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Particulate Matter (PM) CEMS RRA and ROP PM Test Report

EUBOILER3

Consumers Energy Company
J.H. Campbell Plant
17000 Croswell Street
West Olive, Michigan 49460
SRN: B2835
FRS: 110000411108

Test Date: August 8, 2017

October 4, 2017

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section – Air Emissions Testing Body
Laboratory Services
Work Order No. 29436194
Revision 0

EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter (PM) testing of the single exhaust of coal-fired boiler EUBOILER3 (Unit 3) operating at the J.H. Campbell Generating Station in West Olive, Michigan. EUBOILER3 is a coal-fired electric utility steam generating unit (EGU) that turns a turbine connected to an electricity producing generator. The testing was performed to ensure the continued validity of the PM CEMS correlation curve via a relative response audit (RRA) as required in 40 CFR Part 63, Subpart 63.10010(i)(2)(i) utilizing Procedure 2—Quality Assurance Requirements for Particulate Matter Continuous Emission Monitoring Systems at Stationary Sources (40 CFR Part 60 Appendix F). The criteria to pass an RRA described in Section 10.4(6) of Performance Specification 2 are listed below. Secondarily, the results were used to demonstrate compliance with the PM limits in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013a.

Triplicate minimum 60-minute PM test runs were conducted on August 8, 2017 following the procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 2, 3A, 4, 5, and 19 in 40 CFR 60, Appendix A. Each test run sampled a minimum of 60 dry standard cubic feet (dscf). There were no deviations from the approved stack test protocol or the associated USEPA Reference Methods. During testing, Unit 3 was operated at the maximum load achievable under normal operating conditions. The Unit 3 PM results are summarized below.

Summary of PM Test Results

Parameter	Units	Run			Average	Emission Limit	
		1	2	3		ROP	MATS
PM	lb/mmBtu	0.0016	0.0008	0.0005	**0.0010**	**0.10**	**0.03**
	lb/hr	11.92	4.64	3.40	**6.65**	370	-

Summary of PM RRA Results

Procedure 2 Criteria	**10.4(6)(i)**	PASS **(All PM CEMS responses ≤ 19.818 mg/wacm)**
	10.4(6)(ii)	PASS **(All PM CEMS responses ≥ 0.000 & ≤ 19.818 mg/wacm)**
	10.4(6)(iii)	PASS **(All sets of PM CEMS and reference method measurements fall within ± 25% of the emission limit on a graph of the correlation regression line)**

The results of the testing indicate the 3-run average PM results are in compliance with applicable limits and the PM CEMS met all criteria specified in Section 10.4(6) in Procedure 2 of 40 CFR 60 Appendix F.

Detailed results are presented in Table 1. 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 information are provided in Appendices D and E.

1.0 INTRODUCTION

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter (PM) testing of the dedicated exhaust of coal-fired boiler EUBOILER3 (Unit 3) in operation at the J.H. Campbell Generating Station in West Olive, Michigan. Unit 3 is a coal-fired electric utility steam generating unit (EGU) that turns a turbine connected to an electricity producing generator. The testing was performed to ensure the continued validity of the PM CEMS correlation curve via a relative response audit (RRA) as required in 40 CFR Part 63, Subpart 63.10010(i)(2)(i) utilizing Procedure 2—Quality Assurance Requirements for Particulate Matter Continuous Emission Monitoring Systems at Stationary Sources (40 CFR Part 60 Appendix F). Secondarily, the results were used to demonstrate compliance with the PM limits in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013a.

Notification to the EPA, as well as a courtesy notification to the MDEQ was sent June 28, 2017 informing the agencies of Consumers Energy's intention to perform this test program. The test protocol was approved by Mr. Jeremy Howe, Environmental Quality Analyst with MDEQ in his letter dated July 28, 2017.

The criteria to pass an RRA described in Section 10.4(6) of Performance Specification 2 are listed below. The results of the testing were also used to demonstrate compliance with the applicable emission limits summarized in Table 1-1.

- 10.4(6)(i): For all three test runs (data points), the PM CEMS response value can be no greater than the highest PM CEMS response value used to develop the correlation curve (19.818 mg/wacm).
- 10.4(6)(ii): For two of the three data points, the PM CEMS response value must lie within the PM CEMS output range used to develop the correlation curve (see above for the maximum PM CEMS responses; minimum response was 0.000 mg/wacm).
- 10.4(6)(iii): At least two of the three sets of PM CEMS and reference method measurements must fall within the area on a graph of the correlation regression line bounded by two parallel lines at ± 25% of the permit emission limit. (When assessing PM CEMS performance in relation to the "emissions limit," the MATS PM emission limit of

0.030 lb/mmBtu is used. The preceding MATS PM emission limit equates to 22.07 mg/wacm.)

Table 1-1.
PM Emission Limits

Parameter	Emission Limit	Units	Applicable Requirement
PM	0.10	lb/mmBtu	MI-ROP-B2835-2013a, Section1, EUBOILER3 Emission Limits
	370	lb/hr	

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

The test was conducted on August 8, 2017 following the procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 2, 3A, 4, 5, and 19 in 40 CFR 60, Appendix A.

1.1 Contact Information

Table 1-2 presents the EGU test program organization, major lines of communication, and names and phone numbers of responsible individuals.

Table 1-2.
Contact Information

Program Role	Contact	Address
State Regulatory Administrator	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
Responsible Official	Mr. Norman J. Kapala Executive Director of Coal Generation 616-738-3200 Norman.Kapala@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Facility	Mr. Joseph J. Firlit Sr. Engineering Tech Analyst Lead 616-738-3260 Joseph.Firlit@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Facility	Mr. John J. Olle Senior Technician 616-738-3278 John.Olle@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460

Test Team Representative	Mr. Dillon A. King, QSTI 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 Engineering Technical Analyst 616-738-3334 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 performance test, the boiler fired 100% western coal and was operated at maximum normal operating load conditions. The testing was performed while the boiler was operating within the range of 881 MWg to 883 MWg (97.9-98.1% of the achievable capacity).

