

Power Plant Multimedia Toxics Characterization - Program 59

Program Overview

Program Description

Current and future air toxics emissions, water discharges, and solid waste disposal regulations will result in increasingly stringent limits and increased compliance costs for power companies and other industrial emissions sources. Recent court decisions have reopened the need to review and update power plant emissions characterization data for mercury and other hazardous air pollutants (HAPs) as part of the U.S. Environmental Protection Agency's (EPA's) ongoing Maximum Achievable Control Technology (MACT) rulemaking. There is a critical need to address environmental releases in a holistic, multimedia (air, land, water) manner so that a pollutant removed by a control technology from one medium (e.g., flue gas) does not adversely affect the regulatory situation in other media (e.g., water and solid waste). Moreover, environmental issues associated with new and emerging technologies such as renewables and distributed generation need to be examined in advance of widespread deployment. In the future, there will be an increasing need to minimize the environmental footprint of power plants, achieved through further optimization of existing power plant operations and design of new plants.

The Electric Power Research Institute's (EPRI's) power plant characterization program provides the methods and tools for measuring and managing toxic emissions and discharges from power plants and prepares power companies to meet evolving regulations. It helps members, the scientific community, and the public to evaluate discrete air, water, and land environmental impacts as well as the interplay between these receiving media that might result from changes in fuel composition or fuel blend, implementation of new or enhanced control technologies, or changes in plant operating practices. Information generated from this program will become more critical as EPA considers rules for mercury, arsenic, hydrochloric acid, and other HAPs emissions.

Research Value

EPRI began its power plant toxics characterization research well before the 1990 Clean Air Act Amendments that established the HAPs program. This longevity positions it as a visionary program that anticipates issues well ahead of time, helps inform effective regulations, and develops practical solutions. Characterization of power plant emissions and discharges requires accurate and sensitive analytical methods; where these do not exist, this program supports method development studies. The program addresses environmental impacts from advanced generation technologies such as integrated gasification combined-cycle (IGCC), as well as from renewable technologies (e.g., biomass, solar) and distributed generation facilities (e.g., microturbines, fuel cells). The program also assists generators with permitting and reporting processes by providing credible emission data. This research helps power companies

- monitor and, if necessary, control important HAPs;
- meet potential regulatory requirements at least cost, including fines for violations; and
- design and operate plants that minimize overall chemical releases.

Approach

The Power Plant Integrated Systems Chemical Emissions Studies (PISCES) Database is the most comprehensive data set available on HAPs emissions. It is a multimedia database containing primary information on the concentration and fate of substances in power plant process and discharge streams. The program also assists with Toxics Release Inventory (TRI) reporting and record-keeping requirements. This approach helps minimize the cost of overall environmental compliance and management. This program delivers

- accurate characterization of chemical substances in air, water, and solid discharges from fossil fuel power plants, especially coal-fired plants; results play a key role in informing the regulatory debate on mercury and other HAPs;
- sampling and analytical methods that can reduce the risk of permit violations;
- significant cost savings from use of the PISCES Database and TRI reporting software, the Land-Air Estimating, Reporting, and Recordkeeping System for the Toxics Release Inventory for Power Plants (LARK-TRIPP); and
- early warning of issues that can inform the development of technology and address potential environmental and public perception issues.

Accomplishments

Research from this program has excellent credibility with regulators as a source of objective, scientific information. Data generated from this program's research has been valuable to member companies in improved plant operation and cost-effective environmental compliance. Program accomplishments include the following:

- PISCES power plant mercury characterization data provided critical information to members and regulators during the development of the Clean Air Mercury Rule and played a key role in informing the discussions leading to the Rule.
- The PISCES Database is a detailed database of mercury and other HAPs emissions from coal- and oil-fired power plants. A recent update should help member companies and EPA as the Agency revisits the MACT rulemaking.
- EPA approved QuickSEM as a mercury emissions reference method. Jointly developed and tested with the Continuous Emissions Monitoring (CEM) program in Generation, QuickSEM is a cost-effective sorbent-tube continuous mercury emissions monitoring system.
- Program research provided an assessment of the multimedia fate of mercury in power plants with selective catalytic reduction (SCR) and wet flue gas desulfurization (FGD) systems.
- The program provided updated tools for environmental compliance and improved plant operation (PISCES Database and LARK-TRIPP software).

