PROGRAM facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

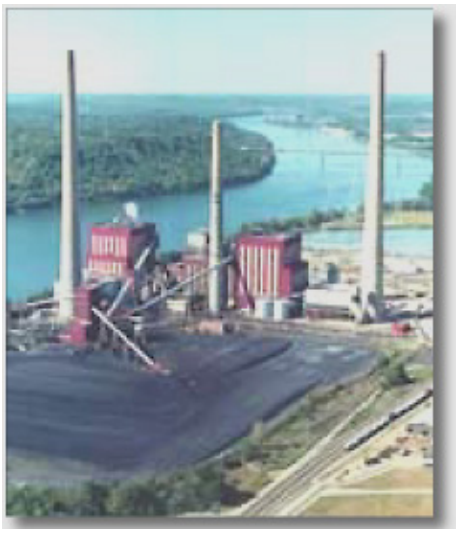
Innovations for Existing Plants

02/2005

Phase II Field Testing of Advanced Mercury Control Technology

Background

The United States Environmental Protection Agency (EPA) has determined that regulation of mercury emissions from coal-fired utilities is necessary. Currently, EPA is in the process of developing mercury regulations for new and existing coal-fired electric generating units. In parallel, several proposed legislative measures have been introduced in recent sessions of Congress to control mercury along with sulfur dioxide and nitrogen oxides. To help ensure that the existing fleet of coal-fired power plants can meet future regulatory requirements, the U.S. Department of Energy's National Energy Technology Laboratory (DOE/NETL) has been carrying out a research and development (R&D) program focused on the control of mercury emissions from coal-based power systems. Working collaboratively with power plant operators, the Electric Power Research Institute (EPRI), academia, state and local agencies, and EPA since 1990, the program has greatly advanced our understanding of the formation, distribution, and capture of mercury from electric-utility boilers. Continued R&D is necessary in order to bring advanced mercury control technology to the point that it is ready for commercial demonstration.



CONTACT POINTS

Thomas J. Feeley, III
Technology Manager
Innovations for Existing Plants
National Energy Technology Laboratory
412-386-6134
thomas.feeley@netl.doe.gov

Lynn Brickett
Project Manager
National Energy Technology Laboratory
412-386-6574
lynn.brickett @netl.doe.gov

Andrew O'Palko
Project Manager
National Energy Technology Laboratory
304-285-4715
andrew.o'palko@netl.doe.gov

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

http://www.netl.doe.gov/coal/e&wr/index.html

Mercury Research

The mercury control technology research activities are part of NETL's Innovations for Existing Plants (IEP) Program. The IEP Program seeks to create technology options that will enable the current fleet of coal-fired power plants to cost-effectively comply with future environmental regulations. The mercury component of the program is directed at the development of a broad suite of low-cost control options to respond to future regulatory decisions.

The near-term goal is to develop mercury control technologies that can achieve 50-70% mercury capture at costs 25-50% less than baseline estimates of $50,000-$70,000/ lb of mercury removed. These technologies would be available for commercial demonstration by 2005 for bituminous plants and 2007 for lignite and subbituminous coal plants. The longer-term goal is to develop advanced mercury control technologies to achieve 90% or greater capture that would be available for commercial demonstration by 2010.

