LONG-TERM MERCURY MONITORING

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Principal Investigator

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Project Description

Currently, wet-chemistry methods such as the U.S. Environmental Protection Agency (EPA) Method 29 and EPA Method 101A (for total mercury) and the Ontario Hydro (OH) mercury speciation method (speciated mercury) are used for monitoring mercury emissions at coal-fired power plants. Although wet-chemistry methods provide good results with a high level of sensitivity (<0.5 μg/Nm^3), they have several disadvantages which could be overcome, to some degree, by using near-real-time continuous (or near-continuous) mercury monitors (CMMs). These analyzers are based on well-established techniques, including cold-vapor atomic absorption spectroscopy, cold-vapor atomic fluorescence spectroscopy (CVAFS), and atomic emission spectroscopy, as well as on the emerging technology of chemical microsensors.

To prove the reliability and ruggedness of CMMs and to determine the variability of mercury emissions from coal-fired power plants, it is necessary to conduct longer term monitoring—25–30 days. In response, the EERC, with funding from CATM, the U.S. Department of Energy, and EPRI, completed longer-term monitoring at three different power plants.

Goal

This project has two major objectives. The first is to provide longer-term data (typically 20–30 days in duration) to determine the reliability and ruggedness of CMMs used in field research at the full scale. The second objective is to determine the level of variability of mercury emission from coal-fired power plants.

Rationale

In late 2000, EPA issued a report stating that it intended to regulate mercury emissions from coal-fired electric utility boilers. The regulation is authorized under Section 112 (Maximum Achievable Control Technology [MACT]) of the Clean Air Act. The EPA established a MACT working group to develop an advisory report as part of the rule-making process. The work group focused on three primary areas:

1. Total and speciated mercury emissions as a function of coal rank
2. The ability of current and potentially new air pollution control technologies to reduce mercury emissions
3. The variability of mercury emissions from coal-fired power plants.

This project was specially designed to provide data as to mercury variability to the MACT work group and to the EPA rule makers. Mercury variability can only be established using a more continuous approach to mercury measurements over a relatively longer period of time (up to 1 month) than that represented by the established wet-chemistry methods. Therefore, automated on-line mercury analyzers are being developed to measure both total and speciated mercury emissions. The EERC is conducting tests using CMMs, in conjunction with OH samples for validation, for periods of 25–30 days to examine this issue.

Approach

Two plants were chosen initially for this project, with a third plant recently added to the project. Information about these three plants is provided in Table 1.

Table 1. Power Plants Tested

Plant ID	Unit No.	Coal	Particulate Control	SO_2 Control	NO_x Control	CMM Location
L1	1	Eastern bit.	FF[1]	Fuel sulfur	LNB[2]	FF outlet (duct)
L1	7	Eastern bit.	ESP[3]	Fuel sulfur	LNB	Stack
L2	1	TX lig.	FF	Fuel sulfur	LNB	FF outlet (duct)
L2	3	TX lig/PRB[4]	ESP	Wet FGD[5]	LNB	Between ESP and FGD
L4	NA[6]	PRB	FF	Spray dryer	LNB	Inlet to spray dryer and stack

[1] Fabric filter.
[2] Low-NO_x burners.
[3] Electrostatic precipitator.
[4] Powder River Basin.
[5] Flue gas desulfurization.
[6] Not applicable as the plant has only one unit.

The first plant (L1) was located in Ohio and burns a blend of low- and high-sulfur bituminous coals. As shown in Table 1, the CMMs were located on two generating units: one with an ESP and the other an FF. Two CMMs were also operated at the second plant (L2), which was located in Texas. The units at this facility burned either a 100% Texas lignite or a blend of Texas lignite and PRB coals. The CMMs were located following the particulate control device. However, because Unit 1 had a wet flue gas desulfurization (FGD), the CMM was located between the ESP and the FGD. The third plant tested (L4) was located in Kansas and burned a PRB. This facility has only one unit, but two CMMs were used. The first was located at the inlet to the air spray dryer/FF and the second at the stack. The work at this plant was completed in November 2002, and the data are currently being evaluated and, therefore, not part of this report.

