

Consumers Energy

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**PM and HCl
40 CFR 63, Subpart UUUUU
Test Report**

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APR 23 2018

EUBOILER1

AIR QUALITY DIVISION

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

April 18, 2018

Test Date: February 21, 2018

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 27538841
Version No.: 0

EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter and hydrogen chloride testing of the dedicated exhaust of coal-fired boiler EUBOILER1 (Unit 1) operating at the J.H. Campbell Generating Station in West Olive, Michigan. EUBOILER1 is a coal-fired electric utility steam generating unit (EGU) that turns a turbine connected to an electricity producing generator. The test program was performed on February 21, 2018 to evaluate compliance of the EUBOILER1 source with the applicable PM and HCl limits in 40 CFR 63, Subpart UUUUU, "National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units," (aka Mercury and Air Toxics Rule [MATS]) as incorporated in the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013b.

Triplicate 125-minute PM and HCl test runs were conducted following the procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 2, 3A, 4, 5, 19, and 26A in 40 CFR 60, Appendix A. There were no deviations from the approved stack test protocol or the associated USEPA Reference Methods. During testing, Unit 1 was operated within the maximum normal operating load requirement range of 90 and 110 percent of design capacity as specified in 40 CFR §63.10007(2). The Unit 1 PM and HCl results are summarized in the following table.

**Table E-1
Summary of JHC1 EUBOILER1 Test Results**

Parameter	Units	Run			Average	Emission Limit	
		1	2	3		MATS	MATS LEE ¹
PM	lb/mmBtu	0.0003	0.0009	0.00003	0.0004	0.030	0.015
HCl	lb/mmBtu	<0.00005	<0.00005	<0.00005	<0.00005	0.0020	0.0010

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

The results of the Unit 1 testing indicate the 3-run average PM and HCl results are in compliance with applicable MATS regulation limits and the qualifying low emitting EGU (LEE) PM and HCl emission rate thresholds.

Detailed 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.

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1.0 INTRODUCTION

This report summarizes the results of compliance air emissions testing conducted February 21, 2018 on EUBOILER1, operating at the Consumers Energy J.H. Campbell Plant in West Olive, Michigan.

This document follows the Michigan Department of Environmental Quality (MDEQ) format described in the December 2013, Format for Submittal of Source Emission Test Plans and Reports. Reproducing only a portion of this report may omit critical substantiating documentation or cause information to be taken out of context. If any portion of this report is reproduced, please exercise due care in this regard.

1.1 IDENTIFICATION, LOCATION, AND DATES OF TESTS

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted filterable particulate matter (PM) and hydrogen chloride (HCl) testing of the dedicated exhaust of coal-fired boiler EUBOILER1 (Unit 1) operating at the J.H. Campbell Generating Station in West Olive, Michigan on February 21, 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 letter reflects a standing approval for all quarterly MATS tests as long as no modifications from the original protocol are required, as was the case for this test event.

1.2 PURPOSE OF TESTING

The test program was performed on February 21, 2018 to evaluate compliance of the EUBOILER1 source with applicable PM and HCl limits and support qualification as a low emitting electrical generating unit (LEE) in 40 CFR 63, Subpart UUUUU, "National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units," (aka Mercury and Air Toxics Rule [MATS]) as incorporated in the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013b. The applicable MATS emission limits are presented in Table 1-1.

Table 1-1
Applicable MATS Emission Limits

Parameter	Emission Limit	Units	Applicable Requirement
PM	0.030	lb/mmBtu	Table 2 to Subpart UUUUU of Part 63— Emission Limits for Existing EGU's
HCl	0.0020		
lb/mmBtu pound per million British thermal unit heat input			

Qualification of LEE status as defined within MATS requires quarterly sampling over a period of three consecutive years. The results of each quarterly test must be less than or equal to 50 percent of the applicable standard listed in Table 2 of the MATS rule, equating to 0.015 lb/mmBtu for PM and 0.0010 lb/mmBtu for HCl.

1.3 BRIEF DESCRIPTION OF SOURCE

EUBOILER1 is a coal-fired electric utility steam generating unit (EGU) that turns a turbine connected to an electricity producing generator. The boiler is operated as needed to provide electricity to the regional grid and Consumers Energy customers.

1.4 CONTACT INFORMATION

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

**Table 1-2
Contact Information**

Program Role	Contact	Address
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	Ms. Kathryn M. Cunningham Senior Engineer 517-768-3462 kathryn.cunningham@cmsenergy.com	Consumers Energy Company Environmental Services Department 1945 West Parnall Road; P22-234 Jackson, Michigan 49201
Test Facility	Mr. Joseph 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. Thomas Schmelter, QSTI Engineering Technical Analyst II 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY OF RESULTS

2.1 OPERATING DATA

During the performance test, the boiler fired 100% western coal and was operated at maximum normal operating load conditions. 40 CFR §63.10007(2) states the maximum normal operating load is generally between 90 and 110 percent of design capacity but should be representative of site specific normal operations. The performance testing was performed while the boiler was operating within the range of 253 MWg to 254 MWg (92-93% of the achievable capacity).

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

2.2 APPLICABLE PERMIT INFORMATION

The J.H. Campbell generating station has State of Michigan Registration Number (SRN) B2835 and operates in accordance with air permit MI-ROP-B2835-2013b. The air permit incorporates state and federal regulations, and the USEPA has assigned the facility a Federal Registry Service (FRS) identification number of 110000411108. EUBOILER1 is the emission unit source identification in the permit and is included in the FGBOILER12 flexible group. Incorporated within the permit are the applicable requirements of 40 CFR 63, Subpart UUUUU – National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-fired Electric Utility Steam Generating Units.

