Consumers Energy
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Performance Test Report
Particulate Matter
40 CFR 63 Subpart UUUUU

EUBOILER01 and EUBOILER02

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

April 18, 2019

Test Dates: February 26 - 27, 2019

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 4102182
Version No.: 0

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EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter (PM) performance testing at the exhaust locations of coal-fired boilers EUBOILER01 and EUBOILER02 (Units 1 and 2) operating at the Tondu Energy Systems (TES) Filer City Station in Filer City, Michigan. TES is a cogeneration power plant with a rated output of 60-megawatts net and 50,000 pounds of process steam per hour, subject to the United States Environmental Protection Agency (USEPA), 40 Code of Federal Regulations (CFR) Part 63, Subpart UUUUU – National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-fired Electric Utility Steam Generating Units, also known as the Mercury and Air Toxics (MATS) rule. This 1st quarter 2019 PM test program, conducted on February 26 and 27, 2019, was performed to fulfill the consecutive MATS quarterly test requirements in 40 CFR 63.10006(c), to verify compliance with the 0.030 lb/mmBtu MATS PM emission limit in 40 CFR 63, Subpart UUUUU, Table 2, and to establish Low Emitting EGU (LEE) qualifying status as described in 40 CFR 63.10005(h)(1)(i).

Triplicate 120-minute PM test runs were conducted following procedures in USEPA Reference Methods (RM) 1 – 5, as proposed in the Consumers Energy Test Protocol submitted to the Michigan Department of Environmental Quality (MDEQ) on May 1, 2017, and subsequently approved by Mr. Jeremy Howe, MDEQ Environmental Quality Analyst, in a letter dated May 11, 2017. There were no deviations from the approved stack test protocol and Reference Methods therein, with the exception of diluent gas collection and analysis procedural changes described in the *Alternative Method 123* (ALT-123) guidance document published March 6, 2018. The Unit 1 and 2 PM results are summarized in the following table.

Table E-1
Executive Summary of Test Results

Source	Units	Run 1	Run 2	Run 3	Average	Emission Limit MATS	Emission Limit MATS LEE[1]
EUBOILER01	lb/mmBtu	0.0007	0.0008	0.0007	**0.0007**	**0.030**	**0.015**
EUBOILER02	lb/mmBtu	0.0225	0.0058	0.0057	**0.0113**		

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

The MATS PM test results indicate EUBOILER01 and EUBOILER02 are operating in compliance with the MATS PM emission limit and the <50 percent LEE criteria in 40 CFR 63, Subpart UUUUU, Table 2. This test event represents the 10th consecutive calendar quarter where the LEE emission rate for PM was achieved. After 12 consecutive qualifying quarters, the reduced test frequency incentives in the MATS rule may be applied.

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 February 26 and 27, 2019.

This document follows the Michigan Department of Environmental Quality (MDEQ) format described in the March 2018 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 filterable particulate matter (PM) testing at the TES Filer City Station in Filer City, Michigan on February 26 and 27, 2019.

A test protocol was submitted to the Michigan Department of Environmental Quality (MDEQ) on May 1, 2017 and subsequently approved by Mr. Jeremy Howe, MDEQ Environmental Quality Analyst, in his letter dated May 11, 2017. The preceding reflects a standing approval for all quarterly MATS PM tests as long as no modifications from the original protocol occur; however, updated and agency approved EGU diluent gas collection and analysis procedures in the March, 2018 USEPA publication ALT-123 were implemented.

1.2 Purpose of Testing

The 1st quarter 2019 air emissions tests were performed to (1) satisfy 40 CFR 63.10006(c) quarterly testing requirements, (2) evaluate compliance with the applicable emission limit, and (3) to evaluate qualifying Low Emitting EGUs (LEE) status as specified 40 CFR 63.10005(h)(1)(i). The applicable emission limit and LEE qualification criteria are summarized in Table 1-1.

The PM LEE demonstration requires quarterly performance tests over a period of three consecutive years (12 quarters), the results of which must be less than 50 percent of the 0.030 lb/mmBtu applicable emission limit in Table 2 of the MATS rule. Initial MATS PM LEE testing began in 2015, calendar quarter 4, however elevated PM results in quarter 3, 2016 triggered a new PM LEE qualification test series at that time.

Table 1-1
MATS PM Emission Limits

Parameter	MATS Emission Limit/LEE Qualification Criteria for Existing EGU's (lb/mmBtu)	Applicable Requirement
PM	0.030 (Emission Limit)	40 CFR 63 Subpart UUUUU, Table 2
	0.015 (LEE Eligibility)	40 CFR 63 Subpart UUUUU, Table 2, and 40 CFR 63, § 10005(h)(1)(i)

