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, rivers, estuaries, and oceans those operations impact. In the United States, the Clean Water Act §316(b) requires plant owners to install fish protection technologies on cooling water intake structures, while §316(a) requires management of thermal discharges. In June 2013, final regulations for existing facilities with once-through cooling will be issued, which will require installation of cooling water intake fish protection technologies and even potential retrofit of cooling towers. Plant owners will also be required to perform numerous studies to support determining the Best Technology Available (BTA) for reducing impingement and entrainment. In addition, facilities are seeing increasingly stricter permit requirements limiting their thermal discharges in order to prevent aquatic impacts. The outcome of the regulatory process will impose significant costs on the electric sector. The need for cost-effective fish protection technologies will be a critical element of future research to identify and test appropriate technologies and conduct necessary monitoring studies.

The Electric Power Research Institute’s (EPRI’s) 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 industrywide imperatives to control costs, ensure or even exceed environmental compliance, and manage business risks.

Research Value
EPRI performs extensive research on fish protection technologies for cooling water intake structures. The research has demonstrated the site-specific nature of aquatic impacts, the efficacy of various technologies for different fish and shellfish species, improvements to technologies to enhance survival rates, and technology costs and value of the benefits achieved. This program helps environmental compliance managers and power plant operators effectively manage water resources and protect aquatic communities in accordance with fish protection regulations. Program information may reduce compliance costs, enhance permitting processes, and identify cost-effective management strategies. The research supports the development of viable intake and discharge protection approaches for cost-effective operating permits at individual facilities. It also provides access to new and enhanced fish protection technologies, information on fish protection–related issues, and information on cost, economic, environmental, and electric system impacts of impingement and entrainment reduction standards. The public will benefit from minimized impacts to aquatic environments and cost-effective compliance strategies that will have minimal impact on electricity rates.

EPRI recently completed a study of the estimated costs, benefits, impacts, and environmental consequences of a potential national requirement to retrofit cooling towers on all once-through facilities. The estimated costs exceed $100 billion on a net present value basis. The results have been used to inform the rulemaking process for the §316(b) water intake regulations to ensure that the final regulations consider all aspects of the issue and technology options. The results from these studies are directly transferable to international applications as well.

Approach
This program provides information, analytical tools, innovative mitigation technologies, and expert services to help environmental compliance managers and power plant operators effectively manage water resources and protect aquatic communities in accordance with fish protection regulations. The program also provides methods to support technology performance verification monitoring. The program delivers

- collaboration with industry, 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;
• analysis and performance evaluation of fish protection technologies (traveling screen systems, vacuum pump systems, wedge-wire screens, and barrier net systems), including technology design, construction, operation and maintenance requirements, and costs; and
• thermal discharge risk analyses.

Accomplishments
Program information supports current industry compliance efforts as well as updates to guidance on thermal discharge assessment variance procedures. The information is expected to support a regulatory structure that is informed by scientific and engineering information. Program accomplishments include

• information on performance of intake fish protection technologies in identifying BTA for new and existing power plants;
• impingement mortality and entrainment sampling information in support of §316(b) compliance;
• technical resource documents on fish protection technology performance and costs;
• technical information on the impacts and the environmental and economic benefits of reducing impingement mortality and entrainment;
• extensive information on the costs of a cooling tower retrofit requirement (more than $100 billion to retrofit cooling towers, with an estimated benefit of $16 million per year to recreational and commercial fisheries); and
• work on fish protection issues in France and other localities, continuing to provide value that transcends borders.

Current Year Activities
Program R&D for 2014 will focus on developing information on technologies to reduce impingement and entrainment, assessing environmental benefits, evaluating the environmental and economic trade-offs of once-through cooling versus closed-cycle systems, and developing approaches for resolving discrepancies between laboratory and field studies for establishing thermal fish protection criteria. Specific research efforts will include

• sponsorship of a national conference to present and exchange technical information to support compliance with the final Clean Water Act §316(b) Rule for existing facilities, issued in 2012;
• continued research into the performance of intake fish protection technologies for reducing impingement mortality and entrainment;
• technical data and guidance on performing studies to identify BTA for entrainment control;
• technical data and guidance for the design, installation, and operation of fish return systems;
• engineering, economic, and environmental consequences of potential closed-cycle cooling system retrofits on power plants with once-through cooling systems;
• updated guidance for performing economic benefit analyses;
• a final report of a three-year study to evaluate the change in fish community structure 20 years after the retirement of a once-through cooled power plant in the U.S. Midwest;
• a study of fish thermal tolerance data to support technically defensible thermal discharge permit criteria;
• a study of the causes of discrepancies between laboratory and field observations of fish responses to thermal plumes; and
• application of fish protection research results to European issues.

