

42 Air Toxics Health and Risk Assessment

Program Overview

Program Description

The Air Toxics program provides a comprehensive, stakeholder-oriented approach to technical and policy-related issues. It examines trace substances, including hazardous air pollutants (HAPs). The main efforts in this program currently focus on associated health impacts and potential risks of mercury, arsenic, and lead emissions. Additional work also is under way on substances of emerging concern, such as nickel, chromium, cadmium, and dioxins. The program conducts basic health science research to address cutting-edge questions on health effects and health risk assessment across multimedia (air, water, and land).

Industry Needs and Issues Addressed

- Reconsideration of EPA's Clean Air Mercury Rule (CAMR) will require a detailed examination of the implications for a potential MACT rule including source-receptor effects, health risks, and interactions between source mitigation and public health benefits for all hazardous air pollutants, as well as other rules that apply regarding residual risk and urban air toxics.
- Ongoing federal requirements for new information on toxics effects levels via all media and their potency above any threshold are leading to increasingly stringent ambient and source regulations. Scientific examination of the factual basis for proposed revised standards is required.
- The recognized stature of the Electric Power Research Institute (EPRI) as an unbiased research partner allows it to provide forward-looking insight into federal, state, and international regulatory considerations before they emerge.

Impact

- Recognized international expertise in HAP and multimedia toxicant transport, fate, and health impacts
- Results that inform federal rulemaking efforts on mercury regulation using the highest quality science
- Research that facilitates engagement on global technical issues with international governments
- Immediate, timely, and credible information to respond to stakeholder information needs
- Technical support to states in determining the impact of utility mercury controls in light of deposition improvements
- Demonstration of regional mercury changes to state agencies considering regulatory steps
- Groundbreaking integrative research examining regulatory consequences regarding deposition of and human exposure to mercury.
- Research that serves as a model for complementary analyses by others, all of which supports the goal of informed decisionmaking for mercury

Key Accomplishments

- Informed federal and state regulators and policymakers regarding mercury emissions, transport, deposition, health effects, and environmental cycling
- Developed library of communications materials interpreting key results, available to all stakeholders
- Provided the scientific basis for ongoing re-examination of the dose-response function (the cancer slope factor) for arsenic

Current Year Objectives

- Timely delivery of thorough, unbiased scientific information on mercury and other potentially hazardous air pollutants to decisionmakers during reconsideration of the Clean Air Mercury Rule
- More-precise quantification of source, source category, and geographic contributors to air and multimedia toxics exposure in the United States and internationally
- Clarification of health effects of toxicants, particularly arsenic and lead, at community levels by all exposure routes
- Integrative studies of source-to-fate-to-effects paths for particular toxicants of relevance
- Improved measurement methods for mercury concentration, source attribution, and exposure
- Refined utility source attribution information via improved knowledge of plume mercury chemistry reactions

Industry Involvement

- Estimated 2009 funding: \$2.6M

Program Technical Lead

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Summary of Projects

Project Number	Project Title	Value
P42.001	Mercury, Multimedia, and Air Toxics Exposure and Risk	Integrates new field and laboratory data for use in quantitative tools for assessing impacts of mercury and other trace substances on the environment and human health. Models alternative scenarios to assess changes in emissions fate and transport and evaluate impacts on human health under evolving emissions patterns.
P42.002	Health Effects of Trace Metals and Organics	Seeks continuing quantitative clarity on the severity of toxics health effects for all endpoints in humans. Mercury health effects requiring clarification include possible IQ impacts, adult cardiovascular effects, and immunodepressive reports. Arsenic health effects are strikingly different and require increased scrutiny at low doses common in U.S. residents, particularly for potential cancer impacts.
P42.003	Mercury and Multimedia Cycling and Fate	Gathers and integrates data from field and laboratory studies on chemistry and physics of toxics, source characteristics, and other basic processes. Findings are sought to clarify source-receptor relationships amid mixed near- and long-range scales of impact. Work proceeds via aircraft, remote mountain stations, and basic field and laboratory process investigations.
P42.004	Communications	Conducts internal and external scientific reviews to develop communication vehicles on emerging EPRI and external scientific research results. Integrates rapid-response interpretive papers, critical reviews, briefing documents, information packages, and decisionmaker testimony. Maintains coordination with responsible technical staff across EPRI and throughout the research community for in-depth review of new materials. Designs delivered products as technically balanced, factual presentations of current research findings, tailored for primary users. Includes longer-term communications such as research briefs, updated as required.

