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REPORT ON HYDROGEN CHLORIDE TESTING – FIRST QUARTER 2017

St. Clair Power Plant
4901 Pointe Drive
East China, MI 48054

Unit 6 Stack

DTE Energy
One Energy Plaza
Detroit Michigan, MI
Client Reference No. 4701078400

CleanAir Project No. 13236
STAC Certificate No. 2007.002.0113.1217
Revision 0, Final Report
May 24, 2017

COMMITMENT TO QUALITY

To the best of our knowledge, the data presented in this report are accurate, complete, error free and representative of the actual emissions during the test program. Clean Air Engineering operates in conformance with the requirements of ASTM D7036-04 Standard Practice for Competence of Air Emission Testing Bodies.

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I hereby certify that the information contained within each appendix section of the final test report has been reviewed and, to the best of my ability, verified as accurate.

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1. PROJECT OVERVIEW

Test Program Summary

DTE Energy contracted CleanAir Engineering (CleanAir) to perform air emissions compliance testing on the Unit 6 Stack at the St. Clair Power Plant (SCPP) located in East China, Michigan. The objective of the test program was to demonstrate quarterly compliance with the hydrogen chloride (HCl) emission limit required by 40 CFR Part 63, Subpart UUUUU. Compliance testing was performed to meet the requirements for performance testing in the first quarter of 2017.

A summary of the test program results is presented in Table 1-1. Section 2 Results provides a more detailed account of the test conditions and data analysis. Test program information, including the test parameters, on-site schedule and a project discussion, begin at the bottom of this page.

Table 1-1:
Summary of Results

Source Constituent	Sampling Method	Average Emission	Limit[1]
Unit 6 Stack			
HCl (lb/MMBtu)	ASTM 6348 EPA M19	0.00054	0.0020

[1] Emission limit outlined in 40 CFR Part 63, Subpart UUUUU, Table 2.

Test Program Details

Parameters

The test program included the following emission measurements:

- oxygen (O_2)
- carbon dioxide (CO_2)
- hydrogen chloride (HCl)
- flue gas moisture (H_2O)

Sampling was performed using ASTM D6348 for HCl, CO_2 and moisture content. ASTM D6348 uses fourier transform infrared spectroscopy (FTIR) analytical principle for analysis of the flue gas sample on a semi-continuous basis. Oxygen was measured using EPA Method 3A as a QA/QC measure. One coal sample was taken during the HCl testing in order to determine a fuel specific Fc factor (EPA Method 19) to calculate mass emissions in units of lb/MMBtu.

Schedule

Testing was performed on March 28, 2017. 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	Unit 6 Stack	Method 3A	O_2	3/28/17	12:30	13:30
2	Unit 6 Stack	Method 3A	O_2	3/28/17	13:50	14:50
3	Unit 6 Stack	Method 3A	O_2	3/28/17	15:08	16:08
1	Unit 6 Stack	ASTM D6348	HCl	3/28/17	12:30	13:30
2	Unit 6 Stack	ASTM D6348	HCl	3/28/17	13:50	14:50
3	Unit 6 Stack	ASTM D6348	HCl	3/28/17	15:08	16:08
1	Unit 6 Stack	ASTM D6348	CO_2/H_2O	3/28/17	12:30	13:30
2	Unit 6 Stack	ASTM D6348	CO_2/H_2O	3/28/17	13:50	14:50
3	Unit 6 Stack	ASTM D6348	CO_2/H_2O	3/28/17	15:08	16:08

Discussion

A total of three consecutive 60-minute runs were performed. Testing took place on the Unit 6 stack EPA sampling platform. Flue gas was extracted from a single point inside the 10% centroid area of the stack through a heated probe and Teflon® filter then through one 100-foot heated sample line to the FTIR analyzer located inside a covered location near the stack.

A constant sample flow was maintained using a heated pump, which delivered sample gas to the FTIR analyzer through a 10-ft. heated sample line and a heated valve connected to the inlet port of the analyzer. This heated valve assembly allowed the selection of calibration or sample gas.

All components of the sampling system were heated to 375˚F. Exposed connections were wrapped with insulation to prevent moisture condensation and maintain a representative sample. A detailed picture of the sampling system can be found in Appendix A

The exit of the FTIR was connected to a gas conditioner for removal of moisture by means of a ⅜" Teflon® line to prevent back pressure. The flue gas was then delivered to a paramagnetic analyzer for oxygen concentration analysis.

During the pre-test QA checks for the FTIR, a dynamic spike for the QA gas (HCl) was performed and a 94.8% recovery was achieved. The post-test QA spike was recovered at 99.8%. Therefore, no correction factor was applied to the final HCl concentration results.

End of Section

2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices, specifically Appendix C Parameters.

