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

Quarterly Technical Progress Report
Reporting Period: April 1, 2005 – June 30, 2005

Prepared by
Richard E. Johnson
Wisconsin Electric Power Company
333 West Everett Street
Milwaukee, WI 53203

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DOE Cooperative Agreement No. DE-FC26-04NT41766

Theodore J. McMahon
USDOE Contracting Officer's Representative

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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 April 1, 2005, through June 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 8. Mobilize Contractors.
- Task 9. Foundation Erection.
- Task 10. Erect Steel, Baghouse and Ductwork.
- Task 11. Balance of Plant Mechanical and Civil/Structural Installation.
- Task 12. Balance of Plant Electrical.
- Task 14. Start Up.
- Task 15. TOXECON™ Testing 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, and
- 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 initiates the project with project definition activities including NEPA, followed by design, which includes 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 moved fully into 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. For reference in this and future quarterly reports, the original SOPO for this project can be found in Appendix C.

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 previously completed.

Task 5 – Process Equipment Design and Major Equipment Procurement

Work associated with this task was previously completed.

Task 6 – Prepare Construction Plan

Work associated with this task was previously completed.

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 production-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.

CEM Update

Several major milestones were accomplished during this reporting period, including the introduction of Thermo Electron's *Mercury Freedom System* at EPRI's User Group Meeting and Exhibit in May, hearing that the CEM passed the first set of EPA supervised performance tests, and the installation of one of the beta systems at Presque Isle.

On May 3, Thermo Electron publicly introduced their mercury CEM for coal fired power plants as the *Mercury Freedom System*. A press release announced that purchase orders for the system could now be placed and that the system was on display at EPRI's User Group Meeting in Savannah Georgia. Actual delivery of the first systems is expected to be in November 2005. The press release and the initial brochure can be found in Appendix A.

This announcement is significant because when this Clean Coal Power Initiative program was selected in 2003, stack compliance-grade CEM mercury monitors were not available. Several research-grade mercury monitors were proven accurate and reliable; however, they required operation by a highly skilled engineer and continuous maintenance. In the past year, ADA-ES has worked with Thermo Electron to accelerate the development of a mercury CEM for use on this program and for availability to the large CEM end user market. ADA-ES's role has been to validate the different components by operating them in parallel with ADA-ES's mercury analyzer at different sites and provide feedback on performance to Thermo Electron.

The Thermo Electron instrument has four key components: sample extraction probe, sample converter, mercury analyzer, and calibration module. Figure 1 shows a schematic of these components. Component design has evolved over the past year, with several modifications being made during this reporting period. The following paragraphs describe the components in their current state of development.

The extraction probe uses an inertial filter to obtain a particulate-free vapor-phase sample without passing the gas through a fly ash filter cake. This minimizes the sample gas interactions with the fly ash, which can cause sampling artifacts. An eductor, driven with compressed, dry, mercury-free motive air, draws the ash-free sample from the inertial filter. The line between the inertial filter and the vacuum port on the eductor contains a critical-flow orifice. To maintain a constant sample flow rate to the analyzer, the eductor dilutes the sample with the motive air resulting in a dilution ratio between 25:1 to 100:1, depending on the size of the critical-flow orifice. The dilution ratio is determined based on flue gas conditions and operator preference. All of the extraction probe internal surfaces exposed to sample gas have a glass coating to prevent unwanted chemical reactions with the mercury.

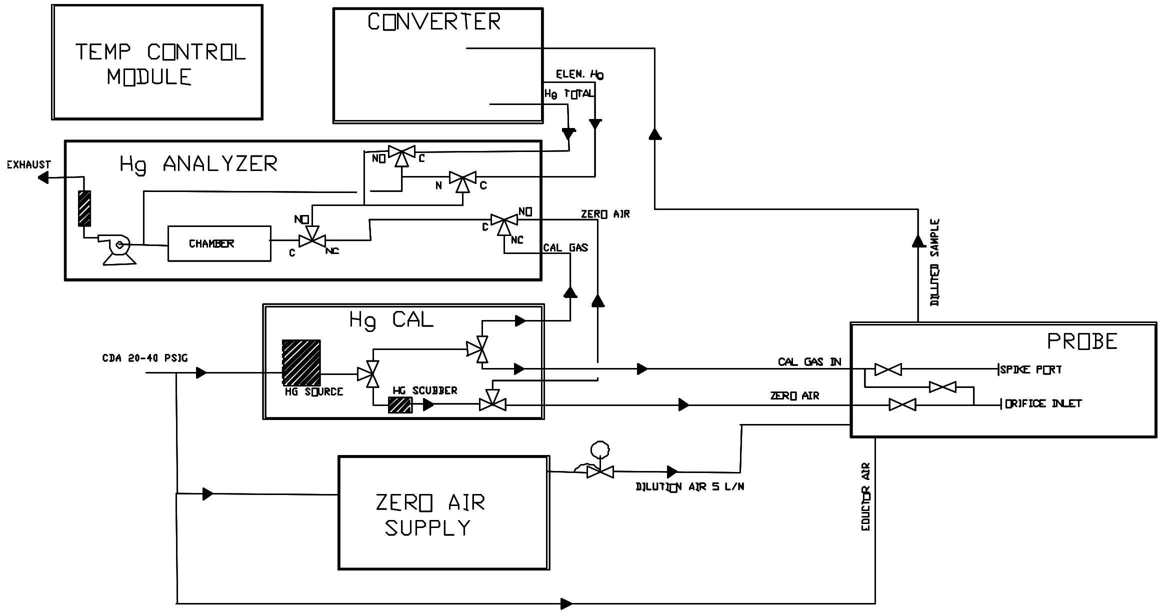


Figure 1. Schematic of Thermo Electron Prototype Mercury CEM.

A vapor phase elemental mercury calibrator is used to spike mercury either upstream or downstream of the inertial separator. This range allows the operator to directly calibrate the analyzer at post-dilution concentrations and dynamically spike into the extraction probe. The technology uses a Peltier Cooler/vapor pressure control and a mass flow controller. The calibrator can deliver a concentration of elemental mercury between 0.1 to 300 µg/m^3. Calibration gas from the calibration module can be introduced into the sample stream either upstream or downstream of the inertial filter.

The converter module converts the oxidized mercury in the diluted sample to elemental mercury for a total vapor phase mercury measurement, or it scrubs oxidized mercury from the diluted sample to deliver only elemental mercury to the analyzer when a speciated measurement is desired. The proprietary design combines high temperature (>750ºF) and a chemical reaction to achieve the conversions.

The analyzer measures mercury directly using Cold Vapor Atomic Fluorescence technology. Because the sample is diluted, it has low moisture, is relatively non-reactive, and therefore has minimal interference from other gases. Currently, the analyzer detection limit is 1 ng/m^3 (~0.1 ppt) and no cross interference from SO_2 has been observed.

Field Validation Tests

EPA is conducting two different field test programs to collect data to assess the ability of different mercury CEMs to provide reliable and accurate information over an extended time period, while meeting durability, data availability, and set-up/maintenance requirements.[1] Thermo Electron provided a beta version instrument to each of the sites. In these tests, the supplier is asked to provide the instrument and installation. EPA's contractor operates the instruments and conducts the certification tests.

In January 2005, Thermo Electron joined the round robin test of mercury CEMs coordinated by EPA's Office of Air Quality Planning and Standards (OAQPS). The tests are being conducted at Louisville Gas and Electric's Trimble County Station. This station fires a high sulfur coal and has an SCR for NO_X control and a wet scrubber for SO_2 control.

Certification tests are designed to determine if the mercury CEMs will satisfy selected requirements of the proposed performance specifications (PS-12A, FR 1/30/04, 69(20), 4652) and Part 75 proposed rules[1]. The results from initial certification tests were released in May 2005. Thermo Electron was one of two CEM suppliers that passed the tests. The results are summarized in Table 1.

Table 1. Results from U.S. EPA field tests at Trimble County, Spring 2005

U.S. EPA Performance 12A Compliance – Preliminary field test results	
7-day Cal Error Test, 2 points, zero and upscale (Passing criteria: <5% span or <1 $\mu g/m^3$)	**Passed**
Linearity Check, 3 points, low, mid, high (Passing criteria: <10% of ref tag or <1 $\mu g/m^3$)	**Passed**
Cycle Time (Passing criteria: <15 minutes to 95%)	**Passed**
Converter Efficiency (Passing criteria: <5% of span)	**Passed**
Relative Accuracy (Passing criteria: <20% of mean Reference Method)	**Passed**

In April 2005, an analyzer was installed at the second EPA round robin test site. The site for this test is Progress Energy's Cape Fear Station in Moncure, NC. This station fires a low sulfur bituminous coal and has an electrostatic precipitator for particulate control. Performance tests were conducted in June 2005. Information will be reported when available.

[1] "Long-Term Field Evaluation of Mercury Continuous Emission Monitoring Systems: Coal-fired Power Plants Burning Eastern Bituminous Coal and Equipped with SCR and Wet Scrubber", EPA Contract NO. 68-D-01-002, March 11, 2005.

Site Progress

On June 29 and 30, 2005, a beta version Thermo analyzer 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. An analyzer, calibrator, probe control box , pump, and mercury scrubber (for dilution and zero air) was installed in a CEM shelter acquired for this program, located underneath the Unit 8 ductwork and inside the plant. Figure 2 is a picture of the extraction probe installed in a 4" port on Unit 8. Figure 3 is a photograph of the analyzer installed in the CEM rack in the shelter.

