Consumers Energy

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PM and CPM Test Report

EUBOILER1

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

November 25, 2020

Test Dates: October 6 and 7, 2020

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 36035036
Version No.: 0

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EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter (PM) and condensable particulate matter (CPM) testing at the single dedicated exhaust of coal-fired boiler EUBOILER1 (Unit 1), an electric utility steam generating unit (EGU) making steam to turn a turbine and generate electricity at the J.H. Campbell Plant in West Olive, Michigan. The test program was performed on October 6 and 7, 2020.

The purpose of the testing was to satisfy requirements and evaluate compliance with limits in Michigan Department of Environment, Great Lakes and Energy (EGLE) Permit No. MI-ROP-B2835-2020a, including the enduring performance, operation, maintenance and control technology requirements based from a federal Consent Decree (CD), Civil Action No.: 14-13580, which was terminated on September 2, 2020.

Triplicate 125-minute FPM and CPM test runs were conducted following the procedures in USEPA Reference Methods (RM) 1, 2, 3A, 4, 5, and 19 in 40 CFR 60, Appendix A and RM 202 in 40 CFR 51, Appendix M. During each test, Unit 1 fired 100% western coal and operated within the maximum normal operating load representative of site specific normal operations as specified in 40 CFR §63.10007(2). There were no deviations from the approved stack test protocol or the USEPA Reference Methods therein. The Unit 1 FPM and CPM results are summarized in the following table.

Table E-1
Executive Summary of Test Results

Parameter	Units	Run			Average	Emission Limit
		1	2	3		
FPM	lb/1000 lb exhaust gas corrected to 50% excess air	0.002	0.001	0.001	0.001	**0.16**
	lb/mmBtu	0.0020	0.0008	0.0010	0.0013	**0.015†**
CPM	lb/mmBtu	0.0106	0.0060	0.0124	0.0097	**None**

lb/mmBtu: pound per million British thermal unit heat input
† The emission limit represents both the CD as well as the applicable qualifying emission limit for MATS low emitting EGU (LEE) status (non-LEE limit is 0.030 lb/mmBtu), however MATS compliance testing is not due until 2022.

The Unit 1 FPM emission results meet the applicable emission limits in MI-ROP-B2835-2020a and satisfy the requirement to verify PM emission rates every three years. The FPM results also comply with the 0.015 lb/mmBtu CD limit, and with emissions less than 0.010 lb/mmBtu, Unit 1 continues to qualify for the reduced test frequency incentive in paragraph 153 of the CD, reducing the annual FPM and CPM testing requirement to every other year.

The CPM results in this report were not used to determine PM emission rate compliance but are provided for informational purposes per Paragraph 156 in the CD which states: *The results of the PM stack test conducted pursuant to this Paragraph 156 shall not be used for the purpose of determining compliance with the PM Emission Rates required by this Consent Decree.*

Detailed test results are presented in Appendix Table 1. 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 compliance filterable particulate matter (PM or FPM) and condensable particulate matter (CPM) testing conducted October 6 and 7, 2020 on EUBOILER1 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) Air Quality Division, *Format for Submittal of Source Emission Test Plans and Reports* published in November of 2019. 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 PM and CPM tests at the dedicated exhaust of coal-fired boiler EUBOILER1 (Unit 1) operating at the J.H. Campbell Generating Station in West Olive, Michigan on October 6 and 7, 2020.

A test protocol was submitted to EGLE on September 18, 2020 and subsequently approved by Mr. Matt Karl, Environmental Quality Analyst, in his letter dated September 30, 2020. Mr. Karl's approval letter stated that a separate fuel sample must be taken and analyzed for each day of testing. However, via e-mail on October 7, 2020, he indicated using the Method 19 default fuel factor for subbituminous coal as described in the Test Protocol was acceptable and collection and analysis of a fuel sample each day of testing was not required.

1.2 PURPOSE OF TESTING

The purpose of the testing was to satisfy requirements and evaluate compliance with limits in Michigan Department of Environment, Great Lakes and Energy (EGLE) Permit No. MI-ROP-B2835-2020a, including the enduring performance, operation, maintenance and control technology requirements based from a federal Consent Decree (CD), Civil Action No.: 14-13580, which was terminated on September 2, 2020.

The Unit's PM emission limits and testing requirements are listed in Table 1-1.

Table 1-1
EUBOILER1 PM Emission Limits and Testing Requirements

Parameter	Emission Limit	Units	Applicable Requirement	Current Testing Frequency
Filterable PM	0.16	lb/1000 lb exhaust gas corrected to 50% excess air	MI-ROP-B2835-2020a, Section C, EUBOILER1 I.1	Once every 3 years*
	0.015†	lb/mmBtu	MI-ROP-B2835-2020a, Section C, EUBOILER1 I.5 MI-ROP-B2835-2020a, Appendix 5 U.S. V Consumers Energy Company, Civil Action 14-13580, E.D. Mich., 2014, paragraph 144 and 153	Biennial (once every 2 years, if qualify, otherwise Annually)

Table 1-1
EUBOILER1 PM Emission Limits and Testing Requirements

Parameter	Emission Limit	Units	Applicable Requirement	Current Testing Frequency
	0.030	lb/mmBtu	MI-ROP-B2835-2020, Section D, FGMATS_U12 I.1 Table 2 to Subpart UUUUU of Part 63—Emission Limits for Existing EGU's	Triennial (Quarterly when not qualifying as LEE)
Condensable PM	None	lb/mmBtu	U.S. V Consumers Energy Company, Civil Action 14-13580, E.D. Mich., 2014, paragraph 156; the results of the CPM tests shall not be used for the purpose of determining compliance with PM emission rates required by the CD.	Biennial (once every 2 years, if qualify, otherwise Annually)

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

* Unless more frequently pursuant to an agency request.

† The emission limit represents both the CD as well as the applicable qualifying emission limit for MATS low emitting EGU (LEE) status (non-LEE limit is 0.030 lb/mmBtu), however MATS compliance testing is not due until 2022.

1.3 Brief Description of Source

EUBOILER1 is a coal-fired EGU that operates on a continuous basis to provide baseload electricity to the regional grid and Consumers Energy customers.

