Consumers Energy
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JHC12 Hg CEMS RATA Report

EUBOILER1
EUBOILER2

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

August 16, 2023

Test Dates: Unit 1 - June 20, 2023
Unit 2 - June 22, 2023

Test performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Department
Work Order No. 6515938 and 6515939
Revision No.: 1.0

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1.0 INTRODUCTION

Consumers Energy Company (Consumers Energy), Regulatory Compliance Testing Section (RCTS) performed relative accuracy test audits (RATAs) on the mercury (Hg) continuous emission monitoring systems (CEMS) installed in the exhaust ducts of emission units EUBOILER1 and EUBOILER2 (Units 1 and 2) operating at the Consumers Energy J.H. Campbell (JHC) Generating Complex located in West Olive, Michigan. The Hg CEMS RATAs were performed on June 20 at Unit 1 and June 22, 2023, at Unit 2. The tests were completed 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/or protocol containing detailed sampling, calibration, and quality assurance procedures was submitted to the USEPA and EGLE on May 17, 2023. EGLE representative Lindsey Wells approved the protocol in the letter dated June 13, 2023. This 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 Dillon King and Thomas Schmelter conducted the RATAs. Mr. Kevin Starken, JHC Air Quality Lead, and Roger Vargo, JHC Senior Technician, 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
Contact Information

Program Role	Contact	Address
EPA Regional Contact	Michael Compher 312-886-5745 compher.michael@epa.gov	USEPA Region 5 77 W. Jackson Blvd. (AR-18J) Chicago, IL 60604
EGLE AQD Emissions Measurement Representative	Mr. Jeremy Howe Technical Programs Unit Supervisor Environmental Manager 231-878-6687 howej1@michigan.gov	EGLE Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933-1502
EGLE AQD Site Inspector	Ms. 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	Mr. Nathan J. Hoffman Director of Plant Operations 616-738-5436 nathan.hoffman@cmsenergy.com	Consumers Energy Company J.H. Campbell Generating Complex 17000 Croswell Street West Olive, Michigan 49460

Table 1-1
Contact Information

Program Role	Contact	Address
Site Environmental	Mr. Kevin Starken Supervisor – Engineering Support 616-738-3241 kevin.starken@cmsenergy.com	Consumers Energy Company J.H. Campbell Generating Plant 17000 Croswell Street West Olive, Michigan 49460
CEMS Technician	Mr. Roger D. Vargo Senior Technician / Environmental 616-738-3270 roger.vargo@cmsenergy.com	
Test Team Representative	Mr. Thomas Schmelter, QSTI Engineering Technical Analyst 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY OF RESULTS

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

2.1 Operating Data

During the relative accuracy tests, the boilers were operated at the normal operating level(s) 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 in accordance with air permit MI-ROP-B2835-2020b. The air permit incorporates federal regulations and reporting requirements, and the facility has been assigned a Facility Registry Service (FRS) identification number 110000411108. EUBOILER1 and EUBOILER2 are the emission unit sources identified in the permit and are included in the FGBOILER12 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 Units 1 and 2 meet the applicable On-Going QA Test Requirements of 40 CFR 63, Subpart UUUUU, Appendix A, Table A-2. Because the average reference method (RM) Hg concentrations measured at both units was <2.5 micrograms per standard cubic meter (µg/scm), the applicable performance specification criterion of ≤0.5 µg/scm, calculated as the absolute RM/CEMS Hg difference plus the confidence coefficient, was used to evaluate quality assurance. The Hg CEMS RATA results 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 (%)	Alternative RATA Result (µg/scm)[1]
EUBOILER1	1.033	0.956	0.0641	13.73	**0.142**
EUBOILER2	1.133	0.889	0.0558	26.50	**0.300**

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 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 preceding Hg CEMS and RM values have been rounded to the nearest 0.1 µg/scm before evaluating the RA. For comparison purposes, the unrounded CEMS and RM values are presented in Appendix A, which show similar agreement with the Table 2-1 results.