lb/mmBtu: pound per million British thermal unit heat input

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	Ms. Karen Kajiya-Mills Technical Programs Unit Manager 517-335-4874 kajiya-millsk@michigan.gov	Michigan Department of Environmental Quality Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
Regulatory Agency Inspector	Ms. Caryn Owens Environmental Engineer 231-876-4414 owensc1@michigan.gov	Michigan Department of Environmental Quality Cadillac District 120 W. Chapin Street Cadillac, Michigan 49601
Regulatory Agency Representative	Mr. Jeremy Howe Environmental Engineer 231-876-4416 howej1@michigan.gov	Michigan Department of Environmental Quality Cadillac District 120 W. Chapin Street Cadillac, Michigan 49601
Responsible Official	Mr. Henry Hoffman General Manager 231-723-6573, Ext 102 henry.hoffman@cmsenergy.com	CMS Generation Filer City Operating, LLC Filer City Station 700 Mee Street Filer City, Michigan 49634
Plant Representative	Mr. Austin Swiatlowski Plant Operator 231-723-6573, Ext 108 austin.swiatlowski@cmsenergy.com	CMS Generation Filer City Operating, LLC Filer City Station 700 Mee Street Filer City, Michigan 49634
Test Team Representative	Mr. Dillon A. King, QSTI Senior Engineering Technical Analyst 989-891-5585 dillon.king@cmsenergy.com	Consumers Energy Company D.E. Karn Power Plant 2742 N. Weadock Highway, ESD Trailer #4 Essexville, Michigan 48732
Test Team Representative	Mr. Thomas R. Schmelter, QSTI Senior Engineering Technical Analyst 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 296.6 klbs/hr for Unit 1 and 297.5 klbs/hr for Unit 2 (93% load, with a full load rating of 320 klbs/hr for each unit). Recorded operating data, including fuel blend firing rate and composite fuel factor data, is included in Appendix D. Note that during Run 1 for Unit 1, and Runs 1 and 2 for Unit 2, invalid exhaust flow data also resulted in a loss of valid heat input data (calculated using CO_2 concentration and exhaust flow, pursuant to equation F-14 in 40 CFR Part 75, Appendix F).

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 MATS PM test results indicate EUBOILER01 and EUBOILER02 are operating in compliance with the MATS PM emission limit and the <50 percent LEE criteria described in 40 CFR 63, Subpart UUUUU, Table 2. This test event represents the 10^{th} consecutive PM test calendar quarter where the LEE emission limit for PM was achieved. After 12 consecutive qualifying quarters, the MATS rule reduced test frequency incentives may be applied. Refer to Table 2-1 for a summary of the PM test results. Refer to Section 5.0 for further discussion.

Table 2-1
Summary of PM Test Results

Source	Units	Run			Average	Emission Limit	
		1	2	3		MATS	MATS LEE
Unit 1	lb/mmBtu	0.0007	0.0008	0.0007	**0.0007**	**0.030**	**0.015**
Unit 2	lb/mmBtu	0.0225	0.0058	0.0057	**0.0113**	**0.030**	**0.015**

lb/mmBtu: pound per million British thermal heat input
lb/hr: pound per hour

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

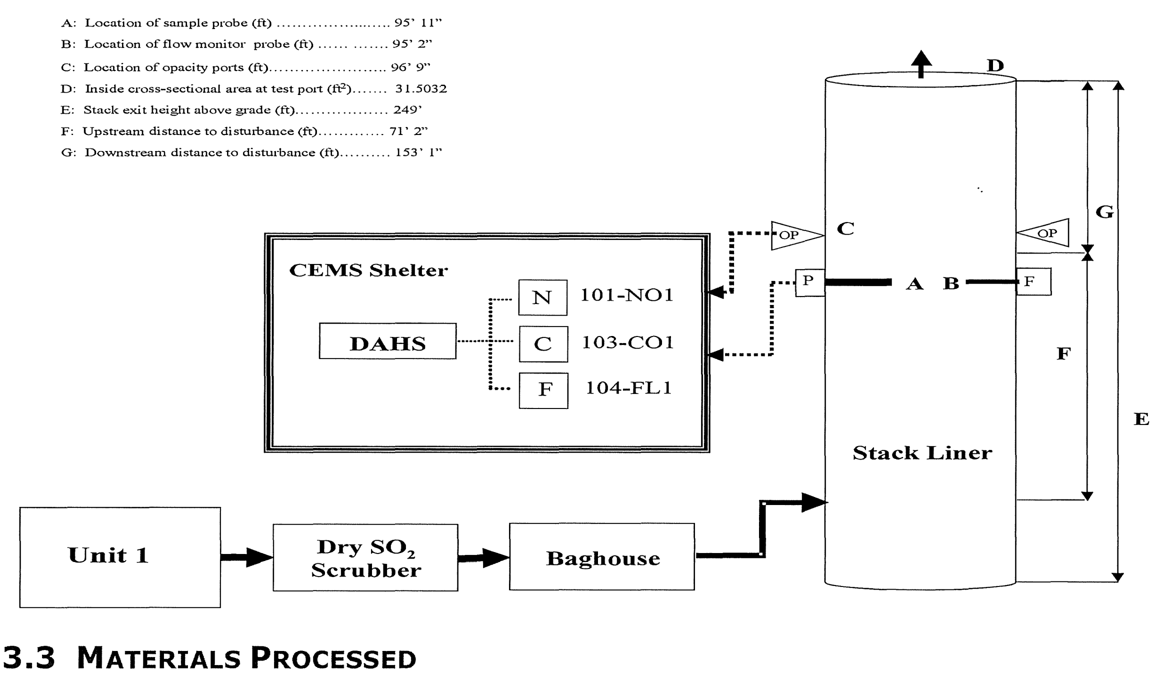
TES Filer City Station operates as a cogeneration electric power plant with a rated output of approximately 60-megawatts net (MW_n) and is also capable of generating 50,000 pounds of process steam per hour. The facility commenced commercial operations in 1990.

