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PM, CPM, and HCl MATS and NOV-CD Test Report

EUBOILER2

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

November 15, 2018

Test Dates: September 26 and 27, 2018

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
MATS Work Order No. 31805898
NOV-CD Work Order No. 31731630
Version No.: 0

EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) personnel conducted filterable particulate matter (PM or FPM), condensable particulate matter (CPM), and hydrogen chloride (HCl) testing at the exhaust of coal-fired boiler EUBOILER2 (Unit 2) operating at the J.H. Campbell Generating Station in West Olive, Michigan. EUBOILER2 is an electric utility steam generating unit (EGU) which produces steam to turn a turbine and generate electricity. The test program, performed September 26 and 27, 2018, was conducted to verify FPM and HCl emission limit compliance with 40 CFR 63, Subpart UUUUU (MATS rule), and to satisfy CPM and FPM test requirements in the Consent Decree (CD), Civil Action No.: 14-13580, entered between Consumers Energy, the United States Environmental Protection Agency (USEPA), and the United States Department of Justice (DOJ) on November 4, 2014. The relevant test requirements and emission limits for each aspect are incorporated in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013b.

Triplicate FPM, CPM, and HCl test runs were conducted following the procedures in USEPA Reference Methods (RM) 1, 2, 3A, 4, 5, 19, and 26 in 40 CFR 60, Appendix A and RM 202 in 40 CFR 51, Appendix M. During each test, Unit 2 fired 100% western coal and operated at the maximum achievable load when firing such fuel (i.e., representative of site specific normal operation) 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 2 FPM, CPM, and HCl results are summarized in the following table.

Table E-1
Executive Summary of Test Results

Parameter	Units	Run			Average	Emission Limit		
		1	2	3		MATS	MATS LEE[1]	CD
FPM	lb/mmBtu	0.0006	0.0009	0.0007	**0.0007**	**0.030**	**0.015**	**0.015**
HCl	lb/mmBtu	<0.00011	<0.00011	<0.00011	**<0.00011**	**0.0020**	**0.0010**	**N/A**
CPM	lb/mmBtu	0.006	0.006	0.006	**0.006**	**N/A**	**N/A**	**N/A**

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

The Unit 2 FPM and HCl emission results meet the MATS rule emission limits described in 40 CFR 63, Subpart UUUUU, Table 2. The FPM and HCl emissions were also less than or equal to 50 percent of the 0.030 lb/mmBtu FPM and 0.0020 lb/mmBtu HCl limits, thereby meeting the low emitting EGU (LEE) criteria. These results, therefore, represent the 9th consecutive Unit 2 LEE qualification calendar quarter. After 12 consecutive qualifying quarters, the source qualifies for MATS LEE status, triggering reduced test frequency incentives. A chronological list of qualifying Unit 2 LEE tests is provided in Table 5-1.

The FPM results also comply with the 0.015 lb/mmBtu CD limit with emissions less than 0.010 lb/mmBtu, which represents continued Unit 2 FPM emission results of less than 0.010 lb/mmBtu. Therefore, Unit 2 qualifies for the reduced test frequency incentive in paragraph 153 of the CD, reducing the annual FPM/CPM 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 Tables 1 and 2. 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), condensable particulate matter (CPM), and hydrogen chloride (HCl) testing conducted September 26 and 27, 2018 on EUBOILER2 operating at the Consumers Energy J.H. Campbell Plant in West Olive, Michigan.

This document was prepared using the Michigan Department of Environmental Quality (MDEQ) *Format for Submittal of Source Emission Test Plans and Reports* published in March of 2018. 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) personnel conducted FPM, CPM, and HCl tests at the dedicated exhaust of coal-fired boiler EUBOILER2 (Unit 2) operating at the J.H. Campbell Generating Station in West Olive, Michigan on September 26 and 27, 2018.

A test protocol was submitted to the MDEQ on September 23, 2016 and subsequently approved by Mr. Tom Gasloli, Environmental Quality Analyst, in his letter dated October 18, 2016. The approval letter reflects standing blanket approval of all quarterly 40 CFR 63, Subpart UUUUU tests conducted at J.H. Campbell Units 1 and 2 as long as no modifications from the original protocol occur.

1.2 PURPOSE OF TESTING

The purpose of the test was to verify FPM and HCl emission limit compliance with 40 CFR 63, Subpart UUUUU (MATS rule), and to satisfy CPM and FPM test requirements in the Consent Decree (CD), Civil Action No.: 14-13580, entered between Consumers Energy, the United States Environmental Protection Agency (USEPA), and the United States Department of Justice (DOJ) on November 4, 2014. The relevant test requirements and emission limits for each aspect are incorporated in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013b. The applicable emission limits are presented in Table 1-1.

Table 1-1
Applicable Emission Limits

Parameter	Emission Limit	Units	Applicable Requirement
FPM	0.030	lb/mmBtu	Table 2 to Subpart UUUUU of Part 63—Emission Limits for Existing EGU's
HCl	0.0020		
FPM	0.015	lb/mmBtu	Consent Decree paragraphs 145 and 153
CPM	N/A	lb/mmBtu	Consent Decree 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.

lb/mmBtu pound per million British thermal unit heat input

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 and 0.0020 lb/mmBtu HCl limits on a quarterly basis over a three year period. This test event represents the 9th consecutive quarterly Unit 2 FPM and HCl LEE evaluation.

Paragraph 153 in CD Civil Action No.: 14-13580 requires annual FPM testing, which *may be satisfied by stack tests conducted by Consumers as may be required by permits from the State of Michigan*. Furthermore, the paragraph states *Consumers may perform testing every other year, rather than every year, provided that two of the most recently completed test results demonstrate the PM emissions are equal to or less than... 0.010 lb/mmBtu.* Thereafter, any test result demonstrating PM emissions greater than 0.010 lb/mmBtu will trigger annual PM test requirements, beginning the year immediately following that event.

