® control case equipped with a pump, dry gas meter, and calibrated orifice.

The filters used in the sampling were initially weighed to a constant weight as described in the Method to obtain the initial tare weight.

After completion of the final leak test for each test run, the filter was recovered, and the probe, nozzle and the front half of the filter holder assembly were brushed and rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The container was labeled with the test number, test location, test date, and the level of liquid marked on the outside of the container. Immediately after recovery, the sample containers were placed in a cooler for storage.

At the laboratory the acetone rinses were transferred to clean pre-weighed beakers, and evaporated to dryness at ambient temperature and pressure. The beakers and filters were then placed in a desiccator for a minimum of 24 hours prior to their initial final weight. Final weights were taken at 6 hour or greater intervals until two weights agreed within 0.5 mg. The data sheets containing the initial and final weights on the filters and beakers can be found in Appendix D.

Collected field blanks consisted of a blank filter and acetone solution blank. The acetone blank was collected from the rinse bottle used in sample recovery. The blank filter and acetone were collected and analyzed following the same procedures used to recover and analyze the field samples.

Field data sheets for the Method 5/Method 202 sampling can be found in Appendix B.

3.4.2 Condensable Particulate Sampling Method (Method 202)

USEPA Method 202, "Dry Impinger method for Determining Condensable Particulate Emissions from Stationary Sources" was used to measure the condensable particulate matter (CPM). This method includes procedures for measuring both organic and inorganic CPM. The Method 202 samples were collected in conjunction with the EPA Method 5 samples as part of the sampling train (impingers).

The Method 202 impinger configuration consisted of the following:

(1) Method 23 type condenser (capable of cooling the stack gas to less than 85 °F
(2) Condensate dropout impinger (dry) without the bubbler tube
(3) Modified Greenburg-Smith impinger (dry) with no taper as a backup impinger
(4) A 3" glass filter holder with a Teflon filter (maintained at a temperature between 65°F and 85°F)
(5) Modified Greenburg-Smith impinger containing 100 millimeters (ml) of de-ionized distilled water
(6) Modified Greenburg-Smith impinger containing approximately 300 grams of silica gel desiccant

The condensate dropout impinger and backup impinger were placed in an insulated box with water between 65°F and 85°F. The water and silica gel impingers were placed in an ice water bath to maintain the exit gas temperature from the silica gel impinger below 68°F.

All Method 202 glassware was pre-cleaned prior to testing with soap and water, and rinsed using tap water, distilled de-ionized (DDI) water, acetone, and finally, hexane. After cleaning, the glassware was baked at 300°C for 6 hours. Prior to each sampling run, the train glassware was rinsed thoroughly with distilled deionized ultra-filtered water.

As soon as possible after the post-test leak check was completed, the Method 5 probe and heated filter box was detached from the Method 202 condenser and impinger train. The Method 202 impinger train was then carefully disassembled. The liquid volume of each impinger was measured in a graduated cylinder and recorded on the field data sheet. The silica gel was re-weighed, and any increase was recorded on the field data sheets. Moisture from the condensate dropout impinger was added to the second impinger. If insufficient water was collected in the first two impingers to allow the impinger stem to extend below the water level, 50-100 ml of degassed, DDI water was added to the impinger and noted on the sampling data sheet. The Method 202 impinger train was purged with ultra-high purity compressed nitrogen at 14 liters per minute for one hour. During the purge the condenser recirculation pump was operated and the first two impingers were heated/cooled to maintain the gas temperature exiting the CPM filter below 85°F.

Contents from the dropout impinger and the impinger prior to the CPM filter were collected into a pre-cleaned sample container. The condenser, impingers and front-half of the CPM filter holder were rinsed with DDI water and the rinses added to the sample container. The condenser, impingers and front-half of the CPM filter holder were then rinsed with acetone followed by two rinses with hexane. The acetone and hexane rinses were collected into a pre-cleaned sample container. The CPM filter was recovered and placed into a labeled container. All containers were labeled with the test number, test location, test date, and the level of liquid marked on the outside of the container. Immediately after recovery, the sample containers were placed in a cooler for storage.

Collected blanks consisted of an acetone rinse blank, a DDI water rinse blank and a hexane rinse blank taken directly from the bottles used during recovery of the samples. Additionally, a field train blank was assembled and recovered following the same procedures used to prepare and recover the test samples.

