Effluent Guidelines and Water Quality Management - Program 56

Program Overview

Program Description

The U.S. Environmental Protection Agency (EPA) is required by the Clean Water Act Section 304(b) to periodically review and, if appropriate, revise effluent guidelines. EPA is currently evaluating the steam electric industry and is expected to make a decision as to whether to proceed with a rulemaking in 2010. This review process requires reliable data to inform science-based regulatory guidelines that properly characterize trace elements in power plant wastewater steams and to evaluate the overall performance and costs for wastewater treatment options for trace metals and nutrients. In addition, some states and regions (e.g., the Great Lakes) are considering low parts-per-trillion limits for mercury, while some power plants are unable to achieve selenium permit limits based on traditional iron coprecipitation.

The Electric Power Research Institute's (EPRI's) Effluent Guidelines and Water Quality Management program delivers credible data to characterize power plant wastewaters and inform the regulatory debate on EPA’s potential revisions to the effluent guidelines for the steam electric industry. The program also develops sound guidelines for effective management of ash pond chemistry and discharges, provides cost-effective and reliable options 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.

Research Value

Program products help facility owners develop effective effluent guideline compliance strategies. As water discharge permit limits for trace metals and nutrients tighten, power companies require accurate analytical methods, reliable data, and independent, unbiased treatment performance and cost data. In addition, new flue gas desulfurization (FGD) systems may require wastewater treatment for mercury and selenium. Key motivation for this research includes the following:

- Inaccurate analytical methods may lead to false permit violations.
- Inaccurate analytical methods may lead to increased capital and operating/maintenance costs for wastewater treatment, and higher likelihood of permit violations.
- EPA may develop effluent guideline standards without the best scientific data available.
- Plants may be unable to achieve permit limits in ash ponds, requiring additional water treatment.
- Limited options exist for nonoxidizing alternative to chlorine.

Approach

- EPRI is developing analytical methods to support characterization and monitoring, and is independently evaluating water treatment performance and costs. Program results are communicated through briefings for key stakeholders, including regulatory and other government agencies; reports; presentation materials; information summaries for public consumption; and service on various advisory panels. This program delivers industry-specific data and information that assists in determining the need for effluent guideline revisions;
- cost-effective, reliable wastewater treatment systems with the potential to save O&M costs;
- strategies to ensure compliance with existing or revised discharge permits; and
- 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.

Accomplishments

EPRI's effluent guidelines and water quality management program R&D will help inform EPA in its determination of whether to proceed with a full rulemaking on effluent guidelines. If EPA does proceed, the program's research will be relevant in terms of informing the Agency regarding potential discharge limits and

feasibility of treatment technologies. Program information has also been useful to power companies that install new FGD systems, negotiate new wastewater discharge permits, and plan water treatment and management options. Program accomplishments include:

- evaluation of promising technologies for FGD wastewater treatment of mercury and selenium, including physical/chemical precipitation/adsorption, passive treatment, and anaerobic biological reduction;
- design guidelines for passive treatment technologies for traditional wastewater constituents and some trace metals;
- screening data identifying FGD wastewater constituents of interest;
- laboratory evaluation of the selenium chemistry in wet FGD systems;
- characterization data and predictive tools for estimating trace metals in ash pond wastewater;
- guidelines for optimizing ash pond management of total suspended solids and pH; and
- full-scale evaluation of a nonoxidizing alternative to chlorine for macrofouling control.

Current Year Activities

Program R&D for 2010 will continue to focus on mercury and selenium water characterization and treatment evaluation and will also begin to include other constituents of interest (e.g., arsenic, boron, nutrients). This program's research related to water quality and treatment on ash ponds will be coordinated with Program 49, Coal Combustion Products – Environmental Issues. Specifically, the research will

- characterize power plant wastewater, evaluate the impact of FGD systems 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 for trace metals and nutrients;
- evaluate design considerations and implementation issues for conversion of ash handling systems from a wet basis to a dry basis, and evaluate pond management of low-volume wastewater streams without fly ash sluice water; and
- evaluate alternatives to chlorine for micro- and macrofouling control.