Refer to Attachment D for detailed operating data, which was recorded in Eastern Standard Time. Note the time convention for the reference method (RM) testing was Eastern Daylight Savings Time (EDT); therefore, there is a one hour offset between the RM time stamps and continuous emissions monitoring system (CEMS)/process data time stamps.

2.2 APPLICABLE PERMIT INFORMATION

The J.H. Campbell generating station has State of Michigan Registration Number (SRN) B2835 and operates in accordance with air permit MI-ROP-B2835-2013a. The air permit incorporates state and federal regulations, and the USEPA has assigned the facility a Federal Registry Service (FRS) identification number of 110000411108. EUBOILER3 is the emission unit source identification in the permit. 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.

In addition to the state issued air permit, Consumers Energy operates Unit 3 in accordance with the requirements in Consent Decree (CD), Civil Action No.: 14-13580, entered between Consumers Energy, the United States Environmental Protection Agency (EPA), and the United States Department of Justice (DOJ) on November 4, 2014.

2.3 RESULTS

The results of the testing indicate the 3-run average PM results are in compliance with applicable limits and the PM CEMS met all criteria specified in Section 10.4(6) in Procedure 2 of 40 CFR 60 Appendix F. Refer to Table 2-1 for a summary of the PM results in comparison to emission limits. Refer to Table 2-2 and Figure 2-1 for a summary of the PM CEMS RRA.

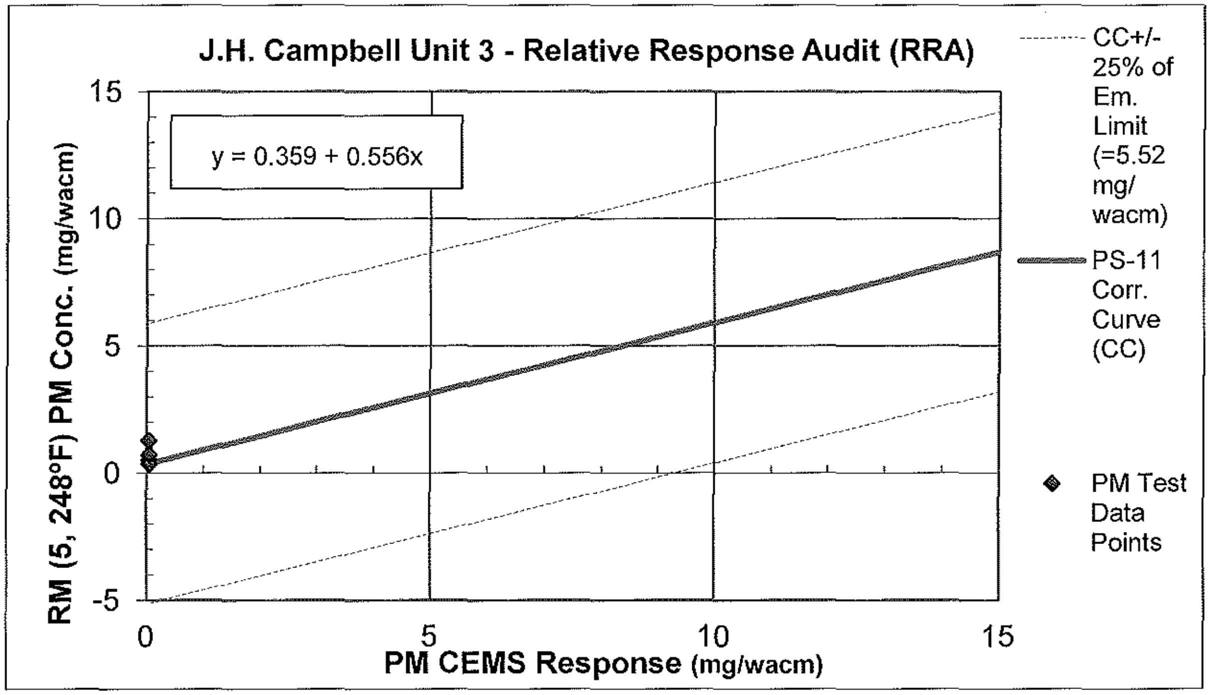
Table 2-1.
Summary of PM Test Results

Parameter	Units	Run			Average	Emission Limit	
		1	2	3		ROP	MATS
PM	lb/mmBtu	0.0016	0.0008	0.0005	**0.0010**	0.10	0.03
	lb/hr	11.92	4.64	3.40	**6.65**	370	-

Table 2-2.
Summary of PM CEMS RRA Results

Run	Parameter	Units	PM Concentration	
			RM Result	PM CEMS Response
1	PM	mg/wacm	1.277	0.051
2			0.513	0.051
3			0.353	0.055
Average			0.714	0.052
Procedure 2 Criteria				
10.4(6)(i)	**PASS (All PM CEMS responses ≤ 19.818 mg/wacm)**			
10.4(6)(ii)	**PASS (All PM CEMS responses ≥ 0.000 & ≤ 19.818 mg/wacm)**			
10.4(6)(iii)	**PASS (All sets of PM CEMS and reference method measurements fall within ± 25% of the emissions limit on a graph of the correlation regression line)**			

Figure 2-1. PM CEMS 10.4(6)(iii) Assessment



Detailed results are presented in Table 1, 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 information are provided in Appendices D and E.

3.0 SOURCE DESCRIPTION

EUBOILER3 is a coal-fired EGU that turns a turbine connected to an electricity producing generator.

