

Maintenance Management & Technology - Program 69

Program Overview

Program Description

Existing fossil generating assets serve a strategic need while technical and regulatory issues associated with future generation technology are addressed. Maintaining desired reserve generating capacity through high availability of these aging fossil assets requires efficient operations and maintenance procedures, knowledge of damage mechanisms, and advanced condition monitoring. At the same time, continued reliance on tacit knowledge held by experienced plant staff presents the risk that a critical loss of expertise will occur as the result of continued high staff turnover rates.

The top performers in the fossil generating industry are reacting to these business drivers by continuing to move away from conservative, time-based maintenance as well as highly reactive corrective maintenance. Condition-based maintenance is an effective strategy, but it requires technology advancements and focused expertise on equipment monitoring and machinery failure modes and effects. Fossil plants in the future will be maintained by fewer staff, and these staff will have less experience. EPRI must assist member companies in effectively utilizing these staff by increasing their proficiency in advanced processes, facilitating peer collaboration, creating databases, documenting case histories, and deploying EPRI research results on new information management technology.

The Electric Power Research Institute's (EPRI's) Maintenance Management and Technology program (Program 69) helps plant operators improve maintenance processes and technologies within today's business constraints to achieve high plant availability. All major process elements are covered, including maintenance basis, work planning, work management, continuous improvement, corrective action, and outage management. The current research focus is on predictive and condition-based maintenance. Structured knowledge of failure modes and effects is critical to development of a maintenance basis, as well as improved fault diagnoses. Risk increasingly is being used as a prioritization parameter when selecting high-value proactive maintenance tasks.

Research Value

EPRI's Operations and Maintenance programs address the key issues: increasing reliability and staff safety, reducing maintenance costs, and providing technical support for the next generation of plant staffs. The program focus is on providing an integrated solution that addresses the needs for processes, technologies, and skilled people, combining condition-based maintenance with risk-informed maintenance decision support. By using the R&D in this program, members can:

- Achieve operation and maintenance excellence through an integrated approach that includes process improvements, technologies, and knowledge management
- Increase maintenance effectiveness, yielding less rework and higher plant availability
- Optimize use of limited maintenance resources through processes and strategic technologies
- Increase plant availability through improved outage management and performance

Approach

The ongoing evolution of enhanced fossil maintenance processes is an inherently collaborative activity involving member companies, industry experts, and EPRI staff. Involvement in the program as an advisor or participant in the various user groups is the primary means by which value is received from EPRI. Research findings are published in reports, guidelines, and computer-based training; however, EPRI recognizes that active support of implementation of these findings is critical. The program supports self-assessments through a maintenance excellence matrix that is built on the framework of a peer-reviewed Plant Reliability Optimization process. In addition, regular workshops, conferences, and user groups enable peer information

exchange and technology gap identification. Member collaboration to share best practices helps improve plant reliability. Industry data on metrics supports ongoing self-assessments by members.

- The Plant Reliability Optimization User Group (PROUG) provides a structure for sharing peer information about, and experience with, fossil plant maintenance through technical workshops, conferences, training, and webcasts on current topics.
- Fossil plant maintenance processes focus on development and improvement. Technical reports cover detailed aspects of the primary process elements such as work management, maintenance basis, outage planning/execution, corrective action, and continuous improvement. The EPRI Maintenance Excellence Matrix is used to assist in member self-assessments, and a new initiative is examining the need for tighter integration between major component reliability research and maintenance processes needed to implement the research results.
- Fossil plant maintenance technology R&D facilitates deployment of advanced maintenance processes, which are essential to achieving desired performance. These include technologies to support advanced predictive maintenance (PdM) tools, diagnostics, risk management, and craft work execution. The software products in this project will provide databases that members can use to apply component and system knowledge and perform effective risk analysis. EPRI facilitates member application of these databases through training courses.

Accomplishments

Maintenance engineers, planners, and system owners need information, technologies, and processes to achieve high performance in plant availability and production costs. This program has provided:

- Development and application of Plant Reliability Optimization (PRO) processes at members' facilities
- Widely used enterprise software tool, PlantView, which facilitates sustained high performance derived from processes such as Plant Reliability Optimization
- More than 100 technical reports, technical updates, and software products that cover all aspects of maintenance planning and execution
- Technical basis for a risk-informed approach to production optimization and resource allocation; the approach is based on a combination of advanced condition assessment and prognostics to assess remaining life.

