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AIR QUALITY DIVISION



REPORT ON HYDROGEN
CHLORIDE TESTING – SECOND
QUARTER 2017

River Rogue Power Plant

1 Belanger Park Drive
River Rouge, Michigan 48218

Unit 3 Stack

DTE Energy
One Energy Plaza
Detroit, Michigan Zip
Client Reference No. 4701091716

CleanAir Project No. 13280
STAC Certificate No. 2007.002.0113.1217
Revision 0, Final Report
July 14, 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

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Test Program Summary

DTE Energy (DTE) contracted CleanAir Engineering (CleanAir) to successfully complete testing on the Unit 3 Stack at the River Rogue Power Plant (RRPP) located in River Rogue, 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 second quarter of 2017.

A summary of the test program results is presented in Table 1-1 below. 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	Permit Limit ¹
Unit 3 Stack HCl (lb/MMBtu)	ASTM 6348 EPA M19	0.0003	0.0020

¹ Permit limits obtained from 40 CFR Part 63, subpart UUUU.

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Test Program Details

Parameters

The test program included the following emissions measurements:

- oxygen (O₂)
- carbon dioxide (CO₂)
- hydrogen chloride (HCl)
- flue gas moisture (H₂O)

Sampling was performed using ASTM D6348 for HCl 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 and Carbon Dioxide were measured using EPA Method 3A. Oxygen was determined as a QA/QC measure. One coal sample was taken during the HCl testing to determine a fuel specific Fc factor (EPA Method 19) to calculate mass emissions in units of lb/MMBtu.

Schedule

Testing was performed on June 1, 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 3 Stack	Method 3A	O2	6/01/17	15:05	16:05
2	Unit 3 Stack	Method 3A	O2	6/01/17	16:27	17:27
3	Unit 3 Stack	Method 3A	O2	6/01/17	17:48	18:48
1	Unit 3 Stack	Method 3A	CO2	6/01/17	15:05	16:05
2	Unit 3 Stack	Method 3A	CO2	6/01/17	16:27	17:27
3	Unit 3 Stack	Method 3A	CO2	6/01/17	17:48	18:48
1	Unit 3 Stack	ASTM D6348	HCl	6/01/17	15:05	16:05
2	Unit 3 Stack	ASTM D6348	HCl	6/01/17	16:27	17:27
3	Unit 3 Stack	ASTM D6348	HCl	6/01/17	17:48	18:48
1	Unit 3 Stack	ASTM D6348	H2O	6/01/17	15:05	16:05
2	Unit 3 Stack	ASTM D6348	H2O	6/01/17	16:27	17:27
3	Unit 3 Stack	ASTM D6348	H2O	6/01/17	17:48	18:48

Discussion

A total of three consecutive 60-minute runs were performed. Testing took place on the Unit 3 stack EPA testing 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 set up next to the plant's CEMS shelter located between units 2 and 3 stacks.

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 and 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 3/8" 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.

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 3 Stack – Hydrogen Chloride**

Run No.	1	2	3	Average
Date (2017)	Jun 1	Jun 1	Jun 1	
Start Time	15:05	16:27	17:48	
End Time	16:05	17:27	18:48	
Elapsed Time	1:00	1:00	1:00	
Operating Conditions				
Fc1 - Unit 3 Stack (dscf/MMBtu)	1,879	1,879	1,879	1,879
DSI Injection Rate - Unit 3 Stack (lb/hr)	945	944	943	944
ACI Injection Rate - Unit 3 Stack (lb/hr)	125	125	125	125
Load - Unit 3 Stack (MW)	151.9	150.4	149.4	150.6
Gas Parameters				
Oxygen (O2) - Unit 3 Stack (%dv)	9.56	9.68	9.82	9.69
Carbon Dioxide (CO2) - Unit 3 Stack (%dv)	10.42	10.50	10.30	10.41
Moisture (H2O) - Unit 3 Stack (%wv)	8.96	8.75	8.66	8.79
Hydrochloric Acid (HCl) - Unit 3 Stack				
Concentration (ppmw)	0.25	0.15	0.11	0.167
Concentration (ppmdv)	0.27	0.16	0.12	0.183
Mass Rate (lb/MMBtu) - Fc	4.64E-04	2.73E-04	1.99E-04	3.12E-04

