Consumers Energy
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PM CEMS
Response Correlation Audit
Test Report
EUBOILER3

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

November 16, 2022

Test Dates: September 26 through 29, 2022

Test performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Department
Work Order No. 39545719
Version No.: 0

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EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter (PM) tests at the exhaust of coal-fired boiler EUBOILER3 (Unit 3) at the J.H. Campbell Plant in West Olive, Michigan. The test program, performed on September 26 through 29, 2022, evaluated the validity of the existing particulate matter (PM) continuous emissions monitoring system (CEMS) correlation by conducting a response correlation audit (RCA) as required by 40 CFR 63, Subpart UUUUU, *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units* (aka Mercury and Air Toxics Rule [MATS]), Section 63.10010(i)(2) and incorporated in Michigan Department of Environment, Great Lakes, and Energy (EGLE), Renewable Operating Permit (ROP) MI-ROP-B2835-2020b. The PM CEMS is used to demonstrate continuous compliance with EUBOILER3 filterable particulate matter (FPM) emission limits listed in the ROP.

Thirteen, 60-minute PM test runs were conducted following procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 2, 3A, 4, 5, and 19, in 40 CFR 60, Appendix A; Appendix B Performance Specification (PS) 11; and Appendix F, Procedure 2; and 40 CFR 63, Subpart UUUUU. There were no RM or other deviations from the Consumers Energy test protocol submitted July 26, 2022 and approved by EGLE on September 19, 2022.

The RM measurements were compared with simultaneous PM CEMS responses at three different levels of PM mass concentration achieved by means of PM spiking as described in PS-11, § 8.6 with Unit 3 firing 100% western subbituminous coal at normal operation conditions. The three levels of PM mass concentration were based on the maximum RM PM concentration of 12.841 milligrams/wet actual cubic meter (mg/wacm) used to develop the initial linear correlation as specified in 40 CFR 60, Appendix B – Procedure 2, §10.4(5) and PS 11 §8.6(4), with Level 1 (low) representing zero to 50 percent of maximum, Level 2 (mid) representing 25 to 75 percent, and Level 3 (high) 50 to 100 percent. The Unit 3 PM CEMS RCA results are shown in the following tables and graph.

Table E-1
Summary of PM CEMS RCA Results

Run	PM Concentration Level	Spiking Rate	PM CEMS Response	RM Result
		lb/hr	mg/wacm	
EUBOILER3			**Linear Correlation Curve: Y = 0.556X + 0.359**	
1	Low Level 1	0	0.001	0.430
2		0	0.030	0.971
3		0	0.016	1.041
4	Mid Level 2	50.33	2.851	3.814
5[a]	High Level 3	97.36	6.482	9.554
6	High Level 3	99.49	7.215	9.009
7	Mid Level 2	64.19	11.688	5.888
8	High Level 3	65.10	11.385	7.488
9		79.37	13.530	6.567
10		79.93	16.029	11.148
11	Low Level 1	62.69	17.109	4.363
12	Mid Level 2	49.88	13.640	6.421
13	High Level 3	59.96	15.654	7.323