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 320,000 pounds per hour of steam. This steam is used to turn a common steam turbine that is connected to an electricity producing generator. 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, flame stabilization, and other purposes. As documented in Appendix D of this report, the fuel fired during this test was coal, natural gas, and TDF. Consistent with normal plant practice, wood was not fired during testing due to low ambient temperatures and concerns with the wood freezing and resulting malfunctions with the wood conveying system.

3.4 Rated Capacity

Each Unit is nominally rated at 384 mmBtu/hr heat input capacity and 320,000 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/3B ALT-123	Alternative Test Method for Diluent Measurement to Support Particulate Matter Testing Under 40 CFR 63, Subpart UUUUU
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

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 (2018)	Run	Sample Type	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
Feb 26	1	Unit 1 PM	9:40	11:45	120	MATS5	No issues
	2	Unit 1 PM	12:05	14:15	120	MATS5	Soot blow occurred at 12:40
	3	Unit 1 PM	14:35	16:40	120	MATS5	No issues
Feb 27	1	Unit 2 PM	9:08	11:11	120	MATS5	Flow CEMS blowback at approximately 9:45
	2	Unit 2 PM	11:30	13:32	120	MATS5	Soot blows occurred at 11:53 and 13:06
	3	Unit 2 PM	13:45	15:48	120	MATS5	No issues

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 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

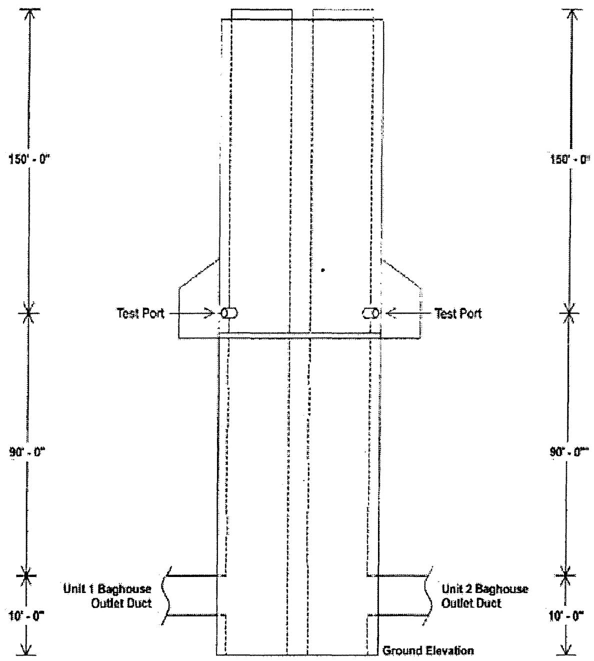
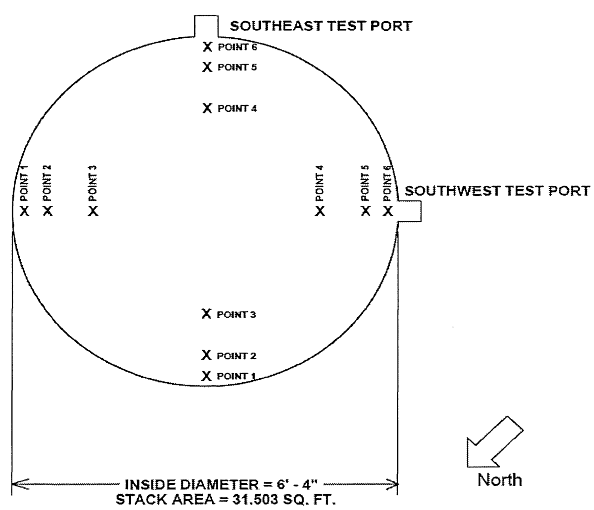


