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REPORT ON COMPLIANCE TESTING

Renaissance Power Plant

Unit 4 (EU-TURBINE4SC) Exhaust

DTE Energy Corporate Services

One Energy Plaza

Detroit, MI 48226

Client Reference No. 4701349277

CleanAir Project No. 13915

A2LA ISO 17025 Certificate No. 4342.01

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1. PROJECT OVERVIEW

TEST PROGRAM SUMMARY

DTE Energy Corporate Services (DTE) contracted CleanAir Engineering (CleanAir) to complete testing on the Unit 4 Exhaust at the Renaissance Power Plant, located in Carson City, Michigan. The objective of the test program was to perform testing to meet requirements with Michigan Permit No. MI-ROP-N6873-2015a that testing be conducted.

This test program consisted of two mobilizations deemed Mobilization 1 and Mobilization 2. PM_{10}, as defined in the applicable permit, was tested at 100% of maximum load condition twice: the first mobilization utilizing EPA Method 5/202 and the second mobilization utilizing EPA Method 201A/202 to determine emissions. Refer to the Discussion section of this report for further details.

A summary of the test program results is presented below. Section 2 Results provides a more detailed account of the test conditions and data analysis.

Table 1-1:
Summary of Results

Source Constituent	Sampling Method	Average Emission
Unit 4 Exhaust - 100% Load		
PM_{10} (lb/hr)	EPA 5/202	12.3
PM_{10} (lb/hr)	EPA 201A/202	15.6
VOC (ppmdv @ 15%O_2)	EPA 25A	<0.430
Formaldehyde (ppmdv)	EPA 320	<0.23
Unit 4 Exhaust - 70% Load		
PM_{10} (lb/hr)	EPA 5/202	5.6
VOC (ppmdv @ 15%O_2)	EPA 25A	<0.438
Formaldehyde (ppmdv)	EPA 320	<0.23

TEST PROGRAM DETAILS

PARAMETERS

The test program included the following measurements:

- particulate matter less than 10 microns in diameter (PM_{10}), considered the sum of filterable particulate matter (FPM) and condensable particulate matter (CPM) – Mob. 1
- particulate matter less than 10 microns in diameter (PM_{10}), considered the sum of filterable particulate matter less than 10 microns (FPM_{10}) and condensable particulate matter (CPM) – Mob. 2
- volatile organic compounds (VOCs), measured as total hydrocarbons (THCs) as propane
- formaldehyde (HCOH)
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas temperature
- flue gas flow rate

The test program included testing for each parameter at the following conditions:

- 100% of maximum load
- 70% of maximum load

SCHEDULE

Testing was performed on July 10 and 11 and August 27 and 28, 2019. The on-site schedule followed during the test program is outlined in Tables 1-2 and 1-3 below.

Table 1-2:
Test Schedule – Mobilization 1

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	Unit 4 Exhaust - 100% Load	USEPA Method 5/202	FPM/CPM	07/10/19	07:38	09:57
2[1]	Unit 4 Exhaust - 100% Load	USEPA Method 5/202	FPM/CPM	07/10/19	10:55	13:08
3	Unit 4 Exhaust - 100% Load	USEPA Method 5/202	FPM/CPM	07/10/19	14:49	17:04
4	Unit 4 Exhaust - 100% Load	USEPA Method 5/202	FPM/CPM	07/10/19	18:04	20:17
5	Unit 4 Exhaust - 70% Load	USEPA Method 5/202	FPM/CPM	07/11/19	08:05	10:17
6	Unit 4 Exhaust - 70% Load	USEPA Method 5/202	FPM/CPM	07/11/19	11:03	13:14
7	Unit 4 Exhaust - 70% Load	USEPA Method 5/202	FPM/CPM	07/11/19	13:50	16:01
1	Unit 4 Exhaust - 100% Load	USEPA Method 25A	VOC	07/10/19	08:15	09:15
2	Unit 4 Exhaust - 100% Load	USEPA Method 25A	VOC	07/10/19	10:57	11:57
3	Unit 4 Exhaust - 100% Load	USEPA Method 25A	VOC	07/10/19	15:07	16:07
4	Unit 4 Exhaust - 70% Load	USEPA Method 25A	VOC	07/11/19	08:33	09:33
5	Unit 4 Exhaust - 70% Load	USEPA Method 25A	VOC	07/11/19	11:04	12:04
6	Unit 4 Exhaust - 70% Load	USEPA Method 25A	VOC	07/11/19	13:52	14:52
1	Unit 4 Exhaust - 100% Load	USEPA Method 320	Formaldehyde	07/10/19	08:15	09:18
2	Unit 4 Exhaust - 100% Load	USEPA Method 320	Formaldehyde	07/10/19	10:58	12:00
3	Unit 4 Exhaust - 100% Load	USEPA Method 320	Formaldehyde	07/10/19	15:07	16:10
4	Unit 4 Exhaust - 70% Load	USEPA Method 320	Formaldehyde	07/11/19	08:34	09:38
5	Unit 4 Exhaust - 70% Load	USEPA Method 320	Formaldehyde	07/11/19	11:04	12:07
6	Unit 4 Exhaust - 70% Load	USEPA Method 320	Formaldehyde	07/11/19	13:53	14:54

[1] Run is deemed invalid due to A-Side failed post-run leak-check. Refer to Discussion section for details.

Table 1-3:
Test Schedule – Mobilization 2

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	Unit 4 Exhaust - 100% Load	USEPA Method 201A/202	FPM_{10}/CPM	08/27/19	10:30	13:08
2	Unit 4 Exhaust - 100% Load	USEPA Method 201A/202	FPM_{10}/CPM	08/27/19	15:30	17:49
3[1]	Unit 4 Exhaust - 100% Load	USEPA Method 201A/202	FPM_{10}/CPM	08/28/19	07:45	11:36
4	Unit 4 Exhaust - 100% Load	USEPA Method 201A/202	FPM_{10}/CPM	08/28/19	13:05	15:21

[1] Run is deemed invalid due to B-Side sample contamination. Refer to Discussion section for details.

DISCUSSION

Determination of PM_{10} Emissions

PM_{10} emissions at 100% of maximum load were measured over the course of two mobilizations. PM_{10} emission results at 100% of maximum load during Mob. 1 yielded results exceeding the limit of 9.0 lb/hr for PM_{10}, according to the Michigan Permit No. MI-ROP-N6873-2015a (refer to Table 2-3 in Section 2). Upon this realization, PM_{10} front-half rinse sample fractions were sent to RJ Lee Group (RJLG) in Monroeville, Pennsylvania, for computer-controlled scanning electron microscopy and energy dispersive x-ray spectrometry (CCSEM EDS) analysis to determine sample composition and particle size distribution. Results from the RJLG analysis, as presented in Appendix K of this report, indicate that a significant portion of the PM_{10} front-half rinse sample fractions contained particulate particles greater than 10 microns in diameter (>PM_{10}). Based on the results of this analysis, it was determined that, initially conducting EPA Method 5/202 to measure PM_{10}, assuming PM_{10} was equivalent to the sum of total FPM and CPM was an incorrect assumption. The decision was then made to conduct a re-test of PM_{10} at 100% of maximum load utilizing EPA Method 201A/202, which would speciate < PM_{10} from total particulate.