Sample calculations are presented in Appendix B. Reference method data are presented in Appendix C with Hg sample laboratory data provided in Appendix D. Quality assurance data is presented in Appendix F.

3.0 SOURCE AND MONITOR DESCRIPTION

EUBOILER1 and EUBOILER2 are coal-fired electric generating units (EGUs) that turn turbines connected to electricity producing generators.

3.1 Process

The J.H. Campbell Plant operates one coal-fired dry bottom, tangential-fired boiler designated as EUBOILER1, and one wall-fired (converted from cell burner) boiler designated as EUBOILER2. Both units exhaust to a common exhaust stack and each are classified as existing EGUs under the MATS rule. 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. Units 1 and 2 are equipped with low nitrogen oxides (NO_x) burners, over fire air (OFA) systems, activated carbon injection (ACI) process for mercury (Hg) reduction, dry sorbent (lime) injection (DSI) systems for control of sulfur dioxides (SO_2) and other acid gasses, and pulse jet fabric filter (PJFF) baghouses to control particulate matter emissions. In addition, Unit 2 has a selective catalytic reduction (SCR) system for NO_x control.

[1] Refer to Page 65 of the ECMPS Reporting Instructions for Quality Assurance and Certification (Sept. 14, 2022).

After passing through the control device systems, flue gas is exhausted to atmosphere through an approximate 400-feet high stack, shared by both EUBOILER1 and EUBOILER2. Refer to Figures 2-1 and 2-2 for the Unit 1 and Unit 2 Data Flow Diagram.

Figure 2-1. Unit 1 Data Flow Diagram

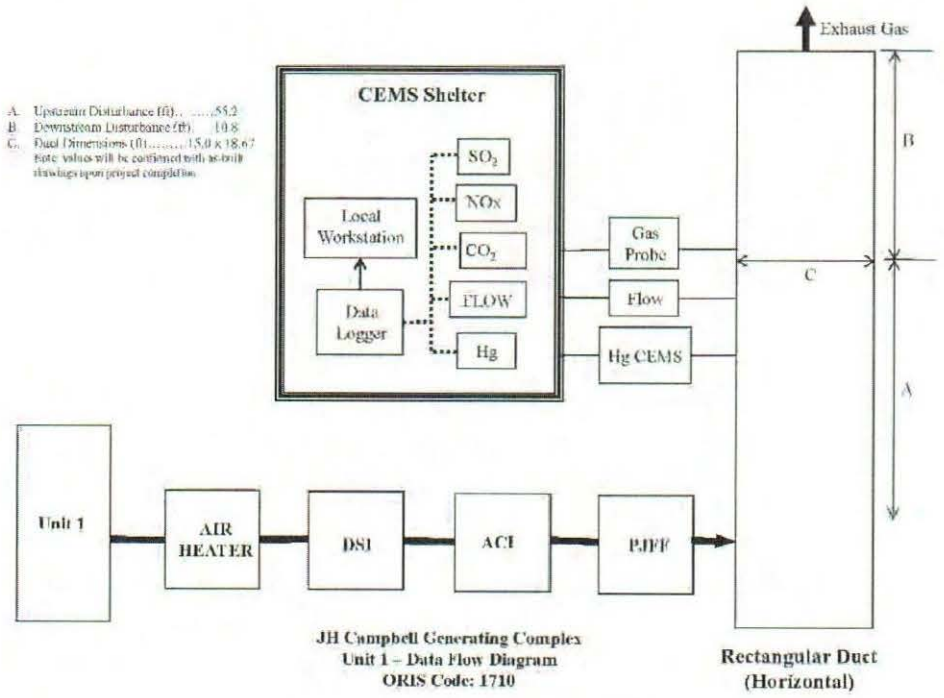
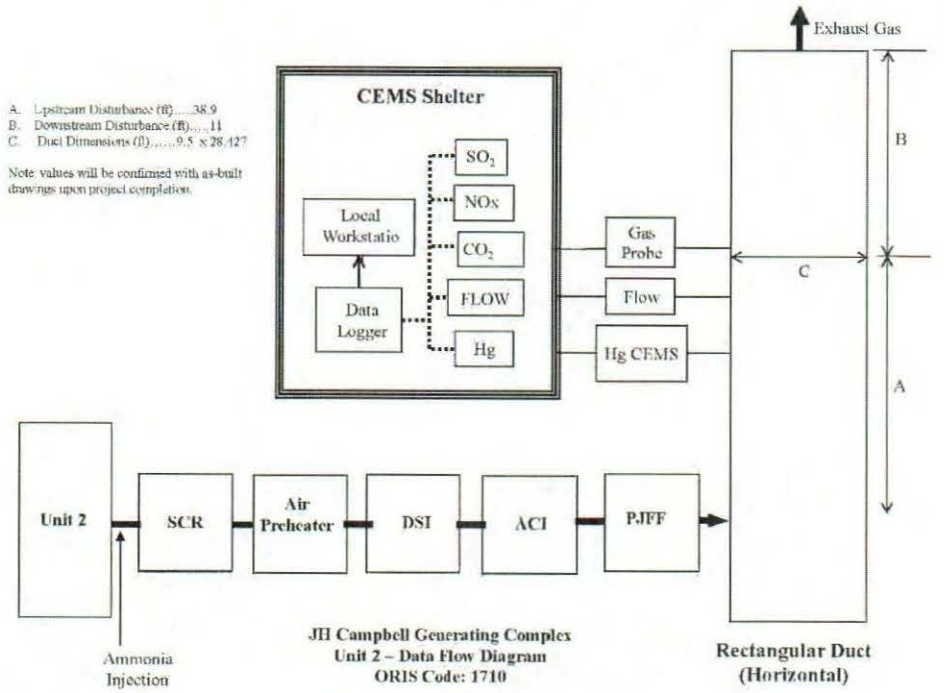


