Consumers Energy
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Hg CEMS RATA Report

EUBOILER3

Consumers Energy Company
J.H. Campbell Generating Complex
17000 Croswell Street
West Olive, Michigan 49460
SRN:2835

November 1, 2023

Test Date: September 21, 2023

Test performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Department
Work Order No. 41142206
Revision No.: 1.0

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1.0 INTRODUCTION

Consumers Energy Company (Consumers Energy), Regulatory Compliance Testing Section (RCTS) performed a relative accuracy test audit (RATA) on the mercury (Hg) continuous emission monitoring system (CEMS) installed in the exhaust duct of emission unit EUBOILER3 (Unit 3) operating at the Consumers Energy J.H. Campbell Generating Complex located in West Olive, Michigan. The Hg CEMS RATA was performed on September 21, 2023, to satisfy United States Environmental Protection Agency (USEPA) requirements 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 [MATS] Rule) as incorporated in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-B2835-2020b.

A test notification and protocol containing detailed sampling, calibration and quality assurance procedures was submitted to the USEPA on July 12, 2023, EGLE on August 16, 2023, and subsequently approved by Jeremy Howe, Supervisor of EGLE's Technical Programs Unit of the Air Quality Division, on August 17, 2023. The Hg CEMS RATA test program followed the test protocol without deviation and incorporated USEPA test methods 4, 30A, and 30B.

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1.1 Contact Information

RCTS representatives Thomas Schmelter and David Kawasaki conducted the RATA on September 21, 2023. Kevin Starken, Supervisor – Engineering Support, and Joe Mason, Senior Equipment Technician, at the Consumers Energy J.H. Campbell Generating Complex coordinated the tests with applicable plant personnel and verified CEMS data.

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

Table 1-1
Test Program Contact List

Program Role	Contact	Address
EPA Regional Contact	Michael Compher 312-866-5745 compher.michael@epa.gov	U.S. EPA Region 5 77 W. Jackson Blvd. (AR-18J) Chicago, IL 60604
State Regulatory Administrator	Jeremy Howe Technical Programs Unit Supervisor 231-878-6687 howej1@michigan.gov	EGLE Technical Programs Unit Constitution Hall, 2nd Floor S 525 W. Allegan Lansing, Michigan 48933
State Regulatory Inspector	Heidi Hollenbach Air Quality Manager Grand Rapids District 616-540-1136 hollenbachh@michigan.gov	EGLE Grand Rapids District Office 350 Ottawa Avenue NW, Unit 10 Grand Rapids, Michigan 49503-2316
Responsible Official	Nathan J. Hoffman Director of Plant Operations 616-738-5436 nathan.hoffman@cmsenergy.com	Consumers Energy J.H. Campbell Generating Complex 17000 Croswell Street West Olive, Michigan 49460

Program Role	Contact	Address
Site Environmental	Kevin Starken Supervisor – Engineering Support 616-738-3241 kevin.starken@cmsenergy.com	Consumers Energy J.H. Campbell Generating Complex 17000 Croswell Street West Olive, Michigan 49460
CEMS Technician	Joe Mason Senior Equipment Technician 616-738-3278 joe.mason@cmsenergy.com	Consumers Energy J.H. Campbell Generating Complex 17000 Croswell Street West Olive, Michigan 49460
Test Team Representative	Thomas Schmelter, QSTI Sr. Engineering Technical Analyst 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY OF RESULTS

The RATA results indicate the Unit 3 Hg CEMS installed and operated at the J.H. Campbell Generating Complex meets the RATA acceptance criteria for on-going quality assurance test requirements in Appendix A of the MATS Rule. The RATA results are summarized in Table 2-1 with detailed results presented in Appendix A.

2.1 Operating Data

During the relative accuracy tests, the boiler was operated at the normal operating level, designated as High load between 698.1 to 910.0 megawatts (MW), as defined in the site-specific monitoring plan and determined following the provisions in 40 CFR 75, Appendix A, §6.5.2.1. Add-on controls were operated in a normal manner. Boiler operating data recorded during the testing are provided in Appendix E.

