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

Quarterly Technical Progress Report
Reporting Period: October 1, 2005 – December 31, 2005

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January 25, 2006

DOE Cooperative Agreement No. DE-FC26-04NT41766

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DISCLAIMER

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 October 1, 2005, through December 31, 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 a previous Quarterly Report (DOE Report No. 41766R05).

CEM Update

Several activities were completed this quarter:

- Successful operation of the prototype, c-series mercury CEM at the outlet of Unit 8. This analyzer operated continuously from June 30 until December 2005 when it was replaced with a production grade analyzer.
- Enabled remote access to the CEM(s) through the Internet, replacing the dialup connection and improving monitoring and data downloading capabilities.
- Conducted QA/QC checks for mercury CEMs outlined in the CAMR.
- Installed two new i-series CEMs at the inlet and outlet of TOXECON™. One of these replaces the c-series CEM that was running at the outlet of Unit 8 (inlet of TOXECON™).
- Successful testing of the converter and i-series CEM at a site with high-selenium flue gas.

Site Progress

On June 30, 2005, a beta version (c-series) Thermo Electron CEM was installed at the outlet of the air preheater on Unit 8. A description of its performance during the third quarter can be found in DOE Report No. 41766R06. The system has been working very well, with an availability of 94%. Figure 1 shows the mercury data trends for September 30 through November 19, 2005. During this period, total mercury concentration varied between 4.0 to 9.7 μg/Nm^3 and the speciation split was typically 75% elemental/25% oxidized vapor phase mercury.

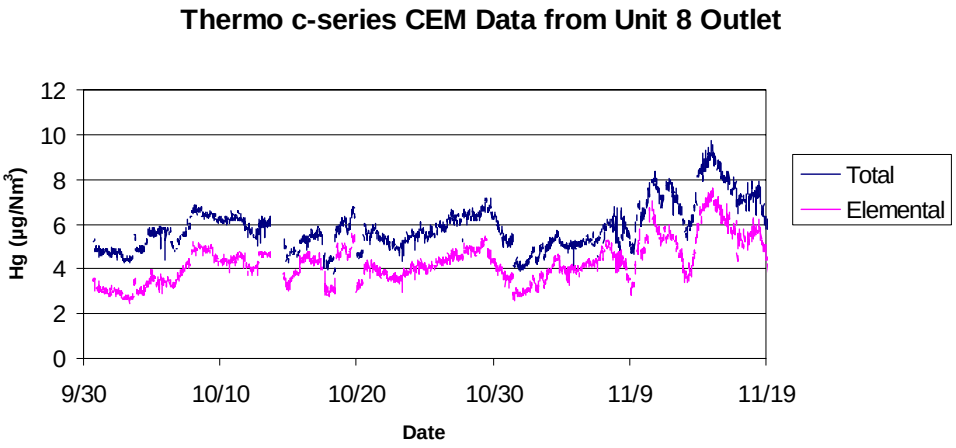

Figure 1. Thermo CEM Trends from Unit 8 APH Outlet

QA/QC Checks

During this quarter, several QA/QC tests outlined in the CAMR were conducted on the system. These were 7-day calibration error tests, linearity tests and cycle time tests.

The system passed the 7-day Calibration Error Test Using Hg^0 as shown in Table 1. The test was performed with the Hg^0 calibration gas unit provided by Thermo. The purpose of the test was to determine the extent of calibration drift.

Table 1. Results of 7-day Calibration Error Test Using Hg^0

DAY	DATE	TIME START	TIME END	SPAN	CEMS	% ERROR -or- ABS DIFF		PASS/ FAIL
1	10/21/2005	6:30		9.94	9.92	0%	0.02	PASS
2	10/22/2005	12:54	13:05	9.99	10.02	0%	-0.03	PASS
3	10/23/2005	16:25	16:47	9.99	9.6	4%	0.39	PASS
4	10/24/2005	16:40	16:55	9.82	9.55	3%	0.27	PASS
5	10/25/2005	13:45	14:15	9.87	9.87	0%	0	PASS
6	10/26/2005	15:20	15:45	9.85	10.09	-2%	-0.24	PASS
7	10/27/2005	14:45	15:15	9.84	10.2	-4%	-0.36	PASS

The Thermo CEM also passed the 3-Point Linearity Check using Hg^0 as shown in Table 2. This test was also performed using the Hg^0 calibration gas unit provided by Thermo.