Figure 2. Probe installed at PIPP APH outlet, Unit 8.

Figure 3. Thermo C-platform CEM installed at PIPP.

A phone line connected to the analyzer permits remote access to the system. Both ADA-ES and Thermo Electron are tracking measurements and system performance remotely.

Task 8 – Mobilize Contractors

CaTS is proceeding with managing the field construction work. Staff during this period included the construction manager, construction engineer, a safety coordinator, electrical coordinator, schedule coordinator, and an administrative clerk. A start-up manager was added to the site staff during this quarter.

The superstructure contractor, Jamar, has been on site since the previous quarter performing the mechanical and structural erection work.

The baghouse erection contractor, Boldt, has been on site since the previous quarter.

Northland Electric mobilized this quarter in May 2005 and initiated the electrical and instrumentation and control installation work.

Task 9 – Foundation Erection

All Major foundation work by Boldt Construction Co. was completed during last quarter.

Boldt's activity this quarter has included installing only minor equipment housekeeping pads and paving activities.

Task 10 – Erect Steel, Baghouse and Ductwork

Erection work initiated this period.

This work included start of erection of the baghouse by Boldt. Boldt erected baghouse support steel, the baghouse hoppers, and initiated baghouse compartment panel erection.

Superstructure Contract erection work was also initiated by Jamar during this period. Work included erection of ductwork support steel, silo support steel, the ID Booster Fan enclosure steel and field fabrication and erection of ductwork sections. Erection and insulation of the Phase 1 ductwork (ductwork under baghouse) was completed during this period. Insulation of the remainder of the ductwork was initiated during this quarter.

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

Balance of plant mechanical work was initiated during this period by Jamar. This work included erection of the ash silo structural steel, ID booster fans, air compressor/dryer skid, ash piping, and PAC piping which is currently ongoing. The diverter damper for Unit 8 was installed during a scheduled plant outage which occurred during this period. Completion of the installation of the Unit 7 diverter damper was also accomplished during this quarter.

Task 12 – Balance of Plant Electrical

Northland Electric, the Electrical, Control/Instrumentation Contractor, mobilized on site. Their work effort focused on developing their construction implementation schedule and erection of cable tray supports and cable tray in the plant and baghouse areas.

Task 14 – Start-up

CaTS mobilized their start-up manager during this period. Start-Up work effort focused on development of the detailed start-up schedule, development of the start-up program outline and developing the start-up program component documents.

Task 15 – TOXECON™ Testing for Mercury Control

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

Sorbent Screening Tests

As described earlier in this report, mercury will be controlled by injection of activated carbon or other novel sorbents upstream of the baghouse. Full-scale test programs have demonstrated that activated carbon effectively removes mercury on plants firing PRB coals and with flue gas temperatures up to 330°F (DOE Report No 41005R22). However, at temperatures above 350°F, laboratory testing shows the capacity of activated carbon decreases significantly. Figure 4 presents data from laboratory tests of adsorption capacity as a function of temperature.

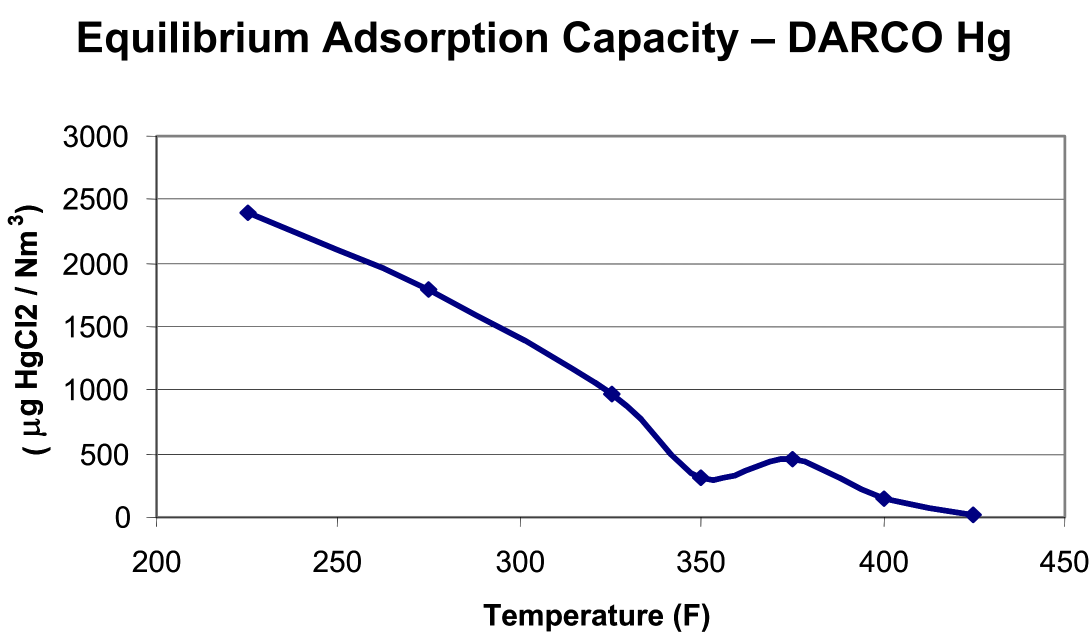


Figure 4. Sorbent Adsorption Capacity vs. Temperature (graph developed by URS Corporation).

Currently, flue gas temperatures entering the TOXECON™ baghouse are expected to vary between 330 and 360°F, depending on boiler load and ambient temperature. There is concern about the performance of activated carbon at temperatures above 350°F. At these higher temperatures, more carbon or a different carbon product may be required to achieve 90% mercury removal. To understand the impact of operating temperatures on activated carbon and TOXECON™ performance, a test program was developed and designed to characterize mercury capture with Norit Americas (Norit) activated carbons. Testing was conducted in April 2005 using ADA-ES's Sorbent Screening Device (SSD) on a slipstream of flue gas from Unit 7 or 9.

The objectives of this test were:

1. Characterize performance of Norit's standard activated carbon, DARCO Hg, and Norit's treated activated carbon, DARCO Hg-LH in a slipstream test at two different activated carbon loadings.
2. Characterize performance of Norit's standard activated carbon, DARCO Hg, and Norit's treated activated carbon, DARCO Hg-LH in a slipstream test at three different temperatures.

Test Description

ADA-ES' slipstream sorbent test device simulates the sorbent loading to a baghouse and permits comparison of the effectiveness of potential sorbents. Up to three sorbents can be tested in parallel over a period of several hours. The sorbent screening device is an extractive system designed to simulate the gas velocity, temperature, sorbent and ash loading of a baghouse.

For this test, activated carbon was mixed with ash taken from the Unit 7 hot-side ESP hoppers and preloaded onto one of three standard, 2-inch EPA Method 5 filters to permit direct side-by-side comparison of three samples. Total vapor-phase mercury concentration was measured at a common inlet and the three filter outlets with semi-continuous mercury analyzers. A photograph of the equipment set-up for this test can be seen in Figure 5. Both the SSD and the analyzers were placed on a walkway near the extraction location.

With the SSD, a sorbent/ash mixture is preloaded onto a glass filter and flue gas is pulled across the filter. This method simulates a batch loading of carbon into a baghouse at the beginning of a cleaning cycle, and not a continuous injection of sorbent over time. As would be expected, the highest mercury removal occurs at the beginning of the test when the activated carbon is fresh. As mercury is adsorbed by the activated carbon, the adsorption capacity of the carbon decreases and mercury removal decreases until full breakthrough is reached. A relative injection concentration can be calculated by using the carbon loading and the flow, in acfm, across the filter. For example, in these tests 0.03 grams of carbon was loaded on each filter and after 180 minutes, 21.6 ft^3 of flue gas passed through the filter. If the same amount of carbon were injected continuously during this time, the equivalent injection concentration would be 3.0 lbs/MMacf. To obtain the collection efficiency at half the injection concentration, 1.5 lbs/MMacf, the test would be run for twice the amount of time, or 360 minutes, at the same flow rate.

Two commercially available activated carbons were tested, they were Norit Americas DARCO Hg, Norit's standard activated carbon, and DARCO Hg-LH, a brominated sorbent with the potential for better performance at higher temperatures. Each of these carbons was tested at three different temperatures, 300, 350 and 380^{o}F.