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End of Section

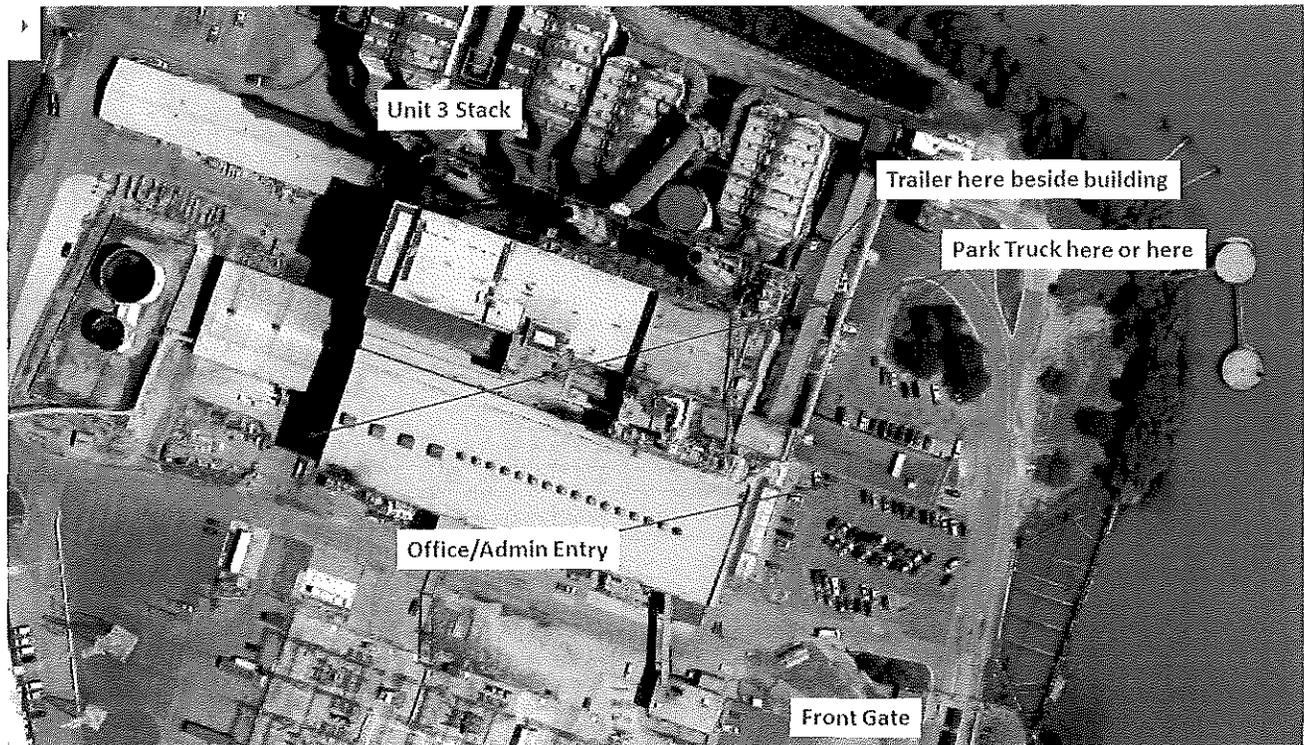
3. DESCRIPTION OF INSTALLATION

Process Description

DTE owns and operates the River Rouge Power Plant located in River Rouge, Michigan. The station currently consists of two coal-fired units, identified as Units 2 and 3. The all testing outlined in this report was performed on Unit 3.

Unit 3, commissioned in 1958, is a dry-bottom wall-fired boiler connected to a 300-megawatt turbine. The monitoring probe for the unit is installed at the 719 ft. elevation monitoring platform outside of the Unit 3 stack. Sample gas is transported through a separate extended heated sample line to an environmentally controlled shelter at grade where the plant's HCl monitor is located. The HCl sampling was performed using an available EPA sampling port located on the same elevation as the plant's HCl monitoring location. The overhead view of the sampling location is seen below in. A schematic of the process, indicating sampling locations, is shown in Figure 3-1.