Table 2. Results of 3-Point Linearity Check Using Hg^0

PT	DATE	TIME START	TIME END	SPAN	CEMS	% ERROR -or- ABS DIFF		PASS/ FAIL
1	10/27/2005	14:30	14:45	0	0	-	0	PASS
2	10/27/2005	15:25	15:50	4.92	4.63	6%	0.29	PASS
3	10/27/2005	14:45	15:15	9.84	10.2	-4%	-0.36	PASS

The CEM passed the Cycle Time Test as shown in Figure 2. This test was performed by delivering Hg^0 calibration gas from the calibrator in the CEM shelter to the probe. Cycle time is determined by measuring the time required to reach 95% recovery. During the span shown, the time required to reach 95% of the span value was 2.5 minutes. The span was started at 15:50.

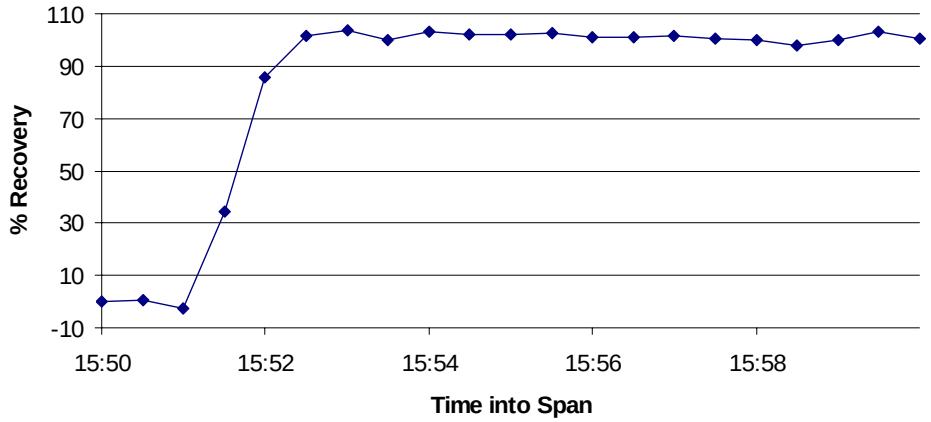

Figure 2. Cycle Time for the Hg CEM Span Check to the Probe

Installation of i-Series CEMs

Two new i-series Mercury Freedom™ CEMs were installed in December. The first was installed at the outlet duct from the baghouse the week of December 12. The CEMs include a CVAF analyzer, elemental mercury calibrator, stack probe controller, inertial sampling system, zero air supply, and heated sample line. A schematic of the system can be seen in Figure 3. Figure 4 shows the installed probe above the access platform at the outlet, and the nearby CEMs shelter in the baghouse enclosure. Figure 5 is a photograph of the analyzer installed in the outlet shelter.