Mobilization 1

PM_{10} emissions during Mob. 1 were determined using EPA Method 5/202. Initially, as specified in Appendix 5 of Permit No. MI-ROP-N6873-2015a, during Mob. 1, PM_{10} was assumed equivalent to the sum of FPM and CPM. The Method 5/202 sample train yields a front-half, FPM result and a back-half, CPM result. The total PM_{10} result (FPM plus CPM) from Method 5/202 was initially used as a worst-case estimation of total PM_{10} since Method 5 collects all FPM present in the flue gas (regardless of particle size). This assumption was proven to be incorrect during Mob. 1.

A total of seven (7) 120-minute Method 5/202 test runs were performed: four (4) test runs while the unit was running at 100% of maximum load and three (3) test runs while the unit was running at 70% of maximum load. Two (2) Method 5/202 sample trains were conducted concurrently on opposite sides of the duct deemed 'A-Side' and 'B-Side.' Weighted resultant concentrations based on duct velocities from each respective side from concurrent test runs were combined into a single test run result. Emission results were calculated in units of pounds per hour (lb/hr) utilizing volumetric flows calculated from EPA Method 19. The final result for each test condition was expressed as the average of the three (3) valid runs. Method 19 was required because the velocities, as measured with the EPA Method 5 train, do not allow for calculations of a representative exhaust flow volume due to poor exhaust stack configuration.

Mobilization 2

PM_{10} emissions during Mob. 2 were determined using EPA Method 201A/202. During Mob. 2, PM_{10} was assumed equivalent to the sum of FPM_{10} and CPM instead of the sum of FPM and CPM. The Method 201A/202 sample train yields a front-half, FPM_{10} result and a back-half, CPM result. The typical EPA Method 201 configuration was modified, such that the filter was positioned in a heated box outside of the stack. EGLE was informed of this modification in advance of testing.

A total of four (4) approximately 120-minute Method 201A/202 test runs were performed while the unit was running at 100% of maximum load. Two (2) Method 201A/202 sample trains were conducted concurrently on opposite sides of the duct deemed 'A-Side' and 'B-Side.' Weighted resultant concentrations based on duct velocities from each respective side from concurrent test runs were combined into a single test run result. Emission results were calculated in units of lb/hr utilizing volumetric flows calculated from EPA Method 19. The final result for each test condition was expressed as the average of the three (3) valid runs. The resultant emission rate also exceeded the limit for PM_{10} during Mob. 2. Method 19 was required because the velocities, as measured with the EPA Method 201A train, do not allow for calculations of a representative exhaust flow volume due to poor exhaust stack configuration.

Volumetric Flow and Fuel Gas Analysis

Volumetric flow for each set of concurrent PM_{10} runs were determined using EPA Method 19. A fuel sample was collected during each day of testing and sent to SPL Inc. (SPL) in Traverse City, Michigan, for fuel gas compositional analysis. The results of the SPL analysis are presented in Appendix J of this report.

An F_d factor for each respective day of testing was calculated based on analysis results using equations outlined in EPA Method 19. Oxygen (O_2) concentrations utilized in Method 19 calculations were obtained from multi-point integrated gas samples (IGS) continuously collected at a constant rate from a slipstream of the exhaust of each sample train. O_2 concentrations from concurrent sample trains were then averaged to yield one (1) O_2 concentration for the entire duct. Minute by minute heat input data from CT4 process data was supplied by DTE to CleanAir to be utilized in the Method 19 calculations. Volumetric flow calculated using Method 19 was used to determine PM_{10} mass emissions in units of lb/hr.

Invalid Runs

Run 2 of Mob. 1 was deemed invalid due to a failed post-test leak-check on the A-Side. The sample train was leaking at the connection from the front of the probe to the nozzle. Because of the leak being at a point in the sample train that was inside the duct, the O_2, carbon dioxide (CO_2), and H_2O concentrations do not indicate a leaking sample train; however, the sample is still unrepresentative of duct conditions. Sample fractions from Run 2 of Mob. 1 are archived.

Run 3 of Mob. 2 was deemed invalid due to sample contamination on the B-Side. After completion of the run, the CleanAir Field Technician noted a significant amount of reddish matter on the filter that was not representative of duct conditions. There were also numerous instances during the run that the sample train was thought to be leaking. This might have been a contributing factor to the sample contamination. Front-half rinse and Cyclone I rinse sample fractions from B-Side Run 3 are archived. Other sample fractions from the sample train were not recovered.

Special Notes

A foreign object (what appeared to be a probe bristle) was found in the EPA Method 5 front-half rinse sample fraction for B-Side Run 4 of Mob. 1. The foreign object was removed from the sample fraction. Sample weights with and without the foreign object are reported in the laboratory report presented in Appendix K. Final results are reported using the sample weight without the foreign object.

Additionally, a foreign object (what appeared to be a glass chip) was found in the EPA Method 202 back-half inorganic sample fraction of A-Side Run 1 of Mob. 1. The foreign object was removed from the sample fraction. Sample weights with and without the foreign object are reported in the laboratory report presented in Appendix K. Final results are reported using the sample weight without the foreign object.

Due to the variance in the duct velocity profile, Mob. 2 did not meet EPA Method 201A, Section 8.5.5(b) specifications for number of sampling points in the Δp_{min} and Δp_{max} range. An initial pre-test velocity traverse just prior to EPA Method 201A/202 testing during Mob. 2 determined the velocity profile of the sample location would likely not meet specifications per EPA Method 201A. This was discussed on-site with Tom Gasloli of the Michigan Department of Environment, Great Lakes and Energy (EGLE). The decision was made to proceed with testing.

Despite a passing post-test leak-check witnessed by Mr. Gasloli (EGLE), Side-A Run 2 of Mob. 2 yielded an elevated O_2 concentration and depressed moisture content, typical indicators of a leaking sample train. Consequently, the sample volume collected during the run was corrected using the EPA's approved calculation for correcting concentrations to a specific percent O_2:

$$V_C = V_M \times [\ (O_{2A} - O_{2M})/(O_{2A} - O_{2Ave})\ ]$$

Where:

V_C = Corrected sample volume
V_M = Measured sample volume
O_{2A} = Ambient O_2 (assumed to be 20.9%)
O_{2M} = Elevated O_2 concentration measured during run (16.3%)
O_{2Ave} = Average O_2 concentration of Runs 1, 3, and 4 (14.0%)

The corrected volume was used in all subsequent calculations for Run 2 of Mob. 2. The average O_2 and CO_2 concentrations of A-Side Runs 1, 3, and 4 were used in all subsequent calculations for A-Side Run 2. Because of the sample volume correction, A-Side Run 2 did not meet isokinetic criteria. The percent isokinetic for the run was below the range specified in Method 201A; however, a low isokinetic percentage biases the sample high.