2.2 Applicable Permit Information

The J.H. Campbell Generating Complex operates under State of Michigan Registration Number (SRN) B2835 and in accordance with air permit MI-ROP-B2835-2020b, issued on July 2, 2021. The air permit incorporates federal regulations and reporting requirements, and the facility has been assigned a Facility Registry Service (FRS) identification number 110000411108. EUBOILER3 is the emission unit source identified in the permit and included in the FGMATS_U3 flexible group. Incorporated within the permit are the applicable requirements of the MATS Rule.

2.3 Results

The Hg CEMS installed and operated at J.H. Campbell Generating Complex Unit 3 meets the applicable On-Going QA Test Requirements of 40 CFR 63, Subpart UUUUU, Appendix A, Table A-2. The results of the Hg CEMS RATA indicate that Unit 3 meets the RA performance specification criterion of ≤20% and the alternative performance specification criterion where the absolute difference of the RM and CEMS Hg concentrations plus the confidence coefficient must be ≤0.5 µg/scm when the average RM Hg concentration is <2.5 µg/scm. The results of the Hg CEMS RATA are summarized Table 2-1.

Table 2-1
Summary of Hg CEMS RATA Results

Source	RM_{avg} (µg/scm)	C_{avg} (µg/scm)	CC	RATA RA Result (%) Passing: ≤20.0%	Alternative RATA Result (µg/scm)[1] Passing: ≤0.5
EUBOILER3	0.967	0.967	0.0384	**3.98**	**0.038**

RA relative accuracy
C_{avg} mean CEMS value
RM_{avg} mean reference method value
CC confidence coefficient from Equation 2-5 of Performance Specification 2 in Appendix B of 40 CFR Part 60
[1] RM_{avg} must be <2.5 µg/scm to evaluate relative accuracy by the alternative acceptance criteria of $|RM_{avg}+C_{avg}|+|CC| \leq 0.5$ µg/scm

To be consistent with the USEPA's Emission Collection Monitoring Plan System (ECMPS) reporting instructions[1], the run average Hg CEMS and RM concentrations have been rounded to the nearest 0.1 µg/scm before evaluating the RA. Results with Hg CEMS and RM concentrations rounded to three significant figures are also presented within the Results Tables contained in Appendix A. These results show similar agreement with the Table 2-1 results.

Sample calculations are presented in Appendix B. Detailed results and reference method data are presented in Appendix C. Laboratory data, including sample analysis, calibration results, and chain-of-custody forms, are presented in Appendix D. Boiler operating data and supporting information are provided in Appendix E. Quality assurance data is presented in Appendix F.

3.0 SOURCE AND MONITOR DESCRIPTION

EUBOILER3 is a coal-fired electric generating unit (EGU) that turns a turbine connected to an electricity-producing generator.

3.1 Process

Unit 3 is a dry bottom wall-fired boiler which combusts pulverized coal as the primary fuel and oil as an ignition/flame stabilization fuel. EUBOILER3 is classified as an existing EGU under the MATS rule. The source classification code (SCC) is 10100222. Coal is fired in the furnace where combustion heats water within boiler tubes to produce steam. The steam turns a turbine connected to an electricity producing generator and the electricity is routed through the transmission and distribution systems to consumers.

