

Integrated Environmental Controls - Program 75

Program Overview

Program Description

Power generators need information and technologies to inform regulators and achieve emissions compliance, including credible information on current hazardous air pollutant (HAPS) emissions and control capabilities; 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 SO₂ removal or low- to medium-cost moderate SO₂ removal; and independent, current information on costs and performance of emerging integrated environmental controls (IECs).

The Electric Power Research Institute's (EPRI's) Integrated Environmental Controls program (Program 75) develops technology and provides independent engineering evaluations and performance and cost assessments for systems that control HAPS and acid gases.

Research Value

The R&D focus is on technologies that capture multiple pollutants (IECs), specific controls for Hg and other air toxics (e.g., arsenic and selenium), and new options for sulfur dioxide (SO₂). Members benefit through:

- Informed negotiations with suppliers and higher-confidence planning by using independently determined data on performance and costs for controlling Hg and other HAPS
- Lower-cost technology options (e.g., on-site activated carbon production)
- Reduced balance-of-plant impacts from the implementation of mercury controls
- Savings if EPRI-supplied data on Hg and other HAPS emission control capabilities lead to science-based, cost-effective regulations that avoid the cost of overly conservative designs or lower the risk of noncompliance
- Information about emerging IECs, which saves \$10-20K compared to the cost to acquire the data in-house

Approach

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.

- R&D for multipollutant technology evaluations and databases conducts technical analyses of emerging IEC processes; updates IECCOST (which allows users to analyze IEC options for their specific sites); and obtains independent test data on large pilot or early commercial installations.
- Mercury and IEC technology development research comprehensively characterizes controlled mercury emissions by source category; conceptualizes, develops, and demonstrates novel concepts; evaluates emerging mercury control processes, and develops as warranted; and demonstrates techniques to avoid re-emissions in SO₂ scrubbers and drive captured mercury to desired discharge streams.
- Research involving flue gas desulfurization (FGD) selection and operation for optimized multipollutant control develops "lessons-learned" guidelines for selection, installation, and operation of new FGD designs; determines long-term performance capability; demonstrates low-cost/moderate SO₂ removal performance; minimizes heavy metal discharges from FGD; evaluates cost and performance of potential water-saving concepts; and demonstrates the value of enhanced instrumentation and control (I&C) systems to monitor, diagnose, and optimize FGD operation.

Accomplishments

EPRI's annual reports on mercury controls are recognized in the electricity industry as the authoritative source for credible, independent, up-to-date information on mercury controls.

- 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 SO₂ controls
- Successful implementation of TOXECON, demonstrating an option for high mercury and particulate removals with no impact on ash usability
- Demonstration of novel Hg controls that offer the potential for lower cost or plant impacts
- Control approaches and countermeasures to minimize the impact of mercury controls on ash and gypsum usability or on the difficulty of landfilling it
- Compliance planning assistance via validated models for predicting mercury emissions and control effectiveness
- Education of regulators on control technology capabilities and status
- EPRI's database on emerging IECs and its economic comparisons of IECs with conventional controls, which have helped power companies assess these options with minimal in-house effort and respond quickly to queries on their applicability

Current Year Activities

The program R&D for 2010 will focus on reducing the remaining uncertainties in mercury emissions and control capabilities, maximizing the ability of other pollutant controls to reduce HAPS (e.g., arsenic and selenium), reducing the costs of SO₂ controls, and lowering scrubber water use. Specific efforts will include:

- Methods to avoid Hg re-emissions from SO₂ scrubbers and keep gypsum free of Hg
- Demonstration of novel, much-lower-cost mercury controls: e.g., on-site sorbent activation, fixed structures (e.g., slow-moving carbon beds)
- Resolution of remaining issues, such as sorbents for medium-high SO₃ flue gas, agreed-upon sorbent specifications leading to predictable performance
- Solutions to balance-of-plant impacts of Hg controls
- Very high reliability, optimized wet SO₂ scrubber operation through improved instrumentation and controls
- Pilot tests of enabling technologies for water minimization in wet SO₂ controls