The two CMMs used for this project were the instruments developed by Tekran and PS Analytical. Both of these instruments require a conversion unit to measure speciation, and both measure mercury using a CVAFS dector. Flue gas readings were taken at 2½-minute increments. The instruments were set primarily to measure total mercury, but were switched at set intervals to measure elemental mercury. The intent was to operate each CMM as near to 24 hours a day as feasible. In addition, for verification purposes, two OH samples were taken at the beginning of the testing period (one at each location) and two near the end of the testing period. At each plant, one person remained on-site for the duration of the test period to monitor the equipment, troubleshoot problems, and provide routine maintenance. At both stations, the CMM data were logged continuously on a computer and downloaded to the EERC for evaluation.

During the testing at each plant, coal and ash samples were collected daily. Coal samples were analyzed for mercury, chlorine, proximate–ultimate analysis, heating value, and major elements. Ash samples were analyzed for mercury, loss on ignition, and major elements.

Progress

The results for plants L1 and L2 are presented in Figures 1–4. Substantial variability in mercury emissions occurred at both facilities. The daily mercury averages for the plant burning the Texas lignite/PRB blend with an ESP for particulate control ranged from approximately 12 to 21 $\mu g/m^3$ over a 1-month period (Figure 1). For the test with 100% Texas lignite and an FF, the daily mercury average ranged from 32 to 41 $\mu g/m^3$ (Figure 2).

Although the vapor-phase mercury concentration was considerably lower for Site L2, a similar amount of variability occurred. For the unit with an FF, the mercury ranges from 1 to 5 $\mu g/m^3$ (Figure 3) and from 3.5 to 10.5 $\mu g/m^3$ for the unit with an ESP (Figure 4).

At both facilities, daily maintenance of the instrument was required. In addition, there were several periods of time that the instrument was down for several days. It is apparent that, at the current time, substantial maintenance and highly trained personnel are needed to obtain usable data from CMMs.

Status

Testing the CMMs at the three locations has been completed. The data evaluation has been completed for the first two facilities, but is in progress for the third facility (L4).

Potential Users/Technology Transfer

As pending regulation becomes a reality, more importance will be placed on securing reliable, near-real-time emission data for mercury. These data are being used by the MACT working group and are being included in its report to the EPA. In addition, the data are proving useful to the vendors in developing more reliable instrumentation.

