Mercury (Hg) CEMS Relative Accuracy Test Audit

EUBOILER3

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

Report Submitted: September 11, 2017
Test Dates: August 9-10, 2017

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section – Air Emissions Testing Body
Laboratory Services Section
Work Order No. 29436190
Revision No. 0

1.0 INTRODUCTION

Consumers Energy Company (Consumers Energy) Regulatory Compliance Testing Section (RCTS) conducted the relative accuracy test audit (RATA) on the mercury (Hg) continuous emission monitoring system (CEMS) installed on EUBOILER3 (Unit 3) in operation at the J.H. Campbell Generating Station located in West Olive, Michigan. Unit 3 electric utility steam generating unit (EGU) is a coal-fired boiler that generates steam to turn a turbine connected to an electricity producing generator. The electricity is routed to the electrical transmission system.

The Hg CEMS RATA was 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 28, 2017 informing the agency of Consumers Energy's intention to perform this Hg CEMS RATA.

The Hg CEMS RATA was performed on Unit 3 August 9-10, 2017.

1.1 CONTACT INFORMATION

Table 1-1 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 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

Table 1-1
Contact Information

Program Role	Contact	Address
Test Facility	Mr. Joseph J. Firlit Sr. Engineering Tech Analyst Lead 616-738-3260 Joseph.Firlit@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Facility	Mr. Roger D. Vargo Senior Technician 616-738-3270 Roger.Vargo@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Team Representative	Mr. Gregg Koteskey, QSTI Engineering Technical Analyst 616-738-3712 Gregg.Koteskey@cmsenergy.com	Consumers Energy Company J.H. Campbell Training Center 17010 Croswell Street West Olive, Michigan 49460
Test Team Representative	Mr. Thomas R. Schmelter, QSTI Engineering Technical Analyst 616-738-3234 Thomas.Schmelter@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 test the boiler was operated at the normal operating level (High) as defined in the 40 CFR Part 75 monitoring plan.

2.2 APPLICABLE PERMIT INFORMATION

The J.H. Campbell generating station has the State of Michigan Registration Number (SRN) B2835 and operates in accordance with air permit MI-ROP-B2835-2013a. The air permit incorporates federal regulations and reports under Federal Registry Service (FRS) identification number 110000411108. EUBOILER3 is the emission unit source identification in the permit. 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 Unit 3 at the J.H. Campbell generating complex 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 RATA indicates that Unit 3 passes the alternative acceptance criteria under the MATS regulation.

Table 2-1
Hg CEMS RATA Results Summary

Source	RATA Performance Requirements	RATA Results[2]	RM Average[2] (µg/scm)	Alternative RATA Results[2]
EUBOILER3	≤ 20% of mean RM -or- $\lvert RM_{avg} - C_{avg} \rvert + \lvert CC \rvert \leq 0.5$ µg/scm[1]	109.61%	0.4	0.438

[1]RM average must be less than 2.5 µg/scm to qualify for alternative acceptance criteria
[2]RM and CEMS Hg values have been rounded to nearest 0.1 µg/scm prior to calculating RA

The preceding results for Unit 3 meet the alternative RA requirements of less than or equal to 0.5 µg/scm difference between the mean RM and CEMs measurements, plus the confidence coefficient. To be consistent with the ECMPS reporting instructions[1], the per run Hg CEMS values, as well as the per run 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 Appendix B.

Sample calculations are presented in Appendix A, detailed results are presented in Appendix B, quality assurance data is presented in Appendix C, boiler operating data and supporting information is provided in Appendix D, laboratory data is presented in Appendix E.

3.0 SOURCE DESCRIPTION

EUBOILER3 is a coal-fired EGU that turns a turbine connected to an electricity producing generator.

