TOXECON™ RETROFIT FOR MERCURY AND MULTI-POLLUTANT CONTROL ON THREE 90-MW COAL-FIRED BOILERS

Quarterly Technical Progress Report
Reporting Period: July 1, 2005 – September 30, 2005

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ABSTRACT

With the Nation's coal-burning utilities facing tighter controls on mercury pollutants, the U.S. Department of Energy is supporting projects that could offer power plant operators better ways to reduce these emissions at much lower costs. Sorbent injection technology represents one of the simplest and most mature approaches to controlling mercury emissions from coal-fired boilers. It involves injecting a solid material such as powdered activated carbon into the flue gas. The gas-phase mercury in the flue gas contacts the sorbent and attaches to its surface. The sorbent with the mercury attached is then collected by a particulate control device along with the other solid material, primarily fly ash.

We Energies has over 3,200 MW of coal-fired generating capacity and supports an integrated multi-emission control strategy for SO_2, NO_x, and mercury emissions while maintaining a varied fuel mix for electric supply. The primary goal of this project is to reduce mercury emissions from three 90-MW units that burn Powder River Basin coal at the We Energies Presque Isle Power Plant. Additional goals are to reduce nitrogen oxide (NO_x), sulfur dioxide (SO_2), and particulate matter (PM) emissions, allow for reuse and sale of fly ash, demonstrate a reliable mercury continuous emission monitor (CEM) suitable for use in the power plant environment, and demonstrate a process to recover mercury captured in the sorbent. To achieve these goals, We Energies (the Participant) will design, install, and operate a TOXECON™ system designed to clean the combined flue gases of Units 7, 8, and 9 at the Presque Isle Power Plant.

TOXECON™ is a patented process in which a fabric filter system (baghouse) installed downstream of an existing particle control device is used in conjunction with sorbent injection for removal of pollutants from combustion flue gas. For this project, the flue gas emissions will be controlled from the three units using a single baghouse. Mercury will be controlled by injection of activated carbon or other novel sorbents, while NO_x and SO_2 will be controlled by injection of sodium-based or other novel sorbents. Addition of the TOXECON™ baghouse will provide enhanced particulate control. Sorbents will be injected downstream of the existing particle collection device to allow for continued sale and reuse of captured fly ash from the existing particulate control device, uncontaminated by activated carbon or sodium sorbents.

Methods for sorbent regeneration, i.e., mercury recovery from the sorbent, will be explored and evaluated. For mercury concentration monitoring in the flue gas streams, components available for use will be evaluated and the best available will be integrated into a mercury CEM suitable for use in the power plant environment. This project will provide for the use of a control system to reduce emissions of mercury while minimizing waste from a coal-fired power generation system.

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EXECUTIVE SUMMARY

Wisconsin Electric Power Company (We Energies) signed a Cooperative Agreement with the U.S. Department of Energy (DOE) in March 2004 to fully demonstrate TOXECON™ for mercury control at the We Energies Presque Isle Power Plant. The primary goal of this project is to reduce mercury emissions from three 90-MW units (Units 7, 8, and 9) that burn Powder River Basin (PRB) coal. Additional goals are to reduce nitrogen oxide (NO_x), sulfur dioxide (SO_2), and particulate matter (PM) emissions, allow for reuse and sale of fly ash, demonstrate a reliable mercury continuous emission monitor (CEM) suitable for use in the power plant environment, and demonstrate a process to recover mercury captured in the sorbent.

We Energies has teamed with ADA-ES, Inc., (ADA-ES) and Cummins & Barnard, Inc., (C&B) to execute this project. ADA-ES is providing engineering and management on the mercury measurement and control systems. Cummins & Barnard is the engineer of record and will be responsible for construction, management, and start-up of the TOXECON™ equipment.

This project was selected for negotiating an award in January 2003. Preliminary activities covered under the "Pre-Award" provision in the Cooperative Agreement began in March 2003. This quarterly report summarizes progress made on the project from July 1, 2005, through September 30, 2005. During this reporting period, work was conducted on the following tasks:

Task 7. Procure Mercury Continuous Emissions Monitor (CEM) Package and Perform Engineering and Performance Assessment.
Task 10. Erect Structural Steel, Baghouse and Ductwork.
Task 11. Balance of Plant Mechanical and Civil/Structural Installations.
Task 12. Balance of Plant Electrical Installations.
Task 13. Equipment Pre-Operational Testing.
Task 14. Start Up and Operator Training.
Task 15. Operate, Test, Data Analysis and Optimize TOXECON™ for Mercury Control.
Task 19. Reporting, Management, Subcontracts, Technology Transfer.

