1.0 Introduction

1.1 Summary of Test Program

AECOM Technical Services, Inc. (AECOM) was retained by Corteva Infrastructure Services to conduct NOx emission rate testing to determine the compliance status for Boilers 21 and 22 with the requirements under Appendix E (Periodic NOx Emission Rate Testing) in Title 40, Part 75 of the Code of Federal Regulations (40 CFR 75). The testing consisted of measurements for emission rates of nitrogen oxides (NO_X) at peak heat input rate from previous performance testing.

1.2 Regulatory Background

The Boilers operate under Permit Number PTI-916-84 issued by the Air Quality Division of the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The boilers are subject to Michigan Part 8 Rules for the NOx Budget Trading Program as Low Mass Emitter Boilers. The testing was conducted by AECOM testing personnel on March 29 and 31, 2021.

Additional test program details are presented in **Table 1-1**.

1.3 Key Personnel

The key personnel that coordinated this test program were:

- John Keyes is the Lead Engineer, and Kayla Peacock is the Production Leader; both provided support as Process Focal Points. The Process Focal Points were responsible for coordinating the plant operation during the test and ensuring the unit was operated at the agreed-upon conditions in the test plan. They also served as the key contacts for collecting the process data required and provided all technical support related to process operation.
- Patty Worden provided support as the Environmental Focal Point for this test. The Environmental Focal Point was responsible for ensuring that all regulatory requirements and citations were reviewed and considered for the testing. All agency communication was completed through this role. Her contact information is (989) 395-1724.
- James Edmister served as the Test Plan Coordinator. The Test Plan Coordinator was responsible for the overall leadership of the sampling program. The Coordinator also developed the overall testing plan and determined the correct sample methods.
- Gene Youngerman provided support as a technical review of the test data.
- Randy Reinke served as the Field Team Leader. The Field Team Leader was responsible for ensuring the data generated met the quality assurance objectives of the test plan. Quincy Crawford assisted in the field as the sampling technician.
- Wayne Washburn works for AECOM Technical Services and provided support as the Qualified Source Testing Individual (QSTI). The QSTI observed all field QA/QC and sampling during testing as required by 40 CFR 75.

1.4 Document Organization

The remainder of this Report is divided into five (5) additional Sections. Section 2 of this document provides a summary of results. Section 3 includes the source description and sampling location details. Details of the source emissions monitoring and measurement procedures are provided in Section 4 and Section 5 addresses the quality assurance/quality control aspects of the test program. Section 6 discusses data reduction and data reporting.

Field data sheets and field equipment calibration forms for the testing are presented in **Appendix A.** Facility process data are presented in **Appendix B**. Finally, a copy of the compliance test protocol and approval are included in **Appendix C**.

Table 1-1: NOx Emission Rate Testing Program Summary

Responsible Groups	• Corteva Infrastructure Services • Michigan Department of Environment, Great Lakes, and Energy (EGLE) • U. S. Environmental Protection Agency (US EPA)
Applicable Regulations	• MI-ROP-A4033 (P1028) • 40 CFR 75, Appendix E
Industry/Plant	• Michigan Operations Energy & Utilities – Gas Fired Boilers
Plant Location	• I-Park Facilities Midland, Michigan 48667
Date of Last Certification	• June 2016
Emission Points	• Boiler 21 (SVBOIL21-001) • Boiler 22 (SVBOIL22-002) ○ As allowed in 2016, Since Boilers 21 and 22 are identical units, Corteva sampled one unit to represent the emission rate profile for both.
Pollutant(s) / Diluent(s) Measured	• Nitrogen Oxides (NO_x) • Oxygen (O_2)
Test Date(s)	• March 29 and 31, 2021

2.0 Summary of Results

The purpose of this periodic NOx emission rate testing was 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 data presented in this section represent results obtained during emissions testing completed on March 29 and 31, 2021. Emissions testing was conducted at the Michigan Operations Energy & Utilities facility in Midland, MI on the Boiler 21 exhaust stack for the determination of NOx emission rates expressed in units of pounds per million British thermal units (lb/MMBtu).