It should be noted that in-situ velocity measurements, measured utilizing methods incorporated into EPA Method 5 and EPA Method 201A specifications, were used for isokinetic calculations and to yield a weighted composite PM_{10} concentration for concurrent PM_{10} test runs.

Determination of VOC Emissions

VOC emissions were determined using EPA Method 25A to quantify THC emissions. VOC emissions are assumed equivalent to THC emissions. Six (6) 60-minute Method 25A test runs, three (3) at each load condition, were performed concurrently with each EPA Method 5/202 test run. The final result for each load condition was expressed as the average of three (3) consecutive 60-minute runs.

VOC emission results were calculated in units of parts per million, dry volume (ppmdv) @ 15% O_2. THC data was converted from an actual (wet) basis to a dry basis using moisture data collected from concurrent Method 5/202 runs.

For all Method 25A runs, the measured concentrations of THC were below the detection limit defined as 'less than 1%' of the calibration span of the THC instrument. Assuming worst-case scenario, the resultant VOC emissions are reported as 'less than' the defined THC detection limit.

Determination of Formaldehyde Emissions

Formaldehyde emissions were determined using EPA Method 320. Six (6) 60-minute Method 320 test runs, three (3) at each load condition, were performed concurrently with each EPA Method 5/202 test run. The final result for each load condition was expressed as the average of three (3) consecutive 60-minute runs.

Formaldehyde emission results were calculated in units of ppmdv. Formaldehyde data was converted from an actual (wet) basis to a dry basis using moisture data collected from the FTIR.

An on-site minimum detection limit (MDL) study was performed for the target analyte using procedures outlined in ASTM D6348-12 A2.3. The MDL is calculated as three times the standard deviation of the concentrations from 10 representative spectra taken during the MDL study. Results calculated from sample concentrations less than the calculated MDL are reported as 'less than' the MDL. All resultant concentrations were less than the MDL.

End of Section

2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices.

Table 2-1:
Unit 4 Exhaust A-Side – PM_{10}, 100% Load, Mobilization 1

Run No.		1	2*	3	4	Average
Date (2019)		Jul 10	Jul 10	Jul 10	Jul 10	
Start Time (approx.)		07:38	10:55	14:49	18:04	
Stop Time (approx.)		09:57	13:08	17:04	20:17	
Process Conditions						
P_1	Gas Flow (kscf/hr)	1,640		1,573	1,575	**1,596**
P_2	Generation (MW)	163		154	154	**157**
P_3	Water Flow (klb/hr)	3.72		3.75	3.75	**3.74**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387		8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,737		1,667	1,668	**1,691**
Gas Conditions						
O_2	Oxygen (dry volume %)	14.6		14.4	13.9	**14.3**
CO_2	Carbon dioxide (dry volume %)	3.3		3.7	4.0	**3.7**
T_s	Sample temperature (°F)	1095		1115	1117	**1109**
B_w	Actual water vapor in gas (% by volume)	9.1		9.7	9.8	**9.5**
Gas Flow Rate						
Q_a	Volumetric flow rate, actual (acfm)	2,620,000		2,610,000	2,370,000	**2,530,000**
Q_s	Volumetric flow rate, standard (scfm)	872,000		856,000	778,000	**835,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	793,000		773,000	701,000	**756,000**
Sampling Data						
V_{mstd}	Volume metered, standard (dscf)	56.85		57.33	56.78	**56.99**
%I	Isokinetic sampling (%)	100.4		99.4	98.8	**99.6**
Laboratory Data						
m_n	Total FPM (g)	0.00571		0.00441	0.00334	
m_{CPM}	Total CPM (g)	0.00122		0.00103	0.00071	
m_{Part}	Total particulate matter (g)	0.00693		0.00544	0.00405	
PM_{10} Results						
C_{sd}	Particulate Concentration (lb/dscf)	2.69E-07		2.09E-07	1.57E-07	**2.12E-07**

Average includes 3 runs. * indicates that the run is not included in the average.

Table 2-2:
Unit 4 Exhaust B-Side – PM_{10}, 100% Load, Mobilization 1

Run No.		1	2*	3	4	Average
Date (2019)		Jul 10	Jul 10	Jul 10	Jul 10	
Start Time (approx.)		07:38	10:55	14:49	18:04	
Stop Time (approx.)		09:57	13:08	17:04	20:18	
Process Conditions						
P_1	Gas Flow (kscf/hr)	1,640		1,573	1,575	**1,596**
P_2	Generation (MW)	163		154	154	**157**
P_3	Water Flow (klb/hr)	3.72		3.75	3.75	**3.74**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387		8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,737		1,667	1,668	**1,691**
Gas Conditions						
O_2	Oxygen (dry volume %)	14.4		14.8	14.0	**14.4**
CO_2	Carbon dioxide (dry volume %)	3.5		3.5	4.0	**3.7**
T_s	Sample temperature (°F)	1098		1111	1108	**1106**
B_w	Actual water vapor in gas (% by volume)	8.7		8.9	10.3	**9.3**
Gas Flow Rate						
Q_a	Volumetric flow rate, actual (acfm)	2,620,000		2,610,000	2,370,000	**2,530,000**
Q_s	Volumetric flow rate, standard (scfm)	872,000		856,000	778,000	**835,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	793,000		773,000	701,000	**756,000**
Sampling Data						
V_{mstd}	Volume metered, standard (dscf)	71.03		72.69	61.44	**68.39**
%I	Isokinetic sampling (%)	102.9		104.2	104.5	**103.9**
Laboratory Data						
m_n	Total FPM (g)	0.00582		0.00833	0.01024	
m_{CPM}	Total CPM (g)	0.00176		0.00197	0.00182	
m_{Part}	Total particulate matter (g)	0.00758		0.01030	0.01206	
PM_{10} Results						
C_{sd}	Particulate Concentration (lb/dscf)	2.35E-07		3.13E-07	4.33E-07	**3.27E-07**

Average includes 3 runs. * indicates that the run is not included in the average.