Current Year Activities

Program R&D for 2010 will focus on toxics characterization data collection, PISCES database population, multimedia characterization methods, and multimedia environmental impact evaluations of biomass- and coal-based generation technologies.

- Collect toxics characterization data on power plant flue gas streams, including partitioning of chemicals in power plant control equipment; fill data gaps in power plant emissions estimates for mercury and other HAPs.
- Continue to populate the PISCES database with power plant waste stream characterization data; document sampling and analytical methods used; continue support to meet TRI needs.
- Evaluate, develop, and validate sampling and analytical methods for multimedia (gas, liquid, and solid streams) characterization; PISCES will act as the clearinghouse for media-specific sampling and analytical methods.
- Evaluate multimedia environmental impacts of fuel changes, including renewable sources (e.g., biomass) and control technologies on conventional generation plants, IGCC systems, and distributed generation.

Estimated 2010 Program Funding

\$2.2M

Program Manager

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Summary of Projects

Project Number	Project Title	Description
P59.001	Flue Gas Toxics Characterization	Power plant flue gas measurements will be conducted as necessary to address data gaps. The data will be evaluated to provide tools for estimating mercury and HAPs emission estimates.
P59.002	TRI Technical Needs	LARK-TRIPP is a software program used to estimate releases of chemical substances to air, water, and land from coal-, oil-, and gas-fired power plants for purposes of TRI reporting.
P59.003	Multimedia Environmental Impacts - Conventional, IGCC, and Distributed Generation	Power plant measurements are being conducted and the results evaluated to develop the database and tools to assist power plant personnel in understanding and managing their multimedia discharges with coal switching and new control technologies.
P59.004	Sampling and Analytical Methods	This research provides an information resource to aid in selecting sampling and analytical methods for chemicals in power plant waste streams, and develops and validates new or improved methods where necessary.
P59.005	PISCES Database	The PISCES Database is a comprehensive, online database containing information on the concentration and fate of chemical substances in power plant process and discharge streams.

P59.001 Flue Gas Toxics Characterization (101138)

Key Research Question

EPA issued the Clean Air Mercury Rule (CAMR) in 2005. Recently, a federal circuit court remanded CAMR back to EPA for reconsideration, creating uncertainty on the direction of federal mercury regulations. EPA may be required to proceed with a new MACT rulemaking for mercury as well as other HAPs such as arsenic and hydrochloric acid. Accurate, reliable measurement data is required to support sound regulatory decisions. Many power plants are installing SCR and wet FGD systems for NO_x and SO₂ compliance and were depending upon mercury cobenefit removal with the SCR and wet FGD systems to meet some or all of their CAMR requirements. The possible change in regulatory focus to a MACT rulemaking means that controls specifically targeted at mercury reduction may be required in the future. Power plant owners/operators need to understand the impact of coal choice, power plant design and operation, and mercury capture technologies on expected mercury removals. Power plants will need continuous monitors as well as approaches to conducting QA/QC tests (e.g., relative accuracy test audits).

Approach

As EPA proceeds with a new MACT rulemaking, EPRI will provide the best information available to assist all stakeholders as the regulations are under development. EPRI may also assist in providing its review and synthesis of the available mercury emissions data from coal- and oil-fired power plants. In addition to mercury, other HAPs emissions such as arsenic, hydrofluoric acid, and hydrochloric acid from coal-fired power plants may require further examination in a variety of plant configurations. The U.S. power industry needs to understand the impacts of coal choice and power plant design and operation (SCR/FGD systems) on expected mercury removals. The industry also needs cost-effective mercury capture approaches, continuous mercury monitors, and approaches to conducting necessary QA/QC tests. This program will

- review and synthesize available emissions data and update industry estimates of HAPs emissions from coal- and oil-fired power plants;
- support development of scientifically sound environmental regulations and cost-effective emission control strategies for nonmercury HAPs;

- evaluate various approaches to enhance overall mercury removal for SCR/FGD cobenefits, (e.g., the impact of halogen concentrations in coal and flue gas on SCR mercury oxidation and the impact of FGD additives such as iron to manage the mercury in the FGD water); and
- refine existing correlations to predict (speciated) mercury emissions and removal based on coal type, control technology, and level of halogen in coal.