[a]: Run 5 rejected and excluded from RCA

Figure E-1. PM CEMS Response Correlation Audit Curve and Results

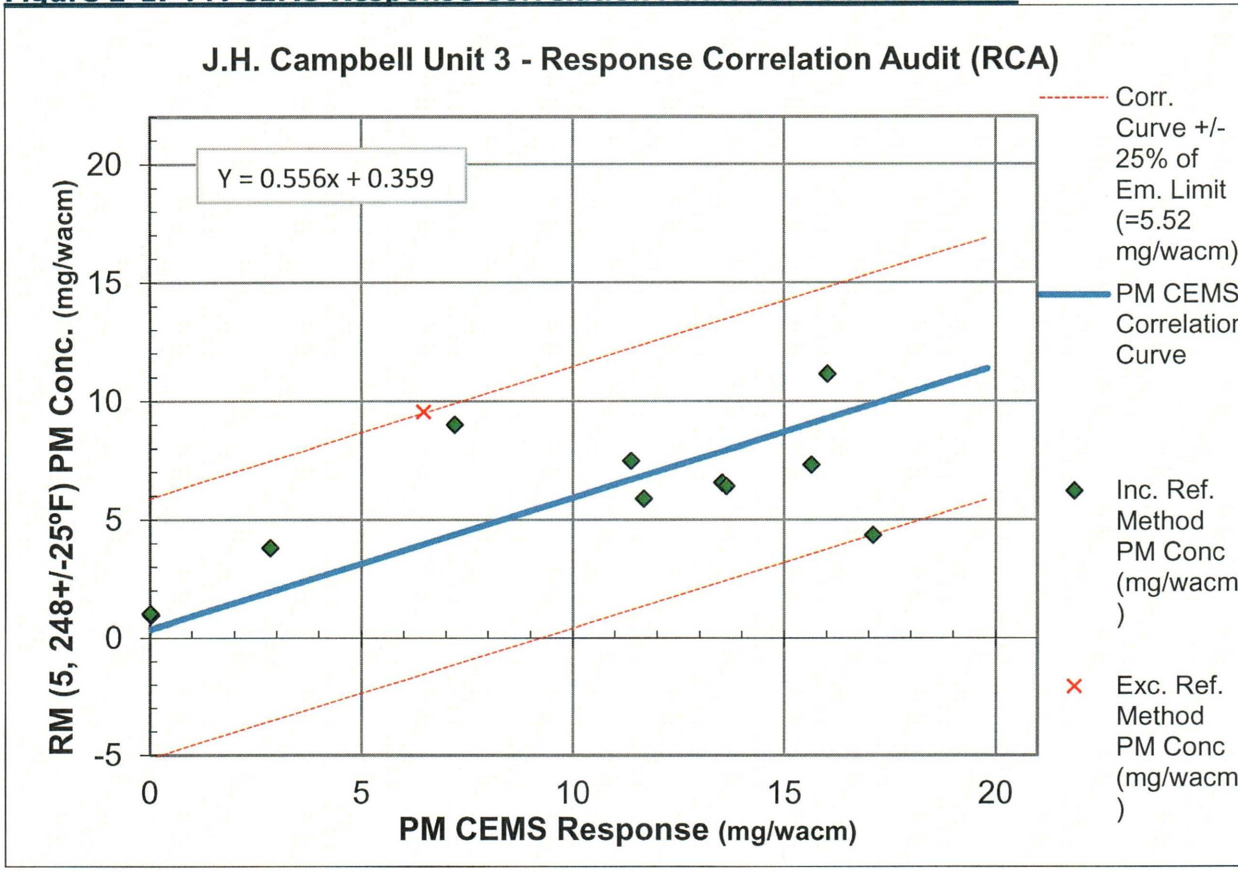

Table E-2
Summary of PM CEMS RCA Criteria and Results

Regulation	Section	Criteria	Result
40 CFR 60, Appendix F – Procedure 2	10.4(5)(i)	For all 12 data points, the PM CEMS response value can be no greater than the greatest PM CEMS response value used to develop the correlation curve (19.818 mg/wacm).	**PASS:** All 12 PM CEMS responses were ≤ 19.818 mg/wacm measured during initial correlation. A maximum PM CEMS response of 17.109 mg/wacm was measured during Run 11.
	10.4(5)(ii)	At least 75% of a minimum number of 12 sets of PM CEMS and reference measurements must fall within a specified area on a graph of the correlation regression line. The specified area on the graph of the correlation regression line is defined by two lines parallel to the correlation regression line, offset at a distance of ±25% of the numerical emission limit value from the correlation regression line. When assessing PM CEMS performance in relation to the "emissions limit," the MATS limit of 0.030 lb/mmBtu is used (expressed as an equivalent mg/wacm concentration, at 22.07 mg/wacm).	**PASS:** 100% of the 12 of the RCA data points fall within ±25% of the emission limit relative to the applicable correlation curve. Also, note that none of the PM CEMS responses were lower than the lowest PM CEMS response (0.000 mg/wacm) for the existing correlation. Therefore, it was not necessary to extend the regression line.

The results of the testing indicate the PM CEMS met the criteria specified in §10.4(5) in Procedure 2 of 40 CFR 60, Appendix F, and supports the continued validity of the PM CEMS correlation to continuously determine compliance with emission standards and/or operating permit limits.

Detailed results are presented within the Appendix Tables section of this report. Sample calculations, field data sheets, and laboratory data are presented in Appendices A, B, and C. Boiler operating data and supporting documentation are provided in Appendices D and E.

1.0 INTRODUCTION

This report summarizes the results of the particulate matter (PM) continuous emission monitoring system (CEMS) response correlation audit (RCA) conducted September 26 through 29, 2022 on EUBOILER3 operating at the Consumers Energy J.H. Campbell Plant in West Olive, Michigan.

This document was prepared using the Michigan Department of Environment, Great Lakes, and Energy (EGLE) *Format for Submittal of Source Emission Test Plans and Reports* published in November of 2019. Please exercise due care if portions of this report are reproduced, as critical substantiating documentation and/or other information may be omitted or taken out of context.

1.1 Identification, Location, and Dates of Tests

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable PM tests at the dedicated exhaust of coal-fired boiler EUBOILER3 (Unit 3) operating at the J.H. Campbell Generating Station in West Olive, Michigan on September 26 through 29, 2022.

A test protocol was submitted to the EGLE on July 26, 2022 and subsequently approved by Ms. Lindsey Wells, Environmental Quality Analyst with EGLE, in her letter dated September 19, 2022.

1.2 Purpose of Testing

The test program was performed to evaluate the continued validity of the PM CEMS correlation curve by conducting a Response Correlation Audit (RCA) as required by 40 CFR 63, Subpart UUUUU, *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units* (aka Mercury and Air Toxics Rule [MATS]) and incorporated in Renewable Operating Permit (ROP) MI-ROP-B2835-2020b.

The criteria to pass an RCA described in Section 10.4(5) of Procedure 2 are listed in Table 1-1 below.

Table 1-1
Criteria for Passing an RCA

Regulation	Section	Criteria
40 CFR 60, Appendix F – Procedure 2	10.4(5)(i)	For all 12 data points, the PM CEMS response value can be no greater than the greatest PM CEMS response value used to develop the correlation curve (19.818 mg/wacm).
	10.4(5)(ii)	At least 75% of a minimum number of 12 sets of PM CEMS and reference measurements must fall within a specified area on a graph of the correlation regression line. The specified area on the graph of the correlation regression line is defined by two lines parallel to the correlation regression line, offset at a distance of ±25% of the numerical emission limit value from the correlation regression line. When assessing PM CEMS performance in relation to the "emissions limit," the MATS limit of 0.030 lb/mmBtu is used (expressed as an equivalent mg/wacm concentration, at 22.07 mg/wacm).

1.3 Brief Description of Source

EUBOILER3 is a coal fired electric utility steam generating unit (EGU) that operates as needed to provide electricity to the regional grid and Consumers Energy customers.

1.4 Contact Information

Table 1-2 presents the names, addresses, and telephone numbers of the contacts for information regarding the test and the test report, and names and affiliation of personnel involved in conducting the testing.

Table 1-2
Contact Information

Program Role	Contact	Address
EPA Regional Contact	Compliance Tracker, ECA-18J Air Enforcement and Compliance Assurance Branch	U.S. EPA Region 5 77 W. Jackson Blvd. Chicago, Illinois 60604
State Technical Programs Supervisor	Mr. Jeremy Brown Acting TPU Supervisor 517-599-7825 brownj9@michigan.gov	EGLE – Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Technical Programs Field Inspector	Ms. Lindsey Wells Technical Programs Unit 517-282-2345 wellsL8@Michigan.gov	EGLE – Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S 525 W. Allegan Lansing, Michigan 48933
State Regulatory Inspector	Ms. Kaitlyn DeVries Environmental Quality Analyst 616-558-0552 devriesk1@michigan.gov	EGLE – Grand Rapids District Office 350 Ottawa Avenue NW; Unit 10 Grand Rapids, Michigan 49503
Responsible Official	Mr. Nathan J Hoffman Plant Business Manager 616-738-5436 nathan.hoffman@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Facility	Mr. Kevin Starken Sr. Engineer II 616-738-3241 kevin.starken@cmsenergy.com	
	Mr. Joe Mason Senior Technician / Environmental 616-738-3278 joe.mason@cmsenergy.com	
Corporate Environmental Coordinator	Mr. Michael Gruber II Sr. Engineer II 989-891-5580 michael.gruberii@cmsenergy.com	Consumers Energy Company D.E. Karn Generating Plant Karn-Weadock Admin Bldg (KWP-100) 2742 N Weadock Highway Essexville, Michigan 48732
Corporate Environmental Coordinator	Ms. Kathryn Ross Principal Environmental Analyst 517-788-0648 kate.ross@cmsenergy.com	Consumers Energy Company Parnall Office (P20-215B-REM) 1945 W. Parnall Road Jackson, Michigan 49201Parnall Office
Test Team Representative	Mr. Thomas Schmelter, QSTI Sr. Engineering Technical Analyst 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460
Ash Injection Representative	Mr. Ralph Bard Software and Integration Specialist 919-790-9090 ralph@b3systems.com	B3 Systems, Inc. 3208 Spottswood St.; Suite 106 Raleigh, North Carolina 27615

2.0 SUMMARY OF RESULTS

2.1 Operating Data

During the performance test, the boiler fired 100% western subbituminous coal and was operated at normal process conditions. The testing was performed while the boiler operated within an average load range of 591 MWg to 600 MWg.