Table 2-3:
Unit 4 Exhaust A-Side and B-Side Composite – PM_{10}, 100% Load, Mobilization 1

Run No.		1	2*	3	4	Average
Date (2019)		Jul 10	Jul 10	Jul 10	Jul 10	
Start Time (approx.)		07:38	10:55	14:49	18:04	
Stop Time (approx.)		09:57	13:08	17:04	20:17	
Process Conditions						
P_1	Gas Flow (kscf/hr)	1,640		1,573	1,575	**1,596**
P_2	Generation (MW)	163		154	154	**157**
P_3	Water Flow (klb/hr)	3.72		3.75	3.75	**3.74**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387		8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,737		1,667	1,668	**1,691**
Gas Conditions						
O_2	Oxygen (dry volume %)	14.5		14.6	14.0	**14.4**
CO_2	Carbon dioxide (dry volume %)	3.4		3.6	4.0	**3.7**
T_s	Sample temperature (°F)	1097		1113	1112	**1107**
B_w	Actual water vapor in gas (% by volume)	8.9		9.3	10.1	**9.4**
V_A	Stack velocity on A-Side (ft/sec)	161.2		167.6	167.2	**165.4**
V_B	Stack velocity on B-Side (ft/sec)	198.5		202.6	173.2	**191.4**
Gas Flow Rate (Method 19)						
Q_a	Volumetric flow rate, actual (acfm)	2,620,000		2,610,000	2,370,000	**2,530,000**
Q_s	Volumetric flow rate, standard (scfm)	872,000		856,000	778,000	**835,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	793,000		773,000	701,000	**756,000**
A-Side Results						
PM_{10} (Total) Results						
C_A	Particulate Concentration (lb/dscf)	2.69E-07		2.09E-07	1.57E-07	**2.12E-07**
B-Side Results						
PM_{10} (Total) Results						
C_B	Particulate Concentration (lb/dscf)	2.35E-07		3.13E-07	4.33E-07	**3.27E-07**
Total Combined Results						
PM_{10} (Total) Results						
C_T	Particulate Concentration (lb/dscf) [1]	2.50E-07		2.66E-07	2.98E-07	**2.71E-07**
$E_{lb/hr}$	Particulate Rate (lb/hr)	11.9		12.3	12.5	**12.3**

Average includes 3 runs. * indicates that the run is not included in the average.

[1] Weighted concentration based on respective stack velocities.

Table 2-4:
Unit 4 Exhaust A-Side – PM_{10}, 100% Load, Mobilization 2

Run No.		1	2	3*	4	Average
Date (2019)		Aug 27	Aug 27	Aug 28	Aug 28	
Start Time (approx.)		10:30	15:30	07:45	13:05	
Stop Time (approx.)		13:08	17:49	11:36	15:21	
Process Conditions						
P_1	Gas Flow (kscf/hr)	1,633	1,614		1,652	**1,633**
P_2	Generation (MW)	162	160		165	**162**
P_3	Water Flow (klb/hr)	3.48	3.49		3.48	**3.48**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,388	8,388		8,388	**8,388**
H_i	Actual heat input (MMBtu/hr)	1,730	1,710		1,750	**1,730**
Gas Conditions						
O_2	Oxygen (dry volume %)	13.9	14.0		14.1	**14.0**
CO_2	Carbon dioxide (dry volume %)	4.0	3.9		3.8	**3.9**
T_s	Sample temperature (°F)	1101	1108		1100	**1103**
B_w	Actual water vapor in gas (% by volume)	8.7	8.1		7.7	**8.1**
Gas Flow Rate						
Q_a	Volumetric flow rate, actual (acfm)	2,350,000	2,350,000		2,410,000	**2,370,000**
Q_s	Volumetric flow rate, standard (scfm)	785,000	782,000		808,000	**792,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	717,000	719,000		746,000	**727,000**
Sampling Data						
V_{mstd}	Volume metered, standard (dscf)	45.89	30.31		45.41	**40.54**
%I	Isokinetic sampling (%)	100.0	71.7		107.9	**93.2**
Laboratory Data						
m_{n-10}	Total FPM < 10 µm (g)	0.00786	0.00452		0.00364	
m_{CPM}	Total CPM (g)	0.00073	0.00215		0.00177	
$m_{Part-10}$	Total PM < 10 µm (g)	0.00859	0.00667		0.00541	
Total PM_{10} Results						
C_{sd}	Particulate Concentration (lb/dscf)	4.13E-07	4.85E-07		2.63E-07	**3.87E-07**

Average includes 3 runs. * indicates that the run is not included in the average.

Table 2-5:
Unit 4 Exhaust B-Side – PM_{10}, 100% Load, Mobilization 2

Run No.		1	2	3*	4	Average
Date (2019)		Aug 27	Aug 27	Aug 28	Aug 28	
Start Time (approx.)		10:30	15:30	07:45	13:05	
Stop Time (approx.)		13:08	17:49	11:36	15:19	
Process Conditions						
P_1	Gas Flow (kscf/hr)	1,633	1,614		1,652	**1,633**
P_2	Generation (MW)	162	160		165	**162**
P_3	Water Flow (klb/hr)	3	3		3	**3**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,388	8,388		8,388	**8,388**
H_i	Actual heat input (MMBtu/hr)	1,730	1,710		1,750	**1,730**
Gas Conditions						
O_2	Oxygen (dry volume %)	13.8	13.9		14.0	**13.9**
CO_2	Carbon dioxide (dry volume %)	4.0	3.8		3.9	**3.9**
T_s	Sample temperature (°F)	1100	1105		1098	**1101**
B_w	Actual water vapor in gas (% by volume)	9.2	8.6		8.7	**8.8**
Gas Flow Rate						
Q_a	Volumetric flow rate, actual (acfm)	2,350,000	2,350,000		2,410,000	**2,370,000**
Q_s	Volumetric flow rate, standard (scfm)	785,000	782,000		808,000	**792,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	717,000	719,000		746,000	**727,000**
Sampling Data						
V_{mstd}	Volume metered, standard (dscf)	48.55	44.47		44.56	**45.86**
%I	Isokinetic sampling (%)	85.0	88.0		88.0	**87.0**
Laboratory Data						
m_{n-10}	Total FPM < 10 µm (g)	0.00574	0.00645		0.00393	
m_{CPM}	Total CPM (g)	0.00137	0.00183		0.00161	
$m_{Part-10}$	Total PM < 10 µm (g)	0.00711	0.00828		0.00554	
Total PM_{10} Results						
C_{sd}	Particulate Concentration (lb/dscf)	3.23E-07	4.11E-07		2.74E-07	**3.36E-07**

Average includes 3 runs. * indicates that the run is not included in the average.

