

## Fish Protection at Steam Electric Power Plants - Program 54

### Program Overview

#### Program Description

A primary challenge for power plant owners is to ensure adequate water supplies for operations while protecting aquatic life living in the lakes, streams, and rivers those operations impact. The Clean Water Act §316(b) requires plant owners to install fish protection technologies on cooling water intake structures, and §316(a) requires management of thermal discharges into water resources.

The Electric Power Research Institute (EPRI) fish protection program assesses the effects of thermal power plant cooling system operation on fish and other aquatic life. Results support the development of effective intake and discharge protection approaches for workable operating permits at individual facilities. By improving the technical basis for regulatory, permitting, and operating decisions, this program serves the public interest in effective resource management while meeting an industrywide imperative to control costs, ensure or even exceed environmental compliance, and manage business risks.

#### Research Value

Technical information is submitted to the U.S. Environmental Protection Agency (EPA) to inform revisions to Clean Water Act §316(a) and (b) policies and regulations. Program results defray or avoid research costs that could range from hundreds of thousands to millions of dollars if funded independently. Program information reduces compliance costs, enhances permitting processes, and identifies cost-effective management strategies. The program also provides access to new and enhanced fish protection technologies, information on fish protection-related issues, and information on costs, economic, environmental and electric system impacts of a potential national requirement for a retrofit of closed-cycle cooling systems. The key motivations for this research are as follows:

- A national retrofit requirement for closed-cycle cooling could cost industry between \$50 billion and \$100 billion (between \$50 million and \$1 billion at the plant level) and could also have short-term impacts on grid reliability.
- Technologies for site-specific application of impingement and entrainment issues are being identified and developed.
- Industry can avoid duplicative costs of doing multiple pilot demonstration of technologies.
- The April 2009 U.S. Supreme Court decision supporting the use of cost-benefit analyses in §316(b) permitting requires that approaches and information for economic analyses be developed.

#### Approach

This program provides information, analytical tools, innovative mitigation technologies, and expert services to help environmental and power plant operators effectively manage water resources and protect aquatic communities in accordance with §316 of the Clean Water Act. The program also provides methods to support technology performance verification monitoring. The program delivers

- collaboration with other industry groups (Utility Water Act Group, National Rural Electric Cooperative Association, American Public Power Association, Edison Electric Institute), professional societies (American Fisheries Society, Ecological Society of America), and federal agencies (EPA, the U.S. Dept. of Energy);
- translation of complex scientific and engineering information into easy-to-understand, site-specific problem solving;
- credibility with resource agencies when addressing specific permit issues;
- biological sampling and fish health assessment information and protocols;

- fish protection technology (screen systems, vacuum pump systems, and behavioral deterrent systems) analysis and performance evaluations, including technology design, construction, O&M requirements, and costs; and
- thermal discharge risk analyses.

### Accomplishments

Program information supports current industry compliance efforts and informs EPA to support its revision of the Clean Water Act §316(b) Phase II regulation as well as updates to guidance on thermal discharge assessment variance procedures. The information provided to EPA is expected to support a regulatory structure that is supported by scientific and engineering information. Program accomplishments include

- information on performance of intake fish protection technologies for EPA consideration in identifying Best Technology Available (BTA) for new (Phase I) and existing (Phase II) power plants, as required under §316(b);
- impingement mortality and entrainment sampling information in support of §316(b) rulemaking;
- technical resource documents on fish protection technology performance and costs;
- technical information on the impacts and environmental and economic benefits of reducing impingement mortality and entrainment; and
- technical workshops and symposia for technical information and cost-effective technology transfer.

### Current Year Activities

Program R&D for 2010 will focus on developing and evaluating entrainment protection technologies, preparation of verification monitoring procedures, and development of information and tools to support industry's effort to comply with the revised §316(b) Phase II regulation.