Figure 4-2. Unit 1 Duct Cross Section and Sampling Point Detail



Probe Depths From
Inside Stack Wall

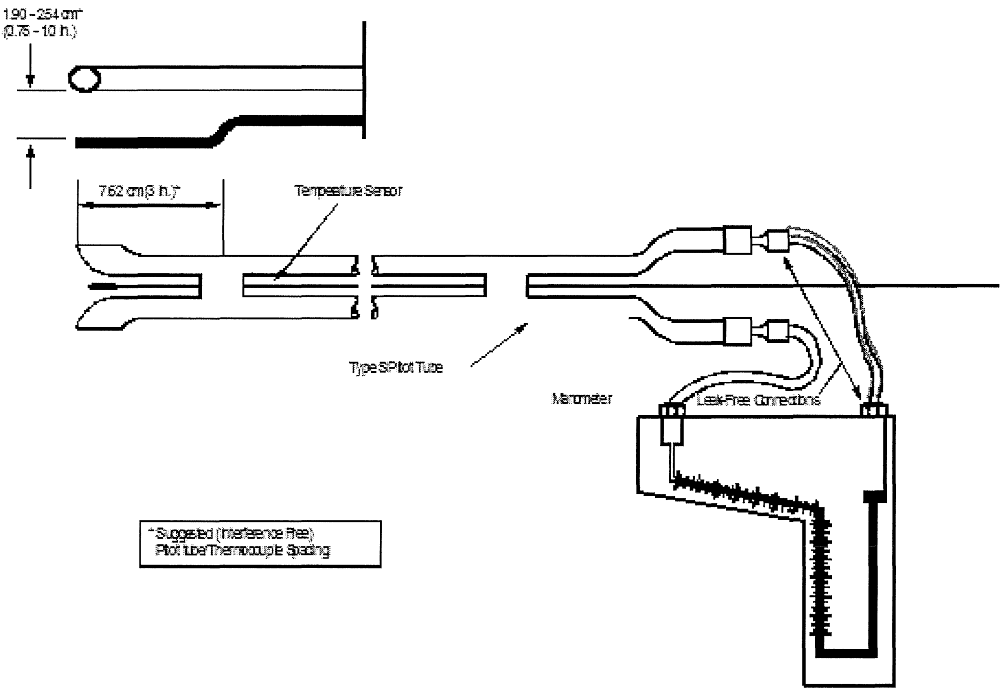
Flow Port Length = 20"

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.

<u>Figure 4-3. Method 2 Sample Apparatus</u>



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.

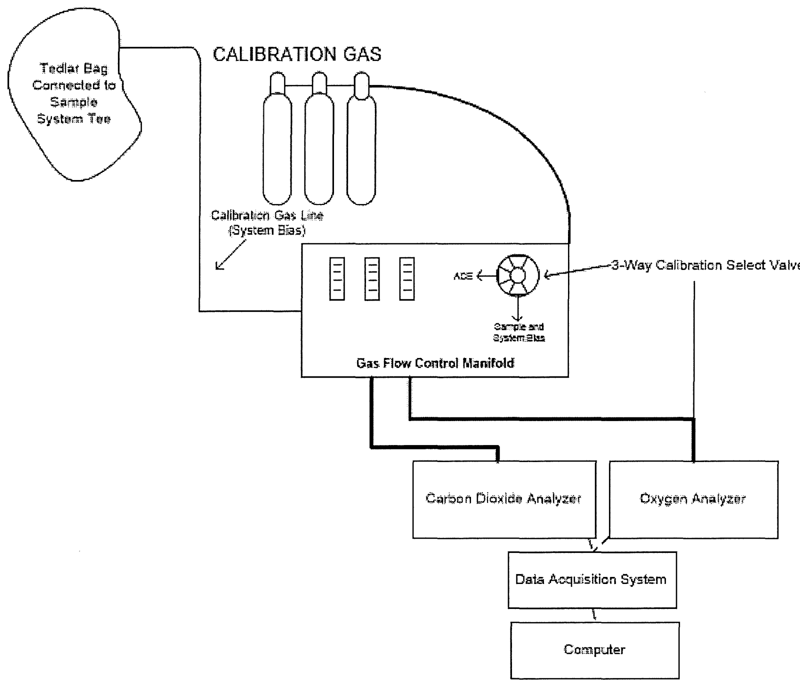
Appendix B of this report includes cyclonic flow test data as verification of the absence of cyclonic flow at each test location. Method 1, § 11.4.2 indicates *if the average* (null angle) *is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology…must 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 ALT-123)

The exhaust gas composition and molecular weight was measured using the sampling and analytical procedures of USEPA ALT-123, *Alternative Test Method for Diluent Measurement to Support Particulate Matter Testing Under 40 CFR 63, Subpart UUUUU*. ALT-123 combines the sample collection procedures of USEPA Method 3B, *Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air* with the analytical procedures of USEPA Method 3A, *Oxygen and Carbon Dioxide Concentrations from Stationary Sources – (Instrumental Analyzer Procedure.)* The flue gas oxygen and carbon dioxide concentrations were used to calculate molecular weight, flue gas velocity and emissions in lb/mmBtu.

Flue gas was extracted from the stack during each test from each of the 12 traverse points through a stainless steel lined probe and inert tubing into a flexible sample bag. The sample was then withdrawn from the flexible bag and conveyed into a multi gas analyzer that measured oxygen and carbon dioxide concentrations. Figure 4-4 depicts the ALT-123 sampling system.