Table 2-1:
Unit 6 Stack – Hydrogen Chloride

Run No.	1	2	3	Average
Date (2017)	Mar 28	Mar 28	Mar 28	
Start Time	12:30	13:50	15:08	
End Time	13:30	14:50	16:08	
Elapsed Time	1:00	1:00	1:00	
Operating Conditions				
Fc1 - Unit 6 Stack (dscf/MMBtu)	1,880	1,880	1,880	**1,880**
Total Avg. DSI Injection Rate (lb/hr)	1182	1165	1150	**1166**
Total Avg. ACI injection Rate (lb/hr)	51	63	45	**53**
Gas Parameters				
Oxygen (O2) - Unit 6 Stack (%dv)	10.07	10.02	9.92	**10.00**
Carbon Dioxide (CO2) - Unit 6 Stack (%dv)	9.95	10.05	10.11	**10.04**
Moisture (H2O) - Unit 6 Stack (%wv)	7.98	8.09	8.17	**8.08**
Hydrocloric Acid (HCl) - Unit 6 Stack				
Concentration (ppmwv)	0.418	0.242	0.184	**0.281**
Concentration (ppmdv)	0.453	0.264	0.200	**0.306**
Mass Rate (lb/MMBtu) - Fc	0.00081	0.00047	0.00035	**0.00054**

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End of Section

3. DESCRIPTION OF INSTALLATION

Process Description

Detroit Edison, a subsidiary of DTE Energy, operates the St Clair Power Plant located in East China Township, Michigan. The station consists of a total of six coal-fired units identified as Unit 1, 2, 3, 4, 6 and 7. The testing outlined in this report was performed on Units 6.

Unit 6 is a tangentially fired Combustion Engineering boiler that burns Western sub-bituminous coal. The unit has a nominal rating of 321 Megawatts and is equipped with low NOx burners, over fire air (OFA) and an electrostatic precipitator (ESP) for particulate removal. The testing ports are installed at the 740.5-ft. elevation (157.5-ft above grade) monitoring platform inside the annulus of the stack which is accessed from 12.5 floor of the boiler house.

Test Location

Table 3-1 presents the sampling point details for the test location. Figure 3-1 shows a cross sectional diagram of the test location with the sampling point shown.

Table 3-1:
Sampling Point Information

Source Constituent	Method	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
Unit 6 Stack							
HCl[1]	ASTM D6348	1-3	1	1	60	60	3-1

[1] HCl was sampled at a single point near the center of the stack.

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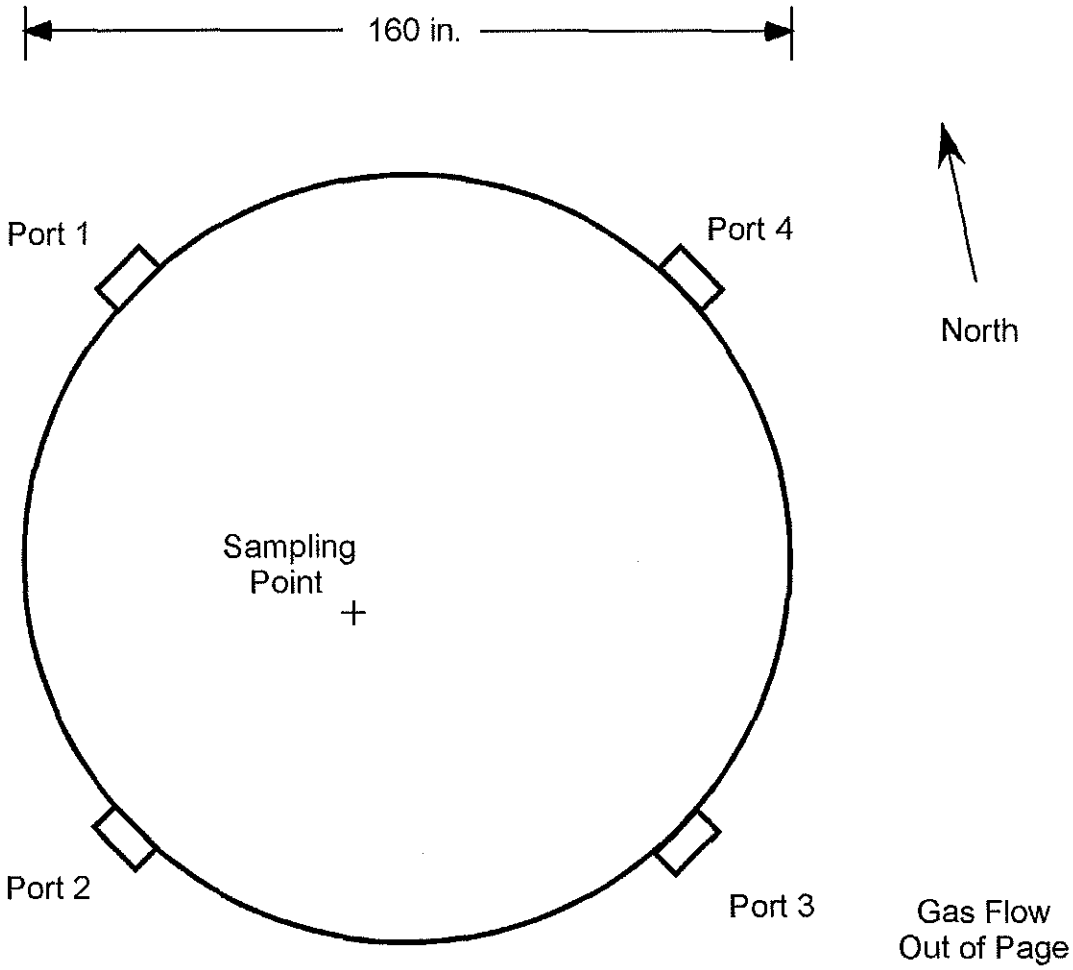
Figure 3-1:
Unit 6 Sample Point Layout