Table 1 - DOE/NETL Phase II Mercury Field Testing

Project Title	Lead Company	Preliminary Test Schedule*	Host Utility	Test Location	Coal Rank	PM
Evaluation of Sorbent Injection for Mercury Control	ADA-ES	3/04 - 6/04	Sunflower Electric	Holcomb	PRB/Bit. Blend	FF
		8/04 - 11/04	AmerenUE	Meramec	PRB	ESP
		7/05 - 10/05	AEP	Conesville	Bit.	ESP
		4/05 - 7/05	Detroit Edison	Monroe 4	PRB/Bit. Blend	ESP
		2/05 - 3/05	Basin Electric	Laramie River	PRB/Bit. Blend	ESP
Demonstration of Amended Silicates for Mercury Control	Amended Silicates	6/05-7/05	Cinergy	Miami Fort 6	Bit.	ESP
Sorbent Injection for Small ESP Mercury Control	URS Group	3/04 & 9/04 - 10/04	Southern	Yates 1	Bit.	ESP
			Southern	Yates 2	Bit.	ESP w/ NH3/SO3
Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems	URS Group	6/04 - 7/05	TXU	Monticello 3	TX Lignite	ESP
		2/05 - 3/06	Southern	Yates	Bit.	ESP
Evaluation of MerCAP for Power Plant Mercury Control	URS Group	8/04 - 2/05	Great River Energy	Stanton 10	ND Lignite	FF
		1/05 - 6/05	Southern	Yates 1	Bit.	ESP
Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems	UNDEERC	4/04 - 6/04	Basin Electric	Leland Olds 1	ND Lignite	ESP
		9/04 - 10/04	Great River Energy	Stanton 10	ND Lignite	FF
		4/05 - 6/05	Basin Electric	Antelope Valley 1	ND Lignite	FF
		4/04 - 5/04	Great River Energy	Stanton 1	ND Lignite	ESP
Mercury Oxidation Upstream of an ESP and Wet FGD	UNDEERC	3/05 - 5/05	Minnkota Power	Milton R. Young 2	ND Lignite	ESP
		8/05 - 9/05	TXU	Monticello 3	TX Lignite	ESP
Advanced Utility Mercury-Sorbent Field-Testing Program	Sorbent Technologies	1/05 - 4/05	Duke	Buck	Bit.	Hot ESP
		6/04 - 9/04	Detroit Edison	St. Clair	Bit./PRB blend	ESP
Low-Cost Options for Moderate Levels of Mercury Control	ADA-ES	5/05 - 6/05	MidAmerican	Louisa 1	PRB	Hot ESP
		TBD	Entergy	Independence 1	PRB	ESP
		TBD	AEP	Gavin	Bit	ESP
		TBD	MidAmerican	Council Bluffs 2	PRB	Hot ESP
Field Demonstration of Enhanced Sorbent Injection for Mercury Control	ALSTOM	10/06 - 12/06	Basin Electric	Leland Olds 1	ND Lignite	ESP
		4/06 - 6/06	Reliant Energy	Portland	Bit.	ESP
		6/05 - 7/05	PacifiCorp	Dave Johnston	PRB	ESP
Demonstration of Integrated Approach to Mercury Control	GE-EERC	7/05 - 8/05 3/06 - 4/06	Progress Energy**	Lee 3	Bit.	ESP
Brominated Sorbents for Cold-Side ESPs, Hot-Side ESPs, and Fly Ash Use in Concrete	Sorbent Technologies	4/06 - 6/06	Mid-West Generation	Crawford 7	Subbituminous	ESP
		7/05 - 9/05	Progress Energy	Lee 1	Bit	ESP
		TBD	Mid-West Generation**	Will County	Subbituminous	Hot ESP
Field Testing of Activated Carbon Injection Options for Mercury Control	UNDEERC	1/06 - 4/06	TXU	Big Brown	TX Lignite or TX Lignite/Sub-bit. Blend	COHPAC
Field Testing of a Wet FGD Additive for Enhanced Mercury Control	URS Group	7/05 - 8/05	Southern	Yates 1	Bit.	ESP
		6/05 - 7/05	AEP	Conesville	Bit.	ESP
		4/05 - 5/05	TXU	Monticello 3	Lignite	---

* These are preliminary test schedules subject to change based on plant availability

** Tentative host utility and test location

In support of the near-term goal, DOE/NETL selected eight new projects in September 2003 to test and evaluate mercury control technologies at coal-fired power plants under a Phase II mercury control technology solicitation. Building on promising advances that resulted from Phase I activities, these projects focus on longer-term, large-scale field testing on a broad range of coal-rank and air pollution control device configurations. These tests will provide important information on mercury removal effectiveness, cost, and the potential impacts on plant operations including by-product characteristics. In October 2004, DOE/NETL awarded a second round of six additional Phase II projects. These new projects will focus on technologies for power plants that burn Powder River Basin coal, Texas lignite, or coal blends. The following provides a brief summary of each of the fourteen Phase II DOE/NETL mercury projects.