2.3 RESULTS

The results of the testing indicate the Unit 1, 3-run average PM and HCl results are in compliance with applicable MATS regulation limits and the qualifying low emitting EGU (LEE) PM and HCl emission rate thresholds. This was the 7th quarterly performance test demonstrating LEE status for EUBOILER1 which began in quarter 3 of 2016. Refer to Table 2-1 for a summary of the PM and HCl test results.

Table 2-1
Summary of Test Results

Parameter	Units	Run			Average	Emission Limit	
		1	2	3		MATS	MATS LEE ¹
PM	lb/mmBtu	0.0003	0.0009	0.00003	0.0004	0.030	0.015
HCl	lb/mmBtu	<0.00005	<0.00005	<0.00005	<0.00005	0.0020	0.0010

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

Detailed results are presented in Appendix Table 1. A discussion of the results is presented in Section 5.0. Sample calculations, field data sheets, and laboratory results are presented in Appendices A, B, and C. Boiler operating data and supporting information are provided in Appendices D and E.

3.0 SOURCE DESCRIPTION

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

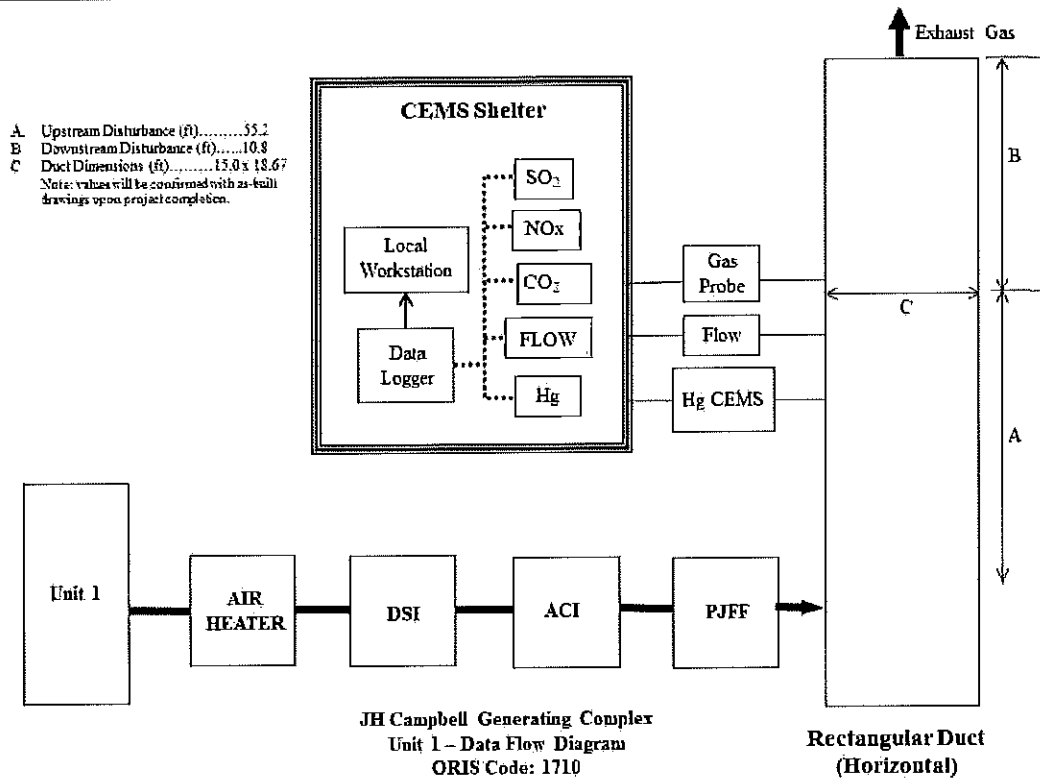
3.1 PROCESS

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 and over fire air (OFA) for NO_x control, a dry sorbent (lime) injection (DSI) system for control of sulfur dioxides (SO₂) and other acid gasses, an activated carbon injection (ACI) system for mercury (Hg) reduction, and a pulse jet fabric filter (PJFF) baghouse to control particulate matter emissions. Post control flue gas is exhausted to atmosphere through an approximately 400-foot high stack, which is 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 Subpart UUUUU. For this quarterly compliance test, Unit 1 was burning 100% western subbituminous coal.

3.4 RATED CAPACITY

Unit 1 has a nominally rated heat input capacity of 2,490 mmBtu/hr and can generate an electrical output of approximately 274 gross megawatts (MWg). The boiler operates in a continuous manner in order to meet the electrical demands of Midcontinent Independent System Operator, Inc. (MISO) and Consumers Energy customers. EUBOILER1 is considered a baseload unit because it is designed to operate 24 hours a day, 365 days a year.