INTRODUCTION

DOE awarded Cooperative Agreement No. DE-FC26-04NT41766 to We Energies to demonstrate TOXECON™ for mercury and multi-pollutant control, a reliable mercury continuous emission monitor (CEM), and a process to recover mercury captured in the sorbent. Under this agreement, We Energies is working in partnership with the DOE.

Quarterly reports will provide project progress, results from technology demonstrations, and technology transfer information.

Project Objectives

The specific objectives of this project are to demonstrate the operation of the TOXECON™ multi-pollutant control system and accessories, and

- Achieve 90% mercury removal from flue gas through activated carbon injection
- Evaluate the potential for 70% SO_2 control and trim control of NO_x from flue gas through sodium-based or other novel sorbent injection
- Reduce PM emission through collection by the TOXECON™ baghouse
- Recover 90% of the mercury captured in the sorbent
- Utilize 100% of fly ash collected in the existing electrostatic precipitator
- Demonstrate a reliable, accurate mercury CEM suitable for use in the power plant environment
- Successfully integrate and optimize TOXECON™ system operation for mercury and multi-pollutant control

Scope of Project

The "TOXECON™ Retrofit for Mercury and Multi-Pollutant Control on Three 90-MW Coal-Fired Boilers" project will be completed in two Budget Periods. These two Budget Periods are:

Budget Period 1: Project Definition, Design and Engineering, Prototype Testing, Major Equipment Procurement, and Foundation Installation. Budget Period 1 initiated the project with project definition activities including NEPA, followed by design, which included specification and procurement of long lead-time major equipment, and installation of foundations. In addition, testing of prototype mercury CEMs was conducted. Activities under Budget Period 1 were completed during the first quarter of 2005.

Budget Period 2: CEM Demonstration, TOXECON™ Erection, TOXECON™ Operation, and Carbon Ash Management Demonstration. In Budget Period 2, the TOXECON™ system will be constructed and operated. Operation will include optimization for mercury control, parametric testing for SO_2 and NO_x control, and long-term testing for mercury control. The

mercury CEM and sorbent regeneration processes will be demonstrated in conjunction with the TOXECON™ system operation.

The project continues to move through Budget Period 2 as of the current reporting quarter. Each task is described in the Statement of Project Objectives (SOPO) that is part of the Cooperative Agreement.

EXPERIMENTAL

None to report.

RESULTS AND DISCUSSION

Following are descriptions of the work performed on project tasks during the quarter.

Task 1 – Design Review Meeting

Work associated with this task was previously completed.

Task 2 – Project Management Plan

Work associated with this task was previously completed.

Task 3 – Provide NEPA Documentation, Environmental Approvals Documentation, and Regulatory Approval Documentation

Work associated with this task was previously completed.

Task 4 – Balance of Plant (BOP) Engineering

Work associated with this task was completed the 1st quarter of 2005 in Budget Period 1.

Task 5 – Process Equipment Design and Major Equipment Procurement

Work associated with this task was completed the 1st quarter of 2005 in Budget Period 1.

Task 6 – Prepare Construction Plan

Work associated with this task was completed in the 1st quarter of 2005 in Budget Period 1. The Construction Plan was issued on January 26, 2005.

Task 7 – Procure Mercury Continuous Emission Monitor (CEM) Package and Perform Engineering and Performance Assessment

The overall goal of this task is to have a compliance-grade, reliable, certified mercury CEM installed and operational for use in the TOXECON™ evaluation. ADA-ES has teamed with Thermo Electron Corporation on this task. The Thermo Electron CEM was described in detail in the previous Quarterly Report (DOE Report No. 41766R05).

CEM Update

Several activities were completed this quarter:

- Successful operation of the CEM at the outlet of Unit 8 since June 30, 2005
- Excellent correlation between Sorbent Trap Method and Thermo Electron CEM
- Developed I/O requirements for new CEM
- Installed cable trays for the CEM hotlines from extraction locations on three inlet ducts to the inlet CEM shelter

Site Progress

On June 29 and 30, 2005, a beta version Thermo Electron CEM was installed at the outlet of the air heater on Unit 8. This analyzer is similar to the units installed at the two EPA test sites and is based on Thermo Electron's c-platform software. The *Mercury Freedom System* will use the new i-series platform, which is designed to be Ethernet compatible. This i-series CEM is scheduled to be installed at Presque Isle in December 2005.

