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Mercury (Hg) CEMS
Relative Accuracy Test Audit
D.E. Karn Plant
Essexville, Michigan

EU-KARN1 and EU-KARN2

Consumers Energy Company
D.E. Karn Plant
2742 North Weadock Highway
Essexville, Michigan 48732
SRN: B2840

Report Submitted: August, 2017
Test Dates: July 10-12, 2017

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section – Air Emissions Testing Body
Environmental and Laboratory Services Section
Work Order No. 26815606
Revision No. 0

1.0 INTRODUCTION

Consumers Energy Company (Consumers Energy) Regulatory Compliance Testing Section (RCTS) conducted relative accuracy test audits (RATAs) on the mercury (Hg) continuous emission monitoring system (CEMS) installed on EU-KARN1 and EU-KARN2 (Units 1 and 2) in operation at the D.E. Karn Generating Station located in Essexville, Michigan. Unit 1 and Unit 2 electric utility steam generating units (EGUs) are coal-fired boilers that generate steam to turn a turbine connected to an electricity producing generator. The electricity is routed to the electrical transmission system.

The Hg CEMS RATAs were performed to satisfy the United States Environmental Protection Agency (USEPA) requirements in the 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.

Notification to the EPA, as well as a courtesy notification to the Michigan Department of Environmental Quality (MDEQ) was sent June 9, 2017 informing the agency of Consumers Energy's intention to perform these Hg CEMS RATAs.

The Hg CEMS RATAs were performed July 10 and 11, 2017 for Unit 1 and July 11 and 12, 2017 for Unit 2.

1.1 CONTACT INFORMATION

Table 1-2 presents the EGU test program organization, major lines of communication, and names of responsible individuals.

Table 1-1
Contact Information

Program Role	Contact	Address
Regulatory Agency Representative	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
Responsible Official	Mr. Norman J. Kapala 616-738-3200 *Executive Director of Coal Generation* Norman.Kapala@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460

Table 1-1

Contact Information

Program Role	Contact	Address
Test Facility	Mr. George Eurich 989-891-3317 Sr. Engineering Tech Analyst Lead George.Eurich@cmsenergy.com	Consumers Energy Company D.E. Karn Power Plant 2742 North Weadock Highway Essexville, Michigan 48732
Test Facility	Mr. Dale Myers 989-891-3358 Technician Dale.Myers@cmsenergy.com	Consumers Energy Company D.E. Karn Power Plant 2742 North Weadock Highway Essexville, Michigan 48732
Test Team Representative	Mr. Dillon King, QSTI 989-891-5585 Engineering Technical Analyst Dillon.King@cmsenergy.com	Consumers Energy Company D.E. Karn Power Plant ESD Trailer #4 2742 North Weadock Highway Essexville, Michigan 48732
Test Team Representative	Mr. Gregg Koteskey, QSTI 616-738-3712 Engineering Technical Analyst Gregg.Koteskey@cmsenergy.com	Consumers Energy Company J.H. Campbell Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY OF RESULTS

2.1 OPERATING DATA

During the relative accuracy tests the boilers were operated at the normal operating level(s) as defined in the 40 CFR Part 75 monitoring plan. For Units 1 and 2, both the Mid and High operating levels are defined as normal operating levels, and the Unit 1 mercury RATA was conducted at the High operating level, while the Unit 2 mercury RATA was conducted at the Mid operating level.

2.2 APPLICABLE PERMIT INFORMATION

The D.E. Karn generating station has the State of Michigan Registration Number (SRN) B2840 and operates in accordance with air permit MI-ROP-B2840-2014a. The air permit incorporates federal regulations and reports under Federal Registry Service (FRS) identification number 110000593171. EU-KARN1 and EU-KARN2 are the emission unit source identifications in the permit and included in the FG-KARN12 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 Hg CEMS installed and operating at Units 1 and 2 at the D.E. Karn meet 40 CFR, Part 63, Subpart UUUUU, Appendix A, Section 4.1.1.5 relative accuracy (RA) requirements as shown in the following table. The results of the Hg CEMS RATAs indicate that both Units 1 and 2 meet the standard RA criteria and pass the alternative acceptance criteria under the MATS regulation.