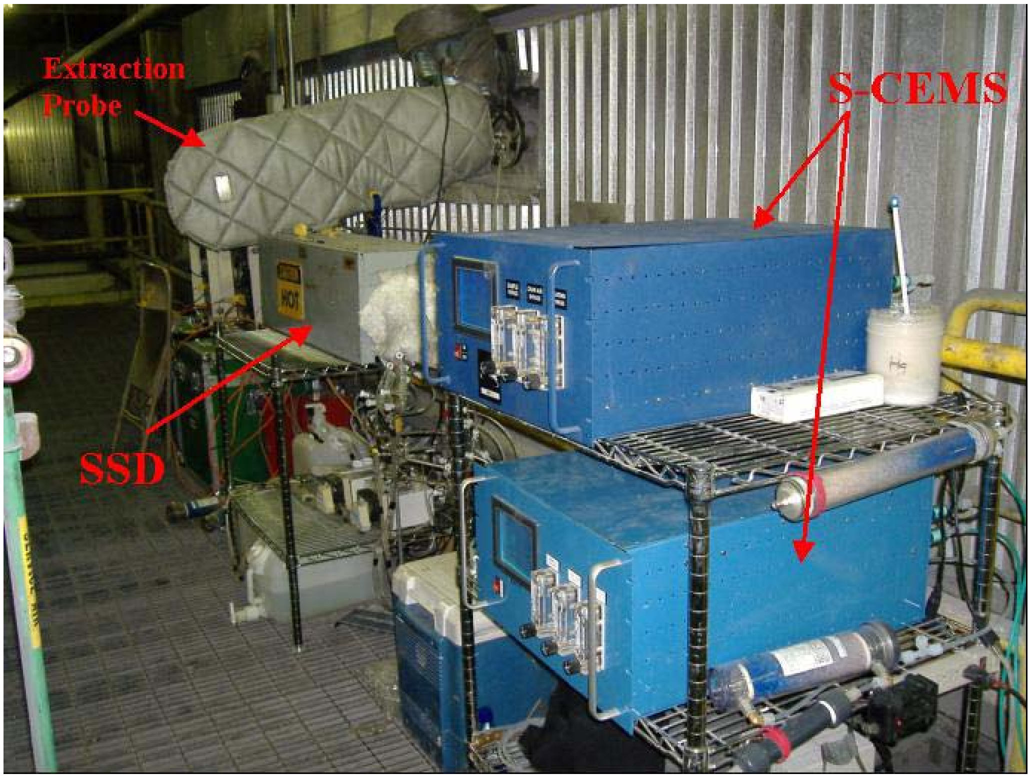
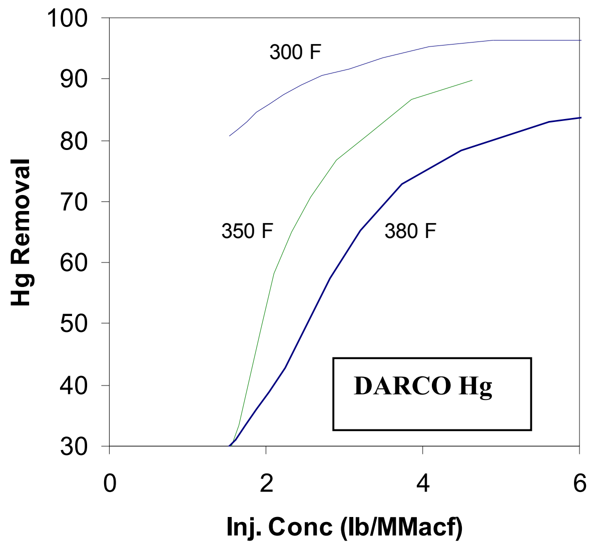


Figure 5. Sorbent screening device and semi-continuous mercury analyzers on walkway near Unit 7 air heater outlet. Testing conducted April 20 – 24, 2005.

Test Results

A comparison of the results from testing on the two carbons for injection concentrations up to 6 lb/MMacf is shown in Figure 6. Observations from the test are summarized below:

- Effectively, no mercury removal was measured with PIPP ash alone.
- Mercury removal at 4 lb/MMacf and 300°F was 94% with DARCO Hg.
- At 350°F, injection concentrations > 4 lb/MMacf resulted in >90% mercury removal for both DARCO Hg and DARCO Hg-LH. At least 70% mercury removal was achieved using DARCO Hg at 2.6 lb/MMacf and with DARCO Hg-LH at 2.9 lb/MMacf.
- At 380°F, the performance of DARCO Hg degraded and the performance of DARCO Hg-LH improved.



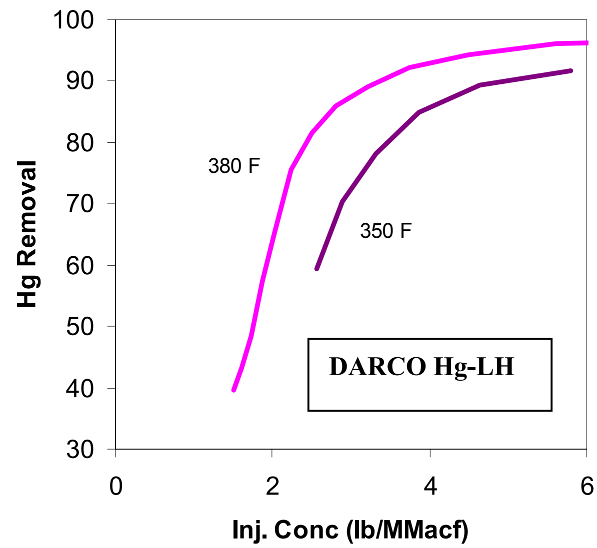


Figure 6. Influence of temperature on mercury removal performance of DARCO Hg and DARCO Hg-LH.

Conclusions and Recommendations

Sorbent screening tests confirmed that increasing flue gas temperature from 300°F to 380°F affects sorbent performance. At 300°F, DARCO Hg achieved > 80% mercury removal at an injection concentration of 2 lb/MMacf. At 380°F, performance of DARCO Hg degraded to < 40% at 2 lb/MMacf.

The performance of DARCO Hg-LH improved when the temperature increased from 350 to 380°F and mercury removal >90% was achievable at injection concentrations of less than 6 lb/MMacf. Based on these results and anticipating an operating temperature close to 350°F, it is recommended that DARCO Hg be used when the TOXECON™ system is started up. However, if operating temperatures are higher, performance with DARCO Hg may be impacted to the point that switching to DARCO Hg-LH will be recommended.

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 both sides
- Scrim material made from 3 ounces/yd^2 of PPS
- Mullen burst minimum of 500 psi
- Permeability at 0.5 inches H_2O of 25 – 40 cfm/ft^2

It is of interest to evaluate different alternative fabrics to see if they are suitable for the flue gas and operating conditions of TOXECON™ at this site. Specifically, it is of interest to evaluate bags that have the potential for operation at higher temperatures (up to 400°F), with higher collection efficiency, with lower pressure drop, and/or offering a cost advantage.

Six materials have been identified for testing, including four different versions of PPS fabric, P84 fabric (a high temperature/high efficiency fabric) and Kermel Tech (a recently released pulse-jet fabric). Except for the Kermel Tech, approximately twelve bags of each of the test fabrics will be installed into one of the compartments at start-up. The Kermel Tech material will be evaluated using swatches. Up to six 4"x11" swatches will be installed into the flue gas at a yet to be determined location and periodically removed for strength tests. Although full-scale bags are preferred for the tests, using swatches reduces the risk of premature failures with experimental bags.

Samples of these experimental bags as well as the base PPS bags will be pulled and tested semi-annually to assess deterioration. A detailed schedule for removing sample bags will be coordinated with plant operations based on outage schedules. Generally, bags will be removed every six months.

Task 16 – TOXECON™ Testing for NOx 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, Specs, Prepare O&M Manual

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.

- Preliminary Public Design Report delivered.
- Communication Plan delivered.
- Two interviews were given to a Marquette TV station (Channel 6).
- Team members attended the EPRI CEM User's Group Meeting.
- Team members participated in a mercury control panel discussion at the Annual A&WMA meeting.
- A draft test plan was prepared and issued for testing the TOXECON™ system.
- A draft test bag test plan was prepared and issued.
- A sorbent screening test report was issued.
- A draft presentation was prepared for the DOE Contractors Review Meeting (July 2005).
- Articles about the project appeared in a Detroit labor magazine and in the Market Mining Journal.
- Technical papers and presentations that were discussed during the quarter for future meetings are Reinhold FF/ESP Conference (July 2005), AQV Meeting (September 2005), an EPRI baghouse workshop (October 2005), and PowerGEN (December 2005).

CONCLUSION

This is the fifth Technical Progress Report under Cooperative Agreement No. DE-FC26-04NT41766. Engineering design activities are complete. Construction went into full swing on the baghouse, fans, ductwork, baghouse superstructure, drainage, paving, silo system support steel, booster fan enclosure, and diverter dampers. Work continued in the evaluation of components for a mercury continuous emissions monitor system. A CEM was installed on site and started up. The project team is actively involved in a number of reporting and technology transfer activities.

REFERENCES

None this reporting period.

PROJECT PHOTOS

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

Photo 1. Baghouse and baghouse structure.
Photo 2. Baghouse hoppers.
Photo 3. Fans and fan enclosure.
Photo 4. Units 7-9 ductwork.

Photo 1. Baghouse and baghouse structure.

Photo 2. Baghouse hoppers.

Photo 3. Fans and fan enclosure.

Photo 4. Units 7-9 ductwork.

Appendix A -
Thermo Mercury CEM Brochures

Thermo
ELECTRON CORPORATION

News

FOR IMMEDIATE RELEASE

Contact Information:
Michael Nemergut
(508) 520-1460
michael.nemergut@thermo.com
www.thermo.com

Stefan Spazek
(617) 275-6547
sspazek@greenoughcom.com

Thermo Launches Mercury Freedom System at Electric Power Research Institute CEM User Group Meeting & Exhibit

Mercury Continuous Emission Monitoring System Bolsters Thermo Electron's Leadership Role in Stack Gas Monitoring in the U.S. Power Generation Market

SAVANNAH, GA — EPRI CEM User Group Meeting & Exhibit 2005 - May 03, 2005 — Thermo Electron Corporation, the world leader in continuous emission monitoring instrumentation, today unveiled the Mercury Freedom System, one of the world's only mercury continuous monitoring systems that stands up to the rigorous standards of the U.S. Environmental Protection Agency's Performance Specifications 12A and the operating and maintenance requirements of the power generation industry.