The following table summarizes the applicable permit citations.

Permit Numbers: MI-ROP-A4033-2017b FGBOILERS21&22-S1 Air Permit #PTI 916-84		
Device	**ROP Table Number**	**Applicable Emission Standard**
Boilers 21 & 22 (SVBOIL21&22-001) & (SVBOIL21&22-002)	FGBOILERS21&22	40 CFR Part 75

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

A total of three (3) test runs were completed at the Boiler 21 exhaust stack. Testing was completed while the boiler was operated at maximum achievable operating load. **Table 2-1** provides a summary of the emissions results for the testing program. The remainder of this section provides a discussion and summary of the test results.

2.1 Discussion

Ms. Lindsey Wells of EGLE AQD Field Operations Section Technical Programs Unit was on-site to observe sampling on March 29.

As required by Appendix E of 40 CFR 75, sampling occurred for all test runs at a minimum of 12 sample points located according to Method 1 in 40 CFR 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 was at least 95 percent (or within 0.5 ppm, whichever was less restrictive) of a stable response for both the low-level and upscale gases was recorded. The response time was determined to be 110 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 initiating the start of a test run. 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.

For informational purposes, statistical analysis was completed on the stratification of the duct. For Run 1, no single NOx sample point differed more than 5% of the mean concentration. As described in EPA M7E and Appendix A of Part 75, this source is considered not stratified.

2.2 Nitrogen Oxides Emissions Results – Exhaust Stack

As shown in **Table 2-1**, NO_X concentrations in units of parts per million by volume on a dry basis averaged 151.1 ppmvd during the emissions testing. Concurrent NO_x mass emission rates averaged 0.182 pounds per million British Thermal unit (lb/MMBtu).

Table 2-1: Summary of NOx Emission Rate Testing Results – Boiler 21 Exhaust Stack

Emissions Summary Table
Part 75 Emissions Test
879 Building (Corteva)
Boiler 21

Run Identification	Boiler 21 Run 1	Boiler 21 Run 2	Boiler 21 Run 3	Average
Run Date	3/29/21	3/31/21	3/31/21	
Run Time	16:00-17:10	08:00-09:05	09:20-10:25	
Exhaust Gas Conditions				
Oxygen (dry volume %)	2.81	2.85	2.81	2.82
Carbon Dioxide (dry volume %)	10.48	10.45	10.47	10.47
Fuel Used	Natural Gas	Natural Gas	Natural Gas	
Fuel F Factor, dry (F_d, dscf/MMBtu)	8,710	8,710	8,710	
Operating Conditions				
Steam Flow Rate (MLb/hr)	260.047	260.163	259.968	260.059
Fuel Gas Flow Rate (MSCFH)	285.705	287.225	285.590	286.173
Heat Input Rate (MMBtu/Hr)	294.9	291.1	292.7	292.9
Air/Fuel Ratio	0.27	0.27	0.27	0.27
Nitrogen Oxides				
Concentration (ppmvd)	157.8	146.5	149.2	151.1
Concentration (ppmvd @3% Oxygen)	156.1	145.3	147.6	149.7
Conversion Factor (C_d) (lb/dscf/ppm)	1.196E-07	1.196E-07	1.196E-07	
Concentration (lb/dscf)	1.887E-05	1.752E-05	1.784E-05	1.808E-05
Emissions (lb/MMBtu)	0.190	0.177	0.180	0.182

3.0 Source Description and Sampling Location

3.1 Source Description

3.1.1 Description of Industrial Process

Corteva Agriscience, LLC 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. Corteva requested and was approved 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 over hauls 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 the units.*

Figure 3-1 is a process flow diagram for the boilers.

3.1.2 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).

3.1.3 Description of Cyclical or Batch Operations that Impact Emission Profiles

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

3.1.4 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 flow rates, pressures, and stack oxygen concentration.