3.5 PROCESS INSTRUMENTATION

The process was continuously monitored by boiler operators, environmental technicians, and data acquisition systems during testing. One-minute data for the following parameters were collected during each PM and HCl test run:

- CO₂ (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 control equipment process instrumentation and reference method data is recorded on Eastern Standard Time (EST), consistent with the continuous emissions monitoring systems. Refer to Appendix D for operating data.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy RCTS tested for PM and HCl using the United States Environmental Protection Agency (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 traverses	1	Sample and Velocity Traverses for Stationary Sources
Flow rate	2	Determination of Stack Gas Velocity and Volumetric Flow Rate
Oxygen	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	26A	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Isokinetic Method

4.1 DESCRIPTION OF SAMPLING TRAIN AND FIELD PROCEDURES

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

**Table 4-2
Test Matrix**

Date (2018)	Run	Sample Type	Start Time (EST)	Stop Time (EST)	Test Duration (min)	EPA Test Method	Comment
February 21, 2018	1	O ₂ PM HCl	8:23	10:40	125	1 3A 4 5 19 26A	No visible particulates on recovered filter. MDEQ witnessed testing.
	2		11:15	13:33	125		HCl audit sample presented to MDEQ and logged on Chain of Custody. MDEQ witnessed testing.
	3		13:58	16:13	125		Samples secured and Chain of Custody completed.

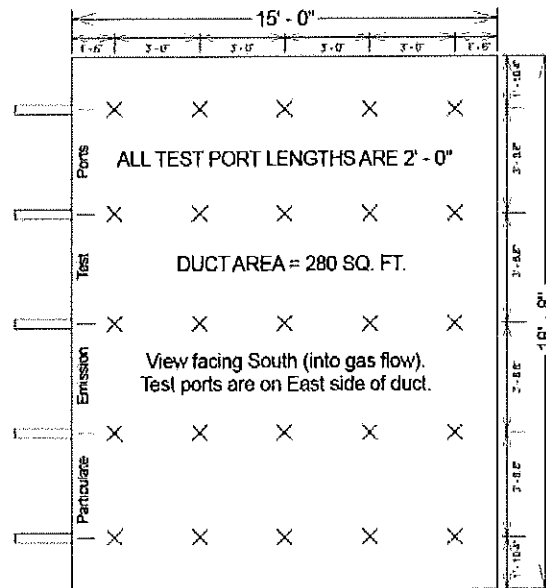
4.1.1 SAMPLE LOCATION AND TRAVERSE POINTS (USEPA METHOD 1)

The number and location of traverse points for measuring exhaust gas velocity and volumetric air-flow was determined in accordance with USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources*. Five test ports are located in the horizontal plane on east 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. The 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.

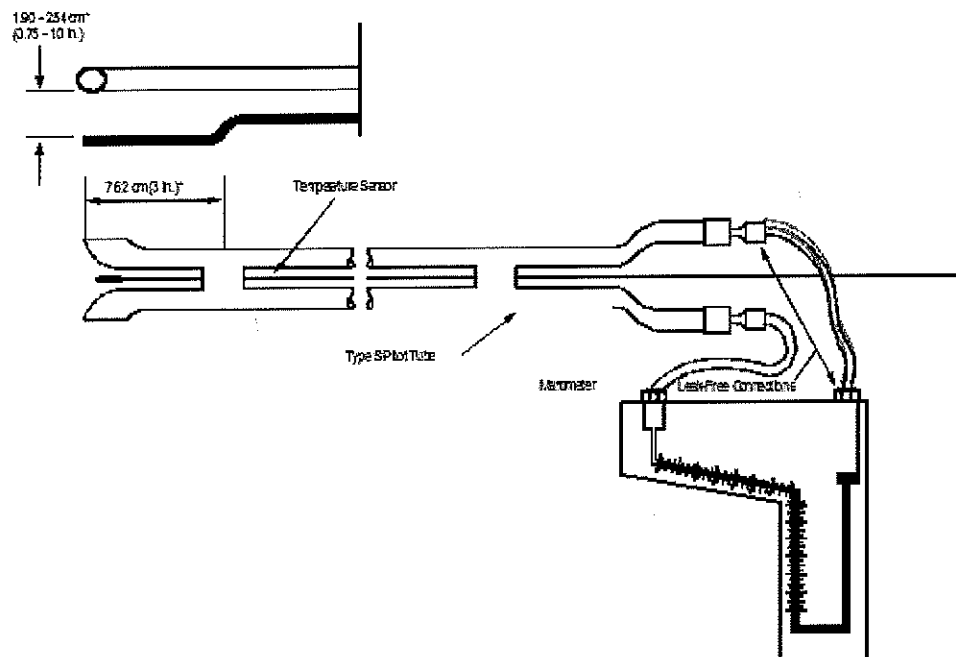
Figure 4-1. Unit 1 Duct Cross Section and Test Port/Traverse Point Detail



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



Appendix B includes cyclonic flow test data as verification of the absence of cyclonic flow at the sample location. Method 1, § 11.4.2 states "if the average (null angle) is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology...must be used." The average null yaw angle measured at the Unit 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.

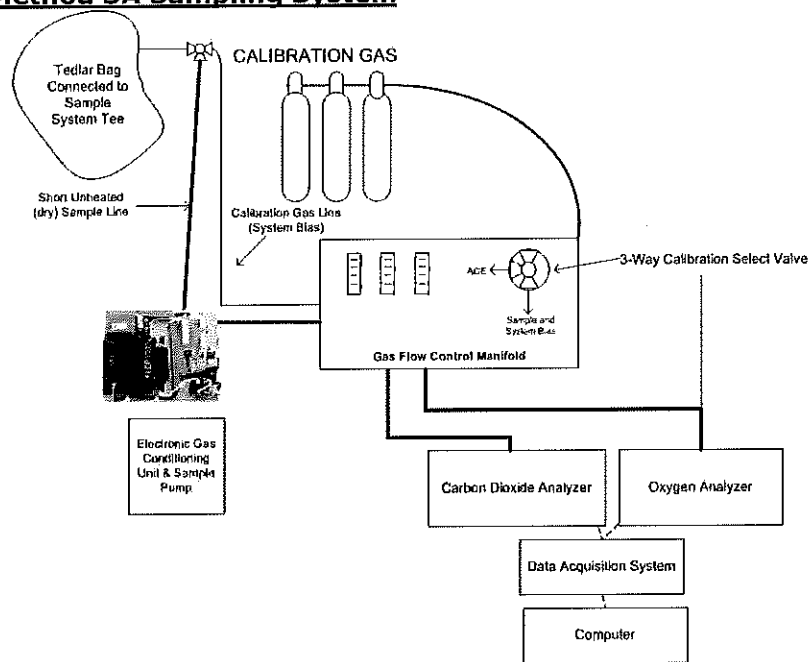
4.1.3 MOLECULAR WEIGHT (USEPA METHOD 3A)

