Renewable Operating Permit (ROP)
MI-ROP-A4033
40 CFR 75
Appendix E – Periodic NOx Emission Rate Test Report

Michigan Operations Energy and Utilities Plant
Boilers 21 and 22

The Dow Chemical Company
Michigan Operations
Midland, Michigan

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Summary of Test Program

The Dow Chemical Company (Dow) is submitting this test report supporting performance testing conducted in accordance with 40 CFR Part 75 Appendix E (Periodic NOx Emission Rate Testing) for Boilers 21 and 22 at their chemical manufacturing facility in Midland, Michigan.

The Boilers operate under Permit Number PTI-916-84 issued by the Air Quality Division of the Michigan Department of Environmental Quality (MDEQ). The testing was conducted by Internal Testing Personnel on June 7, 2016.

The following table summarizes the pertinent data for this compliance test:

Responsible Groups	• The Dow Chemical Company • Michigan Department of Environmental Quality (MDEQ) • Environmental Protection Agency (EPA)
Applicable Regulations	• MI-ROP-A4033 • 40 CFR 75
Industry / Plant	• MIOP Utilities – Gas Fired Boilers
Plant Location	• The Dow Chemical Company Midland, Michigan, 48667
Date of Last Certification	• June 2011
Emission Points	• Boiler 21 (SVBOIL21) • Boiler 22 (SVBOIL22) *As allowed in 2011, Since Boilers 21 and 22 are identical units, Dow requested and was allowed to sample one unit to represent the emission profile for both.*
Pollutants/Diluent Measured	• Nitrogen Oxides (NO_X) • Oxygen (O_2)
Test Dates	• June 7, 2016

Key Personnel

The key personnel who coordinated the test program are:

- Bill Martin provided support as the Process Focal Point. The Process Focal Point is responsible for coordinating the plant operation during the test and ensuring the unit was operating at the agreed upon conditions in the test plan. They also serve as the key contact for collecting any process data required and providing all technical support related to process operation.

- Brad Kischnick provided support as the Environmental Focal Point. The Environmental Focal Point is responsible for ensuring that all regulatory requirements and citations are reviewed and considered for the testing.

- Kayla Peacock also provided support as an Environmental Focal Point. All agency communication will be completed through her role. Her contact information is:

  Kayla Peacock
  The Dow Chemical Company – Michigan Operations
  1100 Building
  Midland, MI 48667
  Phone: (989) 638-1482
  Email: KMPeacock@dow.com

- Chuck Glenn works for the Dow Chemical stack testing team. He served as the test plan coordinator and is responsible for the overall leadership of the sampling program. He developed the overall testing plan, determined the correct sample methods and completed the final report. His contact information is:

  Chuck Glenn
  The Dow Chemical Company – Texas Operations
  B2301 Brazosport Blvd B-2009
  Freeport, TX 77541
  Phone: (979) 238-9109
  Email: CEGlenn@dow.com

- Dan Bennett works for AECOM Technology Corporation and provided support the as Sample Team Leader for the internal Dow Air Sample Team. The Sample Team Leader is responsible for ensuring that the data generated met the quality assurance objectives of the plan.

- Oliver Hertzog works for AECOM Technology Corporation and provided support as the QSTI Certified Observer during testing as required by 40 CFR 75.

- Spencer Hurley works for EH&S Leveraged Delivery group. He served as a knowledgeable reviewer of this stack sample report.

- Michael Abel is a PhD chemist who is a technical contact for air sampling. Michael serves as a quality assurance and technical reviewer of the final test report.

Description of Industrial Process

The Dow Chemical Company operates a chemical manufacturing facility in Midland, Michigan. This facility consists of numerous different chemical manufacturing processes. These chemical manufacturing processes include a steam processing plant that provides steam to the site when the normal supply provided by Midland Cogeneration Venture (MCV) is interrupted.

Both Boilers 21 (SVBOIL21&22-001) and 22 (SVBOIL21&22-002) are fired using only pipeline quality natural gas. The fuel supply is pressure regulated and flow to the burners is controlled by a control valve. The fuel/air mixture is burned in up to two burners and the exhaust gas passes through the economizer and ultimately discharges to the atmosphere through a vent stack.