1.3 Brief Description of Source

EUBOILER2 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	Compliance Tracker, AE-18J 312-353-2000	Air Enforcement and Compliance Assurance U.S. Environmental Protection Agency – Region 5 77 W. Jackson Boulevard Chicago, Illinois 60604
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
State Technical Programs Field Inspector	Mr. Tom Gasloli Technical Programs Unit Environmental Quality Analyst 517-284-6778 gaslolit@michigan.gov	Michigan Department of Environmental Quality Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Regulatory Inspector	Ms. Kaitlyn DeVries Environmental Quality Analyst 616-558-0552 devriesk1@michigan.gov	Michigan Department of Environmental Quality Grand Rapids District Office 350 Ottawa Avenue NW; Unit 10 Grand Rapids, Michigan 49503
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
Corporate Air Quality Contact	Mr. Matthew Hall Senior Engineer 517-788-2231 matthew.hall@cmsenergy.com	Consumers Energy Company Environmental Services Department 1945 West Parnall Road; P22-232 Jackson, Michigan 49201

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. 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. Michael T. Rabideau Senior Technician 616-738-3234 michael.rabideau@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Team Representative	Mr. Calvin J. Mason, QSTI Engineering Technical Analyst II 616-738-3385 joe.mason@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460
Laboratory	Mr. Gordon Cattell 517-788-2334 Sr. Laboratory Tech Analyst Lead gordon.cattell@cmsenergy.com	Consumers Energy Company Laboratory Services 135 W Trail Street Jackson, Michigan 49201
Laboratory	Mr. Clayton Johnson Project Manager – Air Toxics 905-817-5769 cjohnson@maxxam.ca	Maxxam Analytics 6740 Campobello Road Mississauga, Ontario L5N 2L8

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 299 to 300 gross megawatts (MWg), which represents approximately 98 to 102% of the 300 MWg output achievable when firing 100% western coal. 40 CFR §63.10007(2) describes maximum normal operating load as generally between 90 and 110 percent of design capacity, but that they should be representative of site specific normal operations during each test run. As Unit 2 normally operates on 100% western coal at loads of up to approximately 300 MWg, the conditions during testing were representative of site specific normal operations. The CD 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 was recorded in Eastern Standard Time (EST). Note the time convention for the RM tests and Dry Sorbent Injection (DSI) process feed rates was Eastern Daylight Savings Time (EDT); thus a one hour offset exists between these data sets and the continuous emissions monitoring system (CEMS) time stamps.

2.2 APPLICABLE PERMIT INFORMATION

The J.H. Campbell generating station is identified by State Registration Number (SRN) B2835 and operates in accordance with renewable operating permit (ROP) MI-ROP-B2835-

2013b, which incorporates State and Federal air regulations, including the applicable 40 CFR 63, Subpart UUUUU, "National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units," (aka MATS Rule) requirements. The permit identifies EUBOILER2 as an emission unit within the flexible group designation FGBOILER12. The facility is also associated with Federal Registry Service (FRS) Id: 110000411108.

Additionally, Consumers Energy operates Unit 2 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. The ROP incorporates the requirements and emission limits established in the CD.

2.3 RESULTS

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

Table 2-1
Summary of Test Results

Parameter	Units	Run			Average	Emission Limit		
		1	2	3		MATS	MATS LEE[1]	CD
FPM	lb/mmBtu	0.0006	0.0009	0.0007	**0.0007**	**0.030**	**0.015**	**0.015**
HCl	lb/mmBtu	<0.00011	<0.00011	<0.00011	**<0.00011**	**0.0020**	**0.0010**	**N/A**
CPM	lb/mmBtu	0.006	0.006	0.006	**0.006**	**N/A**	**N/A**	**N/A**

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

The Unit 2 FPM and HCl emission results meet the MATS rule emission limits described in 40 CFR 63, Subpart UUUUU, Table 2. The FPM and HCl emissions were also less than or equal to 50 percent of the 0.030 lb/mmBtu FPM and 0.0020 lb/mmBtu HCl limits, thereby meeting the low emitting EGU (LEE) criteria. These results, therefore, represent the 9th consecutive Unit 2 LEE qualification calendar quarter. After 12 consecutive qualifying quarters, the source qualifies for MATS LEE status, triggering reduced test frequency incentives. A chronological list of qualifying Unit 2 LEE tests is provided in Table 5-1.

The FPM results also comply with the 0.015 lb/mmBtu CD limit with emissions less than 0.010 lb/mmBtu, which represents continued Unit 2 FPM emission results of less than 0.010 lb/mmBtu. Therefore, Unit 2 qualifies for the reduced test frequency incentive in paragraph 153 of the CD, reducing the annual FPM/CPM 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 Tables 1 and 2. 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

EUBOILER2 is a coal-fired EGU that turns a turbine connected to an electricity producing generator.