Project Descriptions

P42.001 Mercury, Multimedia, and Air Toxics Exposure and Risk (SP3395)

Issue

As federal and state governments revise mercury regulations, examination of environmental and public health benefits expected from lower mercury emissions will be required. New arsenic health effects information must be incorporated into integrated source-receptor and exposure assessments. To understand future conditions, improved atmospheric and multimedia modeling in close coordination with basic process research and new data results must be integrated. Utility changes due to the federal Clean Air Interstate Rule (CAIR) will impact emissions, but post-CAIR conditions will need evaluation to foresee if additional regulations will be forthcoming. A critical need is the evaluation of all sources of mercury, arsenic, and other substances, to amplify source-receptor relationship information.

Description

The project research focuses on modeling and integrative studies, bringing together data, calculations, analyses, and basic process work for a broader quantification of toxics exposure and risk. The work makes use of the EPRI whole-atmosphere AMSTERDAM model to run future scenarios and case studies for mercury and other air toxics utility scenarios. Interhemispheric transport studies use AMSTERDAM and the GEOS-Chem global air quality model. Integration of AMSTERDAM deposition results with multimedia models, such as EPRI's aquatic Mercury Cycling Model, will be undertaken as well. As required by stakeholders, finer-scale runs with alternative system and source scenarios will also be run. All of the information will enter the EPRI global database for interpretive studies and reporting of trends.

Value

- EPRI's research and analyses continue to provide cutting-edge results that are highly valued and requested by the scientific community, regulators, policymakers, and the public (including the media).
- Program research provides member and cooperating institutions with planning information for decisionmaking, resource management, and future operations planning.
- The research informs current planning for environmental monitoring of national mercury levels.
- Broadening the application of the EPRI family of air and multimedia models will allow integration with international modeling studies currently under way.

How to Apply Results

EPRI communicates research results to members on an ongoing basis, allowing for continual updates as research evolves in association with the broader scientific community. Once these results are released in the public domain (through peer-reviewed journals and technical reports), EPRI and member technical and communications staff should ensure that the results are widely communicated. Members should be proactive in sending key stakeholders the results, ensuring that stakeholders understand those results, and suggesting that results be incorporated into decisions related to public health outcomes. In addition, EPRI facilitates broader use and awareness of the results by briefing key stakeholders, including the U.S. Environmental Protection Agency (EPA) and other federal agencies; developing materials for specialty media; keeping EPRI's public web page current; and continuing EPRI staff service on national and international advisory panels.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Compliance Deposition and Exposure Patterns: Emerging revised mercury regulations for utilities and other sectors (e.g., municipal incinerators) will allow better resolution of changes to public health throughout the United States. Patterns of mercury and arsenic deposition and exposure can be predicted with increasing confidence. This deliverable will develop measures of change in community exposure as these patterns evolve and as international sources change over time.	12/31/2009	Peer Literature
Arsenic Multimedia Health Assessment: Increasing interest in arsenic deposition into drinking water supplies from sources of air emissions will be shaped by future levels and species of the substance. Improved information from EPRI and other health effects research on community risk at low doses is most critical for source attribution considerations, in light of emerging total maximum daily load (TMDL) studies by states and by federal agencies on mercury and potentially on arsenic. This assessment will update information on arsenic input currently and in the future as emissions are controlled under federal regulation.	12/31/2009	Peer Literature

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Arsenic Dose-Response Characteristics: As the work on arsenic's biological effects at low and medium doses continues, a more precise picture emerges of the consistency of the dose-response curve in the transition to low, community-relevant doses. The critical issue of slope change—that is, nonlinearity in the shape of the curve—has a direct impact on the calculated exposure dose and response in human exposures. This deliverable will integrate the in vivo and in vitro work carried out in previous years for an initial look at the dose-response results.	2010	Peer Literature

P42.002 Health Effects of Trace Metals and Organics (SP0357)

Issue

Potential exposure to trace metals and organics (such as dioxins) related to energy production is of critical importance to the electric power industry. This program's health effects research is charged with making basic scientific findings on all trace substances by all routes of plant emission and all routes of exposure. Health effects information on mercury, arsenic, and other trace substances is published in the open literature for maximum credibility and community impact. Communication and interpretation of results are used to inform decisionmaking on health risk assessment and to support science-based policy by reducing uncertainties. Such guidance permits informed selection of regulatory measures that remain protective of human health while defining cost-effective levels of emissions control.

Description

The primary focus of the health effects research is to address scientific uncertainties in biological health effects for trace metals and organics. When key scientific information is lacking, health risk assessments rely on conservative default assumptions to estimate human risk. Methylmercury health risk is associated

principally with prebirth neurological effects; issues remain regarding long-term neurological impacts as well as the balance between exposure to methylmercury versus the beneficial effects of fish consumption. Other studies designed to examine the reported associations with cardiovascular and other effects in adults and children are under way. Scientific uncertainties concerning the potency of arsenic effects at low exposures are being addressed in a comprehensive study conducted in cooperation with EPA scientists.