1.4 Contact Information

Table 1-2 presents the names, addresses, and telephone numbers for contacts involved in this test program.

Table 1-2
Contact Information

Program Role	Contact	Address
EPA Regional Contact	Mr. Ethan Chatfield Environmental Engineer 312-886-5512 chatfield.ethan@epa.gov	U.S. EPA Region 5 77 W. Jackson Blvd. (AE-17J) Chicago, IL 60604
State Regulatory Administrator	Ms. Karen Kajiya-Mills Technical Programs Unit Manager 517-335-4874 kajiya-millsk@michigan.gov	EGLE Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Technical Programs Field 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
Corporate Air Quality Contact	Mr. Michael E. Gruber Senior Engineer II 989-891-5580 michael.gruberII@cmsenergy.com	Consumers Energy Company Environmental Services– Air Quality 2742 N. Weadock Hwy Essexville, MI 48732

Table 1-2
Contact Information

Program Role	Contact	Address
Corporate Air Quality Contact	Ms. Kate Ross Senior Environmental Analyst 517-788-0648 kate.ross@cmsenergy.com	Consumers Energy Company Environmental Services Department 1945 West Parnall Road; P22-231 Jackson, Michigan 49201
Test Facility	Mr. Kevin Starken Sr. Engineer II 616-738-3241 kevin.starken@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Facility	Mr. Roger Vargo Senior Technician 616-738-3270 roger.vargo@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Team Representative	Mr. Thomas Schmelter, QSTI Engineering Technical Analyst 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460
Laboratory	Mr. Clayton Johnson Project Manager – Air Toxics 905-817-5769 cjohnson@maxxam.ca	Maxxam Analytics 6740 Campobello Road Mississauga, Ontario L5N 2L8
Laboratory	Mr. Dillon King, QSTI Sr. Engineering Tech. Analyst 989-891-5585 dillon.king@cmsenergy.com	Consumers Energy Company D.E. Karn Generating Complex 2742 N. Weadock Highway, ESD Trailer #4 Essexville, Michigan 48732

2.0 SUMMARY OF RESULTS

2.1 Operating Data

The boiler fired 100% western coal during the test event and operated at a maximum normal load range of 244 to 245 gross megawatts (MWg), which represents approximately 89% of the 274 MWg rated output. The boiler load was restricted during the test program due to a governor valve issue at the turbine. 40 CFR §63.10007(2) describes maximum normal operating load as generally between 90 and 110 percent of design capacity but should be representative of site specific normal operations during each test run. The Consent Decree requires testing to be performed under representative operating conditions not including periods of startup, shutdown, or malfunction. The boiler was operated in accordance with the applicable requirements during this test program.

Refer to Attachment D for detailed operating data, which like the RM tests data, was recorded in Eastern Standard Time (EST).

2.2 Applicable Permit Information

The J.H. Campbell generating station identifies with State Registration Number (SRN) B2835 and operates in accordance with renewable operating permit (ROP) MI-ROP-B2835-2020a. The ROP incorporates State and Federal air regulations, including the applicable MATS Rule requirements as well as the enduring performance, operation, maintenance, and control technology requirements based from a federal Consent Decree (CD), Civil Action No.: 14-13580, which was terminated on September 2, 2020.

The permit identifies EUBOILER1 as an emission unit within the flexible group designation FGBOILER12 and FGMATS_U12. The facility is also associated with Federal Registry Service (FRS) Id: 110000411108.

2.3 Results

Table 2-1 presents a summary of the FPM and CPM test results.

Table 2-1
Summary of Test Results

Parameter	Units	Run			Average	Emission Limit
		1	2	3		
FPM	lb/1000 lb exhaust gas corrected to 50% excess air	0.002	0.001	0.001	**0.001**	**0.16**
	lb/mmBtu	0.0020	0.0008	0.0010	**0.0013**	**0.015†**
CPM	lb/mmBtu	0.0106	0.0060	0.0124	**0.0097**	**None**

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

† This emission limit represents both the CD as well as the applicable qualifying emission limit for low emitting EGU (LEE) status (non-LEE limit is 0.030 lb/mmBtu), however MATS compliance testing is not due until 2022.

The Unit 1 FPM emission results meet the applicable emission limits in MI-ROP-B2835-2020a and satisfy the requirement to verify PM emission rates every three years. The FPM results also comply with the 0.015 lb/mmBtu CD limit with emissions less than 0.010 lb/mmBtu, therefore Unit 1 continues to qualify for the reduced test frequency incentive in paragraph 153 of the CD, reducing the annual FPM and CPM testing requirement to every other year.

The CPM results in this report were not used to determine PM emission rate compliance but are provided for informational purposes per Paragraph 156 in the CD which states: *The results of the PM stack test conducted pursuant to this Paragraph 156 shall not be used for the purpose of determining compliance with the PM Emission Rates required by this Consent Decree.*

Detailed test results are presented in Appendix Table 1. 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.

3.0 SOURCE DESCRIPTION

EUBOILER1 is a coal-fired EGU that turns a turbine connected to an electricity-producing generator.