Analysis of the Method 202 samples and blanks were conducted by Maxxam Analytics of Mississauga, Ontario. All analysis followed the procedures listed in Method 202. A complete laboratory report can be found in Appendix D.

3.4.3 Quality Control and Assurance

All sampling and analytical equipment was calibrated according to the guidelines referenced in EPA Method 5 (see Appendix C for equipment calibration).

3.4.4 Data Reduction

The filterable and condensable PM data collected during the emissions testing was calculated and reported as pounds per hour (lbs/hr).

Emissions calculations are based on calculations located in USEPA Method 5. Example calculations are presented in Appendix E.

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 F.

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 F.

5.0 DISCUSSION OF RESULTS

Unit 12-1:

Table No. 1 presents the Filterable Particulate Matter (PM) emission testing results, the Condensable Particulate emissions testing results, and the Total PM_{10} emission testing results for CTG 12-1 at 100% and 70% load conditions. Particulate emissions are presented in pounds per hour (lbs/hr) for the filterable, condensable and total PM_{10}. The average total PM_{10} emissions of 4.11 lbs/hr (100% load) and 4.15 lbs/hr (70% load) were below the permit limit of 9.0 lbs/hr.

Unit 12-2:

Table No. 2 presents the Filterable Particulate Matter (PM) emission testing results, the Condensable Particulate emissions testing results, and the Total PM_{10} emission testing results for CTG 12-2 at 100% and 70% load conditions. Particulate emissions are presented in pounds per hour (lbs/hr) for the filterable, condensable and total PM_{10}. The average total PM_{10} emissions of 4.29 lbs/hr (100% load) and 4.82 lbs/hr (70% load) were below the permit limit of 9.0 lbs/hr.

Unit 13-1:

Table No. 3 presents the Filterable Particulate Matter (PM) emission testing results, the Condensable Particulate emissions testing results, and the Total PM_{10} emission testing results for CTG 13-1 at 100% and 70% load conditions. Particulate emissions are presented in pounds per hour (lbs/hr) for the filterable, condensable and total PM_{10}. The average total PM_{10} emissions of 5.72 lbs/hr (100% load) and 5.33 lbs/hr (70% load) were below the permit limit of 9.0 lbs/hr.

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The Auxiliary test data presented in each Particulate Emissions Table for each test includes the Unit Load in gross megawatts (GMW), stack temperature in degrees Fahrenheit (°F), stack gas moisture in percent (%), stack gas velocity in feet per minute (ft/min), and stack gas flow rate in actual cubic feet per minute (ACFM), standard cubic feet per minute (SCFM) and dry standard cubic feet per minute (DSCFM).

The results of the testing indicate that Units 12-1, 12-2, & 13-1 are in compliance with the sources Permit Requirements for PM_{10}.

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
PARTICULATE EMISSIONS TESTING RESULTS
Belle River Power Plant - Unit 12-1
May 23 & 24, 2017

Unit 12-1 - 100% Load

Test	Test Date	Test Time (DAHS)	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	Filterable PM Emissions (lbs/hr)	Condensable PM Emissions (lbs/hr)	Total PM_{10} Emissions [1] (lbs/hr)
PM-1	**24-May-17**	6:50-8:59	81.8	1013.7	7.0	9,799	1,562,724	554,381	515,830	0.81	4.93	5.74
PM-2		9:30-11:39	80.0	1017.8	7.3	9,838	1,568,984	555,064	514,766	0.22	2.71	2.93
PM-3		12:14-14:23	80.3	1017.9	7.5	9,809	1,564,330	553,370	511,973	0.73	2.93	3.66
	Average:		*80.7*	*1016.5*	*7.2*	*9,815*	*1,565,346*	*554,272*	*514,190*	*0.59*	*3.52*	*4.11*

(1) Permit Limit = 9 lbs/hr

Unit 12-1 - 70% Load

Test	Test Date	Test Time (DAHS)	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	Filterable PM Emissions (lbs/hr)	Condensable PM Emissions (lbs/hr)	Total PM_{10} Emissions [1] (lbs/hr)
PM-1	**23-May-17**	6:29-8:39	51.0	1090.0	7.2	7,861	1,253,734	427,676	396,676	1.59	3.39	4.98
PM-2		9:17-11:26	51.0	1091.7	7.0	7,917	1,262,562	430,237	400,063	0.87	2.39	3.26
PM-3		12:00-14:09	51.0	1092.8	7.2	7,778	1,240,473	420,989	390,601	1.24	2.98	4.22
	Average:		*51.0*	*1091.5*	*7.1*	*7,852*	*1,252,256*	*426,301*	*395,780*	*1.23*	*2.92*	*4.15*