Figure 2-2. Unit 2 Data Flow Diagram



3.3 Rated Capacity

Unit 1 has a nominally rated heat input capacity of 2,490 mmBtu/hr as listed in the ROP and can generate a gross electrical output of approximately 300 MW. The ROP states Unit 2 has a nominally rated heat input capacity of 3,560 mmBtu/hr and can generate a gross electrical output of approximately 400 MW. The normal fuel utilized by the boilers is 100% subbituminous coal; however, Unit 2 also has the capability to fire bituminous coal, as well as blends of subbituminous and bituminous coals. When all coal mills are available, the preceding Unit 2 nominal rating can only be achieved when firing blended coals. Unit 2 is limited to approximately 300 MW gross when firing only subbituminous coal.

The boilers operate in a continuous manner to meet the electrical demands of Midcontinent Independent System Operator, Inc. (MISO) and Consumers Energy customers. EUBOILER1 and EUBOILER2 are considered baseload units because they are designed to operate 24 hours a day, 365 days a year.

Relative accuracy testing was performed with the unit's operating at their current normal operating level(s), as defined in 40 CFR 75, Appendix A, § 6.5.2.1. The range of operation for Unit 1 is 110 to 300 MW gross, while the operating range for Unit 2 is 110 to 400 MW gross. 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. The designated normal operating load within the monitoring plans is High load for each unit (224.1 to 300 MW for Unit 1; 284.1 to 400 MW for Unit 2). During the test, the Unit 1 average load was approximately 252.7 MW, and Unit 2 average load was approximately 299.9 MW.