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

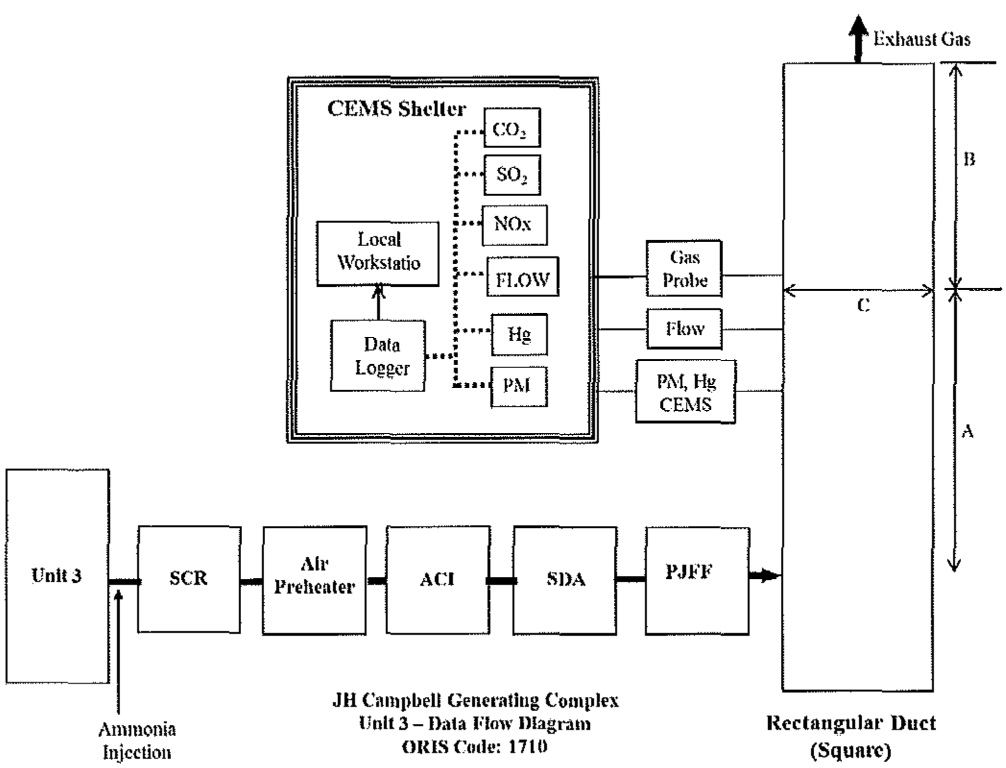
3.1 PROCESS

Unit 3 is a dry bottom wall-fired boiler which combusts pulverized sub-bituminous coal as the primary fuel and oil as an ignition/flame stabilization fuel. Coal is fired in the furnace where the combustion heats boiler tubes containing water producing steam. The steam is used to turn an engine 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

Unit 3 emissions are controlled by low-NO_x burners, over-fire air, and selective catalytic reduction (SCR) for NO_x control, activated carbon injection (ACI) for mercury (Hg) control, spray dry absorbers (SDAs) for control of acid gases (e.g., sulfur oxides (SO_x), HCl), and a low pressure/high volume pulse jet fabric filter (PJFF) system baghouse for particulate matter control. 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 megawatts (MWg).

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 881 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), and total vapor phase Hg (µg/scm). The sampling console clock times were synchronized with the Unit CEMS datalogger times (the CEMS time convention is Eastern Standard Time, with no adjustments for Daylight Savings).

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy performed the Hg CEMS RATA 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]

Table 4-1
Test Methods

Parameter	USEPA	
	Method	Title
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