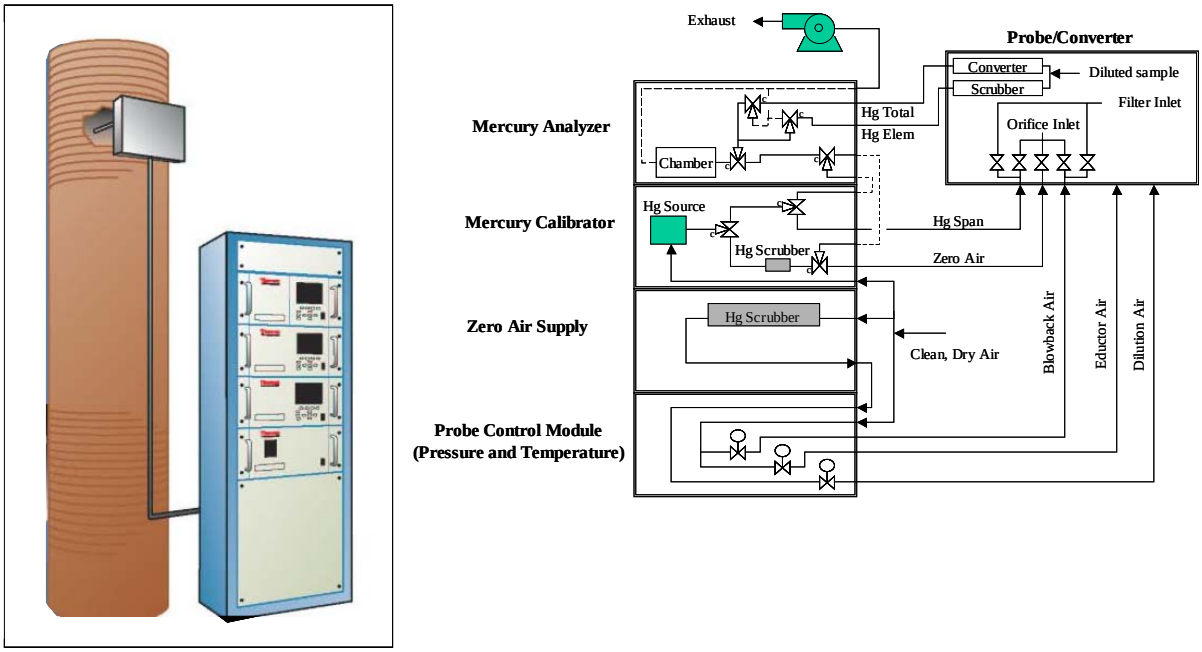

Figure 3. Thermo Electron Mercury Freedom System™ CEM

Figure 4. Outlet Duct CEM Shelter and Installed Probe

Figure 5. Mercury Freedom™ CEM Installed in the Shelter at the Baghouse Outlet

The second CEM was installed the week of December 19 at the inlet to the baghouse/outlet of the air heater on Unit 8. This replaced the beta version (c-series) CEM installed in June 2005. The inlet measurement is complicated because there is no common duct to extract untreated (pre-carbon injection) flue gas. Instead, mercury will be measured at the individual ducts at the outlet of air heaters on Unit 7, 8, and 9. To do this, it will be necessary to have three sets of extraction probe/converters and a valve-switching box. The other two probes/converters will arrive in mid-February.

Offsite Testing

Plans were made in the third quarter to test a new Thermo Electron i-series 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. Testing at one of the sites occurred in this quarter. Testing at the second site is scheduled in January 2006.

The first site fires a blend of coal that contains nominally 1% sulfur, 0.05 to 0.2 ppm mercury and <100 ppm chlorine. The purpose of this test was to evaluate the converter in a flue gas with relatively high selenium. Testing at this site occurred in October and November.

The objective was to operate the mercury CEM continually for three weeks while following QA/QC procedures for a compliance mercury CEM as defined in the CAMR. A modified relative accuracy check was conducted using the sorbent trap method (STM). Two sets of three duplicate STM runs were collected during the test program.

The testing at this site demonstrated that the Mercury Freedom System™ performed very well in a difficult flue gas. The concentrations of total mercury measured by the Thermo CEM were accurate and consistent from early in the testing period. Some operational issues were noted, and modifications to the Thermo CEM design were made when appropriate. In general:

- The Mercury Freedom System™ CEM successfully measured total mercury at a site with high selenium flue gas.
- Speciation measurements of mercury in stack emissions were successful following modifications to the probe design to ensure proper temperature control.
- Remote operation of the analyzers was successful.
- A 5-day calibration drift test indicated the system was stable.
- Under normal operation, the cycle time was less than 8 minutes (90% recovery).
- Relative accuracy showed that the Thermo CEM operated within 12% of STM measurements on two separate occasions.

Task 8 – Mobilize Contractors

Work associated with this task was completed in the 2nd quarter.

Task 9 – Foundation Erection

All major foundation work by Boldt Construction Co. was completed during the 1st quarter of 2005. The remainder of work, including a minor amount of concrete work and paving, was completed during this quarter.

Task 10 – Erect Structural Steel, Baghouse and Ductwork

Erection work was initiated during the 2nd quarter of 2005. The work effort for this task during the 4th quarter of 2005 included baghouse construction and superstructure contract erection. All major construction efforts in this task except punchlist items were completed at the end of the quarter.