Estimated 2010 Program Funding

$2.0M

Program Manager

Paul Chu, 650-855-2812, pchu@epri.com

Summary of Projects

Project Number	Project Title	Description
P56.001	Wastewater Toxics Characterization	Trace metals (including mercury and selenium) and nutrients are characterized to understand how power plant operations impact trace metal fate and distribution in FGDs, ash ponds, and other wastewater streams. Accurate and reliable sampling and analytical methods are developed for these water matrices.
P56.002	Effluent Treatment Technology	The current evaluations focus on treatment approaches that are able to achieve low levels (parts per trillion) for mercury and to remove all forms of selenium (including selenate). Other trace metals (e.g. arsenic, boron) as well as nutrients will also be evaluated.
P56.003	Passive Treatment of Aqueous Discharges	Pilot- and full-scale evaluations of treatment performance are being conducted to develop guidelines and software to assist power plants in evaluating and designing cost-effective and reliable passive treatment systems.
P56.004	Integrated Management of Ash Ponds	Ash pond characterization and management studies are conducted to develop guidelines to assist power plants in the integrated management of ponds for wastewater treatment.
P56.005	Ash Handling	Survey of recent applications and evaluations of converting wet ash handling systems will provide a summary of industry experiences.
P56.006	Nonoxidizing Biocides for Biofouling Control	Pilot- and full-scale evaluations are being conducted at power plant waters to evaluate the efficacy of promising alternatives to chlorine.

P56.001 Wastewater Toxics Characterization (101139)

Key Research Question

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 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.

Approach

This project will characterize power plant wastewater streams and develop wastewater management options to cost-effectively meet current and future permit limits. Specific project activities will

- Characterize total, dissolved, and speciated trace metals (e.g. mercury, selenium) as well as nutrients in FGD waters and ash ponds, and evaluate 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 wet FGD systems 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) in power plant matrices, including FGD waters
- Evaluate reuse of treated plant wastewater within the power plant

Impact

- 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, 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 the public; and continuing service on various advisory panels.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
FGD Water Toxics Summary: This report will summarize the available data characterizing trace metals in power plant FGD wastewater systems and the impact of FGDs on wastewater discharges.	12/31/10	Technical Update
Evaluation of Selenium Chemistry in Wet FGDs: Laboratory studies will be conducted to evaluate the selenium chemistry in wet FGD systems and to develop approaches/additives to manage the selenium and its fate in FGD waters.	12/31/10	Technical Update
Power Plant Discharge Sampling and Analysis Guidelines: Expanding on earlier EPRI research, this report will provide updated guidance on sampling and analyzing aqueous streams from FGD systems, wastewater treatment plants, ash ponds, coal piles, and other sources of liquid discharge. Recommendations will be made for obtaining representative measurements of conventional (e.g., nitrogen, total suspended solids) and organic chemicals, in addition to trace metals.	12/31/10	Technical Report
Nutrients in Power Plant Wastewater: This report will summarize source and fate of nutrients in power plant wastewater, including the ash pond and FGD waters.	12/31/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Selenium Speciation in Power Plant Aqueous Discharges: Building on previous research on selenium speciation in FGD discharge, EPRI will evaluate the best practices for preserving and analyzing samples of FGD waters, ash pond discharge, and other media. A cross-laboratory comparison will focus on comparability between laboratories and identify factors contributing to interlaboratory variability.	12/31/11	Technical Update
Mercury in Acids and Caustics: Mercury (and other trace metals) may be a contaminant in various reagents, including sulfuric acid and caustics, which are often used in power plants for pH controls. This study seeks to characterize mercury in these reagents and to develop a mercury minimization approach.	12/31/11	Technical Update

P56.002 Effluent Treatment Technology (052395)

Key Research Question

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., SCR systems, 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 mercury discharge levels, even though the commercially available technologies can achieve only parts-per-billion performance levels. Limited EPRI data suggest that several forms of selenium may be present in FGD wastewater; the treatment implications are under investigation.