Current Year Activities

The program R&D for 2010 will maintain the focus on improvements in maintenance processes and related technology. Specific research subject areas will include:

- Work planning, scheduling, execution, and closeout
- Techniques for improving wrench-time
- Vendor management
- Predictive maintenance of environmental control equipment
- Assessment of technology to assist fossil plant maintenance craft labor
- Outage management and execution

Estimated 2010 Program Funding

\$1.5M

Program Manager

Stephen Hesler, 704-595-2183, shesler@epri.com

Summary of Projects

Project Number	Project Title	Description
P69.001	User Groups, Training, and Industry Data	This project provides a collaborative forum for exchange of information relating to advanced fossil plant maintenance strategies, processes, and related technologies.
P69.002	Fossil Plant Maintenance Processes	This project assists members in achieving improved equipment reliability, O&M costs, and workforce utilization through development and implementation of advanced maintenance processes.
P69.003	Fossil Plant Maintenance Technology	This project conducts research to identify, refine, and apply emerging technologies that support improved fossil maintenance management processes needed to ensure viability of the existing fossil fleet.

P69.001 User Groups, Training, and Industry Data (062022)

Key Research Question

Maintenance engineers, planners, and system owners need information on current technology and processes to achieve high performance in plant availability and production costs. Obtaining this information requires workshops, conferences, technical webcasts, and user groups that enable peer information exchange and technology gap identification. Member collaboration to share best practices is essential to improving plant reliability. Industry data on metrics is needed to support ongoing self-assessments by members.

Approach

Technical workshops, conferences, and webcasts provide a structure for sharing peer information about, and experience with, fossil plant maintenance. Examples include the Plant Reliability Optimization User's Group (PROUG), EPRI's annual Predictive Maintenance conference, and workshops and training in new technologies. EPRI will maintain a database of metrics pertaining to plant operations and maintenance.

Impact

- Increased plant availability through improved reliability and reduced maintenance downtime
- Reduced nonfuel production costs related to equipment maintenance
- Access to peer-reviewed procedures and practices through participation in workshops, conferences, and webcasts
- Identification of implementation strategies pertaining to advanced maintenance processes and related technologies to improve plant reliability
- Assistance in self-assessment through the use of effective leading metrics

How to Apply Results

Members will receive value from this project by participating in the Plant Reliability Optimization User Group, the annual Predictive Maintenance conference, topical webcasts, and training sessions. Members are encouraged to perform self-assessments and industry benchmarking using metrics developed collaboratively by participating member companies, EPRI staff, and other industry experts.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Plant Reliability Optimization User Group: This project is a continuation of the annual PROUG meetings. This includes an annual three-day conference, meetings held during the Generation Sector Advisor meeting week, periodic teleconferences involving the PROUG Steering Committee, webcasts, and a web forum.	12/31/10	Technical Resource
Annual Conference on Predictive Maintenance Technology: This project is a continuation of the annual meeting that combines the Predictive Maintenance User Group (PdMUG), Vibration Technology User Group (VTUG), and the Infrared User Group (IRUG) into a single comprehensive Predictive Maintenance Conference. These Workshops are sponsored jointly with EPRI's Nuclear Sector.	12/31/10	Technical Resource
User Group Meetings Proceedings and Key Findings: EPRI sponsors a number of meetings, workshops, and conferences each year relating to Program 69. At each of these meetings, a set of key findings is developed that result from discussions and meeting presentations. This Technical Update report will assemble these key findings throughout the year. The information will be organized and formatted into a meeting synopsis and documented in this annual Technical Update that will be available to members and allow easier access to these key takeaways.	12/31/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
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Web-Based Roundtables on Maintenance Topics: Periodic webcasts sponsored by EPRI will address member-selected topics. A member co-sponsor will be given the opportunity to present material on a selected topic or maintenance issue during each webcast. Other member organizations will be encouraged to have their subject-matter experts participate in the webcast to share best practices or methods that have been successful to address the specific issue. Webcast materials consisting of a recording and summary notes will be accumulated throughout the year and assembled into the Key Findings Technical Update report.	12/31/11	Technical Resource

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Equipment Risk Management Conference and Training Seminars: A workshop will be conducted on the application of risk analysis tools to maintenance processes. The topics will include risk fundamentals, generic process description, and training on specific tools such as the new module being developed for PlantView and other enterprise asset management tools.	12/31/12	Technical Resource
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P69.002 Fossil Plant Maintenance Processes (062023)

Key Research Question

Many fossil power plants suffer from a lack of effective and efficient maintenance processes. Fossil maintenance organizations struggle to balance corrective, preventive, predictive, and proactive maintenance activities in a streamlined, process-oriented program. Optimization of these maintenance processes provides significant benefit to member organizations through reduced maintenance costs, improved quality of maintenance, reduced outage durations, avoided unplanned downtime, and enhanced safety. And the need to sustain a high level of fossil plant performance will increase in the future as generation reserve margins decrease, replacement power costs increase, and investors demand continued reductions in operating costs.