Figure 4-4. Method 3A Sampling System



Prior to sampling flue gas, the analyzer was calibrated by performing a calibration error test where zero-, mid-, and high-level calibration gases were introduced directly to the analyzer. The calibration error check was performed to evaluate if the analyzer response was within ±2.0% of the calibration gas span. Analyzer system-bias and drift tests were performed by filling inert flexible sample bags with zero- and mid- or high-level calibration gases and introducing these calibration standards into the gas analyzer to measure the ability of the system to respond to within ±5.0 percent of span.

At the conclusion of the bag sample analysis, an additional system bias check was performed to evaluate the drift from the pre- and post-test system bias checks. The system-bias checks evaluated if the analyzer drift was within the allowable criterion of ±3.0% of span from pre- to post-test system bias checks. The measured oxygen and carbon dioxide concentrations were corrected for analyzer drift. Refer to Appendices B and E for analyzer calibration data and 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 320ºF ±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

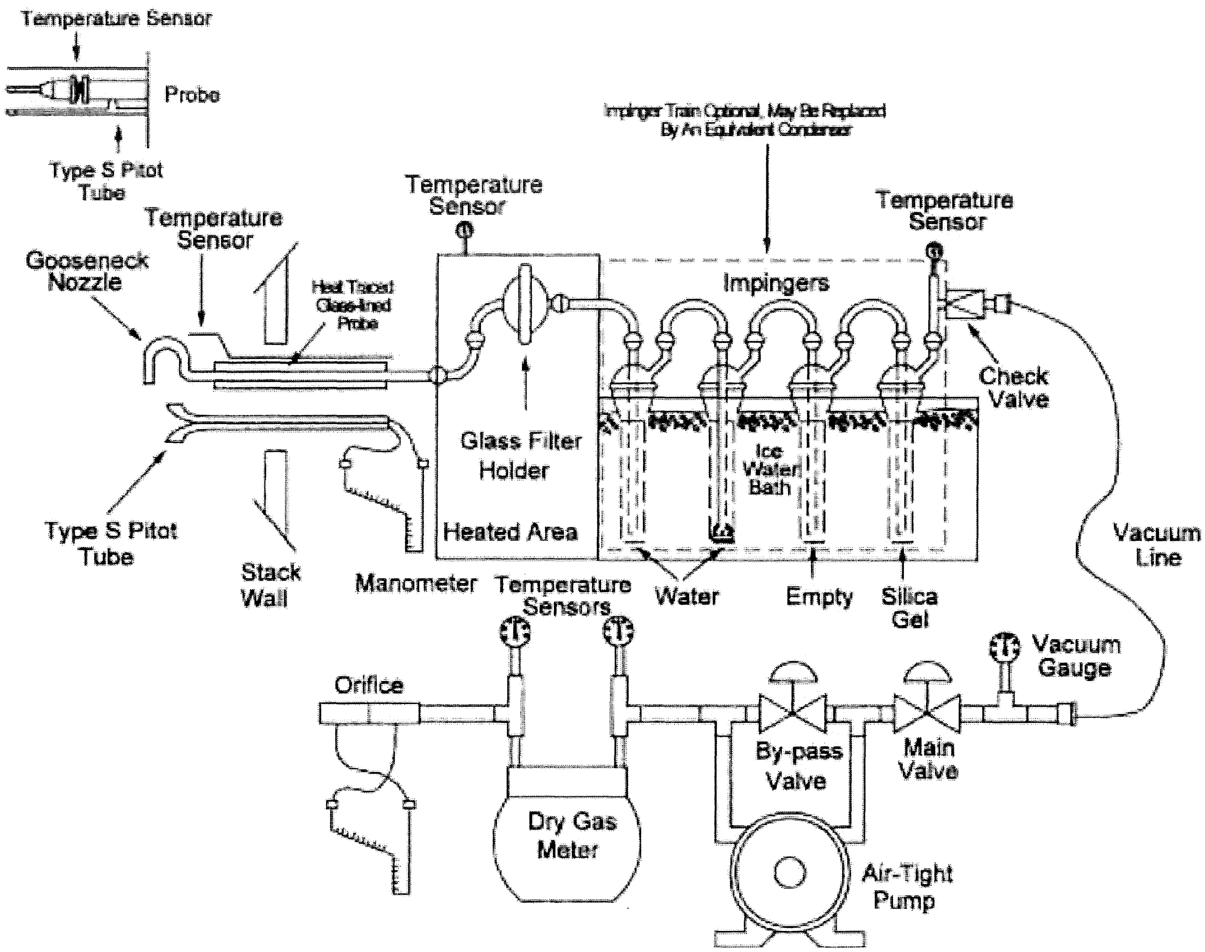
Impinger Order (Upstream to Downstream	Impinger Type	Impinger Contents	Amount (gram)
1	Modified	Water	100
2	Greenburg-Smith	Water	100
3	Modified	Empty	0
4	Modified	Silica gel desiccant	~200-300

