Consumers Energy

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Particulate Matter and Non-Methane Hydrocarbons Test Report

EUBOILER01 and EUBOILER02

CMS Enterprises
TES Filer City Station
700 Mee Street
Filer City, Michigan 49634
SRN: N1685
ORIS: 50835

September 20, 2022

Test Dates: July 26 and 27, 2022

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 4103181
Version No.: 0

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted particulate matter (PM) and total non-methane hydrocarbons (NMHC) emission testing at the exhaust location of EUBOILER01 (Unit 1) and EUBOILER02 (Unit 2), operating at Tondu Energy Systems Filer City (TESFC) Generating Station, in Filer City, Michigan. The purpose of the tests was to satisfy the once per five year PM and NMHC testing requirement in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-N1685-2015b, Table FGBOILERS, Conditions V.1 and V.2.

The PM testing was also performed to satisfy the Low Emitting Unit (LEE) subsequent (every three year) performance test requirements in 40 CFR 63, Subpart UUUUU, *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units* (Mercury and Air Toxics Rule (MATS), Section 63.100006(b) and Table 5, as incorporated in the ROP.

The testing verifies compliance with the ROP specified PM limits of 0.03 lb/mmBtu and 11.5 pounds per hour (FGBOILERS, Conditions I.1 and I.2) and the NMHC limit of 4.6 pounds per hour (FGBOILERS, Condition I.19), as well as the MATS LEE PM criteria of no greater than 0.015 lb/mmBtu (i.e., 50% of the 0.030 lb/mmBtu emission limit).

Triplicate 120-minute PM test runs were conducted following procedures in USEPA Reference Methods (RM) 1, 2, 3A, 4 and MATS 5, as proposed in the Consumers Energy Test Protocol submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on May 1, 2017, and subsequently approved by Mr. Jeremy Howe, EGLE Environmental Quality Analyst, in a letter dated May 11, 2017. Triplicate 120-minute NMHC test runs were conducted following procedures in USEPA RM 25A in conjunction with the PM test runs as proposed in the test protocol submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on June 23, 2022. There were no deviations from the approved stack test protocol and Reference Methods therein. The Units 1 and 2 PM and NMHC results are summarized in the following table.

Table E-1
Executive Summary of Test Results

Parameter	Units	Run			Average	Emission Limit	
		1	2	3		ROP	MATS LEE[1]
EUBOILER01							
PM	lb/mmBtu	0.0023	0.0018	0.0013	**0.0018**	**0.030**	**0.015**
	lb/hr	0.94	0.70	0.52	**0.72**	**11.5**	**N/A**
NMHC	lb/hr	0.30	0.60	0.28	**0.39**	**4.6**	**N/A**
EUBOILER02							
PM	lb/mmBtu	0.0027	0.0013	0.0023	**0.0021**	**0.030**	**0.015**
	lb/hr	1.12	0.56	0.97	**0.88**	**11.5**	**N/A**
NMHC	lb/hr	0.08	0.05	0.10	**0.08**	**4.6**	**N/A**

[1] Applicable qualifying emission limit for low emitting EGU (LEE) status

The test results indicate EUBOILER01 and EUBOILER02 are operating in compliance with the applicable limits. Detailed test results are presented in Appendix Tables 1 and 2. Sample calculations and field data sheets are presented in Appendices A and B. Laboratory data is presented in Appendix C. Operating data and supporting documentation are provided in Appendices D and E.

1.0 INTRODUCTION

This report summarizes the results of compliance air emissions testing conducted from the exhausts of EUBOILER01 (Unit 1) and EUBOILER02 (Unit 2) at the Tondu Energy Systems (TES) Filer City Station in Filer City, Michigan July 26 through 27, 2022.

This document follows the Michigan Department of Environment, Great Lakes, and Energy (EGLE) format described in the November 2019, *Format for Submittal of Source Emission Test Plans and Reports*. Reproducing only a portion of this report may omit critical substantiating documentation or cause information to be taken out of context. If any portion of this report is reproduced, please exercise due care in this regard.

1.1 IDENTIFICATION, LOCATION, AND DATES OF TESTS

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted particulate matter (PM) and total non-methane hydrocarbons (NMHC) testing at the TES Filer City Station in Filer City, Michigan on July 26 through 27, 2022.

A test protocol for the PM testing was submitted to EGLE on May 1, 2017 and subsequently approved by Mr. Jeremy Howe, EGLE Environmental Quality Analyst, in his letter dated May 11, 2017. The preceding reflects a standing approval for all MATS PM tests as long as no modifications from the original protocol occur; a test protocol was submitted to the Michigan EGLE on June 23, 2022 for the NMHC testing.

1.2 PURPOSE OF TESTING

The emissions test was performed to satisfy the once per five year PM and NMHC testing requirement in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-N1685-2015b, Table FGBOILERS, Conditions V.1 and V.2. The PM testing was also performed to satisfy the Low Emitting Unit (LEE) subsequent (every three year) performance test requirements in 40 CFR 63, Subpart UUUUU, *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units* (Mercury and Air Toxics Rule (MATS), Section 63.100006(b) and Table 5, as incorporated in the ROP.

The testing verifies compliance with the ROP specified PM limits of 0.03 lb/mmBtu and 11.5 pounds per hour (FGBOILERS, Conditions I.1 and I.2) and the NMHC limit of 4.6 pounds per hour (FGBOILERS, Condition I.19), as well as the MATS LEE PM criteria of no greater than 0.015 lb/mmBtu (i.e., 50% of the 0.030 lb/mmBtu emission limit).

Table 1-1
Emission Limits

Parameter	Units	Required Emission Limits	
		FGBOILERS	MATS LEE[1]
PM	lb/mmBtu	0.030	0.015
	lb/hr	11.5	N/A
NMHC	lb/hr	4.6	N/A

[1]Applicable emission limit to qualify for low emitting EGU (LEE) status

1.3 Brief Description of Source

TES Filer City Station is a cogeneration power plant consisting of two predominantly solid-fuel fired boilers. EUBOILER01 and EUBOILER02 are spreader stoker boilers that produce steam used to generate electricity and sold to an adjacent industrial customer, when needed.

1.4 Contact Information

Table 1-2 presents the test program organization, major lines of communication, and names and contact information of responsible individuals.