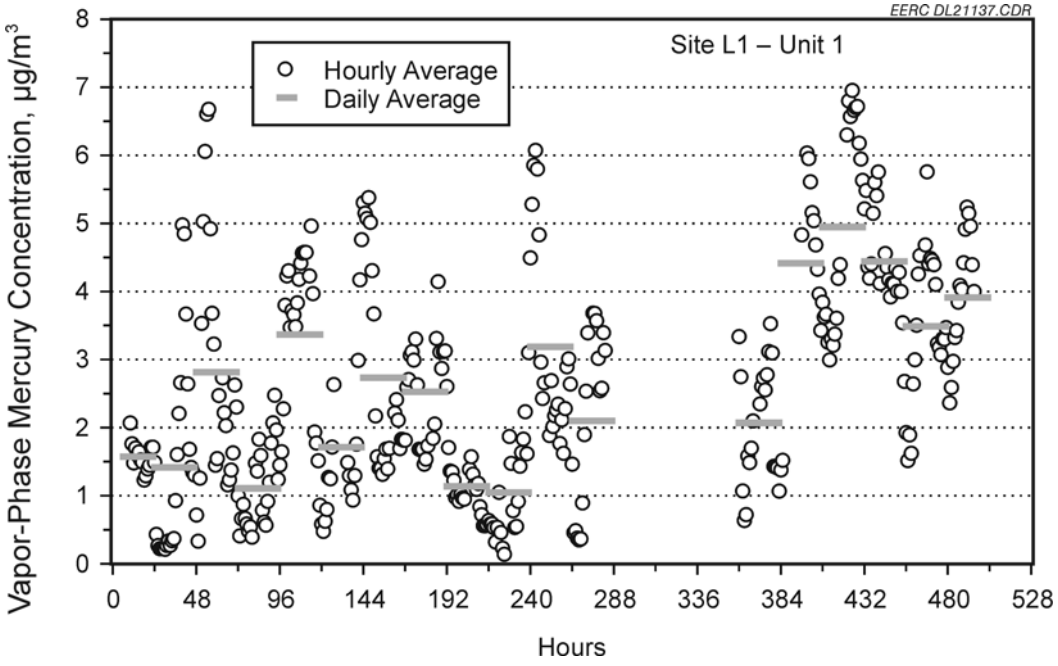

Figure 1. Hourly and Daily Mercury Averages for Site L1; Firing 100% Eastern Bituminous Coal with an FF for Particulate Control

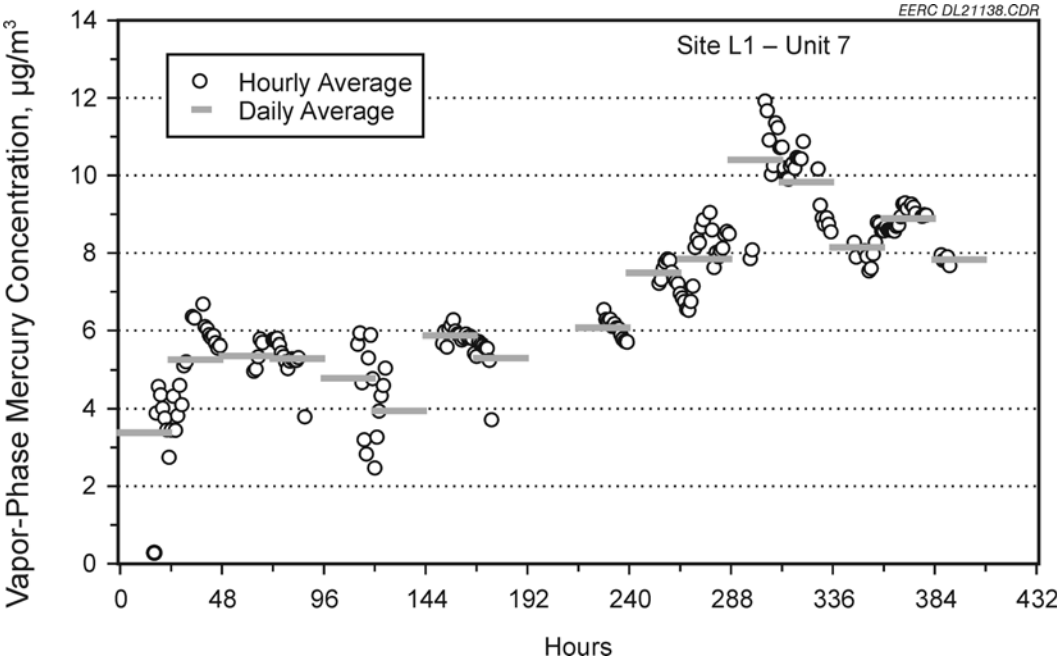

Figure 2. Hourly and Daily Mercury Averages for Site L1; Firing 100% Eastern Bituminous Coal with an ESP for Particulate Control