Note: *Please note that Boilers 21 and 22 are identical units. Dow requested and was allowed to sample one unit to represent the emission profile for both. To be considered identical, all low mass emission units must be of the same size (based on maximum rated hourly heat input), manufacturer and model, and must have the same history of modifications (e.g., have the same controls installed, the same types of burners and have undergone major overhauls at the same frequency (based on hours of operation)). Also, under similar operating conditions, the stack or turbine outlet temperature of each unit must be within ±50 degrees Fahrenheit of the average stack or turbine outlet temperature for all of the unit*

Type and Quantity of Raw and Finished Materials used in Process

Both Boilers 21 and 22 are fired using only pipeline quality natural gas. The units use natural gas to create steam to supply the Michigan Operations Midland plant with steam when the normal steam supply is interrupted from the Midland Cogeneration Venture (MCV).

Description of cyclical or batch operations that impact emission profiles:

The Boilers 21 and 22 are not cyclical in nature although they can be operated at different steam loads. Dow followed the guidance found in §75.19 (c)(1)(iv)(I)(2) which states "if multiple-load appendix E test was initially performed to determine the fuel-and-unit specific NOx emission rate, then periodic retest required under paragraph (c)(1)(iv)(D) of this section may be single load test, performed at the load for which the highest average NOx emission rate was obtained in the initial test".

Operating Parameter Requirement

The facility uses a process control computer to automatically control the process within specific ranges dictated by process limits. Operating ranges are variable and dictated by customer demand. Process parameters are monitored for automatic or semi-automatic action. Parameters include, but are not limited to temperatures, pressures and flow rates.

Process Rate:

Dow followed the guidance found in §75.19 (c)(1)(iv)(I)(2) which states "if multiple-load appendix E test was initially performed to determine the fuel-and-unit specific NOx emission rate, then periodic retest required under paragraph (c)(1)(iv)(D) of this section may be single load test, performed at the load for which the highest average NOx emission rate was obtained in the initial test". Since the worst case emission results were at highest firing rate, Dow proposed to complete emission sampling at the highest firing rate. Note that the boilers are capped at 90% of the original design (357 MMBTU/hr) – as the boilers are 46 years old.

Table 1 – Processing Rate Summary

Process Unit	Design Maximum Operating Rate	Actual Operating Rate During Test
Boilers 21 & 22 (SVBOIL21&22) & (SVBOIL21&22)	357 MM BTU/hr	~ 308 MM BTU/hr

Note: *Boilers 21 and 22 are identical units. Dow is requested and was allowed to sample one unit to represent the emission profile for both.*

Description of Air Pollution Control Equipment

Both Boilers 21 and 22 are fired using only pipeline quality natural gas. Therefore, the EPA Method 19 F-factor of 8710 was used in all pound per million British thermal units (lb/MMBtu) emission calculations. The fuel supply is pressure regulated and flow to the burners is controlled by a control valve. The fuel/air mixture is burned in up to two burners and the exhaust gas passes through the economizer and ultimately discharges to the atmosphere through a vent stack. The specifications for the units are:

- 300,000 lb/hr boilers manufactured by Zurn (Erie City)
- 2 DAZ-36 Natural Gas fired burners;
- Forced draft combustion air; and
- Installation in 1970.

Objectives and Test Matrix

The purpose of this periodic NOx emission rate testing is to determine a new fuel-and-unit specific NOx emission rate for the purpose of calculating NOx mass emissions in compliance with the 40 CFR 75 for the Boilers 21 and 22. The specific objective of this test was:

- Determine the NOx lb/mmBtu emissions on the Boiler 21 or 22 Boiler stack

The table, below summarize the applicable permit citations.

Permit Numbers: MI-ROP-A4033-2011e FGBOILERS21&22-S1 Air Permit #PTI 916-84		
Device	**ROP Table Number**	**Applicable Emission Standard**
Boilers 21 & 22 (SVBOIL21&22) & (SVBOIL21&22)	FGBOILERS21&22	40 CFR Part 75

Note: *Boilers 21 and 22 are identical units. Dow requested and was allowed to sample one unit to represent the emission profile for both.*

Comments

- Mr. Jeremy Howe of MDEQ AQD Cadillac District Office was on-site to observe sampling.