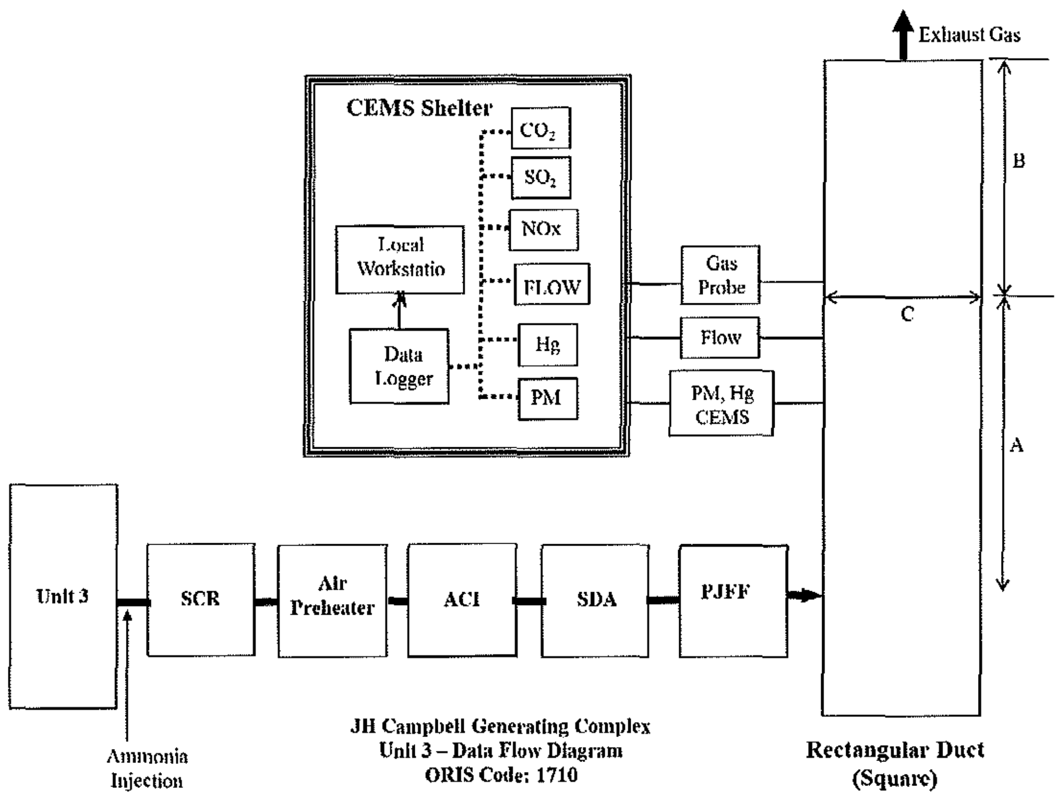
3.1 Process

Unit 3 is a dry bottom wall-fired boiler which combusts pulverized sub-bituminous coal as the primary fuel and oil as an ignition/flame stabilization fuel. The source classification code (SCC) is 10100222. Coal is fired in the furnace where the combustion heats boiler tubes containing water producing steam. The steam is used to turn an engine turbine that is connected to an electricity producing generator. The electricity is routed through the transmission and distribution system to consumers.

3.2 PROCESS FLOW

Unit 3 emissions are controlled by low-NO_x burners, over-fire air, and selective catalytic reduction (SCR) for NO_x control, activated carbon injection (ACI) for mercury (Hg) control, four spray dry absorber (SDA) modules for control of acid gases (e.g., sulfur oxides (SO_x), HCl), and a low pressure/high volume pulse jet fabric filter (PJFF) system baghouse for particulate matter control. Refer to Figure 3-1 for the Unit 3 Data Flow Diagram.

Figure 3-1. Unit 3 Data Flow Diagram



3.3 MATERIALS PROCESSED

The normal fuel utilized in Unit 3 is 100% western subbituminous coal. The boiler is classified as a coal-fired unit not firing low rank virgin coal as described in Table 2 to Subpart UUUUU. For this test, Unit 3 was burning 100% western subbituminous coal.

3.4 Rated Capacity

Unit 3 has a nominally rated heat input capacity of 8,240 mmBtu/hr and can generate a gross electrical output of approximately 910 megawatts (MWg). The boiler operates in a continuous manner in order to meet the electrical demands of Midcontinent Independent System Operator, Inc. (MISO) and Consumers Energy customers. EUBOILER3 is considered a baseload unit because it is designed to operate 24 hours a day, 365 days a year.

3.5 Process Instrumentation

The process was continuously monitored by boiler operators, environmental technicians, and data acquisition systems during testing. One-minute data for the following parameters were collected during each PM test run: PM (mg/wacm), load (MWg), CO_2 concentration (vol-%, Wet), and opacity (%). Due to the various instrumentation systems, the sampling times were correlated to instrumentation times. The control equipment process instrumentation and reference method data is recorded on Eastern Daylight Time (EDT), whereas, the continuous emissions monitoring systems records data on Eastern Standard Time (EST). During the test program, EDT was one hour later than EST. (i.e., 8:00 am EDT = 7:00 am EST). Refer to Appendix D for operating data.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy RCTS tested for PM emissions using the USEPA test methods presented in Table 4-1. The sampling and analytical procedures associated with each parameter are described in the following sections.

Table 4-1.
Test Methods

Parameter	USEPA	
	Method	Title
Sampling location	1	Sample and Velocity Traverses for Stationary Sources
Traverse points	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)

Table 4-1.
Test Methods

Parameter	USEPA	
	Method	**Title**
Moisture	4	Determination of Moisture Content in Stack Gases
Filterable particulate matter	5	Determination of Particulate Matter Emissions from Stationary Sources
Pollutant 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 and analytical methods performed for the specified parameters during this test program.

Table 4-2.
Test Matrix

Date (2017)	Run	Sample Type	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
August 8	1	PM	8:18	9:51	60	M5	30 traverse points; isokinetic sampling; 60 minute test duration; minimum sample volume of 60 dscf
	2	PM	10:41	12:21	60	M5	30 traverse points; isokinetic sampling; 60 minute test duration; minimum sample volume of 60 dscf
	3	PM	13:15	14:51	60	M5	30 traverse points; isokinetic sampling; 60 minute test duration; minimum sample volume of 60 dscf

Note: Appendix D presents Operating Data for the duration of the test period, inclusive of the time during test port changes, between run start and stop times.

