

53 Water Quality Criteria Development and Assessment

Program Overview

Program Description

This program advances science and technology to mitigate the risks associated with the presence of mercury, other metals, and organic compounds in aquatic environments. The program delivers credible information and analytical tools for incorporating site-specific conditions and new ecological science into regulatory and permitting processes. The program also improves the body of scientific information available for decisions on key regulatory issues such as mercury emission standards and drinking water standards. The scientific information can be used by resource agencies in place of assumptions to develop regulations and permit conditions addressing human health and aquatic toxicity.

Industry Needs and Issues Addressed

- Air emission controls are increasing loadings of metals and other compounds to aqueous waste streams at a time when discharge limits are becoming more stringent.
- Waste managers are challenged to manage new, more-complex waste streams while minimizing the associated management costs.
- Site-specific permitting methodologies and implementation guidance are needed for discharges containing metals and other potential toxics.
- Rigorous field data and more-comprehensive, risk-based modeling approaches are needed to address health and environmental risks of mercury, selenium, and arsenic in aquatic environments.

Impact

- A substantial volume of peer-reviewed literature, considered by government agencies when developing new regulations, is key to informing development of cost-effective and protective regulations and permits.
- Assistance to the U.S. Environmental Protection Agency (EPA) in developing new site-specific guidelines for selenium discharges provides for permit flexibility.
- Site-specific applications of program results have resulted in documented savings in compliance costs in the hundreds of thousands of dollars.

Key Accomplishments

- Technical briefings to the U.S. Congress and the White House inform policymakers on metals issues of importance to the industry, such as mercury.
- An authoritative method, the Dynamic Mercury Cycling Model (D-MCM), provides understanding of how mercury moves and behaves in lakes and other freshwater bodies.
- The Electric Power Research Institute's (EPRI's) mercury research plays a critical role in increasing understanding of the fate of mercury in the environment, helping address policy and regulatory issues.
- EPRI's Biotic Ligand Model (BLM) for copper has been accepted by EPA.

Current Year Objectives

- Upgrade EPRI's D-MCM to improve prediction of the environmental fate and transport of mercury
- Refine an EPRI-developed approach for generating site-specific selenium water quality criteria
- Improve the scientific basis for estimating arsenic health risk
- Determine the synergistic toxicity between metals and ammonia in discharged wastewater

Industry Involvement

- Estimated 2009 funding: \$1.2M

Program Technical Lead

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Summary of Projects

Project Number	Project Title	Value
P53.001	Arsenic Health Risk Estimates	A joint EPRI/EPA cancer risk assessment framework is expected to reduce critical uncertainties regarding arsenic's mode of action and toxicokinetics at low exposure levels. This research will apply new biological information to reduce uncertainties in the cancer health risk assessment for arsenic and will reduce reliance on conservative default assumptions in human health risk estimates.
P53.002	Ammoniated Wastewater Assessment	Because of the Clean Air Interstate Rule, many power plants are or will be installing selective catalytic reduction (SCR) equipment and scrubbers. There is uncertainty as to how these control technologies might affect wastewater quality and toxicity. The information developed in this project can be used to better inform utilities on the management of SCR and scrubber waste streams, especially if they are to be comanaged in fly ash basins.
P53.003	Aquatic Life Criteria: Site-Specific Metals Toxicity	This research builds on a critical assessment of the process by which EPA establishes national ambient aquatic life criteria. That assessment, undertaken with EPA, to develop improved, scientifically based methods included an evaluation of the 1985 EPA report, <i>Guidelines for Deriving National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses</i> .
P53.004	Dynamic Mercury Cycling Model (D-MCM)	The D-MCM will assist dischargers in addressing complex issues associated with mercury regulatory requirements. Research conducted now will enhance the applicability of the D-MCM to diverse aquatic ecosystems, ultimately providing a tool to predict ecosystem responses as a function of atmospheric mercury deposition rates.