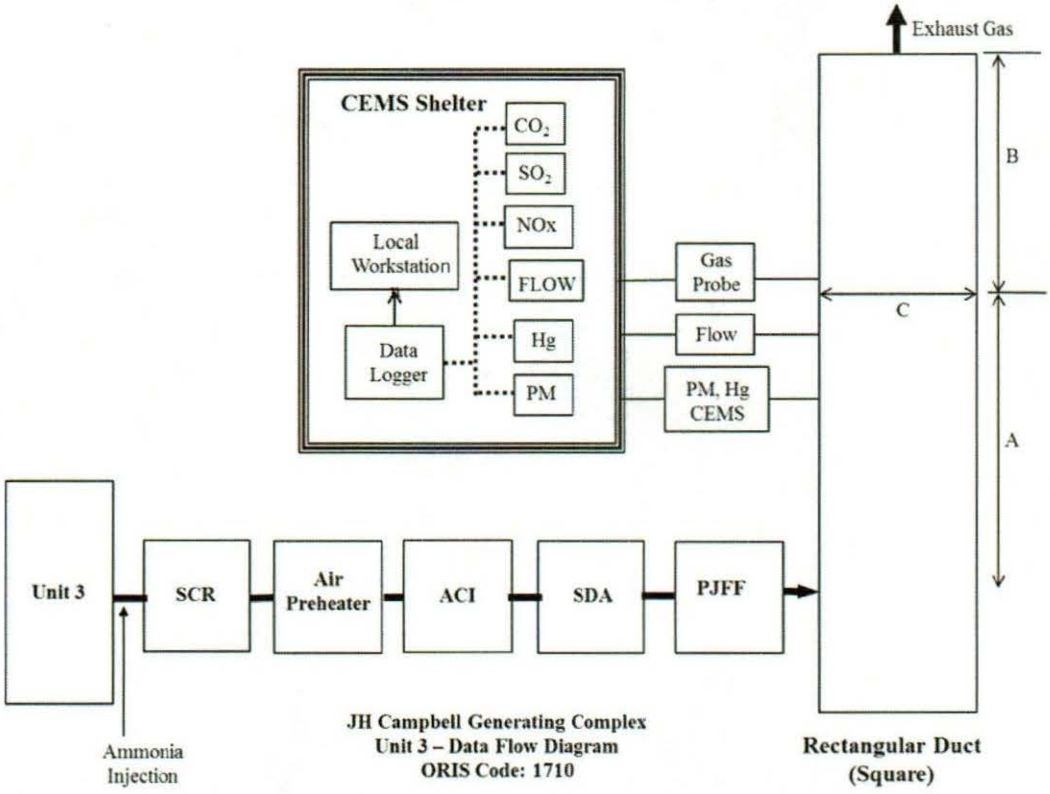
3.2 Process Flow

The flue gas generated through coal combustion is controlled by multiple pollution control devices. Unit 3 controls include: low-NO_x burners, over-fire air, and selective catalytic reduction (SCR) for NO_x control, activated carbon injection (ACI) for mercury (Hg) reduction, four spray dry absorber (SDA) modules for control of acid gases (e.g., sulfur oxides (SO_x), HCl), and a low pressure/high volume pulse jet fabric filter (PJFF) baghouse system for particulate matter control. After passing through the control device systems, flue

[1] Refer to Page 65 of the ECMPS Reporting Instructions for Quality Assurance and Certification (June 15, 2022).

gas is exhausted to atmosphere through an approximate 642-feet high stack. Refer to Figure 3-1 for the Unit 3 Data Flow Diagram.

Figure 3-1. Unit 3 Data Flow Diagram



3.3 Rated Capacity

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

Relative accuracy testing was performed with the unit operating at its current normal operating level(s), as defined in 40 CFR 75, Appendix A, §6.5.2.1. The range of operation for Unit 3 is 380 to 910 MW. The low operating level is the first 30% of the range of operation, mid is between 30% and 60% of the range of operation, and high is greater than 60% of the range of operation. During the test, Unit 3 average load was approximately 898 MW.

3.4 Process Instrumentation

The process was continuously monitored by boiler operators, environmental technicians, and data acquisition systems during testing. One-minute data for the Load (MW) and total vapor phase Hg (µg/scm) were collected during each Hg RATA test run. The sampling console clock time was synchronized with the Unit CEMS data logger time (Eastern Standard Time, or EST).

The facility measured Hg concentrations using a Tekran Instruments Corporation 3300 Mercury CEMS dilution-based system with data recorded by an ESC Spectrum (ESC) data acquisition and handling system (DAHS). Table 3-1 provides a summary of the mercury CEMS analyzer used to evaluate continuous compliance with 40 CFR 63, Subpart UUUUU and audited during this test program.

