1. PROJECT OVERVIEW

TEST PROGRAM SUMMARY

EES Coke Battery, LLC (EES) contracted CleanAir Engineering (CleanAir) to complete compliance testing at the Zug Island EES Coke Battery, LLC facility located in River Rouge, Michigan. The objective of the test program is to perform particulate and NO_x testing on the Pushing Emissions Control System (PECS) to demonstrate compliance with Michigan Permit to Install 51-08C (MI-PTI-51-08C).

The PECS Stack has a baghouse to control particulate emissions during each oven push. Process conditions provided by EES include the following:

- oven number
- push time
- amount of coke pushed
- coke volatile matter content
- fan amps
- baghouse pressure drop

A summary of the permit limits is shown below. Test program information, including the test parameters, on-site schedule and a project discussion, begins on page 2.

Table 1-1:
Summary of Results

Source Constituent	Sampling Method	Average Emission	Permit Limit[1]
PECS Stack			
PM (lb/Ton Coke)	EPA 201A	0.008	0.02
PM (ton/yr)	EPA 201A	1.6	9.7
PM_{10} (lb/hr)[2]	EPA 201A/202	0.32	0.69
$PM_{2.5}$ (lb/hr)[2]	EPA 201A/202	0.27	0.69
Oxides of Nitrogen (lb/hr)[2]	EPA 7E	1.46	2.61

[1] Permit limits obtained from Michigan Permit to Install number: MI-PTI-51-08C.

[2] The source does not emit continuously; lb/hr values are operating hour of the PECS exhaust fan.

TEST PROGRAM DETAILS

PARAMETERS

The test program included the following measurements:

- particulate matter less than 10 microns in diameter (PM_{10})
- particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)
- condensable particulate matter (CPM)
- nitrogen oxide (NO_x)
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas temperature
- flue gas flow rate

SCHEDULE

Testing was performed on September 15-17, 2020. The on-site schedule followed during the test program is outlined in Table 1-2.

Table 1-2:
Test Schedule

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	PECS Stack	USEPA Method 201A/202	PM, PM_{10},$PM_{2.5}$	09/15/20	08:12	18:05
2	PECS Stack	USEPA Method 201A/202	PM, PM_{10},$PM_{2.5}$	09/16/20	09:12	16:12
3	PECS Stack	USEPA Method 201A/202	PM, PM_{10},$PM_{2.5}$	09/17/20	07:43	16:12
1	PECS Stack	Method 3A, 7E	O_2/CO_2, NO_X	09/15/20	09:55	14:42
2	PECS Stack	Method 3A, 7E	O_2/CO_2, NO_X	09/16/20	09:26	16:18
3	PECS Stack	Method 3A, 7E	O_2/CO_2, NO_X	09/17/20	07:56	14:55

DISCUSSION

Emission Calculation Explanation

Due to the intermittent operations of the facility, the approach to the emission calculations was adjusted. Each PM test run consisted of approximately 90 minutes of sampling time. However, 7 to 9 hours of time was required to obtain each sample since sampling can only occur while the PECS exhaust fan is operating. This is referred to as a push. A ratio of the metered sample time to elapsed test time was applied to the emission rate values to ensure representative results based on the process operations. Emission rates shown in pound per hour are therefore corrected to be pound per hour (lb/hr) of clock time.

Test Program Summary

The test program was completed over the span of three test days with each day completing one test run. Due to the intermittent nature of the process at current operations, a minimum of 7 hours was required to complete one test run as the sampling can only occur during a push. A push occurred approximately every 20-25 minutes and during each push, roughly three minutes of sample was collected.

Each Method 201A/202 test run was completed so that 12 total points were sampled. Each point was sampled for approximately seven minutes. Samples were collected isokinetically so that a minimum of 30 dry standard cubic feet (dscf) of sample was collected.

Following a previous-site discussion with Tom Gasloli of MDEQ in September 2018, it was determined that ambient readings for all analytes would be eliminated. The O_2/CO_2 values were displayed only when pushing gas was being measured and this was the same for the NO_x values. All CEMS results were provided with the non-push readings omitted from the average results calculations.

The extended nature of the testing was a potential concern. Typically, bias checks are completed only before and after a test run. However, CleanAir performed bias checks during each test since test runs were at least 6 hours in duration. CleanAir attempted to perform all bias checks between pushes in order to maximize the sample collected. These checks were required to monitor analyzer bias and drift over the day of sampling.