Phase II Round 1 Mercury Control Project Summaries – 8 Projects

Evaluation of Sorbent Injection for Mercury Control – ADA Environmental Solutions, LLC (ADA-ES), Littleton, Colorado, will evaluate sorbent injection to remove mercury for a variety of coal and air pollution control equipment configurations. Testing will be conducted at five power plants: (1) Sunflower Electric's Holcomb Station that burns a blend of subbituminous Powder River Basin (PRB) and bituminous coal; (2) Detroit Edison's Monroe Plant that burns a blend of PRB and bituminous coal; (3) Ameren UE's Meramec Station that burns PRB coal; (4) American Electric Power's (AEP's) Conesville Station that burns bituminous coal and (5) Basin Electric's Laramie River Plant that burns a blend of PRB and bituminous coal.

NETL Project Manager: Andrew O'Palko (andrew.opalko@netl.doe.gov)

Amended Silicates for Mercury Control - Amended Silicates, LLC (a joint venture of ADA Technologies, Inc. and CH2M Hill), Littleton, Colorado, will test a new non-carbon sorbent, Amended Silicates™, which could provide cost effective mercury capture while avoiding adverse impacts on fly ash sales. Testing will be conducted at Cinergy's 175 MW Miami Fort Unit 6 that burns bituminous coal. The research team also includes the University of North Dakota Energy & Environmental Research Center, Western Kentucky University, and Boral Materials Technologies.

NETL Project Manager: Andrew O'Palko (andrew.opalko@netl.doe.gov)

Mercury and Coal By-Products

Because mercury is highly volatile, nearly all of the mercury in coal vaporizes in the boiler and exits in the flue gas. Existing air pollution control devices can provide some degree of mercury control and captured mercury may reside at trace levels in combustion by-products such as fly ash and FGD material. With the use of sorbent and oxidation technologies to control stack mercury emissions, more mercury will partition to the solid by-products.

Coal-fired power plants generate large volumes of solid by-products, which can present significant disposal issues. The American Coal Ash Association estimates that the electric utility industry generated more than 117 million tons of by-products in 2001. In addition, future SO_2 regulations may result in even greater quantities of by-products being generated due to the installation of wet scrubbers.

While almost one-third of the total amount of by-products presently generated is beneficially reused, the remaining two-thirds are disposed of in landfills or surface impoundments. The regulation and subsequent control of mercury emissions from coal-fired power plants could lead to additional scrutiny of current by-product re-use activities and long-term management practices.

In recognition of the potential impact of mercury regulations on by-product use and disposal, DOE/NETL will evaluate the leaching and volatilization of mercury from the Phase II field testing by-products.

Sorbent Injection for Small ESP Mercury Control - URS Group, Inc. (URS), Austin, Texas, will test sorbent injection technology upstream of a small collection area ESP. Previous full-scale sorbent injection tests have involved relatively large ESPs, but more than 60 percent of the industry is equipped with ESPs having small size collection areas. Testing will be conducted at Southern Company's Plant Yates Unit 1 & 2 that burn bituminous coal. Other team members include ADA-ES and EPRI.

NETL Project Manager: Dawn Chapman (dawn.chapman@netl.doe.gov)

Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems - URS will conduct pilot-scale testing of fixed-bed catalysts to oxidize elemental mercury in order to increase overall mercury capture in downstream wet FGD systems. Four catalyst materials are scheduled to be tested including: palladium, titanium/vanadium, gold, and carbon. Testing will be conducted at two plants: (1) TXU's Monticello Station Unit 3 that burns Texas lignite; and (2) Southern Company's Plant Yates that burns low-sulfur bituminous coal. The research team also includes EPRI, Great River Energy, and City Public Service of San Antonio.

NETL Project Manager: Bruce Lani (bruce.lani@netl.doe.gov)

Evaluation of MerCAP for Power Plant Mercury Control - URS will test EPRI's Mercury Control via Adsorption Process (MerCAP™) technology. The process involves placing a regenerable, fixed-structure gold sorbent into the flue gas stream to capture mercury. Testing will be conducted at Great River Energy's lignite-fired Stanton Station and at Southern Company's bituminous-fired Plant Yates. At Stanton Unit 10, MerCAP sorbent structures will be retrofitted into a single compartment of the fabric filter baghouse equivalent to a 6 MW demonstration. At Plant Yates Unit 1, MerCAP sorbent structures will be configured as a mist eliminator located downstream of a 1 MW pilot-scale wet FGD absorber. The research team also includes Apogee Scientific, EPRI, ADA-ES, and North Dakota Industrial Commission.