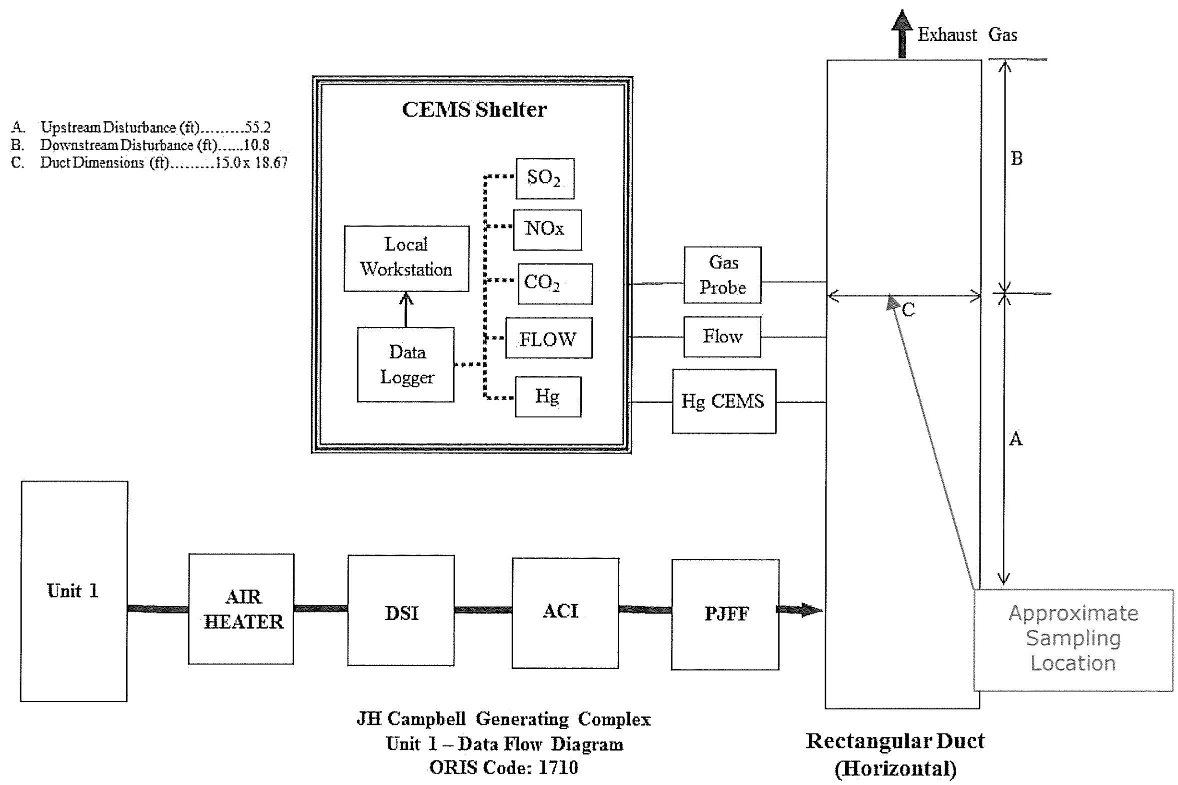
3.1 Process

Unit 1 is a dry bottom tangentially fired boiler, classified as an existing unit under MATS, which combusts pulverized subbituminous coal as the primary fuel and oil as an ignition/flame stabilization fuel. The source classification code (SCC) is 10100226. Coal is fired in the furnace where the combustion heats water within boiler tubes producing steam. The steam turns 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

The flue gas generated through coal combustion is controlled by multiple pollution control devices. The unit is currently equipped with low nitrogen oxides (NO_x) burners (LNB) over fire air (OFA) for NO_x control, a dry sorbent (lime) injection (DSI) system for control of sulfur dioxides (SO_2) and other acid gasses, an activated carbon injection (ACI) system for mercury (Hg) reduction, and a pulse jet fabric filter (PJFF) baghouse to control FPM emissions. Post control flue gas exhausts to atmosphere through an approximately 400-foot high stack shared with EUBOILER2. Refer to Figure 3-1 for the Unit 1 Data Flow Diagram.

Figure 3-1. Unit 1 Data Flow Diagram



Note: DSI injection lances can be utilized either upstream or downstream of the air heater inlet. For this test, injection was post air heater.

3.3 Materials Processed

The Unit 1 boiler is classified as a coal-fired unit not firing low rank virgin coal as described in Table 2 to 40 CFR 63, Subpart UUUUU. Unit 1 fired 100% western subbituminous coal during this test.

3.4 Rated Capacity

Unit 1 has a nominal rated heat input capacity of 2,490 mmBtu/hr and an upper boundary range of operation of 300 MWg, however, the rated capacity is dependent on the coal being fired and boiler conditions. The maximum achievable capacity firing 100% western coal is approximately 274 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. EUBOILER1 is considered a baseload unit because it is designed to operate 24 hours a day, 365 days a year.

3.5 Process Instrumentation

Boiler operators, environmental technicians, and data acquisition systems continuously monitored the process during testing. One-minute data for the following parameters were collected during each FPM and CPM test run:

- Wet CO_2 (Vol-%)
- Gross Electrical Output Load (MWg)
- Opacity (%)

Due to the various instrumentation systems, the sampling times were correlated to instrumentation times on Eastern Standard Time (EST). During the test program, Eastern Daylight Time (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

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
Emission rates	19	Sulfur Dioxide Removal and Particulate, Sulfur Dioxide and Nitrogen Oxides from Electric Utility Steam Generators
Condensable particulate matter	202	Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources

4.1 Description of Sampling Train and Field Procedures

The test matrix presented as Table 4-2 summarizes the sampling and analytical methods performed as specified in this test program.

Table 4-2
Test Matrix

Date 2020	Run	Sample Type	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
Oct. 6	1	Flow rate, O2/CO2, Moisture FPM, CPM	7:24	9:53	125	1 2 3A 4 5 19 202	Isokinetic sampling from 25 traverse points collected 2.39 dscm of sample volume to meet 1.70 dscm CD requirement
	2		10:33	12:53	125		Isokinetic sampling from 25 traverse points collected 2.43 dscm of sample volume to meet 1.70 dscm CD requirement
Oct. 7	3		7:15	9:33	125		Isokinetic sampling from 25 traverse points collected 2.40 dscm of sample volume to meet 1.70 dscm CD requirement