Table 1-2
Contact Information

Program Role	Contact	Address
Regulatory Agency Representative	Mr. Jeremy Howe Acting Technical Programs Unit Supervisor 231-878-6687 howej1@michigan.gov	EGLE Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933-1502
Designated Representative	Mr. Todd Guenthardt 231-723-6573 Plant Manager todd.guenthardt@cmsenergy.com	CMS Energy TES Filer City Generating Station 700 Mee Street Filer City, Michigan 49634
Test Facility	Mr. Austin Swiatlowski 231-723-6573, ext. 108 EH&S Coordinator austin.swiatlowski@cmsenergy.com	CMS Energy TES Filer City Generating Station 700 Mee Street Filer City, Michigan 49634
Test Team Representatives	Mr. Dillon King, QSTI Sr. Engineering Technical Analyst II 989-791-5893 dillon.king@cmsenergy.com	Consumers Energy Company Saginaw Service Center 2400 Weiss St. Saginaw, Michigan 48602
Plant Representative	Mr. Thomas Schmelter, QSTI Sr. Engineering Technical Analyst II 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY OF RESULTS

2.1 Operating Data

During the tests, the boilers were operated as close as possible to maximum normal operating load conditions. 40 CFR 63.10007(2) states the maximum normal operating load will be generally between 90 and 110 percent of design capacity but should be representative of site specific normal operations. The average steam flow during the test was 295.5 klbs/hr for Unit 1 and 284.5 klbs/hr for Unit 2 (95.0% load for Unit 1 and 91.5% load for Unit 2, at a maximum operating capacity of 311 klbs/hr for each unit). Recorded operating data, including fuel blend firing rate and composite fuel factor data, is included in Appendix D.

2.2 Applicable Permit Information

The TES Filer City Station is currently operating pursuant to the terms and conditions of State of Michigan Registration Number (SRN) N1685 air permit MI-ROP-N1685-2015b. The

air permit incorporates state and federal regulations. The USEPA has assigned a Facility Registry Service (FRS) identification number of 110056958225. Emission Units EUBOILER01 and EUBOILER02 are listed within the permit and collectively comprise the FGBOILERS flexible group. Incorporated within the permit are the applicable requirements of 40 CFR 63, Subpart UUUUU – National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-fired Electric Utility Steam Generating Units.

2.3 RESULTS

The test results indicate EUBOILER01 and EUBOILER02 are operating in compliance with the applicable limits in Renewable Operating Permit (ROP) MI-ROP-N1685-2015b, Table FGBOILERS, Conditions I.1, I.2 and I.19 and continue to meet the MATS LEE eligibility criteria for PM.

Refer to Table 2-1 for a summary of the PM and NMHC test results. Refer to Section 5.0 for further discussion.

Table 2-1
Summary of Test Results

Parameter	Units	Run			Average	Emission Limit	
		1	2	3		ROP	MATS LEE[1]
EUBOILER01							
PM	lb/mmBtu	0.0023	0.0018	0.0013	**0.0018**	**0.030**	**0.015**
	lb/hr	0.94	0.70	0.52	**0.72**	**11.5**	**N/A**
NMHC	lb/hr	0.30	0.60	0.28	**0.39**	**4.6**	**N/A**
EUBOILER02							
PM	lb/mmBtu	0.0027	0.0013	0.0023	**0.0021**	**0.030**	**0.015**
	lb/hr	1.12	0.56	0.97	**0.88**	**11.5**	**N/A**
NMHC	lb/hr	0.08	0.05	0.10	**0.08**	**4.6**	**N/A**

[1] Applicable qualifying emission limit for low emitting EGU (LEE) status

Detailed results are presented in Appendix Tables 1 and 2, following the report text. Sample calculations and field data sheets are presented in Appendices A and B. Laboratory data is presented in Appendix C. Boiler operating data and supporting documentation are provided in Appendices D and E, including boiler operator logs documenting when soot blowing was conducted.

3.0 SOURCE DESCRIPTION

TES Filer City Station is a cogeneration facility consisting of two predominantly solid-fuel fired boilers. The electricity output is sold pursuant to a long-term power purchase agreement with Consumers Energy Company. Process steam is sold to an adjacent industrial customer.

3.1 PROCESS

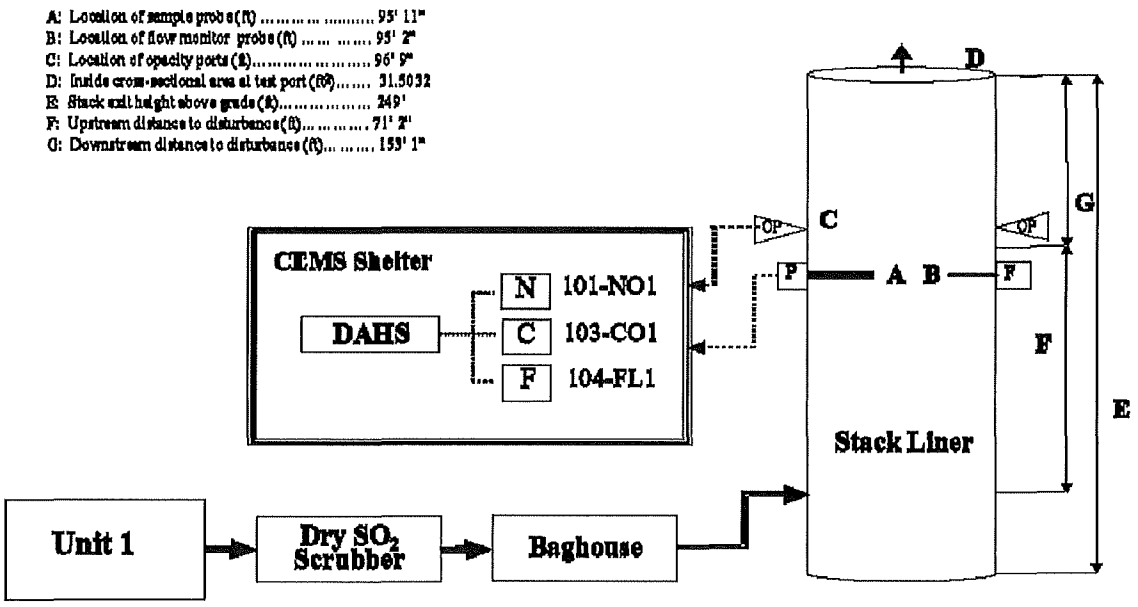
Units 1 and 2 are Foster Wheeler stoker boilers with a nominal per unit heat input rating of 384 million British thermal unit per hour (mmBtu/hr). The facility is a cogeneration plant, supplying electricity to the grid and process steam to a nearby industrial customer.

3.2 PROCESS FLOW

EUBOILER01 and EUBOILER02 are spreader stoker boilers used to generate steam. Each unit has a nominal heat input rating of approximately 384 mmBtu/hour and is currently allowed to combust coal, wood and wood waste, industrial construction/demolition wood waste, tire derived fuel, petroleum coke and natural gas. Note that pursuant to an Administrative Consent Order with EPA, all petroleum coke has been removed from the site and the facility does not anticipate using this fuel in the future. The fuel is fired in the furnace where the combustion heats water within boiler tubes producing steam. At full load, each unit is capable of producing approximately 311,000 pounds per hour of steam. This steam is used to turn a common steam turbine that is connected to an electricity producing generator or sold to an adjacent industrial customer. The electricity is routed through the transmission and distribution system to customers.

The exhaust gas from each boiler is vented to a spray dryer absorber (SDA) flue gas desulfurization system for sulfur dioxide and acid gas control and a baghouse to control particulate matter. In March of 2016, two low NO_x natural gas-fired burners were installed in each boiler. The abated exhaust gases are discharged through separate circular flues housed within a single exhaust stack. The separate flues discharge approximately 250 feet above grade. The Figure 3-1 process flow diagram is representative of both Units.