The c-series CEM is setup for remote operation. Both ADA-ES and Thermo Electron can access the CEM via modem and can download data and make changes to operating parameters. Mercury concentrations since startup are presented in Figure 1. Mercury concentrations appear fairly stable on a day-to-day basis, but did vary between 4 and 8 $\mu g/Nm^3$ while Unit 8 was on-line during the three month period.

The majority of the measurements were made with the analyzer set to measure total, vapor phase mercury. During three periods, the analyzer was set to switch between measuring elemental mercury and total vapor-phase mercury. According to these measurements, the vapor-phase mercury at Presque Isle consists of 70 to 85% elemental mercury. The fraction of elemental mercury is typically greater than 75% for units firing PRB coal and configured with a cold-side ESP (recall that Presque Isle is configured with hot-side ESPs). The fraction of elemental mercury appears to be changing (has decreased) since the Hg CEM was installed.

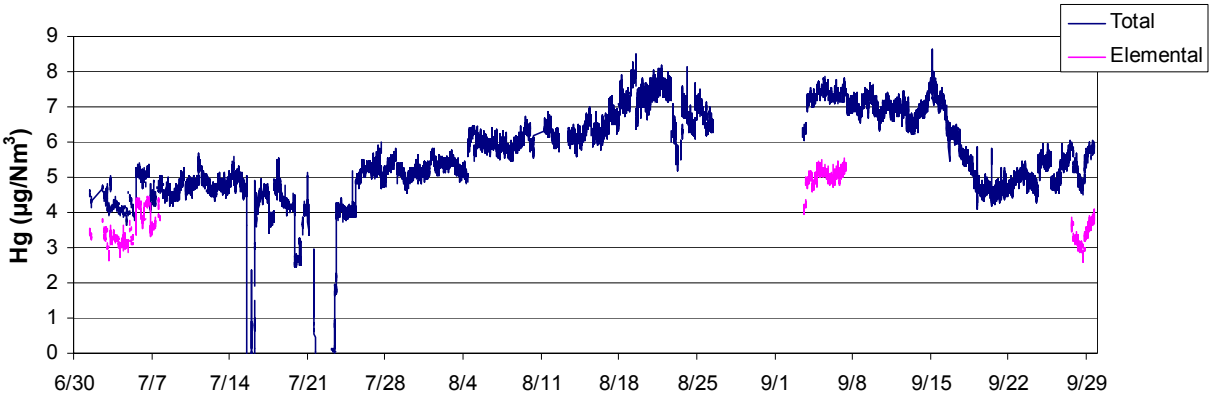

Figure 1. Mercury Concentration Trends, Unit 8

Dry Sorbent Trap Method (STM) tests were conducted at Presque Isle on 8/3/05. These tests us specially prepared carbon traps to collect the mercury sample. A full description of the method can be found in CFR 40 Part 75 Appendix K.

Data from these tests are presented in Figure 2. Duplicate simultaneous samples were conducted during each sampling run. The tests are identified by Run Number (Run 1 through Run 5) and sample box number, either 0200506 or 0200507. Total mercury concentrations for each sorbent trap test are compared to simultaneous CEM measurements. The data indicate that the STM and Thermo CEM compared very well. The mercury concentration measured by each technique was typically within <10%. The largest difference was 17.4% during Run 5 on 8/3/05. This is still within the 20% allowed by EPA under PS12A. There were some malfunctions of the volume totalizer on Sample Box 0200506, which may have increased the relative error between the Thermo CEM and the STM on this run. The sorbent trap for Run 1, Box ID 0205007 was not analyzed due to a bad post-test leak check.

