75 Integrated Environmental Controls (Hg, SO2, NOx, and Particulate)

Program Overview

Program Description

This program develops technology and provides independent engineering evaluations and performance and cost assessments for systems that control hazardous air pollutants and acid gases. The focus is on Integrated Environmental Control (IEC) technologies that capture multiple pollutants, mercury, and other air toxics (e.g., arsenic and selenium), and sulfur dioxide (SO_2). The program helps plant operators optimize system design and operations and maintenance (O&M) practices, enhance compliance planning, reduce assessment and procurement costs, and improve instrumentation, controls, and training.

Industry Needs and Issues Addressed

- Credible information on current mercury emissions and control capabilities to help power generators inform EPA's re-visit of its mercury (Hg) regulations following the February 2008 court decision vacating the Clean Air Mercury Rule (CAMR)
- Demonstrated, robust, reliable, least-cost, and low balance-of-plant impact mercury (Hg) controls for all coals and air pollution controls
- Systems to provide ultra-high SO_2 removal or low- to medium-cost moderate SO_2 removal
- Independent, current information on costs and performance of emerging IEC

Impact

- Informed negotiations with suppliers and higher confidence planning by using independently determined data on performance and costs for controlling Hg and any other hazardous air pollutants (HAPS) being considered for control, NO_x, and SO_2
- Unknown, but potentially very large, savings if EPRI-supplied data on Hg and other HAPS emission control capabilities lead to prudent, cost-effective regulations
- Technology options (e.g., on-site activated carbon production)
- Avoided cost of overly conservative designs or lower risk of noncompliance
- Information about emerging IECs saves $10-20K needed to acquire data in-house

Key Accomplishments

- Real-world data on mercury control by sorbent injection and chemical addition for many fuels and pollution controls, including impacts
- Narrowing of parameter domain believed to affect Hg capture by SO_2 controls
- Commercialization of TOXECON, development testing of novel Hg controls
- Validated Hg chemistry models
- Education of regulators on control technology capabilities and status
- Database on emerging IECs, economic comparisons with conventional controls, EPRI-managed tests of leading processes

Current Year Objectives

- Methods to avoid Hg re-emissions from SO_2 scrubbers and keep gypsum free of Hg
  - Demonstration of novel, much-lower-cost mercury controls; e.g., on-site sorbent activation, fixed structures
  - Resolution of remaining issues, such as sorbents for medium-high SO_3 flue gas, agreed-upon sorbent specifications leading to predictable performance
  - Solutions to balance-of-plant impacts of Hg controls

- Preliminary designs for highly reliable, continuously very-low SO_2 emissions, based, in part, on actual experience with newly-installed SO_2 scrubbers
- Field tests of low-cost 50-70% SO_2 controls

Industry Involvement
- Estimated 2009 funding: $6.6M

Program Technical Lead
George Offen, 650-855-8942, goffen@epri.com

Summary of Projects

Project Number	Project Title	Value
P75.001	Multipollutant Technology Evaluations and Databases	Conduct engineering analyses of emerging IEC processes. Update IECCOST (which allows users to analyze IEC options). Develop test data on large pilot or early commercial installations.
P75.002	Mercury & Integrated Environmental Control Technology Development	Comprehensively characterize controlled mercury emissions by source category for CAMR re-visit. Conceptualize, develop, and demonstrate novel concepts. Evaluate emerging mercury control processes, and develop further, as warranted. Demonstrate techniques to avoid re-emissions in SO_2 scrubbers and drive captured mercury to desired discharge stream.
P75.003	FGD Selection & Operation for Optimized Multipollutant Control	Develop "lessons-learned" guidelines for selection, installation, and operation of new FGD designs. Determine long-term performance capability. Address issues as they arise. Demonstrate low-cost/ moderate SO_2 removal performance. Minimize heavy metal discharges from flue gas desulfurization (FGD). Demonstrate value of enhanced instrumentation and control (I&C) systems to monitor, diagnose, and optimize FGD operation.

Project Descriptions

P75.001 Multipollutant Technology Evaluations and Databases (052528)

Issue
Integrated environmental controls (IEC) promise lower costs than serial application of single pollutant controls. Developing the expertise to follow and evaluate all these new or upgraded versions of processes is expensive for individual power companies. A consolidated, up-to-date listing and assessment of these processes, complemented by an easy-to-use tool for comparing costs of control system options for given sites, greatly reduces these expenses and demands on scarce staff. Power companies also seek the benefits of EPRI staff innovations from its involvement with many technologies and in-depth knowledge of plant needs.