Note that for RCA testing of PM CEMS, there is no regulatory operating unit load requirement. Instead, the stipulated requirement is to obtain three distinct levels of PM concentration. There was no manipulation of the boiler control devices to simulate elevated PM concentrations. Rather, B3 Systems Inc. of Raleigh, North Carolina was contracted to inject representative fly ash into the boiler exhaust gases, just downstream of the fabric filters. Fly ash injection rates ranged between approximately 50 and 100 lbs/hr.

Refer to Appendic C for a B3 Systems Inc. report detailing the per run PM spiking levels and Appendix D D for detailed operating data. The data is recorded in Eastern Standard Time (EST).

2.2 Applicable Permit Information

The J.H. Campbell generating station has the State of Michigan Registration Number (SRN) B2835 and operates in accordance with air permit MI-ROP-B2835-2020b, including the enduring performance, operation, maintenance, and control technology requirements that originated in Consent Decree (CD), Civil Action No.: 14-13580, which was terminated on September 2, 2020. The air permit incorporates federal regulations and reports under Facility Registry Service (FRS) identification number 110000411108.

EUBOILER3 source is the emission unit identification in the permit. EUBOILER3 is also identified within the FGMATS_U3 flexible group conditions. 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.

The PM CEMS is used to evaluate compliance with the MATS PM limit of 0.030 lb/mmBtu and the ROP PM emission limit of 0.015 lb/mmBtu that originated in Consent Decree.

2.3 Results

The results of the testing indicate the PM CEMS met the criteria specified in §10.4(5) in Procedure 2 of 40 CFR 60, Appendix F, and supports the validity of the existing PM CEMS correlation to continuously determine compliance with emission standards and/or operating permit limits.

Refer to Table 2-1 for a summary of the PM RM results and PM CEMS responses. Refer to Table 2-2 for a summary of the overall PM CEMS RCA results and Figure 2-1 for a plot of the data in relation to the existing correlation.

Table 2-1
Summary of PM CEMS RCA Results

Run	PM Concentration Level	Spiking Rate	PM CEMS Response	RM Result
		lb/hr	mg/wacm	
EUBOILER3		Linear Correlation Curve: Y = 0.556X + 0.359		
1	Low Level 1	0	0.001	0.430
2		0	0.030	0.971
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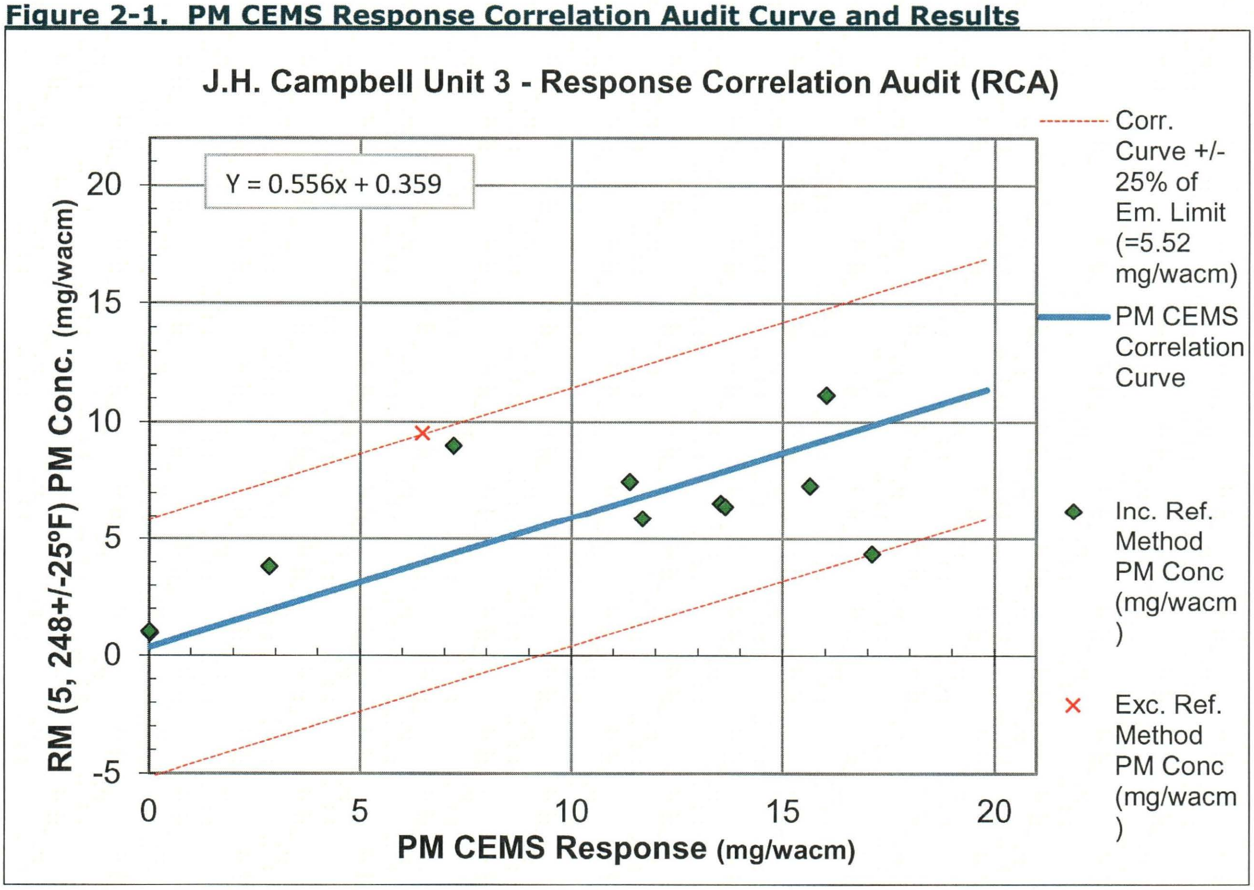

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Detailed results are presented within the Appendix Tables section of this report. A discussion of the results is presented in Section 5.0. Sample calculations, field data sheets, and laboratory results are presented in Appendices A, B, and C. Boiler 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