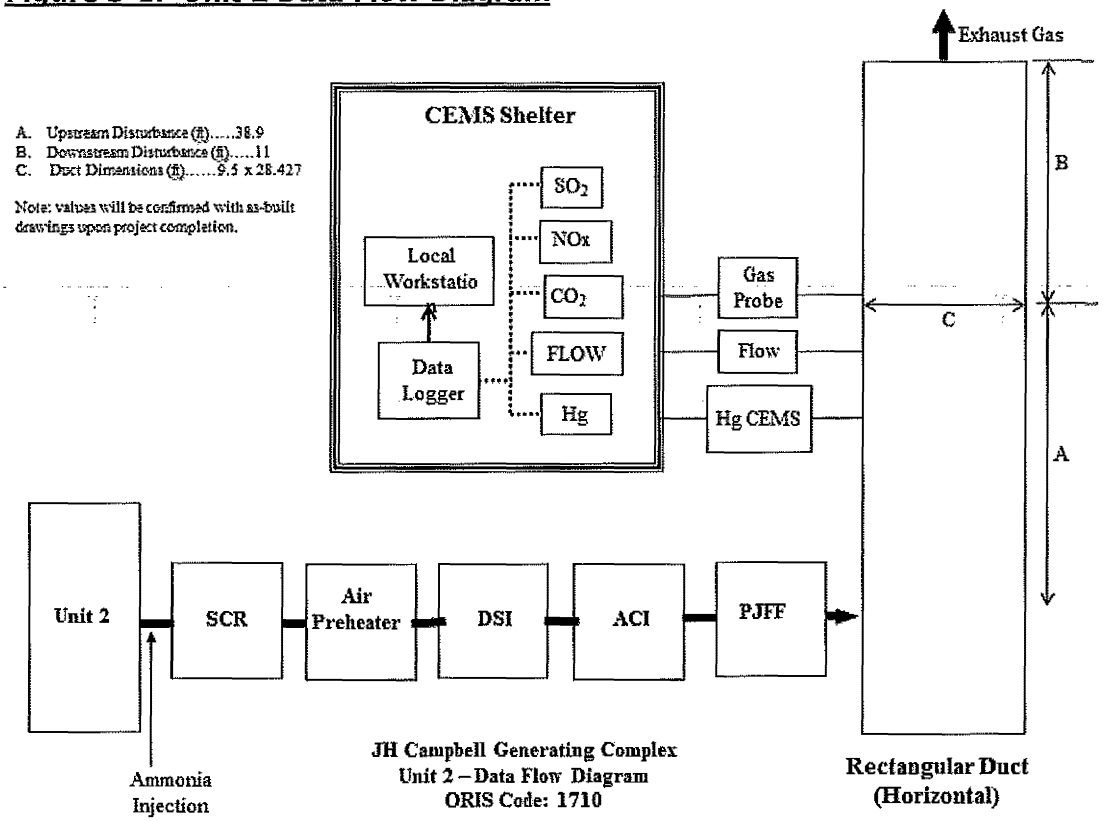
3.1 PROCESS

Unit 2 is a wall-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 unit is also permitted to burn eastern coal blends. 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) and over fire air (OFA), a selective catalytic reduction (SCR) system 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 PM emissions. Post control flue gas exhausts to atmosphere through an approximately 400-feet high stack shared with EUBOILER1. Refer to Figure 3-1 for the Unit 2 Data Flow Diagram.

Figure 3-1. Unit 2 Data Flow Diagram



3.3 Materials Processed

The Unit 2 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. The unit fired 100% western coal for this quarterly compliance test, however the unit is also capable of firing blends of eastern and low-sulfur western coal.

3.4 Rated Capacity

Unit 2 has a nominal heat input capacity of 3,560 mmBtu/hr and a gross electrical output of approximately 378 MWg while firing a blend of eastern and western coal. Unit 2 is capable of firing 100% bituminous (eastern) coal, 100% subbituminous (western) coal, and various mixtures of the two coal types, however the unit is limited to approximately 300 MWg gross when firing only western coal, and the nominal heat input rating is achievable only when firing at least 40% eastern coal with all coal mills operating. 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. EUBOILER2 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, CPM, and HCl test run (note that the dry sorbent injection rate information is presented as run averages only):

- CO_2 (Vol-%)
- Load (MWg)
- Opacity (%)
- Dry sorbent injection rate (lb/hr)

Due to the various instrumentation systems, the sampling times were correlated to instrumentation times. The RM testing and DSI process feed rate data is recorded in EDT, whereas EST applies to the CEMS data. 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

RCTS personnel tested for FPM, CPM and HCl 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)

Table 4-1
Test Methods

Parameter	Method	USEPA Title
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
Hydrogen chloride	26	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Non-Isokinetic Method
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 (2018)	Run	Sample Type	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
Sept. 26	1	FPM and CPM	10:03	12:42	125	5/202	Isokinetic sampling from 25 traverse points collected 2.943 dscm of sample volume to meet 2 dscm LEE minimum Test paused 12:00-12:03 to resolve hoist issue.
	1	HCl	10:03	12:08	125	26	Single point, 250.31 dry liter sample volume to meet 240 liter LEE minimum
	2	FPM and CPM	13:10	15:36	125	5/202	Isokinetic sampling from 25 traverse points collected 2.867 dscm of sample volume to meet 2 dscm LEE minimum
	2	HCl	13:10	15:15	125	26	Single point, 250.85 dry liter sample volume to meet 240 liter LEE minimum
Sept. 27	3	FPM and CPM	8:31	11:05	125	5/202	Isokinetic sampling from 25 traverse points collected 2.936 dscm of sample volume to meet 2 dscm LEE minimum
	3	HCl	8:31	10:41	130	26	Single point, 260.32 dry liter sample volume to meet 240 liter LEE minimum. Test extended 5 minutes to ensure minimum volume collected.

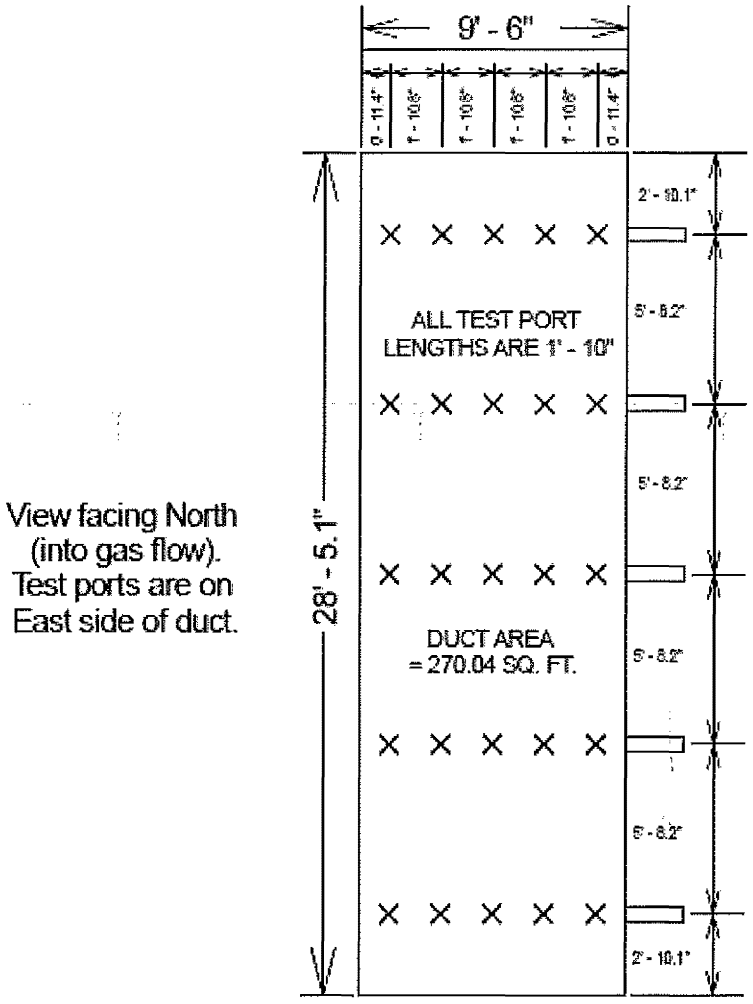
4.1.1 Sample Location and Traverse Points (USEPA Method 1)