3.4 Process Instrumentation

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

The facility measured Hg concentrations using a Tekran Instruments Corporation Series 3300 Mercury CEMS dilution-based system with data recorded by an ESC Spectrum data acquisition and handling system (DAHS). Table 3-1 provides a summary of the mercury CEMS analyzers used to evaluate 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)
EUBOILER1	Tekran Model 2537 S	3080	10.0
EUBOILER2	Tekran Model 2537 S	3075	10.0

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy performed the Hg CEMS RATAs using USEPA reference methods listed in 40 CFR 63, Subpart UUUUU, Appendix A §4.1.1.5 and as presented in Table 4-1. Ten, 30-minute runs were conducted on both Unit 1 and Unit 2 to calculate RA. Descriptions of the sampling and analytical procedures are presented in the following sections.

Table 4-1
Test Methods

Parameter	USEPA	
	Method	Title
Moisture	4	Determination of Moisture Content in Stack Gases
Mercury (sampling 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 Method 30A)

The location and number of traverse points used to measure mercury concentrations were determined in accordance with 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 RATAs 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 Units 1 and 2 mercury CEMS used to document Hg concentrations prior to the RATAs and the associated sixty-minute stratification exemption reports for Units 1 and 2 are presented in Appendices E1 and E2, respectively. 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.

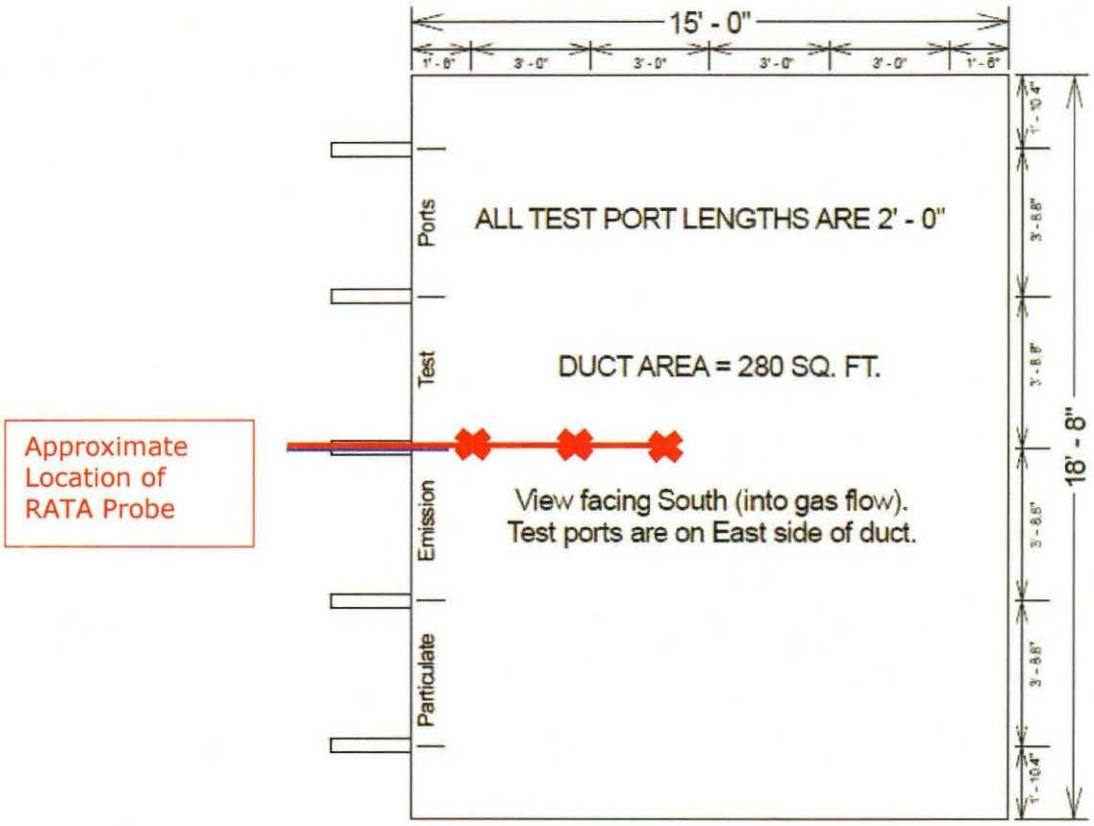
For the Unit 1 sampling location, five test ports exist in the horizontal plane on eastern side of the 15 feet by 18 feet 8-inch rectangular duct. The duct has an equivalent duct diameter of 16 feet 7.6 inches. The ports are situated:

- Approximately 55.2 feet or 3.3 duct diameters downstream of a sound deadening silencer 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 22 inches beyond the duct wall. For the purposes of the Unit 1 Hg RATA testing, the flue gas samples were collected from the second test port from the bottom of the duct, at three traverse points. A duct cross sectional diagram including sample ports is presented in Figure 4-1.

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

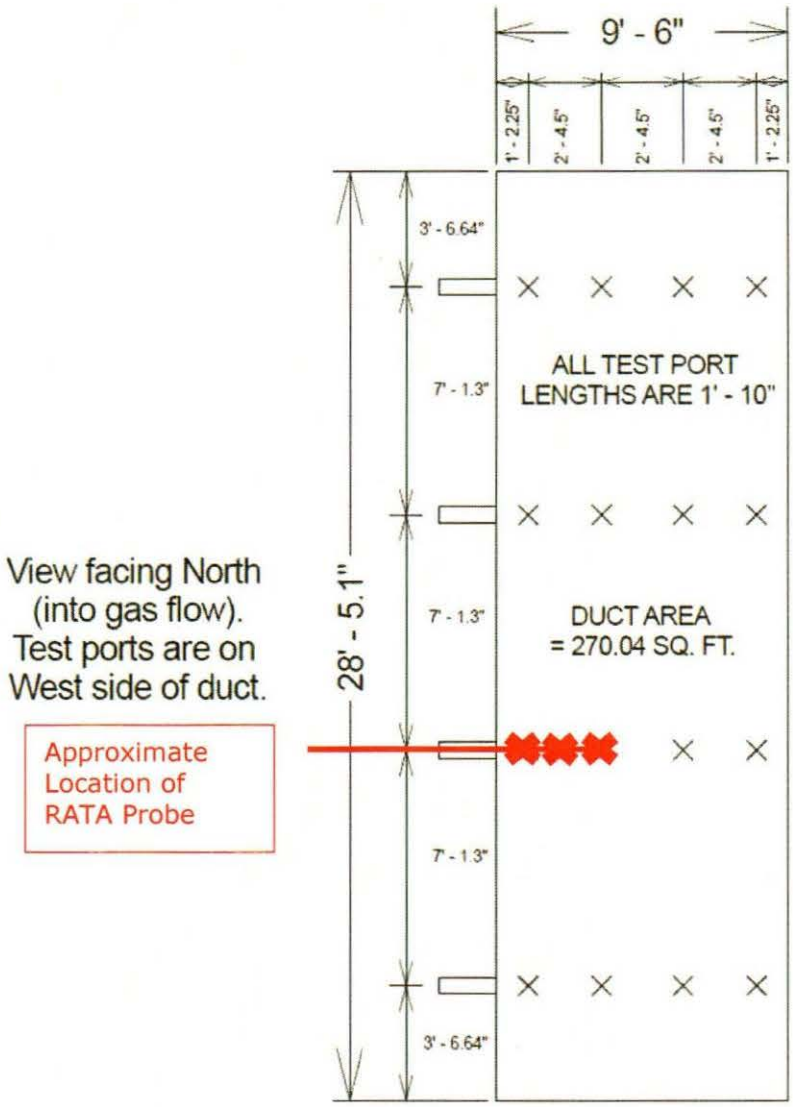


For the Unit 2 sampling location, four test ports exist in the horizontal plane on the west side of the 9.5 feet by 28 feet 5.1-inch rectangular duct. The duct has an equivalent duct diameter of 14.2 feet. The ports are situated:

- 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. For the purposes of the Unit 2 Hg RATA testing, the flue gas samples were collected from the third test port, at three traverse points. A figure of the Unit 2 duct cross section is presented in Figure 4-2.