Description
EPRI continues to review the technical literature and gather intelligence from its members for announcements of new IEC processes. EPRI then collects information from the developers and users, summarizes the information, and shares it with its members via web postings. When processes show promise and have adequate process data, EPRI subjects them to engineering and economic analyses,

compares their costs to the best combination of single-pollutant controls, and documents its findings. Periodically, EPRI updates its IECCOST worksheet used to develop site-specific evaluations of multi-pollutant control options. Whenever possible, EPRI serves as an independent performance test manager for demonstrations of IEC processes. To benefit from other EPRI technologies or support novel concepts that have large potential payoffs but are too risky to attract normal financing, EPRI can develop and demonstrate processes, or provide support and direction to a developer.

Value

- Save up to $20K in avoided costs per process using EPRI evaluations in lieu of in-house studies. Also receive quick responses to questions raised by management or the public about new processes.
- Save 10%–25% in levelized cost by using IECs instead of single pollutant controls; possibly more with very simple EPRI processes in which moderate reductions are acceptable and large investments cannot be justified
- Quickly estimate the costs of various multi-pollutant control options using member's in-house staff.

How to Apply Results

Plant or corporate engineers can use the EPRI reports—including engineering and economic analyses and field test reports—to understand a new process when reporting to management, working with a developer, or doing a technology search for cost-effective multi-pollutant controls for a given plant. Engineers can keep abreast of ongoing developments through the quarterly advisor updates and can conduct their own, site-specific cost estimates of different control options using IECCOST, either directly or via a contractor.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Technical Evaluation of Emerging IEC Processes: Engineering and cost assessments of promising new processes (including EPRI-developed processes), updates of previously assessed processes where further developed. Nonproprietary results of emerging IEC process field tests with EPRI involvement (as invited). Updated web database of emerging IECs, including first-order technical assessment. Update of IECCOST, if promising new technologies are found and sufficiently developed.	12/31/2009	Technical Report
Coal Upgrading as a Component of an Environmental Compliance Strategy: Case Studies: Assuming 2008 Technology Innovation study shows value of coal upgrading for environmental compliance, conduct two to three case studies of representative or specific plants. Include fuel supply factors, environmental control savings, boiler impacts for plants meeting current/near-term emission limits, and future CO_2 limits.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Technical Evaluation of Emerging IEC Processes: Update of improved or new processes. Accompanying update of IECCOST, if promising new technologies are found and sufficiently developed or cost components change significantly.	2010	Technical Report
Technical Evaluation of Emerging IEC Processes: Update of improved or new processes. Accompanying update of IECCOST, if promising new technologies are found and sufficiently developed or cost components change significantly.	2011	Technical Report
Technical Evaluation of Emerging IEC Processes: Update of improved or new processes. Accompanying update of IECCOST, if promising new technologies are found and sufficiently developed or cost components change significantly.	2012	Technical Report

P75.002 Mercury & Integrated Environmental Control Technology Development (065775)

Issue

The February 2008 Court decision to vacate EPA's Clean Air Mercury Rule (CAMR) has created substantial uncertainty about mercury emission limits and compliance dates. EPA's rulemaking in response to the court decision needs credible data on realistic performance of mercury controls. At the same time, power producers in more than 20 states already must comply with very stringent emission limits and need cost-effective, reliable control technologies with limited or manageable balance-of-plant impacts. Further, EPA and environmental groups are discussing limits on other trace metals, especially arsenic and selenium, as well as metals that are fine particulate. At the same time, New Source Review (NSR) rules require that any controls added for mercury and other trace metals must avoid increases in other pollutants, such as fine particulate. To prepare for all these obligations with minimum cost and risk of performance issues, power producers need credible, comprehensive, experiential data on a wide range of controls for Hg and other trace metals.