3.1.5 Process Rate

Corteva followed the guidance found in §75.19 (c)(1)(iv)(I)(2), which states: "if a multiple-load Appendix E test was initially performed to determine the fuel-and-unit specific NOx emission rate, then periodic retesting required under paragraph (c)(1)(iv)(D) of this section may be a 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 the highest firing rate, Corteva proposed to complete emission sampling at the highest firing rate achievable on the day of testing. Note that the boilers are capped at 90% of the original design capacity (357 MMBTU/hr) – as the boilers are 51 years old.

Processing Rate Summary		
Process Unit	Design Maximum Operating Rate	Actual Tested Operating Rate
Boilers 21 & 22 (SVBOIL21&22-001 & SVBOIL21&22-002)	300 pph steam flow 357 MMBtu/hr	260 pph steam flow ~ 293 MMBtu/hr

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

3.1.6 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 8,710 dscf/MMBtu was used in all emission rate (lb/MMBtu) 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 an exhaust 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.

3.2 Emissions Measurement Sampling Location

The emissions measurement sampling location is required to meet the requirements of 40 CFR 60, Appendix A, Method 1 as well as Method 7E (Section 8.1.1) for measurements of NO_x and O_2/CO_2. The monitoring location for sampling from the Boiler 21 exhaust stack meets the criteria of a minimum of two equivalent duct diameters downstream from the nearest control device and one-half equivalent diameter upstream from the stack exhaust to atmosphere.

As specified in Part 75, Appendix E, the monitoring location for sampling was traversed at twelve traverse points as specified in Method 1 during each test run. The twelve traverse points also meet the requirement in Method 7E for performing a stratification test. Exhaust gas stratification was evaluated for future reference and was found to be unstratified.

Figure 3-2 illustrates the Boiler 21 exhaust stack (SVBOIL21-001) sampling test ports location.

3.3 Operating Conditions

Emissions from Boiler 21 were measured while the unit was operated at the maximum achievable operating load condition. This test program was designed to quantify emission rates of NO_x in order to demonstrate compliance with the EGLE operating permit test requirements and emission limits. Testing was completed using approved EPA test methods as follows:

Exhaust Stack Parameters

- Oxides of Nitrogen (NO_x) – EPA Method 7E
- Oxygen and Carbon Dioxide (O_2/CO_2) – EPA Method 3A
- Fuel F Factor (F_d) – EPA Method 19

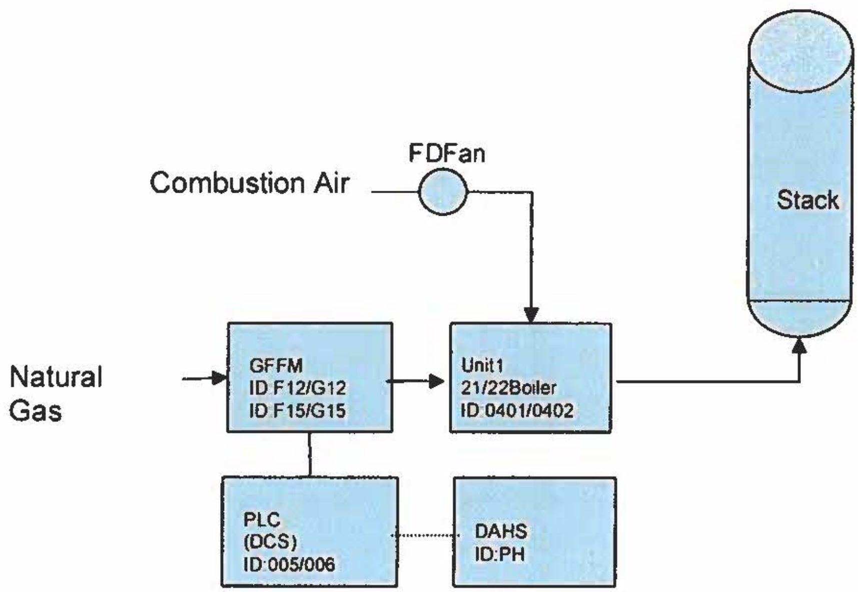
3.4 Process Operating Data

During each test run, process data was recorded at a minimum frequency of 5-minute intervals by Corteva boiler operators and provided to AECOM for inclusion in the emissions test report. The process data collected, at the minimum, included fuel usage (i.e., feed rates of natural gas), heat input rate (MMBtu/hr), and steam production rates for the boiler along with other pertinent information (e.g., stack gas oxygen, air to fuel ratio, and air flow, as needed).