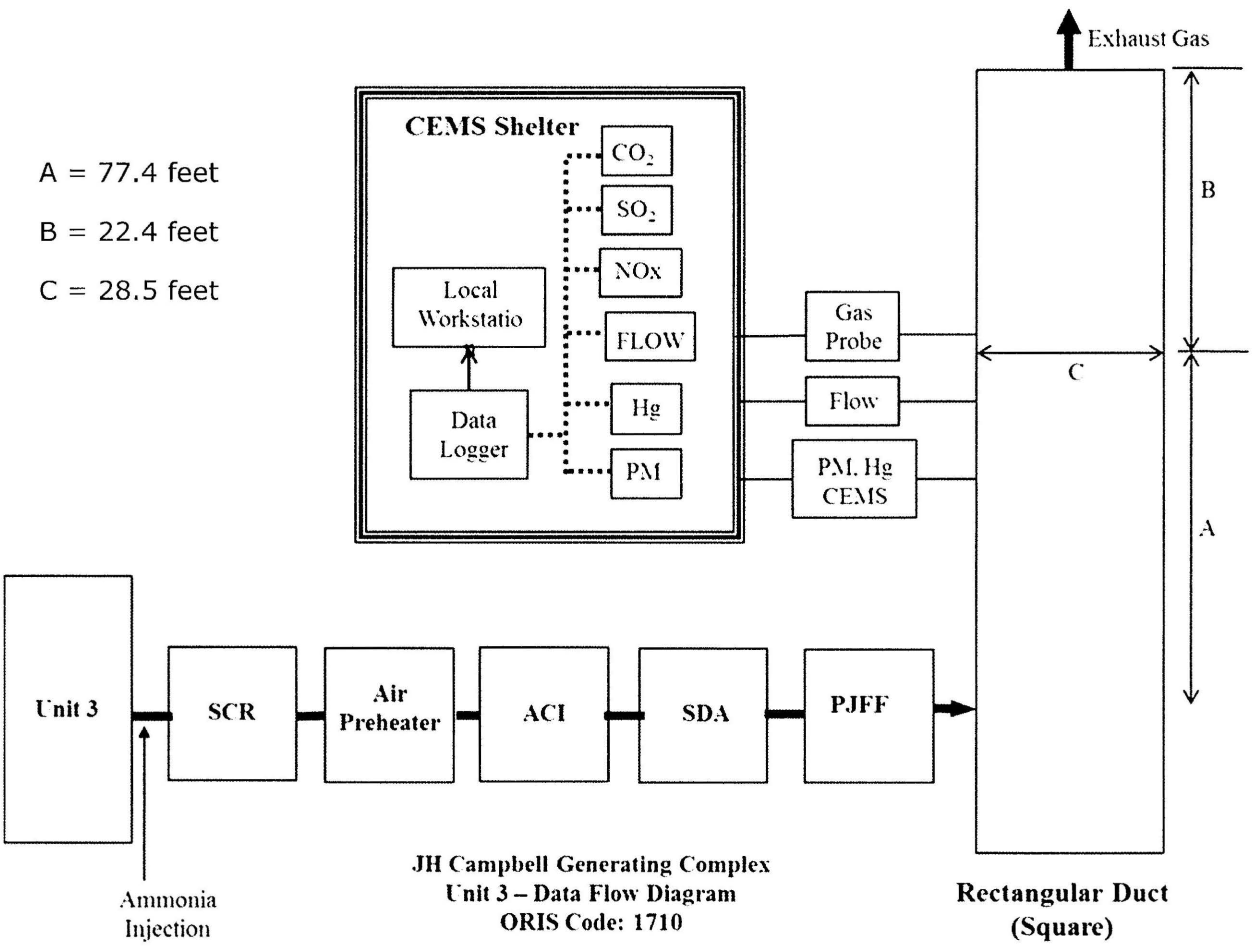
Unit 3 is a dry bottom wall-fired boiler for which construction began in 1974 and which combusts pulverized subbituminous coal as the primary fuel, bituminous coal as the secondary fuel, and oil as an ignition/flame stabilization fuel. The source classification codes (SCC) for Unit 3 are 10100222, 10100202, and 10100501, respectively.

Coal is fired in the furnace where the combustion heats boiler tubes containing water, producing steam. The steam is used to turn a 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 control of Nitrogen Oxides (NO_x), activated carbon injection (ACI) for mercury (Hg) control, four spray dry absorbers (SDAs) 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. J.H. Campbell 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.

Particulates removed by the PJFF were collected and reinjected downstream of this control device during testing. The material was collected in 55-gallon drums and added to a weigh hopper connected to a pneumatic conveyance system used to introduce the particles downstream of the PJFF and upstream of the induced draft air fans. The rate of material injection was set to achieve distinct levels of particulate concentrations measured by the PM CEMS and RM sampling systems as specified in PS-11 Section 8.6(4)(iii). The three levels of particulate matter concentrations were:

- Level 1 (low): 0-50% of maximum PM concentration;
- Level 2 (mid): 25-75% of the maximum PM concentration; and
- Level 3 (high): 50-100% of the maximum PM concentration.

According to a document entitled, "Frequently Asked Questions for PS 11 and Procedure 2," issued by USEPA and dated September 16, 2016, the term "maximum PM concentration" corresponds to the maximum RM test run result achieved during the testing. Further clarification from the EPA's Emissions Measurement Center indicates that for the RCA, the "maximum PM concentration" is based on the maximum RM concentration associated with the initial correlation curve, not the maximum RM concentration observed during the RCA. The maximum PM concentration measured during the initial correlation curve was 12.841 mg/wacm. Refer Appendix C for the PM Spiking Report prepared by B3 Systems, Inc.

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 to meet the electrical demands of Midcontinent Independent System Operator, Inc. (MISO) and Consumers Energy's 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:

- CO_2 (Vol-%)
- NO_x (Vol-ppm)
- SO_2 (Vol-ppm)
- Load (MWg)
- Flowrate (KSCFH)
- Pressure (in Hg)
- Temperature (°F)
- Opacity (%)
- PM CEMS raw response (mg/wacm)

Refer to Appendix D for operating data.

The facility measured particulate concentrations using a SICK Dusthunter SP100 PM CEMS system with data recorded by an ESC Spectrum (ESC) data acquisition and handling system (DAHS). Table 3-1 provides a summary of the PM CEMS audited during this test program.

Table 3-1
PM CEMS Specifications

Unit	Manufacturer and Model Number	Serial Number
EUBOILER3	SICK Dusthunter SP100	15308348

4.0 SAMPLING AND ANALYTICAL PROCEDURES

RCTS tested for PM 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	Method	USEPA Title
Sample/traverse point locations	1	Sample and Velocity Traverses for Stationary Sources
Flow rate	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	5	Determination of Particulate Matter Emissions from Stationary Sources
Emision Rates	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 (2022)	Run	Sample Type	Start Time	Stop Time	Test Duration (min)	EPA Test Method	Comment
Sept. 26	1	Flow rate O_2/CO_2 Moisture PM	9:15	11:11	60	1 3A 4 5 19	Baseline condition tests, no ash injection
	2		11:45	13:33			
	3		14:02	15:36			
Sept. 27	4		7:54	9:33			Ash injection of ~50 lbs/hr
	5		12:50	14:20			Ash injection of ~100 lbs/hr
	6		16:01	18:31			Ash injection of ~100 lbs/hr
Sept. 28	7		8:00	9:24			Ash injection of ~65 lbs/hr
	8		9:45	11:26			Ash injection of ~65 lbs/hr
	9		12:45	14:09			Ash injection of ~80 lbs/hr
	10		14:42	16:22			Ash injection of ~80 lbs/hr
Sept. 29	11		7:08	8:33			Ash injection of ~63 lbs/hr
	12		8:55	10:36			Ash injection of ~50 lbs/hr
	13		12:05	13:51			Ash injection of ~60 lbs/hr