- Evaluate the performance of intake fish protection technologies for reducing impingement mortality and entrainment
- Evaluate via video recording the interaction of early life stages of fish and shellfish with screen material and fish return system components under different water velocities to improve engineering design specifications
- Develop verification monitoring procedures for evaluating the performance of fish protection technologies
- Develop fish thermal tolerance data to support technically defensible thermal discharge permit criteria
- Transfer information and application services via workshops, conferences, and consultations with members
- Continue as necessary pending §316(b) regulatory status, the assessment of the cost, environmental, social, and economic impacts of a potential national retrofit of closed-cycle cooling (CCC) systems to plants with once-through cooling operation

### Estimated 2010 Program Funding

\$3.6M

### Program Manager

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## Summary of Projects

Project Number	Project Title	Description
P54.001	Environmental and Economic Effects of a Potential National Retrofit of Closed-Cycle Cooling Systems	This project provides EPA, the public, and industry with technical information on the economic and environmental consequences of a potential CCC systems retrofit on power plants with once-through cooling systems. This information will be provided to EPA via EPRI's technical comments on the draft Phase II Rule during the public comment period.
P54.002	Biological Sampling and Fish Health Assessment Research	Information on entrainment and entrainment survival sampling, mortality caused by the experimental sampling procedures, and benefit valuation.
P54.003	Fish Protection Technology Research	This research will conduct laboratory and field research, gather information, and develop summaries of information on fish technology performance, operation, and maintenance.
P54.004	Thermal Discharge Risk Analysis	The project expands scientific and technical knowledge on thermal discharge effects and means to cost-efficiently address issues related to thermal discharge permits, regulations, and policies.

### **P54.001 Environmental and Economic Effects of a Potential National Retrofit of Closed-Cycle Cooling Systems (067512)**

#### Key Research Question

Court action in 2007 remanded EPA's Phase II Rule under Clean Water Act §316(b) for a revised determination of Best Technology Available (BTA). Most importantly, the court required EPA to reevaluate closed-cycle cooling (CCC) as BTA. The court noted that EPA could consider in its reevaluation whether CCC costs could be reasonably borne by industry, what the potential impacts to energy production and efficiency might be, and any adverse environmental factors. In late 2007, EPA began its efforts to revise the Phase II Rule, and a draft for public review and comment is expected in late 2009 or early 2010. Up-to-date scientific and engineering information on the potential ramifications of a CCC systems retrofit is required to inform EPA's considerations and serve the public interest.

#### Approach

This project provides EPA, the public, and industry with technical information on the engineering, economic, and environmental consequences of a potential CCC systems retrofit on power plants with once-through cooling systems. This information will be provided to EPA via EPRI's technical comments on the draft Phase II Rule during the public comment period.

#### Impact

- EPRI research informs the EPA rulemaking process with credible engineering and scientific information.
- EPRI research provides critical information on the overall costs, benefits, and impacts of a potential national retrofit of CCC on all power plants with once-through cooling. Such a retrofit could cost the industry from \$50 billion to \$100 billion or more and could impact overall plant efficiency and electric system reliability. EPRI's research is providing documentation of these costs such that EPA can use it for effective decision making and the industry can plan accordingly if the retrofit alternative is pursued.
- EPRI research focuses on the engineering, scientific, and permitting issues that will need to be addressed should EPA specify CCC as BTA.

## How to Apply Results

Members can review EPRI's information on CCC to support their own preparation and submittal of comments on the draft Phase II Rule when it becomes available for public comment. Should EPA determine CCC as BTA, the engineering, scientific, and permitting information resulting from this project can support member planning of future compliance efforts.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p><b>EPRI Technical Comment on Future EPA §316(b) Phase II Rule Actions:</b>            This research includes assessment projects focused on retrofit costs, environmental and social impacts, and energy efficiency impacts from a potential retrofit of CCC systems. The scope of this effort is dependent upon a number of future actions with unpredictable outcomes, including the U.S. Supreme Court's review of the 2007 Second Circuit Court decision on the initial Phase II Rule and the scope of EPA's revised draft Phase II Rule.</p>	12/31/10	Technical Update

## P54.002 Biological Sampling and Fish Health Assessment Research (100033)

### Key Research Question

Compliance with Clean Water Act §316 regulations requires sampling of fish and shellfish in the aquatic environment in the vicinity of cooling water intakes and discharges, as well as off of intake structures and within power plant cooling water systems. Water body type (e.g., reservoir, estuary, river), power plant cooling system configuration and operation, and intake fish protection technology all present site-specific challenges to collecting representative sample data. The health of impinged and entrained fish can also further compromise the interpretation of sample results and fish protection technology performance.