In addition, continuously recorded process data from the boiler monitoring instrumentation were provided to AECOM from the data records in the boiler control room.

Figure 3-1: Boilers 21 and 22 Process Block Diagram

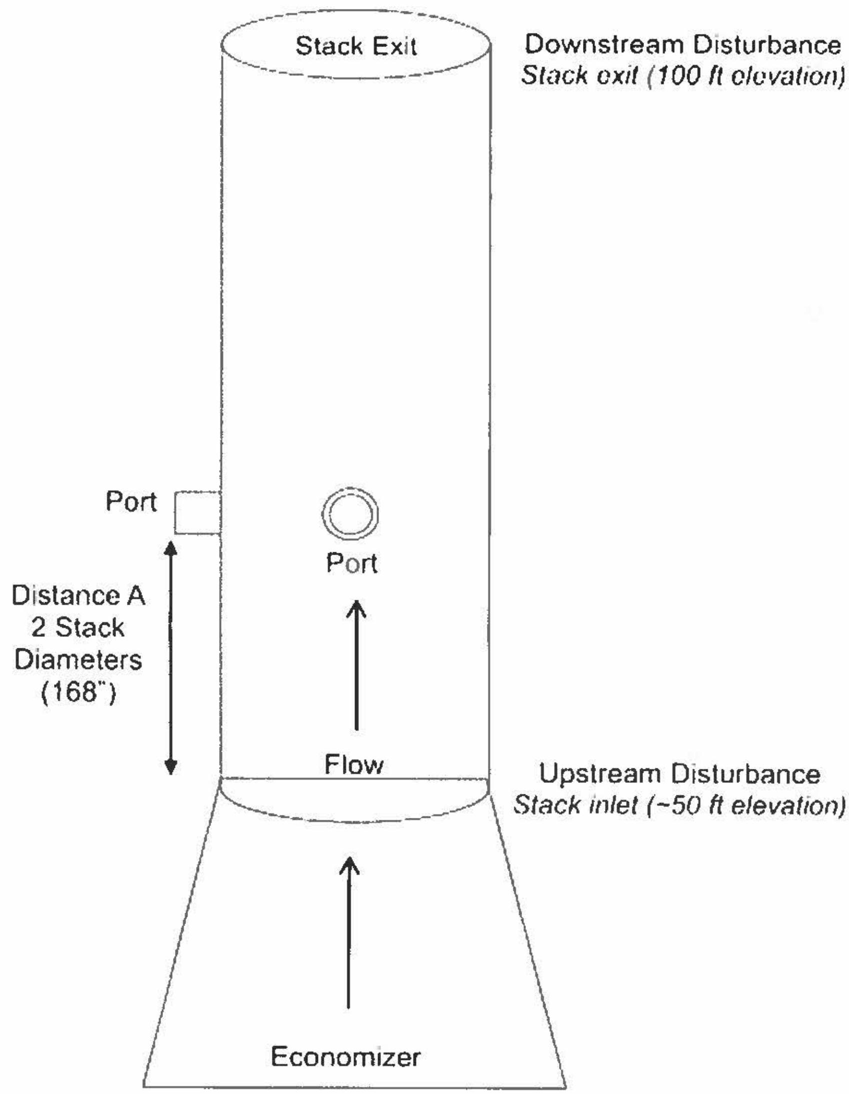
Block Flow Diagrams



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

Figure 3-2: Boiler 21 (SVBOIL21-001) Exhaust Stack Sampling Test Ports Location



4.0 Sampling and Analytical Procedures

4.1 Overview

Sampling and analytical procedures employed during this program were completed as specified in the Test Protocol.