Value

- Provides results focused on the basic uncertainties and critical data gaps that have not been addressed by other institutional research programs. This information is critical to the exposure and risk assessments conducted in Program 42 as well as other EPRI programs in water and groundwater.
- Provides improved information to assess the validity and incidence of neurological, cardiovascular, and other health endpoints ascribed to mercury exposures.
- Reduces uncertainties in key assumptions for health risk assessments, leading to increased accuracy and less reliance on conservative default factors. More-accurate science can lead to reduced costs for compliance, with equal or improved protection of health and the environment.
- Applies cutting-edge science and technology, such as computational toxicology and genomic chips, to evaluate health effect results for arsenic.
- Supports research designed to set reasonable yet necessary public health limits by evaluating the factual basis for numerical health effects standards.

How to Apply Results

EPRI communicates research results to members on an ongoing basis, allowing for continual updates as research evolves in association with the broader scientific community. Once these results are released in the public domain (through peer-reviewed journals and technical reports), EPRI and member technical and communications staff should ensure that results are widely communicated. Members should be proactive in sending key stakeholders the results, ensuring that stakeholders understand those results, and suggesting that results be incorporated into decisions related to public health outcomes. In addition, EPRI facilitates broader use and awareness of the results by briefing key stakeholders, including EPA and other federal agencies; developing materials for specialty media; keeping EPRI's public web page current; and continuing EPRI staff service on national and international advisory panels.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Critical Review of Methylmercury Exposure and Cardiovascular Effects: A number of studies have investigated the role of lifetime methylmercury exposure on excess risk of cardiovascular health effects and coronary heart disease mortality. This review will investigate the weight of evidence for cardiovascular health effects and coronary heart diseases mortality across all relevant human-subject studies, and the effects of diet and other cofactors on mortality rates.	12/31/2009	Peer Literature

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<p>Evidence for Delayed Health Effects Following Early Life Exposure to Trace Metals: Scientific and regulatory interest in the identification of noncarcinogenic health effects associated with early life exposure to trace metals, including arsenic, mercury, lead, and cadmium, continues to increase both in the United States and internationally. However, the relative contribution of early life exposures to metals in the etiology of health concerns manifesting later in life, such as cardiovascular, immunologic, and neurological diseases, remains difficult to quantify. This deliverable will summarize the available toxicological and epidemiologic data available for attributing such delayed health outcomes to metal exposure.</p>	2009	Peer Literature

P42.003 Mercury and Multimedia Cycling and Fate (SP3396)

Issue

Accurate source attribution of contributions to U.S. mercury deposition is of major significance for operators of coal-fired utility boilers. Determining the relative contribution of emissions from all mercury sources, domestic or international, as well as utility power plants is a critical research area as regulations evolve. Increasingly, joint field and analysis efforts by institutions and governments will be instituted to monitor progress in controlling mercury deposition. Much of this effort will focus on emerging methods for controlling dry deposition. In addition, re-analyses of existing mercury observations are key to understanding measures of improvement in mercury deposition. Such knowledge about the relative importance of different source contributions, especially for power plants, will provide decisionmakers and policy analysts with crucial information and assistance in assessing how effective U.S. management steps will be in changing community levels of mercury, arsenic, and other critical toxicants.

Description

This project conducts fundamental experimental and field research on mercury and arsenic atmospheric and multimedia processes and cycling. Mercury studies include aircraft measurements, mountaintop observations of mercury plumes, field experiments on wet and dry deposition and throughfall, maintenance of mercury wet deposition monitoring stations, and design of observation networks. Field studies of mercury atmospheric processes are applied to improve the EPRI AMSTERDAM model, while studies of intermedia cycling are used to update integrative modeling. Much of the work involved is aimed at innovative methods for new observations, such as time trends in critical receptor systems and dry-deposition field methods.

Value

- Provides a data observation basis for a credible, complete, and rigorous depiction of mercury's environmental cycling and fate
- Provides research insight to clarify the role of local-versus-regional-versus-international transport scales, deposition contributions, and health effects
- Promotes new and innovative measurement techniques and research areas
- Improves the understanding of mercury chemistry in power plant plumes and in the atmosphere following stack release
- Quantifies and provides estimates for local and specific sources of arsenic and other substances