Estimated 2010 Program Funding

\$4.9M

Program Manager

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Summary of Projects

Project Number	Project Title	Description
P75.001	Multipollutant Technology Evaluations and Databases	This project seeks or develops and evaluates new IECs as they become known, or as significant improvements are announced or communicated to EPRI. For the most promising technologies, the project develops cost models.
P75.002	Mercury & Integrated Environmental Control Technology Development	This project finds or develops and demonstrates least-cost, lowest-impact emission controls for mercury and other HAPS for all fuels and criteria air pollution control systems.
P75.003	FGD Selection & Operation for Optimized Multipollutant Control	This project demonstrates performance of optimized scrubber systems for very low emissions of SO ₂ and other acid gases with high availability. For "shoulder" units, it demonstrates cost-effective moderate SO ₂ removal processes.

P75.001 Multipollutant Technology Evaluations and Databases (052528)

Key Research Question

Integrated environmental controls (IEC) promise lower costs than serial application of single-pollutant controls. Developing the expertise to follow and evaluate the many new or upgraded versions of processes being offered to power companies is expensive. 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.

Approach

EPRI continues to review the technical literature and gather intelligence from its members for announcements of new IEC processes. EPRI 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 for use by power companies to develop site-specific cost comparisons of multipollutant 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.

Impact

- 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 multipollutant 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 conducting a technology search for cost-effective multi-pollutant controls. 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.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Coal Upgrading as a Component of Environmental Compliance Strategy: Two to three case studies of benefits and costs of coal cleaning or upgrading to reduce multiple emissions, as alternatives to costly back-end pollution controls. Draws on multipollutant benefits of removing species such as pyrites.	12/31/10	Technical Update
Technical Evaluation of Emerging IEC Processes: Updated evaluations of new or improved processes (e.g., EnviroScrub, MAPS). Accompanying update of IECCOST, if promising new technologies are found and sufficiently developed or cost components change significantly.	12/31/10	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Technical Evaluation of Emerging IEC Processes: Updated evaluations of new or improved processes. Accompanying update of IECCOST, if promising new technologies are found and sufficiently developed or cost components change significantly.	12/31/11	Technical Report
Coal Upgrading for Environmental Compliance -- Field Demo: Report on emission measurements and balance-of-plant impacts during test burn in a commercial boiler of coal specifically upgraded to reduce release of multiple pollutants (NO _x , SO ₂ , SO ₃ , and Hg) without using postcombustion controls.	12/31/11	Technical Report
Technical Evaluation of Emerging IEC Processes: Updated evaluations of new or improved processes. Accompanying update of IECCOST, if promising new technologies are found and sufficiently developed or cost components change significantly.	12/31/12	Technical Report

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

Key Research Question

In early 2009, the new EPA Administrator announced that EPA would develop Maximum Achievable Control Technology (MACT) standards for electricity generation units (EGUs) and that these standards will place limits not only on mercury (Hg) but also on other hazardous air pollutants (HAPS) — trace metals, acid gases, and organics. By providing EPA with credible data on realistic performance of mercury controls and the effectiveness of mercury and criteria pollutant controls to limit emissions of the other potentially-regulated species, the industry is able to promote the development of science-based regulations.

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. As they seek ways to comply with both existing and projected emission limits, power producers

also need to avoid the delays and costs of New Source Review (NSR). To meet both goals, they need technologies that enable them to demonstrably control the regulated species without increasing other pollutants (especially particulates). And 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 HAPS.

Approach

The core of this project remains the development and demonstration of robust, high-performance, cost-effective mercury emission controls for all fuels and air pollution control configurations. A new thrust, initiated in 2008-2009 and continuing through the next several years, is to assess the ability of these controls to also reduce the emissions of other pollutants that could be regulated under a MACT rule, including the removal of the acid gases hydrochloric/hydrofluoric (HCl/HF) by dry or semidry SO₂/SO₃ controls. In parallel, to provide EPA with the data that it needs to set science-based standards, the project will continue the initiative started in 2009 to obtain industrywide emissions data from plants that have recently installed mercury controls and may serve as the data set used by EPA to set emission limits. These characterization efforts will address all HAPS that may be regulated and will be coordinated with EPRI's PISCES program (Program 59). 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, preventing Hg adsorption by gypsum, and avoiding levels of regulated species in the water discharge that exceed permit levels. 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
- Continuing search for, and testing of, additives that reduce re-emissions and mercury sorption onto the gypsum.