Impact

- Provide accurate and reliable data to inform the mercury and HAPs regulatory process
- Optimize mercury cobenefit removals for SCR/FGDs
- Provide predictive correlations for mercury and HAPs for all key coal types and control technology configurations

How to Apply Results

Project findings and deliverables will be used by power company staff in environmental affairs/controls to support the regulatory process as well as assist power plants in developing management options for mercury and HAPs. Members should send key stakeholders the results, ensure that stakeholders understand those results, and suggest that results be considered as environmental policies are developed. The results will also assist engineering staff (design and operations) in developing and implementing effective management options for controlling toxics emissions from power generation facilities. EPRI staff will also communicate the results to key stakeholders such as regulatory agencies, environmental policymakers, and the public.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Mercury and HAPs Characterization and Emissions: This report will summarize field measurements characterizing mercury speciation and removal, as well as other trace elements as necessary, to support the ongoing regulatory process.	12/31/10	Technical Update
Enhancing Mercury SCR/FGD Cobenefits: Field studies evaluating various approaches (e.g., halogen addition, FGD water additives, activated carbon injection) to enhance mercury SCR/FGD cobenefits will be summarized.	12/31/10	Technical Update
Guidelines for Sorbent Tube Mercury Monitoring: This report will summarize best practices and procedures for accurate measurement of mercury emissions in flue gas using sorbent trap monitoring methods. Previous EPRI research on sorbent materials, sampling techniques, and analytical methods will be used to prepare recommendations. Both long-term ("Appendix K") monitoring and reference method (EPA Method 30B) applications will be addressed. This is a joint project with Program 77, Continuous Emissions Monitoring, in the Generation Sector.	12/31/10	Technical Report

P59.002 TRI Technical Needs (100809)

Key Research Question

Power plant owners must report emissions of specific compounds to state and federal regulators. This process can be very labor intensive, as environmental department staff must spend many hours in compiling, analyzing, and reporting the required data. It is also necessary to maintain records of regulatory reporting and to defend assumptions made in estimating emissions if questions are raised by regulators.

Approach

This project assists companies in responding to EPA's TRI reporting requirements. The project provides technical approaches, software, emission factors, and data evaluation to reduce reporting costs and improve release estimates. EPRI's LARK-TRIPP software helps users estimate chemical substance releases to air, water, and land. It is updated regularly to reflect changes in EPA's TRI program and changes to power generation and pollutant control technologies.

Impact

- Provides rigorous and credible estimation techniques and emission factors.
- Reduces costs for preparing TRI reports and other emissions reports. One member estimated annual savings of \$500,000 from the use of EPRI's LARK-TRIPP software versus manual methods of preparing TRI reports.
- Standardizes industry approach to emissions estimation, thus improving acceptability to regulators.
- Can be used for "what-if" analysis to evaluate impacts of fuel changes or new pollution control equipment.

How to Apply Results

The LARK-TRIPP software for TRI reporting can be implemented by environmental department staff or plant engineers on a Windows-based workstation. Data from plant operations (e.g., coal burned, hours of operation) are entered into the software. The resulting estimates are uploaded directly into EPA's web-based Toxics Release Inventory—Made Easy (TRI-ME Web) reporting software, avoiding the need for manual data entry. Training and support are provided as part of the project to help staff learn and use the program. Emissions estimation models for sulfuric acid and ammonia will be provided as part of the LARK-TRIPP program and documentation.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
LARK-TRIPP: LARK-TRIPP will be updated to reflect changes in EPA's TRI program and improvements recommended by software users.	09/30/10	Software
Emission Factors Handbook Updates: The <i>Emission Factors Handbook</i> will be revised to reflect updated emission factors and correlations based on EPRI's mercury and HAPs emissions estimates and the new data available. Updates will include estimates for new configurations of power plant pollution control devices, such as SCR and selective noncatalytic reduction (SNCR), developed from the new emissions data.	12/31/10	Technical Update