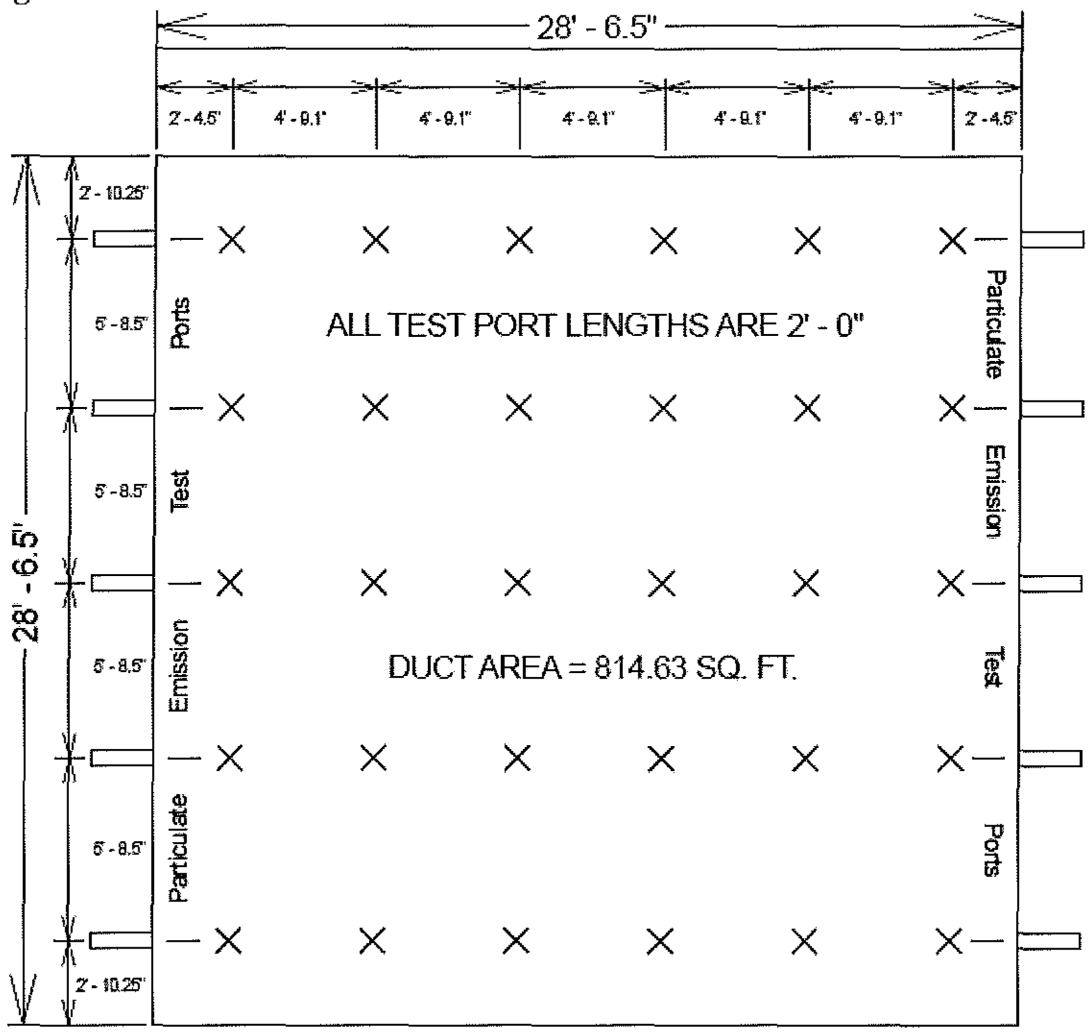
4.1.1 Sample Location and Traverse Points (USEPA Method 1)

The number and location of traverse points for determining exhaust gas velocity and volumetric air-flow was determined in accordance with USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources.* Five test ports are located in the horizontal plane on east and west side of the 28 feet 6.5 inch square duct. The duct has an equivalent duct diameter of 28 feet 6.5 inches. The ports are situated:

- Approximately 77.4 feet or 2.7 duct diameters downstream of a sound deadening silencer flow disturbance, and
- Approximately 22.4 feet or 0.8 duct diameters upstream of flow disturbance caused by a curve in the duct as it enters the exhaust stack.

The sample ports are 6-inches in diameter and extend 2 feet beyond the duct wall. The area of the exhaust duct was calculated and the cross-sectional area divided into a number of equal rectangular areas based on distances to air flow disturbances. Flue gas for particulate matter was sampled for two minutes at each of the traverse points accessed from the ten sample ports (3 traverse points were accessed from each test port located on the east and west sides of the duct) for a total of 30 sample points and 60 minutes. A drawing of the Unit 3 exhaust test port and traverse point locations is presented as Figure 4-1.

