56 Effluent Guidelines and Water Quality Management

Program Overview

Program Description
This program delivers credible data to characterize power plant wastewaters and inform the regulatory debate on the U.S. Environmental Protection Agency's (EPA's) potential revisions to the effluent guidelines for the steam electric industry. The program also develops sound guidelines for effective management of ash ponds, provides innovative technologies for wastewater treatment to remove chemicals such as trace metals, and develops practical tools for biofouling control using nontoxic alternatives to oxidizing biocides such as chlorine. Its products help facility owners develop effective compliance strategies.

Industry Needs and Issues Addressed
- Reliable data to support the industry in negotiating science-based regulatory guidelines
- Cost-effective, reliable wastewater treatment options for trace metals and nutrients
- Data to characterize the fate of trace elements in power plant wastewater streams
- Accurate analytical methods to characterize total and speciated trace element concentrations in power plant wastewaters
- Tools to optimize ash pond management of total suspended solids (TSS), pH, ammonium, and trace metals
- Alternatives to chlorine for biofouling control

Impact
- Data and information to assist the industry and EPA in EPA's determination of the need for effluent guidelines revisions
- Cost-effective wastewater treatment systems with the potential to save O&M costs
- Strategies to ensure compliance with existing or revised permits
- Optimized ash pond management techniques that can avoid the need for costly chemical/physical wastewater treatment, which may cost tens of millions of dollars at individual power plant sites

Key Accomplishments
- Characterization data and predictive tools for estimating trace metals in ash pond wastewater
- Screening data identifying flue gas desulfurization (FGD) wastewater constituents of interest
- Guidelines for optimizing ash pond management of TSS and pH
- Design guidelines for passive treatment technologies for traditional wastewater constituents and some trace metals
- Surveys of promising chemical precipitation adsorption technologies for power plant wastewater treatment

Current Year Objectives
- Characterize power plant wastewater, evaluate the impact of FGD on wastewater quality, and develop FGD water management options
- Assess and demonstrate promising technologies that cost-effectively remove trace metals from power plant wastewaters
- Optimize ash pond management for removal of solids as well as trace metals and nutrients
- Evaluate design considerations and implementation issues for conversion of ash handling systems from a wet basis to a dry basis
- Evaluate alternatives to chlorine for micro- and macrofouling control

Industry Involvement
- Estimated 2009 funding: $1.6M

Program Technical Lead
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Summary of Projects

Project Number	Project Title	Value
P56.001	Wastewater Toxics Characterization	Data and analytical methods to evaluate and characterize the impact of FGD technologies and other air pollution controls on wastewater
P56.002	Effluent Treatment Technology	Evaluation of promising wastewater treatment options and development (if necessary) of cost-effective technologies for trace metals
P56.003	Passive Treatment of Aqueous Discharges	Alternative, lower-O&M-cost treatment options to traditional chemical precipitation and adsorption technologies
P56.004	Integrated Management of Ash Ponds	Optimization of ash pond management of TSS, pH, ammonium, and other trace metals
P56.005	Ash Handling	Identification and evaluation of O&M issues and cost considerations for alternates to wet ash handling
P56.006	Nonoxidizing Biocides for Biofouling Control	Environmentally friendly alternatives to chlorine for biofouling control

Project Descriptions

P56.001 Wastewater Toxics Characterization (101139)

Issue
EPA is in the process of determining whether to revise the effluent guidelines for the steam electric industry. Reliable data are needed to support the stakeholder community in providing EPA with the best information available to recommend and potentially propose science-based regulatory guidelines. Power plants are installing new air pollution control technologies (wet flue gas desulfurization [FGD] technologies, selective catalytic reduction [SCR] technologies, mercury controls), as well as changing coal types, which may impact power plant wastewater characteristics. Facilities need accurate data to understand the impact of plant operational changes on wastewater, so that, if necessary, cost-effective wastewater management options can be implemented while complying with current permit limits and negotiating future permits.