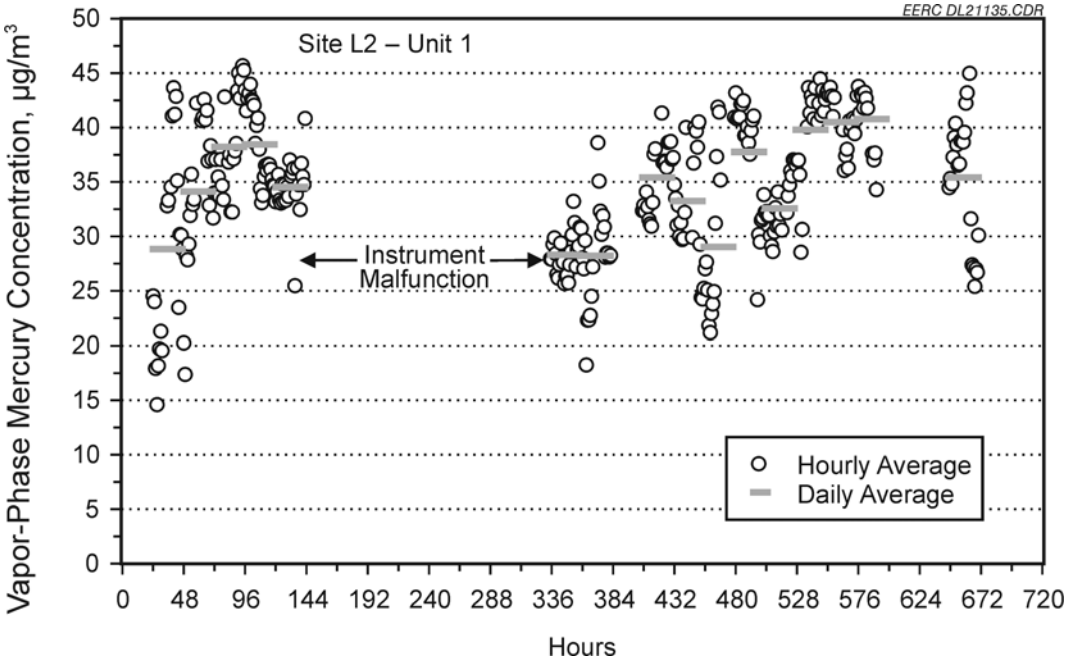

Figure 3. Hourly and Daily Mercury Averages for Site L2; Firing 100% Texas Lignite with an FF for Particulate Control

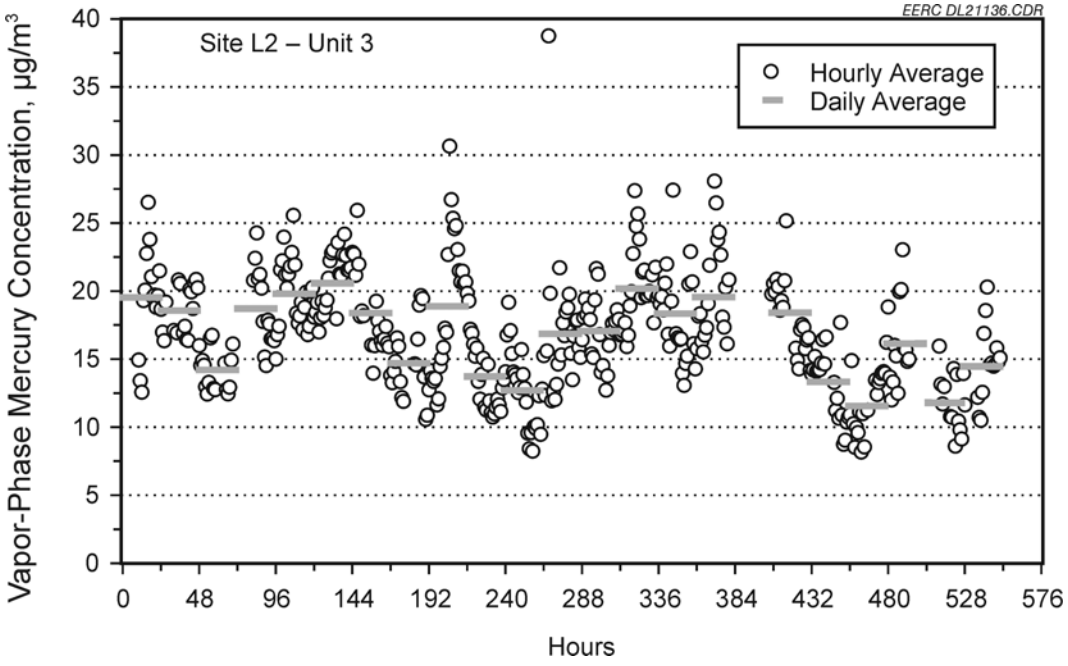

Figure 4. Hourly and Daily Mercury Averages for Site L2; Firing a Texas Lignite–PRB Blend with an ESP for Particulate Control