Figure 3-1. Unit Data Flow Diagram



3.3 MATERIALS PROCESSED

At the time of testing, Units 1 and 2 were capable of firing mixtures of coal (bituminous and subbituminous), wood and wood waste, construction/demolition (C/D) material, tire-derived-fuel (TDF), petroleum coke and natural gas, however the facility does not anticipate firing petroleum coke in the future. Natural gas is utilized as a clean startup fuel, for flame stabilization, and other purposes. Since mid-2018, natural gas has been a consistent part of the fuel mixture for each boiler. As documented in Appendix D of this report, the fuels fired during this test were coal, natural gas, TDF and wood.

3.4 RATED CAPACITY

Each Unit is nominally rated at 384 mmBtu/hr heat input capacity and 311,000 lbs/hr steam generation capacity, generating a combined net electrical output of approximately 60 MW_n and 50,000 pounds of process steam per hour. The boilers normally operate in a continuous manner near their rated capacity to meet contractual electrical and steam requirements.

3.5 PROCESS INSTRUMENTATION

The boiler process was continuously monitored by operators, environmental technicians, and data acquisition systems during testing. Process instrumentation and monitoring system time stamps were correlated to the local reference method test times as Eastern Daylight Time (EDT). The following process and operating parameters were documented during the test program:

- Carbon dioxide concentration (%)
-
- Fuel blend (coal, natural gas, TDF and wood) firing rates (lb/hr), (scfm for natural gas)
- Steam load flow (1,000s lb/hr) and pressure (psia); [In lieu of electrical load, which is only determined on a combined basis.]
- Opacity (%)
- Total heat input (mmBtu/hr)
- Mixed fuel factor, F_c (scf/mmBtu)
- SO_2 reduction (%)

4.0 SAMPLING AND ANALYTICAL PROCEDURES

RCTS performed the USEPA test methods presented in Table 4-1. The sampling and analytical procedures associated with each are described in the following sections.

Table 4-1
Test Methods

Parameter	Method	USEPA Title
Sample Location and Traverse Points	1	Sample and Velocity Traverses for Stationary Sources
Stack Gas Velocity and Temperature	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight (O_2 and CO_2)	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Moisture Content	4	Determination of Moisture Content in Stack Gases
Filterable Particulate Matter	MATS 5	Determination of Particulate Matter Emissions from Stationary Sources (probe and filter temperatures set to 320±25°F)
Emission rate	19	Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates
Non-methane Hydrocarbons	25A	Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

4.1 Description of Sampling Train and Field Procedures

The test matrix presented in Table 4-2 summarizes the sampling methods performed for the specified parameters during this test program.

Table 4-2
Test Matrix

Date (2022)	Run	Sample Type	Start Time (EST)	Stop Time (EST)	Test Duration (min)	EPA Test Method	Comment
July 26	1	Unit 2 PM and NMHC	7:30	9:55	120	MATS5 25A	No issues
	2	Unit 2 PM and NMHC	10:45	13:00	120	MATS5 25A	No issues
	3	Unit 2 PM and NMHC	13:55	16:10	120	MATS5 25A	No issues
July 27	1	Unit 1 PM and NMHC	7:20	9:35	120	MATS5 25A	No issues
	2	Unit 1 PM and NMHC	10:30	12:45	120	MATS5 25A	No issues
	3	Unit 1 PM and NMHC	13:46	16:00	120	MATS5 25A	No issues, Soot blow occurred

Note that the run end times in Table 4-2 represent when the last reading was taken, not the last full minute of actual sampling. Elsewhere in the test documentation, the run ends times may be presented as one minute earlier relative to Table 4-2 based on the last full minute of actual sampling.

4.1.1 Sample Location and Traverse Points (USEPA Method 1)

The selection of the measurement site was evaluated using the procedure in USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources.* Each exhaust gas flue is 76 inches in diameter with two 4-inch internal diameter sample ports that extend 20 inches from the flue interior wall. The sample ports are situated:

- Approximately 90 feet or 14 duct diameters downstream of a duct bend disturbance where the combustion gases exit the baghouse and enter the exhaust stack, and
- Approximately 150 feet or 24 duct diameters upstream of the exhaust to atmosphere.

Because the sampling locations are at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame and meet the requirements of USEPA Method 1, flue gas measurements were collected from a total of 12 traverse points. The area of the exhaust duct was calculated and the cross-section divided into a number of equal areas based on distances to air flow disturbances. Flue gas was sampled for 10 minutes at six traverse points from each of the two sample ports for a total test duration of 120 minutes.

A dimensioned sketch of the sample location showing the sampling ports in relation to breeching and to upstream and downstream disturbances or obstructions in gas flow is presented as Figure 4-1. The Unit 1 duct cross section and sampling point detail is presented as Figure 4-2; Unit 2 is identical to Unit 1 with the exception the two test ports are located at the northeast and northwest compass positions.