4.1.1 Sample Location and Traverse Points (USEPA Method 1)

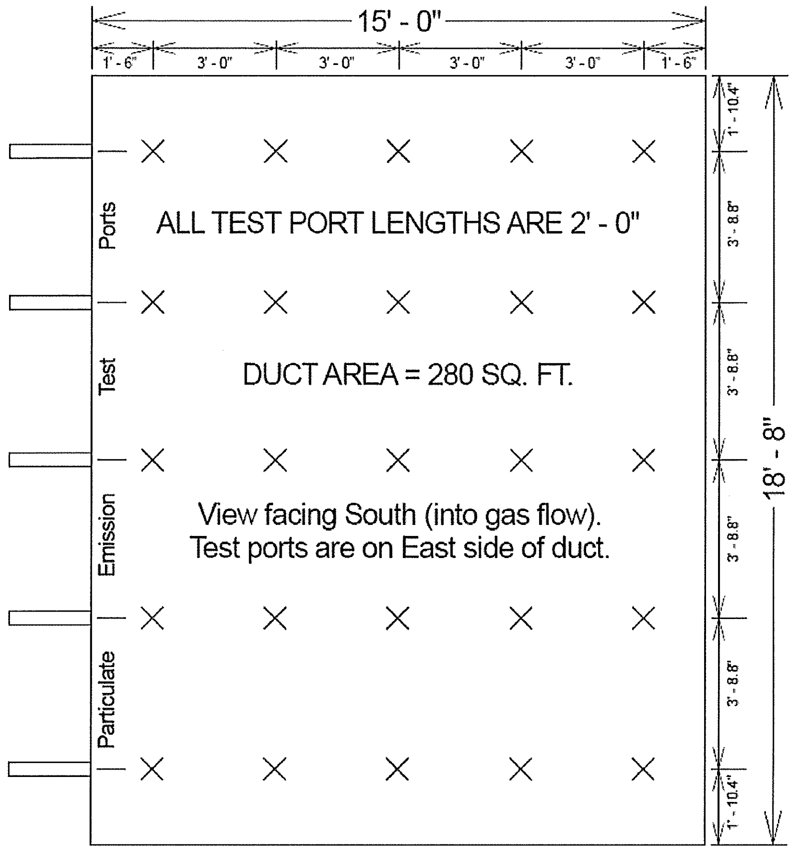
The number and location of traverse points for measuring exhaust gas velocity and volumetric airflow was determined in accordance with USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources.* Five test ports are located in the horizontal plane on east side of the 15 feet by 18 feet 8-inch rectangular duct. The duct has an equivalent duct diameter of 16 feet 7.6 inches. Refer to Figure 3-1 for a drawing showing the upstream and downstream disturbances. The sampling ports are situated:

- Approximately 55.2 feet or 3.3 duct diameters downstream of a duct diameter change flow disturbance, and

- Approximately 10.8 feet or 0.6 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 24 inches beyond the stack 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 was sampled for five minutes at each of the five traverse points from the five sample ports for a total of 25 sample points and 125 minutes. A drawing of the Unit 1 exhaust test port and traverse point locations is presented as Figure 4-1.

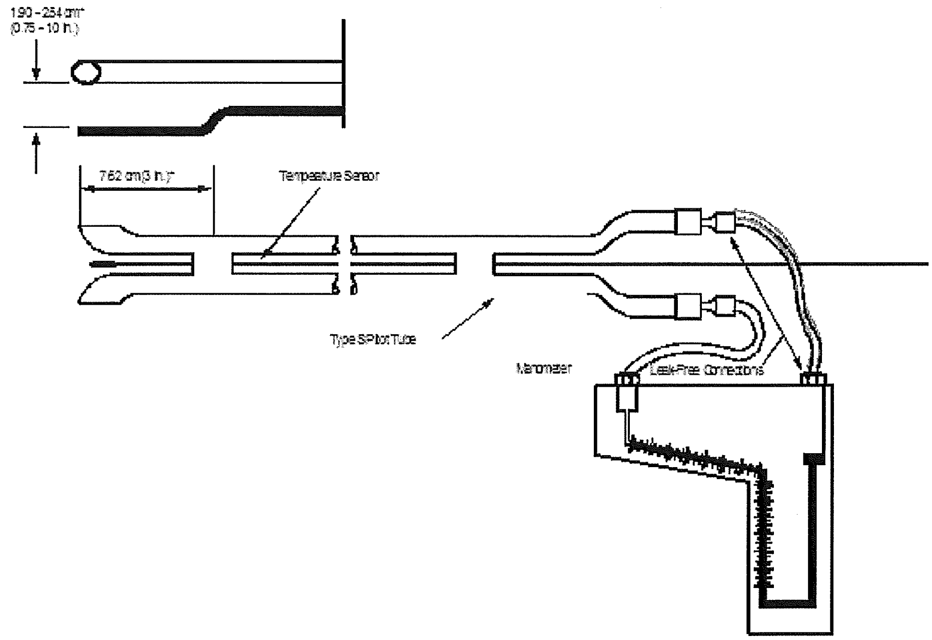
Figure 4-1. Unit 1 Duct Cross Section and Test Port/Traverse Point Detail