PM_{10} / $PM_{2.5}$ – USEPA Method 201A/202

EPA Method 201A, "Determination of PM_{10} and $PM_{2.5}$ Emissions", was used for the particulate matter measurements along with EPA Method 202, "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources". These methods are contained in Appendix M of 40 CFR 51.

Method 201A defines PM_{10} as particulate emissions equal to or less than an aerodynamic diameter of nominally 10 microns, and $PM_{2.5}$ as particulate emissions equal to or less than an aerodynamic diameter of nominally 2.5 microns.

The sampling apparatus utilized stainless steel in-stack cyclones followed by a Gelman filter holder. The cyclones are constructed according to the design specifications provided in Method 201A. When operated at a specified flow rate, the first cyclone is designed to collect particles greater than 10 microns while allowing particles less than or equal to 10 microns to pass through. The second cyclone is designed to collect particles greater than 2.5 microns while allowing particles less than or equal to 2.5 microns to pass through. The exit of the second cyclone connects directly to a 45-mm stainless steel filter holder that contains a high-efficiency quartz fiber filter to collect the $PM_{2.5}$ particles.

Sampling was performed at a constant flow rate that maintains the 10/2.5-micron cut-points of the cyclones. The sampling time (dwell time) at each traverse point varied proportionally with the velocity at each point, as determined from a pre-test velocity traverse. All particulate analyses were performed gravimetrically following EPA Method 5 procedures.

The condensable particulate matter was collected in dry impingers after the gas has traveled through the Method 201A cyclone. Total CPM was represented by the impinger fractions and the CPM filter. Immediately following a test run, Method 202 sample trains were purged with Ultra High Purity Nitrogen at a rate of 14 liters per minute for 60 minutes to remove any potential dissolved sulfur dioxide gases from the impingers.

The CPM fractions were used for the PM_{10} and $PM_{2.5}$ results.

Continuous Emissions Testing – USEPA Methods 3A and 7E

O_2, CO_2 and NO_x were continuously measured from a heated probe, filter, and sample line assembly run from the stack location to the test trailer. The heat remained enough to prevent condensation of the sample in the sample lines. The sample was extracted and conditioned prior to being sent to a flow panel. The flow panel diverts enough flow rate to the dry analyzers.

Test runs were conducted at a three-point traverse located at 15.75 in., 39.37 in and 78.74 in. In previous test mobilizations, the three points showed that the location met the requirements for single-point testing.

However, during on-site discussions in December 2014 between Tom Gasloli (MDEQ, now EGLE) and Josh Childers (CleanAir), it was agreed that due to the process the CEMS sampling would continue to be performed at three points, not one. A total of three test runs were performed.

Modifications to Test Methodology

Due to the extended nature of the test runs, CleanAir performed a mid-test bias calibration of the CEMS system. An attempt was made for this to occur only during non-push periods to avoid missing peaks during each push.

Michigan Department of Environment, Great Lakes, and Energy (EGLE) addressed bias/drift check procedures in an email dated September 9, 2016:

"The proposal to check the calibration of the analyzers mid run, during non-push periods is appropriate. To simplify calculations, the data may be corrected using the initial and final drift/bias checks, provided that all intermediate checks are within the acceptable range. (i.e. if the run is 6 hours long and drift bias checks were done every hour, and all are acceptable you may use the 1st and last calibration checks to correct all pushing data.)"

End of Section

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2. RESULTS

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

Table 2-1:
PECS Stack – Particulate Matter (PM)

Run No.		1	2	3	Average
Date (2020)		Sep 15	Sep 16	Sep 17	
Start Time (approx.)		08:12	09:12	07:43	
Stop Time (approx.)		18:05	16:12	16:12	
Process Conditions					
R_P	Production rate (ton/hr)	46	48	47	**47**
P_1	Starting Oven Number	29	57	33	
P_2	Elapsed pushing time (minutes)	551	415	516	**494**
P_3	Amount of coke pushed (tons)	423	330	406	**386**
F_d	Coke volatile matter content (%)	0.81	0.74	0.69	**0.75**
F_c	Sample Time (minutes)	89	89	90	**89**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	20.9	20.9	20.9	**20.9**
CO_2	Carbon dioxide (dry volume %)	0.163	0.174	0.156	**0.165**
T_s	Stack temperature (°F)	110	115	108	**111**
B_w	Actual water vapor in gas (% by volume)	1.53	1.76	1.51	**1.60**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	172,000	170,000	168,000	**170,000**
Q_s	Volumetric flow rate, standard (scfm)	158,000	154,000	154,000	**155,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	155,000	152,000	152,000	**153,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	35.53	34.99	35.53	**35.35**
%I	Isokinetic sampling (%)	96.2	97.5	97.9	**97.2**
Laboratory Data					
m_n	Total FPM (g)	0.00386	0.00342	0.00336	
n_{MDL}	Number of non-detectable fractions	N/A	1 out of 4	2 out of 4	
DLC	Detection level classification	ADL	DLL	DLL	
PM Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.361	0.419	0.330	**0.370**
$E_{T/yr}$	Particulate Rate (Ton/yr)	1.58	1.84	1.45	**1.62**
E_{Rp}	Particulate Rate - Production-based (lb/ton)	0.00784	0.00880	0.00700	**0.00788**