For unscrubbed units, R&D will address:

- Remaining data gaps (e.g., sorbent effectiveness in the presence of SO₃, when used at plants burning blends, or when used at plants with hot-side electrostatic precipitators [ESPs])
- Achieving high Hg capture by sorbent injection without increasing particulate emissions
- Minimizing sorbent use
- Identifying and mitigating balance-of-plant issues (e.g., halogen buildup in scrubbers, loss of ash sales)
- Seeking co-benefits for SO₃, acid gases, arsenic and selenium reduction
- Testing new approaches (e.g., on-site carbon production, novel sorbents, enhanced capture by unburned carbon in ash).

Impact

This project provides both (a) information that industry can use with policymakers and regulators to guide the development of emission rules, and (b) HAPS emission control technologies that are lower cost, more widely applicable, and have less impact than current technologies. With DOE's withdrawal from this area, EPRI now provides the only avenue for developing, validating, and improving emission controls for mercury and other HAPS. Specific benefits to be realized from this project include:

- Availability of Hg controls at 25–50% the cost expected five years ago.
- Credible, third-party data on best, 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 SO₂ controls, even with 90% removal requirements.

- Reduced balance-of-plant impacts due to mercury controls, such as increased particulate emissions, reduced bag life or increased pressure drop across baghouses, corrosion (especially due to bromide addition), loss of ash sales, and discharge to the FGD water treatment system of difficult-to-remove species.
- 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 least-cost, least-impact Hg controls in unscrubbed units — sorbent injection or otherwise.
- Reduced risk of unknown issues in commercial applications.

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 and other HAPS controls available or being developed for their specific fuels and air pollution controls. This knowledge is useful externally and internally, because it can be deployed to inform policymakers and regulators about the actual state-of-the-technology in mercury/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/HAPS capture; evaluate new processes being introduced by developers; and select technologies and suppliers with reasonable risk.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Mercury and other HAPS Emissions from Coal-fired Boilers with Current Generation Controls: State of Technology: Assembly and synthesis of field test data from controlled boilers for use by EPA in developing the next round of mercury/HAPS emission regulations. Focus on sustainable emission levels at units using commercial controls. Analysis of data to understand differentiation by fuel or criteria air pollution control system. Joint effort with PISCES Program (P59) in Environment Sector.	12/31/10	Technical Update
Surrogates for Demonstrating HAPS Emission Rates: Laboratory, field tests, or computer modeling of the relationship between key trace metals (e.g., As, Se, Cd, Cr), acid gases (HCl, HF), and organics and potential surrogates for each of these classes of HAPS. Search for reasonable, acceptable surrogates to avoid need for individual species monitoring.	12/31/10	Technical Update
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. Traditional annual reports on year's R&D on control processes for scrubbed and unscrubbed units will be appendices to this guideline	12/31/10	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Advanced Mercury Controls: Large pilot and field test results of technologies such as on-site sorbent production, MercScreen, PMscreen (to avoid particulate emission increases with sorbent injection), novel sorbents (designed to reduce consumption or impacts on ash use, or to tolerate SO ₃), FGD additives to avoid re-emissions and keep mercury out of gypsum, and processes or approaches that provide co-benefit capture of other HAPS.	12/31/11	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 2010.	12/31/12	Technical Report
Mercury Control Selection Guideline Update: Update of 2010 report based on additional development/demonstration and commercial experience.	12/31/12	Technical Report

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

Key Research Question

As the EPA considers its response to the court-remanded Clean Air Interstate Rule (CAIR), policy observers indicate that the final rules are likely to be stricter and applied to more units than was CAIR. At the same time, the probable inclusion of limits on the acid gases that are considered to be HAPS (notably hydrogen chloride and hydrogen fluoride [HCl and HF]) under a Maximum Achievable Control Technology (MACT) rule places more demands on the scrubber. Combined with the driver for lower SO₂ limits under the Clean Air Visibility Rule (CAVR)/Regional Haze Rule (RHR), these regulatory thrusts will make it imperative that power companies procure highly effective SO₂ controls and operate them at high availability.