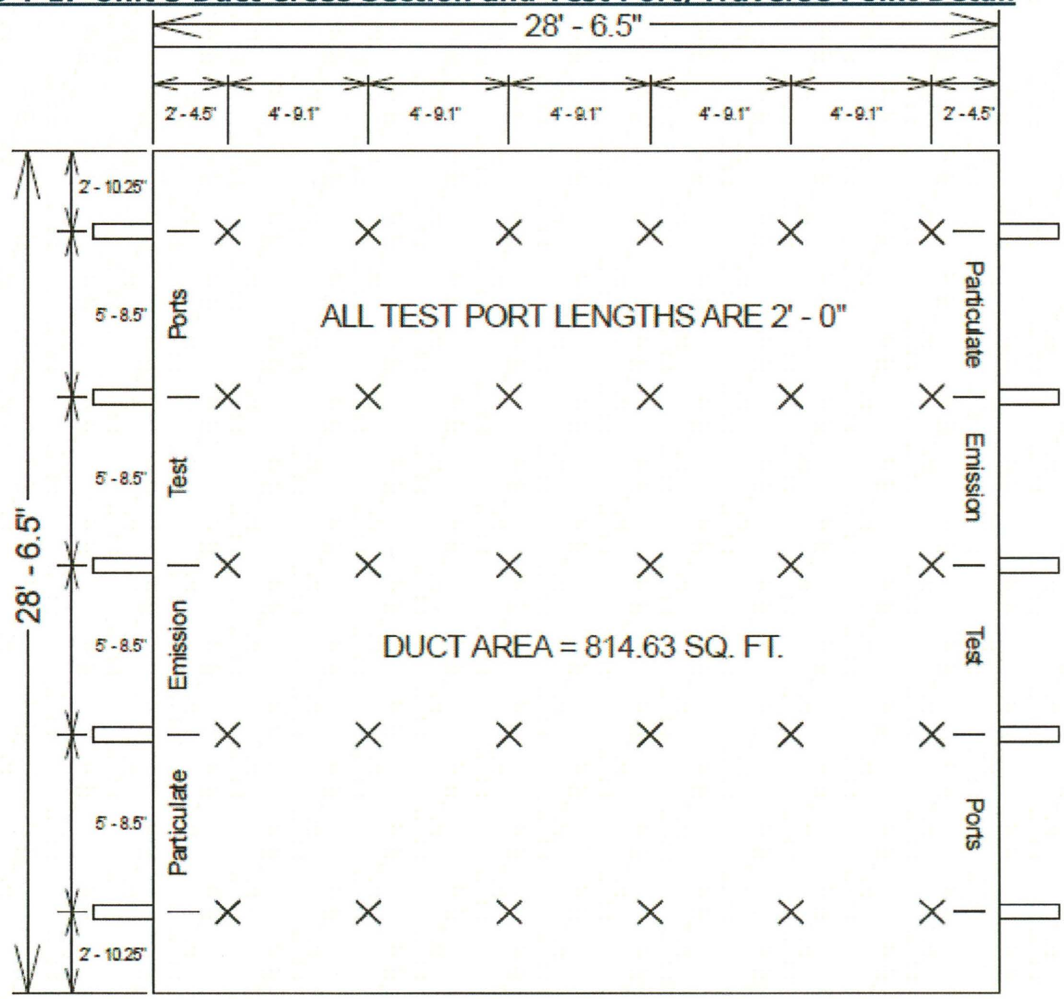
4.1.1 Sample Location and Traverse Points (USEPA Method 1)

The number and location of traverse points for determining exhaust gas velocity and volumetric airflow was determined in accordance with USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources.* Five test ports are in the horizontal plane on the 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. As shown in Figure 3-1, the reference method sampling location is situated approximately:

- 77.4 feet or 2.7 duct diameters downstream of a sound deadening silencer flow disturbance, and
- 22.4 feet or 0.8 duct diameters upstream of a flow disturbance caused by a curve in the duct as it enters the vertical 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 several 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. Three 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 test duration of 60 minutes. A drawing of the Unit 3 exhaust test port and traverse point locations is presented as Figure 4-1.

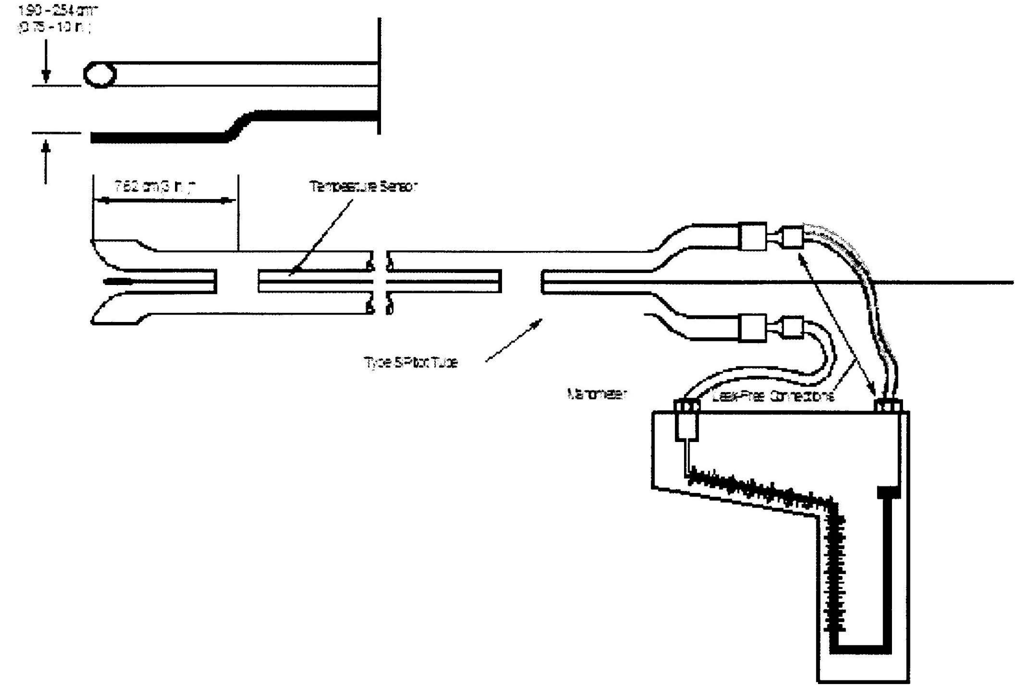
Figure 4-1. Unit 3 Duct Cross Section and Test Port/Traverse Point Detail