Description
This project will characterize power plant wastewater and develop wastewater management options to cost-effectively meet current and future permit limits.
- Characterize total, dissolved, and speciated trace metals in FGD waters, as well as the partitioning of trace metals in FGD systems
- Evaluate the impact of FGD on wastewater discharge and develop water management options
- Clarify the chemistry of selenium oxidation in the wet FGD and optimize selenium wastewater management with sulfur dioxide treatment performance

- Evaluate and determine suitable sampling and analytical approaches for trace elements (including speciation for selenium and arsenic) in power plant matrices, including FGD waters
- Evaluate reuse of treated plant wastewater within the power plant

Value

- Provides credible, accurate data to inform the EPA effluent guidelines study
- Assists power plants with managing the impact of future air pollution controls (e.g., FGD, SCR, sulfur trioxide mitigation, mercury controls) and coal switching on wastewater
- Improves risk management and supports development of science-based regulations
- Provides data for permit negotiations by developing predictive estimates for trace substance concentrations in wastewater, as well as developing toxics management options that could reduce environmental discharges and potentially reduce operating costs

How to Apply Results

Project findings and deliverables will be used by power company staff in environmental affairs/compliance in responding to EPA's effluent guidelines study, so that stakeholders have sufficient high quality, accurate data. The project will also assist facilities in responding to permit negotiations with state and local agencies. The results will assist wastewater engineers and scientists in developing wastewater management options for new FGD systems, as well as in evaluating the potential impact of other power plant operations changes (e.g., coal changes). In addition, the Electric Power Research Institute (EPRI) will facilitate broader use and awareness of the results by holding periodic briefings for key stakeholders, including regulatory and other government agencies; developing materials for the trade press/media; and continuing service on various advisory panels.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Field Site Report(s): Water Toxics Characterization: These reports will summarize field measurements characterizing trace metals in power plant wastewater systems, including a description of the power plant and sampling/analytical methods employed. Results may include total, dissolved, and speciated characterization for mercury, selenium, arsenic, and other trace elements.	12/31/2009	Technical Update
Water Toxics Characterization Summary Report: This report will synthesize the available water toxics characterization data and provide an assessment of potential issues and wastewater management options for power plant wastewater streams.	12/31/2009	Technical Report
Selenium and Arsenic Speciation Measurement Evaluation: EPRI will evaluate the various selenium and arsenic speciation methods as appropriate. Additional characterization studies will be conducted as necessary, and all the results will be synthesized.	12/31/2009	Technical Update
Selenium Chemistry in Wet FGDs: Laboratory and field studies will be summarized to clarify the selenium chemistry in wet FGDs and evaluate practical management options for FGD wastewaters.	12/31/2009	Technical Update

Product Title & Description	Planned Completion Date	Product Type
Mercury in Acids and Caustics: Mercury concentrations in various commercial production-grade caustics and acids will be characterized and options for mercury pollution prevention presented.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Field Site Report(s): Water Toxics Characterization: These reports will summarize field measurements characterizing trace metals in power plant wastewater systems, including a description of the power plant and sampling/analytical methods employed.	2010	Technical Update
Water Toxics Characterization Summary Report: This report will synthesize the available water toxics characterization data and provide an assessment of potential issues and wastewater management options for power plant wastewater streams.	2010	Technical Report
Selenium/Arsenic Speciation Methods Evaluation: EPRI will evaluate the various selenium and arsenic speciation methods as appropriate. Additional characterization studies will be conducted, as necessary, and all the results synthesized.	2010	Technical Update

P56.002 Effluent Treatment Technology (052395)

Issue

Water discharge permits are becoming increasingly stringent, allowing for release of only very low concentrations of pollutants in plant effluents. This trend may accelerate through, for instance, revised effluent guidelines. As new air pollution controls (e.g., selective catalytic reduction systems, wet flue gas desulfurization [FGD] systems) are installed, their impact on wastewater may require cost-effective and reliable technologies to remove trace metals and other compounds (e.g., mercury, selenium, arsenic, boron, total suspended solids, and ammonia). Some states require low parts-per-trillion (ppt) mercury discharge levels, even though the commercially available technologies can achieve only parts-per-billion (ppb) performance levels. Limited EPRI data suggests that several forms of selenium may be present in FGD wastewater; the treatment implications are under investigation.