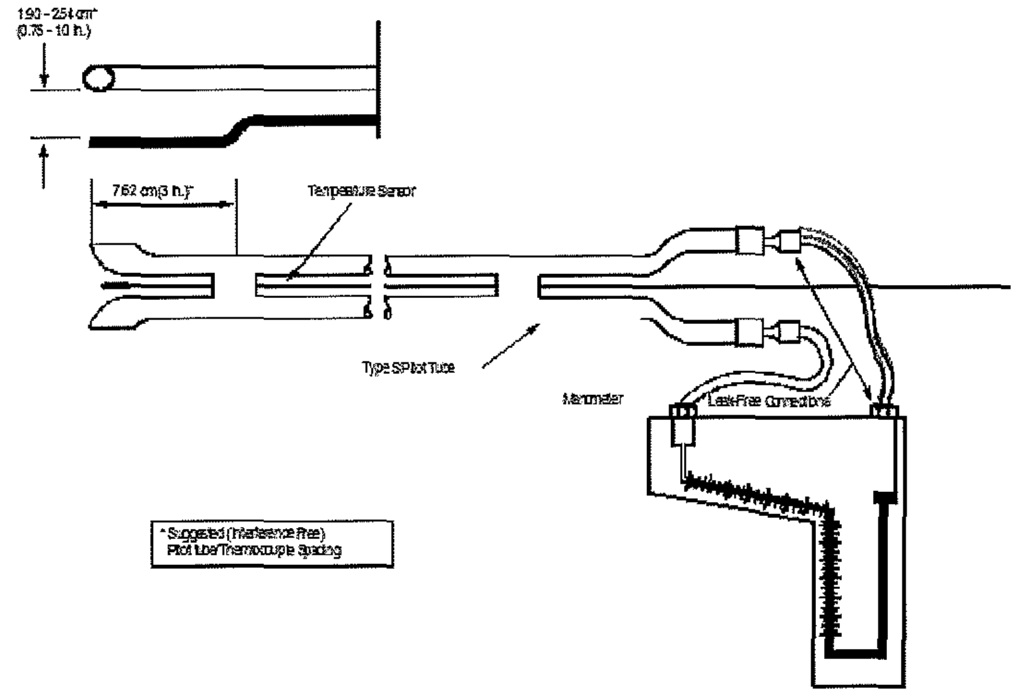
Figure 4-1. Unit 3 Duct Cross Section and Test Port/Traverse Point Detail



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 impact and negative static 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 nickel-chromium/nickel-alumel "Type K" thermocouple and a temperature indicator. Refer to Figure 4-2 for the Method 2 Pitot tube, thermocouple, and inclined oil-filled manometer configuration.

Figure 4-2. Method 2 Sample Apparatus



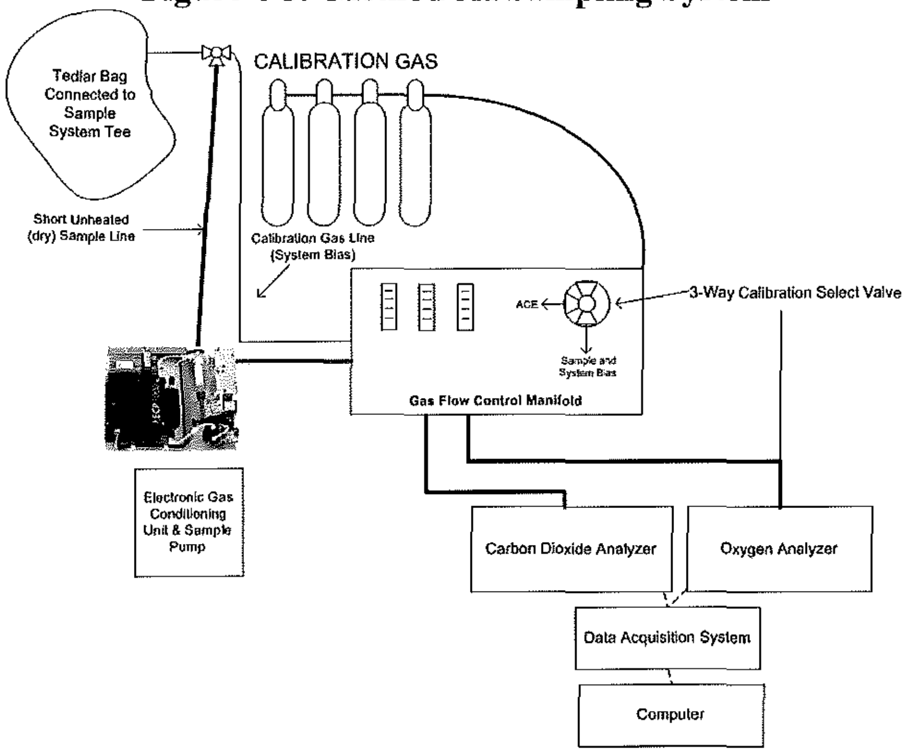
Appendix B of this report includes cyclonic flow test data as verification of the absence of cyclonic flow at the sample location. Method 1, § 11.4.2 states "if the average (null angle) is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology…must be used." The average null yaw angle measured at the Unit 3 exhaust on August 7, 2017 was observed to be 2.97°, thus meeting the less than 20° requirement.

4.1.3 Molecular Weight (USEPA Method 3A)

The exhaust gas composition and molecular weight was 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 flue gas oxygen and carbon dioxide concentrations were used to calculate molecular weight, flue gas velocity, emissions in lb/mmBtu, and/or lb/1,000 lbs corrected to 50% excess air.

Flue gas was extracted from the duct through a heated stainless steel lined probe and Teflon® sample line into a flexible sample bag. The sample was withdrawn from the flexible bag and conveyed through a gas conditioning system to remove water content before entering paramagnetic and infrared gas analyzers that measure oxygen and carbon dioxide concentrations. Figure 4-3 depicts the Method 3A sampling system.

Figure 4-3. Method 3A Sampling System



Prior to sampling flue gas, the analyzers were calibrated by performing a calibration error test where zero-, mid-, and high-level calibration gases are introduced 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. A system-bias and drift test was performed where the zero- and mid- or high- calibration gases are introduced at the inlet to the gas conditioner to measure the ability of the system to respond to within ±5.0 percent of span.

In lieu of performing a stratification test, the flexible bag samples were collected throughout the particulate matter tests at each of the 30 traverse points.

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 analyzers drift is 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 Appendix E for analyzer calibration supporting documentation.

4.1.4 Moisture Content (USEPA Method 4)

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

4.1.5 Particulate Matter (USEPA Method 5)

Filterable particulate matter samples were collected isokinetically by withdrawing a sample of the flue gas through a nozzle, heated probe, and filter following the procedures of USEPA Method 5 (RM5), *Determination of Particulate Matter Emissions from Stationary Sources.* USEPA Method 5 measures filterable particulate matter (aka PM, FPM) collected on a filter heated to 248±25°F.