Estimated 2014 Program Funding
$3.6M

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Summary of Projects

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<th>Project Number</th>
<th>Project Title</th>
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<td>P54.001</td>
<td>Environmental and Economic Effects of a Potential Retrofit of Closed-Cycle Cooling Systems</td>
<td>This project provides EPA, the public, and industry with technical information on the economic and environmental consequences of a potential CCC system retrofit on power plants with once-through cooling systems. Specific products will be added pending EPRI’s review of the content of the final Existing Facility Rule planned to be issued on or before June 27, 2013.</td>
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<td>P54.002</td>
<td>Biological Sampling and Fish Health Assessment Research</td>
<td>This project provides information on impingement 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 final EPA Existing Facility Rule, scheduled for release on June 27, 2013.</td>
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<td>P54.003</td>
<td>Fish Protection Technology Research</td>
<td>This project is conducting laboratory and field research, gathering information, and developing summaries of information on fish protection technology performance, operation, and maintenance. Additional products may be added as needed pending EPRI’s review of the final EPA Existing Facility Rule.</td>
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<td>P54.004</td>
<td>Thermal Discharge Risk Analysis</td>
<td>This 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.</td>
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P54.001 Environmental and Economic Effects of a Potential Retrofit of Closed-Cycle Cooling Systems (067512)

Description

On April 20, 2011, EPA released a proposed rule implementing the requirements of §316(b) of the Clean Water Act for existing facilities. A final rule will be promulgated by June 27, 2013. In the proposed Rule, EPA noted that closed-cycle cooling (CCC) systems were not a national Best Technology Available (BTA) for reducing adverse environmental impacts of cooling water intake structures; however, entrainment standards developed on a site-specific basis could require retrofits of CCC systems. In fact, as part of a potentially EPA-required Comprehensive Technical Feasibility and Cost Evaluation Study, the owner or operator of the facility must evaluate the technical feasibility of closed-cycle recirculating systems such as natural draft cooling towers, mechanical draft cooling towers, hybrid designs, and compact or multiecell arrangements. Costs of retrofits, impacts to plant operations, environmental and social impacts, and potential impacts to system reliability may also need to be investigated if the rule is promulgated as proposed.

Furthermore, although EPA rejected CCC as BTA and selected a regulatory option that provides for site-specific development of entrainment standards for protecting aquatic life, EPA did consider two options that included requirements for CCC, and one of these options could be adopted for the final rule. Up-to-date scientific and engineering information on the potential ramifications of a CCC system retrofit, therefore, remains an important R&D issue to inform permit considerations and serve the public interest.
P54.002 Biological Sampling and Fish Health Assessment Research (100033)

Description

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 (for example, reservoir, estuary, and 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 before their contact with power plant systems can also compromise the interpretation of sample results and fish protection technology performance. The proposed 2011 U.S. Environmental Protection Agency (EPA) Existing Facility Rule implementing §316(b) requires several applicant studies related to characterizing impingement and entrainment, as well as many future technology performance monitoring studies, which, if promulgated in the Final Rule (expected June 27, 2013) as proposed in 2011, will be a challenge for permit applicants and permit authorities and may raise questions from the public at large. This project will provide the requisite learning to assist permit applicants, resource agencies and regulators, and the public in conducting technically sound sampling programs and interpreting the results.

P54.003 Fish Protection Technology Research (SP0473)

Description

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 the Clean Water Act §316(b) New and Existing Facility rules. EPA released a proposed rule for existing facilities on April 20, 2011, and a final rule is planned for release on or before June 27, 2013. The proposed rule requires power plants with design intake flows exceeding 2 million gallons per day (MGD) to reduce impingement mortality by either reducing cooling water intake structure design through-screen velocity to less than 0.5 feet per second (fps), or meeting an impingement mortality performance standard. EPA identified modified (“fish-friendly”) traveling water screens with 3/8-inch mesh and fish return systems as BTA for meeting the impingement mortality standard. These proposed compliance options were slightly modified by EPA in 2012 in a Notice of Data Availability (NODA), and several new options EPA is considering were also discussed, including the use of a streamlined approach, two defined technologies (closed-cycle cooling and offshore velocity caps), a site-specific approach, and an exception for low levels of impingement. EPA may include one, several, or all the considered impingement compliance options in the final rule. Facilities with design intake flows exceeding 2 MGD are also subject to reducing entrainment mortality; however, only facilities withdrawing more than 125 MGD actual intake flow must submit a Comprehensive Entrainment Characterization Study, evaluate entrainment reduction technologies (including closed-cycle cooling and fine-mesh screens), and evaluate their environmental impacts and benefits (nine specific factors must be evaluated). Entrainment compliance is determined by the permitting authority on a case-by-case basis and could result in a determination ranging from the existing cooling water intake structure being deemed BTA to a requirement to retrofit with closed-cycle cooling. EPA’s proposed provisions for entrainment control are not expected to change in the final rule.