Description

This project will assess and demonstrate promising technologies that cost-effectively remove trace metals from power plant wastewaters. As necessary, EPRI will seek to develop technologies for those substances that may face regulatory scrutiny, such as mercury and selenium.

- Provide an informed, impartial third-party evaluation of commercially available wastewater treatment technologies
- Evaluate promising technologies to achieve low levels (parts per trillion) of mercury in effluents as well as technologies to cost-effectively remove all species of selenium (e.g., selenate)
- Develop design criteria for an integrated passive treatment system for treating ammoniated wastewater and trace metals, including mercury and selenium

- Evaluate the applicability and limitations of zero-liquid-discharge approaches
- Address future priorities such as boron, chloride, total suspended solids, ammonia, and other trace metals as the need arises

Value

- Evaluates and provides cost-effective, reliable, environmentally protective wastewater treatment approaches and options to achieve increasingly stringent trace metal, inorganic, and organic effluent limits
- Reduces O&M costs for wastewater treatment technologies
- Enhances compliance
- Maintains overall plant reliability

How to Apply Results

Project findings and deliverables will assist power plant water engineers and scientists in providing wastewater treatment options for new FGD systems, ash ponds, and other low-volume waste streams. Power plants can participate in hosting pilot- and full-scale evaluations of promising wastewater treatment technologies. The results will also be employed by corporate environmental staff in responding to EPA's effluent guidelines study. Information from this project will be communicated to regulatory agencies and other stakeholders at the state and federal levels through reports, information summaries, and briefings.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Mercury and Selenium Treatment Evaluation: EPRI will evaluate the treatment performance and limitations of various approaches for wastewater treatment of mercury and selenium, including precipitation and adsorption technologies. The results of the various field site evaluations will be synthesized and the performance of all the various promising approaches evaluated.	12/31/2009	Technical Report
Field Evaluation Site Report(s): These site reports will summarize site-specific treatment performance evaluations for mercury and selenium wastewater treatment technologies.	12/31/2009	Technical Update
Zero Liquid Discharge Evaluation: An engineering evaluation will summarize potential issues and limitations of zero-liquid-discharge approaches.	12/31/2009	Technical Update
Arsenic Treatment Evaluation: EPRI will evaluate the treatment performance and limitations of various commercial approaches for precipitation and adsorption of arsenic, as well as developing technologies such as hybrid-ion exchange technology.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Field Demonstration Report(s): Promising mercury/selenium wastewater treatment technologies will be evaluated in full-scale evaluation studies. A site report will be prepared for each power plant evaluation summarizing the sampling and analytical measurements, as well as operating and maintenance costs and issues.	2010	Technical Update
Literature/Vendor Wastewater Survey Update: Other Trace Elements: A survey of the literature and treatment vendors will be conducted to summarize potential treatment approaches for the trace elements of concern.	2010	Technical Update

P56.003 Passive Treatment of Aqueous Discharges (SP1756)

Issue
Water discharge permits are becoming increasingly stringent with the advent of water quality–based effluent limits that allow for the release of only very low concentrations of pollutants in plant effluents. As new air pollution controls (e.g., wet flue gas desulfurization [FGD] systems and selective catalytic reduction/selective noncatalytic reduction systems) are installed, their impact on wastewater may require cost-effective and reliable approaches to removing trace metals and other inorganics (e.g., mercury, selenium, arsenic, boron, total suspended solids, and ammonia). Power plants require a portfolio of options in addition to traditional chemical treatment approaches. Passive treatment systems offer a low cost, low maintenance alternative for meeting discharge limits.

Description
Passive treatment systems can be a cost-effective method for treating wastewater discharges. Currently, these systems are used to remove metals, providing significant savings compared with chemical-based approaches. Current research efforts focus on the evaluation of a vertical-flow wetland for selenium and mercury removal. These efforts also develop design criteria for an integrated passive treatment system that treats ammoniated wastewater and associated metals, including mercury, and employs a field-scale pilot passive treatment system. As part of this research, spiking of the passive treatment system with mercury, arsenic (III and V), and selenium (IV and VI) will be undertaken to support the development of the design criteria.