Figure 4-1. Unit 1 and 2 Sample Locations

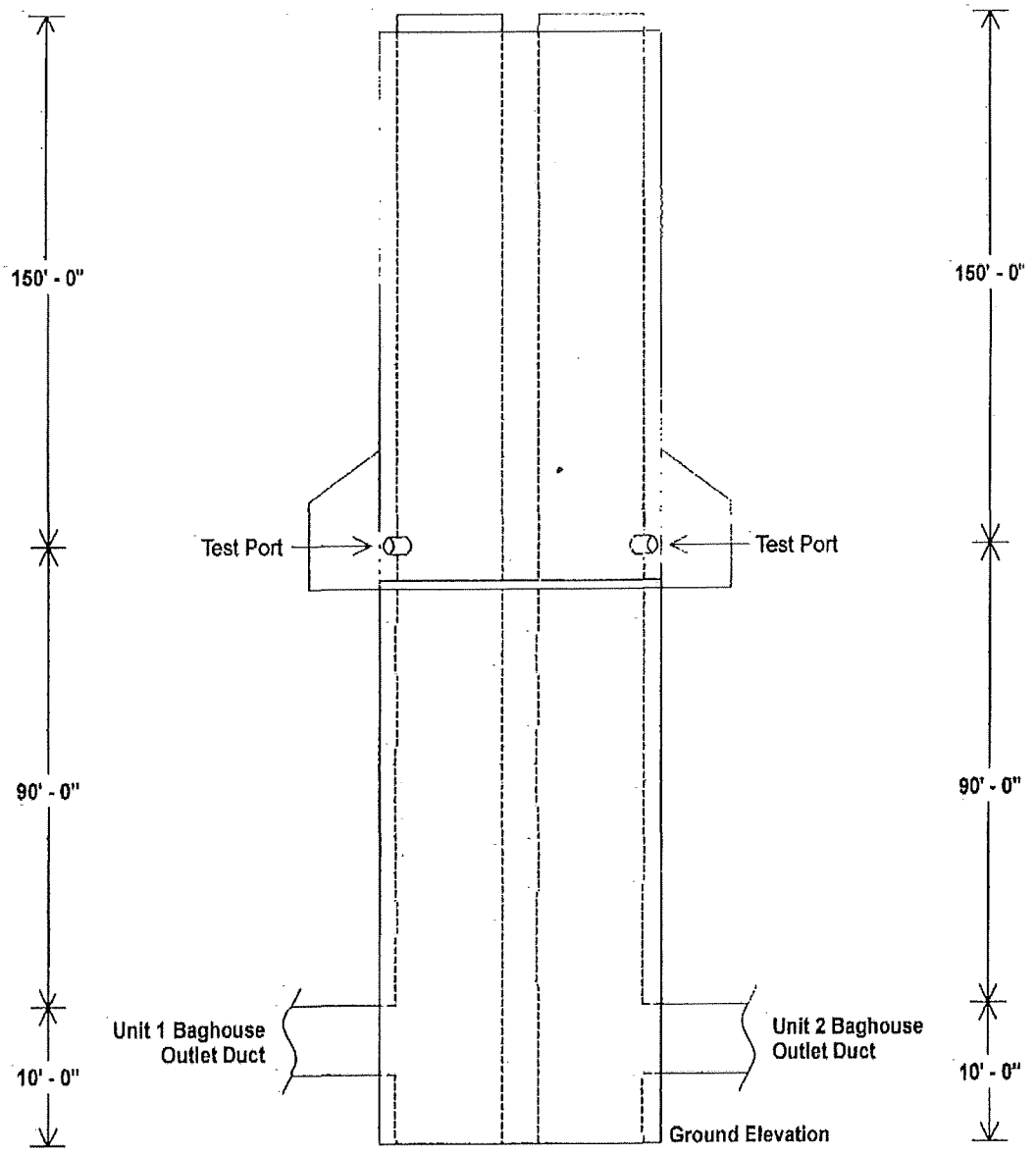
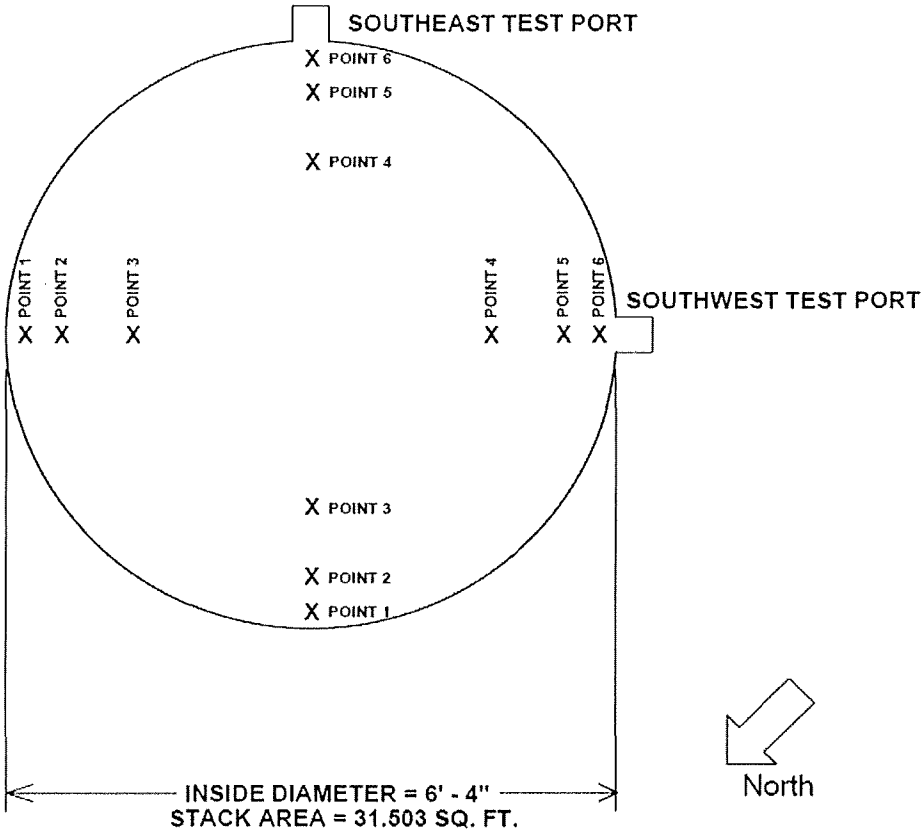


Figure 4-2. Unit 1 Duct Cross Section and Sampling Point Detail



Probe Depths From
Inside Stack Wall

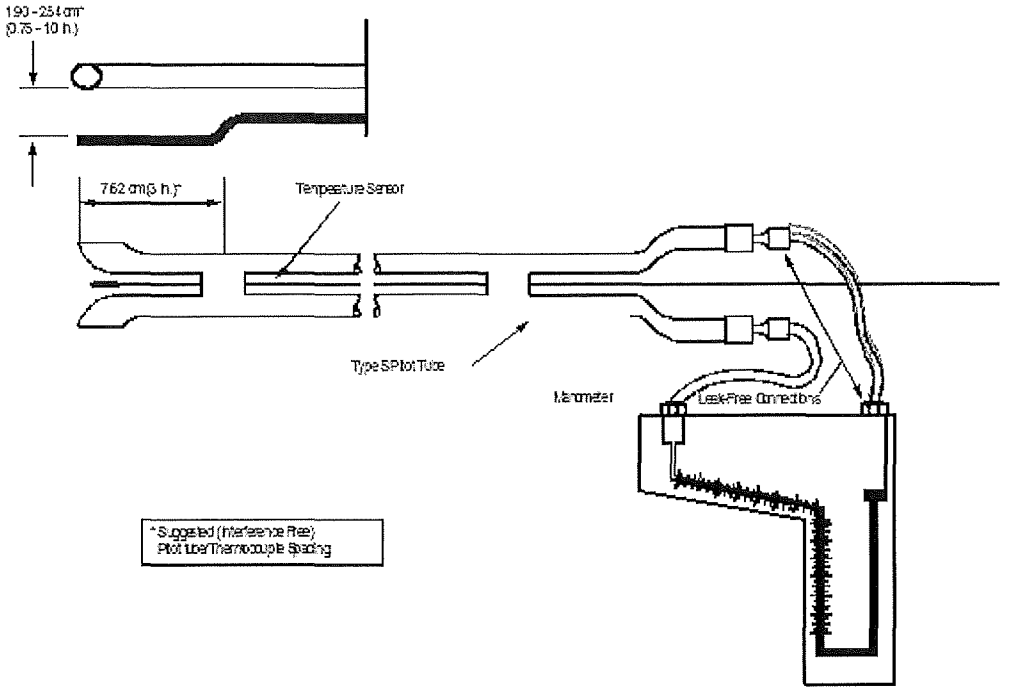
Flow Port Length = 20"

Point 1 = 72.656"
Point 2 = 64.904"
Point 3 = 53.504"
Point 4 = 22.496"
Point 5 = 11.096"
Point 6 = 3.344"

4.1.2 Velocity and Temperature (USEPA Method 2)

The exhaust gas velocity and temperature were measured using USEPA Method 2, *Determination of Stack Gas Temperature and Velocity (Type S Pitot Tube)*. The pressure differential (ΔP) across the positive and negative openings of the Pitot tube inserted in the exhaust duct at each traverse point were measured using an "S Type" (Stauscheibe or reverse type) Pitot tube connected to an appropriately sized oil filled inclined manometer. Exhaust gas temperatures were measured using a chromel/alumel "Type K" thermocouple and a temperature indicator. Refer to Figure 4-3 for a drawing of the Method 2 sample apparatus showing the Pitot tube and thermocouple configuration.