Table 2-6:
Unit 4 Exhaust A-Side and B-Side Composite – PM_{10}, 100% Load, Mobilization 2

Run No.		1	2	3*	4	Average
Date (2019)		Aug 27	Aug 27	Aug 28	Aug 28	
Start Time (approx.)		10:30	15:30	07:45	13:05	
Stop Time (approx.)		13:08	17:49	11:36	15:21	
Process Conditions						
P_1	Gas Flow (kscf/hr)	1,633	1,614		1,652	**1,633**
P_2	Generation (MW)	162	160		165	**162**
P_3	Water Flow (klb/hr)	3.48	3.49		3.48	**3.48**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,388	8,388		8,388	**8,388**
H_i	Actual heat input (MMBtu/hr)	1,730	1,710		1,750	**1,730**
Gas Conditions						
O_2	Oxygen (dry volume %)[1]	13.9	14.0		14.1	**14.0**
CO_2	Carbon dioxide (dry volume %)[1]	4.0	3.9		3.9	**3.9**
T_s	Sample temperature (°F)	1100	1107		1099	**1102**
B_w	Actual water vapor in gas (% by volume)	8.9	8.3		8.2	**8.5**
V_A	Stack velocity on A-Side (ft/sec)	177.7	167.5		163.1	**169.4**
V_B	Stack velocity on B-Side (ft/sec)	239.9	230.9		233.3	**234.7**
Gas Flow Rate (Method 19)						
Q_a	Volumetric flow rate, actual (acfm)	2,350,000	2,350,000		2,410,000	**2,370,000**
Q_s	Volumetric flow rate, standard (scfm)	785,000	782,000		808,000	**791,667**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	717,000	719,000		746,000	**727,333**
A-Side Results						
PM_{10} Results						
C_A	Particulate Concentration (lb/dscf)	4.13E-07	4.85E-07		2.63E-07	**3.87E-07**
B-Side Results						
PM_{10} Results						
C_B	Particulate Concentration (lb/dscf)	3.23E-07	4.11E-07		2.74E-07	**3.36E-07**
Total Combined Results						
PM_{10} Results						
C_T	Particulate Concentration (lb/dscf)[2]	3.61E-07	4.42E-07		2.69E-07	**3.58E-07**
$E_{lb/hr}$	Particulate Rate (lb/hr)	15.5	19.1		12.1	**15.6**

Average includes 3 runs. * indicates that the run is not included in the average.

[1] Run 2 O_2/CO_2 concentration is an average of B Side concentration and average of A Side Run 1, 3, and 4 concentrations.

[2] Weighted concentration based on respective stack velocities.

Table 2-7:
Unit 4 Exhaust A-Side – PM_{10}, 70% Load

Run No.		5	6	7	Average
Date (2019)		Jul 11	Jul 11	Jul 11	
Start Time (approx.)		08:05	11:03	13:50	
Stop Time (approx.)		10:17	13:14	16:01	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,275	1,275	1,275	**1,275**
P_2	Generation (MW)	120	120	120	**120**
P_3	Water Flow (klb/hr)	3	3	3	**3**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,351	1,351	1,351	**1,351**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.2	15.2	14.4	**14.6**
CO_2	Carbon dioxide (dry volume %)	3.6	3.0	3.5	**3.4**
T_s	Sample temperature (°F)	1113	1114	1116	**1114**
B_w	Actual water vapor in gas (% by volume)	8.3	8.6	8.5	**8.5**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	1,990,000	2,210,000	2,080,000	**2,090,000**
Q_s	Volumetric flow rate, standard (scfm)	652,000	725,000	679,000	**686,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	598,000	663,000	622,000	**628,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	58.05	56.21	56.50	**56.92**
%I	Isokinetic sampling (%)	102.7	101.4	101.6	**101.9**
Laboratory Data					
m_n	Total FPM (g)	0.00273	0.00415	0.00259	
m_{CPM}	Total CPM (g)	0.00068	0.00069	0.00070	
m_{Part}	Total particulate matter (g)	0.00341	0.00484	0.00329	
PM_{10} Results					
C_{sd}	Particulate Concentration (lb/dscf)	1.30E-07	1.90E-07	1.29E-07	**1.49E-07**

Table 2-8:
Unit 4 Exhaust B-Side – PM_{10}, 70% Load

Run No.		5	6	7	Average
Date (2019)		Jul 11	Jul 11	Jul 11	
Start Time (approx.)		08:05	11:03	13:50	
Stop Time (approx.)		10:17	13:14	16:01	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,275	1,275	1,275	**1,275**
P_2	Generation (MW)	120	120	120	**120**
P_3	Water Flow (klb/hr)	3	3	3	**3**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,351	1,351	1,351	**1,351**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.4	14.7	14.7	**14.6**
CO_2	Carbon dioxide (dry volume %)	3.5	3.3	3.3	**3.4**
T_s	Sample temperature (°F)	1115	1114	1114	**1114**
B_w	Actual water vapor in gas (% by volume)	8.2	7.7	7.6	**7.8**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	1,990,000	2,210,000	2,080,000	**2,090,000**
Q_s	Volumetric flow rate, standard (scfm)	652,000	725,000	679,000	**686,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	598,000	663,000	622,000	**628,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	55.38	57.63	59.88	**57.63**
%I	Isokinetic sampling (%)	102.9	102.3	102.2	**102.5**
Laboratory Data					
m_n	Total FPM (g)	0.00333	0.00282	0.00321	
m_{CPM}	Total CPM (g)	0.00061	0.00065	0.00077	
m_{Part}	Total particulate matter (g)	0.00394	0.00347	0.00398	
PM_{10} Results					
C_{sd}	Particulate Concentration (lb/dscf)	1.57E-07	1.33E-07	1.47E-07	**1.45E-07**

Table 2-9:
Unit 4 Exhaust A-Side and B-Side Composite – PM_{10}, 70% Load

Run No.		5	6	7	Average
Date (2019)		Jul 11	Jul 11	Jul 11	
Start Time (approx.)		08:05	11:03	13:50	
Stop Time (approx.)		10:17	13:14	16:01	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,275	1,275	1,275	**1,275**
P_2	Generation (MW)	120	120	120	**120**
P_3	Water Flow (klb/hr)	2.97	3.00	3.00	**2.99**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,351	1,351	1,351	**1,351**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.3	15.0	14.6	**14.6**
CO_2	Carbon dioxide (dry volume %)	3.6	3.2	3.4	**3.4**
T_s	Sample temperature (°F)	1114	1114	1115	**1114.2**
B_w	Actual water vapor in gas (% by volume)	8.3	8.1	8.0	**8.1**
V_A	Stack velocity on A-Side (ft/sec)	147.9	145.4	146.2	**146.5**
V_B	Stack velocity on B-Side (ft/sec)	154.2	160.5	166.8	**160.5**
Gas Flow Rate (Method 19)					
Q_a	Volumetric flow rate, actual (acfm)	1,990,000	2,210,000	2,080,000	**2,090,000**
Q_s	Volumetric flow rate, standard (scfm)	652,000	725,000	679,000	**686,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	598,000	663,000	622,000	**628,000**
A-Side Results					
PM_{10} (Total) Results					
C_A	Particulate Concentration (lb/dscf)	1.30E-07	1.90E-07	1.29E-07	**1.49E-07**
B-Side Results					
PM_{10} (Total) Results					
C_B	Particulate Concentration (lb/dscf)	1.57E-07	1.33E-07	1.47E-07	**1.45E-07**
Total Combined Results					
PM_{10} (Total) Results					
C_{sd}	Particulate Concentration (lb/dscf) [1]	1.44E-07	1.60E-07	1.38E-07	**1.47E-07**
$E_{lb/hr}$	Particulate Rate (lb/hr)	5.2	6.4	5.2	**5.6**

[1] Weighted concentration based on respective stack velocities.