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



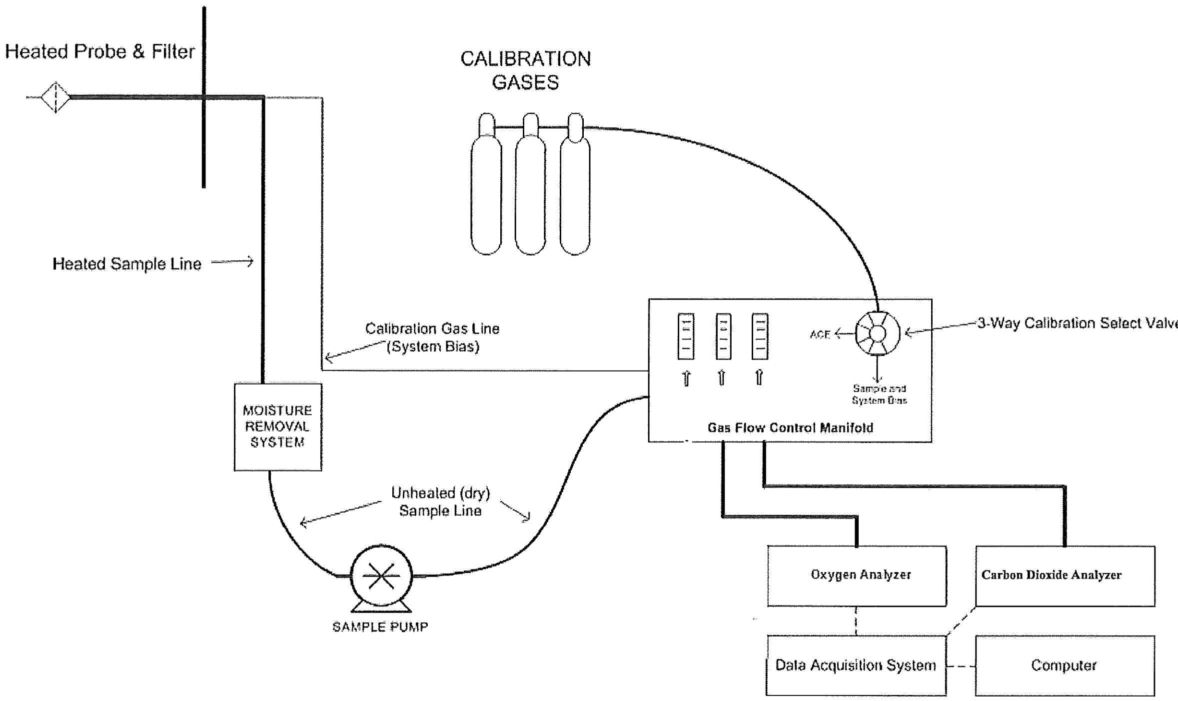
Historic flow test data is provided in Appendix E as verification to the absence of cyclonic flow. Method 1, § 11.4.2 states "if the average (null angle) is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology…must be used." The average null yaw angle measured at the Unit 1 exhaust on September 22, 2016, was measured to be 2.4°, thus meeting the less than 20° requirement. Since no ductwork and/or stack configuration changes have occurred since that time, the null angle information is considered reliable 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 Methods 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure).* The measured concentrations were used to calculate emissions rates using USEPA Method 19 (refer to Section 4.1.7). The method 3A sample probe was attached to the method 5/202 sample probe to collect O_2 and CO_2 concentrations at each of the 25 traverse points simultaneously with FPM and CPM measurements.

Flue gas was sampled from the stack through a stainless steel probe, heated Teflon® sample line, and through a gas conditioning system to remove water and dry the sample before entering a sample pump, flow control manifold, and paramagnetic and infrared gas filter correlation 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 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)

Flue gas moisture was measured using USEPA Method 4, *Determination of Moisture in Stack Gases* in conjunction with the Method 5 and 202 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 moisture content.

4.1.5 Filterable Particulate Matter (USEPA Method 5)

Filterable particulate matter samples were collected isokinetically in conjunction with RM 202 following USEPA Method 5, *Determination of Particulate Matter Emissions from Stationary Sources* procedures.

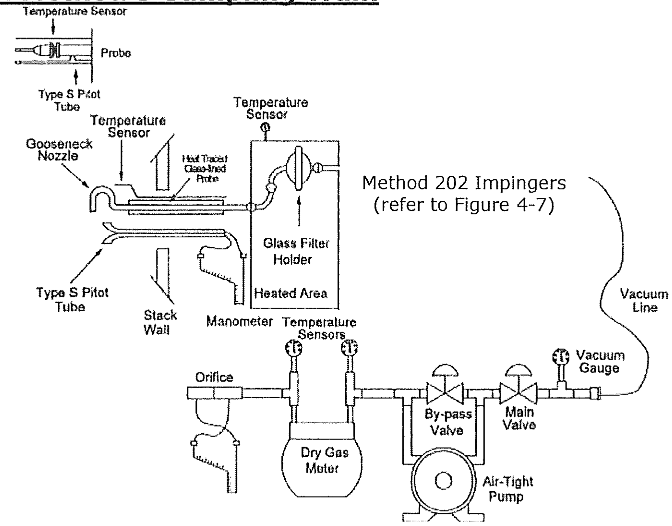
In the Method 5 sampling apparatus the flue gas was passed through a nozzle, heated probe, quartz-fiber filter, and into a series of impingers with the configuration presented in Table 4-3. The filter collected filterable particulate matter while the impingers collected water vapor and/or condensable particulate matter. Figure 4-4 depicts the USEPA Method 5 sampling apparatus.

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 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



At the conclusion of a test run and the post-test leak check, the sample train was disassembled and the impingers and FPM 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 impinger contents were recovered following Method 202 CPM requirements (see Section 4.1.6). 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