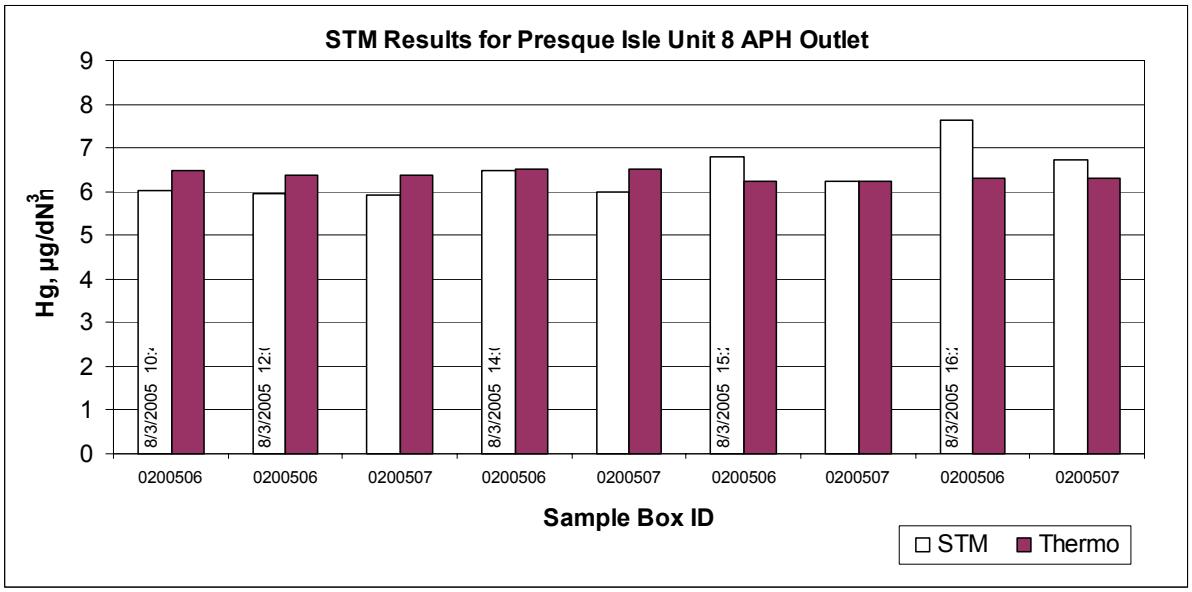

Figure 2. Mercury Concentration Measured by STM and Thermo CEM

Offsite Testing

Plans were made to test the Thermo Electron CEM at two additional coal-fired power plants. These two sites have flue gas compositions that have created problems with other CEMs in the past. The tests will be conducted in the fourth quarter of 2005. A description of the sites follows.

Site #1

The first site fires a blend of Texas lignite and PRB coal. The coal contains nominally 1% sulfur, 0.05 to 0.2 ppm mercury and <100 ppm chlorine. The purpose of this test is to evaluate the converter in a flue gas with relatively high selenium. Testing at this site is scheduled to begin in mid-October.

Site #2

The second test site is AEP's Conesville Power Plant located near Coshocton, Ohio. Conesville fires an Ohio Basin bituminous coal with a sulfur content of 3.6% (dry basis) and a chlorine concentration of 273 ppm (dry basis). The pollution control equipment consists of ESPs for particulate control and wet lime scrubbers for sulfur control.

The Thermo units have not been evaluated on high-sulfur flue gas. Therefore, the purpose of this test is to conduct four weeks of shakedown testing: two weeks upstream of the ESP, and two weeks downstream of the wet scrubber. Testing at this site will begin in mid-November and continue for four weeks.

EPA Demonstration Programs

Testing continues at both EPA sites. Testing at the first site is part of an EPA Office of Air Quality Planning and Standards (OAQPS) demonstration. This is a 500 MW unit burning eastern bituminous coal. Earlier this year, the operation of the mercury analyzer system was tested following EPA PS12A protocol, including a Relative Accuracy Test Audit (RATA), 7-day calibration error test, and a linearity check (Segall, et al., 2005). The CEM passed the Initial Certification Test Criteria (7-day Calibration Error Test, Linearity Test, Cycle Time Test, Converter Efficiency Test, Measurement Error Test, and Zero and Upscale Drift Test). A RATA test was conducted and the Thermo Electron CEM was within the relative accuracy range for all 8 valid Ontario Hydro runs out of the 12 performed. EPA considers this a no-pass because 9 valid runs are necessary for a complete RATA test. The CEM is currently undergoing long-term testing. Data will be reported when available.

Testing at the second site is being conducted by the EPA Office of Research and Development (ORD). This unit fires a low sulfur bituminous coal and has an electrostatic precipitator for particulate control. The Thermo Electron CEM is currently undergoing long-term testing. Information will be reported when available.

Task 8 – Mobilize Contractors

CaTS is proceeding with managing the field construction work. Staff during this period included the construction manager, construction engineer (2), a safety coordinator, electrical coordinator/engineer (2), a start-up manager and an administrative clerk.