The RM5 sampling apparatus was setup and operated in accordance with the method. The flue gas was passed through a nozzle, heated probe, quartz-fiber filter, and into a series of impingers with the configuration presented in Table 4-3. The filter collects filterable particulate matter while the impingers collect water vapor. Figure 4-4 depicts the USEPA Method 5 sampling train.

Table 4-3.
Method 5 Impinger Configuration

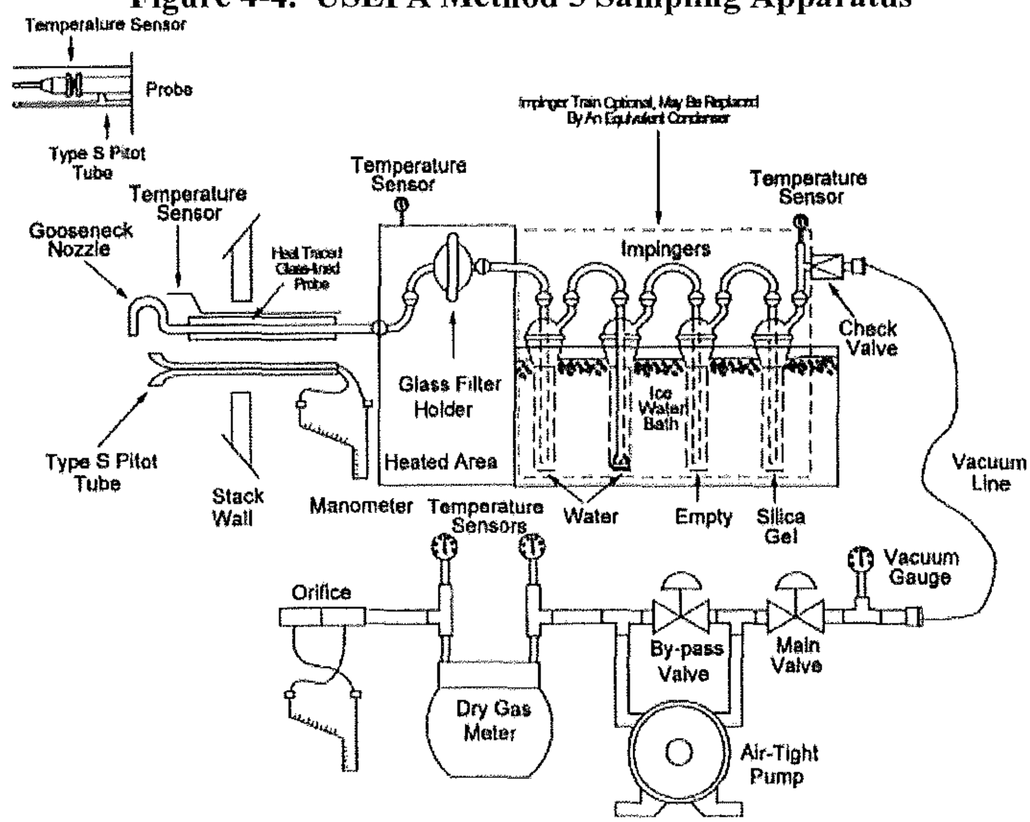
Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount (gram)
1	Modified	Water	100
2	Greenburg-Smith	Water	100
3	Modified	Empty	0
4	Modified	Silica gel desiccant	~200-300

Prior to testing, representative velocity head and temperature data were reviewed to calculate an ideal nozzle diameter that would allow isokinetic sampling to be performed. The diameter of the selected nozzle was measured with calipers across three cross-sectional chords and used to calculate its cross-sectional area. Prior to testing the nozzle was rinsed and brushed with deionized water and acetone, and connected to the sample probe.

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

Ice and water were placed around the impingers and the probe and filter temperature were allowed to stabilize to 248±25°F. After the desired operating conditions were coordinated with the facility, testing was initiated. Stack and sampling apparatus parameters (e.g., flue gas velocity head, filter temperature) were monitored to calculate and sample at the isokinetic rate within 100±10% for the duration of the test. Refer to Appendix B for field data sheets.

Figure 4-4. 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 4-5 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 4-6. Refer to Appendix C for laboratory data sheets.