Table 3-1
Mercury Analyzer Specification Summary

Unit	Manufacturer and Model Number	Serial Number	Span Value (µg/scm)
EUBOILER3	Tekran Model 2537Xi	6112	10.0

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy performed the Hg CEMS RATA using the acceptable USEPA reference methods listed in 40 CFR 63, Subpart UUUUU, Appendix A §4.1.1.5. The applicable reference methods utilized during this test program are presented in Table 4-1. Ten, 30-minute runs were conducted on Unit 3 to calculate the mercury CEMS RA. Descriptions of the sampling and analytical procedures are presented in the following sections.

Table 4-1
Test Methods

Parameter	USEPA	
	Method	Title
Sample Location	1	Sample and Velocity Traverses for Stationary Sources
Molecular weight	3	Gas Analysis for the Determination of Dry Molecular Weight
Moisture	4	Determination of Moisture Content in Stack Gases
Mercury (sample location)	30A	Determination of Total Vapor Phase Mercury Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Mercury (sampling and analysis)	30B	Determination of Total Vapor Phase Mercury Emissions from Coal-Fired Combustion Sources using Carbon Traps

4.1 SAMPLE LOCATION AND TRAVERSE POINTS (USEPA METHODS 1 AND 30A)

The location and number of traverse points used to measure mercury concentrations were determined in accordance with USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources*, and USEPA Method 30A, *Determination of Total Vapor Phase Mercury Emissions from Stationary Sources (Instrumental Analyzer Procedure)*. Prior to testing, a minimum of one hour of representative Hg emissions data was collected by the CEMS. This data indicated expected Hg concentrations at the time of the Hg monitoring system RATA was ≤3 µg/m^3, which met the stratification testing exemption provisions of Section 8.1.3.4 of Method 30A. Quality assured data from the certified Unit 3 mercury CEMS used to document Hg concentrations prior to the RATA and the associated sixty-minute stratification exemption are presented in Appendix E. In accordance with Section 8.1.2 of Method 30A, samples were collected at three traverse points located at 0.4, 1.2, and 2.0 meters from the stack wall.