The exhaust gas composition and molecular weight was measured using the sampling and analytical procedures of USEPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)*. The flue gas oxygen and carbon dioxide concentrations were used to calculate molecular weight, flue gas velocity, emissions in lb/mmBtu, and/or lb/1,000 lbs corrected to 50% excess air.

Flue gas was extracted from the stack through a heated stainless steel lined probe and inert tubing into a flexible sample bag. In lieu of performing a stratification test, integrated flexible bag samples were collected throughout each PM test from each of 25 traverse points.

The sample was then withdrawn from the flexible bag and conveyed through a gas conditioning system before entering paramagnetic and infrared gas analyzers measuring oxygen and carbon dioxide concentrations. Figure 4-3 depicts the Method 3A sampling system.

Figure 4-3. Method 3A Sampling System



Prior to sampling flue gas, the analyzers were calibrated by performing a calibration error test where zero-, mid-, and high-level calibration gases were introduced to the back of the analyzers. The calibration error check was performed to evaluate if the analyzers response was within $\pm 2.0\%$ of the calibration gas span. A system-bias and drift test was performed where the zero- and mid- or high- calibration gases were introduced at the inlet to the gas conditioner to measure the ability of the system to respond to within ± 5.0 percent of span.

At the conclusion of the bag sample analysis, an additional system bias check was performed to evaluate the drift from the pre- and post-test system bias checks. The system-bias checks evaluated if the analyzer drift was within the allowable criterion of $\pm 3.0\%$ of span from pre- to post-test system bias checks. The measured oxygen and carbon dioxide concentrations were corrected for analyzer drift. Refer to Appendix E for analyzer calibration supporting documentation.

4.1.4 MOISTURE CONTENT (USEPA METHOD 4)

The exhaust gas moisture content was measured using USEPA Method 4, *Determination of Moisture in Stack Gases* in conjunction with the Method 5 and 26A sample apparatus. Sampled gas was drawn through a series of impingers immersed in an ice bath to condense and remove water from the flue gas. The amount of water condensed and collected in the impingers was measured gravimetrically and used to calculate the exhaust gas moisture content.

4.1.5 PARTICULATE MATTER AND HYDROGEN CHLORIDE (USEPA METHODS 5 AND 26A)

Filterable particulate matter and hydrogen chloride samples were collected isokinetically following the procedures of USEPA Method 5 (RM5), *Determination of Particulate Matter Emissions from Stationary Sources*, and USEPA Method 26A (RM26A), *Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Isokinetic Method*. RM 5

measures filterable particulate matter (aka PM, FPM) collected on a filter heated to $248\pm 25^{\circ}\text{F}$, while RM26A measures hydrogen halides collected in acidic absorbing solutions. These reference methods were combined into a single sample apparatus to collect PM and HCl samples simultaneously.

In a letter to the USEPA dated February 10, 2016, Consumers Energy requested and received approval for the use of RM5, rather than MATS5 when conducting quarterly PM testing to demonstrate compliance with MATS PM limits. Consumers Energy also requested and received approval to combine RM5 and RM26A in one apparatus when determining quarterly PM and HCl MATS compliance. As part of this approval, the USEPA included additional test specifications; the first of which required comparative RM5 and MATS5 testing consisting of triplicate RM5 test runs immediately followed by triplicate MATS5 test runs at the same boiler operating condition. This comparative approach would help determine if the RM5 front half filter temperature criterion of $248\pm 25^{\circ}\text{F}$ would bias PM loading, relative to the $320\pm 25^{\circ}\text{F}$ front half filter criterion in MATS5. The comparative RM5/MATS5 test program requested by USEPA was conducted at the source on August 23-24, 2016. The subsequent RM5/MATS5 results indicated there was no appreciable PM emission rate differences between the methodologies used, thus for all subsequent quarterly Unit 2 PM events, including this test event, RM5 methodology was employed.

The second approval stipulation for a combined RM5 and RM26A sampling apparatus required substituting the RM5 specific glass fiber filter without organic binders with a 99.95 percent efficient on 0.3 dioctyl phthalate (DOP) smoke particles, Teflon and borosilicate glass fiber PM filter. Furthermore, a filter temperature maintained between 248°F and 273°F was required during sampling as specified in RM26A. Therefore, a combined RM5 and RM26A sample apparatus was used for each test run during this event that met the prescribed USEPA stated filter and sampling temperature stipulations.

The RM5 and 26A sampling apparatus was setup and operated in accordance with method requirements. The flue gas was passed through a Teflon lined nozzle, heated probe, heated borosilicate glass microfiber reinforced with woven glass cloth and bonded with polytetrafluoroethylene (PTFE) filter, and into a series of impingers with the configuration presented in Table 4-3. The filter collected filterable particulate matter and halide salts while the impingers collected water vapor, hydrogen halides, and halogens. Figure 4-4 depicts the USEPA Method 5/26A sampling apparatus.