The superstructure contractor, Jamar, mobilized in the 1st quarter of 2005 and continues performing the mechanical and structural erection work.

The baghouse erection contractor, WAPC (Boldt), mobilized in the 1st quarter of 2005 and continues work associated with baghouse erection.

Northland Electric mobilized the 2nd quarter of 2005 and continues the electrical, instrumentation, and control installation work.

Task 9 – Foundation Erection

All major foundation work by Boldt Construction Co. was completed during the 1st quarter of 2005 leaving only a minor amount of work remaining including equipment housekeeping, pads, personnel landings and paving activities. The remaining work continued this quarter to support the erection activities of the other Contractors.

Task 10 – Erect Structural Steel, Baghouse and Ductwork

Erection work was initiated during the 2nd quarter of 2005. Work continued on this task in the following areas:

- Baghouse Construction
- Superstructure Contract Erection
- Sorbent Injection System

Baghouse Construction

Work continued from last quarter on erection of the baghouse by WAPC (Boldt) and included:

- Baghouse compartment erection
- Baghouse stair tower erection
- Erection of the inlet and outlet plenums
- Erection of baghouse tubesheets
- Installation of the inlet, outlet, and bypass dampers
- Erection began on baghouse penthouse steel.

Superstructure Contract Erection

Superstructure contract erection work continued during this period. Work activities included:

- Ductwork support steel erection
- Fabrication of ductwork and ductwork erection
- Installation of ductwork expansion joints
- Ash silo support steel erection
- Booster fan enclosure steel erection
- Continued work on installation of access platforms

Sorbent Injection System

The NORIT Activated Carbon Injection System was delivered to the site in July 2005. Installation of the system is planned for early November 2005.

ADA-ES finished the first draft of the DCS code for controlling the PAC Injection system. Inside the code are six different control schemes to control PAC injection rates. The startup document was completed by ADA-ES and NORIT. The startup schedule was also completed.

Task 11 – Balance of Plant Mechanical and Civil/Structural Installations

Balance of plant mechanical work continued during this period and included:

- Fabrication and erection of the ash silo
- Erection of the three ID booster fans
- Erection of ash piping, PAC piping, air piping and booster fan lube oil piping
- Installation of ash system equipment
- Installation of the diverter damper for unit 9. This work is taking place during a scheduled unit outage
- Installation of the ID booster fan inlet and outlet guillotine dampers and seal air fans
- Insulation and lagging of the ductwork and the baghouse began
- Siding installation on booster fan enclosure began

Task 12 – Balance of Plant Electrical Installations

Electrical work for the quarter just completed included the following:

- Installation of cable tray and cable
- Installation of transformers, switchgear and MCCs
- Setting of the DCS cabinets
- Installation of baghouse lighting was started

Task 13 - Equipment Pre-Operational Testing.

Checkout was performed for the electrical power system transformers, feeders, and MCC's, the UPS and the compressed air system.

Task 14 – Start-Up and Operator Training

Work effort for this task included:

- Finalization of the detailed start-up schedule
- Finalization of start-up program component documents
- Finalization of the tag out and lockout procedure and training on implementation of the procedure was provided to personnel on site
- The electrical system including transformers, feeder breakers and UPS were put into operation
- The compressed air system was started
- Final O&M manuals were received for the ash system, PAC equipment, compressed air system, diverter and guillotine dampers
- Preliminary O&M manuals were received for the MCCs, switchgear, baghouse and ID booster fans
- The operator training program was developed and 2 training sessions were held onsite this quarter to train the plant operations personnel

Task 15 – Operate, Test, Data Analysis and Optimize TOXECON™ for Mercury Control

The multi-year evaluation of the TOXECON™ process will be conducted under this task.

Test Bags

The base design for the TOXECON™ fabric filter is to use fabric bags made with polyphenylene sulfide (PPS) fiber with the following specifications:

- Felted, 2.7 denier PPS fabric
- Weight of nominally 18 ounces/yd^2
- Singed on outside
- Scrim material made from 3 ounces/yd^2 of PPS
- Mullen burst minimum of 500 psi
- Maximum temperature for continuous use is 375ºF
- Permeability at 0.5 inches H_2O of 25 – 40 cfm/ft^2

This specification is similar to that used in other pulse-jet installations, including the pulse-jet baghouses at We Energies' Valley Station.