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 located in the horizontal plane on east side of the 9.5 feet by 28 feet 5.1-inch rectangular duct. The duct has an equivalent duct diameter of 14 feet 2.4 inches. Refer to Figure 3-1 for a drawing showing the upstream and downstream disturbance distances. The ports are situated:

- Approximately 38.9 feet or 2.7 duct diameters downstream of a duct diameter change flow disturbance, and
- Approximately 11 feet or 0.8 duct diameters upstream of flow disturbance caused by a change in duct diameter as it enters the exhaust stack.

The sample ports are 6-inches in diameter and extend 22 inches 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 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 2 exhaust test port and traverse point locations is presented as Figure 4-1.

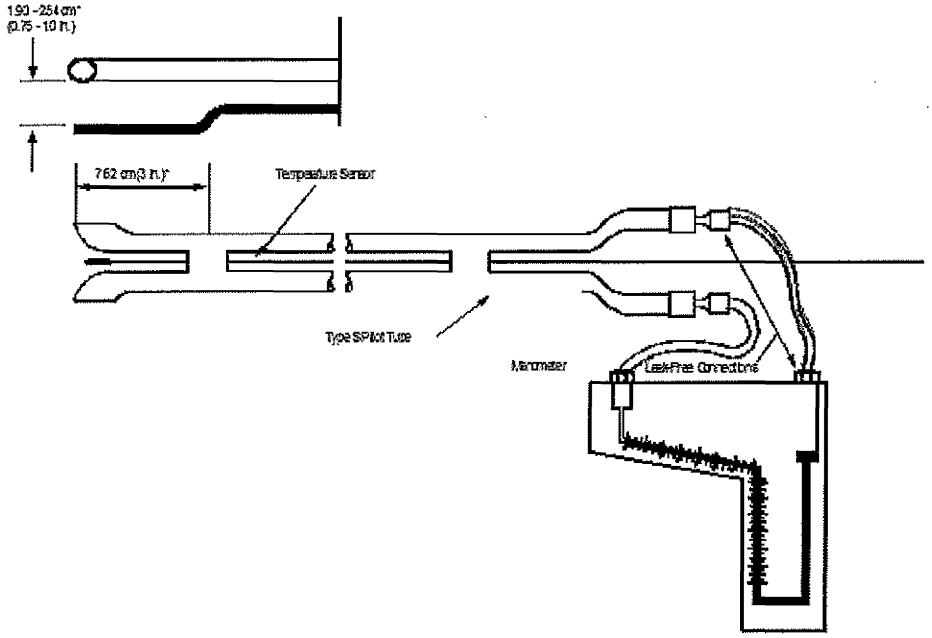
Figure 4-1. Unit 2 Duct Cross Section and Test Port/Traverse Point Detail



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



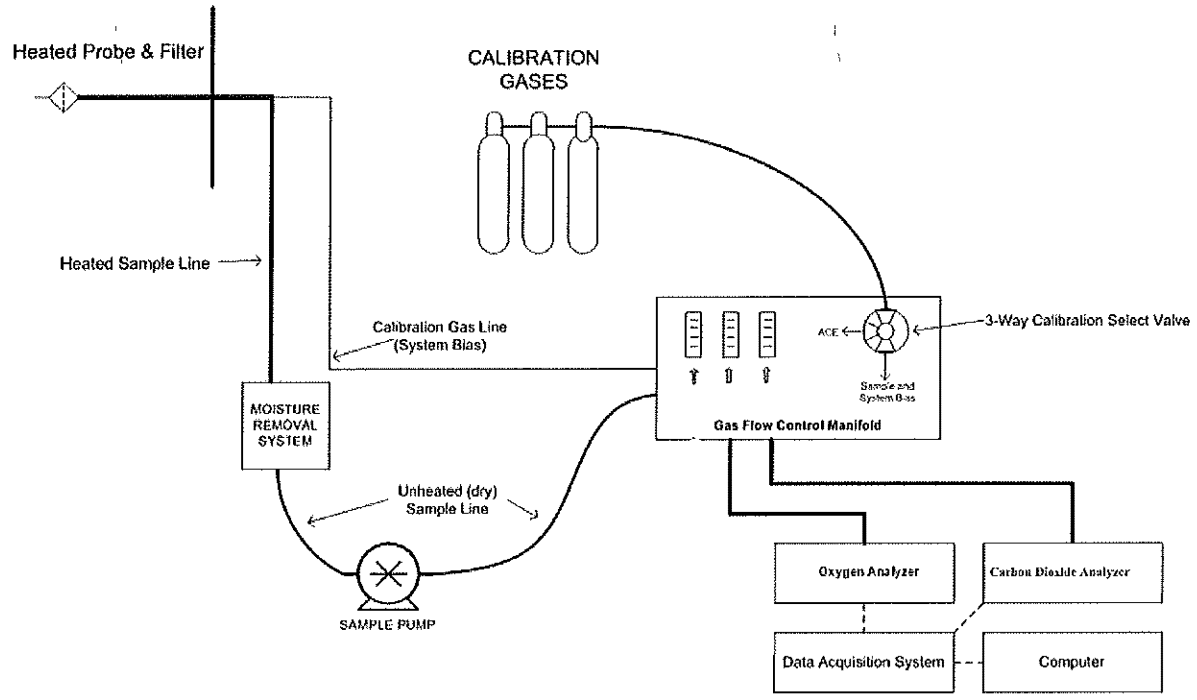
Historic sample location flow test data is provided in Appendix E as verification to the absence of cyclonic flow. Method 1, § 11.4.2 states "if the average (null angle) is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology...must be used." The average null yaw angle measured at the Unit 2 exhaust on August 23, 2016, was measured to be 3.4°, thus meeting the less than 20° requirement and in the absence of ductwork and/or stack configuration changes, this null angle information is considered to be valid and additional cyclonic flow verification was not performed.