Figure 4-3. Method 2 Sample Apparatus



Flue gas velocity and velocity vector measurements (cyclonic flow evaluation) were measured following the procedures in USEPA Method 2 at the sampling locations. Cyclonic flow is defined as a flow condition with an average null angle greater than 20 degrees. The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head reading—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack walls when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20 degrees, the flue gas is considered to be cyclonic at that sampling location and an alternative location should be found.

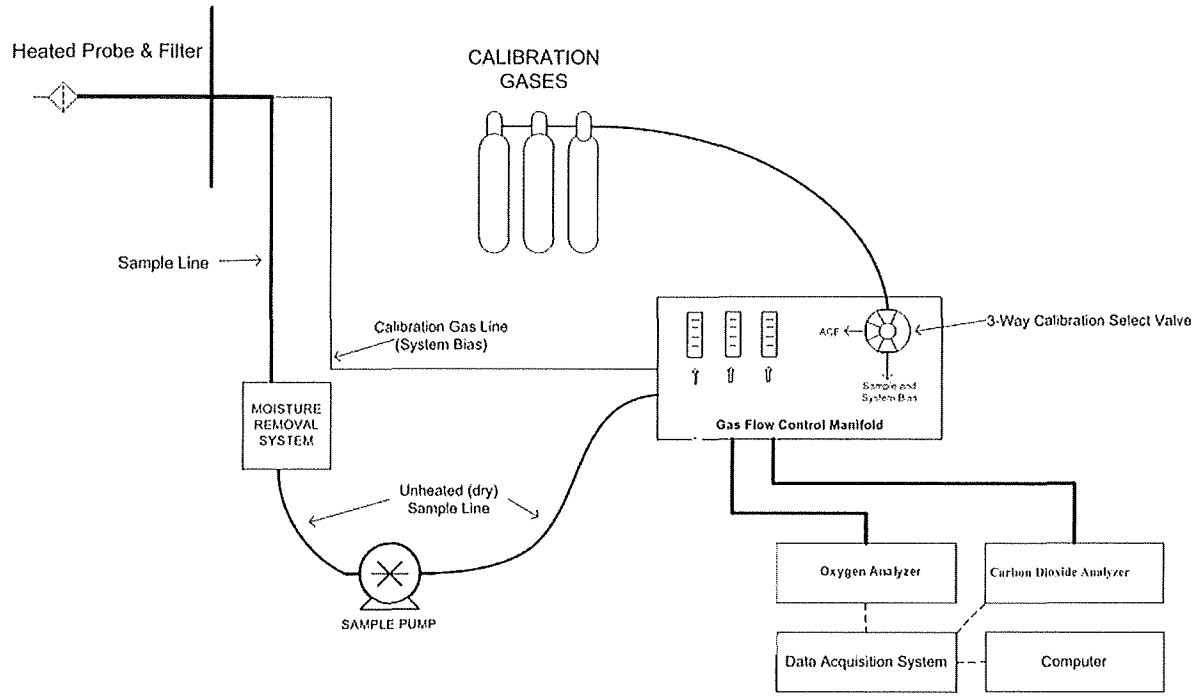
Appendix B of this report includes cyclonic flow test data as verification of the absence of cyclonic flow at each test location. Method 1, § 11.4.2 indicates *if the average* (null angle) *is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology…must be used*. The average null yaw angle measured in August 2017 was 3.25° for Unit 1 and 8.25° for Unit 2, thus meeting the less than 20° requirement. Because there have been no significant ductwork and/or stack configuration changes, this null angle information is considered valid and additional cyclonic flow verification was not performed prior to the PM test.

4.1.3 Molecular Weight (USEPA Method 3A)

Oxygen (O_2) and carbon dioxide (CO_2) concentrations were measured using the sampling and analytical procedures of USEPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure).* The measured concentrations were used to calculate lb/mmBtu emissions rates using USEPA Method 19 (refer to Section 4.1.6). The method 3A sample line was attached to stainless steel tubing on the method 5 sample probe to measure O_2 and CO_2 concentrations at each of the 12 traverse points simultaneously with PM measurements.

Flue gas was sampled from the stack through a stainless steel probe, Teflon® sample line, and through a gas conditioning system to remove water and dry the sample before entering a sample pump, flow control manifold, and paramagnetic and infrared gas filter correlation gas analyzers. Figure 4-4 depicts the Method 3A sampling system.

Figure 4-4. USEPA Method 3A Sampling System



Prior to sampling boiler exhaust gas, the analyzers were calibrated by performing a calibration error test where zero-, mid-, and high-level calibration gases were introduced directly to the back of the analyzers. The calibration error check was performed to evaluate if the analyzers response was within ±2.0% of the calibration gas span or high calibration gas concentration or ±0.5% absolute difference to be acceptable.

An initial system bias check was then performed by measuring the instrument response while introducing zero- and mid- or high-level (upscale) calibration gases at the probe, upstream of all sample conditioning components, and drawing it through the various sample components in the same manner as flue gas. The initial system bias check is acceptable if the instrument response at the zero and upscale calibration is within ±5.0% of the calibration span or ±0.5% absolute difference.

Upon successful completion of the calibration error and initial system bias tests, sample flow rates and component temperatures were verified, and the probe was inserted into the duct at the appropriate traverse point. After confirming the boiler was operating at established conditions, the test run was initiated. O_2 and CO_2 concentrations were recorded at 1-minute intervals throughout the test run, however data collected during port changes were excluded from the test run average.

At the conclusion of the test run, a post-test system bias check was performed to evaluate analyzer bias and drift from the pre- and post-test system bias checks. The system-bias checks evaluate if the analyzers bias was within ±5.0% of span or ±0.5% absolute difference and that drift was within ±3.0%. The analyzers responses were used to correct the measured oxygen and carbon dioxide concentrations for analyzer drift. The corrected concentrations were used to calculate molecular weight and emission rates. Refer to Appendix E for analyzer calibration supporting documentation.

4.1.4 Moisture Content (USEPA Method 4)

The exhaust gas moisture content was determined using USEPA Method 4, *Determination of Moisture in Stack Gases* in conjunction with the MATS Method 5 sample apparatus. The sampled gas was conveyed through a series of impingers immersed in an ice bath to condense water in the flue gas. The amount of water condensed and collected in the impingers was measured gravimetrically and used with the volume of gas sampled to calculate the exhaust gas moisture content.

4.1.5 Particulate Matter (USEPA Method 5)

Filterable particulate matter samples were collected isokinetically following the procedures of USEPA Method 5, *Determination of Particulate Matter Emissions from Stationary Sources* with the necessary modifications specified in the MATS Rule for low emitting EGU (LEE) status determinations. Specifically, the probe and filter temperatures were maintained at 320°F ±25°F, throughout the duration of each test run and a minimum of 2 dry standard cubic meters (dscm) or 70.629 dry standard cubic feet (dscf) of sample volume was collected.