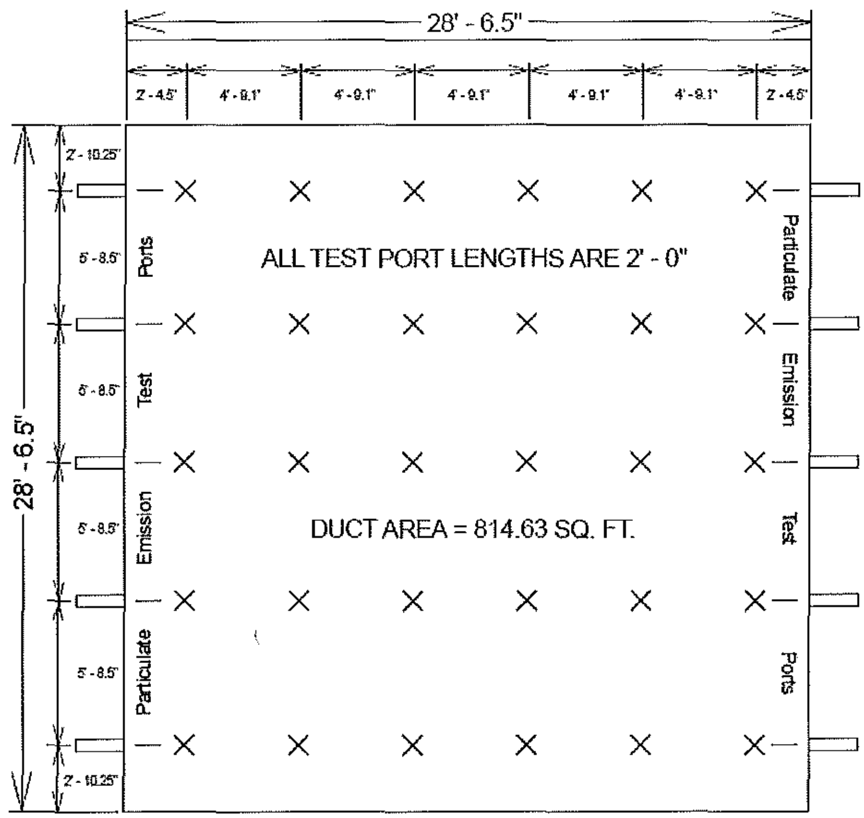
The number and location of traverse points for determining the mercury concentration was determined in accordance with USEPA Method 30A, *Determination of Total Vapor Phase Mercury Emissions From Stationary Sources (Instrumental Analyzer Procedure)*. In accordance with Section 8.1.2 of Method 30A, sampling 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 μg/scm immediately prior to when testing commenced. Quality assured data from the certified Unit 3 Hg CEMS were used to document Hg concentrations prior to the RATA (average mercury concentration was 0.4 μg/scm), and the associated sixty-minute stratification exemption report is presented in Appendix D.

For the Unit 3 sampling location, five test ports are located in the vertical plane on both sides of the 28.54 feet by 28.54 feet square duct. The ports are situated:

- Approximately 77.4 feet or 2.7 duct diameters downstream of a sound deadening silencer flow disturbance, and
- Approximately 22.4 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 and extend 2 feet (24 inches) beyond the stack wall. A diagram of the Unit 3 duct cross section is presented in Figure 4-1.