Advanced management practices are needed throughout the industry in areas such outage planning/execution, preventive maintenance, backlog management, work closeout, inventory management, and human error reduction. Collaboration between member organizations and EPRI ensures that the processes and practices developed in this project are applicable and readily usable by today's fossil power industry.

Approach

This project focuses on maintenance process development and improvement. EPRI works with member companies to identify gaps and improvement opportunities relating to maintenance program management. Solutions and best practices are developed that optimize plant performance by balancing equipment reliability and maintenance costs. Specific emphasis is placed on condition-based maintenance processes that are used to facilitate risk-based decision-making. Technical reports cover detailed aspects of the primary process elements such as work management, predictive maintenance, maintenance basis, outage planning/execution, maintenance decision-making, and continuous improvement.

Impact

- Significant benefits in plant availability and production costs can be achieved through the implementation of comprehensive maintenance process improvements.
- Plant availability increases by reducing outage duration through better planning and reduced rework due to improved execution of maintenance tasks.
- Worker safety improves through the use of standard maintenance procedures, effective job planning, and management oversight.
- Documentation of structured maintenance processes are valuable reference documents used by new staff members in planning and executing maintenance activities.

How to Apply Results

Members who participate with EPRI as technical advisors in process development initiatives, or attend forums such as the Plant Reliability Optimization User Group can more easily integrate findings and processes from this project into their plant maintenance programs. In addition, technical reports produced by this project are valuable reference guides and serve as instructional tools for new staff. This project will explore new ways to deliver and apply advanced process elements to member organizations through enterprise software tools.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Comprehensive Maintenance Program Model: A strategic model can greatly improve the ability to assess and compare current aspects of a company's maintenance program, as well as identify opportunities for advancement. Although such models exist in certain sectors of the power industry, fossil power generation lacks any form of standardized maintenance process model. This deliverable will focus on producing an industry standard model that can be used as a framework to guide development of, or improvements to, a plant's processes. This model is intended to be scalable by definition in order to meet the varying needs of different organizations; however, the standardized elements and objectives of the model will allow the industry, including EPRI, to better identify areas requiring improvement. The model will provide a unifying framework to which all other programs/initiatives (PRO, maintenance optimization, outage management, etc.) can be mapped. A technical update report will be issued at the end of 2010 for a one-year review period.</p>	12/31/10	Technical Update
<p>Human Error Reduction Techniques: This technical report will expand the research on human error reduction conducted previously in Program 108 (Operations Management and Technology). The report scope will extend beyond operations to the maintenance function, and will provide real plant examples of successes and failures. The resulting technical report will be a single comprehensive reference guide, outlining practices for human error reduction on a plantwide level.</p>	12/31/10	Technical Report

Product Title & Description	Planned Completion Date	Product Type
<p>Outage Management: Checklists and Key Milestones: EPRI has compiled a series of Outage Management Guidelines that cover subjects ranging from scoping and planning to outage closeout and unit restarts. EPRI has provided direct support in the form of assessments to members seeking to implement these guidelines to improve outage performance. As a result of these assessments, a standard outage checklist and key milestones have evolved. This deliverable will assemble these EPRI checklists and milestones into a document that can be used or adapted by member companies seeking to improve outage performance. Example elements of the report will include milestones and checklists for pre-outage preparation, scope management, execution, and unit restart.</p>	12/31/10	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<p>Integration of Major Component Reliability: Plant-Focused Remaining Life Assessments: This deliverable is the final in a series of reports covering integration of major component reliability into standard maintenance processes. This final task will establish a technical basis and process for assembling the results of all system and component life assessments and standardizing this information to use as input for a common plant maintenance decision-making process. This process will support prioritization of both large maintenance projects as well as capital expenditures that support reliability of existing plants. A technical report will be produced that identifies best practices for integrating life assessments involving various boiler circuits, piping, turbine components, and other relevant plant equipment.</p>	12/31/11	Technical Report
<p>Work Packages: Effective Formats and Delivery Techniques: Planning is an important element of all effective plant maintenance programs. The development and utilization of effective work packages can have a significant impact on the success of a maintenance planning process. This deliverable will focus on best practices for establishing formats for work packages, as well as identifying effective techniques for delivery and utilization of work packages by maintenance personnel.</p>	12/31/11	Technical Report
<p>Maintenance Process Implementation: Techniques and Case Studies: Past EPRI research reports in the area of fossil plant maintenance have emphasized definition of the desired "end-state" organization, processes, and metrics. The focus also has been on describing best practices relating to various aspects of maintenance programs. This deliverable will focus on describing <i>how to achieve</i> the desired end-state more than <i>describing</i> the end-state itself. Many member companies indicate a need for assistance in defining the practical steps needed on their journey to top-tier maintenance performance. Case studies and successful techniques will be outlined that describe a pathway that organizations can follow to achieve desired plant reliability and cost-effectiveness.</p>	12/31/11	Technical Report