On March 15, 2005, the U.S. EPA issued its first ever Clean Air Mercury Rule to permanently cap and reduce mercury emissions from coal-fired power plants. When fully implemented, the rule aims to reduce utility emissions of mercury from 48 tons per year to 15 tons per year, a reduction of nearly 70 percent. The Thermo Mercury Freedom System utilizes a dilution extractive design and a dry thermal conversion system mounted at the stack, to help power generation plants efficiently and accurately meet these new requirements.

"Our Mercury Freedom System, more than two years in development, is an example of our commitment to the power generation industry and stack gas monitoring, and is an extension of our ongoing efforts to help power suppliers comply with regulations mandated under the 1990 Clean Air Act Amendments," noted Greg Herrema, president of Thermo's Environmental Instruments Division. "Recognizing the potential for a mercury monitoring requirement some time ago, we applied our analytical instrument and stack gas monitoring applications expertise to develop a mercury CEMS that we believe is the most cost effective, accurate, and reliable solution for our customers in the power generation industry."

This complete solution includes the following:

Mercury Analyzer - The mercury analyzer is based upon atomic fluorescence. An advanced cold vapor atomic fluorescence design provides continuous sample measurement, with no additional gases or pre-concentration required and virtually no interference from SO2. Detection limits down to 1.0 ng/m^3 allow high sample dilution (100:1) minimizing moisture, heat and interfering pollutants.

Mercury Calibrator - The elemental mercury calibrator was developed using a Peltier cooler/vapor pressure control and mass flow controllers. The mercury concentration output range is currently 0.1 µg/m^3 to 300 µg/m^3. This range allows the operator to directly calibrate the analyzer at post-dilution concentrations and dynamically spike into the sampling probe.

Zero Air Supply - The mercury analyzer is designed for use with a dilution probe. The zero air supply provides dry, mercury-free dilution air to the probe, zero gas for analyzer calibrations, and air to the mercury calibrator.

Stack Probe and Inertial Filter - The extraction probe uses an inertial filter to separate a particulate-free vapor-phase sample while minimizing the interactions with fly ash, which can cause sampling artifacts. All components that are exposed to sample gas are glass coated to prevent reactions with mercury. The probe incorporates a dilution assembly and calibration gas that can be introduced either upstream or downstream of the inertial filter.

Converter – A high temperature module converts all vapor phase species of mercury to elemental mercury for analysis. The proprietary, high efficiency conversion technology has been demonstrated to meet the U.S. EPA PS-12A criteria of less than 5 percent of span value deviation from the certified gas value.

Probe Control Box - The probe control box is located in the CEM shelter. An umbilical connects the probe to the probe control box and mercury converter. The unit:

- Allows dynamic Hg spiking and auto dilution confirmation
- Automates probe calibration and dynamic spiking via Calibrator Microprocessor

- Measures fast loop flow
- Automates blowback via Calibrator Software

In order to minimize maintenance as much as possible, the Thermo Mercury Freedom System uses a dry mercury conversion technology which requires no short term consumables, a valuable feature when the converter is mounted hundreds of feet up on the stack. Also, there exists no need to pre-concentrate the sample, which eliminates the need for complicated pre-concentration devices that require even further maintenance. Finally, the Mercury Freedom System will be available on Thermo's recently released advanced iSeries platform, a comprehensive, user-friendly family of stack gas monitoring instruments that supports the detection of a broad range of targeted gaseous pollutants.

For more information about the Thermo Electron Mercury Freedom System or any of Thermo's air quality instruments, please visit www.thermo.com/aqi.

About Thermo Electron Corporation
Thermo Electron Corporation is the world leader in analytical instruments. Our instrument solutions enable our customers to make the world a healthier, cleaner and safer place. Thermo's Life and Laboratory Sciences segment provides analytical instruments, scientific equipment, services and software solutions for life science, drug discovery, clinical, environmental and industrial laboratories. Thermo's Measurement and Control segment is dedicated to providing analytical instruments used in a variety of manufacturing processes and in-the-field applications, including those associated with safety and homeland security. Based near Boston, Massachusetts, Thermo has revenues of more than $2 billion, and employs approximately 10,000 people in 30 countries. For more information, visit www.thermo.com.

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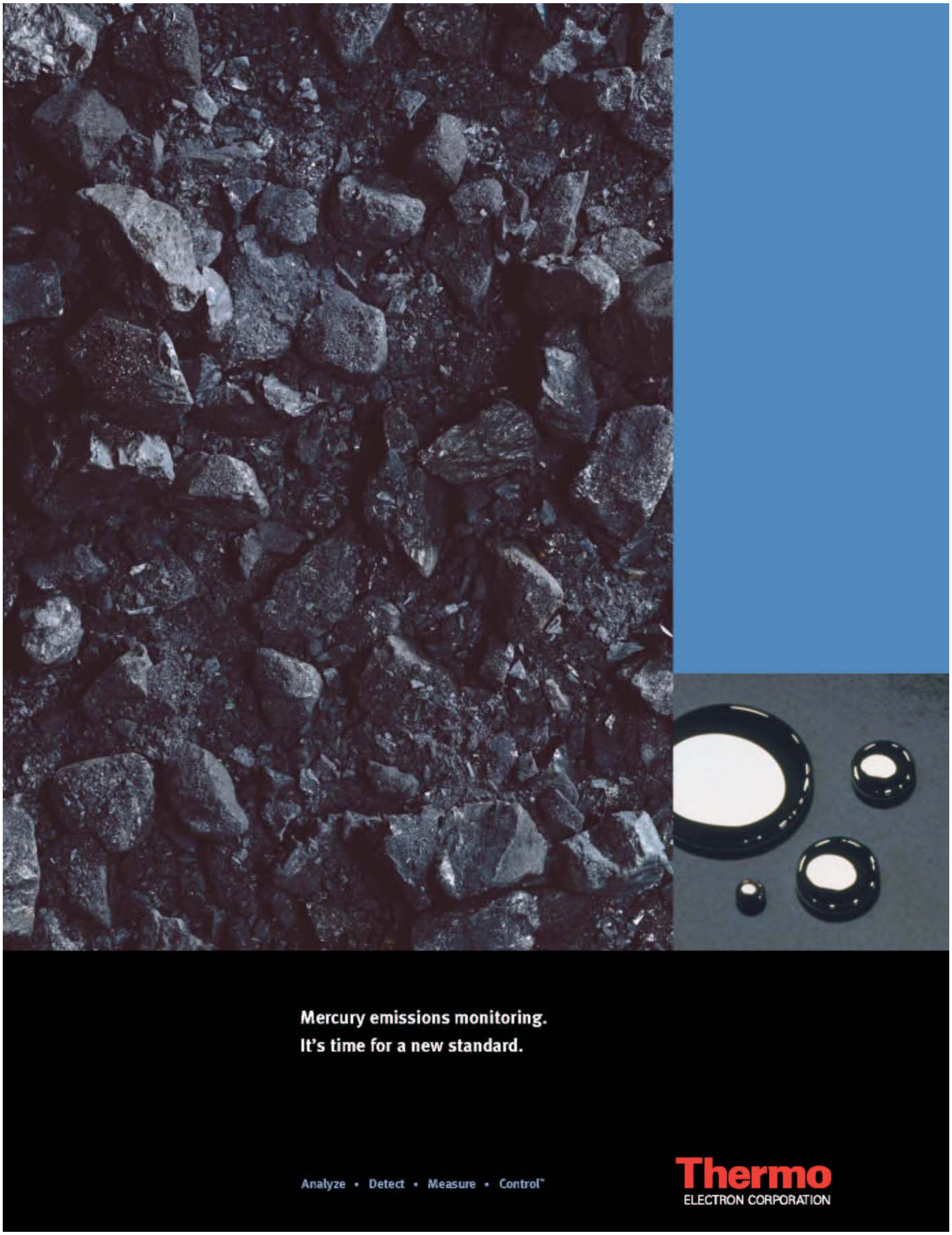
Mercury emissions monitoring.
It's time for a new standard.
Analyze • Detect • Measure • Control™
Thermo
ELECTRON CORPORATION

Clean Air now includes mercury.

The Clean Air Mercury Rule.

The Environmental Protection Agency recently announced the Clean Air Mercury Rule, limiting mercury emissions from coal-fired power plants. While U.S. power plants contribute only about one percent of the global total, once fully implemented the program will reduce utility emissions of mercury by 33 tons per year.

The regulations together mandate that mercury emissions be reduced by almost 70% from 1999 levels. They also create a market-based cap and trade system that provides an incentive for the development and continuous improvement of control technologies to facilitate early emission reductions. A primary challenge is to achieve accurate monitoring of mercury control technologies – monitoring that will meet the new standard.

Thermo introduces a complete mercury monitoring solution.