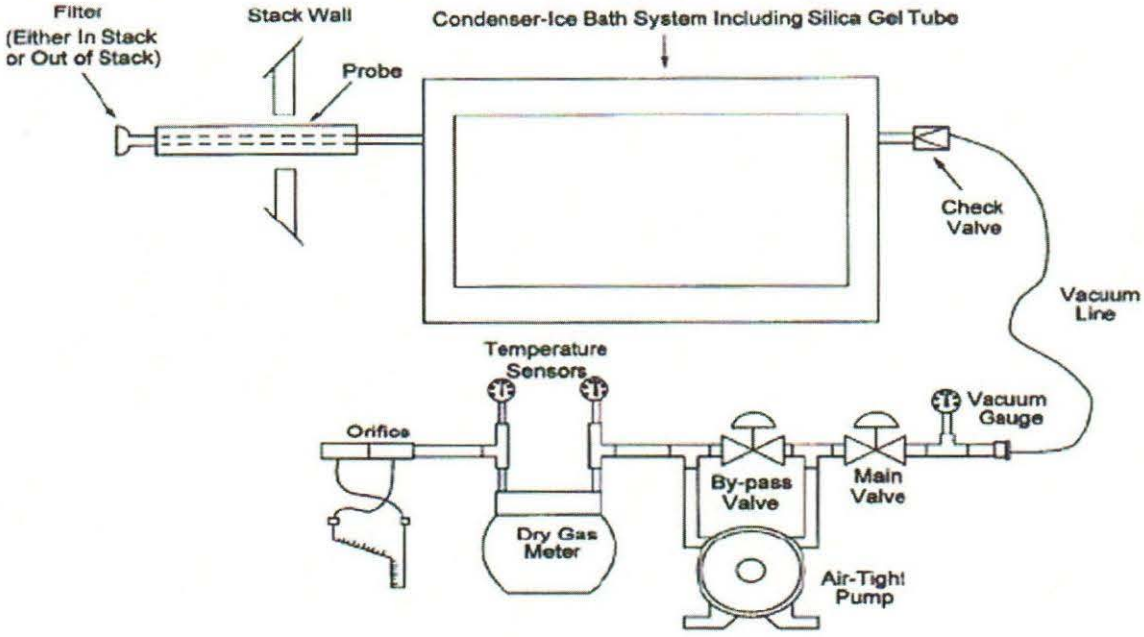
Figure 4-2. Unit 2 Duct Cross Section and Test Port Detail



4.2 Moisture Content (USEPA Method 4)

Exhaust gas moisture content for Units 1 and 2 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 4-3 for a drawing of the RM4 Moisture Apparatus.