Baghouse Construction

Baghouse construction during this quarter included the following baghouse erection activities:

- Setting of baghouse tubesheets
- Installation of internal baffles and turning vanes
- Erection of the penthouse steel and siding
- Installation of the inlet, outlet and bypass dampers
- Insulation and lagging of the baghouse
- Installation of bags and cages
- Installation of pulse air headers and actuators
- Installation of baghouse heating and ventilation systems

Superstructure Contract Erection

Superstructure Contract erection work continued and was completed during this period. Work activities included:

- Fabrication and erection of ductwork and ductwork support steel
- Installation of ductwork expansion joints
- Insulation and lagging of the ductwork
- Continuation of installation of access platforms

The baghouse was brought on line on December 17, 2005 using flue gas from Unit 7 boiler. Although the baghouse was operational as of this date, work will continue into the first quarter of 2006 involving the tie in of Units 8 and 9 (January 2006), tie in of the PAC system (January, 2006), and completing the punchlist items.

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

Principal work activities associated with balance of plant mechanical work were completed during the 4th quarter of 2005. The work completed included:

- Installation of ash silo equipment and piping
- Installation of PAC silo, PAC equipment and piping
- Installation of the ID booster fans inlet and outlet guillotine dampers and seal air fans
- Installation of unit 9 diverter damper
- Siding installation on Booster Fan enclosure was completed.
- Installation of fan enclosure and ash silo heating and ventilation systems

Task 12 – Balance of Plant Electrical Installations

Principal work activities associated with BOP Electrical were completed during the 4th quarter of 2005. Activities included the following:

- Pulling and termination of cable for the ID booster fan equipment, ash equipment, PAC equipment, DCS equipment, guillotine dampers and damper seal air systems, units 8 and 9 diverter dampers and seal air systems, heating and ventilation systems and permanent power to Unit 7 diverter damper
- Energizing the MCC's
- Installation of baghouse and BOP lighting continued
- Installation of Gai-Tronics PA/phone units

Task 13 - Equipment Pre-Operational Testing.

Work effort for this task for the 4th quarter of 2005 included:

- Point to point wiring checks, loop checking, I/O checking and logic checkout
- Checkout of the baghouse, ash system, fans, dampers, CEMs, electrical system and DCS

Task 14 – Start-Up and Operator Training

Work effort for this task included:

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- ID booster fan, ash transport and wet and dry ash unloading systems were started up.
- Final O&M manuals were received for the MCC's, switchgear, and ID booster fans during this quarter.
- The operator training program was completed during the 3rd quarter to train the plant operations personnel.
- The baghouse was initially brought into operation on December 17 with unit 7.

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

A description of the base design for the TOXECON™ fabric filters is described in detail in the previous Quarterly Report (DOE Report No. 41766R06). In addition, bags made from seven different test materials were installed in one of the baghouse compartments to determine performance and durability. Information on the test bag material and number is outlined in Table 3.

Table 3. Test Bag Material Description

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
Scrim-supported PPS felt with a BHA-TEX Expanded Microporous PTFE Membrane	12
Toray proprietary material	4

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. The sixth test material from GE/BHA contains a membrane material, which may provide higher efficiency filtration. The seventh material from Toray is a proprietary blend of PPS, PTFE and glass fibers with a PPS scrim.

During this quarter, all of the test bags were installed in compartment 8A (Figure 6) using the arrangement shown in Figure 7.