4.2 Test Methodologies

The following subsections detail the individual test methodologies employed during this test program.

4.2.1 Instrumental Analyzer Measurements Procedures – AECOM

Measurement of O_2 and CO_2 for gas stream molecular weight determination and constituent oxygen correction were determined in accordance with EPA Method 3A (continuous instrumental analyzer method) during each test run. Continuous instrumental measurements of NO_x were performed in accordance with EPA Method 7E. Further details of the continuous instrumental analyzer procedures for each parameter are presented in the following subsections.

Instrument outputs from the analyzers were recorded continuously using a laptop personal computer (PC) programmed with Microsoft Windows™ compatible software. The instruments were linked to the PC via an analog to digital electronic interface. The PC polled data from each analyzer a minimum of five times per second and displayed and stored data as ten-second averages.

4.2.2 Nitrogen Oxides – EPA Method 7E

NO_x emissions were measured in accordance with EPA Method 7E. This method uses continuous instrumental analyzer measuring equipment. AECOM used a Thermo Environmental Instruments (TEI) Model 42i chemiluminescent NO_x analyzer (or equivalent) with 8 ranges from 0-10,000 ppm. The analyzer operating range for the test program was appropriate for the concentrations measured in the exhaust gas. This instrument meets the performance specifications of this method. The analyzer was calibrated before and after each test run using EPA Protocol gases. The analyzer was also calibrated using a mid-range span gas (40-60% of high span value) and low value span gas (0% of high span value, using 99.998% pure nitrogen).

4.2.3 Oxygen and Carbon Dioxide – EPA Method 3A

Oxygen (O_2) and carbon dioxide (CO_2) were measured in accordance with EPA Method 3A. This method used continuous emissions monitoring instrumentation. AECOM used a Servomex 1400 Series, or equivalent, analyzer pair with individual analyzer measurement ranges of 0-25 percent O_2 and 0-20 percent CO_2. The instruments meet the performance specifications of the method. The analyzers were calibrated before and after each test run using calibration gases prepared according to EPA Protocol 1.

The O_2 instrument was calibrated to the 0-25 percent output range with a high value span gas of approximately 18-21 percent. The analyzer was also calibrated using a mid-range span gas (40-60% of high span value) and low value span gas (0% of high span value, using 99.998% pure nitrogen). Similarly, the CO_2 instrument was calibrated to the 0-20 percent output range with a high value span gas of approximately 17-19 percent. The analyzer was also calibrated using a mid-range span gas

(40-60% of high span value) and low value span gas (0% of high span value, using 99.998% pure nitrogen).

Table 4-1: Instrument Specifications

Parameter	O_2 / CO_2	NO_x
Instrument Manufacturer	Servomex	Thermo Environmental Instruments (TEI)
Instrument Model	1440	42i-HL
Measurement Principal	Paramagnetic	Chemiluminescence
Measurement Ranges	0-25%/0-20%	0-500 ppm
EPA Reference Method	3A	7E

5.0 Quality Assurance / Quality Control

5.1 Overview

This section provides an overall assessment of compliance test data quality using the data quality indicators and objectives outlined in the test protocol. Sample collection during the field test program, and laboratory performance during the sample analysis phase are addressed insofar as conformance to test plan objectives.

In general, all QC criteria cited for sampling equipment were met and copies of field equipment calibration data are included in Appendix B. All analytical and QC sample criteria were met, and these data are summarized later in this section and in the analytical data reports found in Appendix B.

5.2 CEM Equipment and Instrumentation

Continuous emissions monitoring equipment brought to the site were housed in a dedicated, climate-controlled trailer that was transported to the test site and set up adjacent to the sampling location. The equipment (analyzers, calibration gases and ancillary equipment) were thoroughly checked prior to each job and the appropriated calibration standards are procured. Daily calibrations and other instrument bias checks are performed in accordance with the specific method followed.