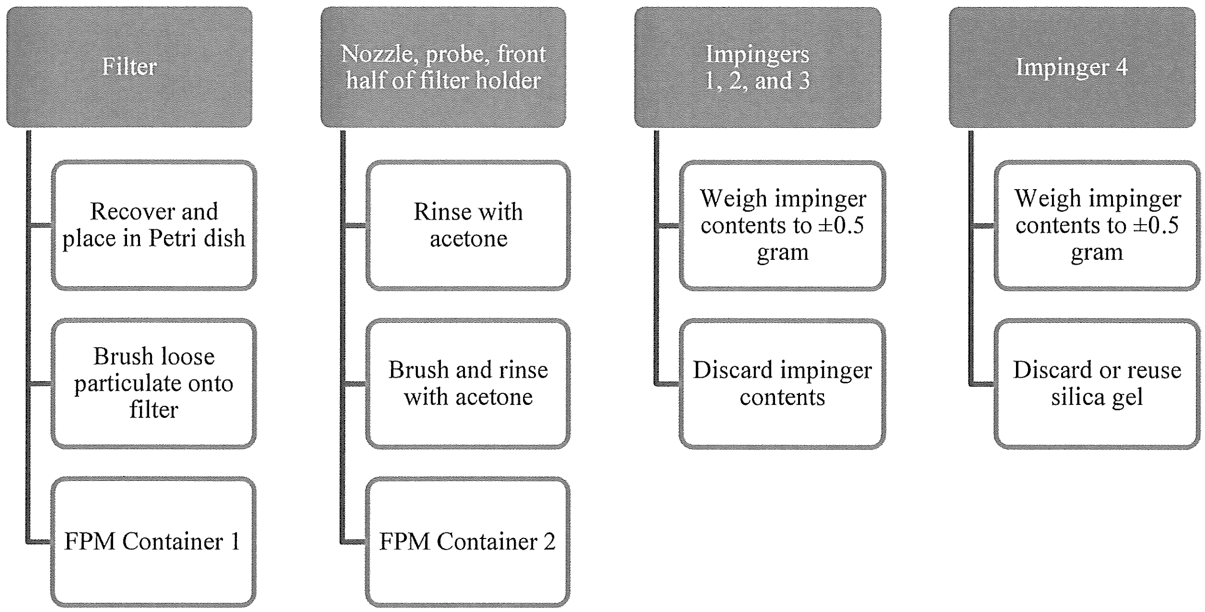
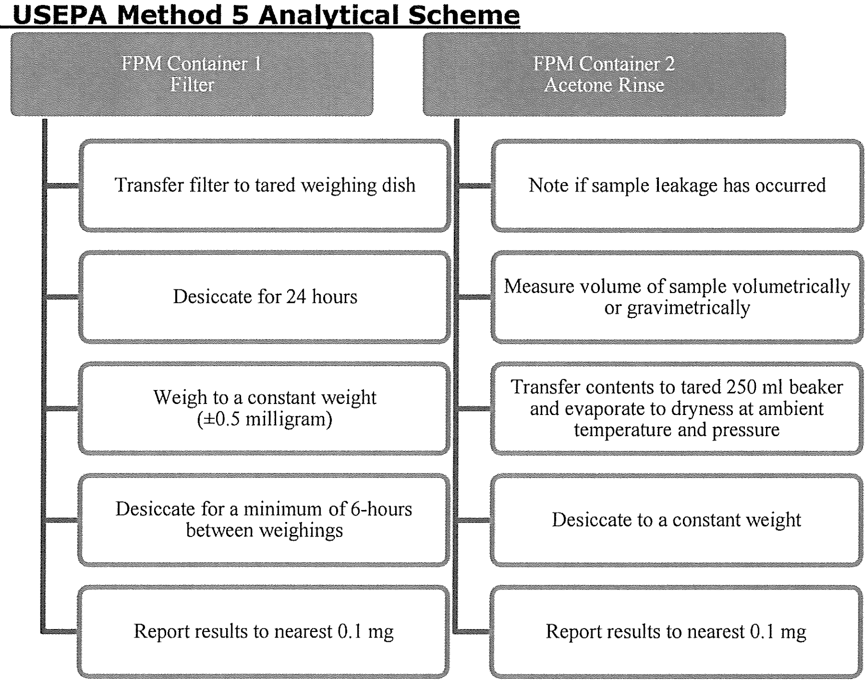


Figure 4-6. USEPA Method 5 Analytical Scheme



4.1.6 Condensable Particulate Matter (USEPA Method 202)

Condensable particulate matter was collected isokinetically in conjunction with USEPA Method 5 using 40 CFR Part 51, EPA Method 202, *Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources.* The Method 202 sample apparatus uses clean, baked glassware comprised of a glass coil type condenser, a dropout impinger, a modified Greenburg-Smith (GS) impinger with an open tube tip, a CPM filter holder containing a Teflon filter, one impinger containing approximately 100 milliliters of water and one impinger containing silica gel desiccant. During each CPM run, temperature controlled water was recirculated in the coil condenser jacket that maintained the CPM filter temperature between 65 and 85°F. Refer to Figure 4-7 for a drawing of the Method 202 sample apparatus and Table 4-3, which describes the Method 5/202 impinger configuration.

Figure 4-7. USEPA Method 202 Sampling Train

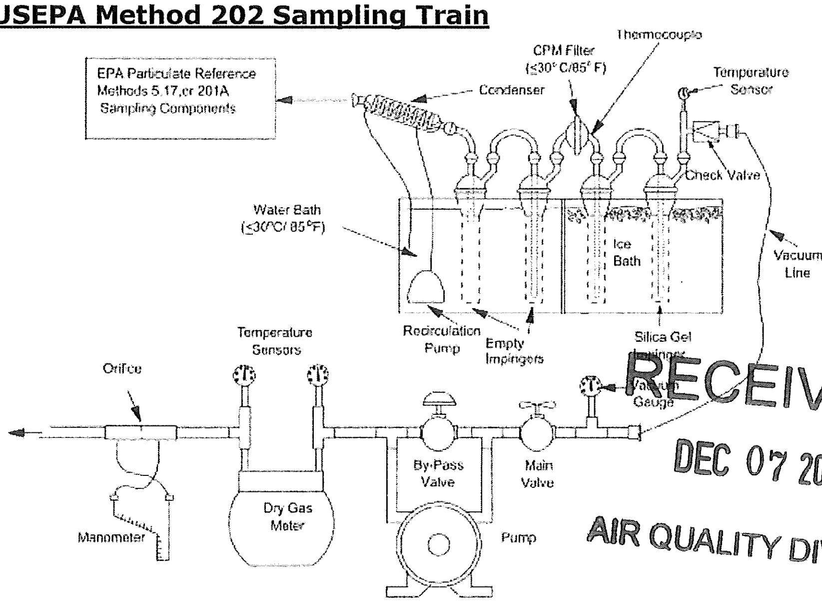


Table 4-3
Method 5/202 Impinger Configuration

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

Upon test completion, each impinger was weighed to determine gas moisture content. The condenser, dropout and back-up impingers, and the CPM filter housing were then re-assembled and purged with ultra-high purity nitrogen at a rate of approximately 14 liters per minute for a minimum of one hour to remove dissolved sulfur dioxide (SO_2) gases from the impinger water. During the purge, water continued to recirculate in the condenser jacket to maintain the CPM filter exit temperature and the impingers were observed to ensure the contents did not evaporate.

After the nitrogen purge, the condensate collected in the dropout and back-up impingers were transferred to a clean sample bottle labeled as CPM Container #1, Aqueous Liquid Impinger. The back half of the Method 5 filter bell, condenser, impingers and connecting glassware were then rinsed twice with deionized, ultra-filtered water into the same container. The water rinses were followed by an acetone rinse and duplicate hexane rinses into a separate sample bottle identified as CPM Container #2 (organic rinses). The CPM filter was removed prior to the water and organic rinses and placed in a clean Petri dish identified as CPM Container #3. Liquid levels on the sample bottles were marked and the samples were sealed and transported to Maxxam Analytics laboratory in Mississauga, Ontario for analysis. Refer to Figures 4-8 and 4-9 for the Method 202 sample recovery and analytical scheme.