Project Descriptions

P53.001 Arsenic Health Risk Estimates (SP0489)

Issue

The planned revision of the arsenic ambient water quality criterion will result in more-stringent limits if the current no-threshold linear default extrapolation for cancer risk is applied. This research will reduce reliance on default assumptions and uncertainties in the scientific basis for human health risk assessment for arsenic, leading to sounder regulatory decisions for wastewater discharges.

Description

Although recent scientific evidence suggests a nonlinear mode of action for arsenic, a comprehensive risk framework for these observations has yet to be developed. The principal objective of this project is to develop such a framework. Laboratory research to describe kinetics and develop models for arsenic's behavior in the body will be conducted. Laboratory studies also will measure the effect of different arsenic

exposure levels on important molecules and genes in animal and human cells. Field studies will measure and compare laboratory results with similar endpoints in exposed humans. Results will be integrated into a new, comprehensive, scientifically based cancer risk framework for arsenic that may then be applied to regulatory revisions for wastewater discharges.

Value

- EPRI works closely with EPA to develop a human cancer risk framework for arsenic that can accommodate nonlinearity in exposure response.
- Use of new data to develop this framework enhances dependence on science and reduces uncertainties in human health risk assessment for arsenic by reducing reliance on default assumptions in human health risk estimates.
- Program research leads to more scientifically sound regulatory decisions for wastewater discharges.

How to Apply Results

As credible, rigorous scientific results are released in the public domain, members should be proactive in sending key stakeholders the results, making sure that stakeholders understand those results, and suggesting that results be considered as environmental policies are developed. Members should also use this information to communicate with various public groups as necessary. In addition, EPRI will facilitate broader use and awareness of the results by briefing key stakeholders, including EPA 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
Effect of Arsenic on Mammalian Cells: A laboratory study will be conducted measuring the effect of arsenic on molecules and genes in cells across multiple doses and time points.	12/31/2009	Peer Literature

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Impact of Interindividual Variability in Response on Non-linear Risk Assessment Framework: Measured human-to-human differences in response to arsenic exposure will be assessed and incorporated into the new cancer risk assessment framework, in place of reliance on default assumptions concerning these differences.	2010	Peer Literature
Refine Risk Framework by Incorporation of Key Biological Interactions Data and Apply to Nonlinear Cancer Risk Estimate: The comprehensive nonlinear risk framework will be refined by incorporation of new data on arsenic's interactions with cellular components, and the refined framework will be applied to a nonlinear cancer risk estimate.	2011	Peer Literature

P53.002 Ammoniated Wastewater Assessment (057716)

Issue

Electric utilities are beginning to install selective catalytic reduction (SCR) and selective noncatalytic reduction (SNCR) units to reduce nitrogen oxides for control of ground-level ozone. In some cases, utilities are injecting ammonia to mitigate for sulfur trioxide. Each of these technologies releases ammonia, which may be conveyed to fly ash ponds or flue gas desulfurization (FGD) systems and landfills. Additionally, many utilities will be adding new controls for sulfur dioxide, which will add additional constituents to wastewater from these units.

Description

Anticipated increases in ammonia and metals in waste streams may lead to currently unknown synergies and subsequent elevated toxicity of discharges.

- Field studies to predict future changes in composition of waste streams and fly ash pond waters
- Laboratory studies to evaluate and predict synergistic toxicity of complex mixtures
- Laboratory and field studies to estimate potential of discharges for toxicity to current and future threatened species (e.g., freshwater mussels)

Value

- Improves the understanding of how air emission control technologies affect wastewater quality, thereby reducing risks and costs associated with discharge compliance requirements
- Identifies potential discharge impacts to aquatic life at an early stage so mitigation can be considered
- Avoids future treatment costs by identifying potential synergisms of ammonium and other constituents before they are actually mixed in waste streams (i.e., identifies necessary segregation and/or treatment of waste streams)