Thermo's Mercury Freedom System™ has been designed to efficiently and accurately meet the new U.S. EPA PS-12A and/or Part 75 provisions. The new system measures elemental, ionic, and total mercury in exhaust stacks from both coal-fired boilers and waste incinerators.

A demonstrated solution.

As a key participant in the U.S. EPA Mercury CEMS Field Evaluation Program conducted at a coal-fired power plant burning eastern bituminous coal and equipped with SCR and a wet scrubber, Thermo's Mercury Freedom System met or exceeded all performance requirements reviewed thus far (see table below). Other successful field tests have also been conducted with a variety of coals and a full range of concentration ratios of elemental to ionic mercury.

A solution with proven support.

No other mercury monitoring system is backed by Thermo's thirty-five year track record and extensive global support.

U.S. EPA Performance Specification 12A Compliance – Preliminary field test results	
7-day Cal Error Test, 2 points, zero and upscale Passing criteria: <5% span or <1 μg/m³	Passed
Linearity Check, 3 points, low, mid, high Passing criteria: <10% of ref tag or <1 μg/m³	Passed
Cycle Time Passing criteria: <15 minutes to 95%	Passed
Converter Efficiency Passing criteria: <5% of span	Passed
Relative Accuracy Passing criteria: <20% of mean Reference Method (RM) Need to match 9 valid RM runs, or for low emitters (<5 μg/m³): < 1 μg/m³ difference	Pending

Field-proven to meet U.S. EPA PS-12A and/or Part 75 provisions. Tested under harsh conditions, Thermo's *Mercury Freedom System* successfully passed rigorous, EPA-supervised PS-12A and Part 75 testing. (Details of the field trials can be obtained at www.thermo.com/mercury.)

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A solution with reliability.

Engineered for unattended, continuous-duty reliability, Mercury Freedom System rack-mountable components integrate seamlessly into most existing stack monitoring configurations. The system features a highly sensitive cold vapor atomic fluorescence analyzer, and requires no wet chemicals or costly gold amalgamation concentrator.

Thermo's new Mercury Freedom System is a complete, integrated solution. It includes a stack probe, plus analysis and control modules that fit a standard EIA rack. Data outputs are compatible with your existing plant control and data system.

Demands of the Clean Air Mercury Rule

By establishing standards of performance for new and existing coal-fired electric utility steam generating units under Section III of the Clean Air Act and finalizing Performance Specification 12A, "Specification and Test Methods for Total Vapor Phase Mercury Continuous Emission Monitoring Systems in Stationary Sources," the U.S. EPA has set the stage for regulating Hg emissions in a similar manner to that of NO_X and SO_2 emissions under the Acid Rain Program.

Since the introduction of the 1990 Clean Air Act Amendments, Thermo Electron has been supplying probes, analyzers, and systems to the utility industry for compliance emissions monitoring under 40 CFR Part 75. With an installed base of approximately 71% of the SO_2 analyzers and 64% of the NO_X analyzers reporting into the U.S. EPA Part 75 Electronic Data Report (EDR) files, Thermo has demonstrated a clear understanding of the monitoring needs of the utility industry, the complexities associated with a variety of flue gas matrices, and the critical importance of system reliability. This knowledge base and experience makes Thermo an ideal partner for addressing the monitoring demands of the Clean Air Mercury Rule.

Today's most effective – and cost-effective – mercury monitoring solution.

High sensitivity
Detection limits down to 1 ng/m^3 allow high sample dilution (100:1) reducing moisture, heat, and interfering pollutants.

Protection against artifacts
Glass-coated inertial filter and conversion at stack prevent loss of ionic Hg.

No expensive consumables
Unique atomic fluorescence design avoids expensive gold amalgamation which is subject to acid gas poisoning. This design also eliminates the need for an SO_2 scrubber.

No flue gas moisture analyzers
Dilution-based system reports Hg concentrations on a wet basis. No costly flue gas moisture analyzers are needed to correct dry basis Hg concentrations back to wet basis for calculating Hg mass emissions.

No support chemistry
No water to remove acid gases. No resulting hazardous liquid waste.

True continuous monitoring
Continuous processing verses batch collection by gold preconcentration.

Easy to use.
Fast, intuitive navigation. Simple, menu-driven programming. Common interface with all new Thermo iSeries analyzers.

Easy to maintain.
Key components are readily accessible for quick maintenance or change-out.

Easy to interface.
Expanded I/O functionality and connectivity capabilities make the Mercury Freedom System easy to integrate into just about any plant operation and data flow.

The Mercury Freedom System™ consists of five primary components:

At the stack –
Probe and converter

Rack-mounted in shelter –
Probe controller
Analyzer
Calibrator
Zero gas generator

Stack probe and inertial filter

The sampling probe is designed to minimize measurement artifacts due to interactions with fly ash. It uses a high-flow, sintered-metal inertial filter to provide a particulate-free, vapor-phase sample for analysis. Automated blow-back helps to ensure trouble-free continuous operation, and all components exposed to sample gas are glass-coated to prevent reactions with mercury.

Dilution and calibration take place within the probe. Calibration gas can be introduced either upstream or downstream of the inertial filter.

Hg converter

A high temperature module converts all vapor-phase species of mercury to elemental mercury for analysis. The proprietary, high-efficiency conversion technology has been demonstrated to meet the U.S. EPA PS-12A criteria of <5% span value deviation from the certified gas value.

Hg probe controller

The microprocessor-driven probe control unit is connected by an umbilical to the stack probe and mercury converter. The controller automates probe calibration and dynamic spiking, and confirms autodilution. In addition, it monitors probe temperature, measures flow rates and pressure in the sampling loop, and enables automated filter blowback.

Hg analyzer

An advanced cold vapor atomic fluorescence analyzer provides continuous sample measurement, with no additional gases or pretreatment required – and virtually no interference from SO_2. Detection limits down to 1 ng/m³ allow high sample dilution (100:1) reducing moisture, heat, and interfering pollutants.

Hg calibrator

A vapor generator allows standard calibration and dynamic spiking into the extraction probe. A wide calibration range of 0.1 μg/m³ to 300 μg/m³ lets you directly calibrate the analyzer at post-dilution concentrations. The calibrator is ideally suited for daily zero/span checks and routine converter efficiency and linearity testing.

Zero air supply

The zero air supply delivers clean, dry dilution air to the probe, as well as air to the Hg calibrator for sensitive, accurate analyzer calibrations.

Integrated – and integratable – systems for every utility application.

Best-of-breed modular components, world-class systems.
Thermo analyzers are widely used. So widely used, they're integrated into the majority of installed U.S. power generation 40 CFR Part 75 CEMS. Our newest generation iSeries analyzers are easier to use, easier to maintain, and easier to interface than ever before. They help our customers monitor a complete spectrum of gases:

HCl	CO_2	NO_X	SO_2	H_2S
CO	C_XH_Y	NH_3	Hg	

There's more to Thermo than analyzers.
We also provide probes, flow meters, opacity monitors, environmentally controlled shelters, portable stack monitors and VOC monitors – individually, or as complete CEMS (Continuous Emission Monitoring Systems) for virtually every utility application.

Extractive or dilution sampling, wet basis or dry basis, high temperature, high particulate, high moisture – whatever your sampling environment, Thermo has the experience to deliver the optimum solution for your unique monitoring needs.

Data management has become as important as datalogging.
It's not enough to simply be in compliance – you have to be able to prove it. That's why we give you the connectivity options you need to integrate your Thermo monitoring solution into your plant's data and control system.

More than systems, a knowledge base.
Thermo's thirty-five years of monitoring emissions from a multitude of sources provides the industry's broadest, deepest knowledge base for you to rely on.

Reliability is everything.
Uptime is built right into the design of every Thermo system – with easy access to components, simplified on-site maintenance, and maximum parts interchangeability. And if you ever need a hand with troubleshooting or service, our technical support team is ready to respond quickly when you call.

An ongoing commitment to you.
At Thermo, we want to make it as easy as possible for you to do business with us. So every Thermo instrument comes with one of the largest, most knowledgeable service and support organizations anywhere. Before the sale, after the sale, in any time zone, any place in the world – our highly trained and experienced customer care, service, and support professionals are always ready to help.

Mission-critical service and support.

Technical support when you need it.
Our highly trained and experienced technical support team is ready to provide application expertise and work with you to determine the product and configuration that best meets your needs. The team is also there to troubleshoot instruments.

Customer service.
Our customer service team processes orders, provides status of current orders as well as pricing and availability of product. Our international customer service team is export-compliant trained and extremely experienced in shipping to all regions of the world.

Call us.
Our team can be reached between 7:30 am and 6:30 pm Eastern Standard Time by calling 866-282-0430 or 508-520-0430. Or fax 508-520-2800.

For more information about Thermo's Mercury Freedom mercury monitoring system, or any of our other monitoring solutions, visit **www.thermo.com/mercury.**

For ordering information, please contact your local dealer or Thermo representative.

About Thermo Electron Corporation
Thermo Electron Corporation is the world leader in analytical instruments. Our instrument solutions enable our customers to make the world a healthier, cleaner, and safer place. Thermo's Life and Laboratory Sciences segment provides analytical instruments, scientific equipment, services, and software solutions for life science, drug discovery, clinical, environmental, and industrial laboratories. Thermo's Measurement and Control segment is dedicated to providing analytical instruments used in a variety of manufacturing processes and in-the-field applications including those associated with safety and homeland security. Based near Boston, Massachusetts, Thermo has revenues of more than $2 billion, and employs approximately 10,000 people in 30 countries. For more information, visit www.thermo.com.