P59.003 Multimedia Environmental Impacts - Conventional, IGCC, and Distributed Generation (063346)

Key Research Question

As a trace element (e.g., mercury or selenium) is removed from one medium (such as flue gas), this pollutant is transferred to the other media (water and/or solids). Understanding the multimedia fate is critical for sound environmental management as well as for responses to state and local regulatory drivers. Renewable energy portfolio requirements in many states are leading to new interest in alternative fuel sources (e.g., biomass, biofuels) as well as distributed generation. The potential for multimedia environmental issues associated with manufacture and use of these energy sources must be fully understood.

Approach

Studies will improve understanding of fate of chemicals in power plant systems, leading to cost-effective management in both central station and distributed generation facilities.

- For conventional plants, characterize changes to air, water, and land releases from fuel changes (e.g., low- to high-sulfur coal as well as alternative fuels such as biomass or biofuels) and new control technologies (e.g., activated carbon)
- For IGCC plants, characterize streams and evaluate impacts
- For distributed generation facilities, characterize releases from microturbines and solar power
- Perform life-cycle assessment of chemical releases

Impact

- Assists power plant environmental engineers and compliance staff to evaluate the impact of changing fuels and controls on the fate of toxic chemicals in power plants
- Assists power plants in managing multimedia impacts and responding to state and local issues

How to Apply Results

Project findings and deliverables will be employed by personnel in environmental affairs/compliance departments of power companies in responding to EPA and state agencies in developing sound environmental regulations and permits. Members should send key stakeholders the results, ensure that stakeholders understand those results, and suggest that results be considered as environmental policies are developed. The results will also assist engineering staff (design and operations) in developing and implementing effective management options for controlling toxics emissions from power generation facilities. EPRI staff will also communicate the results to key stakeholders such as regulatory agencies, environmental policymakers, and the public.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Multimedia Impacts of New/Refined Control Technologies and Coal Changes: This report will summarize research to characterize multimedia discharges to air, water, and land resulting from changes to control technologies (e.g., for sulfur dioxides, nitrogen oxides, mercury) as well as the associated coal changes (e.g., low- to high-sulfur coal). Potential issues will be identified and initial multimedia approaches will be developed.	12/31/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Multimedia Impacts of Distributed Generation Technologies: This report will summarize multimedia environmental impacts from chemicals produced during manufacture or operation of distributed generation facilities, including fuel cells and microturbines.	12/31/11	Technical Update

P59.004 Sampling and Analytical Methods (065616)

Key Research Question

Accurate characterization of potentially toxic chemicals in fuels, reagents, intermediate streams, air emissions, liquid and solid waste streams, and other discharges is essential for developing effective strategies for multimedia management of these chemicals. Some existing sampling and analytical methods do not have the required sensitivity or specificity to meet increasingly stringent regulatory needs. Better methods, and validation of existing methods, are needed to support compliance monitoring. The research conducted in this project will be targeted toward the most pressing needs of the industry, as determined by changes in regulations or fossil-fueled power plant technology. Methods that are likely to require improvement or validation include metals in flue gas desulfurization (FGD) wastewaters and stack gases, and fine particulates (PM_{2.5}) in flue gas from wet FGD systems. The drivers for this research are regulatory programs that require new pollution control technologies and impose increasingly strict limits on emissions to air, land, and water. For example, plants that install FGD systems will divert some metals from stack gas to wastewater. Power plants facing lower surface water discharge limits for these metals may not be able to measure them accurately with existing analytical methods. Techniques to avoid contaminating the samples will become increasingly important.