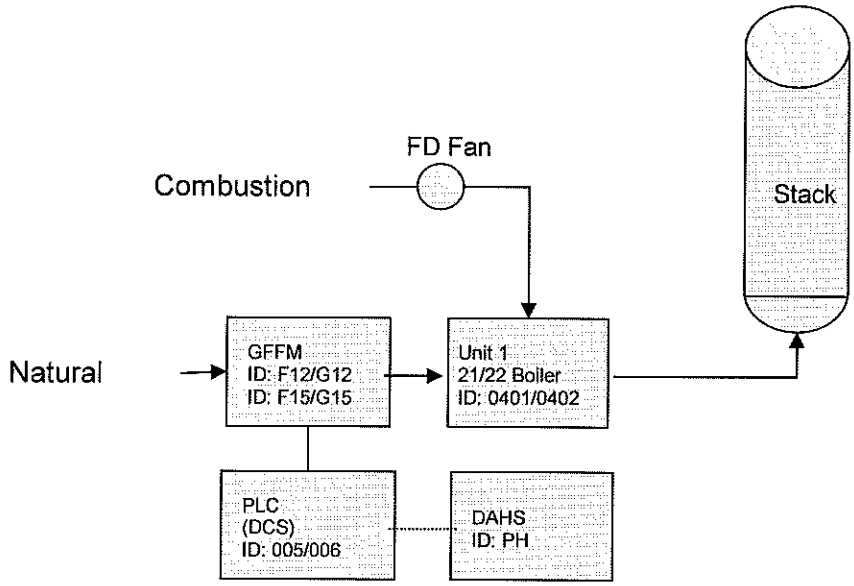
- As required by 40 CFR Part 75, sampling occurred at a minimum of 12 sample points located according to Method 1 in Title 40 of the Code of Federal Regulations, Part 60, Appendix A.

  Before sampling began a "Response Time" test was completed. Certified gas standards were introduced at the probe upstream of all sample conditioning components in system calibration mode. The time it took for the measured concentration to reach a value that is at least 95 percent or within 0.5 ppm (whichever is less restrictive) of a stable response for both the low-level and upscale gases was recorded. The response time was determined to be 45 seconds.

  The probe was placed at the first sampling point. The system was purged for at least two times the response time (2 minutes) before recording any data. Please note there is a 2 minute lag each time the probe was moved between sample points. Required sampling points were traversed and sampled at each point for an equal length of time (5 minutes per point) while the appropriate sample flow rate was maintained.

  Statistical analysis was completed on the stratification of the duct. For Run #1 and Run #3, no single NOx sample point differed more than 5% of the mean concentration. As described in EPA M7E, this source is considered not stratified. For Run #2, one NOx sample point differed more than 5% and less than 10% of the mean concentration. As described in EPA M7E, this source is considered minimally stratified.

Block Flow Diagrams



ORIS Code: 88031
Plant ID: A4033
Boiler ID: 0401/0402
Monitoring System ID: B21/B22
Components:
GFFM (Certified Appendix D Fuel Flow meter) ID: F12/G12
GFFM (Certified Appendix D Fuel Flow meter) ID: F15/G15
PLC (DCS) ID: 005/006
DAHS ID: PH

Monitoring Methodology for Non-Acid Rain Subpart H Low Mass Emission Unit
NOx Emission Rate: Unit and Fuel Specific, 5-year frequency
Heat Input: Long-term fuel flow
Stack Height Above Grade: 100 ft (Grade elevation: 616 ft USGS)
Stack Diameter at Test Port: 7 ft ID
Inside Cross-sectional Area at Test Port: 38.5 sq. ft
Test Port Location: 2 stack diameters downstream
6 stack diameters upstream

Test Summary

Engine	SAMPLE TYPE	TEST METHOD	*ACTUAL EMISSION RATE
Boiler 21	NOx Emissions (NOx Lb/MMBtu)	EPA Method 7E/19	0.152 NOx Lb/mmBtu

* Average over three one-hour runs.

