LONGER-TERM TESTING OF CONTINUOUS MERCURY MONITORS

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Project Description

At the time this project was initiated, wet-chemistry methods such as U.S. Environmental Protection Agency (EPA) Methods 29 and 101A (for total mercury) and the Ontario Hydro (OH) mercury speciation method (speciated mercury) were the only accepted methods used for monitoring mercury emissions at coal-fired power plants. Although these methods were very sensitive, the power industry needed monitors that provided continuous, near-real-time data. However, mercury semicontinuous emission monitors (Hg SCEMs) had not been field-tested adequately to gauge their reliability or ruggedness. Also, although chemical analysis indicated wide variability in coal samples taken within close proximity, the variability of flue gas emissions was unknown.

To address these issues, the Energy & Environmental Research Center conducted longer-term field testing (20–30 days in duration) of Hg SCEMs at four coal-fired power plants. This project was funded by CATM, the U.S. Department of Energy, and EPRI.

Goal

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

Rationale

In late 2000, EPA issued a statement that it intended to regulate mercury emissions from coal-fired electric utility boilers. This project was established to provide data to the EPA Maximum Achievable Control Technology (MACT) Mercury Working Group concerning the ability of Hg SCEMs to operate at the full-scale for extended periods of time (approximately a month in duration) in order to capture total and specitated mercury emissions as a function of coal rank. In addition, the project examined the variability of mercury emissions from coal-fired power plants with various air pollution control devices (APCDs). Table 1 reflects the plant information for this project.

Table 1. Power Plant Information

Plant	Coal	Boiler Size, MW	Boiler Type	NO_x Control	Particulate Control	SO_2 Control
L1 – Unit 1	Eastern bituminous	190	Wall-fired	LNB*	Fabric filter	None
L1 – Unit 7	Eastern bituminous	680	Cell burner	LNB	Cold-side ESP**	None
L2 – Unit 1	Lignite–PRB*** blend	593	Tangentially fired	LNB	Cold-side ESP	None
L2 – Unit 3	Lignite–PRB blend	793	Wall-fired	LNB	Cold-side ESP	Wet FGD****
L4	PRB	348	Wall-fired	LNB	Fabric filter	Spray dryer
L5	Western bituminous	950	Wall-fired	LNB with overfire air	Fabric filter	Wet FGD

* Low-NO_x burners.
** Electrostatic precipitator.
*** Powder River Basin.
**** Flue gas desulfurization.

Approach

During the course of this project, four plants (six units) were tested. Each unit had different APCD configurations and burned different coals or blends. Hg SCEMs were placed prior to APCDs and at the stack in order to measure mercury removal rates and speciation as a result of the technologies.

The Hg SCEMs used for this project were either Tekran or PS Analytical instruments. Both of these instruments require a conversion unit to measure speciation and both measure mercury using a cold-vapor atomic fluorescence spectrometry detector. 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 Hg SCEM as close to 24 hours a day as feasible.

Data loggers maintained near-real-time data. Wet-chemistry tests were conducted using American Society for Testing and Materials Method D6784-02, the OH method, in order to confirm test results at the beginning of the testing period (one at each location) and two near the end of the testing period. Statistical analysis was performed by RMB Consulting to measure the variability of the emissions and to provide confidence intervals related to the reliability of the Hg SCEM data.

To correlate variability to coal chemistry, coal and ash samples were collected daily at each unit tested. 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

Testing for this project has been completed. At each unit, significant variability in mercury emissions was measured by the Hg SCEMs. Table 2 gives the statistical analysis done for each of the units on both hourly and daily bases. Based on the percent relative standard deviation (RSD) at the plants and sampling locations, the data showed variability. However, the plant firing the eastern bituminous coal and that firing the lignite–PRB blend (Sites L1 and L2) showed considerably more variability than Site L4 which fired

Table 2. Statistical Analyses of the Data

	Hourly Averages				Daily Averages			
	Confidence Intervals (95%)				Confidence Intervals (95%)			
Plant/Unit	Geometric Mean, $\mu g/m^3$	Upper, $\mu g/m^3$	Lower, $\mu g/m^3$	% RSD	Geometric Mean, $\mu g/m^3$	Upper, $\mu g/m^3$	Lower, $\mu g/m^3$	% RSD
L1 – Unit 1	2	9.4	0.4	18.5	2	6.4	0.9	12.7
L1 – Unit 7	6.5	14	3.1	24.8	6.3	11.9	3.3	17.4
L2 – Unit 1	33.7	49.9	22.8	62.3	34.4	44.4	26.7	46.6
L2 – Unit 3	16.3	29.9	9.9	30.1	16.4	23.6	11.5	31.4
L4 – FGD Inlet	9.4	13	6.7	14.2	9.5	11.4	7.9	9.1
L4 – Stack	9.9	11.9	8.3	8.8	9.9	10.9	9.4	4.7
L5 – FGD Inlet	0.18	0.4	0	59.3	0.18	0.4	0	45.8
L5 – Stack	0.05	0.1	0	33.7	0.05	0.1	0	12.9

100% PRB subbituminous coal. Site L5 appeared to have a substantial amount of variability, but the mercury concentrations at both sample locations were very low. In general, the bituminous coals have greater variability than the subbituminous coals. These results are supported by the larger data set that was analyzed by RMB Consulting and EPRI (1).

Status

All of the data pertaining to this project have been submitted to the appropriate sponsors and to the EPA MACT Mercury Working Group.

Quality Assurance/Quality Control

In order to validate all Hg SCEM results, OH wet-chemistry tests were taken and correlated to the data. Overall, the results correlated very well.

In addition, statistical analysis was performed for the data results for all units. When computing the hourly and daily averages, the following criteria were used:

- Hourly averages must contain a minimum of 30 minutes of valid Hg SCEM readings in order to be included.
- Daily averages must contain a minimum of 12 valid hourly averages in order to be included.

In addition, quality assurance/quality control (QA/QC) measures had to be applied in order to account for the natural "noise" that occurs as a result of using the pretreatment unit. For the purposes of QA/QC, values that exceeded ±200% of the rolling average were discarded as invalid.

Potential Users/Technology Transfer

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

References

1. Roberson, R.; Laudal, D.; Brickett, L.; Pan, W. Characterization of "Longer-Term" Mercury Emissions from Coal-Fired Power Plants. Presented at the Combined Power Plant Air Pollutant Control Mega Symposium, Washington, DC, May 2003.