As flue gas is withdrawn isokinetically from the stack, filterable PM is collected on a heated quartz-fiber filter. Moisture or water vapor in the gas condenses in a series of impingers following the heated filter. Figure 4-5 depicts the Method 5 sample apparatus and Table 4-3 provides the Method 5 impinger configuration detail.

Table 4-3
Method 5 Impinger Configuration

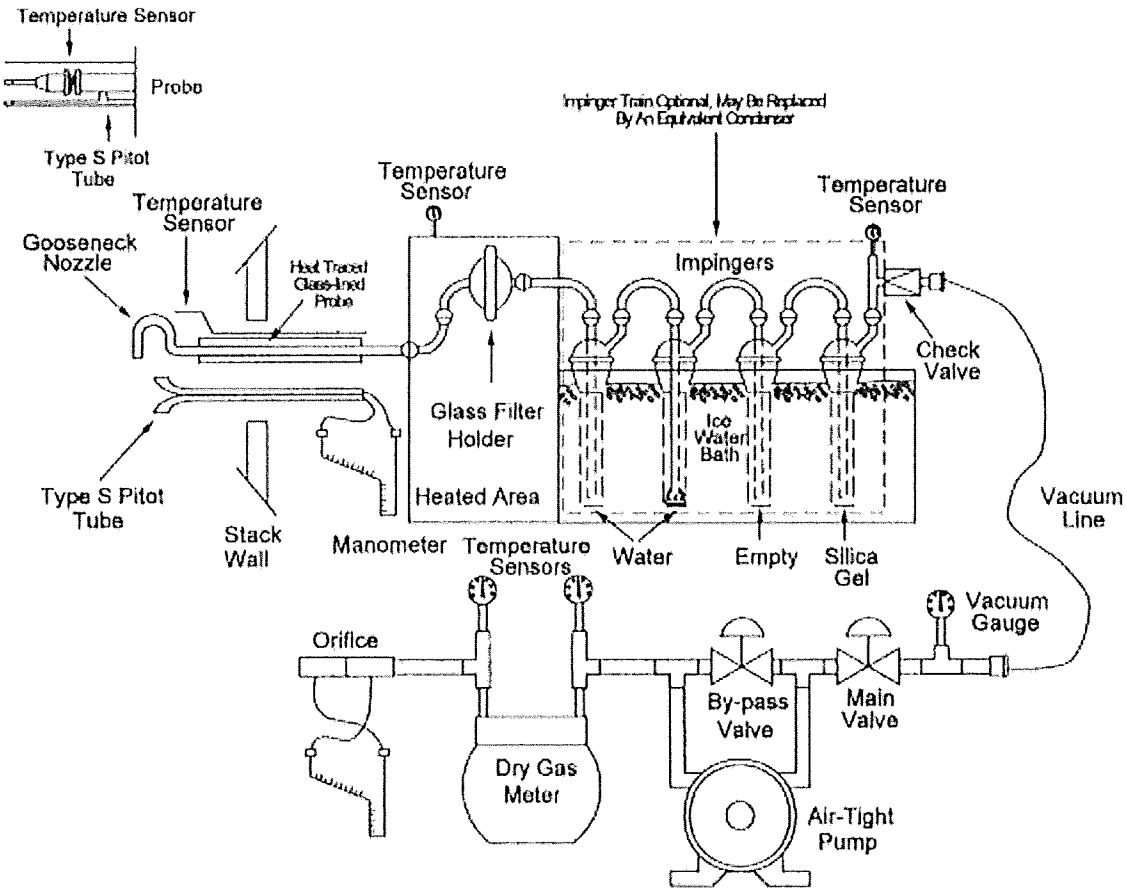
Impinger Order (Upstream to Downstream	Impinger Type	Impinger Contents	Amount (gram)
1	Modified	Water	100
2	Greenburg-Smith	Water	100
3	Modified	Empty	0
4	Modified	Silica gel desiccant	~200-300

Prior to testing, representative velocity head and temperature data was reviewed to calculate an ideal nozzle diameter allowing isokinetic sampling to be performed. The diameter of the selected nozzle was measured with a caliper across three cross-sectional chords; this data was used to calculate the cross-sectional area. Prior to testing, the nozzle was rinsed and brushed with acetone, and connected to the sample probe.

The impact and static pressure openings of the S-Type Pitot tube were leak-checked at or above a velocity head of 3.0 inches of water for a minimum of 15 seconds. The PM sample apparatus was leak-checked by capping the nozzle tip and applying a vacuum of approximately 15 inches of mercury while the dry-gas meter was monitored for approximately 1 minute to verify the sample train leakage rate was less than 0.02 cubic foot per minute (cfm). The sample probe was then inserted into the sampling port to begin sampling.

After placing ice around the impingers, the probe and filter temperatures were allowed to stabilize to a temperature of 320±25°F. Once the desired operating conditions were coordinated with the facility, testing was initiated. Stack and sampling apparatus parameters (e.g., flue velocity head, temperature) were then monitored throughout each run to maintain an isokinetic rate of 100±10%. Refer to Appendix B for field data sheets.

Figure 4-5. USEPA Method 5 Sampling Apparatus



At the conclusion of a test run and post-test leak check, the sampling apparatus was disassembled and the impingers and filter housing were transported to the recovery area.

The filter was recovered from the filter housing and placed in a Petri dish, sealed with Teflon tape, and labeled as "FPM Container 1." The nozzle, probe liner, and the front half of the filter housing were triple rinsed with acetone to collect particulate matter. The acetone rinses were collected in pre-cleaned sample containers, sealed with Teflon tape, and labeled as "FPM Container 2." The weight of liquid collected in each impinger, including the silica gel impinger, was measured using an electronic scale; these weights were used to calculate the moisture content of the sampled flue gas. The contents of the impingers were discarded. Refer to Figure 4-6 for the USEPA Method 5 sample recovery scheme.

The sample containers, including a filter and acetone blank, were transported to the laboratory for analysis. The sample analysis followed USEPA Method 5 procedures as summarized in the analytical scheme presented in Figure 4-7. Refer to Appendix C for laboratory data sheets.