Figure 4-8. USEPA Method 202 Sample Recovery Scheme

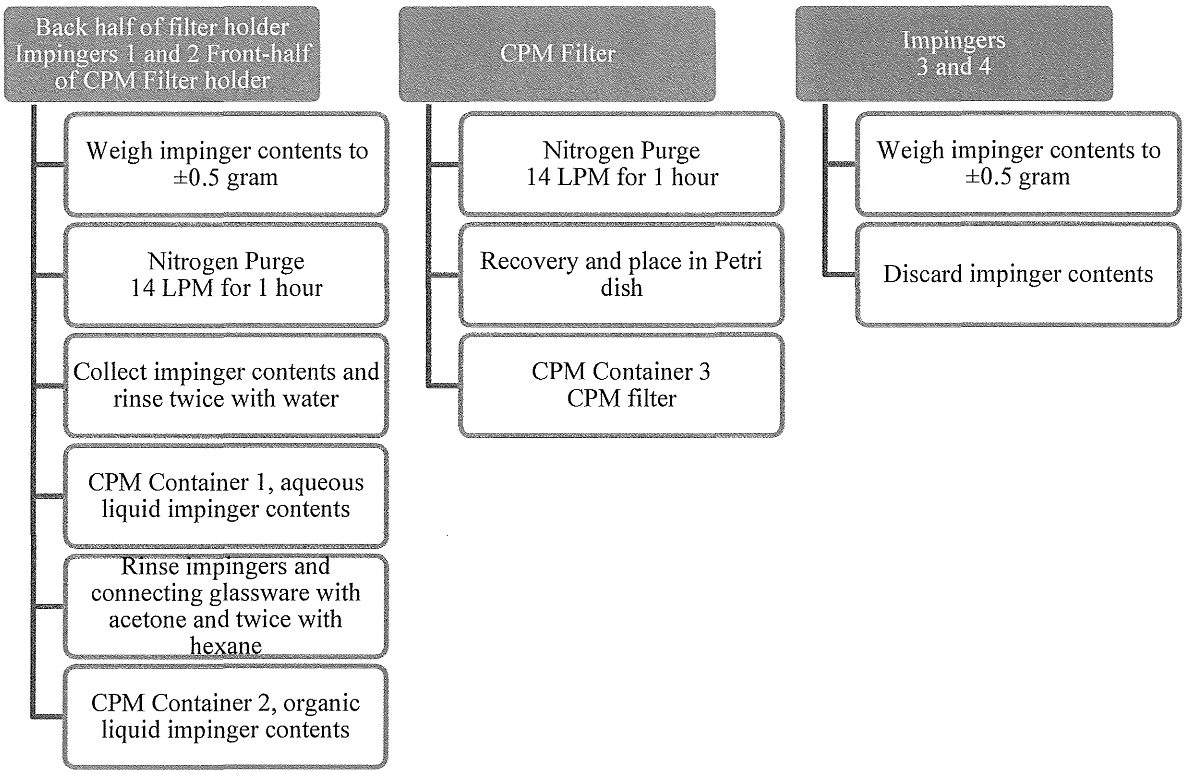
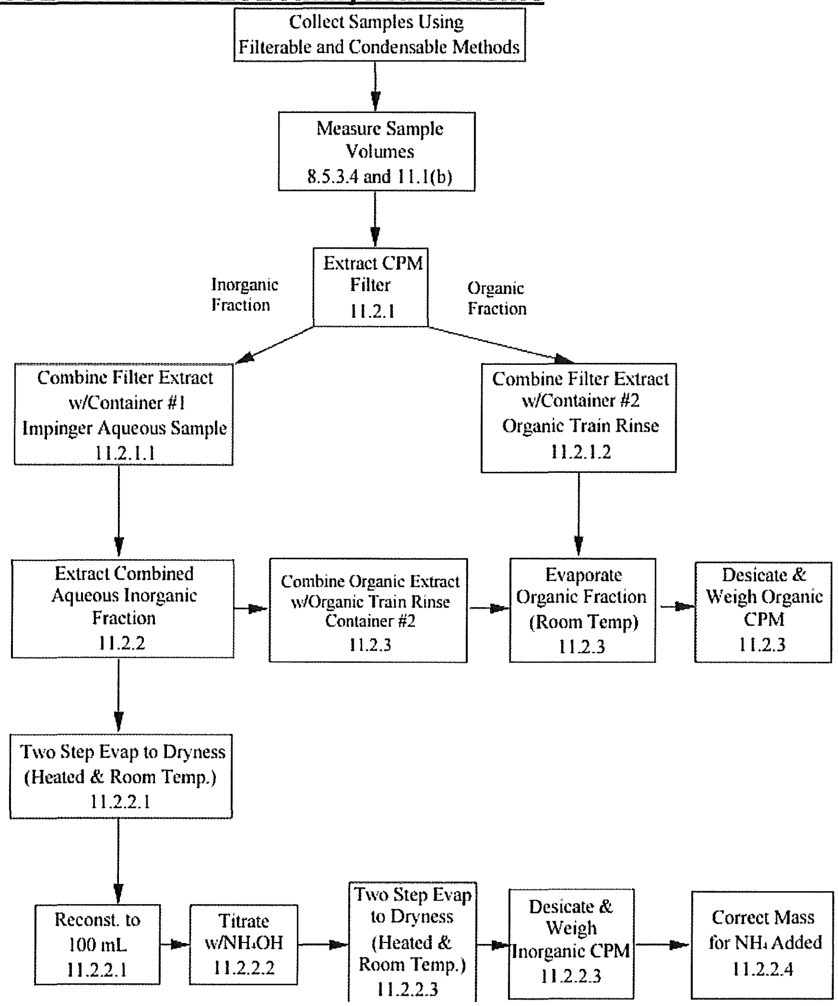


Figure 4-9. USEPA Method 202 Analytical Scheme



4.1.7 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 CO_2 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 4-10 presents the equation used to calculate lb/mmBtu emission rate:

Figure 4-10. USEPA Method 19 Equation 19-6

$$Eq. 19-6 \quad E = C_d F_c \frac{100}{\%CO_{2d}}$$

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)

5.0 TEST RESULTS AND DISCUSSION

The Unit 1 FPM emission results meet the applicable emission limits in MI-ROP-B2835-2020a and satisfy the requirement to verify PM emission rates every three years. The FPM results also comply with the 0.015 lb/mmBtu CD limit, and with emissions less than 0.010 lb/mmBtu, therefore Unit 1 continues to qualify for the reduced test frequency incentive in paragraph 153 of the CD, reducing the annual FPM and CPM testing requirement to every other year.