**Table 4-3
USEPA Methods 5 and 26A Impinger Configuration**

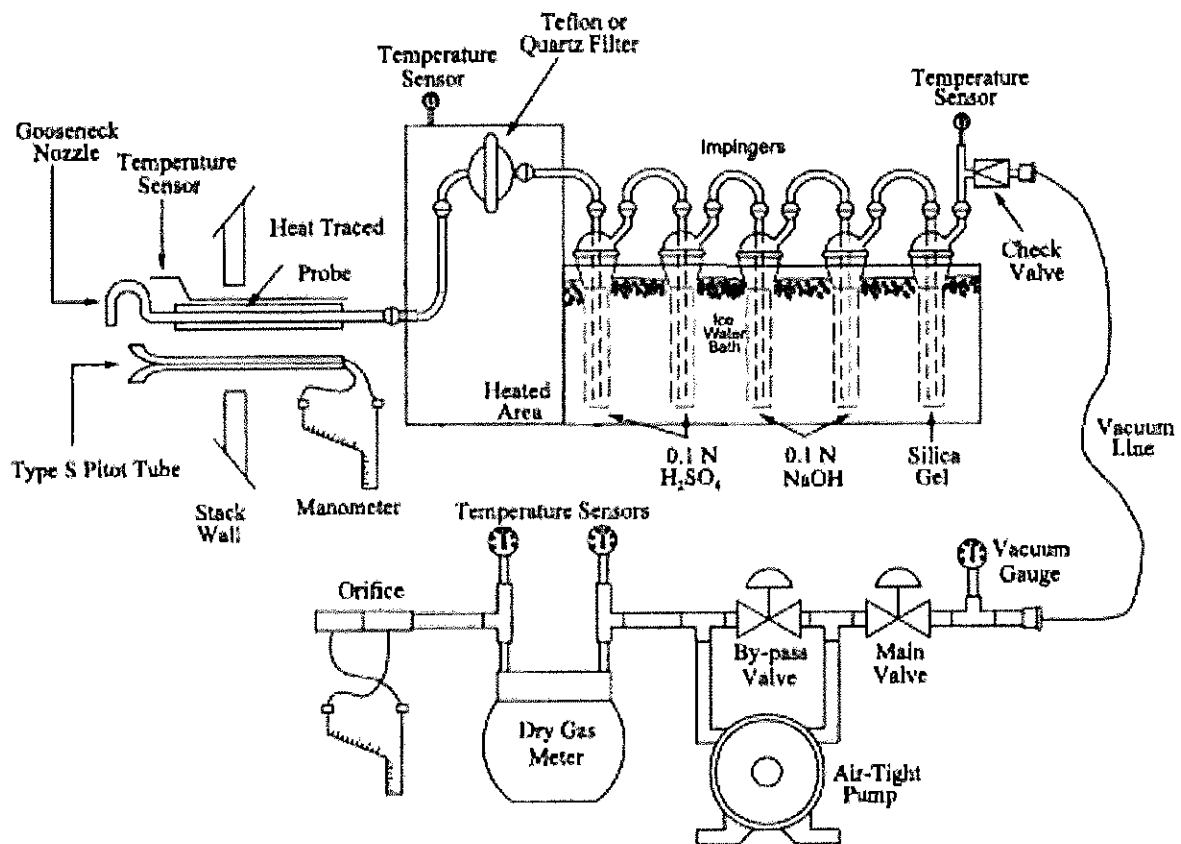
Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount (gram)
1	Greenburg-Smith	0.1 N H_2SO_4	~100
2	Greenburg-Smith	0.1 N H_2SO_4	~100
3	Modified	0.1 N NaOH	~100
4	Modified	0.1 N NaOH	~100
5	Modified	Silica Gel Desiccant	~200-300

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

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

Ice and water were placed around the impingers and the probe and filter temperature were allowed to stabilize to between 248°F and 273°F. After the desired operating conditions were coordinated with the facility, testing was initiated. Stack and sampling apparatus parameters (e.g., flue gas velocity head, filter temperature) were monitored to calculate and sample at the isokinetic rate within $100 \pm 10\%$ for the duration of the test. Refer to Appendix B for field data sheets.