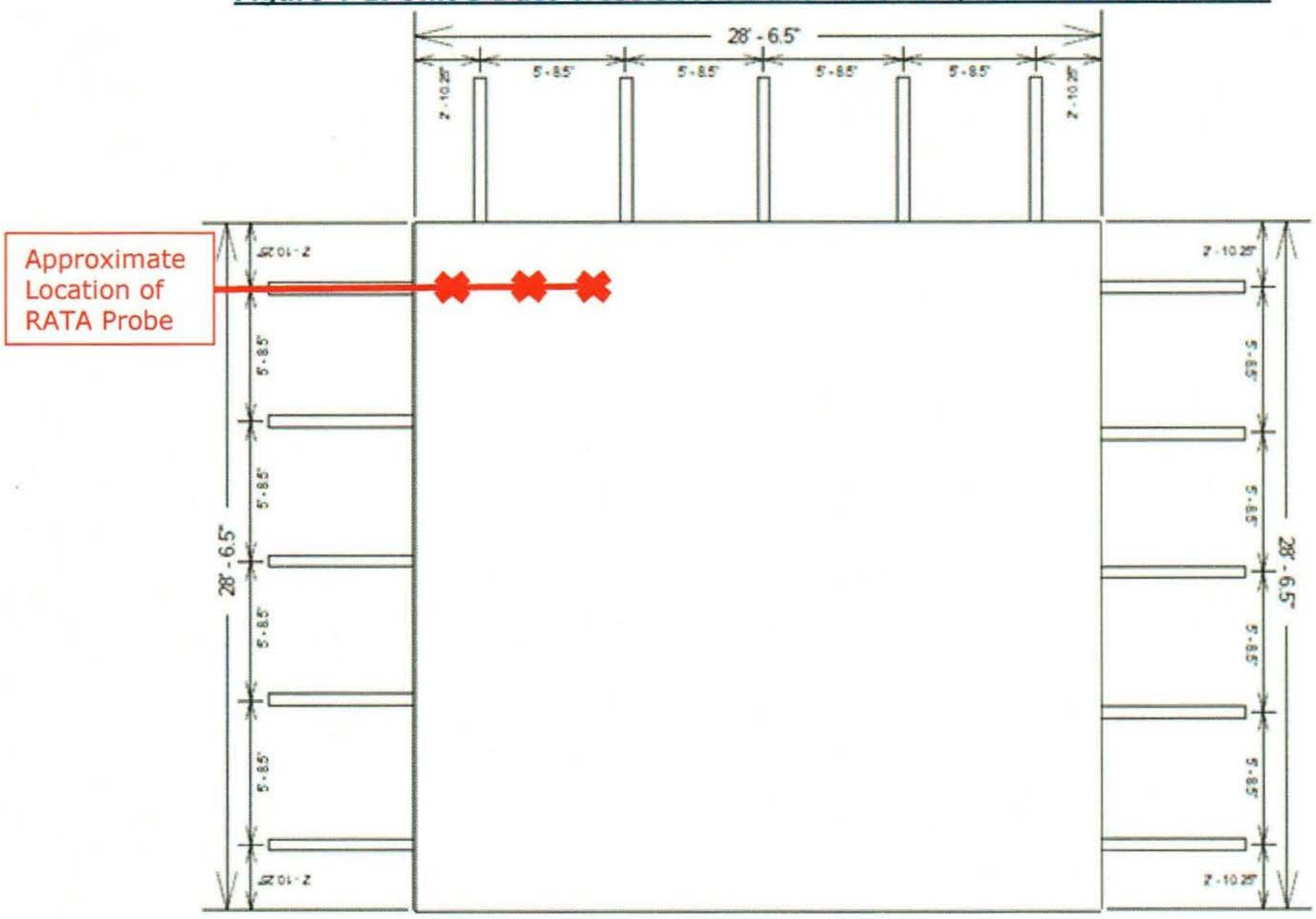
For the Unit 3 sampling location, five test ports are in the vertical plane on the top of the 28.54 feet by 28.54 feet square duct. Additional test ports are in the horizontal plane on the east and west sides of the duct. The ports are situated:

- Approximately 107.5 feet or 3.8 duct diameters downstream of a sound deadening silencer flow disturbance, and

- Approximately 23.1 feet or 0.8 duct diameters upstream of flow disturbance caused by a curve in the duct as it enters the exhaust stack.

The sample ports are 6-inches in diameter. A duct cross sectional diagram including the approximate location of the sample probe is presented in Figure 4-1. For this test event, the samples were collected from the topmost port located on the east side of the duct near the Hg CEMS probe.

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



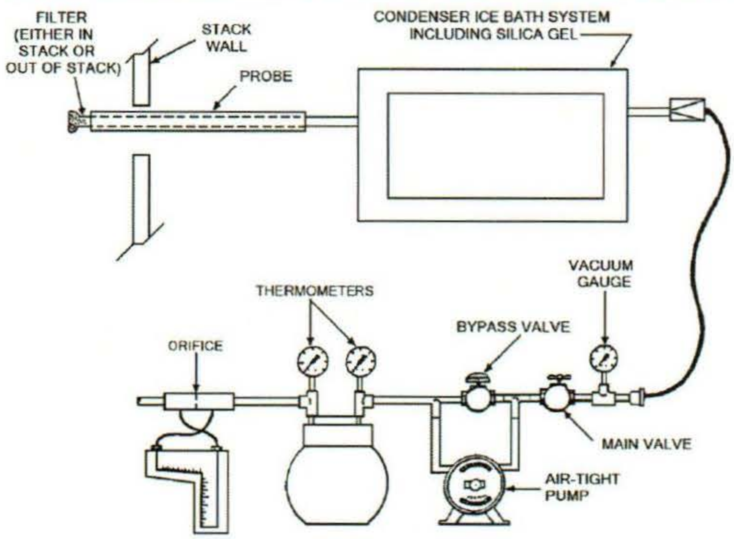
4.2 Molecular Weight (USEPA Method 3)