Value
- Provides design information on efficacy, costs, and operating parameters for passive treatment systems to enable cost-effective response to potential effluent limitations
- Lowers O&M costs because passive treatment systems, which use natural processes, are potentially more cost-effective than traditional treatment systems
- Enables design of robust systems that can treat wastewaters with varying concentrations of constituents without adjustments

How to Apply Results
The results of this project will allow water engineers and scientists to properly evaluate and design a passive system to treat ammoniated wastewater and associated metals. In addition, EPRI will facilitate broader use and awareness of the results and software via periodic workshops. Summary information about these passive approaches will be provided to external stakeholders as necessary so they are familiar with the technology and its advantages. Presentations and briefings will be provided as well.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Evaluation of Vertical-Flow Wetlands for the Treatment of Mercury and Selenium in Flue Gas Desulfurization Waste Water: Vertical-flow wetlands will be designed and built at one or more utilities to treat FGD wastewater. Influent and effluent water quality will be characterized, and the data will be used to improve wetland designs and support a revision of the design guidelines for passive treatment systems and the Treatment Planning Tool (PT2), Version 2.0.	12/31/2009	Technical Update
Design Guidelines for the Passive Treatment of Ammoniated Wastewater and Associated Metals: The design guidelines manual will assist users in the treatment of ammoniated wastewater and associated metals using passive-treatment-system technology. Results from the research will be used to support a revision of the design guidelines and the Treatment Planning Tool (PT2), Version 2.0.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Design Guideline for Passive Treatment Systems, and the Treatment Planning Tool (PT2), Version 2.0: This manual and software will provide guidance on designing passive treatment systems, including information on efficacy, cost, and operating parameters.	2010	Software
Implementation Workshop for Operators Planning To Use the Design Guidelines for Passive Treatment Systems, and the Treatment Planning Tool (PT2), Version 2.0.: A workshop for operators will be held to implement the design guidelines for passive treatment systems and the Treatment Planning Tool (PT2), Version 2.0.	2011	Workshop, Training, or Conference

P56.004 Integrated Management of Ash Ponds (055830)

Issue

Many power plants currently operate ash ponds primarily for solids settling to meet total-suspended-solids (TSS) limits. Water discharge permits have become increasingly stringent, allowing for the release of only very low concentrations of pollutants in plant effluents. As new air pollution controls (e.g., selective catalytic reduction [SCR]/selective noncatalytic reduction [SNCR] systems, flue gas desulfurization [FGD] systems) are installed, the ash pond may be impacted by ammonia (captured on the fly ash from SCR or SNCR slip) as well as metals (from the FGD wastewater). FGD wastewater may also impact the settling characteristics of TSS when the TSS is comanaged with the ash pond. In addition, power plants inject trona-, magnesium-, and calcium-based reagents for sulfur trioxide mitigation, and the associated ash product may impact the ash pond via pH swings and/or the transfer of volatile trace elements such as selenium captured from the flue gas.

Description

This project will evaluate and develop integrated approaches for comanaging various solids and solutes that occur in coal-ash settling pond water for the benefit of reducing discharge concentrations. This project also will optimize the ash pond for solids removal as well as trace metal and nutrient removal.

- Evaluate comanagement of FGD blowdown water with the ash pond and its impact on TSS and metals such as mercury and selenium
- Evaluate ways to permanently sequester solutes such as selenium and chromium in ash pond sediments
- Manage nutrient (nitrogen and phosphorus) species to avoid algal blooms that can increase total suspended solids and cause high pH
- Optimize ash pond designs (physical structure) to maximize the ability of operators to manage them as treatment facilities

Value

- Optimizes ash pond treatment of TSS, pH, ammonium, and trace metals to meet discharge compliance limits at least cost
- Optimizes FGD wastewater management costs with ash pond operation
- Reduces O&M costs
- Enhances compliance to achieve stringent trace metal and organic effluent limits