Appendix B -
Electrical/Instrumentation/Control
Installation Package

Electrical/Instrumentation/Control Installation Package

Specification Scope

The following is a summary of the Electrical and Instrumentation/Control work for the Contractor. The Work includes but is not limited to:

- Receive, inspect and unload electrical equipment and material deliveries from Owners purchase contracts.
- Install electrical equipment consisting of transformers, medium voltage starters, MCC's.
- Provide and install raceways for electrical conductors.
- Provide and install power and instrument cabling.
- Terminate wiring for all BOP equipment (outside of baghouse).
- Provide, install and terminate fiber optic cables.
- Provide fire detection and standpipe system.
- Terminate and connect ground stingers to equipment.
- Provide and install heat tracing.
- Perform loop checks of wiring.
- Provide calibration for instrumentation.

Technical Evaluation Criteria

Compliance with the specification.

Economic Cost Criteria

Overall Price and ability to meet scheduled dates.

Appendix C -
Statement of Project Objectives

The primary goal of this project is to reduce mercury emissions from three 90-MW units 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; develop and 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 Plant.

TOXECON™ is a patented process in which a fabric filter system (baghouse) installed downstream of an existing particulate control device is used in conjunction with sorbent injection for removal of pollutants from combustion flue gas. 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 PM control. Sorbents will be injected downstream of the existing particle collection device to allow for sale and reuse of captured fly ash that is uncontaminated by activated carbon or sodium sorbents.

Methods for sorbent regeneration, i.e. mercury recovery from the sorbent, will be explored and evaluated. 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 demonstration will provide for the use of a novel multi-pollutant control system to reduce emissions of mercury and other air pollutants, while minimizing waste, from a coal-fired power generation system.

A. Project Objectives

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

- achieve 90% mercury removal from flue gas through activated carbon injection,
- evaluate the potential for 70% SO2 control and trim control of NOx 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.

The Participant will design and construct a TOXECON™ multi-pollutant control system as a retrofit to three 90-MW coal-fired boilers at the Presque Isle Power Plant. The objectives will be achieved through injection of various sorbents into the flue gas stream to capture mercury, SO_2, NO_x, and other air toxics as appropriate. Efforts will be focused on development and demonstration of two ancillary technologies, a mercury continuous emission monitor and a method of treating the captured activated carbon sorbent for regeneration or for reuse in the system rather than disposal. The demonstration project will provide the utility industry a benchmark for cost and performance of a commercial scale mercury control systems for application on coal-fired power generation systems.

B. 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& Engineering, Prototype Development, Major Equipment Procurement, and Foundation Installation.

Budget Period 2: CEM Demonstration, TOXECON™ Erection, TOXECON™ Operation, and Carbon Ash Management Demonstration.

As indicated by the title, Budget Period 1 will initiate the project with project definition activities including NEPA, followed by design, which includes specification and procurement of long lead-time major equipment, and installation of foundations. In addition, prototype development for mercury CEM and sorbent regeneration processes will be conducted.

Following 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 SO_2 and NO_x control. The mercury CEM and sorbent regeneration processes will be demonstrated in conjunction with the TOXECON™ system operation.

C. Tasks to be Performed

(The Participant will work directly with the company identified in the parentheses.)

Budget Period 1: Project Definition, Design and Engineering, Prototype Development, Major Equipment Procurement, Foundation Installation, and Management and Reporting.

Task 1 - Design Review Meeting (ADA-ES)

The project team will hold a Kickoff Design Review Meeting including the Participant, the DOE Contracting Officer's Representative (COR), major subcontractors, and other project team members as appropriate to discuss the project, system hardware components, costs, and schedules. This meeting will take place within sixty days after award with the primary purpose of providing a status of the ongoing work, specifying system requirements, and planning future project activities.

Task 2 – Project Management Plan (ADA-ES)

An updated Project Management Plan will be prepared as a deliverable within thirty days following the Design Review Meeting. This plan will be updated based on information provided at the Design Review Meeting held under Task 1. The plan will be suitable for use in tracking project progress at the task level using the earned value management system and will include the following information.

- Final Work Breakdown Structure. A final Work Breakdown Structure will be prepared that identifies Tasks and Subtasks to be performed under the project.
- Final Statement of Project Objectives. A final Statement of Project Objectives will be prepared that describes the work to be performed under the project at the Task and Subtask level of detail, following the format of the Work Breakdown Structure.
- Schedule Baseline. A Schedule Baseline will be prepared in Gantt Chart format that shows the project schedule for the entire project at the Task level of detail, including major milestones and decision points. The Schedule Baseline will follow the Task structure of the Work Breakdown Structure.
- Cost Baseline. A Cost Baseline will be prepared showing projected monthly total project cost as a function of Task, following the format of the Work Breakdown Structure.
- Technology Baseline. A description of the Baseline Technology will be prepared, including a summary of technology experience and applications, design issues to address as identified in the Design Review Meeting, mass balances, and identification of major equipment.
- Management Controls. An updated listing of key organizations and individuals involved with the project, functions and authorities of each, lines of authority, procedures used to control cost expenditures, and technical decision-making procedures.

Task 3 – Provide NEPA Documentation, Environmental Approvals Documentation, and Regulatory Approval Documentation (ADA-ES)

The Participant will provide a completed Environmental Information Volume and other information to DOE and any DOE-authorized subcontractors necessary to allow completion of the Environmental Assessment required for compliance with the National Environmental Policy Act (NEPA). The Participant will provide documentation to DOE demonstrating that the participant has the necessary approvals from appropriate environmental regulatory bodies to proceed with the project. The Participant will provide any rulings received from state public utilities commissions regarding this project to DOE.

Task 4 – Balance of Plant (BOP) Engineering (C&B)

In addition to the major process equipment, ductwork, and distributed control systems (DCS) described herein, a substantial balance of plant engineering and design effort is required. The Participant will provide BOP engineering and design necessary for the construction, installation, and operation of the TOXECON^{TM} technology. The Participant will subject the BOP design to standard engineering review and acceptance procedures. The BOP engineering and design scope includes the following items.

- Demolition, excavation, and underground utility relocation design.
- Baghouse arrangement and plant equipment general arrangement design.
- Foundation design.
- Civil, structural, and ductwork design.
- Baghouse and building enclosure design.
- Mechanical design, including fans, ductwork, dampers, sorbent handling silo, and air compressors.
- Electrical system study, motor control center (MCC), and electrical design.
- Plant controls and instrumentation design, and CEM design.
- Piping and instrumentation diagrams, and piping design for carbon, water, air, sorbent/ash, and flue gas subsystems.
- Water injection skid system design.
- Carbon injection skid systems design.

For each BOP design item, the Participant will provide a definition of design scope, appropriate drawings, specifications, and instructions sufficient for the construction, installation, and operation of TOXECON^{TM} system. The participant will subject the BOP design to standard engineering review and acceptance procedures.

Task 5 – Process Equipment Design and Major Equipment Procurement (C&B)

The Participant will provide expertise in the development of the final design and specifications for the TOXECON^{TM} technology. Major equipment bid packages will be prepared and awarded in this task.

Subtask 5.1 – Process Equipment Design

The Participant will provide a design for the TOXECON^{TM} system to be installed at the Presque Isle Plant. The Participant will provide the final design and specifications for the baghouse and sorbent injection system, which are the major components that must be integrated in the TOXECON^{TM} technology. The baghouse will be capable of processing the combined flue gases of units 7, 8, and 9 at the Presque Isle Plant. The baghouse will be capable of filtering activated carbon sorbent and other sorbents used in the TOXECON^{TM} system, and shall be sized appropriately such that sufficient sorbent can be injected to meet project pollution reduction goals as stated in Section A, Project Objectives. The sorbent injection system will be capable of injecting activated carbon and other sorbents in sufficient quantity to meet project pollution reduction goals. Performance data from ongoing, non-commercial demonstrations will be included in the design as appropriate. Flow modeling will be performed to confirm design parameters. Process instrumentation necessary to track performance will be specified.

Subtask 5.2 – Major Equipment Procurement

Formal specifications and bid packages will be prepared, negotiated, and awarded as appropriate. Equipment packages include baghouse, demolition, and underground work; foundation, mechanical and steel; electrical and controls; sorbent silo and sorbent handling system; ID fans and motors; and air compressors.

Task 6 – Prepare Construction Plan (C&B)

The Participant will develop a Construction Plan that identifies and describes all crucial activities required for an on-time completion of the design, procurement, construction, and start-up phases of the project. The Construction Plan will include a Project Plan that will specify material types and quantities, labor craft requirements, and schedules necessary for the successful construction of the TOXECON^{TM} system. The Construction Plan will also include a detailed Gantt chart that will identify design, procurement, construction, and start-up activity schedules with all critical path items and milestones identified. The Construction Plan Gantt chart will be used to coordinate activities among subcontractors, and to track progress of activities against a baseline schedule to assist in maintaining the project schedule.