How to Apply Results

EPRI reports on the toxicity of ammoniated ash pond wastewaters will provide guidance for ash pond managers and staff responsible for regulatory compliance in determining whether there is a need to manage and treat separate waste streams prior to discharge. Laboratory studies to be conducted during 2009–2011 will provide benchmark data on whole effluent toxicity before new waste streams (primarily wet scrubber waste) become commingled with ash pond waters. These results will be crucial for planning future research that will be necessary for *a priori* evaluations of changes in ash pond discharges.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Whole Effluent Toxicity Testing of Ammoniated Ash Pond Waters: Whole effluent toxicity testing of ammoniated ash pond discharge waters will be undertaken to assess the potential toxicity of these discharges and to determine any interferences with the testing protocol, given the complex matrix to be tested.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Aquatic Toxicity of Total Dissolved Solids: Updated whole effluent toxicity testing will be performed on ash pond discharges to evaluate the potential toxicity of these discharges as new emissions control systems come on line.	2010	Technical Report
Site-Specific Criteria and Toxicity Testing: An updated guidance manual will be developed for developing site-specific criteria and whole effluent toxicity limits for FGD and ammonia influenced aqueous discharges.	2011	Technical Report

P53.003 Aquatic Life Criteria: Site-Specific Metals Toxicity (101916)

Issue

EPA develops national ambient water quality criteria, which are then implemented by the states. Utilities are subject to limits on metals and other substances in their discharge permits based on existing criteria and also on new criteria as those are developed and implemented. There is a need to develop improved scientifically based methods for the development of water quality criteria, for two purposes: to revise old water quality criteria using up-to-date information and methods, and, over the long term, to develop additional modeling approaches that describe more accurately the risk to aquatic life from the release of metals to surface waters. The Biotic Ligand Model (BLM) is such an approach. Use of the BLM will result in metal-related national ambient water quality criteria being implemented on site-specific bases, with the likely result of less-conservative permit limits.

Description

This research supports critical assessments of the process by which EPA establishes national ambient aquatic life criteria.

- Develop a kinetic-based toxicity model to account for site-specific differences in the magnitude and duration of exposure of target organisms to regulated substances
- Further enhance the BLM (now in the public domain through EPA)
- Update existing criteria with new information
- Update the existing manual for setting site-specific criteria for selenium

Value

- Reduction in compliance costs through rigorous, scientifically valid models for deriving site-specific water quality criteria
- Further compliance-cost reductions over the long term through addition of other metals to the BLM
- Assurance that up-to-date scientific knowledge (e.g., metals speciation) is considered in criteria development
- Excellent working relationship with EPA, which ensures that project results will be implemented

How to Apply Results

EPRI disseminates results to members and EPA through technical reports, peer-reviewed literature, workshops, and meetings. The project is an effort to improve the development of ambient aquatic life criteria at the national level over the long term, streamlining the process and reducing the costs of compliance. Members will also find project results useful in discussions with state water agencies.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Biotic Ligand Pulse Exposure Model: Addition of a pulse exposure model to the BLM, to take into account duration, frequency, and fluctuations in the concentration of metals in aquatic environments	12/31/2009	Software
Evaluation of Criteria Toxicity Databases for Flue Gas Desulfurization Constituents: Phase I of this project will be a literature review and analysis of toxicity databases and a survey of state criteria for constituents of concern in FGD wastewaters, to help guide Phase II laboratory toxicity research.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Workshop on Implementing the Biotic Ligand Pulsed Exposure Model: EPRI will hold a workshop for members and for EPA and state staff to explain and demonstrate the Biotic Ligand Pulsed Exposure Model for establishing site-specific permit limits.	2010	Workshop, Training, or Conference
Biotic Ligand Pulse Frailty Model: EPRI will evaluate the need for a frailty model subroutine or some other modification to the BLM to address the variability of individuals within a population in sensitivity to aqueous metals.	2011	Technical Report
Evaluation of Criteria Toxicity Databases for FGD Constituents: Phase II laboratory toxicity testing is contingent upon the results of the Phase I research for FGD wastewaters of concern, to assist utilities in addressing changing wastewater characteristics as new FGD systems are deployed.	2010	Technical Report
Site-Specific Human Health Mercury Criteria: EPA has developed a tissue-base criterion for mercury. This research will provide information on alternative site-specific mercury limits that could be developed using dynamic modeling or other methods to translate the tissue-based criterion to a permit limit	2011	Technical Report
Compilation of Bioaccumulation Models: This deliverable will comprise a compilation of bioaccumulation models, with information on the strengths and weaknesses of each model, settings in which each is appropriate, costs, and other characteristics.	2012	Technical Report