The CPM results in this report were not used to determine PM emission rate compliance but are provided for informational purposes per Paragraph 156 in the CD which states: *The results of the PM stack test conducted pursuant to this Paragraph 156 shall not be used for the purpose of determining compliance with the PM Emission Rates required by this Consent Decree.*

Refer to Section 2.3 for a summary of the test results.

5.1 Tabulation of Results

Table 2-1 in Section 2 of this report summarizes the results of the testing. Appendix Table 1 in the Appendix of this report 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-%), Load (MWg), and opacity (%). 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 facility's continuous emissions monitoring system (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 7:24-9:53. While the last RM Run 1 value was recorded at 9:53, the last full minute of sampling was actually 9:52.

5.2 Significance of Results

The Unit 1 FPM results signify ongoing compliance with applicable ROP regulation limits. The ROP requires verification of EUBOILER1 FPM emission rates every three years or more frequently upon request of EGLE Air Quality District. Based on the results of this test program EUBOILER1, the next ROP required particulate matter testing is required in 2023.

The FPM results also indicate ongoing compliance with the CD limit. Paragraph 153 of the CD requires annual particulate matter testing or testing every other year, rather than every year, provided that two of the most recently completed test results are less than or equal to 0.010 lb/mmBtu. Based on particulate matter results from testing performed in 2015 (0.004 lb/mmBtu) of the combined effluent of Unit 1 and 2, and thereafter at the dedicated exhaust duct of EUBOILER1 in 2016 (0.002 lb/mmBtu), 2018 (0.0006 lb/mmBtu), and 2020 (0.0013), the next CD testing is required in 2022.

As specified in CD Paragraph 156, CPM test results were not used to determine compliance with PM Emission Rates, they were provided for informational purposes only.

40 CFR 63, Subpart UUUUU, allows electric utility steam generating units (EGU's) to qualify as low emitting EGUs (LEE), with reduced testing frequency incentives, when emissions are demonstrated to be less than or equal to 50 percent of the 0.030 lb/mmBtu PM emission limit on a quarterly basis over a three year period. Since EUBOILER1 achieved LEE status on May 14, 2019, the filterable particulate matter results from this test program were not used to evaluate continued LEE status because it occurred within 506 days from the previous performance test. MATS states that at least 1,050 calendar days must separate performance tests conducted every 3 years. MATS testing is required in 2022.

5.3 Variations from Sampling or Operating Conditions

There were no significant sampling or operating variations encountered during the test program, with the exception of a governor valve issue at the turbine. While this limited the operating capacity of the boiler testing was still conducted while at site-specific representative, normal operating conditions.

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.

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.

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 in order to provide a measure of test data bias. Currently, performance audit samples are not available for USEPA Methods 5 and 202.

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 5-2 summarizes the primary field quality assurance and quality control activities that were performed. Refer to Appendix E for supporting documentation.

Table 5-2
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
M1: Cyclonic flow evaluations	Evaluate the sampling location for cyclonic flow	Measure null angles	Pre-test	≤20°
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
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: 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 or ±0.5% absolute difference
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	±5.0% of the analyzer calibration span or ±0.5% absolute difference for bias and ±3.0% of analyzer calibration span for drift
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
M4: Impinger temperature	Ensures collection of condensed water	Maintain last impinger temperature ≤68°F	Throughout test	Last impinger temperature must be ≤68°F
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: Apparatus Temperature	Prevents condensation within sample apparatus	Set probe & filter heat controllers to 248±25°F	Verify prior to and during each run	Apparatus temperature must be 248±25°F

Table 5-2
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M5: sample rate	Ensure representative sample collection	Calculate isokinetic sample rate	During and post-test	100±10% isokinetic rate
M5: Sample volume	Ensure minimum required sample volumes collected	Record pre- and post-test dry gas meter volume reading	Post test	ROP PM: ≥30 dscf CD PM: ≥60 dscf
M202: impinger temperature	Ensure collection of condensate	Maintain CPM filter temperature between 65°F and 85°F	Throughout test	CPM filter temperature must be ≥248°F and ≤273°F
M5/202: Post-test leak check	Evaluate if system leaks biased the sample	Cap sample train; monitor DGM	Post-test	≤0.020 cfm
M5/202: post-test meter audit	Evaluates sample volume accuracy	DGM pre- and post-test; compare calibration factors (Y and Yqa)	Pre-test Post-test	±5%

5.8 Calibration Sheets

Calibration sheets, including dry gas meter, gas protocol sheets, and analyzer quality control and assurance checks 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

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	2.4 mg	Sample volume was 200 milliliters Acetone blank corrections were applied
Method 5 Filter Blank	0.3 mg	Reporting limit is 0.1 milligrams
Method 202 DI H_2O Blank	<0.5 mg	Sample volume was 200 grams Result is for inorganic condensable
Method 202 Acetone Blank	<1.0 mg	Sample volume was 160 grams Result is for organic condensable
Method 202 Hexane Blank	<1.0 mg	Sample volume was 130 grams Result is for organic condensable
Method 202 Field Train Recovery Blank	2.1 mg inorganic 5.0 mg organic	Maximum blank correction of 2.0 mg applied to results

High Method 5 acetone blank and Method 202 field train recovery blank results were measured. The origin of the high blank values is unknown and likely bias the CPM and total PM results high for the testing performed. Although, 7.1 milligrams of condensable particulate matter were measured in the field train recovery blank, which is used to correct the measured condensable particulate matter result, the maximum mass of 2.0 milligrams as allowed by USEPA Method 202 was subtracted from the total mass collected.