It is also of interest to evaluate alternative fabrics that may provide either performance or cost advantages. Initially, five fabrics have been identified for full-scale evaluation in this program. Information on the test bag material and number is outlined in the following table:

Material/Design	**Quantity**
7 denier Torcon with Torcon scrim (Midwesco style #9056)	12
7 denier Torcon with 2.0 oz PTFE scrim (#9054)	8
7 denier Torcon with 4.0 oz PTFE scrim (#9055)	8
Dual density Torcon (0.9 and 2 denier blend on filter side, 7 denier on other side) (#9065)	10
P84 bags	13

The first three bag types in the above table address bag life issues by using different, more robust scrim materials. The fourth bag type is a dual density design, which may provide higher efficiency filtration. These four fabric types are also being evaluated in EPRI's Novel Filter Bag Program. P84, the fifth test material, is a commercially available product that can operate at higher temperatures than the PPS fabric and has the potential for higher particulate collection efficiency. During this quarter, 51 test bags were fabricated and shipped to Presque Isle for installation in one of the baghouse compartments.

Samples of these experimental bags as well as the base PPS bags will be pulled and tested periodically to assess bag strength and filtration properties. A detailed schedule for removing sample bags will be coordinated with plant operations based on outage schedules.

Task 16 – Operate, Test, Data Analysis and Optimize TOXECON™ for NO_x and SO_2 Control

No work was done on this task during this period.

Task 17 – Carbon – Ash Management System

No work was done on this task during this period.

Task 18 – Revise Design Specifications, Prepare O&M Manuals

No work scheduled during this period.

Task 19 – Reporting, Management, Subcontracts, Technology Transfer

Reports as required in the Financial Assistance Reporting Requirements Checklist and the Statement of Project Objectives are prepared and submitted under this task. Subcontract management, communications, outreach, and technology transfer functions are also performed under this task.

Activity during the Quarter

- Quarterly Technical Progress Report delivered.
- Quarterly Financial Status Report delivered.
- Quarterly Federal Assistance Program/Project Status Report delivered.
- Comments on the Preliminary Public Design Report were incorporated.
- A site visit in August included We Energies, ADA-ES, DOE, and C&B, Marquette TV6 conducted interviews on the project.
- A presentation was made at DOE/NETL Mercury Control Technology R&D Program Review Meeting in July.
- A presentation was made to the Subbituminous Energy Coalition meeting in September 2005.
- A poster presentation was made at the AQV Conference in September.
- The draft test plan was updated for testing the TOXECON™ system.
- A draft test bag layout was prepared and issued.
- Technical papers and presentations for future meetings include the EPRI baghouse workshop (October 2005), POWER-GEN (December 2005), ASME Power Conference (March 2006), DOE Clean Coal and Power Conference (November 2005), and EUEC (January 2006).
- A possible event at the site after construction is complete was discussed.

CONCLUSION

This is the sixth Technical Progress Report under Cooperative Agreement No. DE-FC26-04NT41766. Construction continued on the baghouse including erection of compartment, stair tower, inlet and outlet plenums, tubesheets, inlet, outlet and bypass dampers and penthouse steel. Superstructure work included erection of ductwork, expansion joints and ductwork support steel, erection of support steel for ash silo and booster fan enclosure, and installation of access platforms. Balance of plant mechanical work included erection of the three ID booster fans, ash silo, air piping, ash line piping, PAC piping and booster fan lube oil piping. The ash system, ID booster fan guillotine dampers, and diverter damper for unit 9 were installed. Insulation of ductwork and the baghouse also began this quarter. .

Work continued in the evaluation of components for a mercury continuous emissions monitor system. The CEM installed last quarter has been running unattended and has performed well on comparison tests with the Sorbent Trap Method. Plans have been made to test the CEM at two other sites that have problematic flue gas components. The project team is actively involved in a number of reporting and technology transfer activities.

REFERENCES

Segall, R., Grimley, B. and Ryan, J. (2005). "EPA Mercury CEMS Demonstrations Update" presented at the Air Quality V International Conference on Mercury, Trace Elements, SO_3, and Particulate Matter, Arlington, VA, September 20.

PROJECT PHOTOS

The following photos are included showing progress of activities at the site during the reporting quarter:

Figure 3. Photo of Baghouse and Ash Silo

Figure 4. Photo of Fan Building

Figure 5. Top View of Baghouse and Fan Building