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



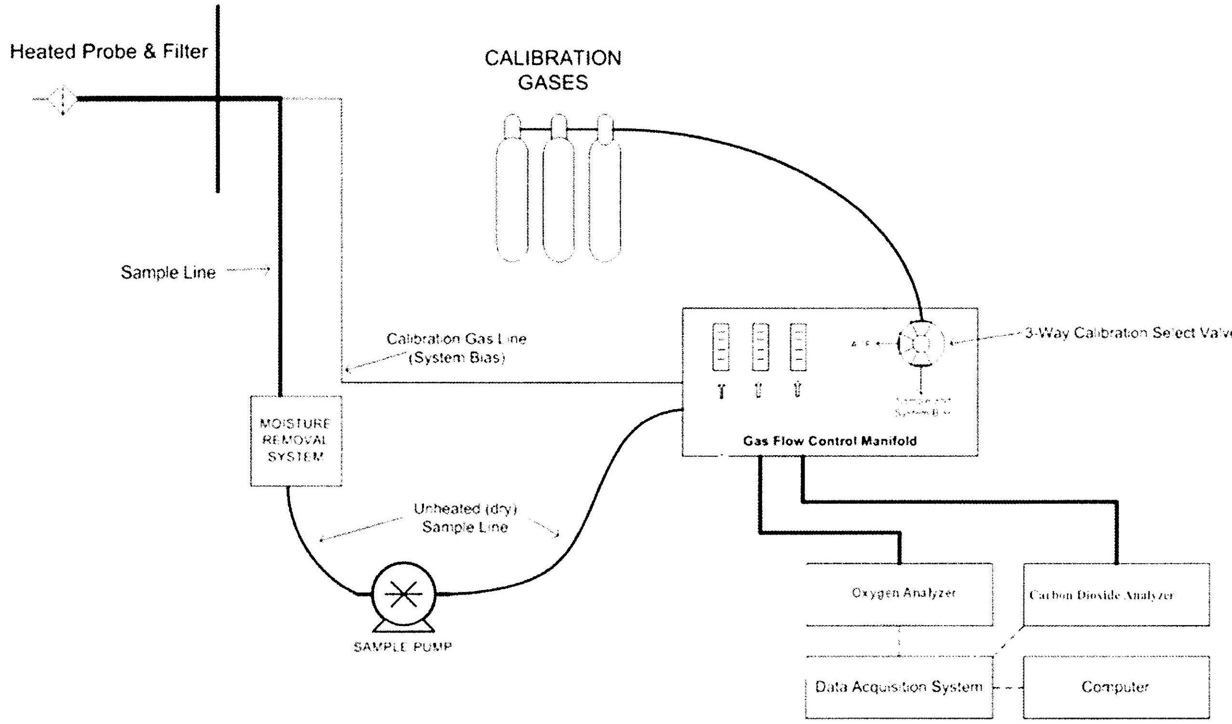
Appendix B of this report includes cyclonic flow test data as verification of the absence of cyclonic flow at the sample location. Method 1, § 11.4.2 states "if the average (null angle) is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology…must be used." 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. In the absence of ductwork and/or stack configuration changes, this null angle information is considered valid and additional cyclonic flow verification was not performed.

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 method 3A sample line was attached to the method 5 sample probe to collect O_2 and CO_2 concentrations at each of the 30 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, gas flow control manifold, and paramagnetic and infrared gas filter correlation gas analyzers. Figure 4-3 depicts the Method 3A sampling system.

Figure 4-3. 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 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 pre-weighed filter following the procedures of USEPA Method 5, *Determination of Particulate Matter Emissions from Stationary Sources.*

In a letter received from USEPA on April 12, 2016, in response to a February 10, 2016 request by Consumers Energy, USEPA has approved the use of USEPA Method 5 (probe and filter temperature set points at 248±25°F) as an alternative to MATS 5 (probe and filter temperature set points at 320±25°F) to avoid having to conduct compliance tests using multiple test methods. Documentation of this approval was included as an attachment to the test notice and provided in Appendix E.

In the Method 5 sampling apparatus 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 collected filterable particulate matter while the impingers collected water vapor and/or condensable particulate matter. Figure 4-4 depicts the USEPA Method 5 sampling apparatus.

Table 4-3
USEPA Method 5 Impinger Configuration

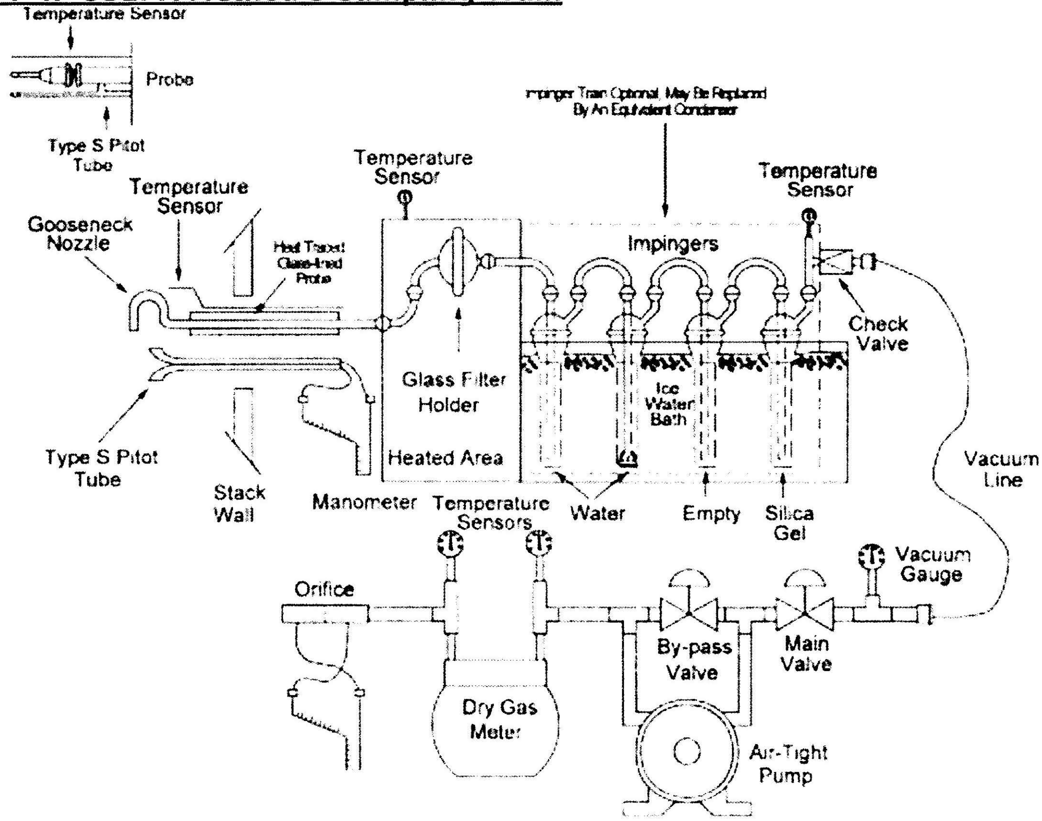
Impinger Order (Upstream to Downstream	Impinger Type	Impinger Contents	Amount (gram)
1	Modified	Water	~100
2	Greenburg-Smith	Water	~100
3	Modified	Empty	-
4	Modified	Silica Gel Desiccant	~200-300

Before testing, representative flow data from previous measurements were reviewed to calculate an ideal nozzle size that allowed isokinetic sampling to be performed. A pre-cleaned nozzle that had an inner diameter that approximates the calculated value was measured with calipers across three cross-sectional chords, rinsed and brushed with 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 opening and applying a vacuum of approximately 15 inches of mercury. The dry-gas meter was monitored for approximately 1 minute to verify the sample apparatus 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.