4.1.3 Molecular Weight (USEPA Method 3A)

Oxygen and carbon dioxide 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 4.1.8). 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. This data was also used to determine the diluent gas concentrations during the HCl testing.

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, gas flow control manifold, 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 analyzer's response was within ±2.0% of the calibration gas span (i.e., high calibration gas concentration). An initial system-bias test was performed where the zero- and mid- or high- calibration gases were introduced at the sample probe to measure the ability of the system to respond accurately to within ±5.0% of span.

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. Oxygen and carbon dioxide concentrations were recorded at 1-minute intervals throughout the test run. Oxygen and carbon dioxide concentration 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 and drift was within ±3.0%. The analyzer's 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 D 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 and 202 sample apparatus. Flue

gas was drawn through a series of impingers immersed in an ice bath to condense and remove water from the sample. 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 Filterable Particulate Matter

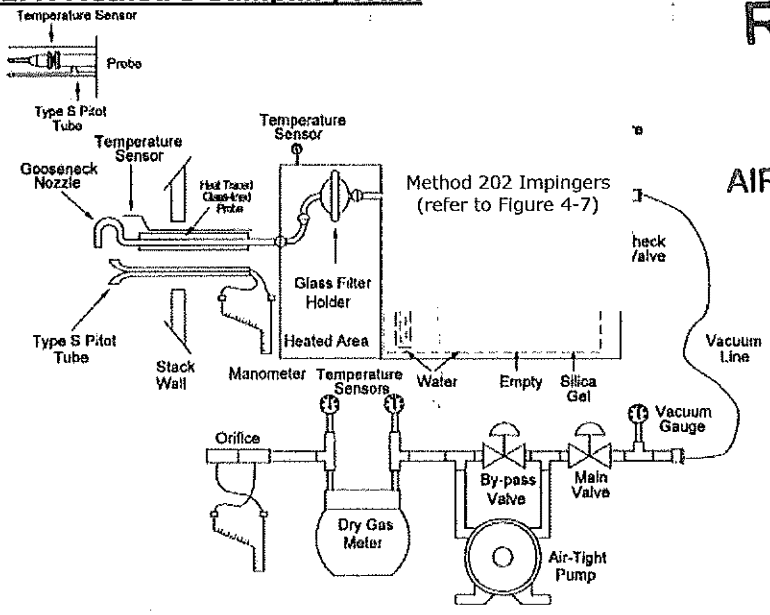
Filterable particulate matter samples were collected isokinetically in conjunction with RM 202 following USEPA Method 5, *Determination of Particulate Matter Emissions from Stationary Sources* procedures. The flue gas is collected using a specifically sized nozzle, heated probe, quartz-fiber filter, and a series of impingers configured as shown in Method 5/202 Table 4-3. The FPM is collected on the filter and water vapor and/or CPM is collected in the impingers. Figure 4-4 depicts the USEPA Method 5 sample apparatus.

Before testing, a preliminary velocity traverse was performed and/or representative flow data from previous measurements was reviewed to calculate an ideal nozzle size that allowed isokinetic sampling to be performed. A pre-cleaned nozzle that had an inner diameter approximating 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 PM sample 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 a sample apparatus leak rate of less than 0.02 cubic feet per minute (cfm). The sample probe was inserted into the sampling port to begin sampling.

Ice was placed around the impingers and the probe, and filter temperatures were allowed to stabilize to a temperature of 248±25°F before sampling, as applicable. Note that the EPA's Emissions Measurement Center previously provided approval for conducting MATS PM tests at 248±25°F in lieu of the typical 320±25°F temperature stipulated in MATS. After the desired operating conditions were coordinated with the facility, testing was initiated. Stack and sample apparatus parameters (e.g., flue velocity, temperature) were monitored to ensure isokinetic sample rates were 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, 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 was triple rinsed with acetone and collected in pre-cleaned sample containers, sealed with Teflon tape, and labeled as "FPM Container 2." The flue gas moisture condensed in the impingers was weighed on an electronic scale to determine flue gas moisture content, after which the impingers 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 RCTS laboratory for analysis. The sample analysis followed USEPA Method 5 procedures as summarized in the sample recovery scheme presented in Figure 4-6.