NETL Project Manager: William Aljoe (william.aljoe@netl.doe.gov)

Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems - University of North Dakota Energy & Environmental Research Center (UNDEERC), Grand Forks, North Dakota, will test enhancements to activated carbon sorbent injection to increase mercury capture for plants burning low-rank lignite coals. Lignite produces higher levels of elemental mercury, which is more difficult to remove. Two different technology approaches will be evaluated: (1) injection of chlorine-based additives in conjunction with activated carbon sorbents, and (2) injection of chemically treated activated carbon sorbents. The first approach will be tested at Basin Electric's 210 MW Leland Olds Station Unit 1 and the 440 MW Antelope Valley Station Unit 1. The second approach will be tested at Great River Energy's 140 MW Stanton Station Unit 1 and the 60 MW Stanton Station Unit 10. The research team also includes URS, ADA-ES, B&W, EPRI, NDIC, and the Lignite Consortium.

NETL Project Manager: Lynn Brickett (lynn.brickett@netl.doe.gov)

Mercury Oxidation Upstream of an ESP and Wet FGD - UNDEERC will test the effectiveness of using chlorine-based additives without supplemental sorbent injection to increase mercury oxidation and therefore enhance mercury capture at lignite-fired plants equipped with an ESP and wet FGD. Testing will be conducted at Minnkota Power Cooperative's Milton R. Young Unit 2 that burns North Dakota lignite and TXU's Monticello Unit 3 that burns Texas lignite. The research team also includes URS, ADA-ES, B&W, EPRI, NDIC, and the Lignite Consortium.

NETL Project Manager: Andrew O'Palko (andrew.opalko@netl.doe.gov)

Advanced Utility Mercury Sorbent Field-Testing Program - Sorbent Technologies Corporation (Sorbent Technologies), Twinsburg, Ohio, will test an advanced halogenated activated carbon sorbent that can be used as a cost-effective alternative to commercial activated carbon injection for mercury capture. A short-term trial of the halogenated sorbent was conducted at Duke Energy's Cliffside Plant that is equipped with a hot-side ESP. Longer-term testing will be conducted at Duke Energy's 140 MW Buck Plant that burns low-sulfur bituminous coal and at Detroit Edison's 80 MW St. Clair Station that burns a blend of PRB and bituminous coal. Other team members include Fuel Tech, Western Kentucky University's Combustion Laboratory, PS Analytical, Spectra Gases, and Stock Equipment Company.

NETL Project Manager: Lynn Brickett (lynn.brickett@netl.doe.gov)

NETL's IEP Program seeks to create technology options that will enable the current fleet of coal-fired power plants to cost-effectively comply with future environmental regulations

The near-term goal is to develop mercury control technologies that can achieve 50-70% mercury capture at costs 25-50% less than baseline estimates of $50,000-$70,000/ lb of mercury removed.

Phase II Round 2 Mercury Control Project Summaries – 6 Projects

Low-Cost Options for Moderate Levels of Mercury Control – ADA-ES will test two new mercury control technologies: TOXECON II™ and unique sorbents for injection into hot-side ESPs. The TOXECON II technology injects activated carbon directly into the downstream collecting fields of an electrostatic precipitator (ESP). The majority of the fly ash is collected in the upstream collecting fields, resulting in only a small portion of carbon-contaminated ash. The TOXECON II technology will be tested at AEP's Gavin Station which burns bituminous coal and Entergy's Independence Station which burns PRB coal. The novel sorbents for hot-side ESPs technology will be tested at MidAmerican's Council Bluffs Energy Center and MidAmerican's Louisa Station, both of which burn PRB coal. The research team also includes EPRI, Dynegy, and Olgethorpe Power.