Table 2-1
Hg CEMS RATA Results Summary

Source	RATA Performance Requirements	RATA Results[1]	RM Average[1] (µg/scm)	Alternative RATA Results[2]
EU-KARN1	≤ 20% of mean RM -or- $\lvert RM_{avg} - C_{avg} \rvert + \lvert CC \rvert \leq 0.5$ µg/scm[1]	11.84%	1.656	0.196 µg/scm
EU-KARN2		15.78%	0.356	0.056 µg/scm

[1]RM and CEMS Hg values have been rounded to nearest 0.1 µg/scm prior to calculating RA.
[2]RM average must be less than 2.5 µg/scm to qualify for alternative acceptance criteria consisting of the mean difference plus the 2.5% confidence coefficient.

To be consistent with the ECMPS reporting instructions[1], the above Hg CEMS values, as well as the RM values have been rounded to the nearest 0.1 µg/scm before evaluating the RA. Unrounded Hg CEMS and RM values are presented in Appendices B1 and B2.

Sample calculations are presented in Appendix A. Detailed results are presented in Appendices B1 for Unit 1 and B2 for Unit 2. Quality assurance data is presented in Appendix C. Boiler operating data and supporting information are provided in Appendices D1 and D2. Laboratory data is presented in Appendix E.

3.0 SOURCE DESCRIPTION

EU-KARN1 and EU-KARN2 are coal-fired EGUs that turn turbines connected to electricity producing generators.

[1] Refer to Page 65 of the ECMPS Reporting Instructions for Quality Assurance and Certification (June 14, 2017).

3.1 PROCESS

EU-KARN1 is a dry bottom tangential coal fired boiler with fuel oil startup capabilities and supplemental co-firing for flame stabilization and mill outages. EU-KARN2 is a dry bottom wall coal fired boiler also with fuel oil startup capabilities and supplemental co-firing for flame stabilization and mill outages.

3.2 PROCESS FLOW

The flue gas generated through coal combustion is controlled by multiple pollution control devices for each unit. Both EU-KARN1 and EU-KARN2 have a Selective Catalytic Reduction (SCR) system for the control of nitrogen oxides (NOx), and EU-KARN2 also has low NOx burners for additional control of nitrogen oxides (NOx). Further, both units are equipped with pulse jet fabric filter (PJFF) baghouses for Particulate Matter (PM) control and Spray Dryer Absorbers (SDAs) for the control of sulfur dioxide (SO2) and other acid gases. Each unit is also equipped with Activated Carbon Injection (ACI) for the control of mercury (used on an as needed basis to comply with the applicable MATS mercury emission limit).

3.3 RATED CAPACITY

Unit 1 has a nominally rated heat input capacity of 2,500 million BTU per hour and can generate a gross electrical output of approximately 272 megawatts (MWg). Unit 2 has a nominally rated heat input capacity of 2,540 million BTU per hour and can generate a gross electrical output of approximately 277 megawatts (MWg).

Relative accuracy testing was performed independently on each unit, with each 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 Units 1 and 2 are as follows: Unit 1 = 130 to 285 MWg; Unit 2 = 110 to 290 MWg. 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 1 average load was approximately 257 MWg, and Unit 2 average load was approximately 210 MWg.

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 following parameters were collected during each Hg RATA test run: Load (MWg), total vapor phase Hg (µg/scm) and heat input (mmBtu/hr). The sampling console clock times were synchronized with the Unit CEMS

datalogger times (the time convention is Eastern Standard Time, with no adjustments for Daylight Savings).

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy performed the Hg CEMS RATAs using the United States Environmental Protection Agency (USEPA) test methods presented in Subpart UUUUU, Appendix A, Section 4.1.1.5. Descriptions of the sampling and analytical procedures are presented in the following sections.