Figure 4-3. Reference Method 4 Moisture Apparatus



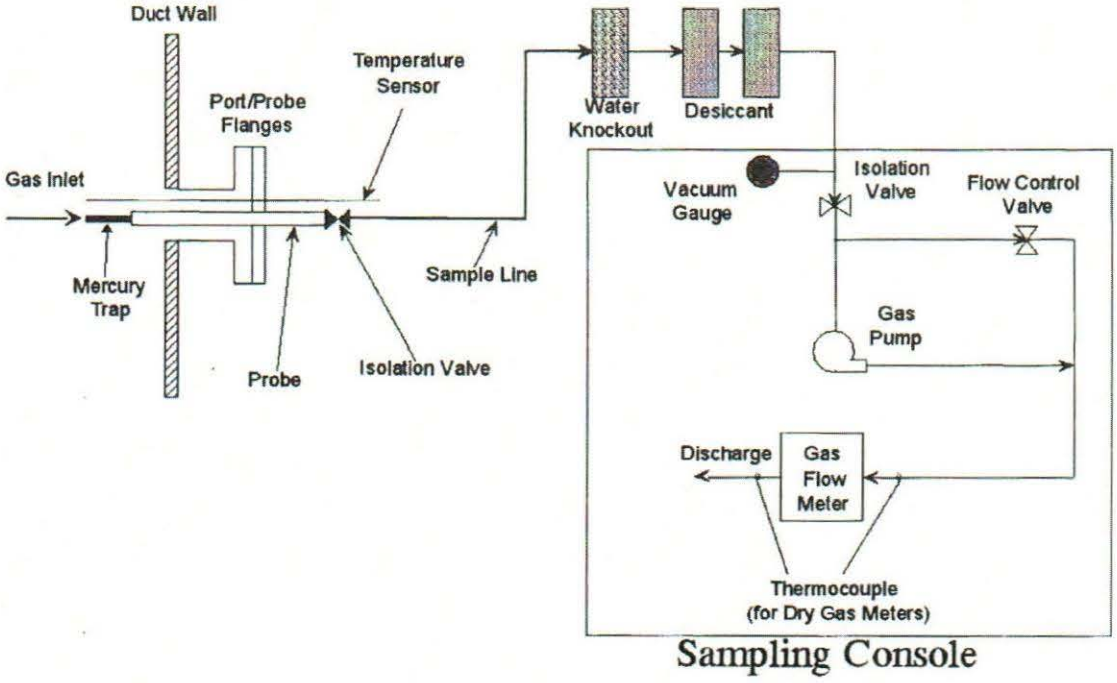
4.3 Mercury (USEPA Method 30B)

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 4-4 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 approximately 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 tubes was spiked with a known mass of mercury and used to sample flue gas during the test run. The field 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 for each unit and are presented in Appendices C1 and C2 for Units 1 and 2, respectively.

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



5.0 TEST RESULTS AND DISCUSSION

The Hg CEMS RATAs were performed to satisfy USEPA requirements in 40 CFR 63, Subpart UUUUU. The test results indicate that both Units 1 and 2 Hg CEMS meet 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, or EST). Test runs were 30 minutes in duration and 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 Appendices C1 and C2 will 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. A comparable situation exists for the moisture run end times reflected in these same appendices.

5.1 VARIATIONS AND UPSET CONDITIONS

Analyses of the Section 2 carbon beds of the sorbent traps during both the Units 1 and 2 RATA tests resulted in slightly negative Hg mass values. These negative values are presented in the Hg analysis results data tables in Appendices D1 and D2, however in these instances, a mass of zero (0.00) nanograms Hg was used for calculating Hg concentrations.

The process and control equipment were operating in a normal manner and no upsets were encountered.

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 USEPA Method 30B 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 from 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.
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

Table 5-1
Summary of USEPA Method 30B Sampling QA/QC Requirements

QA/QC Test or Specification	Acceptance Criteria	Frequency	Consequences if not met
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 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 a minimum three spiked sorbent traps.	Field sample runs not validated without successful field recovery test.

Method 30B requires a field recovery test, once per test program, which evaluates the performance of the combined sampling and analytical practices. The test must be successfully passed with a three-run average elemental Hg spike recovery of 85 to 115%. The Method also allows for the field recovery test runs to be used as RATA 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 nanograms of elemental Hg were therefore utilized in Runs 1, 2, and 3 for the Unit 1 RATA with a calculated field recovery of 98.5%. Similar spiked sorbent traps were utilized in Runs 1 through 3 and Run 10 for Unit 2, with a calculated field recovery result of 103.7% utilizing Runs 1, 2, and 10. Field recovery test results are presented in the Sorbent Trap Results Tables in Appendix C1 and C2 for Units 1 and 2, respectively.

Following the completion of the Units 1 and 2 Hg CEMS RATAs, RCTS performed a single 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 that 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 E.