(1) Permit Limit = 9 lbs/hr

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TABLE NO. 2
PARTICULATE EMISSIONS TESTING RESULTS
Belle River Power Plant - Unit 12-2
June 1 & 5, 2017

Unit 12-2 - 100% Load

Test	Test Date	Test Time (DAHS)	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	Filterable PM Emissions (lbs/hr)	Condensable PM Emissions (lbs/hr)	Total PM_{10} Emissions (1) (lbs/hr)
PM-1	**5-Jun-17**	6:27-8:36	79.6	996.4	6.5	9,964	1,589,167	574,059	536,523	0.59	3.60	4.19
PM-2		9:12-11:22	78.6	1000.5	6.9	9,843	1,569,729	565,420	527,513	0.65	3.49	4.14
PM-3		11:58-14:07	78.5	1001.4	6.8	9,833	1,568,138	564,508	526,738	0.22	4.33	4.55
	Average:		*78.9*	*999.4*	*6.7*	*9,880*	*1,575,678*	*567,996*	*530,258*	*0.49*	*3.81*	*4.29*

(1) Permit Limit = 9 lbs/hr

Unit 12-2 - 70% Load

Test	Test Date	Test Time (DAHS)	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	Filterable PM Emissions (lbs/hr)	Condensable PM Emissions (lbs/hr)	Total PM_{10} Emissions (1) (lbs/hr)
PM-1	**1-Jun-17**	6:32-8:41	52.0	1075.4	6.7	7,733	1,233,219	425,997	397,364	1.02	4.35	5.37
PM-2		9:09-11:17	52.0	1077.2	6.7	7,827	1,248,296	430,691	402,069	0.51	4.02	4.53
PM-3		11:48-13:58	52.0	1076.9	6.6	7,920	1,263,148	435,910	406,950	1.16	3.41	4.57
	Average:		*52.0*	*1076.5*	*6.7*	*7,827*	*1,248,221*	*430,866*	*402,128*	*0.90*	*3.93*	*4.82*

(1) Permit Limit = 9 lbs/hr

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TABLE NO. 3
PARTICULATE EMISSIONS TESTING RESULTS
Belle River Power Plant - Unit 12-2
May 25 & 31, 2017

Unit 13-1 - 100% Load

Test	Test Date	Test Time (DAHS)	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	Filterable PM Emissions (lbs/hr)	Condensable PM Emissions (lbs/hr)	Total PM_{10} Emissions (1) (lbs/hr)
PM-1	**31-May-17**	6:37-8:48	80.2	1007.0	7.1	9,633	1,536,305	553,802	514,735	0.00	10.08	10.08
PM-2		9:17-11:27	79.5	1013.6	6.8	9,684	1,544,420	554,225	516,480	0.29	3.17	3.46
PM-3		11:53-14:04	78.9	1015.7	6.7	9,447	1,506,653	539,909	503,554	0.00	3.63	3.63
	Average:		*79.5*	*1012.1*	*6.9*	*9,588*	*1,529,126*	*549,312*	*511,590*	*0.10*	*5.63*	*5.72*

(1) Permit Limit = 9 lbs/hr

Unit 13-1 - 70% Load

Test	Test Date	Test Time (DAHS)	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	Filterable PM Emissions (lbs/hr)	Condensable PM Emissions (lbs/hr)	Total PM_{10} Emissions (1) (lbs/hr)
PM-1	**25-May-17**	6:39-8:47	50.0	1071.4	7.6	7,721	1,231,367	419,572	387,517	2.25	3.56	5.81
PM-2		9:17-11:25	50.0	1032.0	7.3	7,409	1,181,651	417,235	286,797	1.38	3.21	4.59
PM-3		11:51-14:00	50.0	1071.9	7.4	7,713	1,230,077	420,407	389,508	1.67	3.92	5.59
	Average:		*50.0*	*1058.4*	*7.4*	*7,614*	*1,214,365*	*419,071*	*354,607*	*1.77*	*3.56*	*5.33*