NETL Project Manager: Andrew O'Palko (andrew.opalko@netl.doe.gov)

Field Demonstration of Enhanced Sorbent Injection for Mercury Control – ALSTOM Power, Inc., Windsor, Connecticut, will test its proprietary chemically-treated activated carbon sorbent, which promotes oxidation and capture of mercury. Testing will be conducted at three utilities burning different coals: (1) PacificCorp's Dave Johnston Plant which burns PRB coal; (2) Basin Electric's Leland Olds Station which burns North Dakota lignite; and (3) Reliant Energy's Portland Station which burns bituminous coal. The research team also includes UNDEERC, the North Dakota Industrial Commission, and Minnkota Power.

NETL Project Manager: Lynn Brickett (lynn.brickett@netl.doe.gov)

Demonstration of an Integrated Approach to Mercury Control – GE Energy & Environmental Research (GE EER), Irvin, California, has developed a new, cost-effective technology that combines mercury removal with nitrogen oxide emission control. GE EER will conduct a field demonstration of its technology at Progress Energy's Lee Unit 3 which burns a bituminous coal. The objective of the demonstration is to demonstrate at least 90 percent mercury removal.

NETL Project Manager: Peter Botros (peter.botros@netl.doe.gov)

Brominated Sorbents for Small Cold-Side ESPs, Hot-Side ESPs, and Fly Ash Use in Concrete – Sorbent Technologies will lead an extensive team to demonstrate how the injection of brominated powdered activated carbon (B-PAC™) can cost-effectively reduce mercury emissions from power plants. Testing will be conducted at 3 sites: (1) Midwest Generation's Crawford Station which burns subbituminous coal; (2) Progress Energy's Lee Station which burns bituminous coal; and (3) Midwest Generation's Will County Station[1] which burns subbituminous coal. The research team also includes Headwaters/ISG Resources, Fuel Tech, Inc., Western Kentucky University and Acticarb Tailored Products LLC.

NETL Project Manager: Lynn Brickett (lynn.brickett@netl.doe.gov)

Field Testing of Activated Carbon Injection Options for Mercury Control at TXU's Big Brown Station – UNDEERC will evaluate the long-term feasibility of using activated carbon injection to reduce mercury emissions from a Texas electric generating plant that burns either Texas lignite or a lignite-subbituminous coal blend. UNDEERC will conduct the field test at TXU Energy's Big Brown Steam Electric Station. The project will test several activated-carbon injection options to cost-effectively remove mercury from lignite combustion gases. The research team also includes TXU, EPRI, ADA-ES, B&W, along with several Texas state agencies and a consortium of Texas and North Dakota utilities.

NETL Project Manager: Sara Pletcher (sara.pletcher@netl.doe.gov)

Round 2 of Phase II projects will focus on technologies for power plants that burn Powder River Basin coal, Texas lignite, or coal blends.

---

1 Plans to test at Midwest Generation's Will County Station are tentative.

PARTNERS

ADA Environmental Solutions

ADA Technologies

Alstom Power

Amended Silicates

Apogee Scientific

Babcock & Wilcox

Boral Materials Technologies

CH2M Hill

EPRI

Fuel Tech

GE Energy & Environmental Research

Lignite Consortium

Norit Americas

North Dakota Industrial Commission

PS Analytical

Sorbent Technologies

Spectra Gases

Stock Equipment

UNDEERC

URS Group

Western Fuels Association

Western Kentucky University

Field Testing of a Wet FGD Additive for Enhanced Mercury Control - URS will demonstrate the use of an additive in wet lime or limestone FGD systems. The additive is designed to prevent oxidized mercury from being reduced and subsequently re-emitted into power plant flue gas streams as elemental mercury. The additive also assists in the removal of mercury from by-products to provide for its separate disposal. Testing will be conducted at three sites: (1) TXU's Monticello Station which burns lignite coal; (2) Southern Company's Plant Yates which burns bituminous coal; and (3) AEP's Conesville Station which burns bituminous coal. The research team also includes EPRI, TXU Energy, AEP, the Southern Company, and Degussa Corporation.

NETL Project Manager: Charles Miller (charles.miller@netl.doe.gov)