### Approach

Building on its past work in impingement, entrainment, and fish population and community sampling and assessments, EPRI will continue to improve and develop technical resources to support member compliance with the provisions of the §316(a) and (b) regulations. Most importantly, EPRI's research efforts will be directed at the development of information to support preparation of site-specific verification monitoring plans, including research on the numbers of and reasons for dead and moribund fish and on biological criteria for identification.

### Impact

- Supports strategic and cost-effective §316(a) and (b) compliance planning
- Provides credible technical information to EPA in its efforts to revise the scope of the §316(b) Phase II Rule in light of the Second Circuit Court's 2007 decision and the 2009 U.S. Supreme Court decision on the allowed use by EPA of cost-benefit analysis in §316(b) permitting
- Defrays or avoids research costs that could exceed half a million dollars or more if funded individually

## How to Apply Results

The information developed in this program will be used by power plant environmental affairs and compliance staff and by federal and state §316 permit writers when developing permit compliance and monitoring plans. Clients will read reports and disseminate information to community water resource stakeholders and government agencies. EPRI staff will provide company-specific compliance support through supplemental projects.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Verification Monitoring Technical Resource Document:</b> Interim procedures and technical information for verifying the performance of fish protection technologies will be included in this technical update.	12/31/10	Technical Update
<b>Health Assessment of Impinged Fish:</b> Final criteria for identifying dead and moribund fish, larvae, and eggs in impingement and entrainment samples; frequency of occurrence; and possible reasons for the condition will be presented in this final technical report.	12/31/10	Technical Report
<b>National Impingement Mortality and Entrainment Survey:</b> This report will summarize results of EPRI's national survey of impingement mortality and entrainment. Results will be tabulated by, for example, region, water body type, plant size, intake configuration, and species.	12/31/10	Technical Report
<b>Summary of Entrainment Survival Monitoring Data:</b> This report will be an update of EPRI's 2000 review of the subject (report 1000757). The report will document, by species and life stage, the extent to which entrainment survival occurs as well as the factors that influence survival. The report will also present a conceptual model that can be used to evaluate the relative benefits of different screen mesh sizes for protecting fish and shellfish.	12/31/10	Technical Report

## Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<b>Verification Monitoring Technical Resource Document:</b> Final procedures and technical information for verifying the performance of fish protection technologies will be included in this final report.	12/31/12	Technical Report

## P54.003 Fish Protection Technology Research (SP0473)

### Key Research Question

Identification of cost-effective fish protection technologies for installation at cooling water intake structures to control impingement and entrainment of fish and shellfish is a primary goal of industry in seeking to comply with Clean Water Act §316(b) Phase I and Phase II rules. This need is even more critical following a 2007 Second Circuit Court decision that voided other compliance options (e.g., restoration and cost-benefit analysis). EPA is expected to issue a revised Phase II Rule in late 2009 or early 2010, and this Rule may require implementation of impingement and entrainment control technologies, and required performance standard(s).

### Approach

Various screen systems (coarse- and fine-mesh rotary screens, band screens, modified Ristroph screens, and wedge-wire screens), vacuum pump systems, and behavioral deterrent systems will be evaluated for performance relative to the revised EPA 316(b) Phase II impingement and entrainment reduction standards. Technology design, construction, O&M requirements, and costs will also be addressed in the evaluation.