During the RATA, oxygen (O_2) and carbon dioxide (CO_2) concentrations were measured using calibrated Fyrite gas analyzers in order to calculate flue gas composition, following USEPA Method 3, *Gas Analysis for the Determination of Dry Molecular Weight*. Triplicate grab samples were captured in absorbing fluid, resulting in a proportional fluid rise to the gas concentration absorbed. Each sample concentration was read on the instrument scale, and the calculated dry molecular weight verified to not differ from the triplicate sample mean by more than 0.3 g/g-mole (0.3 lb/lb-mole), with the average result reported to the nearest 0.1 g/g-mole (0.1 lb/lb-mole).

4.3 Moisture Content (USEPA Method 4)

Exhaust gas moisture content for Unit 3 was determined using USEPA Method 4, *Determination of Moisture in Stack Gases*. Exhaust gas was drawn at a constant rate through a series of impingers immersed in an ice bath to condense moisture, which was subsequently measured gravimetrically to calculate moisture content. Refer to Figure 4-2 for a drawing of the RM4 Moisture Apparatus.

Figure 4-2. Reference Method 4 Moisture Apparatus



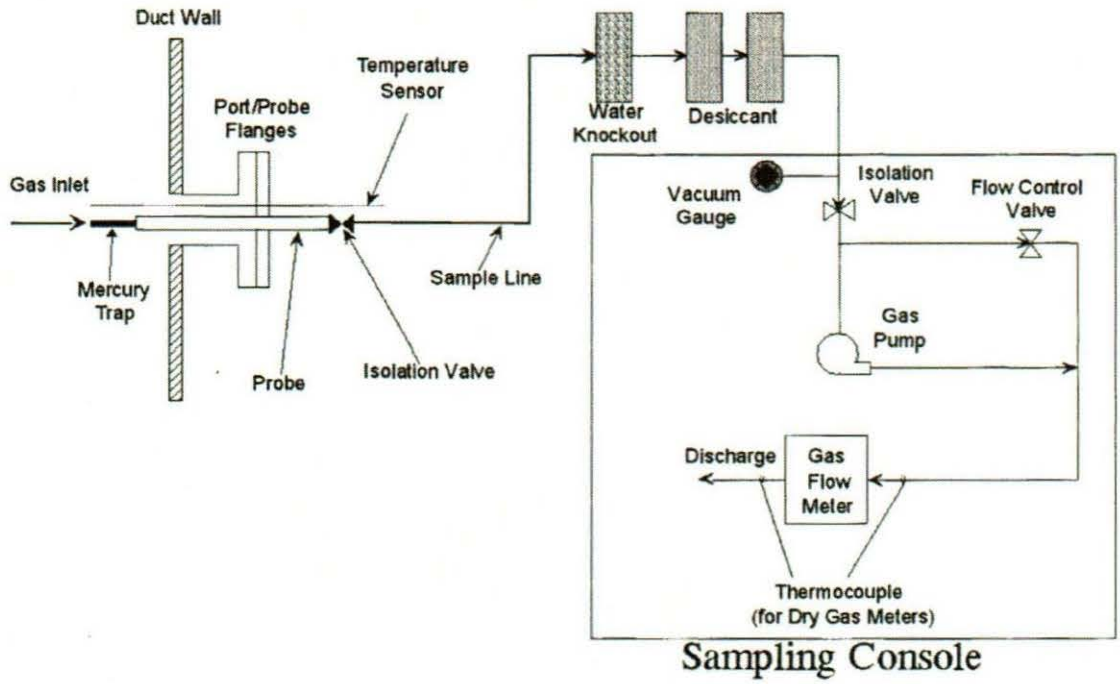
4.4 Mercury (USEPA Method 30B)