Figure 4-4. USEPA Methods 5 and 26A Sampling Apparatus

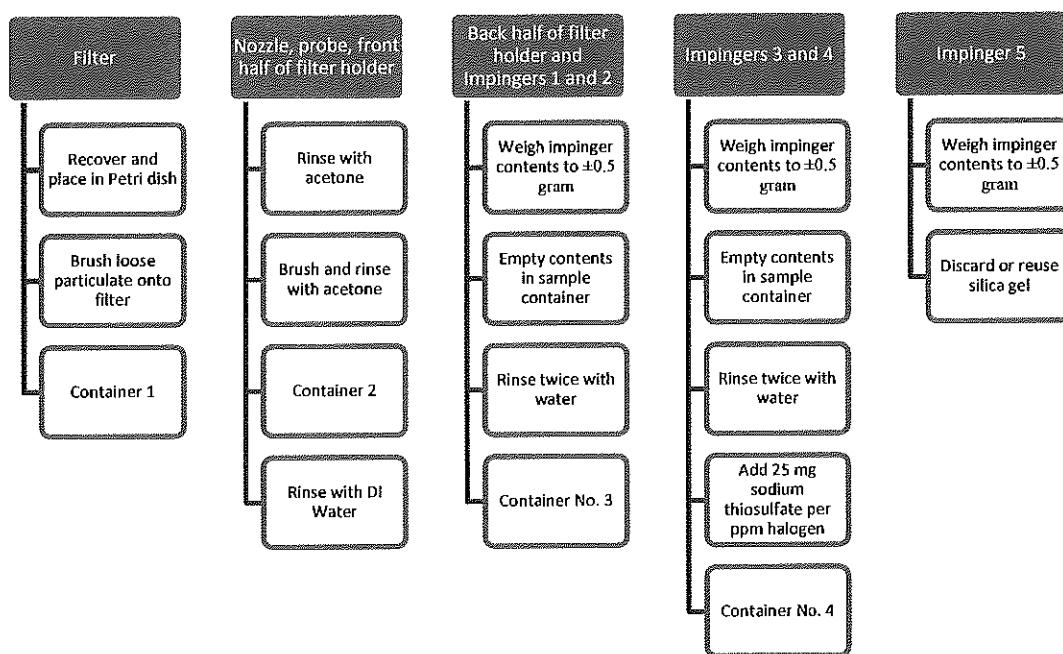


At the conclusion of a test run and post-test leak check, the sampling apparatus was disassembled and the impingers and filter housing were transported to the recovery area.

The filter was recovered from the filter housing and placed in a Petri dish, sealed with Teflon tape, and labeled as "FPM Container 1." The nozzle, probe liner, and the front half of the filter housing were triple rinsed with acetone to collect particulate matter. The rinsate was collected in pre-cleaned sample containers, sealed with Teflon tape, and labeled as "FPM Container 2." Prior to the start of subsequent runs, deionized, distilled water was used to final rinse the probe liner and nozzle; this rinse was discarded.

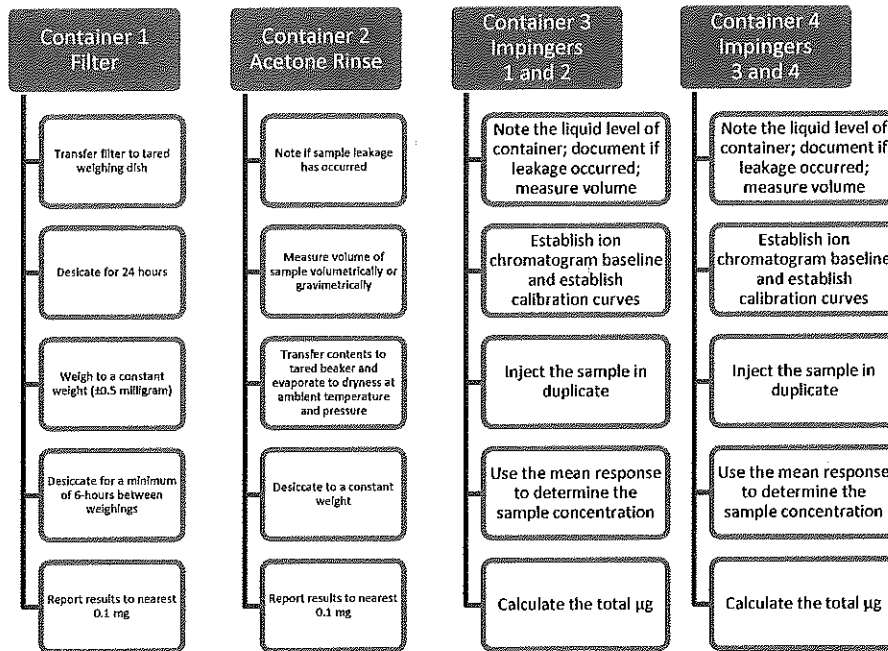
The weight of water vapor liquid collected in each impinger, including the silica gel impinger, was measured using an electronic scale. The volume of gas sampled and the difference between the pre-test and post-test impinger weights was used to calculate the moisture content of the sampled flue gas. The acidic and alkaline impinger contents were transferred to separate, labeled polyethylene sample containers. Each impinger was rinsed with deionized, distilled water and the rinsate was collected in the appropriate sample container. Approximately 20 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. The alkaline and acidic impinger contents were submitted to the laboratory. Since halogens are not part of this test program, the sample chain of custody directed the lab to not analyze the 0.1N NaOH samples unless notified. Refer to Figure 4-5 for the Method 26A sample recovery scheme.

Figure 4-5. USEPA Methods 5 and 26A Sample Recovery Scheme



The sample containers, including filters, reagents, and water blanks, were transported to the laboratory for analysis. The chain of custody was prepared in accordance with ASTM D4840-99(2010) procedures and included the sample date, collection time, identification, and requested analysis. The sample analysis followed USEPA Method 5 and 26A procedures as summarized in the analytical scheme presented in Figure 4-6. Refer to Appendix C for laboratory data sheets. Included with the samples was an HCl performance audit sample and associated documentation. Refer to Section 5.7.1 for further discussion of the audit sample results.

Figure 4-6. USEPA Methods 5 and 26A Analytical Scheme



4.1.6 EMISSION RATES (USEPA METHOD 19)

USEPA Method 19, *Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates*, was used to calculate PM 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 4-7 presents the equation used to calculate lb/mmBtu emission rate:

Figure 4-7. USEPA Method 19 Equation 19-6

$$E = C_d F_c \frac{100}{\%CO_{2d}}$$

Where:

- E = Pollutant emission rate (lb/mmBtu)
- C_d = Pollutant concentration, dry basis (lb/dscf)
- F_c = Volumes of combustion components per unit of heat content
1,840 scf CO₂/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 program was performed to evaluate compliance with the applicable PM and HCl limits in 40 CFR 63, Subpart UUUUU, "National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units," (aka Mercury and Air Toxics Rule [MATS]) as incorporated in the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2835-2013b.