**Figure 3-1:
Site Overhead**



Test Location

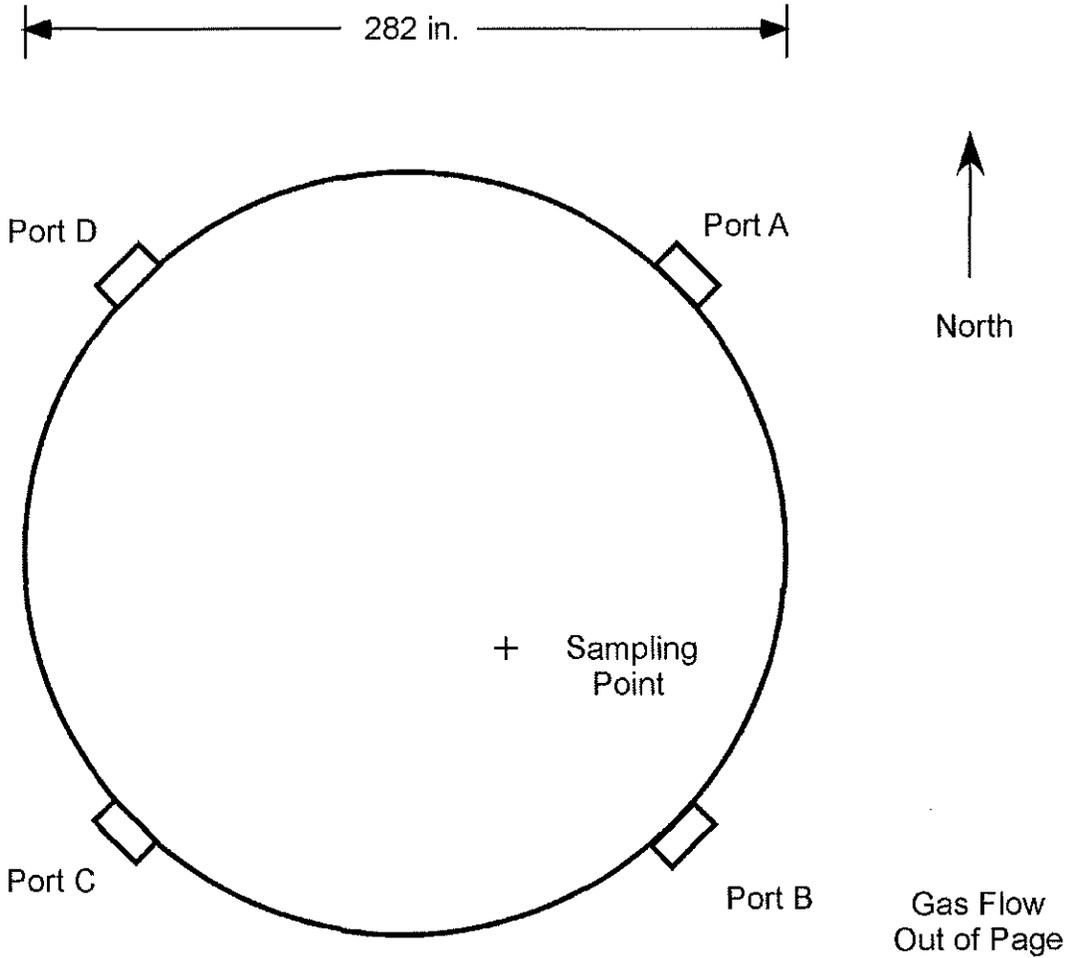
Table 3-1 presents the sampling information for the test location. The figure shown on page 7 represents the layout of the test location.

**Table 3-1:
 Sampling Information**

<u>Source</u>							
Constituent	Method	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
<u>Unit 3 Stack</u>							
HCl ¹	ASTM D6348	1-3	1	1	60	60	3-2

¹ HCl was sampled at the approximate center of the duct.

**Figure 3-2:
 Unit 3 Stack Sample Point Layout**



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	38.0	108.0

Duct diameters upstream from flow disturbance (A): >2
 Duct diameters downstream from flow disturbance (B): 5.7

Limit: 0.5
 Limit: 2.0

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 (CO₂) and moisture (H₂O). HCl is the most reactive analyte to be sampled; because of that, HCl was used as the Quality Assurance (QA) gas. A separate cylinder of nitrogen dioxide (NO₂) was used as the tracer gas since the FTIR used on site was thermal electronically cooled and does not operate in the range to quantify sulfur hexafluoride (SF₆). A mass flow controller was used to determine HCl readings compared to that of the NO₂ readings. Ethylene was used as a calibration transfer standard (CTS) and 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 at least 12 separate spectra, no noise should exist on the spectral image and the MDL can be determined. The CTS, QA and tracer gas is then sent directly to the FTIR at approximately 2 lpm. Again, 12 separate spectra are collected for each gas to determine its response while it is in calibration mode (32 scans per average).

Zero nitrogen and the mid and high calibration gases for O₂ and CO₂ were introduced to the FTIR and to the O₂ analyzer. The FTIR was used to analyze for CO₂ but EPA method 3A procedures were followed. Method 3A was used to test for O₂ 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 4-5 liters works well for most applications. The flow was set at approximately 4.8 liter for this project. The rotameter was removed after the flow check. The native profile of the flue gas was then collected from 12 independent spectra to determine the composition present in the stack. The native values of the QA and NO₂ gases are needed to determine the dynamic spike recovery.

Once the native values were collected, the QA and NO₂ gas was sent to the probe tip at no greater than 10% of the total system flow. The amount of NO₂ was used to determine the dilution factor, as previously mentioned, which was required to calculate the expected amount of QA gas dynamically spiked into the sampling system. Once the QA gas has achieved a steady value through the system, 12 independent spectra are collected. A spike recovery of ± 30% needs to be achieved or adjustments need 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 calculated to correct the results. A recovery within ± 10%, did not require a correction factor or bias adjustment.

The CTS gas was then sent to the probe tip, allowed to steady out and 12 spectra were collected. The response must be within the 5% of the direct CTS response value.

Once the flue gas was reintroduced to the FTIR and allow to steady out the FTIR was put into test mode (64 scans per average) and three 60 minute runs were performed. After each run was completed, a system bias was performed by introducing the CTS to the probe tip for 12 steady independent spectra.

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 and NO₂ gas was sent to the probe tip at < 10% of the system flow. Once the readings were steady 12 separate independent spectra were collected. The bias check for the CTS gas was run after the spike was finished.

End of Section