P54.004 Thermal Discharge Risk Analysis (102877)

Description

As a result of recent extended droughts in many areas of the country, increased societal demands for water withdrawals, continued concern about 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 2011, the EPRI-organized Third Thermal Ecology and Regulation Workshop was held at Great River Energy’s headquarters in Maple Grove, Minnesota. The workshop drew more than 100 attendees. Key topics of discussion included differences between field observations and laboratory measurements of fish responses; interaction of thermal discharge issues with other issues such as §316(b), Total Maximum Daily Loads (TMDLs) and effluent guidelines, interactions of thermal discharges with other pollutants, and macroinvertebrate responses. The Proceedings for the workshop were published in 2012 as an EPRI Technical Report (1025382).
Supplemental Projects

Cooling Water Intake Debris Best Management Practices Interest Group (069787)

Background, Objectives, and New Learning

Blockage of cooling water intakes occurs frequently at nuclear and fossil power plants worldwide. Operational impacts include equipment damage, facility outages, and plant safety concerns. These impacts can ultimately translate to system reliability problems and declines in plant revenue. The causal mechanism for intake blockages is constantly shifting due to changes in land-use practices and aquatic and terrestrial flora and fauna changes in the water body from which a power plant draws its cooling water. EPRI has conducted studies on this issue, including a 2009 survey that found debris-related shutdowns or derating in 55% of the 77 facilities surveyed. EPRI also prepared a Best Management Practices Guidance Manual on state-of-the-art practices and technologies for minimizing intake blockages (EPRI Report 3002000XXX). The recurrent nature of the problem, however, indicates additional research is needed to build on the existing foundation of work through continued information exchange, data collection, evaluation of new management options, and updates of the Best Management Practices Guidelines.

In 2011, loss of cooling water was reported for numerous power plants as a result of screen blockages by aquatic weeds, fish kills, and jellyfish. In the nuclear industry, the World Association of Nuclear Operators (WANO) continues its reporting requirements in light of the 2007 Significant Operating Experience Report (SOER-2007-2) that summarized intake cooling water blockage events that adversely affected nuclear plant safety-related systems and plant reliability. This SOER also contained recommendations that each WANO member minimize or preclude future intake blockage events. Activities in this interest group will help participants meet SOER reporting requirements.

The 2013 Updated EPRI Debris Best Management Practices Guidance Manual contains a review of successful and unsuccessful mitigations for the many types of debris issues power plants encounter, but there are still debris issues that require economically effective solutions. With the pending revisions to the Clean Water Act Section 316(b) fish protection regulation for existing plants, power plant operators may face new challenges to debris management related to operation of fine mesh screens, fish return systems, and other intake technologies.

Project Approach and Summary

The interest group serves as a forum to exchange information on existing and emerging intake debris management issues. Planned activities include the following:

- Organize and conduct a workshop to review and discuss new technology developments, case studies (successful and unsuccessful practices), and the Best Management Practices Manual and required updates, as well as to identify R&D needs;
- Organize and host monthly webcasts with information on the latest debris management technology developments (e.g., traveling water screens, wedge wire screens, debris booms, barrier nets, louvers, debris filters, trash rakes, event warning systems and technology), as well as event forecasting and Clean Water Act §316(b) regulatory developments;
- Prepare a Quarterly Newsletter to review interest group activities and scheduled events, discuss blockage events, and describe other developments from the previous quarter;
- Launch collaborative R&D projects to address common mitigation needs, including new technology evaluations, better forecasting tools, and unresolved debris management problems; and
**Benefits**

At the current cost of power, a 12-hour outage due to intake blockage at a 1,000 MW plant can cost as much as half a million dollars or more in lost revenue. The interest group provides information to prevent or minimize intake blockages precluding plant outages or reduced operating efficiencies. Participants will benefit from experiences gained from other power companies’ best management practices and information on the state of the technology on intake screen design and operation.