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

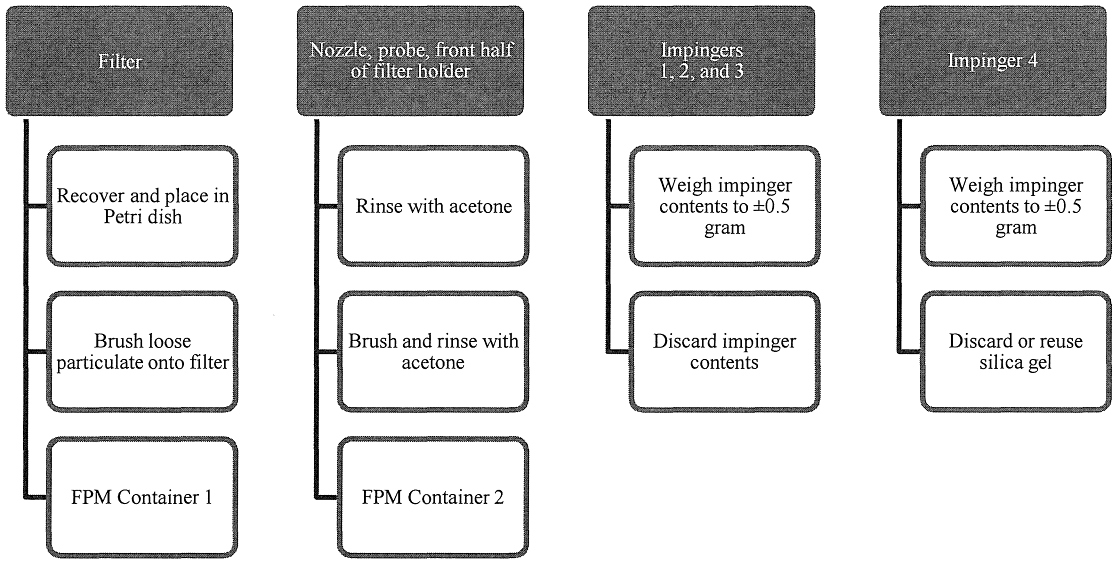
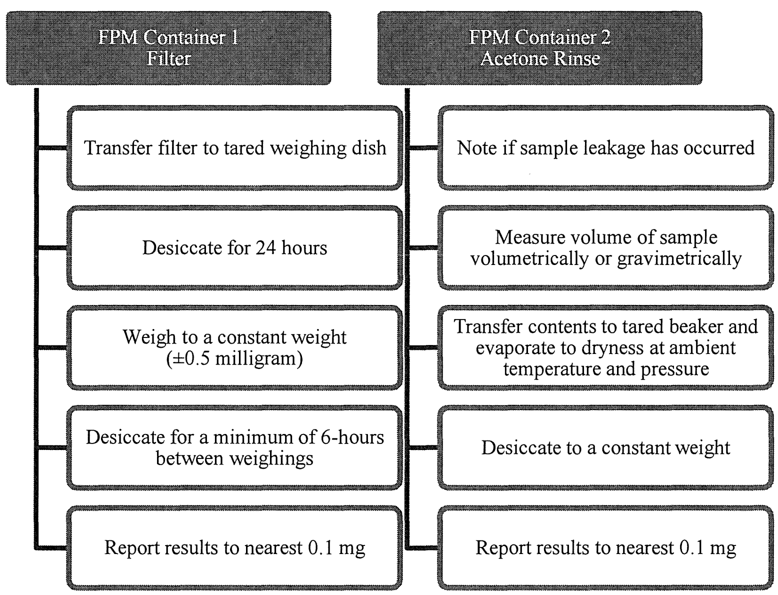


Figure 4-7. USEPA Method 5 Analytical Scheme



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.

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 results of this test program indicate EUBOILER01 and EUBOILER02 are in compliance with the applicable MATS PM emission limit of 0.030 lb/mmBtu. Further, the PM emission rates for both units remain below the MATS LEE qualification threshold of 0.015 lb/mmBtu (i.e., 50% of the MATS PM emission limit).

5.3 Variations from Sampling or Operating Conditions

No sampling variations were encountered during the test program. The elevated PM results on Unit 2 Run 1 are likely due to a blow back that occurred on the flow CEMS around 9:45. During preparation for the first run, the CEMS shelter doors were left open for an extended period exposing the differential pressure lines to below-freezing temperatures. This caused water to freeze in the lines and the flow CEMS began reporting unexpected values. After communication between RCTS and site personnel it was decided that performing a high pressure blow back may correct the issue. Debris in the differential pressure lines was likely cleared from the lines into the stack and partially collected by the PM sample train. Soot blowing was conducted on both units during the Run 2 tests.

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.