Approach

This project will compile and deliver timely information and guidance to aid power plant staff in selecting and implementing appropriate sampling and analytical methods, and will support development and testing of new or improved methods where needed. Work on this project will be coordinated with other EPRI programs, as appropriate (e.g., work on analytical methods for metals in flue gas desulfurization waters will be integrated with work in Program 56, Effluent Guidelines and Water Quality Management).

Impact

Availability of suitable sampling and analytical methods is critical for accurate characterization of power plant streams. This work will enable development of effective strategies for management of these chemicals, and will assist power plant staff to

- minimize or eliminate potential violations of permit limits due to sampling or analytical inaccuracy,
- select appropriate methods for particular study objectives,
- inform regulators and other stakeholders of the quality and representativeness of monitoring data, and
- make good decisions in purchasing or contracting analytical laboratory equipment and services.

How to Apply Results

Project findings and deliverables will be employed by personnel in chemistry labs and environmental affairs/compliance departments of power companies, to apply the most suitable sampling and analytical methods to meet regulatory and other needs. These personnel can also use the information to negotiate reasonable permits and to respond to EPA and state agencies in developing sound environmental regulations. Members should send key stakeholders the results, ensure that stakeholders understand those results, and suggest that results be considered in the development of permit limits and environmental policies. The results will also assist engineering staff (design and plant operations) to accurately measure the concentrations of chemicals of concern and help develop and implement effective management options for controlling release of toxic substances from generating facilities.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Index of Sampling and Analytical Methods: The methods index will be expanded and maintained with up-to-date information on research and resources relating to measurement of chemical parameters in power plant waste streams, fuels, and environmental media.	12/31/10	Technical Resource
PM2.5 - CPM Methods: Sampling/analysis methods for fine particulates in stack gases will be evaluated in several field studies to determine the accuracy and precision of the methods. Candidate techniques to be evaluated include dilution samplers, controlled condensate systems, and EPA's replacement for EPA Method 202.	12/31/10	Technical Update
Evaluation of Analytical Methods for Metals in Power Plant Wastewaters: A modification of EPA Method 1638 for measurement of metals in water by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) using a dynamic reaction cell will be tested in multiple laboratories to evaluate the practicality, precision, and accuracy of the technique. This round-robin study will help to expand the pool of commercial laboratories available to perform this method.	12/31/10	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Index of Sampling and Analytical Methods: The methods index will be expanded and maintained with up-to-date information on research and resources relating to measurement of chemical parameters in power plant waste streams, fuels, and environmental media.	12/31/11	Technical Resource
Evaluation of EPA Method 1668B - PCB Congeners in Water: This two-year project will evaluate the performance of this method when applied to power plant waste streams and aqueous discharges. The focus of the project will be to evaluate potential method biases and interferences associated with these matrices.	12/31/11	Technical Report

P59.005 PISCES Database (100807)

Key Research Question

Companies need to know the chemical characteristics of waste streams released from power plants to comply with environmental regulations, design pollution control devices, and estimate impacts. Companies also need to compare emissions from plants with different configurations to make decisions on plant construction and inform fuel purchasing decisions.

Approach

The Power Plant Integrated Systems Chemical Emissions Studies (PISCES) Database is a comprehensive, multimedia online database containing information on the concentration and fate of chemical substances in power plant process and discharge streams. All of the data entered into the PISCES Database are critically reviewed and quality ranked. This project provides easily accessible data of known quality that can be used for many purposes, including TRI reporting, permitting, design of environmental controls, and fate and transport evaluation. Continued addition of new data provides for an up-to-date and comprehensive set of data on solid, liquid, and gas process streams at power plants.

Impact

- Provides data to respond to regulatory requirements
- Informs pollution control design and fuel purchasing decisions for power plants

How to Apply Results

The PISCES database is web based and is available online 24 hours per day. The desired data can be retrieved and used by member company personnel (e.g., environmental affairs and plant design and operations personnel) for a variety of purposes, including meeting regulatory needs and designing or enhancing plant operations. EPRI provides specific information-access assistance to members if needed.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
PISCES Database: Work will continue on PISCES Database upgrades, data entry, and maintenance.	12/31/10	Software