Longer-term, the industry should prepare itself to provide ultra-low SO₂ concentrations in the flue gas provided to a post-combustion CO₂ capture system. As SO₂/acid gas controls are pushed to their performance limits, they require greater attention and expertise to procure and operate. Power companies can benefit from assistance in procuring new controls (especially the new designs being offered by suppliers and just now beginning to operate commercially in the United States and other locations worldwide), determining what removal efficiencies and outlet emissions to specify, and operating them most cost-effectively. On the expectation that future SO₂ emission rules will allow trading or intermediate-level reductions on smaller emitters, power companies also need very low- to moderate-cost, moderate-removal SO₂ controls for plants that cannot justify a high-capital expense retrofit. Further, as available water resources diminish, SO₂ control operators need strategies for minimizing water consumption.

Approach

This project will identify, develop, and demonstrate opportunities to optimize SO₂ 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 multipollutant capture without creating a water discharge or gypsum use concern; seek strategies to reduce water consumption; and identify and demonstrate very low-cost, moderate SO₂ removal systems, including integration with particulate control. Specific R&D topics may include:

- Advanced sensors/instrumentation (e.g., use of the EPRI-developed On-Line Chemistry Monitor in an expert system)
- Performance-boosting additives

- Tradeoff between material cost savings with low chloride operation and increased water consumption/poorer mercury retention
- Approach to Near-Zero Emission (NZE) levels achieved in practice by the combination of a wet FGD followed by a wet ESP and simple/compact/dry polishing systems.

Impact

- Avoid power replacement costs due to scrubber trips, which can be very large
- Minimize personnel costs for responses to trips
- Realize potential savings of tens of millions of dollars in reduced equipment costs, by optimizing SO₂ control (plantwide bubbling, allowances under a state cap available for new capacity)
- Meet multipollutant emission limits with minimal additional capital equipment
- Extend the commercial viability of smaller, older plants with very low-cost, moderate-removal SO₂ controls

How to Apply Results

Results can be used to ensure that procurement specifications for new SO₂ controls include all necessary parameters and request performance levels most advantageous to the member, including reductions in other acid gases. 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 SO₂ control and to develop the specifications to include in a Request for Proposal/Request for Quotation (RFP/RFQ).

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Optimized FGD Design and Operation: State of Technology Update: Multi-year performance summaries of early installations, with focus on high SO ₂ capture units, preferably treating high-sulfur coal flue gas, and, where data are available, on removals of other acid gases. Seeks to include an assessment of benefits of advanced sensors or additives.	12/31/10	Technical Update
Strategies to Reduce Water Consumption in Power Plants with Wet Scrubbers: Survey of best practices and engineering analysis of options. Includes preliminary results from pilot or field tests on strategies such as cyclic reheat, water recovery from post-FGD flue gas, and novel blowdown treatment.	12/31/10	Technical Update
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 milling with/without deagglomeration; and feasibility and economics of combined coal upgrading/deep cleaning and low-capital-cost technologies to achieve ≥ 70% SO ₂ capture. It could also include results at plant with low-cost ESP upgrade (with EPRI Program 76, Particulate and Opacity Control).	06/30/10	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Performance of Advanced SO₂ Controls Including Multi-pollutant Capabilities: Annual updates on lessons learned and emission results, especially with medium- to high-sulfur coal and very high SO ₂ capture. Will include reports on any improvements or new designs offered by suppliers.	12/31/11	Technical Update
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.	12/31/11	Technical Update
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.	12/31/12	Technical Report
Performance of Advanced SO₂ Controls Including Multi-pollutant Capabilities: Annual updates on lessons learned and emission results, especially with medium- to high-sulfur coal and very high SO ₂ capture. Will include reports on any improvements or new designs offered by suppliers.	12/31/12	Technical Update
Performance of Advanced SO₂ Controls Including Multi-pollutant Capabilities: Annual updates on lessons learned and emission results, especially with medium- to high-sulfur coal and very high SO ₂ capture. Will include reports on any improvements or new designs offered by suppliers.	12/31/13	Technical Update
Strategies to Reduce Water Consumption by SO₂ Controls: Final report on 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.	12/31/13	Technical Report