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

Mercury CEM components will be selected and procured. The Participant will assess the suitability of commercially available equipment to the needs of this program. The Participant will evaluate mercury CEM components and incorporate the various components into a fully functional mercury CEM capable of measuring mercury content of a coal-fired flue gas stream suitable for evaluating performance of the TOXECON^{TM} system. The mercury CEM should allow for automated operation, requiring only periodic operation and maintenance by plant operating personnel. It is a goal of this program to work with suppliers to significantly improve reliability and decrease operations and maintenance requirements of currently available mercury CEM devices. Two subtasks will be performed in Budget Period 1.

Subtask 7.1 – System Design, Evaluation, and Analysis (Laboratory and Field)

The Participant will evaluate mercury CEM components including the extraction, detector, calibration, sample transport, conversion and separation, and control and data management subsystems. The participant will survey existing components for availability and suitability for integration into a mercury CEM system. The participant will perform laboratory and/or field testing as appropriate of each individual subsystem to determine its suitability based on criteria stated above. The Participant will procure suitable components for system integration testing.

Subtask 7.2 – System Integration and Testing

The Participant will integrate components procured in Subtask 7.1 into an operational mercury CEM device. The Participant will perform necessary laboratory evaluations and system checkout procedures to ensure proper operation and suitability prior to field evaluations. The Participant will develop written operating instructions for the mercury CEM system and an evaluation plan, including performance criteria, to assess mercury CEM system performance.

The Participant will perform a field evaluation at a coal-fired power generation facility to assess the performance of the mercury CEM against criteria established above according to the Evaluation Plan identified above.

Task 8 – Mobilize Contractors (C&B)

The Participant will mobilize contractors based on the project schedule in accordance with the Construction Plan developed under Task 6. This includes construction management, demolition and excavation, mechanical, electrical, and foundation contractors. Mobilization is the first step in granting authorization for contractors to initiate work. Mobilization includes installing the temporary construction infrastructure required before crews arrive on site, hiring personnel and subcontractors, and developing a utilization plan for large equipment including cranes.

Task 9 – Foundation Erection (C&B)

After all required demolition work, relocation of below-grade equipment, and earthwork has been completed, foundations for all major equipment will be installed. Work will be performed in accordance with design specifications developed under Tasks 4 and 5, and in accordance with the Completion Plan developed in Task 6.

The existing paved parking lot and other existing structures as required will be demolished and scrap material will be disposed of in an appropriate manner. Excavation will be performed to expose below-grade equipment and utilities, including storm pipe, trench drains, fire suppression water, and water as appropriate. These utilities will be relocated to allow for installation of the TOXECON^{TM} system. New below-grade utilities required for installation and operation of the TOXECON^{TM} system will be installed. General excavation will be performed to prepare for construction of foundations for all major pieces of equipment. Concrete foundations will be installed for the baghouse, sorbent injection equipment, water injection skids, and other equipment as required for the installation and construction of the TOXECON^{TM} system. Roads disturbed during foundation erection will be restored, suitable for supporting access to plant operations. Large equipment will be deployed as required by the Large Equipment Deployment Plan developed in Task 8.

Task 17 – Carbon-Ash Management System (ADA-ES)

Subtask 17.1 – Evaluate Options and Pilot Test Carbon-Ash Management System

The Participant will evaluate the viability of a mercury recovery system for the purpose of recovering mercury from the sorbent/ash mixture and allowing for beneficial reuse of this product. The Participant will also evaluate the processed sorbent for potential reuse. This may also allow the sorbent to be recycled in the TOXECON™ system. Activities to be performed under this budget period will include the following. The Participant will perform a survey to identify potential technology options. From these options, a technology will be chosen for further study. The Participant will evaluate the viability of the system and approach through engineering analysis and laboratory and/or pilot scale testing.

Task 19 – Reporting, Management, Subcontracts, Technology Transfer (ADA-ES)

The Participant will employ standard project management techniques for the purpose of keeping all activities on schedule and within the budget. Activities performed under this task will be used to provide oversight and control throughout execution of the project during Budget Period 1. The Participant will hold team meetings with attendance required from the organizations most involved during the active phase of the project to facilitate communication and enable the appropriate technical input into all activities.

The Participant will prepare and submit reports as required in the Financial Assistance Reporting Requirements Checklist and this Statement of Project Objectives. The Participant will report data such that earned value management techniques can be used to evaluate progress of Tasks under Budget Period 1. Non-proprietary technical progress reports will be distributed among team members to keep the team informed of the project status. Subcontract management, communications, outreach, and technology transfer functions will also be performed under this task.

Budget Period 2: CEM Demonstration, TOXECON™ Erection, TOXECON™ Operation, Carbon-Ash Management Demonstration, and Management and Reporting.

Task 7 – Procure Mercury CEM Package and Perform Engineering and Performance Assessment (ADA-ES)

Subtask 7.3 – Mercury CEM Design, Component Integration, and Field Testing

Efforts to develop a mercury CEM will continue in Budget Period 2. Tasks in this period will focus on integrating components, field testing, and final design issues that have not been addressed in Subtask 7.2. Based on testing performed in Budget Period 1, overall system performance and performance of individual system components will be evaluated. Redesign of the system and individual components will be performed as required. Appropriate modifications, including acquisition and integration of new components, will be made to the prototype device to address system deficiencies. Further laboratory evaluations, system check out, and field evaluations will be performed as required. The prototype monitor will be installed on the TOXECON™ system.

Task 10 – Erect Structural Steel, Baghouse, and Ductwork (C&B)

The Participant will construct and install structural steel, ductwork, a sorbent injection system and a baghouse necessary for the operation of the TOXECON™ mercury removal and multi-pollutant control system. The Participant will construct and install equipment specified and procured in Task 5 in accordance with designs developed in Tasks 4 and 5. Activities will be performed in accordance with the Completion Plan developed in Task 6.

The Participant will install structural steel necessary to support the multi-level duct arrangement, baghouse, induced draft fan enclosure, access and instrumentation supports, sorbent silo, and all other equipment necessary for operation of the TOXECON™ system.

Stiffened plate steel ductwork will be installed that allows flue gas from Presque Isle Units 7, 8, and 9 to enter the TOXECON™ baghouse or exit directly to the existing stack. Ductwork will also be installed to carry flue gas from the TOXECON™ baghouse, which will transition from a single duct into three, each with an induced draft fan, to carry flue gas to existing independent outlet ducts for Units 7, 8, and 9.

The Participant will install a baghouse to filter the combined flue gas streams of Units 7, 8, and 9 at the Presque Isle Plant. The baghouse shall be capable of filtering activated carbon sorbent and other sorbents used in the TOXECON™ system, and shall be sized appropriately such that sufficient sorbent can be injected to meet project pollution reduction goals as stated in Section A, Project Objectives.

The Participant will install steel platforms to serve as working surfaces allowing performance of standard maintenance on equipment and access to test ports and probes. These areas include access inside the existing powerhouse to the exhaust duct water injection ports, if required, and access to baghouse inlet and outlet ducts.

Task 11 – Balance of Plant Mechanical and Civil/Structural Installations (C&B)

The Participant will construct and install mechanical balance of plant equipment necessary for operation of the TOXECON™ system according to designs developed in Tasks 4 and 5, including equipment specified and procured under Task 5. Activities will be performed in accordance with the Completion Plan developed in Task 6. Balance of plant mechanical installations will include the following:

- Baghouse and duct insulation and lagging
- Hopper, fan, and silo enclosures and siding
- Sorbent/Ash vacuum exhauster skids and enclosure
- Piping, valves, support, and accessories
- Sorbent/Ash silo and unloading equipment

- Induced draft fans
- Instrument air and controls system
- Carbon injection system
- Unit tie-ins
- Heating, ventilation, air conditioning, fire protection, and support systems
- Water injection system
- Miscellaneous guard post and guardrails

Task 12 – Balance of Plant Electrical Installations (C&B)

The Participant will install balance of plant electrical equipment necessary for operation of the TOXECON™ system according to designs developed in Tasks 4 and 5, including equipment specified and procured under Task 5. Activities will be performed in accordance with the Completion Plan developed in Task 6. Balance of plant electrical installations will include the following:

- Baghouse power supply
- Three MCCs
- ID fan power supply
- Auxiliary electrical supply
- Baghouse control cable
- ID fan control cable
- Auxiliary equipment control cable
- CEMS system
- DCS system
- Freeze protection system
- Lighting system

Task 13 – Equipment Pre-Operational Testing (C&B)

Prior to start-up of the TOXECON™ system, each major and minor piece of equipment will be powered up and tested to assure that operation meets performance specifications. This includes all fans, blowers, compressors, support instrumentation, control systems, valves, dampers, and plant tie-ins. Pre-operation testing will include:

- ID fan startup and checkout
- Baghouse systems startup and checkout
- Air compressor checkout
- Carbon injection system checkout
- Sorbent/Ash handling system checkout
- Water Injection system checkout
- Instrument and controls systems checkout
- DCS programming checkout
- CEMS system checkout
- Electrical systems checkout

Task 14 – Start Up and Operator Training (C&B)

The Participant will devote sufficient time to allow for successful start up and debugging of full system operation. The Participant will conduct operator training during the start-up period. The Participant will develop operating manuals and distribute copies to operating personnel sufficient for training and operation of the TOXECON^{TM} system. Training will take place in several forms including classroom sessions for all pertinent personnel.