5.1 TABULATION OF RESULTS

The results of the testing indicate the 3-run average PM and HCl results are in compliance with applicable limits and with the low emitting EGU LEE PM and HCl emission rates for Unit 1 under the MATS regulation. Table 2-1 summarizes the results and Appendix Table 1 presents detailed tabulation of results, process operating conditions, and exhaust gas conditions.

5.2 SIGNIFICANCE OF RESULTS

The results of the testing indicate compliance with the MATS rule and ROP.

5.3 VARIATIONS FROM SAMPLING OR OPERATING CONDITIONS

No operating condition variations were encountered during the test program. Two flexible sample bags were used concurrently during each test run to collect sufficient volume of flue gas for determining molecular weight, using USEPA Method 3A. The contents of each bag were analyzed for Oxygen and Carbon Dioxide concentration individually; the resulting concentrations of the paired bag samples for each run were then averaged together. The analysis of the second sample bag of Run 2 however, indicated the integrity of the sample bag had been compromised, and only the results of Run 2, Bag 1 were used for calculating molecular weight.

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. Subsequent air emissions testing will be performed in the second 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). The PA sample consist 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 was obtained for this test program.

After estimating the HCl concentration in the flue gas at the compliant emission limit using The NELAC Institute (TNI) Stationary Source Audit Sample (SSAS) Program audit sample calculation tool, the HCl PA was requested from Environmental Resource Associates (ERA) and obtained prior to the test event.

The audit sample was brought to the field sampling location, handled, and submitted in the same manner as the collected samples. The samples were analyzed at Consumers Energy Laboratory Services facility in Jackson, Michigan. At the laboratory, the audit sample was analyzed by the same analyst using the same analytical reagents and analytical system and at the same time as the compliance samples.

The audit sample result met the $\pm 10\%$ fixed acceptance limit criterion for the specific HCl audit concentration requested. Refer to Table 5-1 for a summary of the audit sample results in comparison the acceptable criterion. ERA's Audit Evaluation Report is included in Appendix C.

Table 5-1
Summary of Audit Sample Results

Analyte Code	Analyte	Units	Reported Value	USEPA Background Value	Difference	Valid Range	Evaluation
1770	HCl	mg/L	13.7	14.3	0.6	12.9-15.7	Acceptable

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
M2: Pitot tube calibration and standardization	Verify construction and alignment of Pitot tube	Inspect Pitot tube against specification and assign a coefficient	Pre-test and after each field use	Alignment and dimension requirements of M2

**Table 5-2
QA/QC Procedures**

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
		value		
M3A: Calibration gas standards	Ensures accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty $\leq 2.0\%$
M3A: Calibration Error	Evaluates operation of analyzers	Calibration gases introduced directly into analyzers	Pre-test	$\pm 2.0\%$ of the calibration span
M3A: System Bias and Analyzer Drift	Evaluates analyzer and sample system integrity and accuracy over test duration	Calibration gases introduced at sample probe tip, heated sample line, and into analyzers	Pre-test and Post-test	$\pm 5.0\%$ of the analyzer calibration span for bias and $\pm 3.0\%$ 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 sample no closer to the stack walls 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
M5/26A: 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
M5/26A: sample rate	Ensure representative sample collection	Calculate isokinetic sample rate	During and post-test	$100 \pm 10\%$ isokinetic rate
M26A: Apparatus Temperature	Ensures purge of acid gases in probe and on filter	Set probe & filter heat controllers to $\geq 248^\circ\text{F}$	Verify prior to and during each run	Apparatus temperature must be $\geq 248^\circ\text{F}$ and $\leq 273^\circ\text{F}$
M5/26A: sample volume	Ensure sufficient sample volume is collected	Record pre- and post-test dry gas meter volume reading	Post test	≥ 1 dscm minimum for PM; ≥ 2 dscm minimum for LEE PM ≥ 0.75 dscm minimum for HCl; ≥ 1.5 dscm minimum for LEE HCl
M5/26A: post-test leak check	Evaluate if the sample was affected by system leak	Cap sample train; monitor dry gas meter	Post-test	≤ 0.020 cfm
M5/26A: post-test meter audits	Evaluates accurate measurement equipment for sample volume	DGM pre- and post-test; compare calibration factors (Y and Yq)	Pre-test Post-test	$\pm 5\%$

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	0.8 mg	Sample volume was 200 milliliters Acetone blank corrections were applied
Method 5 Filter Blank	0 mg	Reporting limit is 0.1 milligrams
Method 26A 0.1 N H ₂ SO ₄ Reagent Blank	<82.5 µg	Blank corrections were not applied
Method 26A Water Blank	<63.8 µg	Blank corrections were not applied