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



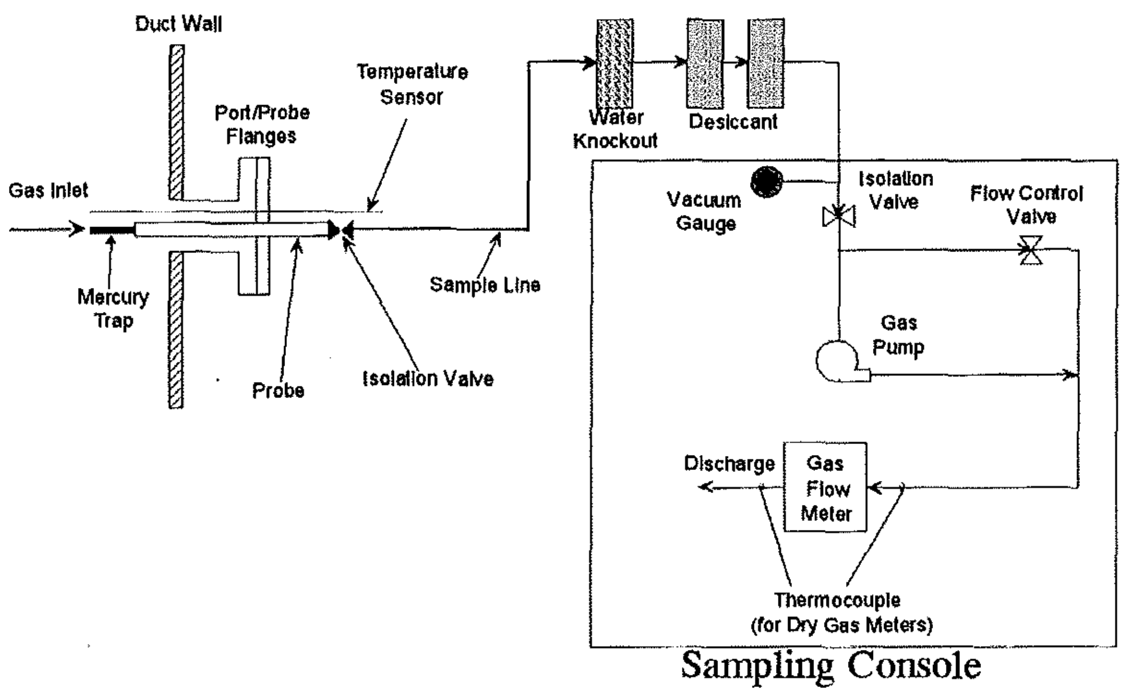
4.2 Moisture Content

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, 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 5-1 for a depiction of the Method 30B sample train.

Figure 5-1. Method 30B Sorbent Trap Sampling Train Diagram



5.0 TEST RESULTS AND DISCUSSION

This Hg CEMS RATA was 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 the Unit 3 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 the 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 Appendix B 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.

5.1 Variations and Upset Conditions

During the Unit 3 Hg CEMS RATA, a run was initiated at 07:13 on August 10, the first run for that day. Approximately five minutes into the test run, the Hg CEMS technician contacted RCTS and informed them that the Hg CEMS was reporting elemental Hg only, not total vapor phase Hg as required for the RATA. Additionally, a probe blowback operation was scheduled to occur during the thirty minute run duration which would have invalidated the concentration data for the minutes affected by the maintenance operation. This run was stopped and the sorbent traps were not analyzed due to the RATA test specific invalid CEMS data. The Hg CEMS technician made the appropriate changes to the Hg CEMS reporting data and deactiviated the automated blowback operations. Run 8 began at 07:47 following the completion of the initially scheduled probe blowback.

The process and majority of control equipment were operating under routine conditions during the Hg CEMS RATA. Two of the four SDA modules experienced abnormal slurry injection rates which may contribute to the higher flue gas temperatures observed during the testing conducted on August 9 compared to the flue gas temperatures observed on August 10.

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 and E for supporting documentation.

Upon analyzing Runs 8 through 10 on the second day of testing, the concentration results were consistently lower than the results of Runs 1 though 7 which had been performed the previous day. Even though a valid and successful Field Recovery Test had been already been performed, to assure the quality of the data collected on the date of August 10th, spiked traps were utilized in Runs 11 and 12 and were analyzed as additional Field Recovery Test runs to verify the performance of the sampling and analytical approach which was the same as had been employed from the previous day. Spike recovery results from Runs 11 and 12 were well within the acceptable tolerance of 85-115% specified in Table 9-1 *Quality Assurance/Quality Control Criteria for Method 30B*, with calculated recoveries of 95.2% and 94.1% respectively.

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	Within ±10% of true value	Following daily calibration, after	Recalibrate and repeat independent standard analysis,

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

QA/QC test or specification	Acceptance criteria	Frequency	Consequences if not met
verification standard (CCVS)		analyzing ≤10 field samples, and at end of each set of analyses	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.