Figure 4-5. USEPA Method 5 Sample Recovery Scheme

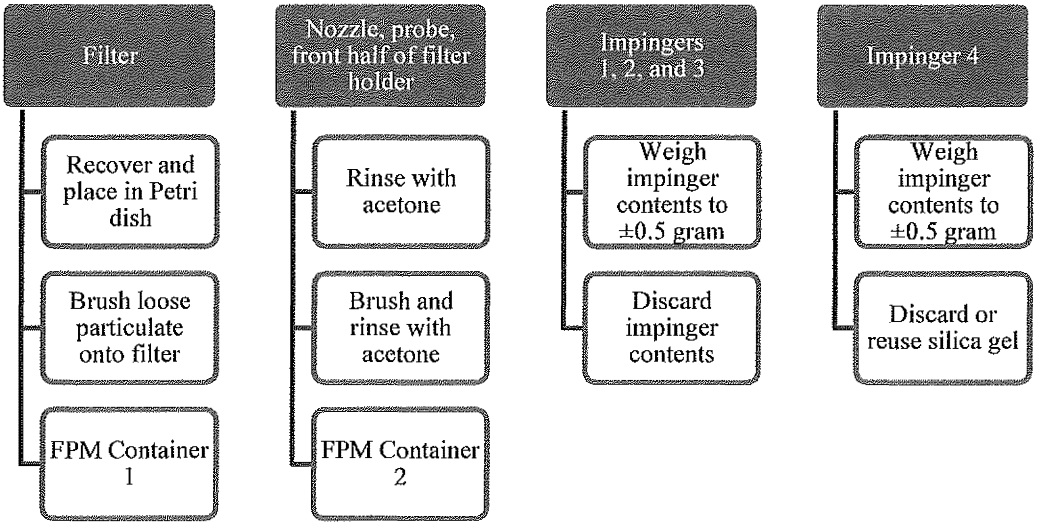
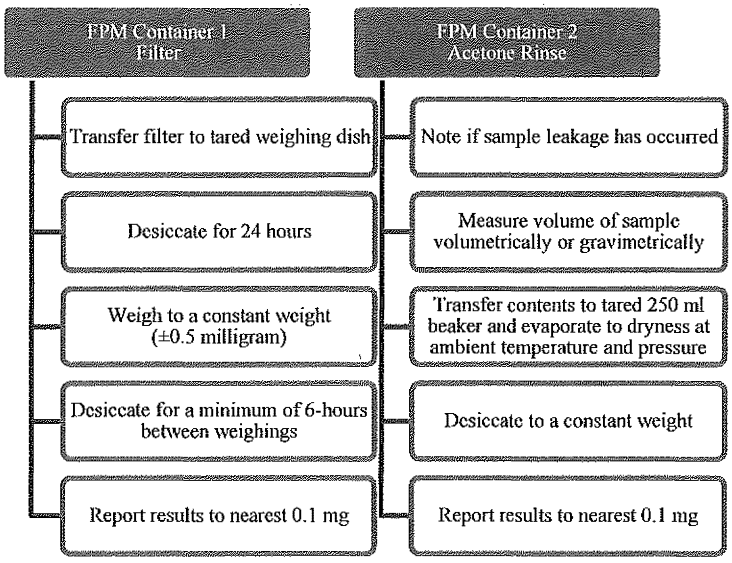


Figure 4-6. USEPA Method 5 Analytical Scheme



4.1.6 CONDENSABLE PARTICULATE MATTER

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. During each CPM run, temperature controlled water recirculated in the coil condenser jacket 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

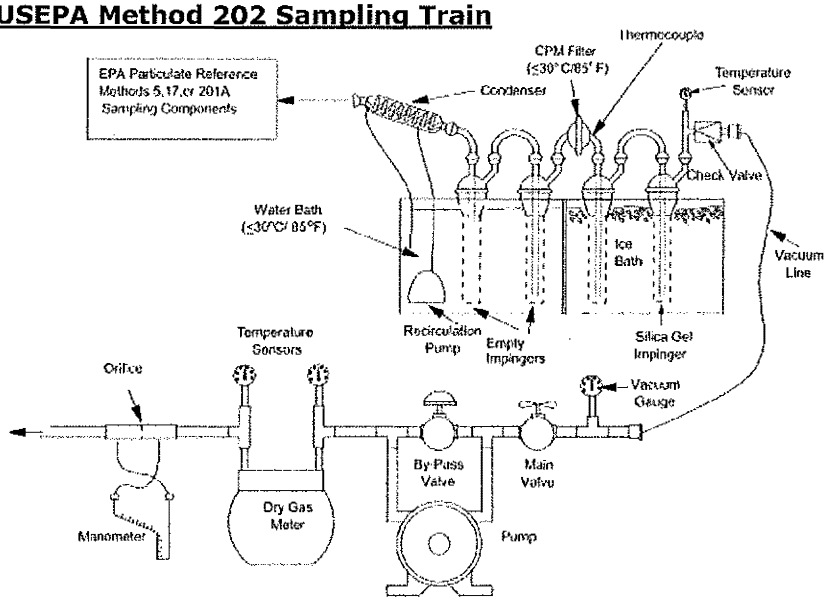


Table 4-3 Method 5/202 Impinger Configuration

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 flue 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

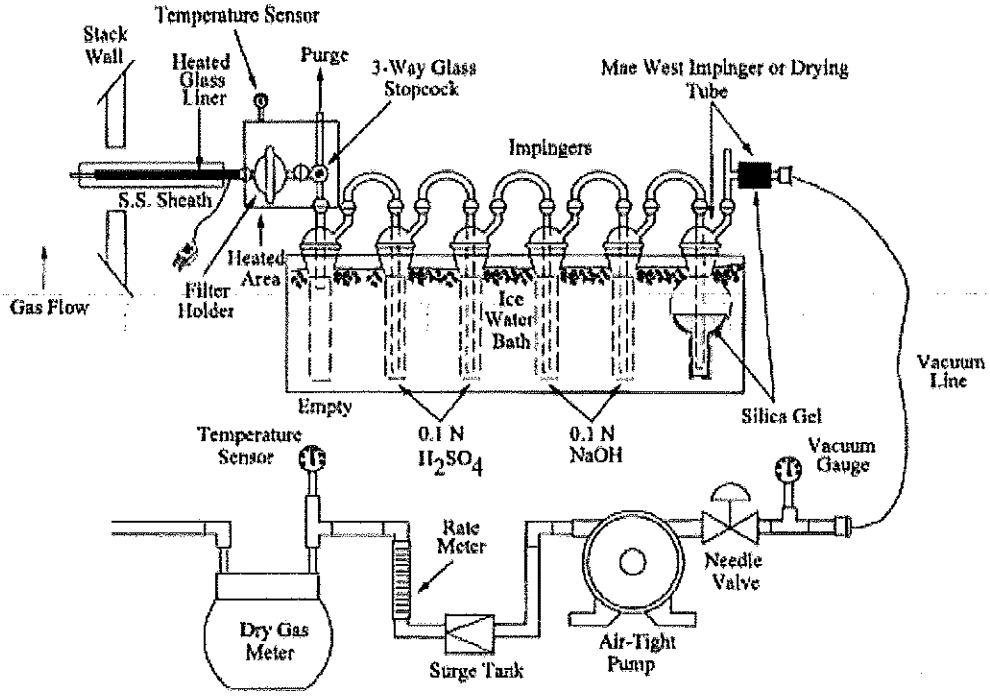
jacket to maintain the CPM filter exit temperature and the impingers were observed to ensure the contents did not evaporate.