Product Title & Description	Planned Completion Date	Product Type
<p>Risk-Based Spares Management Strategies: Spares management requires an effective decision-making process that seeks to optimize the cost and benefit associated with the inventory. Management is required to weigh the advantages and disadvantages of stocking warehouses with materials relating to maintaining plant availability. This deliverable will focus on identifying applications of a risk-informed process to the management of equipment spares. Specific emphasis will be given to the financial implications of keeping certain spares in stock versus other alternatives. Specific algorithms based on optimizing risk will be developed and described in the report in a form that can be employed by member companies in their own decision models.</p>	12/31/12	Technical Report
<p>Future Workforce Concepts: This deliverable will provide an overview of industry trends and drivers that will shape the fossil power generation maintenance workforce of the future. The research will focus on three dynamics:</p> <ul style="list-style-type: none"> • Design improvements to future generating plants that will improve maintainability • Likely technology advances in data acquisition and information management that streamline condition-based maintenance • Differences in the learning styles of next-generation plant staff that will affect the training techniques used. <p>The findings will be published in a technical report.</p>	12/31/12	Technical Report
<p>Vendor/Contractor Management: This project will compile industry best practices and methods for management of supplemental labor resources. Focus will be on the contractual considerations to ensure the scope of the contract is accurate, as well as provide oversight during work activities to ensure the scope is met. Focus also will be on metrics development for ensuring the work is measurable. Finally, methods will be evaluated on how to seek and provide feedback on work quality and satisfaction upon work closure. The results will be published in a technical report.</p>	12/31/12	Technical Report

P69.003 Fossil Plant Maintenance Technology (062024)

Key Research Question

Technology is an essential aspect of the deployment of advanced maintenance processes. Fossil plant maintenance technologies support activities such as predictive maintenance (PdM), work management, equipment diagnostics, risk management, and craft work execution. Current gaps exist in the industry that pertain to the implementation and utilization of new technologies in these areas. Information management to support fossil plant maintenance is one key technology area. Technology gaps inhibit many fossil plants from maximizing their performance capabilities.

Advancements in maintenance technology will improve the ability of plant personnel to conduct integrated condition assessments of plant equipment, utilize risk management practices, and facilitate the maintenance of new environmental control systems. This improvement will allow plants to optimize the use of scarce resources and maximize availability. This need to sustain a high level of fossil plant performance will increase as reserve margins decrease, replacement power costs increase, tighter regulatory restrictions are applied, and investors demand continued reductions in operating costs.

Approach

This project seeks gaps in fossil maintenance practices that can be addressed by emerging technologies, some of which are being applied in other industries, and supports research in key areas of maintenance optimization that can be achieved through technology implementation. This research includes:

- Development and demonstration of new databases for supporting maintenance decision-making. These databases include those that apply component and system knowledge to fault diagnostics, as well as databases that supply information related to prognostics and equipment failure probabilities.
- Technologies that address new plant equipment. Primary emphasis will focus on best-in-class methods for providing predictive maintenance capabilities on scrubbers and other emissions control equipment
- Other technology topics that support work execution, predictive maintenance, scheduling, and configuration management.

Impact

- Integrated diagnostics and risk-informed approaches to maintenance planning improve plant availability by providing a basis for doing the right maintenance at the right time.
- Technology for monitoring equipment condition and assisting system owners in evaluating equipment health will support the industry goal of adopting condition-based maintenance.
- Technology that facilitates the distribution of key information on component health and risk of failure will enable more efficient use of maintenance resources and capital.
- Advanced predictive maintenance capabilities on environmental control equipment will improve the ability of plants to operate within new regulatory compliance standards.