Table 4-1
Test Methods

Parameter	USEPA	
	Method	Title
Moisture	ALT-008	Alternative Moisture Measurement Method Midget Impingers
Mercury	30A	Determination of Total Vapor Phase Mercury Emissions From Stationary Sources (Instrumental Analyzer Procedure) [Mercury Sampling Points]
Mercury	30B	Determination of Total Vapor Phase Mercury Emissions From Coal-Fired Combustion Sources Using Carbon Traps [Mercury Concentration]

4.1 SAMPLE LOCATION AND TRAVERSE POINTS

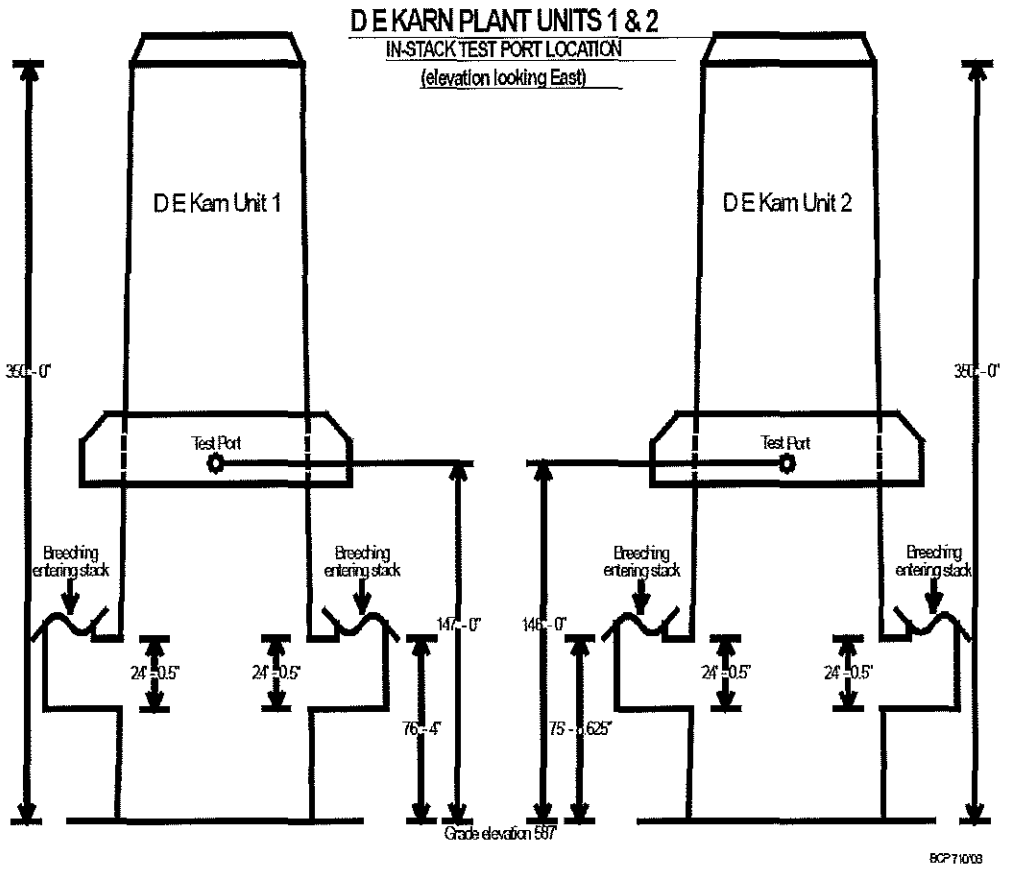
The number and location of traverse points for determining the mercury concentration was determined in accordance with USEPA Method 30A, *Determination of Total Vapor Phase Mercury Emissions From Stationary Sources (Instrumental Analyzer Procedure)*. In accordance with Section 8.1.2 of Method 30A, sampling was conducted at three points located at 0.4, 1.2, and 2.0 meters from the stack wall as the Hg concentrations were demonstrated to be below 3 $\mu g/m^3$ immediately prior to when testing commenced. Quality assured data from the certified Units 1 and 2 mercury CEMS were 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 D1 and D2, respectively.

The Unit 1 duct diameter is 22 feet 4 inches; Unit 2 has a duct diameter of 18 feet. The ports are situated:

- Approximately 70 feet downstream of the breechings entering the exhaust stack, and
- Approximately 200 feet upstream of the exhaust stack exit.

The sample ports are 6-inches in diameter and extend 24 inches beyond the stack wall. Flue gas was sampled for ten minutes at three traverse points from one of the four sample ports, for a total of 3 sample points and 30 minutes. A drawing of the Unit 1 and 2 Test Port Locations is presented as Figure 4-1.