Table 2-10:
Unit 4 Exhaust – VOC, 100% Load

Run No.		1	2	3	Average
Date (2019)		Jul 10	Jul 10	Jul 10	
Start Time (approx.)		08:15	10:57	15:07	
Stop Time (approx.)		09:15	11:57	16:07	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,642	1,603	1,576	**1,607**
P_2	Generation (MW)	163	158	154	**159**
P_3	Water Flow (klb/hr)	3.72	3.73	3.75	**3.73**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,740	1,699	1,670	**1,703**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.0	14.0	13.9	**14.0**
CO_2	Carbon dioxide (dry volume %)	4.0	4.0	4.0	**4.0**
B_w	Actual water vapor in gas (% by volume)[1]	8.8	9.2	9.6	**9.2**
VOC Results[1]					
C_{sd}	Concentration (ppmdv)	<0.504	<0.506	<0.505	**<0.505**
C_{sd}	Concentration (ppmdv @ 15%O_2)	<0.430	<0.433	<0.427	**<0.430**

[1] '<' indicates a measured response below the detection limit (assumed to be 1% of span).

Table 2-11:
Unit 4 Exhaust – VOC, 70% Load

Run No.		4	5	6	Average
Date (2019)		Jul 11	Jul 11	Jul 11	
Start Time (approx.)		08:33	11:04	13:52	
Stop Time (approx.)		09:33	12:04	14:52	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,275	1,275	1,275	**1,275**
P_2	Generation (MW)	120	120	120	**120**
P_3	Water Flow (klb/hr)	2.97	2.99	3.00	**2.99**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,351	1,351	1,351	**1,351**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.2	14.2	14.2	**14.2**
CO_2	Carbon dioxide (dry volume %)	3.9	3.9	3.9	**3.9**
B_w	Actual water vapor in gas (% by volume)[1]	8.8	8.8	8.7	**8.8**
VOC Results[1]					
C_{sd}	Concentration (ppmdv)	<0.501	<0.498	<0.498	**<0.499**
C_{sd}	Concentration (ppmdv @ 15%O_2)	<0.438	<0.437	<0.439	**<0.438**

[1] '<' indicates a measured response below the detection limit (assumed to be 1% of span).

Table 2-12:
Unit 4 Exhaust – Formaldehyde, 100% Load

Run No.		1	2	3	Average
Date (2019)		Jul 10	Jul 10	Jul 10	
Start Time (approx.)		08:15	10:58	15:07	
Stop Time (approx.)		09:18	12:00	16:10	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,641	1,603	1,576	**1,607**
P_2	Generation (MW)	163	158	154	**158.50**
P_3	Water Flow (klb/hr)	3.73	3.73	3.75	**3.73**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,386.68**
H_i	Actual heat input (MMBtu/hr)	1,739	1,699	1,670	**1,702.62**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.0	14.0	13.9	**14.0**
CO_2	Carbon dioxide (dry volume %)	4.0	4.0	4.0	**4.0**
B_w	Actual water vapor in gas (% by volume)[1]	8.8	9.2	9.6	**9.2**
Formaldehyde Results[1]					
C_{sd}	Concentration (ppmdv)	<0.23	<0.23	<0.23	**<0.23**

[1] '<' indicates a measured response below the detection limit.

Table 2-13:
Unit 4 Exhaust – Formaldehyde, 70% Load

Run No.		4	5	6	Average
Date (2019)		Jul 11	Jul 11	Jul 11	
Start Time (approx.)		08:34	11:04	13:53	
Stop Time (approx.)		09:38	12:07	14:54	
Process Conditions					
P_1	Gas Flow (kscf/hr)	1,275	1,275	1,275	**1,275**
P_2	Generation (MW)	120	120	120	**120**
P_3	Water Flow (klb/hr)	2.97	2.99	3.00	**3**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,387	8,387	8,387	**8,387**
H_i	Actual heat input (MMBtu/hr)	1,351	1,351	1,351	**1,351**
Gas Conditions					
O_2	Oxygen (dry volume %)	14.2	14.2	14.2	**14.2**
CO_2	Carbon dioxide (dry volume %)	3.9	3.9	3.9	**3.9**
B_w	Actual water vapor in gas (% by volume)[1]	8.8	8.8	8.7	**8.8**
Formaldehyde Results[1]					
C_{sd}	Concentration (ppmdv)	<0.23	<0.23	<0.23	**<0.23**

[1] '<' indicates a measured response below the detection limit.

End of Section

3. DESCRIPTION OF INSTALLATION

PROCESS DESCRIPTION

The Renaissance Power Plant is a peaking plant composed of four (4) Westinghouse simple cycle natural gas-fired turbines designated as EUTURBINE1SC, EUTURBINE2SC, EUTURBINE3SC, and EUTURBINE4SC, capable of producing 215 MW of electricity. Each unit is equipped with a compressor, combustion turbine, and generator. Mechanical energy is generated at the combustion turbine by drawing in ambient air by means of burning fuel and expanding the hot combustion gases in a four-stage turbine. The mechanical energy is then converted to electrical energy through each respective generator. Each turbine has a nominal heat input rate of 10 million Btu per hour, is equipped with dry low-NO_X burners, and has its own dedicated exhaust.

The testing reported in this document was performed at the Unit 4 Exhaust. Testing occurred at both 100% of maximum achievable load and 70% of the nominal rated capacity.

TEST LOCATION

Table 3-1 presents the sampling information for the test location. Because of the size of the duct, CleanAir tested opposite sides of the duct, deemed 'A-Side' and 'B-Side', concurrently. The figures shown on pages 20 and 21 represent the layout of the test location.