Average includes 3 runs.

Detection level classifications are defined as follows:

ADL = Above Detection Level - all fractions are above detection limit

DLL = Detection Level Limited - some fractions are below detection limit

Table 2-2:
PECS Stack – $PM_{10}/PM_{2.5}$

Run No.		1	2	3	Average
Date (2020)		Sep 15	Sep 16	Sep 17	
Start Time (approx.)		08:12	09:12	07:43	
Stop Time (approx.)		18:05	16:12	16:12	
Process Conditions					
R_P	Production rate (ton/hr)	46	48	47	**47**
P_1	Starting Oven Number	29	57	33	
P_2	Elapsed pushing time (minutes)	551	415	516	**494**
P_3	Amount of coke pushed (tons)	423	330	406	**386**
P_4	Coke volatile matter content (%)	0.81	0.74	0.69	**0.75**
θ	Sample Time (minutes)	89	89	90	**89**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	20.9	20.9	20.9	**20.9**
CO_2	Carbon dioxide (dry volume %)	0.163	0.174	0.156	**0.165**
T_s	Stack temperature (°F)	110	115	108	**111**
B_w	Actual water vapor in gas (% by volume)	1.53	1.76	1.51	**1.60**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	172,000	170,000	168,000	**170,000**
Q_s	Volumetric flow rate, standard (scfm)	158,000	154,000	154,000	**155,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	155,000	152,000	152,000	**153,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	35.53	34.99	35.53	**35.35**
%I	Isokinetic sampling (%)	96.2	97.5	97.9	**97.2**
PM10 Laboratory Data					
$m_{n\text{-}10}$	Total FPM < 10 µm (g)	0.00266	0.00196	0.00179	
m_{CPM}	Total CPM (g)	0.00088	0.00102	0.00094	
$m_{Part\text{-}10}$	Total PM < 10 µm (g)	0.00354	0.00298	0.00273	
n_{MDL}	Number of Non-Detectable Fractions	N/A	1 out of 5	2 out of 5	
DLC	Detection Level Classification	ADL	DLL	DLL	
PM10 Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.331	0.365	0.268	**0.321**
PM2.5 Laboratory Data					
$m_{n\text{-}2.5}$	Total FPM < 2.5 µm (g)	0.00207	0.00148	0.00147	
m_{CPM}	Total CPM (g)	0.00088	0.00102	0.00094	
$m_{Part\text{-}2.5}$	Total PM < 2.5 µm (g)	0.00295	0.00250	0.00241	
n_{MDL}	Number of Non-Detectable Fractions	N/A	1 out of 4	1 out of 4	
DLC	Detection Level Classification	ADL	DLL	DLL	
PM2.5 Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.276	0.306	0.236	**0.273**

Average includes 3 runs.

Detection level classifications are defined as follows:

ADL = Above Detection Level - all fractions are above detection limit

DLL = Detection Level Limited - some fractions are below detection limit

Table 2-3:
PECS Stack – NO_X

Run No.	1	2	3	Average
Date (2020)	Sep 15	Sep 16	Sep 17	
Start Time	9:55	9:26	7:56	
End Time	14:25	16:18	14:55	
Gas Conditions				
Oxygen (O2) - PECS Stack (%dv)	20.9	20.9	20.9	**20.9**
Carbon Dioxide (CO2) - PECS Stack (%wv)	0.161	0.174	0.156	**0.164**
H2O - PECS Stack (%)	1.53	1.75	1.51	**1.60**
Actual Gas Flow Rate - PECS Stack (acfm)	172,010	169,933	167,689	**169,878**
Standard Gas Flow Rate - PECS Stack (scfm)	157,530	154,387	154,250	**155,389**
Dry Standard Gas Flow Rate - 0 (dscfm)	155,126	151,683	151,923	**152,911**
Nitrogen Oxides (NOX) - PECS Stack				
Concentration (ppmdv)	1.29	1.52	1.19	**1.33**
Mass Rate (lb/hr)	1.43	1.65	1.30	**1.46**

Note:
Average includes 3 runs.
Flow and moisture data obtained from USEPA Method 201A/202 testing.