Ice and water were placed around the impingers and the probe, and filter temperatures were allowed to stabilize to a temperature of 248±25°F before sampling. After the desired operating conditions were coordinated with the facility, testing was initiated. Stack and sampling apparatus parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate to within 100±10 % for the duration of the test.

Figure 4-4. USEPA Method 5 Sampling Train



Due to the size and configuration of the Unit 3 duct, 3 traverse points were accessed from each test port located on the east and west sides of the duct, using a hoist system. After commencing sampling on the east or west side of the duct, the sampling apparatus was positioned atop the duct where a mid-test leak check was performed. The mid-test leak check evaluated the system for leaks, validated the first half of the test run, and allowed the nozzle to be rotated 180° to resume sampling in the east or west side of the duct. The volume of air associated with the mid-test leak check was deducted from the overall test run sample volume based on the start and end dry gas meter volume readings.

At the conclusion of a test run and the post-test leak check, the sampling train 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 and 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, were 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 blanks were transported to the laboratory for analysis. The sample analysis followed USEPA Method 5 procedures as summarized in the sample analytical scheme presented in Figure 4-6.

Figure 4-5. USEPA Method 5 Sample Recovery Scheme

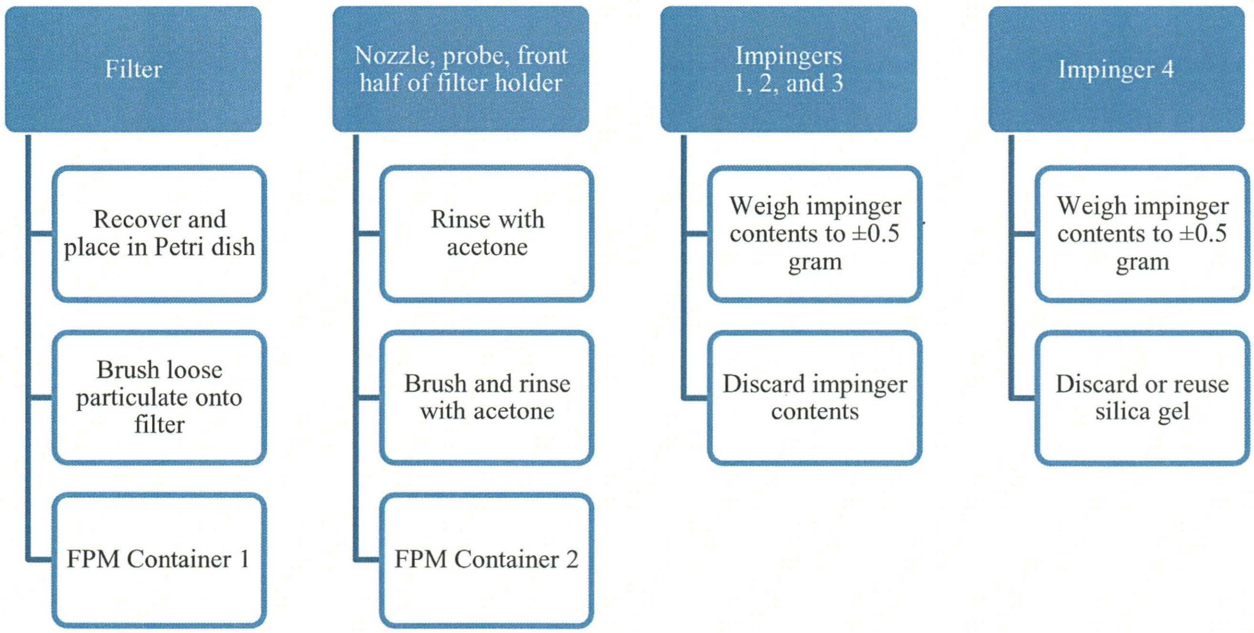
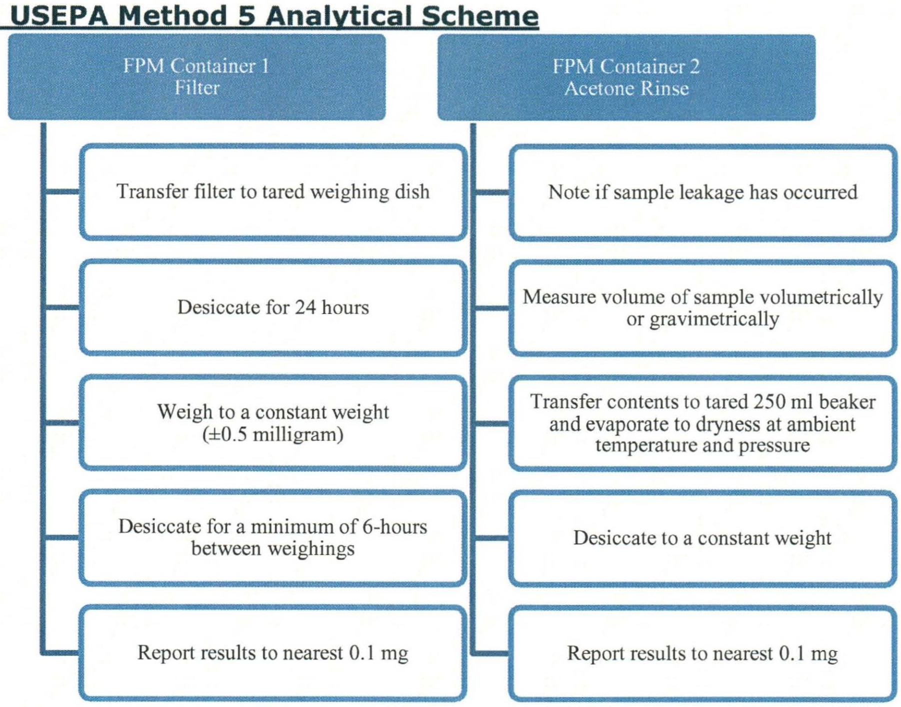


Figure 4-6. USEPA Method 5 Analytical Scheme



4.1.6 Emision 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 lb/mmBtu emission rates. Measured CO_2 and pollutant concentrations and F factors (ratios of combustion gas volume to heat input) were used to calculate emission rates using equation 19-6 from the method.

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, ($scf\ CO_2$/mmBtu)
$\%CO_{2d}$	=	Concentration of carbon dioxide on a dry basis (%, dry)

An F_c factor of 1840 scf CO_2/mmBtu for sub-bituminous coal was used to calculate RM lb/mmBtu emission rates. Refer to Appendix A for a calculation summary presenting the calculations used in this report.