Approach

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, where commercially available technologies do not currently exist. This activity will

- 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

Impact

- 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.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Technology Evaluation Report(s): Promising mercury/selenium wastewater treatment technologies will be evaluated in pilot- and 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.	12/31/10	Technical Update
Mercury and Selenium Treatment Evaluation Summary: This summary report will synthesize the various EPRI studies and evaluate/compare treatment performance, potential limitations and uncertainties, and projected footprint requirements and capital and operating costs.	12/31/10	Technical Report
Arsenic Treatment Evaluation: EPRI will evaluate and compare commercially available arsenic treatment approaches for power plant wastewater applications.	12/31/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Boron Treatment Evaluation: This project will evaluate promising treatment approaches for boron in wastewater.	12/31/11	Technical Update
Zero-Liquid-Discharge Evaluation: This project will evaluate zero-liquid-discharge water management systems, providing a summary of operational experiences, guidelines, and capital and operating costs.	12/31/11	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.	12/31/11	Technical Update

P56.003 Passive Treatment of Aqueous Discharges (SP1756)

Key Research Question

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 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.

Approach

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.

Impact

- 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.

2010 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.	12/31/10	Software

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
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.	12/31/11	Workshop, Training, or Conference

P56.004 Integrated Management of Ash Ponds (055830)

Key Research Question

Ash ponds are under increasing scrutiny and water discharge permits have become increasingly stringent, allowing for the release of only very low concentrations of pollutants in plant effluents. Many power plants currently operate ash ponds primarily for solids settling to meet limits on total suspended solids (TSS). As new air pollution controls (e.g., selective catalytic reduction [SCR]/selective noncatalytic reduction [SNCR]

systems, FGD systems) are installed, the ash pond may be impacted by nutrients (e.g., ammonia captured on the fly ash from SCR or SNCR slip) as well as metals (from the FGD wastewater). In addition, power plants inject sodium-, 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. As power plants convert from wet ash handling to dry ash handling, pond management will shift to management of the various low-volume wastewater streams, without the fly ash sluice water.

Approach

This project will evaluate and develop integrated approaches for comanaging various solids and solutes that occur in ash pond water for the benefit of reducing discharge concentrations. This project will optimize the ash pond for solids removal as well as trace metal and nutrient removal. As power plants convert to dry ash handling, this project will optimize pond management of the remaining wastewater streams. Specific activities will

- Evaluate comanagement of FGD blowdown water with the ash pond and its impact on TSS and metals such as mercury and selenium
- Manage nutrient (nitrogen and phosphorus) species to avoid algal blooms that can increase TSS and cause high pH
- Optimize ash pond designs (physical structure) to maximize the ability of operators to manage them as treatment facilities
- Optimize pond management of the various low-volume wastewater streams, without fly ash sluice water

Impact

- Optimizes ash pond treatment of TSS, pH, nutrients, 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, including the public, so they are familiar with the technology and its advantages. Presentations and briefings will be provided as well.

2010 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.	12/31/10	Technical Resource

P56.005 Ash Handling (067513)

Key Research Question

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.

Approach

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.

Impact

- 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.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Power Plant Evaluation: Alternatives to Wet Ash Handling: This report will provide a summary of various full-scale retrofits of wet ash handling systems and will identify engineering design considerations, operating and maintenance issues, and costs for an alternative to wet ash handling.	12/31/10	Technical Update

P56.006 Nonoxidizing Biocides for Biofouling Control (101136)

Key Research Question

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.

Approach

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.

Impact

- 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.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Biofouling Field Evaluation Report: The results of the field evaluation will be summarized, as well as a description of the biofouling technology, the test program, and the sampling and analysis approach.	12/31/10	Technical Update