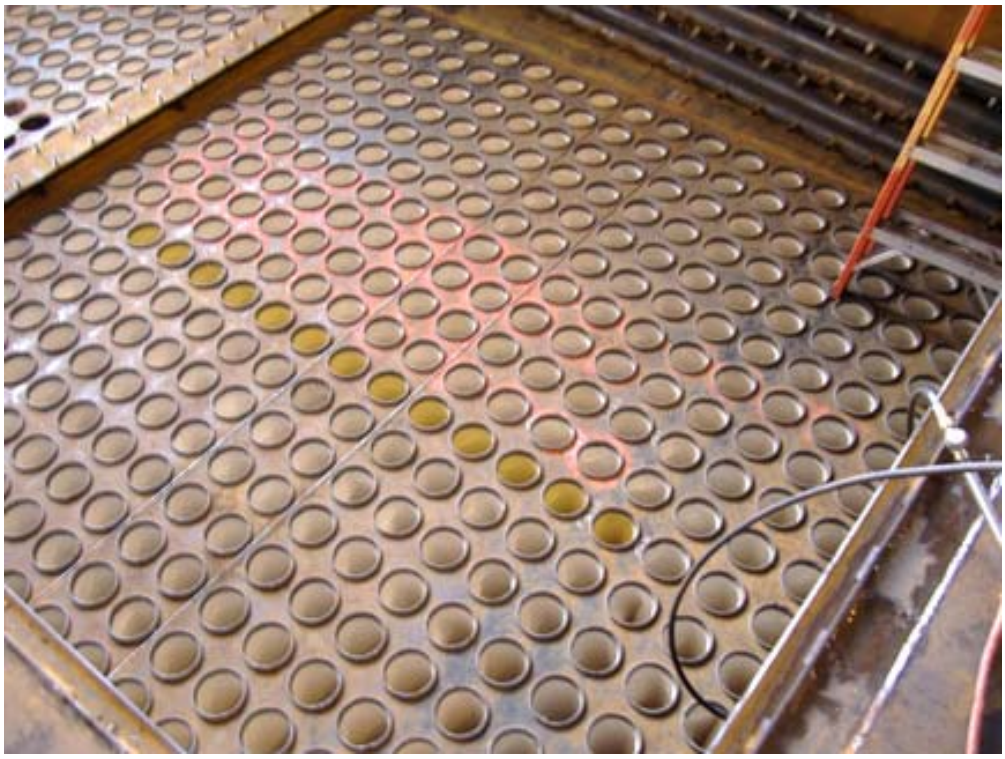

Figure 6. Test Bags Installed at PIPP

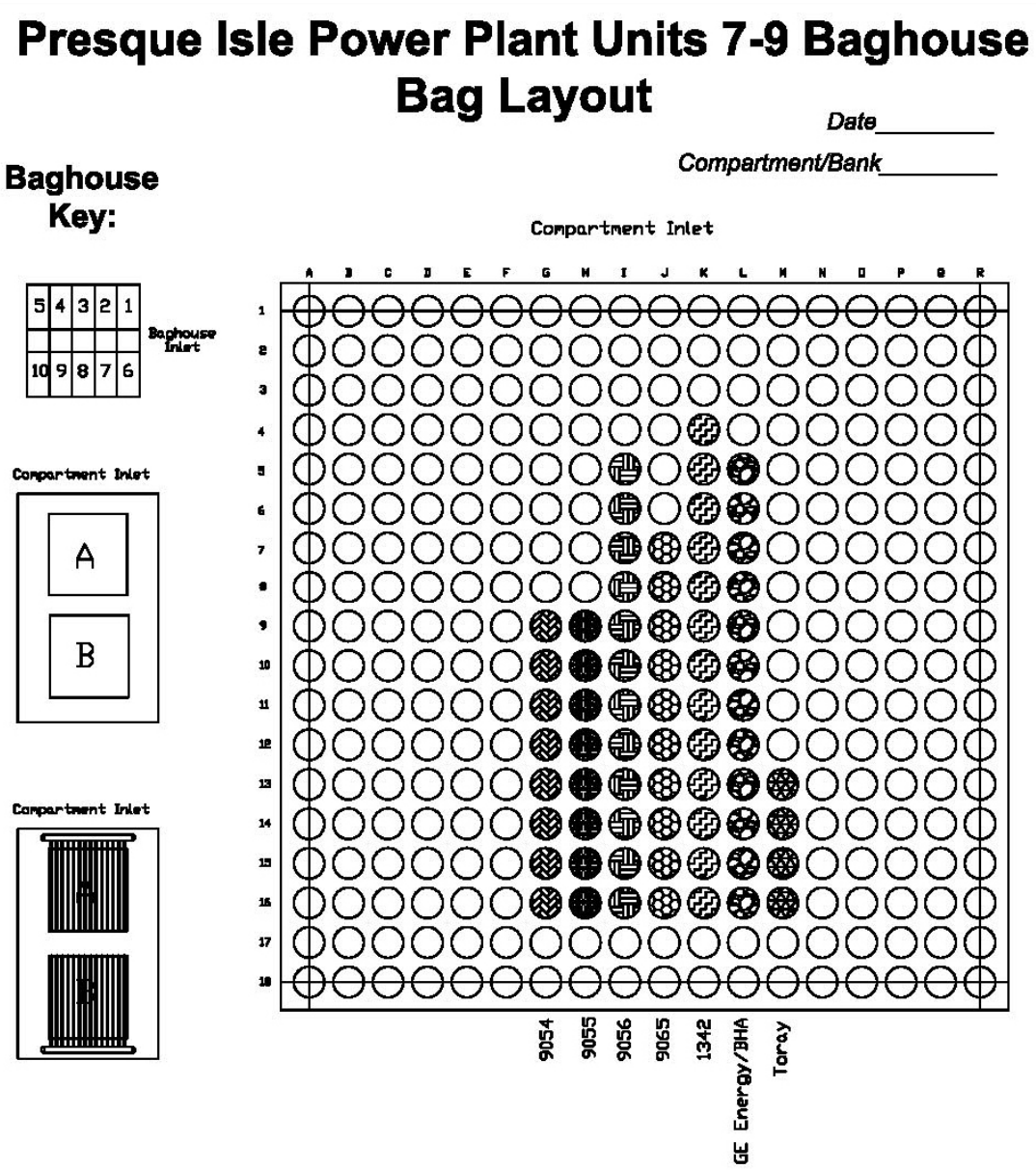

Figure 7. Test Bag Placement in Compartment 8A.

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.

On December 17th the baghouse was put into service with flue gas from Unit 7. Unit 9 will be added in early January and Unit 8 the week of January 23, 2006. The PAC system will be put into service for the first time in late January. TOXECON™ testing will officially begin after check out of the PAC system. A schedule of initial baseline and parametric testing can been seen in Table 4.

Table 4. Schedule

Date	Activity
1/23/06 – 1/27/06	Check out PAC System
1/30/06 - 2/3/06	Start up PAC System
2/13/06 – 2/17/06	Baseline Testing
2/20/06 – 3/15/06	Parametric Testing - Start

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 Draft Preliminary Public Design Report were incorporated and the Preliminary Public Design Report was submitted for review.
- A site visit in November included We Energies, ADA-ES, DOE, and C&B. ADA-ES prepared a short presentation on the mercury CEM for DOE.
- A presentation was made at the EPRI baghouse workshop in October 2005.
- A poster and a presentation were made at the Clean Coal and Power Conference in November.
- A presentation was made at the POWER-GEN Conference in December 2005.
- The draft test plan was submitted to DOE for review.
- A test bag layout was prepared and issued.
- Technical papers and presentations for future meetings include ASME Power Conference (March 2006), and EUEC (January 2006).

CONCLUSION

This is the seventh Technical Progress Report under Cooperative Agreement No. DE-FC26-04NT41766. Construction continued on the baghouse including installation of: baghouse tubesheets, internal baffles, turning vanes, penthouse steel, penthouse siding, bags, cages, and inlet, outlet and bypass dampers. Superstructure contract erection work included: fabrication and erection of ductwork and ductwork support steel; installation of ductwork expansion joints; and installation of access platforms. All major construction efforts were completed during this quarter, with only punchlist items remaining.