Task 15 – Operate, Test, Analyze Data, and Optimize TOXECON^{TM} for Mercury Control (ADA-ES)

Subtask 15.1 – Test Plan Development

The Participant will develop Test Plans for each major area of investigation. The Participant will develop Test Plans with input from team members as appropriate. Test Plans will be subject to review by team members prior to submission to DOE for comment. The Participant will develop Test Plans for evaluating and optimizing the TOXECON^{TM} technology including:

- TOXECON^{TM} Evaluation
- Mercury Recovery
- Mercury CEM

The Participant shall submit a Draft Copy of each Test Plan to the DOE COR for review. The COR shall review each Test Plan and provide comments to the Participant within thirty days of receipt. The Participant shall address comments made by the DOE COR and submit a Final Copy of each Test Plan to the DOE COR for approval. The COR will provide approval of each Final Test Plan that fully addresses COR comments within thirty days of receipt. The Participant shall not initiate testing prior to completion of the Test Plan approval process.

TOXECON^{TM} Evaluation Test Plan. The Participant will develop a Test Plan to evaluate mercury and multi-pollutant control through sorbent injection, and a plan to optimize TOXECON^{TM} operation for maximum mercury and multi-pollutant removal under varying operating conditions. The Test Plan will address the following issues:

- A plan for start-up, optimization, long-term performance monitoring and acceptance testing of TOXECON^{TM} for mercury control under varying operating conditions. Operating strategies for optimizing mercury control including but not limited to temperature control will be addressed.
- A plan and schedule for monitoring mercury entering TOXECON^{TM} and mercury emissions, including demonstrating integrated operation of all subsystems and components. A plan and schedule for periodic manual stack measurements of both particulate matter and mercury. A plan and schedule for measurement of NOx and SO_2 emission reduction.

- Sorbents and suppliers of sorbents for mercury, NOx and SO_2 removal will be identified.
- A plan for evaluating fabric filter bags selected for use to determine their suitability for continued testing. Bag integrity through periodic bag strength testing, and measurement of as-received, vacuumed, and in situ bag permeability will be conducted.
- Operating data to be tracked including but not limited to temperature, pressure drop, cleaning frequency, sorbent injection rate, and opacity will be identified.
- A plan for short-term, parametric tests to evaluate alternate activated carbon sorbents and operating strategies.
- A plan for evaluating and optimizing the control of SO_2 and NOx through sorbent injection under varying operating conditions. A plan for investigating waste disposal and mercury recovery from these sorbents.

Mercury Recovery Test Plan. The Participant will develop a Test Plan to evaluate performance of the mercury recovery system developed under Task 17. The Participant will fully evaluate the ability of the chosen system to recover mercury from spent activated carbon sorbent and the feasibility of reuse of the sorbent in the TOXECON™ system. The plan will include an evaluation of methods for disposing of the mercury captured in the mercury recovery system.

Mercury CEM Test Plan. The Participant will develop a Test Plan to evaluate the performance of the mercury CEM developed under Task 7. The CEM will be evaluated on the full scale TOXECON™ system. The plan will be designed to evaluate the operability and reliability of the instrument. The plan will be designed to evaluate the accuracy and reproducibility of mercury emission measurements.

Subtask 15.2 – Optimize TOXECON™ for Mercury Control

The Participant will operate the TOXECON™ system in accordance with the TOXECON™ Evaluation Test Plan developed under Task 15.1. The Participant will operate the TOXECON™ system to evaluate its performance with respect to mercury control as a function of operating variables. The Participant will evaluate the long-term performance of the TOXECON™ system, and the Participant will perform short term parametric testing to evaluate alternative sorbents and operating strategies. The Participant will measure mercury emission reductions, evaluate filter bag integrity, and track operating data to quantify TOXECON™ performance as a function of operating conditions.

Subtask 15.3 – Continuous Mercury Measurements

The Participant will operate the mercury CEM to evaluate the operability, reliability, accuracy, and repeatability of the mercury CEM system in accordance with the Mercury CEM Test Plan developed in Subtask 15.1. The Participant will evaluate the performance of the mercury CEM developed under Task 7 on the full scale

TOXECON™ system. The mercury CEM will be used to evaluate the performance of the TOXECON™ system for its ability to control mercury emissions.

Task 16 – Operate, Test, Analyze Data, and Optimize TOXECON™ for SO_2 and NO_x Control (ADA-ES)

After TOXECON™ operation and performance is established for mercury control, the Participant will conduct tests to assess the capability of TOXECON™ to control other pollutants, including SO_2 and NO_x. Injection equipment and measurement instrumentation will be designed, procured, and installed specifically for these tests. The Participant will perform evaluations in accordance with the TOXECON™ Evaluation Test Plan developed in Subtask 15.1. The Participant will measure SO_2 and NO_x emission reductions and track operating data to quantify TOXECON™ performance as a function of operating conditions.

Task 17 – Carbon-Ash Management System (ADA-ES)

Subtask 17.2 – Procure Full-Scale Demonstration System and Evaluate Carbon-Ash Management System

Providing that the results from Subtask 17.1 meet project goals, the Participant will procure a full-scale demonstration unit of the mercury recovery system for testing of the sorbent-ash mixture collected in TOXECON™. The Participant will install the mercury recovery system on the TOXECON™ system to allow for continuous removal and processing of the spent sorbent and ash mixture from the TOXECON™ system. The Participant will perform shakedown testing to ensure proper operation of all subsystems and the integrated system as a whole prior to incorporation into the TOXECON™ system. The Participant will evaluate the performance of the mercury recovery system as installed on the TOXECON™ system in accordance with the Mercury Recovery Test Plan developed in Subtask 15.1. The Participant will evaluate the ability of the mercury recovery system to evolve mercury from used sorbent in the presence and absence of SO_2 and NO_x sorbents. The Participant will evaluate the ability of the regenerated sorbent to capture mercury. The Participant will evaluate the methods for disposal of mercury captured in the mercury recovery system. Contingent on successful results, the Participant will provide an assessment of the capital and operating costs of the mercury recovery system and provide a cost-benefit analysis relative to inclusion of this system in the TOXECON™ system.

Task 18 – Revise Design Specifications, Prepare O&M Manuals (ADA-ES)

The Participant will prepare revisions to specifications based on the as-built installation and actual operating experience of the system. The Participant will prepare revised operating and maintenance manuals based on as-built installation and operating experience.

Task 19 – Reporting, Management, Subcontracts, Technology Transfer (ADA-ES)

The Participant will employ standard project management techniques for the purpose of keeping all activities on schedule and within the budget. Activities performed under this task will be used to provide oversight and control throughout execution of the project during Budget Period 2. The Participant will hold team meetings with attendance required from the organizations most involved during the active phase of the project to facilitate communication and enable the appropriate technical input into all activities.

The Participant will prepare and submit reports as required in the Financial Assistance Reporting Requirements Checklist and this Statement of Project Objectives. The Participant will report data such that earned value management techniques can be used to evaluate progress of Tasks under Budget Period 2. Non-proprietary technical progress reports will be distributed among team members to keep the team informed of the project status. Subcontract management, communications, outreach, and technology transfer functions will also be performed under this task.

D. Deliverables

In addition to the reports identified on Attachment B, the Financial Assistance Reporting Requirements Checklist, and in specific sections of this agreement, the Participant shall provide documents, reports, and briefings as identified below.

Project Management Plan. The Participant shall provide an updated Project Management Plan within thirty days of the Design Review Meeting held under Task 1.

Construction Plan. The Participant shall provide a Construction Plan developed under Task 6.

Test Plans. The Participant shall provide the following Draft Test Plans for review by the DOE COR: Draft TOXECON^{TM} Evaluation Test Plan, Draft Mercury CEM Test Plan, and Draft Mercury Recovery Test Plan. The Participant shall provide the following Test Plans for DOE approval: TOXECON^{TM} Evaluation Test Plan, Mercury CEM Test Plan, and Mercury Recovery Test Plan.

Topical Report. The Participant shall submit a Preliminary Public Design Report as a Topical Report for Budget Period 1. The Participant shall submit a Draft Topical Report for Budget Period 1 within sixty days of the conclusion of Budget Period 1. DOE shall review the Draft Topical Report and provide comments to the Participant within thirty days of receipt. The Participant shall address DOE comments and submit a Final Topical Report for Budget Period 1 within thirty days.

Public Design Report. The Participant shall submit a Public Design Report, for the purpose of public use. The Public Design Report must consolidate all design and cost information for the project at the completion of construction and start up. The report must contain sufficient information to provide an overview of the project, salient design features and data, and the role of the demonstration project in commercialization planning.

E. Briefings

Briefings and Technical Presentations shall be provided as follows.

Kickoff Design Review Meeting. The Participant shall hold a Kickoff Design Review Meeting as described in Task 1, within sixty days after award with the primary purpose of providing a status of the ongoing work, specifying system requirements and planning future project activities.

Design Review Meeting. The Participant shall hold a Design Review Meeting near the end of design activities during Budget Period 1 to present a review of the design process and salient design features of the TOXECON^{TM} system.

Final Briefing. The Participant shall provide a Final Briefing at the conclusion of the project to provide a comprehensive summary of the accomplishments and results of this project. The location of the Final Briefing shall be Morgantown, West Virginia.