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.

4.1.7 Hydrogen Chloride (USEPA Method 26)

Hydrogen chloride was measured by collecting an integrated sample of the flue gas following the procedures of USEPA Method 26, *Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources.* Triplicate minimum 125-minute test runs were performed at the EUBOILER2 exhaust duct by sampling flue gas through a heated glass-lined probe, Teflon filter, and into a series of impingers containing absorbing solutions. The filter collects particulate matter and halide salts, and the acidic and alkaline absorbing solutions collect the gaseous hydrogen halides (i.e., HCl) and halogens, respectively. Figure 4-8 depicts the USEPA Method 26 sample apparatus.

Figure 4-8. USEPA Method 26 Sample Apparatus



After charging the impingers, assembling the apparatus, and completing a leak check, the sample probe was inserted into the sampling port. Ice was placed around the impingers and upon achieving probe and filter temperatures between 248°F and 273°F, the sample apparatus was purged with flue gas for a minimum of 5-minutes prior to initiating a test. During the run, probe and filter temperatures were maintained and dry gas meter (DGM) volume, temperatures, and sample apparatus vacuum were recorded at 5-minute intervals.

After collecting a minimum 240-liter sample volume, sampling was stopped, and a post-test leak check was performed. Refer to Appendix B for the field test data sheets.

The impingers were removed from the sample apparatus and transported to the recovery area. The acidic and alkaline impinger contents were transferred to separate, labeled polyethylene sample containers. While the alkaline impinger contents were submitted to the laboratory, they were not analyzed, as halogens were not being assessed as part of the test program. Each impinger was rinsed with deionized water and the rinsate collected in the appropriate sample container. Approximately 0.5 milligrams of sodium thiosulfate was added to the sample storage bottle containing the 0.1 N NaOH impinger catch to assure a complete reaction with the hypohalous acid to form a second chlorine ion. Refer to Figure 4-9 for the Method 26 sample recovery scheme.

The sample containers, including reagent and water blanks, were transported via courier to the Consumers Energy Laboratory Services facility in Jackson, Michigan under chain-of-custody for hydrogen chloride analysis. The chain of custody was prepared in accordance with ASTM D4840-99(2018) procedures and included the sample date, collection time, identification, and requested analysis. Refer to Figure 4-10 for the Method 26 laboratory analytical scheme and Appendix C for the laboratory data sheets.

Figure 4-9. USEPA Method 26 Sample Recovery Scheme

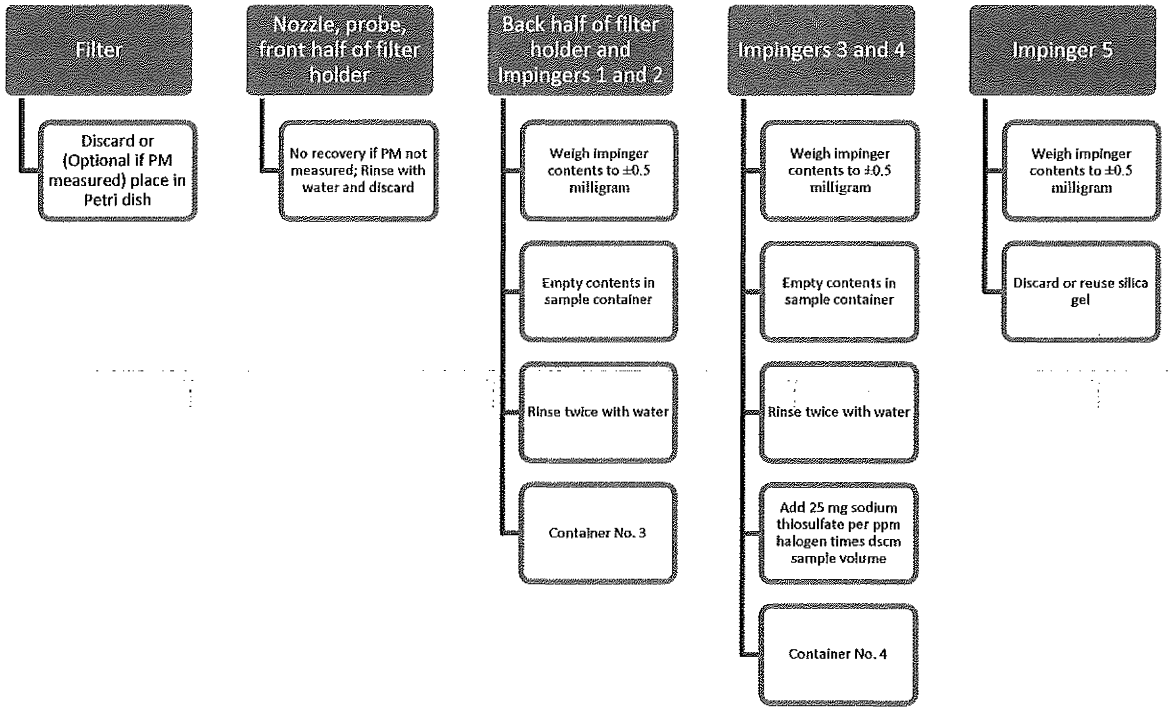
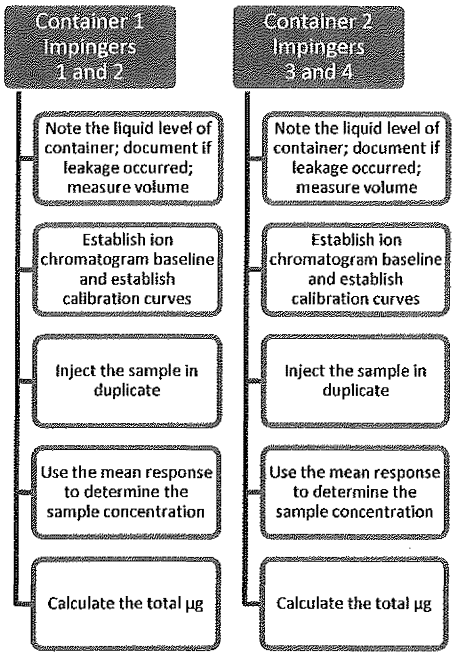