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	52.0	84.0

Duct diameters upstream from flow disturbance (A): >2	Limit: 0.5
Duct diameters downstream from flow disturbance (B): >8	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 Environmental Quality (DEQ). 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.

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 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 19	"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxide Emission Rates"

American Society for Testing and Materials Methods

ASTM D6348-03	"Standard Test Method for Determination of Gaseous Compounds by Extractive Direct Interface Fourier Transform Infrared (FTIR) Spectroscopy"

Methodology Discussion

ASTM Method D6348

ASTM Method D6348, which is used to measure vapor-phase organic and inorganic emissions by extractive Fourier transform infrared spectroscopy (FTIR), was used to measure hydrogen chloride (HCl), carbon dioxide (CO_2) and moisture (H_2O). HCl is the most reactive analyte to be sampled; because of that, a cylinder containing a mixture of HCl and sulfur hexafluoride (SF6) was used as the Quality Assurance (QA) gas. SF6 was a tracer gas in the cylinder since it was a non-reactive gas. That allowed for quality checks to determine HCl readings compared to that of the SF6. Ethylene was also used as a calibration transfer standard (CTS). Nitrogen was used for a zero gas.

Prior to testing, a background-check was performed on the FTIR. The FTIR cannot be calibrated, but performing a background-check while sufficiently flowing zero gas (Nitrogen) sets the FTIR to zero. After a completed background-check of 12 separate cell volumes, no noise should exist on the spectral image. The CTS, QA and tracer gas was then sent directly to the FTIR at approximately 2 lpm. Again, 12 separate volumes are collected for each gas to determine the response while in calibration mode (scanning every 32 seconds).

Zero nitrogen and the mid and high calibration gases for O_2 and CO_2 were introduced to the FTIR and to the O_2 analyzer. The FTIR was used to analyze for CO_2 but EPA method 3A procedures were followed. Method 3A was used to test for O_2 as well.

The probe was then inserted into the stack and flue gas was extracted through the heated sampling system as described previously. The FTIR cell was maintained at 191°C (375°F) and spectral libraries have been developed based on this cell temperature. A complete library was assembled prior to the project. The library has a complete list of analytes that may be found in the flue gas sample.

A rotameter was then connected to the exit line of the FTIR to determine the sample flow through the FTIR. A flow of four to five liters works well for most applications. The flow was set at approximately 4.8 liter for this project. Afterward, the rotameter was removed and the system hooked back up. The native profile of the flue gas was then collected from 12 separate cell volumes to determine the composition present in the stack. The native values of the QA and SF_6 gases were needed to determine the dynamic spike recovery.

Once the native values were collected, the QA/SF6 gas was sent to the probe tip no greater than 10% of the total system flow. A The amount of SF_6 was used to determine this. Once the QA gas achieved a steady value through the system, 12 separate cell volumes were collected. A spike recovery of ± 30% needed to be achieved or adjustments needed to be made to the sampling system. If a recovery of greater than ± 10% but equal to or less than ± 30% was observed, a correction factor was determined to correct the results. Any recovery of ± 10%, the need of a correction factor was eliminated.

The CTS gas was then sent to the probe tip, which could steady out and collect 12 cell volumes. The response must be within the 5% of the direct CTS response value. Zero nitrogen and O_2 / CO_2 calibration gas that closely represented the diluent flue gas composition were sent to the probe tip to determine the sampling system bias for O_2 and CO_2

Once the flue gas was reintroduced to the FTIR and allowed to steady out, the FTIR was put into test mode (64 second scans), and 3 - 1 hour runs were performed. After each run was completed, a system bias was performed by introducing the CTS, zero nitrogen and O_2 / CO_2 calibration gases to the probe tip for 12 steady separate cell volumes for the CTS and at least 3 cell volumes for the zero nitrogen and O_2 / CO_2.

After run 3 was completed, a post-test dynamic QA spike was performed immediately after the run and before the system bias check. The QA/SF_6 gas was sent to the probe tip at < 10% of the system flow. Once the readings were steady ,12 separate cell volumes were collected. The bias checks for the CTS gas and for zero nitrogen and O_2 / CO_2 were run after.

End of Section