P53.004 Dynamic Mercury Cycling Model (D-MCM) (103348)

Issue

Anticipated mercury air emission controls will reduce mercury emissions and deposition. The degree to which controls will impact the environment and improve public health is still uncertain. To maximize the benefit of these controls, which will cost the industry billions of dollars in compliance costs, it is critical to have a detailed understanding of mercury cycling and be able to simulate its cycling with state-of-the-art models.

Description

The Dynamic Mercury Cycling Model (D-MCM) will assist dischargers in addressing complex issues associated with mercury regulatory requirements.

- Environmental mercury research to determine controls on mercury methylation, bioavailability, and food web transport
- Collaboration with EPA and the U.S. Geological Survey to develop long-term monitoring plans for mercury in U.S. watersheds
- Workshops for EPRI members to help them become proficient in using the D-MCM

Value

- Site-specific application of the D-MCM may help reduce compliance costs at individual facilities through an improved understanding of mercury dynamics in the new environment.
- Biogeochemical processes that convert inorganic mercury to its toxic form can be better managed.

How to Apply Results

Although discharges of mercury and methylmercury in aqueous waste streams from power plants are rarely regulated at present under National Pollutant Discharge Elimination System (NPDES) permits, in the future they likely will be regulated. The D-MCM will serve to predict fish responses to changes in discharge limits. The model, which eventually will be placed in the public domain via EPRI and government websites, can be used by utility personnel responsible for regulatory compliance to evaluate scenarios and develop discharge limits that are sufficiently protective of human health and aquatic life. The model also can be used by regulators, stakeholders, and academicians. The software will operate on modern PCs, and EPRI will hold workshops for its members. EPRI will provide product support only to EPRI members.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Controls on Fluxes of Mercury Into Aquatic Food Webs: Laboratory and field research conducted under the Mercury Experiment to Assess Atmospheric Loading in Canada and the United States (METAALICUS) project will continue, with emphasis on delineating sources and rates of mercury methylation in the experimental lake and the movement of mercury off of the upland areas surrounding the lake. As research results become available, they will be published in internationally recognized journals and used to update the D-MCM.	12/31/2009	Peer Literature
Dynamic Mercury Cycling Model Version 3.0 (D-MCM): The D-MCM has not been updated since 2002. This update, Version 3.0, will represent a major revision of the model to incorporate mercury research results funded by EPRI and others since then. The model will also be restructured so that it can address running waters and estuaries.	12/31/2009	Software

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Dynamic Mercury Cycling Model V3.0 (D-MCM): EPRI will hold a workshop for members and for EPA and state staff to explain and demonstrate the Dynamic Mercury Cycling Model V3.0 (D-MCM) for addressing mercury permit limits and Total Maximum Daily Load (TMDL) calculations.	2010	Workshop, Training, or Conference
Dynamic Mercury Cycling Model V3.1 (D-MCM): EPRI will hold a workshop for members and for EPA and state staff to explain and demonstrate the Dynamic Mercury Cycling Model V3.1 (D-MCM) for addressing mercury permit limits and TMDLs.	2012	Workshop, Training, or Conference
Dynamic Mercury Cycling Model V3.1 (D-MCM): This update will be Version 3.1 and will represent a mid-level revision of the model to incorporate mercury research results funded by EPRI and others since the completion of Version 3.0 in 2009. EPRI will provide information on how to link the model to air and watershed models.	2011	Software
Controls on Fluxes of Mercury Into Aquatic Food Webs: This deliverable will be the final report on laboratory and field research conducted under the METAALICUS project, with emphasis on delineating sources and rates of mercury methylation in the experimental lake and the movement of mercury off of the upland areas surrounding the lake.	2010	Technical Report