Test Run Data

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Sample Date	06/07/16	06/07/16	06/07/16	n/a
Sample Times (start/end)	0840/1016	1045/1216	1334/1507	n/a
Outlet NOx (ppmv)	117.7	121.2	123.6	120.8
Outlet O2 (%)	3.6	3.7	3.6	3.6
Outlet NOx (Lb/MMBtu)	**0.148**	**0.153**	**0.155**	**0.152**

PROCESS DATA

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Sample Date	06/07/16	06/07/16	06/07/16	n/a
Sample Times (start/end)	0840/1016	1045/1216	1334/1507	n/a
Steam Rate (MLb/hr)	256	257	256	257
Fuel Gas Flow (MSCFH)	294	293	292	293
Heat Input Rate (MMBtu/Hr)	309	308	307	308

Test Methods

The tables below list all the pollutants and sampling trains used to collect measurements and samples during the performance test. These methods were performed according to the protocol listed in the appropriate Appendix A, 40 CFR 60 EPA Reference Test Method. Schematic diagrams can be found in the EPA Reference Test Methods.

Test Matrix for Emission Sampling:

Sampling Location	No. of Runs	Sample/Type Pollutant	Sampling Organization	Sample Run Time (Min)	Reference Method	Target Reported Units Of Measure
Stack Exhaust	3	Nitrogen Oxides (NOx)	Stack Testing Team	~ 60 Min	US EPA Method 7E	Lb/MMBtu
Stack Exhaust	3	Diluent Oxygen (O2)	Stack Testing Team	~ 60 Min	US EPA Method 3A	%

Procedures

The above methods were completed using mobile continuous emission monitors. Gas was withdrawn from the stack and transported to monitors located at ground level. A stainless-steel probe was inserted into the stack and used to collect sample gas. A Teflon sample line heated to 250°F transported sample gas from the probe to the analyzers. The analyzers were kept at a constant temperature inside the mobile laboratory.

Sample gas was collected continuously from the sample points for a period of 60 minutes per run. At the mobile laboratory, the stack gas was routed to a condenser and then transported to the analyzers for analysis. All vent streams were analyzed "dry". Therefore, no moisture determination is necessary.

EPA Method 3A (Determination of Oxygen and Carbon Dioxide Concentrations, Instrumental Analyzer Procedure)

EPA Method 3A (Instrumental Method) was used to determine the diluent during each run on the outlet.

An analyzer measured O_2 content on the basis of the strong paramagnetic properties of O_2 relative to other compounds present in combustion gases. In the presence of a magnetic field, O_2 molecules become temporary magnets. The analyzer determines the sample gas O_2 concentration by detecting the displacement torque of the sample test body in the presence of a magnetic field.

EPA Method 7E (Determination of Nitrogen Oxides)
EPA Method 7E was utilized to determine nitrogen oxide concentrations during each run on the outlet.

A NOx analyzer was used to monitor the concentration of NOx during each run. A sample of the effluent gas was continuously sampled and conveyed to an analyzer for measuring the concentration of NOx. The gas stream was directed through a NO_2 convertor to convert NO_2 to NO concentration. The analyzer yielded results of a total result of NOx.

Sampling and Analytical Plan				
Sampling Location	*Sampling Method*	*Sampling Plan*	*Analytical Method*	*Analytical Plan*
Boiler Exhaust	Method 3A	The boiler was sampled from twelve points as determined using EPA M1 method requirements and routed to a header used by analyzer system.	Method 3A – Paramagnetic	Samples were completed on-site.
	Method 7E	The boiler was sampled from twelve points as determined using EPA M1 method requirements and routed to a header used by analyzer system.	Method 7E – Chemiluminescent	Samples were completed on-site.
	Method 19	Emissions were determined using the appropriate concentrations and F factors based on the measured pollutant concentrations.	N/A	N/A

FIGURE 4.1: SAMPLING TRAIN USED FOR CO & O_2 (M10 & M3A) –NOTE- No Particulate filter will be used.