How to Apply Results

Results of this project can be implemented as information databases that support advanced maintenance process elements such as diagnostics, prognostics, and risk-informed decision-making. In addition, technical reports or webcasts will be provided that assess emerging technology in related industries and strategies for successful implementation in fossil power generation. Technical content will be provided for new predictive technology practices involving new plant equipment.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Asset Fault Signature Database: During 2009, a working prototype of EPRI's Oracle-based Asset Fault Signature (AFS) Database was released with a limited content of fault signatures sufficient to demonstrate and test functionality. In 2010, EPRI will support the prototype evaluation of the AFS Database through web training. Functionality enhancements suggested by end users will be identified and implemented. Significant effort will be applied in 2010 toward populating the AFS Database with additional design cases using available EPRI sources on fossil plant component failure modes and effects. The final result following the 2010 work will be a production version of the AFS Database ready for use by the industry. This product will be a supporting database to EPRI's Diagnostic Advisor tool that employs a case-based reasoning process for equipment fault diagnostics.</p>	12/31/10	Software
<p>Risk-Based Fossil Component Reliability Database: During 2009, this project produced a pilot database in MS-Excel that demonstrated the functionality of EPRI's collaborative database for component remaining life projections. During 2010, the pilot database will be enhanced by additional data on component remaining life. User-suggested improvements to the database functionality will be sought and implemented. The result of the work in 2010 will be a revision to the MS-Excel database with enhancements and additional component data.</p>	12/31/10	Software

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<p>Risk-Based Fossil Component Reliability Database: During 2010, an enhanced pilot component remaining life database will be released in MS-Excel. During 2011, all remaining suggestions for improvements to the database functionality will be collected and incorporated into a software specification document. The pilot database will be converted to an Oracle-based platform, similar to EPRI's Asset Fault Signature Database. At the end of 2011, a prototype version of the Oracle-based component remaining life database will be released for beta-testing by member companies.</p>	12/31/11	Software
<p>Technology Analysis and Development for Maintenance Craft - Work Execution: In addition to maintenance process improvements, technology that assists craft workers to make the most of their wrench-time is important to achieving top-tier performance. This project will explore recent advances in equipment maintenance technology that assists craft labor in reducing the time required for tasks and improving the quality of the work. Technology to improve the productivity of craft labor can be found in other related process industries that utilize large equipment, and will be identified and assessed in this project. This deliverable will highlight the key findings and will focus on technology rather than process.</p>	12/31/11	Technical Report
<p>Plant/Equipment Configuration Control Technologies: The fossil power generation industry is challenged by poor plant equipment configuration control and documentation. The objective of this project is to evaluate the applicability and potential benefits of emerging technologies that support to plant/system/equipment configuration management. A survey will be conducted of existing configuration management technology, its effectiveness, and barriers to application in the fossil generation industry. A technical report will be issued documenting the research findings.</p>	12/31/11	Technical Report
<p>Risk-Based Fossil Component Reliability Database: During 2011, a working prototype of EPRI's Oracle-based component remaining life database was released. In 2012, EPRI will support the prototype evaluation of the remaining life database by conducting web-training. Functionality enhancements suggested by prototype evaluators will be identified and implemented. The final result following the 2012 work will be a production version of the EPRI's component remaining life database for use by the industry. This product will be a supporting database to EPRI's risk management processes.</p>	12/31/12	Software
<p>Predictive Maintenance Technology Applications for Environmental Control Equipment: New environmental control equipment, such as scrubbers and selective catalytic reduction (SCR) systems, have not had the benefit of decades of evolving technology key to performing predictive maintenance (PdM). This equipment is nonetheless critical to plant operation, and may exhibit new and unique failure modes. This deliverable will document emerging predictive maintenance capabilities that can be applied to new environmental control systems, specifically scrubbers and SCR systems. Investigations will evaluate the capabilities of new technologies and produce benchmarking opportunities. The report will also evaluate technology gaps and technology development opportunities.</p>	12/31/12	Technical Report
<p>Integration and Utilization of Planning and Scheduling Tools: This deliverable will investigate and document methods for achieving effective integration and utilization of planning and scheduling tools. Within the fossil generation industry, these two functions are often managed using independent tools and processes; however, there could be synergies achieved by a more integrated approach. A report will be issued that</p>	12/31/12	Technical Report

documents the research findings and focuses on ways to improve integration of information produced in planning and scheduling tasks.