Description

This project will add industry-wide emissions characterization to its ongoing effort to seek and demonstrate predictable, consistent, cost-effective mercury controls. The characterization work, coordinated with EPRI's PISCES program (Program 59), is aimed at providing EPA's re-visit of its mercury rules with sound, long-term data on the best currently implemented mercury controls. The control technology development and demonstration effort focuses on continuous achievement of high Hg capture levels on all units and fuels while reducing costs. For scrubbed units, the key issues are capturing purposefully oxidized Hg, reducing re-emissions, and preventing Hg adsorption by gypsum. Approaches include long-term field tests to understand the role of transients, and fuel changes on mercury behavior in scrubber liquor; sharper size segregation in the hydroclones to keep mercury out of the coarse gypsum fraction sold for use; and a continuing search for additives that reduce re-emissions and mercury sorption onto the gypsum. For unscrubbed units, R&D will address: (a) remaining data gaps (e.g., sorbent effectiveness in the presence of SO_3, when used at plants burning blends, or when used at plants with hot-side electrostatic precipitators [ESPs]); (b) achieving high Hg capture through sorbent injection without particulate emission increases; (c) identifying and mitigating balance-of-plant issues (e.g., halogen build-up in scrubbers); (d) seeking co-benefits for arsenic and selenium reduction; (e) addressing implementation issues (including injector lance design and sorbent specifications/QA); and (f) testing new approaches (e.g., on-site carbon production, novel sorbents, enhanced capture by unburned carbon in ash).

Value

- Only leveraged avenue for RD&D on mercury controls with DOE total withdrawal from this area.
- Credible, third-party data on best—but realistic—currently implemented mercury controls for industry use in discussing new, revised mercury regulations with federal and state air regulatory agencies and policymakers.
- Avoided capital and O&M costs for separate Hg controls at plants with SO_2 controls, even with 90% removal requirements.
- Assured ability to use FGD gypsum in wallboard manufacture and agriculture, with average savings of $10–$20/ton gypsum from avoided landfill costs and gypsum sales.
- Independent performance data to guide procurement of Hg controls in unscrubbed units.
- Availability of Hg controls at 25–50% the cost expected five years ago.
- Reduced risk of unknown issues in commercial applications.
- Options to sorbent injection for unscrubbed units, avoiding potential plant impacts, ESP upgrades, and loss of ash sales.
- Guidance on meeting plant mercury limits via combustion modifications in lieu of investing in post-combustion mercury controls.

How to Apply Results

Members can use project reports, technical updates at advisor meetings and webcasts, and communications with EPRI staff to learn about the capabilities and limitations of Hg controls available or being developed for their specific fuels and air pollution controls. This knowledge is useful externally and internally, because members can use project characterization data to inform policy makers and regulators about the actual state-of-the-technology in mercury and other HAPS controls. For compliance planning, members can use the project results to create a plan with a higher degree of confidence, develop procurement packages for Hg capture (internally or by guidance to an architect or engineer), evaluate new processes being introduced by developers, and select technologies and suppliers with reasonable risk.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Mercury Removal by SO2 Controls – Annual Status Report: Results from Lower Colorado River Authority (LCRA) Powder River Basin (PRB) full-scale oxidation catalyst ahead of FGD, field-tested model of Hg chemistry in FGD (to avoid re-emissions and isolate Hg in scrubber liquor); field results of model-driven or other approaches that provide continuous 90+% total Hg removal by SO_2 controls; identification of subcategories with different, technology-driven performance for consideration by EPA in rule-making.	12/31/2009	Technical Report
Mercury Removal for Non-scrubbed Power Plants – Annual Status Report: Compilation and analysis of numerous member/EPRI field tests on Hg capture by dry sorbents or unburned carbon in ash, including enhancement by boiler additives. Includes resolution of remaining issues and development/demonstration of novel approaches (e.g., on-site carbon production). Issues include validation of sorbent specifications developed in 2008; SO_3 impacts on sorbent performance; potential particulate emission increases; impact on ash sales; effects of halogen addition on corrosion, and FGD chemistry.	12/31/2009	Technical Report

Product Title & Description	Planned Completion Date	Product Type
Mercury Emissions from Controlled Coal-fired Boilers: State-of-Technology: Input to joint Program 49/Program 75 summary of sustainable mercury emissions by any boilers with commercially-applied mercury controls. Identification of generic categories with clearly differentiated performance.	12/31/2009	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Mercury Control Selection Guideline: Synthesis of results from wide range of field tests on leading controls with information on long-term performance, typical costs, and potential impacts and countermeasures for both scrubbed and unscrubbed units.	2010	Technical Report
Advanced Mercury Controls: Large pilot and field test results of technologies such as on-site sorbent production, MercScreen of technologies such as MerCap, and novel sorbents such as expanded carbon and on-site carbon production.	2011	Technical Report
O&M Guidelines for Mercury Control Systems: Guidelines on O&M practices to minimize cost and maximize continuous performance. Based on lessons-learned by early implementers. Expect interim report in 2009–2011.	2012	Technical Report

P75.003 FGD Selection & Operation for Optimized Multipollutant Control (052532)