5.0 TEST RESULTS AND DISCUSSION

The PM CEMS audit was performed on September 26 through 29, 2022 to evaluate the continued validity of the existing PM CEMS correlation curve by conducting an RCA as required by 40 CFR 63, Subpart UUUUU, *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units* (aka Mercury and Air Toxics Rule [MATS]), Section 63.10010(i)(2)(ii) and incorporated in MI-ROP-B2835-2020b.

The results of the testing indicate the PM CEMS met the criteria specified in §10.4(5) in Procedure 2 of 40 CFR 60, Appendix F, and supports the continued validity of the PM CEMS correlation to continuously determine compliance with emission standards and/or operating permit limits.

5.1 Tabulation of Results

Table 2-1 in Section 2 of this report summarizes the results, and the Appendix Tables contain detailed tabulations of results, process operating conditions (i.e., boiler load), and exhaust gas conditions.

Appendix D contains a summary table for the CEMS related information that was collected, including CO_2 (Vol-%), NO_x (Vol-ppm), SO_2 (Vol-ppm), Load (MWg), exhaust gas flowrate (KSCFH), stack pressure (in Hg), stack temperature (°F), opacity (%), and PM CEMS raw response (mg/wacm). Tables with 1-minute averages for the preceding parameters are presented for each test run, along with the test run averages. When arriving at the test run averages, 1-minute data associated with port changes have been excluded.

When comparing the start and stop times between the RM test runs and the CEMS data, note that the last minute of the CEMS run average data is one minute ahead of the RM run end time. This is due to a difference in reporting convention, where the end minute recorded for each RM run reflects when the last reading was taken, but not the last minute during which sampling occurred. For example, the times for RM Run 1 are listed as 9:15-11:11. While the last RM Run 1 value was recorded at 11:12, the last full minute of sampling was 11:11.

5.2 Significance of Results

The PM CEMS RCA results support the continued validity of the existing PM CEMS correlation; therefore, the PM CEMS linear correlation equation of Y = 0.556X + 0.359 will remain the same. Ongoing PM CEMS data assessment via implementation of the QC program incorporating 40 CFR 60, Appendix F, Procedure 2 requirements will be performed. In accordance with 40 CFR 63.10010(i)(2), a subsequent PM CEMS RCA will be performed at least once every three years (i.e., once every 12 calendar quarters).

5.3 Variations from Sampling or Operating Conditions

To present test data on a consistent basis, O_2 and CO_2 (diluent) concentrations, boiler operating parameters, and PM CEMS concentrations were averaged according to PM sampling start and stop times, omitting sample port changes. No variations from sampling or operating conditions were encountered; however, the diluent RM concentrations measured appear to differin comparison to the facilty CO_2 CEMS.

Review of diluent concentration data suggests ambient air was pulled into the sample path for RM Runs 4 through 13. The cause of inleakage is unknown; however, it is suspected that an intermittent leak within the M3A sampling system and/or sampling of ambient air before and/or after sample port changes were contributing factors. The impact of these diluent errors on the RCA result is negligible, as diluent concentrations are not used to calculate mg/wacm PM concentrations, which is the basis to evaluate the PM CEMS correlation curve.

With respect to the calculated PM lb/mmBtu emission rates, it is clear that O_2 was biased high, while CO_2 was biased low. As presented in Section 4.1.6, the lb/mmBtu emission rates were calculated via Equation 19-6 utilizing CO_2 concentrations. As the CO_2 concentration is in the denominator of the calculation, any systematic low bias in CO_2 concentrations would result in a corresponding high bias in the PM lb/mmBtu emission rates. Again, this is immaterial to the outcome of the RCA, and compliance with the applicable PM emission limits is based upon the PM CEMS data, not the discrete RM testing.

No other sampling or operating condition variations were encountered during the test program.

5.4 Process or Control Equipment Upset Conditions

The boiler and associated control equipment were operating under routine conditions and no upsets were encountered during testing. To limit emissions fluctuations, the boiler load, activated carbon injection rate, and spray dry absorbers were operated in steady-state configurations.

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 equipment 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. The next required PM CEMS RCA test event will be conducted within 12 calendar quarters, with the potential for a 720 operating hour grace period (not to exceed one calendar quarter).

5.7 Results of Audit Samples

5.7.1 Performance Audit Sample

A performance audit (PA) sample (if available) for each test method employed is required, unless waived by the administrator for regulatory compliance purposes as described in 40 CFR 63.7(c)(2)(iii). A PA sample consists of blind audit sample(s), as supplied by an accredited audit sample provider (AASP), which are analyzed with the performance test samples to provide a measure of test data bias. Currently, a particulate matter performance audit sample(s) is not available for USEPA Method 5.

5.7.2 Reference Method Audits

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.

5.8 Calibration Sheets

Calibration sheets, including dry gas meter, gas protocol sheets, nozzle and Pitot tube inspection sheets are presented in Appendix E. Analyzer quality control and assurance check information is presented in Appendix B, along with the field sheet information.

5.9 Sample Calculations

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

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M1: Sampling Location	Evaluates 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	Verifies area of stack/duct is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings
M2: Pitot tube calibration and standardization	Verifies construction and alignment of Pitot tube	Inspect Pitot tube, assign coefficient value	Pre-test and after each field use	Method 2 alignment and dimension requirements
M3A: Calibration gas standards	Ensures accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty ≤2.0%
M3A: Calibration Error	Evaluates operation of analyzers	Introduce calibration gas directly into analyzers	Pre-test	±2.0% of the calibration span

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M3A: System Bias and Analyzer Drift	Evaluates analyzer and sample system integrity and accuracy	Calibration gas introduced at the probe, upstream of all sample conditioning components	Pre-test and Post-test	Bias: ±5.0% of calibration span Drift: ±3.0% of calibration span
M3A: Multi-point integrated sample	Ensure representative sample collection	Insert probe into stack and purge sample system	Pre-test	Collect samples at traverse points
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	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: Apparatus Temperature	Ensures purge of acid gases in probe and on filter	Set probe & filter heat controllers to 248°F±25°F	Verify prior to and during each run	Apparatus temperature must be 248°F±25°F
M5: Post-test leak check	Evaluate if system leaks biased the sample	Cap sample train; monitor DGM	Post-test	≤0.020 cfm
M5: post-test meter audit	Evaluates sample volume accuracy	DGM pre- and post-test; compare calibration factors (Y and Yqa)	Pre-test Post-test	±5%

5.10 Field Data Sheets

Field data sheets are presented in Appendix B.

5.11 Laboratory Quality Assurance / Quality Control Procedures

The method specific quality assurance and quality control procedures in each method employed during this test program were followed, without deviation. 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 analysis are presented in the Table 5-3. Laboratory QA/QC and blank results data are contained in Appendix C.

Table 5-3
QA/QC Blanks

Sample Identification	Result	Comment
Method 5 Acetone Blank	6.3 mg	Sample volume was 200 milliliters. Acetone blank corrections of 0.16 to 0.42 mg were applied; these were less than 0.001% of the weight of the acetone rinse.