Mercury concentrations were measured following the procedures of USEPA Method 30B, *Determination of Total Vapor Phase Mercury Emissions from Coal-Fired Combustion Sources Using Carbon Traps*. Flue gas was extracted from the duct through paired, in-stack sorbent media traps situated in a heated probe at a constant flow rate. Each sorbent trap contained two sections, the first section quantitatively captured Hg and the second section was used to evaluate vapor phase Hg breakthrough. A heated sample line connected to the end of the probe transferred the sampled gas through a moisture removal system and into a dry gas metering console where sample volume and other parameters were recorded. Refer to Figure 4-3 for a depiction of the Method 30B sample train.

At the conclusion of the test run and after the post-test leak check, the sorbent traps were recovered from the sampling system and analyzed on-site using an Ohio Lumex RA-915+ analyzer. The contents of each section of the traps were carefully extracted onto a quartz glass ladle and placed into an oven where the captured mercury was thermally desorbed from the sample matrix (i.e., charcoal) at 680° Celsius. Vapor phase mercury was then measured using a calibrated atomic absorption spectrometry analyzer.

A minimum of three field recovery tests were performed where one of the paired sorbent traps was spiked with a known mass of mercury and used to sample flue gas during the test run. The field (spike) recovery tests assessed the recovery of the elemental mercury spike to determine measurement bias and verify data acceptability. The results of the field recovery tests met the acceptable performance criteria and are presented in Appendix C.

Figure 4-3. Method 30B Sorbent Trap Sampling Train



5.0 TEST RESULTS AND DISCUSSION

The Hg CEMS RATA was performed to satisfy USEPA requirements in 40 CFR 63, Subpart UUUUU and the ROP. The test results indicate that Unit 3 Hg CEMS met the acceptance criteria listed in Table A-2 of Appendix A of the MATS Rule.

The sampling console clock time was synchronized with the Hg CEMS DAHS clock prior to beginning each RATA (i.e., Eastern Standard Time). Test runs were 30 minutes in duration. RM field data run times were reported consistent with the Hg CEMS format (where the start minute and end minute are inclusive), however the field datasheets generated by the sampling console included in Appendix C show what could be perceived as an additional minute at the end of each run, in comparison to the Hg CEMS reports. This additional minute is the time when sampling was completed (i.e., the last reading was taken) and does not represent an average minute data value. An analogous situation exists for the moisture run end times reflected in these same appendices.

5.1 VARIATIONS AND UPSET CONDITIONS

Sorbent trap analysis with results lower than the analyzer method detection limit (MDL) of 1.57 nanograms (ng) Hg were reported as measured. Several sorbent trap analyses of the

Section 2 carbon beds resulted in negative Hg mass values. These negative values are presented in the Appendix C Sorbent Trap Results table; however, in these instances, a mass of zero (0.00) ng Hg was substituted for calculating Hg concentrations.

A response factor based on the analysis of a 2-ng calibration standard was applied to analytical results where the measured mass was greater than the MDL and less than the lowest point on the daily calibration curve.