End of Section

3. DESCRIPTION OF INSTALLATION

PROCESS DESCRIPTION

EES Coke Battery, LLC is a facility located on Zug Island in River Rouge, Michigan. The testing described in this document will be performed at the pushing PECS Stack location. The process includes the PECS Baghouse, Pushing Stack (PECS Stack) and a Combustion Stack.

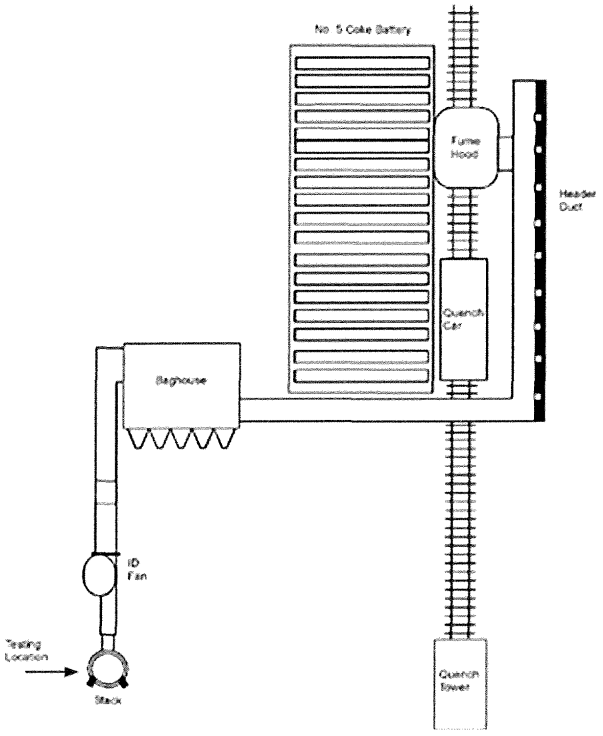
The No. 5 Coke Battery consists of 85, six-meter-high ovens producing furnace coke. A coal blend is used to charge each oven on timed intervals depending on the current production of the battery. Coking of the coal occurs in an oxygen free environment for 17 to 30 hours and the gases produced are collected, cleaned, and used to under fire the battery, supply fuel for other site sources, and sold to permitted off-site utilities.

The current permit limits allow for the charging of up to 1.420 million dry tons of coal per year. The design capacity heating requirement of the battery is approximately 375 MMBtu per hour. The heating requirements of the battery at the current production rate are approximately 325 MMBtu per hour.

Process source description information above was taken from written information provided by EES Coke.

A schematic of the process, indicating sampling locations, is shown in Figure 3-1.