Figure 4-6. USEPA Method 5 Sample Recovery Scheme

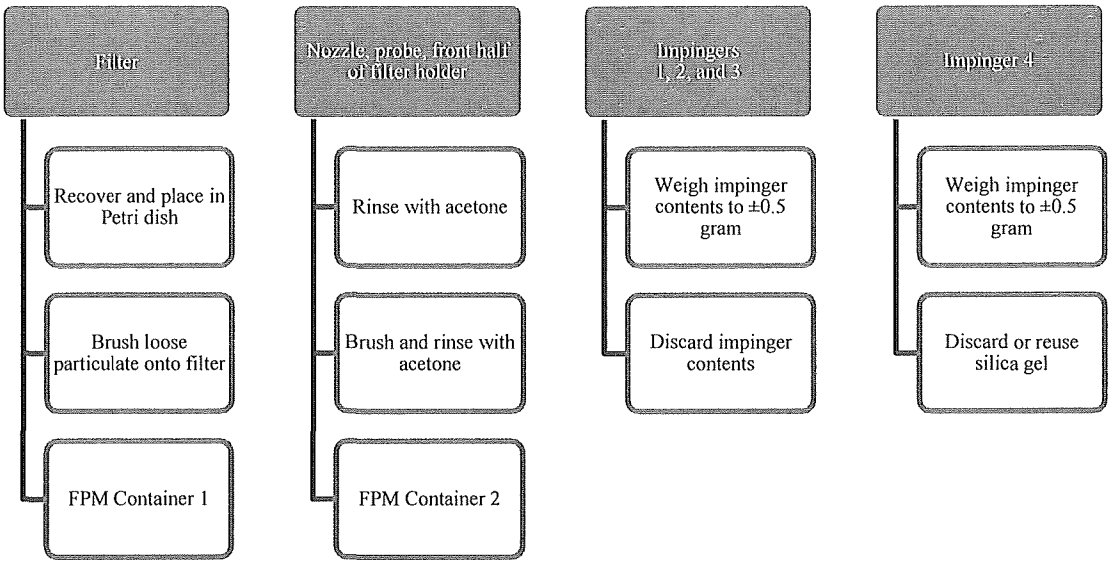
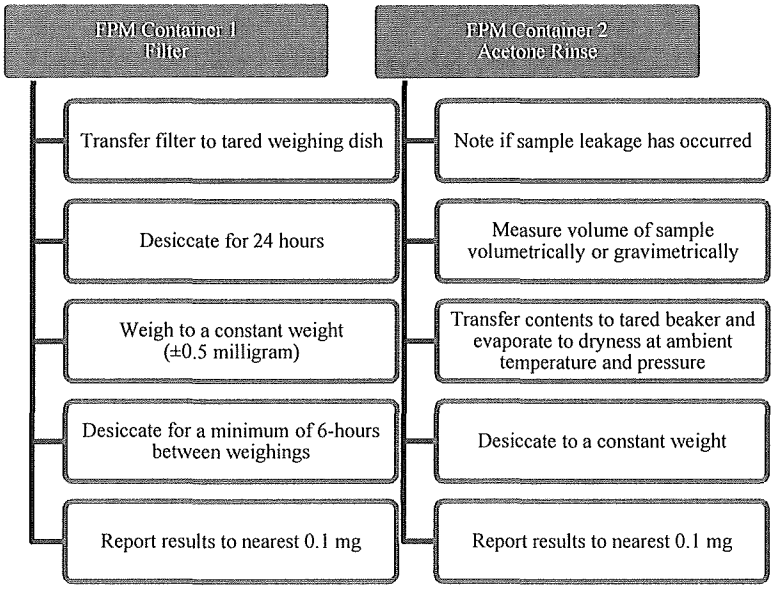


Figure 4-7. USEPA Method 5 Analytical Scheme



4.1.6 Emission Rates (USEPA Method 19)

USEPA Method 19, *Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates*, was used to calculate PM emission rates in units of lb/mmBtu. Measured carbon dioxide concentrations and F factors (ratios of combustion gas volumes to heat inputs) were used to calculate emission rates using equation 19-6 from the method. Figure 4-8 presents the equation used to calculate lb/mmBtu emission rate:

Figure 4-8. USEPA Method 19 Equation 19-6

$$E = C_d F_c \frac{100}{\%CO_{2d}}$$

Where:

E	=	Pollutant emission rate (lb/mmBtu)
C_d	=	Pollutant concentration, dry basis (lb/dscf)
F_c	=	Volumes of combustion components per unit of heat content
$\%CO_{2d}$	=	Concentration of carbon dioxide on a dry basis (%, dry)

Refer to Appendix A for example calculations and Appendix D for operating data that includes the calculated F_c factor based on the fuels combusted during each test run.

4.1.7 Non-Methane Hydrocarbons (USEPA Method 25A)

NMHC concentrations were measured from the boilers using a Thermo Model 55i Direct Methane and Non-methane Analyzer following the guidelines of USEPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer (FIA)*. The instrument uses a flame ionization detector (FID) to measure the exhaust gas total hydrocarbon concentration in conjunction with a gas chromatography column that separates methane from other organic compounds.

The components of the extractive sample interface apparatus are constructed of stainless steel and Teflon. Flue gas was collected from the stack flues via a sample probe and heated sample line and into the analyzer (wet basis), which communicates with the data acquisition handling system (DAHS) via output signal cables. Per Section 8.2 of Method 25A, exhaust gas was sampled from a single point located in the center of each the stack flue. The analyzer uses a rotary valve and gas chromatograph column to separate methane from hydrocarbons in the sample and quantifies these components using a flame ionization detector.

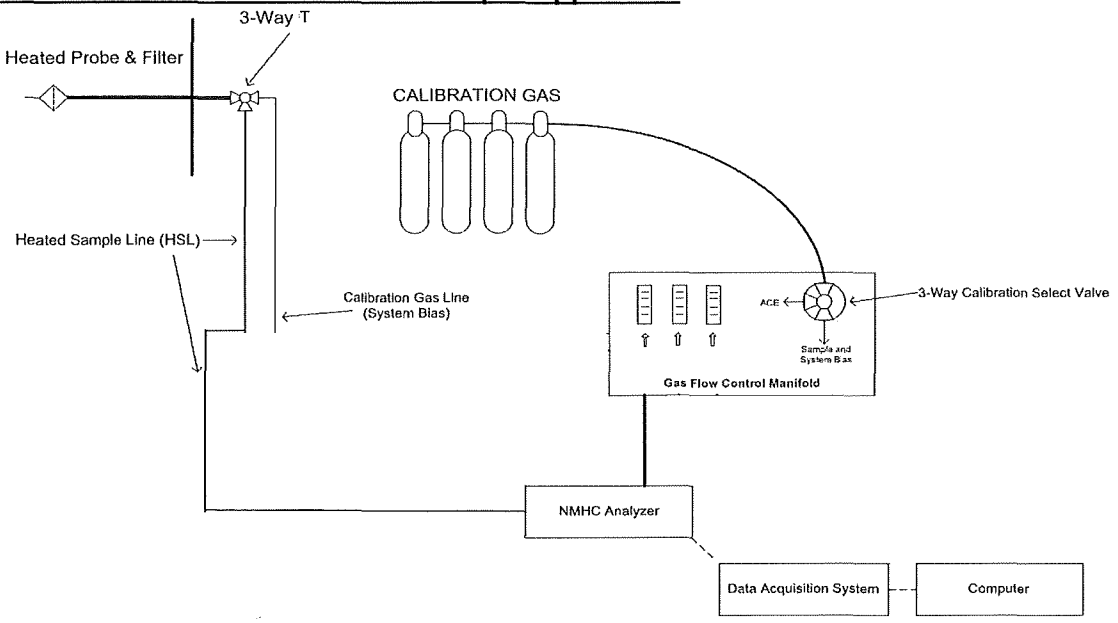
Sample gas is injected into the column and due to methane's low molecular weight and high volatility moves through the column more quickly than other organic compounds that may be present and quantified by the FID. The column is then flushed with inert carrier gas and the remaining non-methane organic compounds are analyzed in the FID. This analytical technique allows separate measurements for methane and non-methane organic compounds via the use of a single FID. Refer to Figure 4-9 for a drawing of the USEPA Method 25A sampling apparatus.