Figure 4-1. Unit 1 and 2 Test Port Locations



4.2 MOISTURE CONTENT

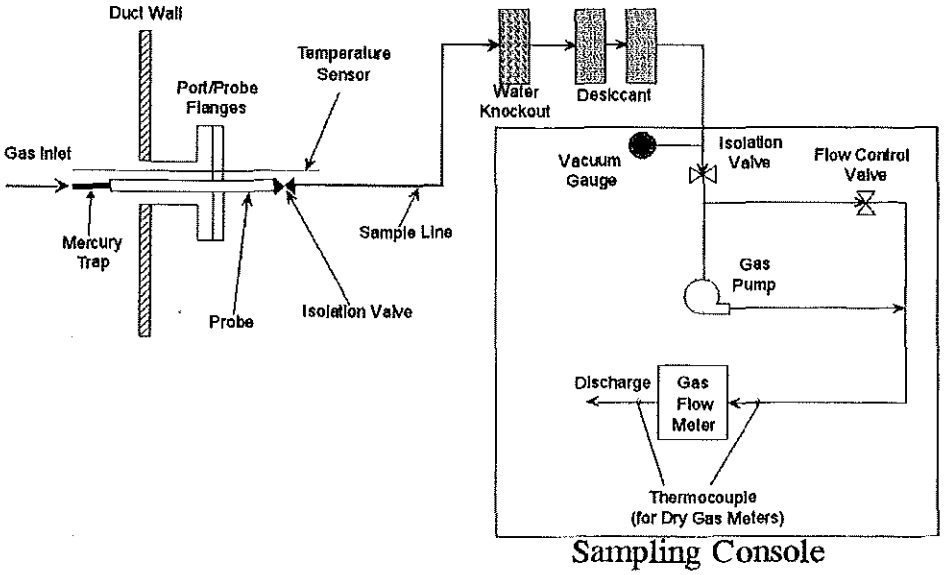
The exhaust gas moisture content was determined using USEPA ALT-008, *Alternative Moisture Measurement Method Midget Impingers*; an alternative method for correcting pollutant concentration data to appropriate moisture conditions (e.g. pollutant data on a dry or wet basis)

validated May 19, 1993 by the USEPA Emission Measurement Branch. The procedure is incorporated into Method 6A of 40 CFR Part 60 and is based on field validation tests described in *An Alternative Method for Stack Gas Moisture Determination* (Jon Stanley, Peter Westlin, 1978, USEPA Emissions Measurement Branch). The exhaust gas was drawn through a series of midget impingers immersed in an ice bath to condense water in the flue gas. The amount of water collected was measured gravimetrically and used to calculate the exhaust gas moisture content. In accordance with Method 30B, Section 8.3.3.7, one moisture sample was collected for each pollutant sample run performed in order to correct the measured Hg concentrations from a dry basis to a wet basis (consistent with the Hg CEMS measurement).

4.3 MERCURY

Mercury was measured by 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 at an appropriate flow rate. A field recovery test was performed and successfully passed for each unit, which assessed recovery of an elemental mercury spike to determine measurement bias and was also used to verify data acceptability. The sorbent traps were recovered from the sampling system and analyzed on-site using an Ohio Lumex RA-915+ analyzer. The contents of the traps were carefully extracted and placed into a controlled heating coil where the captured mercury was thermally desorbed from the sample matrix (i.e., charcoal) at 680° Celsius. Vapor phase mercury was then measured using atomic absorption spectrometry. Refer to Figure 4-2 for a depiction of the Method 30B sample train.

Figure 4-2. Method 30B Sorbent Trap Sampling Train Diagram



5.0 TEST RESULTS AND DISCUSSION

The Hg CEMS RATAs were performed to satisfy the USEPA requirements in the 40 CFR 63, Subpart UUUUU, "National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units," Rule. The test results indicate that both the Unit 1 and Unit 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. 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 B1 and B2 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 1-minute data value. Several analyses of the back half of traps on July 10 and 11 resulted in negative values ranging from -0.06 ng to -0.29 ng. A value of zero was used in emissions calculations when this occurred.

5.1 VARIATIONS AND UPSET CONDITIONS

No test method variations or upset conditions were encountered during this test program. The process and control equipment were operating under routine conditions 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 Appendix C 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 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 don onsite. Apply the new Y value to the field test data.
Temperature sensor calibration	Absolute temperature measures 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
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.