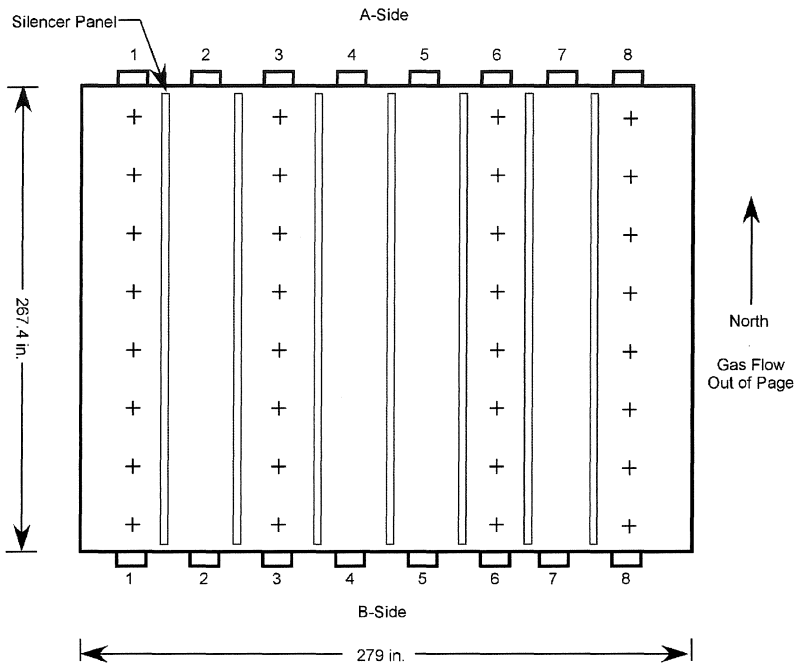
Table 3-1:
Sampling Information

Source Constituent	Method	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
Unit 4 Exhaust (A-Side)							
PM_{10} (Mob. 1)	EPA 5/202	1-7	4	4	7.5	120	3-1
PM_{10} (Mob. 2)	EPA 201A/202	1-4	4	3	~10	~120	3-2
Unit 4 Exhaust (B-Side)							
PM_{10} (Mob. 1)	EPA 5/202	1-7	4	4	7.5	120	3-1
PM_{10} (Mob. 2)	EPA 201A/202	1-4	4	3	~10	~120	3-2
VOC	EPA 25A	1-6	1	1	60	60	N/A[1]
Formaldehyde	EPA 320	1-6	1	1	~60	~60	N/A[1]

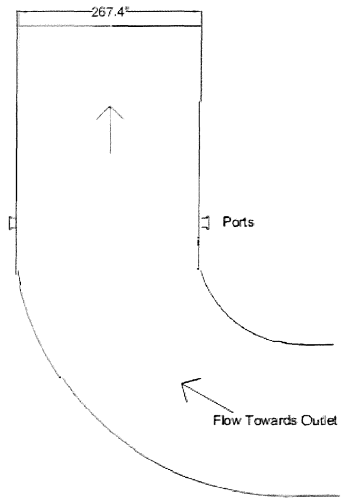
[1] VOC and formaldehyde tested at a single point (B-Side, Port 4) near the center of the duct.

EPA Method 1 is designed to ensure that the sample collected is representative of the actual emission. This is especially important for particulate and particulate-associated emissions. The configuration of the exhaust stack at the sample location meets neither the simplified nor the alternative procedure requirements specified in the method.

Figure 3-1:
Unit 4 Exhaust Sample Point Layout (EPA Method 5/202) – Mobilization 1



Plan View



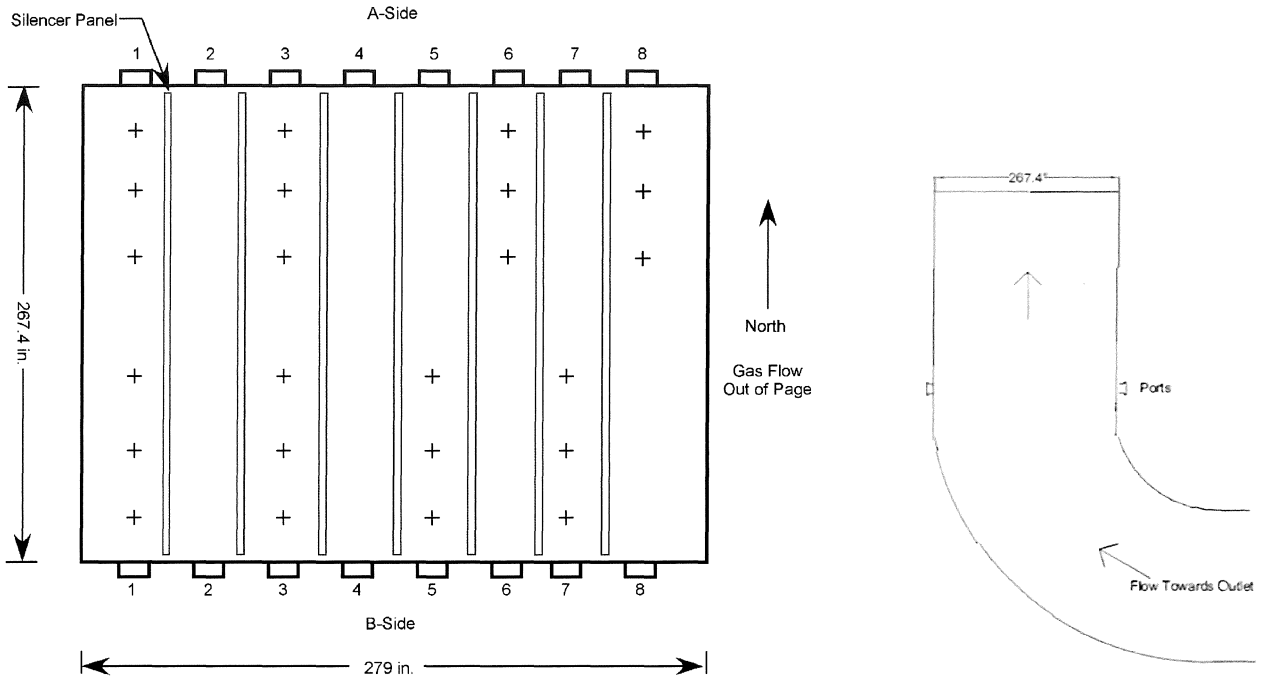
Profile View

Notes:

- Scaffold clearance obstruction aligned with Ports 5 and 7.
- Location does not meet EPA Method 1 criteria.

Sampling Point (Each Side)	% of Stack Diameter	Port to Point Distance (inches)
1	43.7	116.9
2	31.2	83.5
3	18.7	50.1
4	6.2	16.7

Figure 3-2:
Unit 4 Exhaust Sample Point Layout (EPA Method 201A/202) – Mobilization 2



Plan View **Profile View**

Notes:

- Location does not meet EPA Method 1 criteria.
- Smaller diameter on A-Side, Port 5

Sampling Point (Each Side)	% of Stack Diameter	Port to Point Distance (inches)
1	41.7	111.4
2	25.0	66.8
3	8.3	22.3

End of Section

4. METHODOLOGY

PROCEDURES AND REGULATIONS

The test program sampling measurements followed procedures and regulations outlined by the United States Environmental Protection Agency (USEPA) and the EGLE. These methods appear in detail in Title 40 of the CFR and at https://www.epa.gov/emc.

Appendix A includes diagrams of the sampling apparatus, as well as specifications for sampling, recovery, and analytical procedures. Any modifications to standard test methods are explicitly indicated in this appendix. In accordance with ASTM D7036 requirements, CleanAir included a description of any such modifications along with the full context of the objectives and requirements of the test program in the test protocol submitted prior to the measurement portion of this project. Modifications to standard methods are not covered by the ISO 17025 and TNI portions of CleanAir's A2LA accreditation.