The field NMHC instrument was calibrated with a zero air and three propane in air calibration gases following USEPA Method 25A procedures at the zero, low (25 to 35 percent of calibration span), mid (45 to 55 percent of calibration span) and high (equivalent to 80 to 90 percent of instrument span) levels. An additional calibration gas closer to the concentration of the stack gas was also introduced to verify the analyzer's ability to measure at low concentrations. Please note that since the field NMHC instrument measures on a wet basis, exhaust gas moisture content was determined during each test run to convert wet NMHC concentrations to dry basis for calculating NMHC mass emission rates.

The Thermo 55i analyzer used measures exhaust gas ethane as part of the NMHC measurement. Therefore, the NMHC concentrations measured may reflect a positive bias with respect to VOCs, which would not include ethane.

Per previous requests from EGLE, the zero and mid-level analyzer responses observed during the drift determinations were used to drift correct the NMHC concentrations following concepts in Reference Method 7E.

Figure 4-9. USEPA Method 25A Sample Apparatus



5.0 TEST RESULTS AND DISCUSSION

5.1 TABULATION OF RESULTS

The results of the testing are tabulated in Appendix Tables 1 and 2 for EUBOILER01 and EUBOILER02, respectively. The Appendix Tables contain detailed tabulation of results, process operating conditions, and exhaust gas conditions. Additional tabulated supporting data is presented in Appendices B through E.

5.2 SIGNIFICANCE OF RESULTS

The test results indicate EUBOILER01 and EUBOILER02 are operating in compliance with the applicable limits in Renewable Operating Permit (ROP) MI-ROP-N1685-2015b, Table FGBOILERS, Conditions I.1, I.2 and I.19 and continue to meet the MATS LEE eligibility criteria for PM.

5.3 VARIATIONS FROM SAMPLING OR OPERATING CONDITIONS

No sampling variations were encountered during the test program. The acetone field blank results indicate there was some contamination and PM results may be biased slightly high.

5.4 PROCESS OR CONTROL EQUIPMENT UPSET CONDITIONS

The boilers and associated control equipment were operating under routine conditions and no upsets were encountered during testing.

5.5 Air Pollution Control Device Maintenance

No significant pollution control device maintenance occurred during the three months prior to the test. Optimization of the air pollution control devices is a continuous process to ensure compliance with regulatory emission limits.

5.6 Re-Test Discussion

Based on the results of this test program, a re-test is not required and the boilers continue to be classified as MATS LEE with respect to PM.

5.7 Results of Audit Samples

Audit samples are not required for the reference methods utilized during this test program and are not available from USEPA Stationary Source Audit Sample Program providers. A list of QA/QC Procedures is listed below in Table 5-1.

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M1: Sampling Location	Evaluate if the sampling location is suitable for sampling	Measure distance from ports to downstream and upstream flow disturbances	Pre-test	≥2 diameters downstream; ≥0.5 diameter upstream.
M1: Duct diameter/ dimensions	Verify area of stack is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings
M1: Cyclonic flow evaluation	Evaluate the sampling location for cyclonic flow	Measure null angles	Pre-test (if needed)	≤20°
M2: Pitot tube inspection	Verify Pitot and thermocouple assembly is free of aerodynamic interferences	Inspection	Pre-test and post-test	Refer to Section 6.1 and 10.0 of USEPA Method 2
M2: Pitot tube leak check	Verify leak free sampling system	Apply minimum pressure of 3.0 inches of H2O to Pitot tube	Pre-test and Post-test	±0.01 in H2O for 15 seconds at minimum 3.0 in H2O velocity head
M3A/25A: Calibration gas standards	Ensures accurate calibration standards	Calibration Gas Traceability protocol	Pre-test	Calibration gas uncertainty ≤2.0%
M3A/25A: Calibration Error	Evaluates analyzer operation	Introduce cal gas directly to analyzers	Pre-test	3A: ±2.0% of span or ≤0.5 ppmv or ≤0.5% CO_2/O_2 abs. difference; 25A: ±5.0% of the calibration gas value
M3A/25A: System Bias and Analyzer Drift	Evaluates analyzer sample system integrity and analyzer accuracy	Introduce cal gas at sample probe tip	Pre and Post-test	Bias: ±5.0% of span Drift: ±3.0% of span or ≤ 0.5 ppmv or 0.5% CO_2/O_2 abs. difference

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M4: Field balance calibration	Verify moisture measurement accuracy	Use Class 6 weight to check balance accuracy	Daily before use	The field balance must measure the weight within ±0.5 gram of the certified mass
M5: nozzle diameter measurements	Verify nozzle diameter used to calculate sample rate	Measure inner diameter across three cross-sectional chords	Pre-test	Three measurements agree within ±0.004 inch
M5: sample rate	Ensure representative sample collection	Calculate isokinetic sample rate	During and post-test	100±10% isokinetic sample rate
M5: sample volume	Ensure sufficient sample volume is collected	Record pre- and post-test dry gas meter volume reading	Post test	≥ 2 dscm or 70.6 dscf (requirements for MATS PM LEE testing; twice the sampling volume in Table 2 to Subpart UUUUU)
M5: post-test leak check	Evaluate if the sample was affected by system leak	Cap sample train; monitor dry gas meter	Post-test	≤0.020 cfm
M5: post-test meter audits	Evaluates accurate measurement equipment for sample volume	Calibrate DGM pre- and post-test; compare calibration factors (Y)	Pre-test Post-test	±5 %

5.8 CALIBRATION SHEETS

Calibration and inspection sheets for the dry gas meter, Pitot tube, and other equipment are presented in Appendix E.

5.9 SAMPLE CALCULATIONS

Sample calculations and formulas used to compute emissions data are presented in Appendix A.

5.10 FIELD DATA SHEETS

Field data sheets are presented in Appendix B.

5.11 LABORATORY QUALITY ASSURANCE / QUALITY CONTROL PROCEDURES

Laboratory quality assurance and quality control procedures were performed in accordance with USEPA Method 5. Specific QA/QC procedures include evaluation of reagent and filter blanks, laboratory conditions, and the application of blank corrections. Refer to Appendix C for the laboratory data sheets.

5.11.1 QA/QC BLANKS

Reagent and media blanks were analyzed for the parameters of interest. The results of the blanks are presented in the Table 5-2.

Table 5-2
QA/QC Blanks

Sample Identification	Result	Comment
Method 5 Acetone Field Blank	6.7 mg	Sample volume was 200 milliliters. Acetone blank corrections of ~0.25 mg were applied.
Method 5 Laboratory Filter Blank Method 5 Field Filter Blank	0.0 mg	Reporting limit is 0.1 milligrams. No blank correction was applied.