Figure 4-5. USEPA Method 5 Sample Recovery Scheme

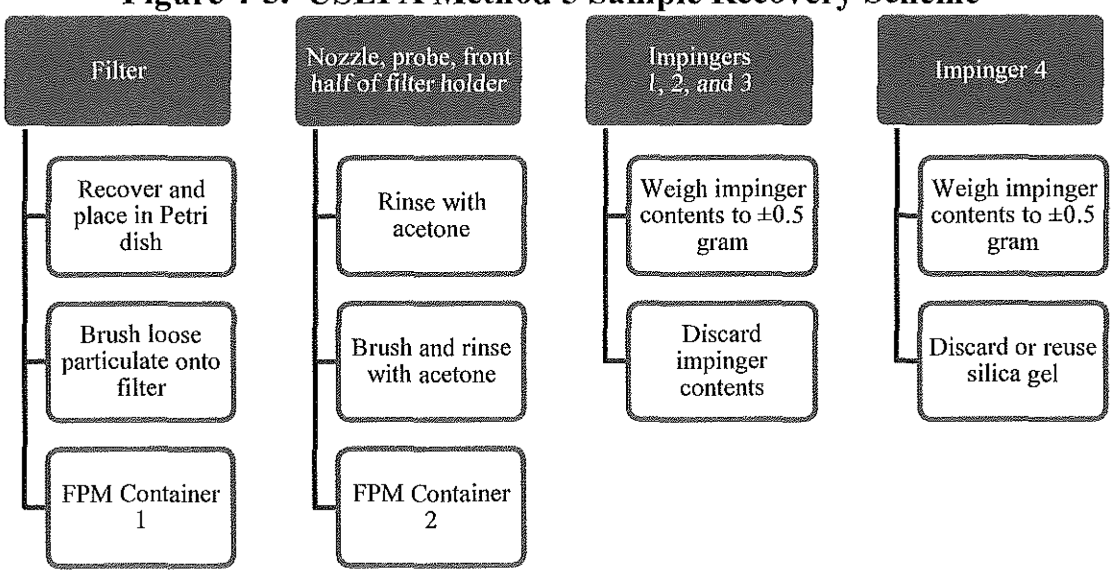
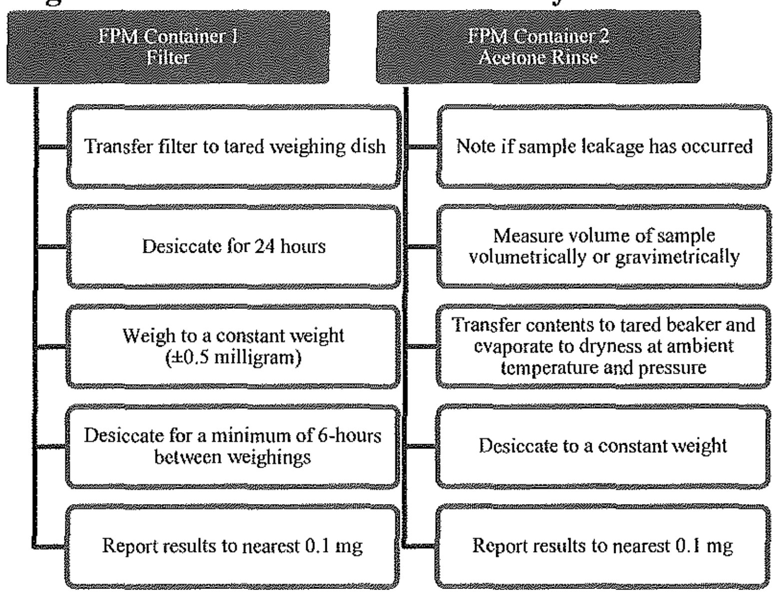


Figure 4-6. USEPA Method 5 Analytical Scheme



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 4-7 presents the equation used to calculate lb/mmBtu emission rate:

Figure 4-7. 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 1,840 scf CO_2/mmBtu for subbituminous coal from 40 CFR 75, Appendix F, Table 1
$\%CO_{2d}$	=	Concentration of carbon dioxide on a dry basis (%, dry)

The Unit 3 CEMS utilize the fuel factor provisions in 40 CFR Part 75, Appendix F, Section 3.3.6.5 whereby the worst case fuel factor for any of the fuels combusted in the unit is used to calculate lb/mmBtu emission rates. Refer to Appendix A for sample calculations.

5.0 TEST RESULTS AND DISCUSSION

The testing was performed to ensure the continued validity of the PM CEMS correlation curve via a relative response audit (RRA) as required in 40 CFR Part 63, Subpart 63.10010(i)(2)(i) utilizing Procedure 2—Quality Assurance Requirements for Particulate Matter Continuous Emission Monitoring Systems at Stationary Sources (40 CFR Part 60 Appendix F). Secondarily, the results were used to demonstrate compliance with PM limits in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013a.

The results of the testing indicate the individual and 3-run average PM results are in compliance with applicable limits and the PM CEMS met all criteria specified in Section 10.4(6) in Procedure 2 of 40 CFR 60 Appendix F.

5.1 VARIATIONS AND UPSET CONDITIONS

No sampling procedure or results affecting boiler operating condition variations were encountered during the test program. The process and control equipment were operating under routine conditions and no upsets were encountered.

It should be noted that midway through each test run, due to the duct size RCTS was required to reorient the sampling apparatus as the duct was traversed from both the east and west sides. The nozzle was rotated 180° and the positive and negative pitot line connections to the manometer were swapped. After which, a leak check was conducted on the sample train to ensure a system leak was not introduced. The volume of air passed through the DGM during this leak check due to pulling a vacuum, then allowing the sampling train to re-pressurize following the assessment, was subtracted from the volume of gas sampled by the DGM (Vm) used in emissions calculations. The values subtracted for each run are denoted as "Leak Check Total Volume (ft^3)" in the test run data sheets in Appendix B.

5.2 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.

5.3 Field Quality Assurance / Quality Control Procedures

The USEPA reference methods performed state reliable results are obtained by persons equipped with a thorough knowledge of the techniques associated with each method. Factors with the potential to cause measurement errors are minimized by implementing quality control (QC) and assurance (QA) programs into the applicable components of field testing. QA/QC components were included in this test program. Table 5-1 summarizes the primary field quality assurance and quality control activities that were performed. Refer to Appendix E for supporting documentation.

Table 5-1.
Quality Control Procedures

QC Specification	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 disturbance	Pre-test	≤2 diameters downstream; ≤0.5 diameter upstream.
M1: Duct diameter	Verify area of stack is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings
M3A: Calibration gas standards	Ensure accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty ≤2.0%
M3A: Calibration Error	Evaluates operation of analyzers	Calibration gases introduced directly into analyzers	Pre-test	±2% of the calibration span
M3A: System Bias and Analyzer Drift	Evaluates ability of sampling system to deliver stack gas to analyzers	Cal gases introduced at inlet of sampling system and into analyzers	Pre-test and Post-test	±5% of the analyzer calibration span for bias and ±3% of analyzer calibration span for drift

Table 5-1.
Quality Control Procedures

QC Specification	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	3 measurements agree within ±0.004 inch
M5: sample rate	Ensure representative sample collection	Calculate isokinetic sample rate	During and post-test	100±10% isokinetic rate
M5: sample volume	Ensure sufficient sample volume is collected	Record pre- and post-test dry gas meter volume reading	Post test	≥ 60 dscf (although not mandated, this volume was deemed necessary to ensure a particulate catch that could be accurately quantified)
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	DGM pre- and post-test; compare calibration factors (Y and Y_{qa})	Pre-test Post-test	±5 %

5.4 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.