Issue

An estimated 180 units, representing almost 100 GW of capacity, are committed or projected to install SO_2 controls by 2010 to comply with the Clean Air Interstate Rule (CAIR) and Clean Air Visibility Rule (CAVR)/Regional Haze Rule (RHR). Expertise in procuring and operating SO_2 controls has decreased in the United States, and the suppliers have developed new, more effective systems, some with very different designs. Power companies can benefit from assistance in preparing to procure new controls, determining what removal efficiencies and outlet emissions to specify, and operating them most cost-effectively. With trading, power companies also need very low- to moderate-cost, moderate-removal SO_2 controls for plants that cannot justify a high capital expense retrofit. Further, as water becomes scarcer, SO_2 control operators need strategies for minimizing water consumption.

Description

This project will identify, develop, and demonstrate opportunities to optimize SO_2 removal at existing scrubbers and in new designs; try to anticipate and address issues with new designs, especially when applied to U.S. coals and boiler operation; assist early-adopter members as they experience such issues; investigate changes to the new designs that would improve multi-pollutant capture without creating a water discharge or gypsum use concern; seek strategies to reduce water consumption; and identify and demonstrate very low-cost, moderate SO_2 removal systems, including integration with particulate control.

Value

- Avoid power replacement costs due to scrubber trips, which can be very large
- Minimize personnel costs for responses to trips
- Earn revenue or savings worth hundreds of thousands of dollars per year in allowance credits, or tens of millions of dollars in avoided equipment costs, by optimizing SO_2 control
- Extend the commercial viability of smaller, older plants with very low-cost, moderate-removal SO_2 controls

How to Apply Results

Reported results can be used to ensure procurement specifications for new SO_2 controls include all necessary parameters and request performance levels most advantageous to the member. Operators of existing units can use FGDexpert and the lessons-learned reports to implement procedures that maximize system performance for very high availability. Planners/engineers can use the reports to determine the feasibility of implementing a very low-cost SO_2 control and to develop the specifications to include in a Request for Proposal/Request for Quotation (RFP/RFQ).

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Optimized FGD Design and Operation: State-of-the-Technology: Identification and early performance summaries of FGD systems with highest continuous SO_2 reductions; description and assessment of designs and operating practices producing these very low SO_2 emissions. Special focus on high-sulfur experience under U.S. constraints. Include chemistry control via advanced sensors and monitoring/optimization techniques, implications of low-chloride operation, and role of additives. Tech Watch for newer/improved designs.	12/31/2009	Technical Update
Multi-pollutant Capture by SO2 Controls: Tech Watch for technologies/chemistries developed for trace metal capture. Field tests of trace metal and fine particulate emissions data at different FGD designs and under varying operating conditions. Research of conditions that minimize emissions and sequester captured trace metals securely.	12/31/2009	Technical Update
Strategies to Reduce Water Consumption in Power Plants with Wet Scrubbers: Survey of best practices; analysis of trade-off between low water use (high chloride concentration) and high SO_2, Hg removal; completion of lab/pilot tests begun in 2008 on cyclic reheat in medium-high SO_3 flue gas, or on any other concepts initiated in 2008.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Performance of Very-low Capital Cost SO2 Controls: Field test data (obtained by EPRI or provided by members) from early applications, including circulating fluid bed adsorbers; possible field tests of advanced subprocesses, such as in-line sorbent grinding with/without deagglomeration; feasibility and economics of combined coal upgrading/deep cleaning and low-capital-cost technologies to achieve $\geq$ 70% SO_2 capture. Possible results at plant with low-cost ESP upgrade (with EPRI Program 76, Particulate and Opacity Control)	2010	Technical Report
Performance of Advanced SO2 Controls Including Multi-pollutant Capabilities: Annual or biannual updates on lessons learned and emission results, especially with medium- to high-sulfur coal and very high SO_2 capture. Will include any improvements or new designs offered by suppliers.	2011	Technical Report
Strategies to Reduce Water Consumption by SO2 Controls: Field experience with water minimization strategies, including impact on SO_2 capture, FGD O&M (e.g., scaling and corrosion), gypsum quality or pond behavior, and actual water reduction achieved. Quantification of benefits and costs, where possible.	2011	Technical Report
Advanced Sensors for Improved FGD Monitoring: Concept, design, operation experience, and benefit to FGD operation (including advanced warning of issues, consistency of gypsum quality, and minimization of limestone grinding energy) of sensors capable of continuously measuring scrubber liquor chemistry online.	2012	Technical Report