How to Apply Results

Project findings and deliverables will be employed by wastewater engineers and scientists in developing wastewater management options for ash pond management, as well as evaluating the potential impact of plant operations changes (e.g., coal changes, SCR and wet FGD additions). Periodic workshops will be used to facilitate broader use and awareness of EPRI results and provide forums for utilities to share experiences and results. Summary information about these passive approaches will be provided to external stakeholders as necessary so they are familiar with the technology and its advantages. Presentations and briefings will be provided as well.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Guidelines for Integrated Management of Multiple Constituents in Fly Ash Ponds, Vol. III: These guidelines will provide power plant operators with a tool to optimize ash pond management for TSS and other criteria pollutants, along with trace metals, pH, and nutrients.	12/31/2009	Technical Resource
Comanagement of FGD Wastewater in Ash Ponds: This report will provide guidelines to assist power plant operating staff to comanage FGD wastewaters with the ash pond while addressing impacts on the settling characteristics of TSS.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Guidelines for Integrated Management of Multiple Constituents in Fly Ash Ponds, Vol. IV: These guidelines will provide power plant operators with a tool to optimize ash pond management for TSS and other criteria pollutants, along with trace metals, pH, and nutrients.	2010	Technical Resource

P56.005 Ash Handling (067513)

Issue
Some power plants may be required to evaluate alternatives to wet ash handling as regulatory pressures on ash pond discharges and constraints on water use and consumption become more stringent in the future.

Description
This research will evaluate engineering design considerations and implementation issues for the conversion of wet ash handling systems to dry ash handling and semidry high-density slurry systems. The initial effort will consist of a survey of current alternative ash handling systems and issues with operation and maintenance.

Value
- Reduce capital and operating costs in managing and transporting fly ash
- Minimize operating and maintenance issues

How to Apply Results
Project findings and deliverables will be employed by water management staff in evaluating alternatives to dry ash handling. Results may assist in permit negotiations.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Case Study: Alternatives to Wet Ash Handling: This report will provide a summary of engineering considerations, potential operating and maintenance issues, and costs for a specific case study evaluating alternatives to wet ash handling, including dry ash handling and high-density slurries.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Power Plant Evaluation: Alternatives to Wet Ash Handling: This report will provide a summary of a full-scale retrofit of a wet ash handling system. An evaluation will be conducted to identify engineering design considerations, operating and maintenance issues, and costs for an alternative to wet ash handling.	2010	Technical Update

P56.006 Nonoxidizing Biocides for Biofouling Control (101136)

Issue

Biofouling is the undesirable accumulation of microorganisms, plants, and animals on heat transfer surfaces such as condenser tubes. Managing biofouling is critical, as such accumulation reduces the heat transfer rate and can lead to material corrosion. Biofouling also can lead to significant plant efficiency and availability problems unless it is controlled and managed. Chlorine is commonly used for biofouling control; however, chlorine use will likely become more limited in the future due to regulatory restrictions (e.g., revised effluent guidelines). Alternative approaches are needed that will allow plants to maintain or improve efficient operations with lower maintenance costs.

Description

This research will provide nontoxic alternatives to oxidizing biocides for biological fouling control (both micro- and macrofouling), aiming to provide environmental benefits while maintaining or improving facility thermal performance. Plant efficiency will become increasingly important in light of possible carbon dioxide emissions constraints.

Value

- Provides environmentally acceptable alternatives to chlorine for biofouling control
- Improves or maintains plant heat rates using environmentally acceptable options for controlling biofouling and also possibly reducing corrosion in cooling and service water systems

How to Apply Results

Project findings and deliverables will assist power plant water engineers and scientists in minimizing biofouling where chlorine use is restricted. Operating guidelines will assist water engineers and scientists in managing service and cooling water biofouling while maintaining plant efficiency and reliability. Power plants may participate in pilot- and full-scale evaluations of alternative biocide approaches.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Field Site Evaluation: These site reports will summarize the evaluation of pilot and field studies evaluating alternative biocides, including dosage and performance results.	12/31/2009	Technical Update