## Impact

- Cost-effective §316(b) compliance planning
- Development and submittal of sound technical information to EPA to inform its efforts to revise the scope of the §316(b) Phase II Rule in light of 2007 Circuit Court decisions
- Defrayed or avoided technology research costs that could exceed half a million dollars or more if funded individually

## How to Apply Results

The information developed in this project will be used by power plant environmental affairs and compliance staff and by federal and state §316 permit writers when developing permit compliance and monitoring plans. Clients will read reports and attend EPRI scheduled workshops and symposia to better understand the results and then disseminate information to community water resource stakeholders and government agencies. EPRI staff will provide company-specific compliance support through supplemental projects.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Intake Impingement Reduction Technology Evaluation:</b> EPRI will evaluate coarse-mesh rotary screens, band screens, modified Ristroph screens, wedge-wire screens, vacuum pump systems, and behavioral deterrent systems for performance relative to EPA's 316(b) Phase II impingement reduction standard, as well as for technology design, construction, O&M requirements, and costs.	03/31/10	Technical Report
<b>Intake Entrainment Reduction Technology Evaluation:</b> EPRI will evaluate fine-mesh rotary screens, band screens, modified Ristroph screens, wedge-wire screens, vacuum pump systems, and aquatic filter barriers for performance relative to EPA's 316(b) Phase II entrainment reduction standard, as well as for technology design, construction, O&M requirements, and costs.	03/31/10	Technical Report

## P54.004 Thermal Discharge Risk Analysis (102877)

### Key Research Question

As a result of recent extended droughts in many areas of the country, increased societal demands for water withdrawals, continued concern about the protection of aquatic biota, and growing demand for more electric power, there is renewed interest in the management and consequences of thermal discharges. In the fall of 2007, the EPRI-organized Second Thermal Ecology and Regulation Workshop was held at Tri-State Generation's headquarters. The workshop drew about 120 domestic and international participants. Key topics of discussion included the convergence of thermal discharge issues with other issues such as §316(b), total maximum daily loads (TMDLs), effluent guidelines, water availability, and climate change; the need to reconcile field and laboratory observations of fish response; interactions of thermal discharges with other pollutants; and responses of acroinvertebrates.

### Approach

This project will provide research and information transfer that will improve the ability to cost-effectively obtain thermal discharge permits and comply with thermal discharge regulations. Research will focus on resolving discrepancies in the observed behavior of fish under laboratory and field conditions. Information transfer will involve holding EPRI's Thermal Ecology Conferences, successfully begun in 2003 and 2007, on a regular four-year cycle.

## Impact

- Reduces compliance costs
- Enhances the permitting process
- Identifies cost-effective management strategies
- Offers potential savings to individual facilities ranging from tens of thousands to millions of dollars based on site conditions

## How to Apply Results

The information developed in this project will be used by power plant environmental affairs and compliance staff and by federal and state §316 permit writers when developing permit compliance and monitoring plans. Members will read reports and disseminate information to community water resource stakeholders and government agencies. EPRI staff will provide company-specific compliance support through supplemental projects.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Methodology to Understand Fish Field Response – Year 1:</b> The first year of field experimentation will be conducted to demonstrate an experimental design to understand how fish behavior may mediate response to a thermal plume. The study will make use of tagging fish with sensors to track movement and temperature exposure. The study will consider thermal acclimation, thermal recovery, and thermal refugia.	12/31/10	Technical Update

## Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<b>Thermal TMDLs:</b> The second and final year of field experimentation will be conducted to demonstrate an experimental design to understand how fish behavior may mediate response to a thermal plume. The study will make use of tagging fish with sensors to track movement and temperature exposure. The study will consider thermal acclimation, thermal recovery, and thermal refugia.	12/31/11	Technical Report
<b>Third Thermal Ecology and Regulation Workshop:</b> An outcome of the Second Thermal Ecology and Regulation Workshop was that participants strongly recommended that the workshop be continued on a regular basis. A steering committee of members and experts in the field will be created to plan the Third Workshop, to be held in 2012.	12/31/12	Workshop, Training, or Conference