

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 §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 may reduce compliance costs, enhance permitting processes, and identify 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 management 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 officers 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 industry groups, professional scientific societies, and federal agencies;
- 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 §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 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 2011 will focus on developing and evaluating entrainment protection technologies, preparation of verification monitoring procedures, and development of information and tools to support industry's efforts to comply with the revised §316(b) Phase II regulation. Specific research efforts will include the following:

- Evaluate the performance of intake fish protection technologies for reducing impingement mortality and entrainment
- 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
- Investigate the causes of discrepancy between laboratory and field observations of fish response to thermal plumes
- Transfer information and application services via workshops, conferences, and consultations with members
- Continue as necessary, pending EPA's draft §316(b) Existing Facility Rule structure (expected release summer 2010), the assessment of the cost, environmental, social, and economic impacts of a potential national retrofit of closed-cycle cooling systems to plants with once-through cooling operation

Estimated 2011 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. Specific products will be added pending EPRI's review of the content of the draft Existing Facility Rule and research needs that could resolve uncertainties. |
| P54.002 | Biological Sampling and Fish Health Assessment Research | This project provides information on entrainment and entrainment survival sampling, mortality caused by the experimental sampling procedures, and benefit valuation. Products may be added as needed pending EPRI's review of the draft EPA Existing Facility Rule expected to be released in summer 2010. |
| P54.003 | Fish Protection Technology Research | This project will conduct laboratory and field research, gather information, and develop summaries of information on fish technology performance, operation, and maintenance. Additional products may be added as needed pending EPRI's review of the draft EPA Existing Facility Rule, expected to be released for public review and comment in the summer of 2010. |
| 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 summer 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.

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 so 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.

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, this project will continue to improve and develop technical resources to support member compliance with the provisions of the §316(a) and (b) regulations. Most importantly, the research will be directed at the development of information to support preparation of site-specific technology performance verification monitoring plans.

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) Existing Facility (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 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. Staff 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.

Future Year Products

| Product Title & Description | Planned Completion Date | Product Type |
|---|-------------------------|------------------|
| Verification Monitoring Technical Resource Document: 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) New (Phase I) and Existing (Phase II) Facility 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 Existing Facility (Phase II) Rule in summer 2010, and this Rule may require implementation of impingement and entrainment control technologies and attainment of required performance standard(s).

Approach

This project will evaluate 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 for performance relative to the revised EPA 316(b) Existing Facility (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) Existing Facility (Phase II) Rule in light of 2007 Circuit Court and 2009 Supreme Court (cost-benefit) decisions
- Defrayed or avoided technology research costs that could exceed half a million dollars 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. Staff members 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.

2011 Products

| Product Title & Description | Planned Completion Date | Product Type |
|---|-------------------------|------------------|
| Evaluation of an Entrainment Reduction Technology: EPRI will evaluate the performance of a specific technology for reducing entrainment of fish eggs and larvae. | 12/31/11 | Technical Update |

| Product Title & Description | Planned Completion Date | Product Type |
|---|-------------------------|------------------|
| Evaluation of an Impingement Reduction Technology: EPRI will evaluate the performance of a specific technology for reducing impingement of fish and shellfish. | 12/31/11 | Technical Update |

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 in Westminster, Colorado. 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 variability; the need to reconcile field and laboratory observations of fish response; interactions of thermal discharges with other pollutants; and responses of macroinvertebrates.

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 updating EPRI's web-based document on thermal discharges (eTherm) and organizing EPRI's Third Thermal Ecology Conference.

Impact

- Supports strategic and cost-effective §316(a) compliance planning
- Provides credible technical information to EPA, state permitting and resource agencies, industry, and the public on §316(a) issues
- 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 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.

2011 Products

| Product Title & Description | Planned Completion Date | Product Type |
|---|-------------------------|--------------------|
| Field Response of Fish to Thermal Plumes - Year One: The first year of a three-year field experiment will be completed. This first-year research will demonstrate how the experimental design can be used to clarify why fish in the field appear to be more tolerant of thermal discharges than predicted by laboratory experiments. The study will focus on how the mobility of fish mediates responses to thermal plumes. The study will make use of tagging fish with sensors to track movement and temperature exposure. The study will also consider thermal acclimation, thermal recovery, and thermal refugia. | 12/31/11 | Technical Resource |

| Product Title & Description | Planned Completion Date | Product Type |
|---|-------------------------|--------------------|
| Third Thermal Ecology and Regulation Workshop: An outcome of the Second Thermal Ecology and Regulation Workshop was that participants strongly recommended that the workshop be continued on a regular basis. The Third Workshop will be hosted by Great River Energy at its headquarters outside of Minneapolis. A steering committee of members and experts in the field will plan the Third Workshop. | 12/31/11 | Technical Resource |

Future Year Products

| Product Title & Description | Planned Completion Date | Product Type |
|--|-------------------------|--------------------|
| Field Response of Fish to Thermal Plumes - Year Two: The second year will be completed of a three-year field experiment to demonstrate an experimental design to clarify why fish in the field appear to be more tolerant of thermal discharges than predicted by laboratory experiments. The study will focus on how the mobility of fish mediates responses to thermal plumes. The study will make use of tagging fish with sensors to track movement and temperature exposure. The study will also consider thermal acclimation, thermal recovery, and thermal refugia. | 12/31/12 | Technical Resource |
| State of the Issue Document: Based on the Third Thermal Ecology and Regulation Workshop and other source material from eTherm, a synthesis of current understanding of the thermal discharge issue will be published. | 12/31/12 | Technical Report |
| Field Response of Fish to Thermal Plumes - Year Three: The third year will be completed of a three-year field experiment to demonstrate an experimental design to clarify why fish in the field appear to be more tolerant of thermal discharges than predicted by laboratory experiments. The study will focus on how the mobility of fish mediates responses to thermal plumes. The study will make use of tagging fish with sensors to track movement and temperature exposure. The study will also consider thermal acclimation, thermal recovery, and thermal refugia. | 12/31/13 | Technical Report |
| Update of Web-Based Thermal Reference: Based on input from the Third Thermal Workshop, government agencies, program advisors, and other sources, EPRI's web-based thermal reference, eTherm, will be updated and expanded. | 12/31/13 | Technical Resource |