Direct calibrations of the O_2, CO_2 NO_x, and CO analyzers were conducted using purified nitrogen (zero) and two upscale compressed gas cylinder standards containing certified concentrations of O_2, CO_2, and NO_x, and CO prepared in a balance of purified nitrogen. These calibration procedures were used to determine instrument calibration error, calibration drift, and system bias to ensure valid test runs were conducted. Calibration results were available on site and are presented in the final report. The calibrations were also used to correct the monitoring data for the observed system drift and bias as allowed by the method. Calibration gas certification documentation were available on-site prior to the start of testing and are presented in the final report.

The criteria for valid test runs under EPA Method 3A, 7E, and 10 are as follows:

- Calibration error = +/- 2% of calibration span
- System Bias = +/- 5% of calibration span
- Zero and Calibration Drift = +/- 3% of calibration span

The equation to be used to correct the data for bias and drift is presented below:

$$C_{gas} = (\bar{C} - C_o)\frac{C_{ma}}{C_m - C_o}$$

Where:

C_{gas} = Effluent gas concentration, ppm
$\bar{C}$ = Average gas concentration indicated by gas analyzer, ppm

C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm
C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm
C_{ma} = Actual concentration of the upscale calibration gas, ppm

All field equipment was calibrated annually or more often if problems occur. Copies of all calibration data for the equipment to be used on this test were brought to the test site and a copy were made available to the test observer, if requested. All calibration data are also subsequently included in the final report appendices.

6.0 Data Reduction, Validation and Data Reporting

Specific Quality Control (QC) measures were used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in such projects.

6.1 Field Data Reduction

The Field Team Leader and the Quality Assurance Officer (QAO) reviewed the field data collected from each sample run. Errors or discrepancies were noted and dealt with accordingly. Both the Field Team Leader and the QAO have the authority to institute corrective actions in the field. Field data reduction (checking of valid sampling rate and other sampling parameters) was done with a laptop computer using standardized Excel spreadsheets. All sample recovery sheets were checked for completeness.

6.2 Data Reduction

6.2.1 Emission Concentrations and Rates Relative to Heat Input

Emissions were calculated in concentration units (parts per million, ppm) and emission rates were calculated in units of pollutant mass per quantity of heat input (lb/MMBtu). Lb/MMBtu was calculated using the pollutant and diluent concentrations as well as the fuel-specific F Factor contained in EPA Method 19 based upon the fuel analytical results provided by the fuels laboratory. The measured concentrations of NO_x and CO in units of parts per million (ppm), as applicable, were first converted to mass per unit volume (lb/scf) for these calculations. The conversion factors for ppm to lb/scf are:

$$NOx\,\frac{lbs}{scf} = ppm\ NOx\ (meas) * 1.194 * 10^{-7}$$

Next, the lb/scf are converted to a mass emission rate in terms of pounds per million Btu (lb/MMBtu) as follows:

$$E = \frac{lbs}{scf} * Fd * \frac{20.9}{20.9 - \%O2}$$

Where:

E = Mass emission rate in terms of lb/MMBtu

Fd = Ratio of the volume of dry effluent gas to the gross caloric value of the wood-fired fuel and calculated from the ultimate analysis of fuel.

Lb/MMBtu data for each test run was calculated and presented in this final report.

6.3 Data Validation

Data was validation by reviewing the data and accepting, qualifying, or rejecting it based on method-specific criteria. The project QAO used validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of the data was maintained, even that judged to be an outlying or anomalous value.

Field sampling data was validated by the Field Team Leader based on a judgment of the representativeness of the sample, maintenance and cleanliness of sampling equipment and the adherence to an approved, written sample collection procedure.

The following criteria were used to evaluate the field sampling data:

- Use of approved test procedures
- Proper operation of the process being tested
- Use of properly operating and calibrated equipment
- Leak checks conducted before and after test runs
- Use of reagents that have conformed to QC specified criteria
- Use of EPA traceable CEM calibration gases
- Proper chain-of-custody maintained
- All sample trains - check to ensure proper sample gas volume collect