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 H_2O to Pitot tube	Pre-test and Post-test	±0.01 in H_2O for 15 seconds at minimum 3.0 in H_2O velocity head
M3A/ALT-123: Calibration gas standards	Ensure accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty ≤2.0%
M3A/ALT-123: Calibration Error	Evaluates operation of analyzers	Calibration gases introduced directly into analyzers	Pre-test	±2.0% of the calibration span
M3A/ALT-123: System Bias and Analyzer Drift	Evaluates ability of sampling system to deliver stack gas to analyzers	Calibration gases introduced via inert sample bags into analyzers	Pre-test and Post-test	±5.0% of the analyzer calibration span for bias and ±3.0% of analyzer calibration span for drift
M3A/ALT-123: Multi-point integrated sample	Ensure representative sample collection	Insert probe into stack and purge sample system	Pre-test	Collect samples at traverse points

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
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 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	0.3 mg	Sample volume was 180 milliliters. Acetone blank corrections of ~0.1 mg were applied.
Method 5 Laboratory Filter Blank	0.0 mg	Reporting limit is 0.1 milligrams. No blank correction was applied.

Tables

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Unit 1 Particulate Matter Results

Facility and Source Information	Units	Run 1	Run 2	Run 3	Average
Customer:		TES Filer City			
Source:		Unit 1			
Work Order:		4102182			
Date:		2/26/2019	2/26/2019	2/26/2019	
Steam Load:	klb/hr	295.0	297.6	297.2	296.6
Stack Diameter	inches	76.0	76.0	76.0	
Cross-sectional Area of Stack, A	ft^2	31.50	31.50	31.50	
Source Pollutant Test Data	**Units**	**Run 1**	**Run 2**	**Run 3**	**Average**
Barometric Pressure, P_{bar}	inches of Hg	29.88	29.88	29.88	29.88
Dry Gas Meter Calibration Factor, Y	dimensionless	0.999	0.999	0.999	0.999
Pitot Tube Coefficient, C_p	dimensionless	0.84	0.84	0.84	0.84
Stack Static Pressure, P_g	inches of H_2O	-0.40	-0.40	-0.40	-0.40
Nozzle Diameter, D_n	inches	0.212	0.212	0.212	0.212
Run Start Time	hr:mm	9:40	12:05	14:35	
Run Stop Time	hr:mm	11:45	14:15	16:40	
Duration of Sample, θ	minutes	120	120	120	120
Dry Gas Meter Leak Rate, L_p	cfm	0.000	0.000	0.000	0.000
Dry Gas Meter Start Volume	ft^3	224.16	315.85	408.88	316.30
Dry Gas Meter Final Volume	ft^3	315.22	408.13	498.37	407.24
Average Pressure Difference across the Orifice Meter, ΔH	inches of H_2O	2.04	1.98	1.95	1.99
Average Dry Gas Meter Temperature, T_m	°F	59.3	66.5	65.5	63.7
Average Square Root Velocity Head, √Δp	√inches H_2O	1.1895	1.1665	1.1605	1.1722
Stack Gas Temperature, $T_{s(abavg)}$	°F	170.3	171.7	175.8	172.6
Source Moisture Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Volume of Water Vapor Condensed, $V_{wc(std)}$	scf	11.9	11.9	11.7	11.8
Volume of Water Vapor Condensed in Silica Gel, $V_{wsg(std)}$	scf	1.1	3.6	1.2	2.0
Total Volume of Water Vapor Condensed, $V_{w(std)}$	scf	13.051	15.512	12.891	13.818
Volume of Gas Sample as Measured by the Dry Gas Meter, V_m	dcf	91.065	92.284	89.491	90.947
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, $V_{m(std)}$	dscf	92.810	92.752	90.108	91.890
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, $V_{m(std)}$	dscm	2.628	2.627	2.552	2.60
Moisture Content of Stack Gas, B_{ws}	% H_2O	12.33	14.33	12.52	13.06
Gas Analysis Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Carbon Dioxide, %CO_2	%, dry	10.0	10.6	10.9	10.5
Oxygen, %O_2	%, dry	9.0	8.3	8.0	8.4
Nitrogen, %N	%, dry	81.0	81.1	81.1	81.1
Dry Molecular Weight, M_d	lb/lb-mole	29.96	30.03	30.06	30.02
Wet Molecular Weight, M_s	lb/lb-mole	28.48	28.31	28.55	28.45
Fuel F-Factor, F_c:	scf/mmBtu	1,724.7	1,717.8	1,725.6	1,722.7
Gas Volumetric Flow Rate Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Average Stack Gas Velocity, v_s	ft/s	73.5	72.4	72.0	72.7
Stack Gas Volumetric Flow Rate, Q	acfm	139,019	136,904	136,048	137,324
Stack Gas Standard Volumetric Flow Rate, Q_s	scfm	116,179	114,170	112,728	114,359
Stack Gas Dry Standard Volumetric Flow Rate, Q_{sd}	dscfm	101,856	97,812	98,620	99,429
Percent of Isokinetic Sampling, I	%	97.6	101.6	97.9	99.1
Gas Concentrations and Emission Rates		**Run 1**	**Run 2**	**Run 3**	**Average**
Mass of Filterable PM Collected, m_n	mg	1.63	2.03	1.76	1.81
Filterable PM Concentration, c_s	gr/dscf	0.00027	0.00034	0.00030	0.00030
Filterable PM Mass Emission Rate, E	lb/hr	0.24	0.28	0.25	0.26
Filterable PM, lb/mmBtu, E	lb/mmBtu	0.0007	0.0008	0.0007	0.0007
Filterable PM, tpy [Assumes 8,760 Hrs/Yr Operation]	tpy	1.03	1.24	1.11	1.13