5.2 Field Quality Assurance / Quality Control Procedures

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

Table 5-1
Summary of Sampling QA/QC Requirements

QA/QC Test or Specification	Acceptance Criteria	Frequency	Consequences if not met
Gas flow meter calibration (At 3 settings or points)	Calibration factor (Yi) at each flow rate must be within ± 2% of the avg. value (y)	Prior to initial use and when post-test check is not within ± 5% of Y	Recalibrate at 3 points until acceptance criteria are met.
Gas flow meter post-test calibration check	Calibration factor (Yi) at each flow rate must be within ± 5% of the Y value form most recent 3-pt. calibration	After each field test. For mass flow meters must be done onsite, using stack gas	Recalibrate gas flow meter at 3 pts. to determine a new value for Y. For mass flow meters, must be done onsite. Apply the new Y value to the field test data.
Temperature sensor calibration	Absolute temperature measured by the sensor within ± 1.5% of the reference sensor	Prior to initial use and before each test thereafter	Recalibrate; sensor may not be used until specification is met.
Barometer calibration	Absolute pressure measured by the instrument within ± 10 mmHg of reading with a mercury barometer	Prior to initial use and before each test thereafter	Recalibrate; instrument may not be used until specification is met.
Pre-test leak check	≤ 4% of target sampling rate	Prior to sampling	Sampling shall not commence until the leak check is passed.
Post-test leak check	Following daily calibration, 4% of average sampling rate	After sampling	Sample invalidated.
Multipoint analyzer calibration	Each analyzer reading within ±10% of true value and $r^2 \geq 0.99$	On the day of analysis, before analyzing any samples	Recalibrate until successful.
Analysis of independent calibration standard	Within ±10% of true value	Following daily calibration, prior to analyzing field samples	Recalibrate and repeat independent standard analysis until successful.

Table 5-1
Summary of Sampling QA/QC Requirements

QA/QC Test or Specification	Acceptance Criteria	Frequency	Consequences if not met
Analysis of continuing calibration verification standard (CCVS)	Within ±10% of true value	Following daily calibration, after analyzing ≤10 field samples, and at end of each set of analyses	Recalibrate and repeat independent standard analysis, reanalyze samples until successful, if possible; for destructive techniques, samples invalidated
Test run total sample volume	Within ± 20% of the total volume sampled during the field recovery test	Each individual sample	Sample invalidated.
Sorbent trap section 2 breakthrough	≤ 10% of section 1 Hg mass for Hg concentrations > 1 µg/dscm; ≤ 20% of section 1 Hg mass for Hg concentrations ≤ 1 and > 0.5 µg/dscm; ≤ 50% of section 1 Hg mass for Hg concentrations ≤ 0.5 and > 0.1 µg/dscm; no criteria for Hg concentrations ≤ 0.1 µg/dscm	Every sample	Sample invalidated.
Paired sorbent trap agreement	≤ 10% Relative Deviation mass for Hg concentrations > 1 µg/dscm; ≤ 20% or ≤ 0.2 µg/dscm absolute difference for Hg concentrations ≤ 1 µg/dscm.	Every run	Run invalidated.
Field recovery	Average recovery between 85% and 115% for Hg.	Average from three spiked sorbent traps.	Field sample runs not validated without successful field recovery test.
Field balance calibration check	Field balance must measure Class 6 weight within ±0.5 g of the certified mass.	Pre-test; before daily use	Perform corrective measures and repeat the check before using balance.
Moisture metering system	Meter ±2.0% of Y_d Temp Sensor ±2 °F Barometer ±10 mmHg	Pre and post-test	Test voided, or calculations for the test series shall be performed.

Method 30B requires that a field recovery test, which evaluates the performance of the combined sampling and analytical practices, must be successfully passed with a three-run average elemental Hg spike recovery of 85 to 115%, once per field test. The Method also allows for these field recovery test runs to be used as test runs when conducting an Hg CEMS RATA under 40 CFR 63, Subpart UUUUU, providing the relative deviation of the calculated Hg concentrations of the paired sorbent traps for each field recovery test run meet the QA criteria specified in Table 9-1 of Method 30B. Sorbent traps spiked with 30 ng of elemental Hg were utilized in Runs 1 through 3, and 10 with a calculated field recovery result of 106.1% based on Runs 1, 2, and 10. Field recovery test results are presented in the Sorbent Trap Results table in Appendix C.

Following the completion of the Unit 3 Hg CEMS RATA, RCTS performed a post-test "console audit" on the Hg sampling equipment used during the tests. The console audit is a series of quality verification procedures, which confirm the sampling console barometric pressure sensor, vacuum sensors, thermocouples, and dry gas meter (DGM) correction values meet the QA requirements of Method 30B. The results of the console audit are presented in Appendix F.