CleanAir follows specific QA/QC procedures outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods," EPA/600/R-94/038C. Appendix D contains additional QA/QC measures, as outlined in CleanAir's internal Quality Manual.

TITLE 40 CFR PART 60, APPENDIX A

Method 1	"Sample and Velocity Traverses for Stationary Sources"
Method 2	"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
Method 3	"Gas Analysis for the Determination of Dry Molecular Weight"
Method 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 4	"Determination of Moisture Content in Stack Gases"
Method 5	"Determination of Particulate Matter Emissions from Stationary Sources"
Method 19	"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxide Emission Rates"
Method 25A	"Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

TITLE 40 CFR PART 51, APPENDIX M

Method 201A	"Determination of PM_{10} and $PM_{2.5}$ Emissions from Stationary Sources (Constant Sampling Rate Procedure)"
Method 202	"Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"

TITLE 40 CFR PART 63, APPENDIX A

Method 320	"Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy"

METHODOLOGY DISCUSSION

PM_{10} Testing – USEPA Method 5/202

PM_{10} emissions during the first mobilization were determined using EPA Method 5/202.

The front-half of the sampling train consisted of a stainless-steel nozzle, stainless-steel liner, glass filter holder heated to 248°F ± 25°F, and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

The back-half (Method 202 portion) of the sampling train is designed to mimic ambient conditions and collect only the particles that would truly form CPM in the atmosphere by minimizing the sulfur dioxide (SO_2) and nitrogen oxide (NO_X) interferences observed with earlier versions of the method, in which flue gas was bubbled through cold water, and SO_2 and NO_X were absorbed and partially oxidized before they could be purged out with nitrogen (N_2).

Flue gas exiting the front-half heated filter passes through a coiled condenser and dry impinger system jacketed by water continually circulated at ambient temperature. Moisture is removed from the flue gas without bubbling through the condensed water. Flue gas then passes through a tetrafluoromethane (TFE) membrane filter at ambient temperature. The temperature of the flue gas at the exit of the filter was directly measured with an in-line thermocouple and maintained in the temperature range of 65°F to 85°F.

After exiting the ambient filter, the flue gas passes through two (2) additional impingers surrounded by ice in a "cold" section of the impinger bucket. The moisture collected in these impingers is not analyzed for CPM and is only collected to determine the flue gas moisture and to thoroughly dry the gas. The sample gas then flows into a calibrated dry gas meter where the collected sample gas volume is determined.

The front-half portion of the sample train (nozzle, probe, and heated filter) was recovered per Method 5 requirements, using acetone as the recovery solvent. The back-half of the sample train (heated filter outlet, condenser, dry impingers, and TFE membrane filter) was recovered per Method 202 requirements. The impinger train was purged with N_2 at a rate of 14 liters per minute (lpm) for one (1) hour following each test run and prior to recovery.

A field train blank was assembled, purged and recovered as if it were an actual test sample; analysis of the field train blank was used to blank-correct the test run results. Reagent blanks were collected to quantify background contamination. All samples and blanks were returned to CleanAir Analytical Services in Palatine, Illinois, for gravimetric analysis. Method 202 samples were maintained at a temperature < 85°F during transport to the laboratory.

PM_{10} Testing – USEPA Method 201A/202

PM_{10} emissions during the second mobilization were determined using EPA Method 201A/202.

The front-half of the sampling train consisted of a stainless-steel Cyclone I PM_{10} sizer and nozzle, stainless-steel liner, glass filter holder heated to 248°F ± 25°F, and a quartz fiber filter. Flue gas samples were extracted near isokinetically, per Method 201A requirements, by varying dwell times at each sample point.

The back-half (Method 202 portion) of the sampling train was sampled, recovered, and analyzed in the same manner as the Method 202 description in the "PM_{10} Testing – USEPA Method 5/202" portion of this section.

The front-half portion of the sample train (cyclone, nozzle, probe, and heated filter) was recovered per Method 201A requirements, using acetone as the recovery solvent. All samples and blanks were returned to CleanAir Analytical Services in Palatine, Illinois, for gravimetric analysis.

VOC Testing – USEPA Method 25A

VOC emissions were determined using EPA Method 25A to quantify THC emissions, which were assumed equivalent to VOC emissions.

The Method 25A sampling system consisted of an unheated probe, heated filter, and heated sample line. Flue gas was delivered at 250°F to a flame ionization analyzer (FIA), which continuously measured minute-average THC concentration expressed in terms of propane (C_3H_8) on an actual (wet) basis. Testing was single-port, single-point, constant-rate testing. The probe was placed near the center of the duct. FIA calibration was performed by introducing zero air, high, mid- and low range C_3H_8 calibration gases to the inlet of the sampling system's heated filter. Bias checks were performed before and after each sampling run in a similar manner.

Formaldehyde Testing – USEPA Method 320

Formaldehyde emissions were determined using EPA Method 320.

The Method 320 sampling system consisted of an unheated probe, heated filter, and heated sample line. Flue gas was delivered at 250°F to an FTIR, which continuously measured minute-average formaldehyde concentration on an actual (wet) basis. Testing was single-port, single-point, constant-rate testing. The probe was placed near the center of the duct. The same sample system was utilized for formaldehyde and VOC testing.

EPA Method 320 is used for the analysis of vapor-phase organic or inorganic compounds, which absorb energy in the mid-infrared spectral region, about 400 to 4000 cm^{-1} (25 to 2.5 µm). This method is used to determine compound-specific concentrations in a multi-component vapor-phase sample, which is contained in a closed-path gas cell. Spectra of samples were collected using double-beam infrared absorption spectroscopy. CleanAir used MKS Type MG2000 software to quantify analyte concentrations from the FTIR. Each sample spectrum was documented with the sampling conditions, the sampling time (period when the cell is being filled), the time the spectrum was recorded, the instrumental conditions (path length, temperature, pressure, resolution, and signal integration time), and a spectral filename.

A dynamic spike was performed during the test program per Method 320 specifications. A spike/tracer gas at a constant flow rate below 10% of the total sample flow was introduced into the sampled exhaust gas stream prior to the external filter. The QA spike check met criteria per Method 320 specifications (70% to 130% expected value). Before and after each run, a calibration transfer standard (CTS) check was performed. The pre- and post-test CTS spectra were then compared, and agreement was determined.

O_2/CO_2 Testing – USEPA Method 3A

EPA Method 3A was utilized to measure the average flue gas composition (O_2/CO_2). CO_2 concentrations were measured using an FTIR. O_2 concentrations were measured using a wet Ametek O_2 analyzer in series subsequent to the FTIR. O_2/CO_2 testing adhered to all specifications and QA/QC procedures outlined in EPA Method 3A.

Calibration error checks were performed by introducing zero N_2, high range and mid-range calibration gases to the inlet of the FTIR. Bias checks were performed before and after the test run by introducing calibration gas to the inlet of the sampling system's heated filter. Per Method 3A, the concentrations for each data point were drift-corrected.

End of Section