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Unit 2 Particulate Matter Results

Facility and Source Information	Units	Run 1	Run 2	Run 3	Average
Customer:		TES Filer City			
Source:		Unit 2			
Work Order:		4102182			
Date:		2/27/2019	2/27/2019	2/27/2019	
Steam Load:	klb/hr	301.0	295.1	296.4	297.5
Stack Diameter	inches	76.0	76.0	76.0	
Cross-sectional Area of Stack, A	ft^2	31.50	31.50	31.50	
Source Pollutant Test Data	**Units**	**Run 1**	**Run 2**	**Run 3**	**Average**
Barometric Pressure, P_{bar}	inches of Hg	29.93	29.93	29.93	29.93
Dry Gas Meter Calibration Factor, Y	dimensionless	0.999	0.999	0.999	0.999
Pitot Tube Coefficient, C_p	dimensionless	0.84	0.84	0.84	0.84
Stack Static Pressure, P_g	inches of H_2O	-0.40	-0.40	-0.40	-0.40
Nozzle Diameter, D_n	inches	0.212	0.212	0.212	0.212
Run Start Time	hr:mm	9:08	11:30	13:45	
Run Stop Time	hr:mm	11:11	13:32	15:48	
Duration of Sample, θ	minutes	120	120	120	120
Dry Gas Meter Leak Rate, L_p	cfm	0.000	0.000	0.000	0.000
Dry Gas Meter Start Volume	ft^3	498.79	594.04	688.23	593.69
Dry Gas Meter Final Volume	ft^3	593.66	687.79	784.01	688.48
Average Pressure Difference across the Orifice Meter, ΔH	inches of H_2O	2.12	2.08	2.13	2.11
Average Dry Gas Meter Temperature, T_m	°F	57.4	63.6	72.0	64.3
Average Square Root Velocity Head, √Δp	√inches H_2O	1.2137	1.1962	1.1958	1.2019
Stack Gas Temperature, $T_{s(abavg)}$	°F	170.3	167.8	166.4	168.2
Source Moisture Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Volume of Water Vapor Condensed, $V_{wc(std)}$	scf	13.0	13.2	13.0	13.1
Volume of Water Vapor Condensed in Silica Gel, $V_{wsg(std)}$	scf	1.1	1.3	1.4	1.2
Total Volume of Water Vapor Condensed, $V_{w(std)}$	scf	14.074	14.529	14.390	14.331
Volume of Gas Sample as Measured by the Dry Gas Meter, V_m	dcf	94.864	93.746	95.778	94.796
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, $V_{m(std)}$	dscf	97.204	94.912	95.460	95.859
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, $V_{m(std)}$	dscm	2.753	2.688	2.703	2.71
Moisture Content of Stack Gas, B_{ws}	% H_2O	12.65	13.28	13.10	13.01
Gas Analysis Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Carbon Dioxide, $\%CO_2$	%, dry	11.0	10.8	10.7	10.8
Oxygen, $\%O_2$	%, dry	7.8	7.9	8.1	7.9
Nitrogen, %N	%, dry	81.2	81.3	81.2	81.2
Dry Molecular Weight, M_d	lb/lb-mole	30.07	30.05	30.03	30.05
Wet Molecular Weight, M_s	lb/lb-mole	28.55	28.45	28.45	28.48
Fuel F-Factor, F_c:	scf/mmBtu	1,700.8	1,697.6	1,700.5	1,699.6
Gas Volumetric Flow Rate Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Average Stack Gas Velocity, v_s	ft/s	74.9	73.8	73.7	74.1
Stack Gas Volumetric Flow Rate, Q	acfm	141,570	139,495	139,275	140,113
Stack Gas Standard Volumetric Flow Rate, Q_s	scfm	118,510	117,238	117,317	117,688
Stack Gas Dry Standard Volumetric Flow Rate, Q_{sd}	dscfm	103,521	101,673	101,949	102,381
Percent of Isokinetic Sampling, I	%	100.6	100.0	100.3	100.3
Gas Concentrations and Emission Rates		**Run 1**	**Run 2**	**Run 3**	**Average**
Mass of Filterable PM Collected, m_n	mg	64.36	15.85	15.44	31.88
Filterable PM Concentration, c_s	gr/dscf	0.01020	0.00257	0.00249	0.00509
Filterable PM Mass Emission Rate, E	lb/hr	9.05	2.24	2.18	4.49
Filterable PM, lb/mmBtu, E	lb/mmBtu	0.0225	0.0058	0.0057	0.0113
Filterable PM, tpy [Assumes 8,760 Hrs/Yr Operation]	tpy	39.63	9.82	9.53	19.66

Appendix A
Sample Calculations