Figure 3-1:
Process Schematic



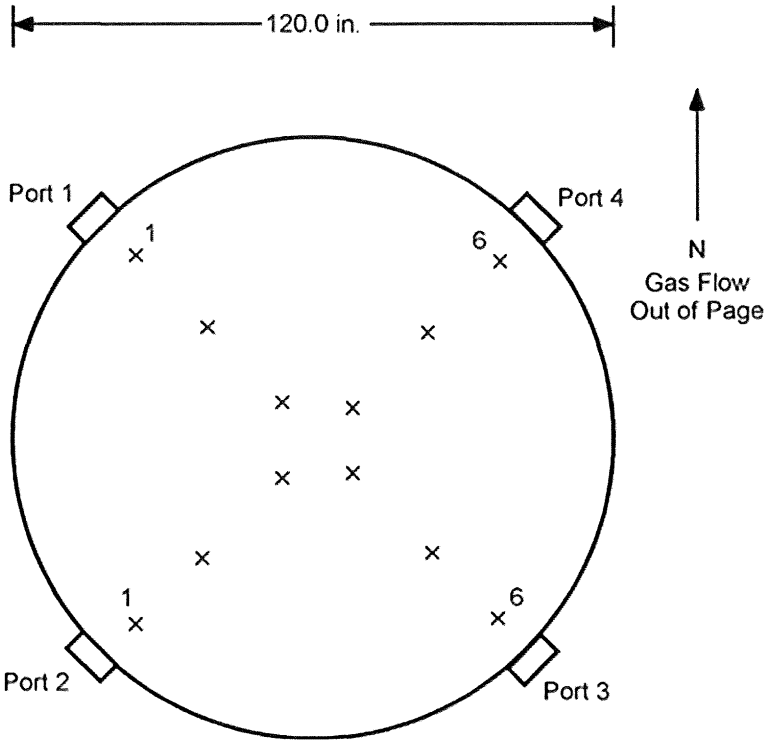
TEST LOCATION

EPA Method 1 specifications determined the sample point locations. Table 3-1 presents the sampling information for the test location. The figure shown on below represents 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
PECS Stack							
$PM_{10}/PM_{2.5}$	EPA 201A/202	1-3	2	6	varied	varied	3-2
O_2, CO_2, NO_X	EPA 3A, 7E	1-3	1	3	20 (minimum)	60 (minimum)	3-3

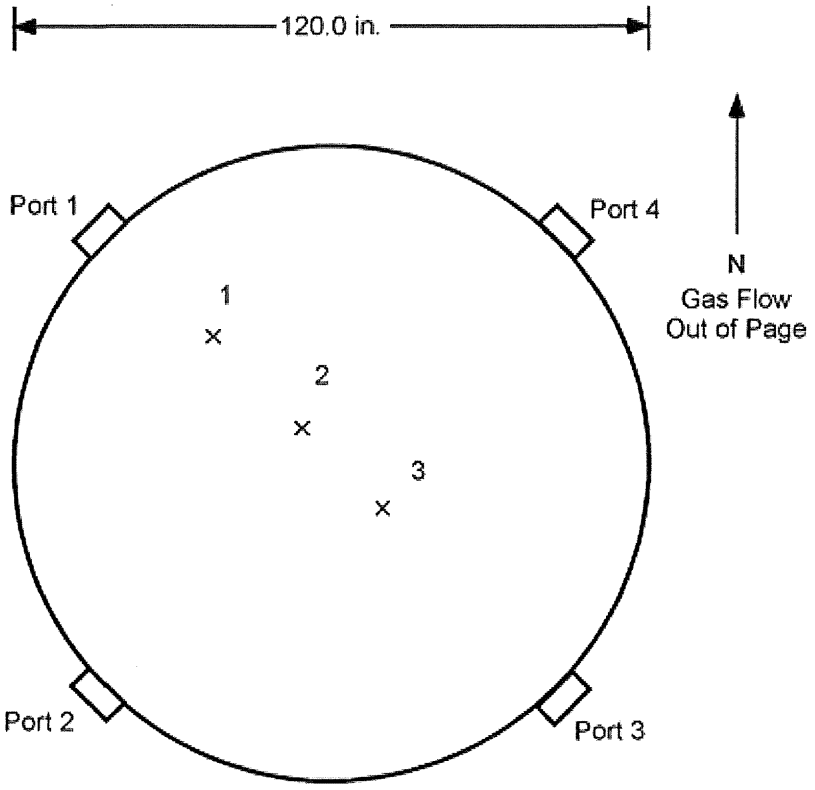
Figure 3-2:
PECS Stack Sample Point Layout (EPA Method 1)



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	95.6	114.7
2	85.4	102.5
3	70.4	84.5
4	29.6	35.5
5	14.6	17.5
6	4.4	5.3

Duct diameters upstream from flow disturbance (A): 2.0 Limit: 0.5
Duct diameters downstream from flow disturbance (B): 8.0 Limit: 2.0

Figure 3-3:
PECS Stack Sample Point Layout (EPA Method 7E)



Traverse Point	Method 7E Long Line Distance (m)	Port to Point Distance (inches)
1	0.4	15.7
2	1.0	39.4
3	2.0	78.7

Duct diameters upstream from flow disturbance (A): 2.0 Limit: 0.5
Duct diameters downstream from flow disturbance (B): 8.0 Limit: 2.0

End of Section

4. METHODOLOGY

PROCEDURES AND REGULATIONS

The test program sampling measurements followed procedures and regulations outlined by the USEPA and Michigan Department of Environment, Great Lakes, and Energy (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 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 7E	"Determination of Nitrogen Oxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)"

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"

End of Section