(1) Permit Limit = 9 lbs/hr

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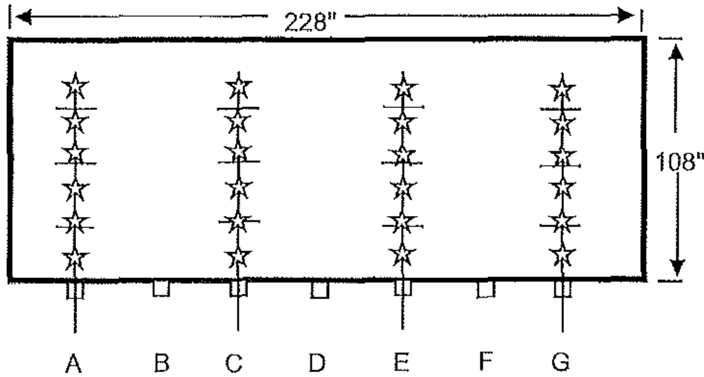
Figure 1 – Sampling Location
DTE Energy – BRPP CTGs
May 23 – June 5, 2017

— 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



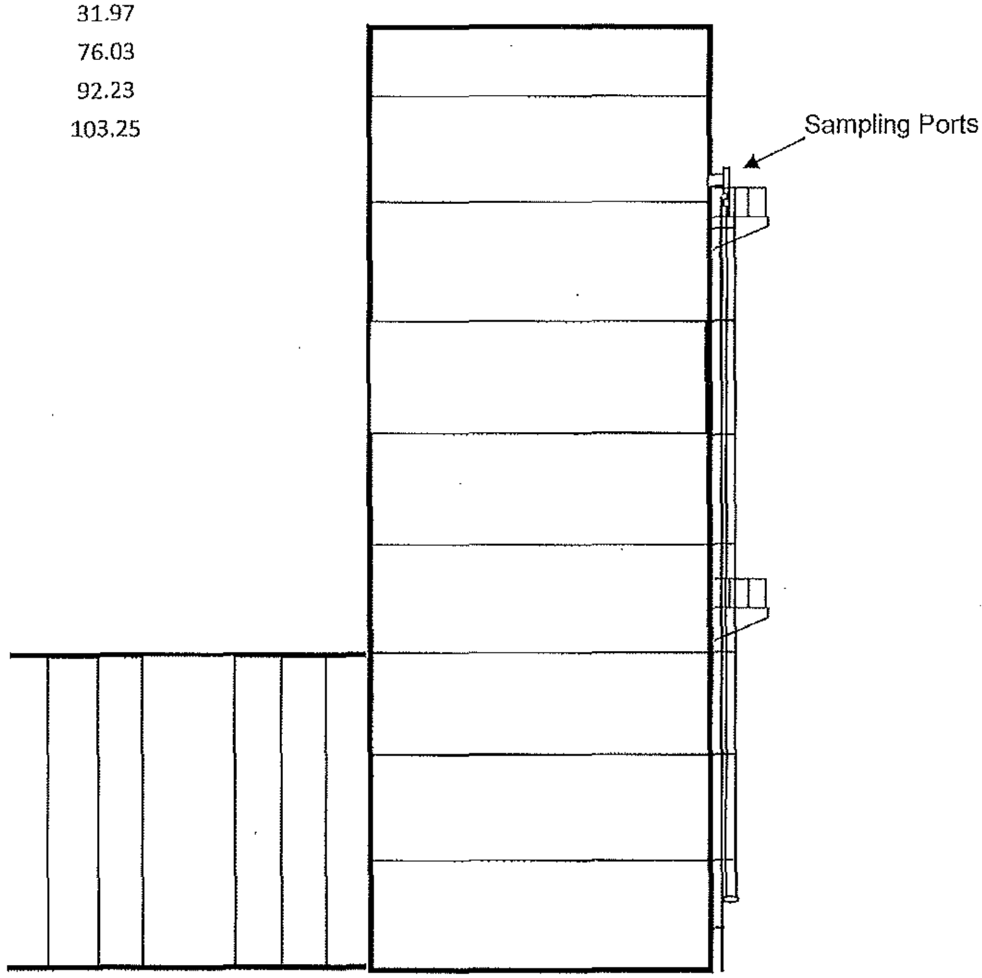


Figure 2 – EPA Method 5/202
DTE Energy– BRPP CTGs
May 23 – June 5, 2017