Figure 4-10. USEPA Method 26 Sample Analytical Scheme



4.1.8 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 FPM and HCl 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 4-11 presents the equation used to calculate lb/mmBtu emission rate:

Figure 4-11. 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)

5.0 TEST RESULTS AND DISCUSSION

The test results obtained as required by 40 CFR 63, Subpart UUUUU, the CD, and the MDEQ ROP MI-ROP-B2835-2013b on September 26 and 27, 2018 indicate the average of the three FPM and HCl runs performed on Unit 2 measured less than or equal to 50 percent of the MATS 0.030 lb/mmBtu FPM and 0.0020 lb/mmBtu HCl limits in Table 2. Therefore, Unit 2 has met the applicable MATS and LEE limits for the 9th consecutive calendar quarter. Refer to Section 2.3 for a summary of the test results.

Table 5-1 depicts a chronological list of qualifying Unit 2 LEE tests.

Table 5-1
MATS LEE PM and HCl Test Event Chronology, JHC Unit 2

Performance Test			Compliance Quarter Event		PM Result (lb/mmBtu)	HCl Result (lb/mmBtu)
Year	Quarter	Date	PM	HCl		
2016	3	July 8	NA	1	NA	0.00050
		August 23-24	1	NA	0.0045	NA
2016	4	October 25	2	2	0.0028	0.00019
2017	1	April 11	3	3	0.0020	0.0001
2017	2	May 9	4	4	0.0025	<0.0001
2017	3	September 14-15	5	5	0.0006	<0.0001
2017	4	November 1	6	6	0.0005	<0.00005
2018	1	June 4-5	7	7	0.0011	0.00005
2018	2	June 27-28	8	8	0.0007	<0.00005
2018	3	September 26-27	9	9	0.0007	<0.00011

5.1 TABULATION OF RESULTS

Table 2-1 in Section 2 of this report summarizes the results and Appendix Tables 1 and 2 contain detailed tabulation of results, process operating conditions, and exhaust gas conditions.

5.2 SIGNIFICANCE OF RESULTS

The Unit 2 FPM and HCl results signify ongoing compliance with applicable MATS regulation limits, as well as 9 of 12 consecutive qualifying quarterly LEE tests. If 12 are achieved, reduced test frequency incentives will result.

The FPM results also indicate ongoing compliance with the CD limit and continued emission rates less than 0.010 lb/mmBtu FPM result, the Unit 2 annual FPM testing requirement is reduced to every other year, per the CD test frequency incentives in Paragraph 153.

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.

5.3 VARIATIONS FROM SAMPLING OR OPERATING CONDITIONS

No 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.

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 test will be the quarterly MATS test scheduled for the fourth quarter of 2018.

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. Based on discussions with the MDEQ, an audit sample shall be conducted once per year on either EUBOILER1 or EUBOILER2. An audit sample was ordered and analyzed for EUBOILER1 during the first quarter 2018 test event. The results of the audit sample analysis were within acceptable limits.

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 is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings

Table 5-2
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M1: Cyclonic flow evaluation	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 systems	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
M3A: System Bias and Analyzer Drift	Evaluates analyzer and sample system integrity and accuracy	Introduce calibration gas at probe, upstream of sample conditioned 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 sample no closer to the stack wall than 1.0 meter; 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
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	PM: ≥1 dscm LEE PM: ≥2 dscm
M5/202: Post-test leak check	Evaluate if system leaks biased the sample	Cap sample train; monitor DGM	Post-test	≤0.020 cfm

Table 5-2
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
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%
M5: Apparatus Temperature	Ensures purge of acid gases in glass probe liner and Teflon filter	Set probe & filter heat controllers to ≥248°F	Verify prior to and during each run	Apparatus temperature must be ≥248°F and ≤273°F
M26: sample rate	Ensure representative sample collection	Calculate rate based on volume collected	During and post-test	Target sample rate is ~ 2 liters/minute
M26: sample volume	Ensure sufficient sample volume is collected	Record pre- and post-test DGM volume reading	Post test	≥120 liters minimum; ≥240 liters minimum for LEE
M26: post-test leak check	Evaluate if the collected sample was affected by leak	Cap sample train; monitor DGM	Pre-test optional, post-test mandatory	Leak rate ≤ 2% of the average sample rate
M202: impinger temperature	Ensure collection of condensate	Maintain CPM filter temperature between 65°F and 85°F	Throughout test	CPM filter temperature must be ≥68°F and ≤85°F

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	0.3 mg	Sample volume was 200 milliliters Acetone blank corrections were applied
Method 5 Filter Blank	0.1 mg	Reporting limit is 0.1 milligrams
Method 202 DI H_2O Blank	1.2 mg	Sample volume was 200 milliliters Result is for inorganic condensable
Method 202 Acetone Blank	<1.0 mg	Sample volume was 150 milliliters Result is for organic condensable
Method 202 Hexane Blank	<1.0 mg	Sample volume was 140 milliliters Result is for organic condensable
Method 202 Field Train Recovery Blank	4.3 mg inorganic 1.0 mg organic	Maximum blank correction of 2.0 mg applied to results
Method 26 0.1 N H_2SO_4 Reagent Blank	<31.2 µg	Sample volume of 44 milliliters Blank corrections were not applied
Method 26 Water Blank	<59.2 µg	Sample volume of 190 milliliters Blank corrections were not applied