Appendix Table

Table 1 - Particulate Matter and Hydrogen Chloride Results

Facility and Source Information		Units	Run 1	Run 2	Run 3	Average
Customer:			JH Campbell			
Source:			EUBOILER1			
Work Order:			27538841			
Date:			2/21/2018	2/21/2018	2/21/2018	
Unit Load:	MW _g		253	254	254	254
Stack Length, L	inches		224.0	224.0	224.0	
Stack Width, W	inches		180.0	180.0	180.0	
Cross-sectional Area of Stack, A	ft ²		280.00	280.00	280.00	
Source Pollutant Test Data		Units	Run 1	Run 2	Run 3	Average
Barometric Pressure, P _{bar}	inches of Hg		29.74	29.85	29.90	29.83
Dry Gas Meter Calibration Factor, Y	dimensionless		1.009	1.009	1.009	1.009
Pitot Tube Coefficient, C _p	dimensionless		0.84	0.84	0.84	0.84
Stack Static Pressure, P _g	inches of H ₂ O		2.50	2.50	2.50	2.50
Nozzle Diameter, D _n	inches		0.265	0.265	0.265	0.265
Run Start Time	hr:mm		8:23	11:15	13:58	
Run Stop Time	hr:mm		10:40	13:33	16:13	
Duration of Sample, θ	minutes		125	125	125	125
Dry Gas Meter Leak Rate, L _p	cfm		0.000	0.000	0.000	0.000
Dry Gas Meter Start Volume	ft ³		285.67	385.41	485.46	385.51
Dry Gas Meter Final Volume	ft ³		384.75	484.81	583.78	484.44
Average Pressure Difference across the Orifice Meter, ΔH	inches of H ₂ O		2.14	2.20	2.13	2.16
Average Dry Gas Meter Temperature, T _m	°F		71.1	69.5	70.4	70.3
Average Square Root Velocity Head, √Δp	√inches H ₂ O		0.8229	0.8418	0.8281	0.8309
Stack Gas Temperature, T _{g(average)}	°F		305.3	309.2	310.4	308.3
Source Moisture Data			Run 1	Run 2	Run 3	Average
Volume of Water Vapor Condensed in Silica Gel, V _{wsg(scd)}	scf		0.8	1.0	1.2	1.0
Total Volume of Water Vapor Condensed, V _{w(stst)}	scf		11.802	12.042	11.830	11.891
Volume of Gas Sample as Measured by the Dry Gas Meter, V _m	dcf		99.081	99.400	98.308	98.930
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, V _{m(stst)}	dscf		99.279	100.280	99.149	99.569
Volume of Gas Sample Measured by the Dry Gas Meter corrected to STP, V _{m(stst)}	dscfm		2.812	2.840	2.808	2.82
Moisture Content of Stack Gas, B _{ws}	% H ₂ O		10.62	10.72	10.66	10.67
Gas Analysis Data			Run 1	Run 2	Run 3	Average
Carbon Dioxide, %CO ₂	%, dry		11.8	11.6	12.6	12.0
Oxygen, %O ₂	%, dry		7.8	7.9	6.4	7.4
Nitrogen, %N	%, dry		80.5	80.4	81.0	80.6
Dry Molecular Weight, M _d	lb/lb-mole		30.19	30.18	30.28	30.22
Wet Molecular Weight, M _w	lb/lb-mole		28.90	28.87	28.97	28.91
Percent Excess Air, %EA	%		57.80	59.79	42.53	53.37
Fuel F-Factor, F _o	dimensionless		1.116	1.113	1.150	1.126
Fuel F-Factor, F _c	scf/mmBtu		1.840	1.840	1.840	1.840
Gas Volumetric Flow Rate Data			Run 1	Run 2	Run 3	Average
Average Stack Gas Velocity, v _g	ft/s		55.6	56.9	55.9	56.1
Stack Gas Volumetric Flow Rate, Q	acfm		934,023	956,505	939,300	943,276
Stack Gas Standard Volumetric Flow Rate, Q _s	scfm		644,472	659,069	647,282	650,274
Stack Gas Dry Standard Volumetric Flow Rate, Q _{std}	dscfm		576,001	588,410	578,284	580,898
Percent of Isokinetic Sampling, I	%		100.9	99.7	100.3	100.3
Gas Concentrations and Emission Rates			Run 1	Run 2	Run 3	Average
Mass of Filterable PM Collected, m _n	mg		0.80	2.59	0.09	1.16
Filterable PM Concentration, c _s	gr/dscf		0.00012	0.00040	0.00001	0.00018
Filterable PM Concentration at Stack Conditions, c _{s@stack conditions}	mg/wacm		0.175	0.561	0.020	0.252
Filterable PM Concentration, C _s [Actual Conditions, Wet Basis]	lb/1,000 lbs		0.00021	0.00068	0.00002	0.00031
Filterable PM Concentration, C _{s50} [Actual Conditions, Wet Basis]	lb/1,000 lbs @ 50% EA		0.00022	0.00072	0.00002	0.00032
Filterable PM Mass Emission Rate, E	lb/hr		0.61	2.01	0.07	0.90
Filterable PM, lb/mmBtu, E	lb/mmBtu		0.0003	0.0009	0.00003	0.0004
Filterable PM, tpy [Assumes 8,760 Hrs/Yr Operation]	tpy		2.67	8.79	0.31	3.92
Mass of HCl Collected, M _{Hx}	mg		<0.157	<0.152	<0.151	<0.153
HCl Concentration, c _{Hx}	gr/dscf		<0.00002	<0.00002	<0.00002	<0.00002
HCl Mass Emission Rate, E _{Hx}	lb/hr		<0.12	<0.12	<0.12	<0.12
HCl Mass Emission Rate	lb/mmBtu		<0.00005	<0.00005	<0.00005	<0.00005
HCl Mass Emission Rate [Assumes 8,760 Hrs/Yr Operation]	tpy		<0.53	<0.52	<0.51	<0.52