How to Apply Results

EPRI communicates research results to members on an ongoing basis, allowing for continual updates as research evolves in association with the broader scientific community. Once these results are released in

the public domain (through peer-reviewed journals and technical reports), EPRI and member technical and communications staff should ensure the results are widely communicated. Members should be proactive in sending key stakeholders the results, ensuring that stakeholders understand those results, and suggesting that results be incorporated into decisions related to public health outcomes. In addition, EPRI facilitates broader use and awareness of the results by briefing key stakeholders, including EPA and other federal agencies; developing materials for specialty media; keeping EPRI's public web page current; and continuing EPRI staff service on national and international advisory panels.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Interhemispheric Mercury Transport: Increased emphasis on sources of U.S. mercury deposition from distant upwind and global sources has resulted in an increase in field and aircraft research as well as international cooperative efforts. Consideration by the United Nations of international transport of mercury is being followed by studies of lead and cadmium. Findings from ground stations, mountain observatories, and aircraft experiments will be reported on and applied in model evaluation work, to further examine local-versus-regional-versus-interhemispheric contributors to U.S. deposition and U.S. contributions to deposition on other continents.	12/31/2009	Peer Literature
Mercury Inventory and Global Balance Reassessment: Understanding and knowledge of mercury's environmental cycling and fate continue to expand as new insights into existing and potential natural and anthropogenic sources increase. Each such finding requires reassessment of global cycling and of local and regional contributions.	12/31/2009	Peer Literature

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Mercury Chemistry in Power Plant Plumes: Additional field, laboratory, and theoretical studies are aimed at clarifying, quantifying, and explaining the increasing measurement evidence that divalent mercury in coal power plant plumes may rapidly reduce to the elemental form. This finding has major implications for the contribution of power plants to local and regional deposition. Potential parameterizations to accommodate the family of generating units and stacks will be derived for application to national modeling. Work on this project is starting in 2008 through a supplemental project.	2010	Peer Literature

P42.004 Communications (060355)

Issue

This project is home to the air toxics communications efforts—the numerous technical and background publications, issue briefs, interpretive documents, critical reviews, news items, and notices to members in air and multimedia toxics and related issues. The critical review work includes briefings to decisionmakers and stakeholders, research results presentations, and stakeholder webcasts. It is vitally important to continually initiate, update, and expand these products as research progresses and results are published in the technical literature by EPRI and other researchers. In addition, EPRI has the responsibility to clarify and amend results and interpretation of results announced by others, often issued rapidly and without

sufficient insight into the meaning of findings. The work here is viewed as “due diligence” by EPRI as part of its mission to inform society with unbiased, thorough, and wide-ranging research and research interpretations.

Description

EPRI staff and the scientific community are deeply involved in national and international research review, planning, and interpretation activities through professional societies, national agencies, the United Nations, and ad hoc research planning bodies. This work is supplemented by reviews of the scientific and popular literature continually carried out by staff and cooperating researchers. As these findings are brought to public attention, EPRI prepares both technical and popular issue briefs and research interpretation documents to allow better understanding of findings and their implications for public policy and environmental quality. Members are invited to transmit these products to the public, regulatory bodies, and other stakeholders.

Value

- Rapid and thorough peer-reviewed interpretations of new findings and applications in environmental research and management
- A spectrum of documents and communications to address a range of audience requirements, from the public to technical leaders
- Important critical reviews of research results, allowing reasoned, thoughtful input to public debates and queries from decisionmaking bodies
- Communication efforts that inform the national and regional debate on current and future regulatory initiatives related to mercury, arsenic, and other air toxics
- Credibility and objectivity that allow EPRI to work closely with regulators, policymakers, and the scientific community in sharing research results and conducting joint studies

How to Apply Results

EPRI communicates research results to members on an ongoing basis, allowing for continual updates as research evolves in association with the broader scientific community. Once these results are released in the public domain (through peer-reviewed journals and technical reports), EPRI and member technical and communications staff should ensure the results are widely communicated. Members should be proactive in sending key stakeholders the results, ensuring that stakeholders understand those results, and suggesting that results be incorporated into decisions related to public health outcomes. In addition, EPRI facilitates broader use and awareness of the results by briefing key stakeholders, including EPA and other federal agencies; developing materials for specialty media; keeping EPRI's public web page current; and continuing EPRI staff service on national and international advisory panels.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Updated Research Briefs: Each year, research briefs will be expanded and revised to incorporate new findings that emerge on mercury, arsenic, lead, dioxins, and other substances of interest. In addition, it will be necessary to expand the discussions of multimedia issues in the briefs; Program 42 is responsible for interpretation and review of multimedia findings across EPRI programs.	11/30/2009	Technical Update

Product Title & Description	Planned Completion Date	Product Type
Critical Reviews of Research Results: Twice yearly, the program will issue detailed summaries and interpretation of critical research results published in the open literature. These critical reviews will cover all aspects of air toxics health and risk assessment—sources and inventory, fate and transport, human exposure, risk assessment, biological processes, and multimedia cycling. These reviews will also include extended discussion of other developments in the field that are of interest to EPRI members and stakeholders.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Critical Air Toxics Reviews and Updates: In the extension of this work into future years, both critical reviews and research updates will broaden and expand to incorporate emerging issues in the air toxics field. These issues will include both technical updates on published research, and notice to members of emerging policy and decision milestones likely to impact research directions in the future.	2010	Technical Update