5.4.1 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	0.2 mg	Sample volume was 150 milliliters. Acetone blank corrections of ~0.06 mg were applied.
Method 5 Laboratory Filter Blank	0.0 mg	Reporting limit is 0.1 milligrams.
Method 5 Field Filter Blank	0.0 mg	Reporting limit is 0.1 milligrams.

5.4.2 Audit Samples

Audit samples were not required for this test program.

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Table 1 - Particulate Matter Results

Facility and Source Information	Units	Run 1	Run 2	Run 3	Average
Customer:		J.H. Campbell Unit 3			
Source:		Unit 3 Common			
Work Order:		29436194			
Date:		8/8/2017	8/8/2017	8/8/2017	
Unit Load:	MW_g	881	883	883	882
Stack Length, L	inches	332.5	332.5	332.5	
Stack Width, W	inches	332.5	332.5	332.5	
Cross-sectional Area of Stack, A	ft^2	767.75	767.75	767.75	
Source Pollutant Test Data	**Units**	**Run 1**	**Run 2**	**Run 3**	**Average**
Barometric Pressure, P_{bar}	inches of Hg	29.54	29.57	29.60	29.57
Dry Gas Meter Calibration Factor, Y	dimensionless	1.003	1.003	1.003	1.003
Pitot Tube Coefficient, C_p	dimensionless	0.84	0.84	0.84	0.84
Stack Static Pressure, P_g	inches of H_2O	-0.20	-0.20	-0.20	-0.20
Nozzle Diameter, D_n	inches	0.320	0.320	0.320	0.320
Run Start Time	hr:mm	8:18	10:41	13:15	
Run Stop Time	hr:mm	9:51	12:21	14:51	
Duration of Sample, θ	minutes	60	60	60	60
Dry Gas Meter Leak Rate, L_p	cfm	0.000	0.000	0.000	0.000
Dry Gas Meter Start Volume	ft^3	32.55	104.45	173.50	103.50
Dry Gas Meter Final Volume	ft^3	104.04	173.09	247.67	174.93
Average Pressure Difference across the Orifice Meter, ΔH	inches of H_2O	4.87	4.55	5.22	4.88
Average Dry Gas Meter Temperature, T_m	°F	74.8	74.3	78.6	75.9
Average Square Root Velocity Head, √Δp	√inches H_2O	0.8385	0.8098	0.8645	0.8376
Stack Gas Temperature, $T_{s(abavg)}$	°F	222.0	221.6	221.7	221.8
Source Moisture Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Volume of Water Vapor Condensed in Silica Gel, $V_{wsg(std)}$	scf	0.8	0.9	1.3	1.0
Total Volume of Water Vapor Condensed, $V_{w(std)}$	scf	12.910	12.886	13.683	13.160
Volume of Gas Sample as Measured by the Dry Gas Meter, V_m	dcf	71.370	68.448	73.920	71.246
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, $V_{m(std)}$	dscf	70.596	67.783	72.814	70.398
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, $V_{m(std)}$	dscm	1.999	1.920	2.062	1.99
Moisture Content of Stack Gas, B_{ws}	% H_2O	15.46	15.97	15.82	15.75
Gas Analysis Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Carbon Dioxide, $\%CO_2$	%, dry	13.9	11.9	12.7	12.8
Oxygen, $\%O_2$	%, dry	5.5	7.3	6.5	6.4
Nitrogen, %N	%, dry	80.6	80.8	80.9	80.7
Dry Molecular Weight, M_d	lb/lb-mole	30.45	30.19	30.29	30.31
Wet Molecular Weight, M_s	lb/lb-mole	28.52	28.24	28.34	28.37
Percent Excess Air, %EA	%	34.83	52.41	43.56	43.60
Fuel F-Factor, F_o:	dimensionless	1.107	1.143	1.139	1.130
Fuel F-Factor, F_c:	scf/mmBtu	1,840	1,840	1,840	1,840
Gas Volumetric Flow Rate Data		**Run 1**	**Run 2**	**Run 3**	**Average**
Average Stack Gas Velocity, v_s	ft/s	54.2	52.6	56.0	54.2
Stack Gas Volumetric Flow Rate, Q	acfm	2,496,303	2,420,752	2,578,457	2,498,504
Stack Gas Standard Volumetric Flow Rate, Q_s	scfm	1,907,033	1,852,282	1,974,762	1,911,359
Stack Gas Dry Standard Volumetric Flow Rate, Q_{sd}	dscfm	1,612,213	1,556,399	1,662,373	1,610,329
Percent of Isokinetic Sampling, I	%	100.4	99.8	100.4	100.2
Gas Concentrations and Emission Rates		**Run 1**	**Run 2**	**Run 3**	**Average**
Mass of Filterable PM Collected, m_n	mg	3.95	1.53	1.13	2.20
Filterable PM Concentration, c_s	gr/dscf	0.00086	0.00035	0.00024	0.00048
Filterable PM Concentration at Stack Conditions, $c_{s@stack\ conditions}$	mg/wacm	1.277	0.513	0.353	0.714
Filterable PM Concentration, C_s [Actual Conditions, Wet Basis]	lb/1,000 lbs	0.001	0.001	0.000	0.001
Filterable PM Concentration, C_{s50} [Actual Conditions, Wet Basis]	lb/1,000 lbs @ 50% EA	0.001	0.001	0.000	0.001
Filterable PM Mass Emission Rate, E	lb/hr	11.92	4.64	3.40	6.65
Filterable PM, lb/mmBtu, E	lb/mmBtu	0.0016	0.0008	0.0005	0.0010
Filterable PM, tpy [Assumes 8,760 Hrs/Yr Operation]	tpy	52.20	20.32	14.91	29.14