All major balance of plant mechanical work was completed and included installation of: pulse air headers and actuators; ash silo equipment and piping; PAC silo, equipment and piping; ID booster fans; guillotine dampers, seal air fans; Unit 9 diverter damper; heating and ventilation systems; insulation and lagging of the ductwork; and siding installation. Punchlist items in this task will to be completed in the next quarter.

All major balance of plant electrical work was completed and included: energizing the MCCs, installation of lighting and phone units, and pulling cable for equipment. There are also punchlist items to be completed in this task.

The baghouse came on line December 17, 2005 with flue gas from Unit 7. All systems operated as expected. Units 8 and 9 will be tied into the baghouse in January of 2006. The PAC system will also be checked out in January.

Work continued in the evaluation of components for a mercury continuous emissions monitor system. The c-series CEM installed in June 2005 has been running unattended and has performed well, and has passed several QA/QC tests. This c-series CEM was replaced with the upgraded i-series CEM and an additional i-series CEM was installed at the outlet of the baghouse. Plans had been made to test the CEM at two other sites that have problematic flue gas components, and tests were completed at one site. The CEM performed very well with a difficult flue gas that is high in selenium. The project team is actively involved in a number of reporting and technology transfer activities.

PROJECT PHOTOS

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

Figure 8. Photo of PAC Silo Placement

Figure 9. Photo of Baghouse, Ash Silo and PAC Silo