Boiler Life and Availability Improvement Program - Program 63

Program Overview

Program Description

The majority of fossil plants worldwide are more than 30 years old and are experiencing increased demand for operational flexibility while addressing age-related issues for major components. High-energy steam and water piping systems also are among the most important safety issues at fossil plants and must be managed reliably through the aging process. Safety and availability loss due to pressure part failures are two key issues driving R&D on major fossil power plant components, especially in older plants. Boiler tube failures (BTFs) continue to be the leading cause of lost availability (with equipment availability losses due to BTFs averaging approximately 3%) in fossil-fired steam plants worldwide.

The Electric Power Research Institute's (EPRI's) Boiler Life and Availability Improvement Program (Program 63) uses international collaboration to develop technology and guidance on safe management of boiler component life to ensure high reliability and reduce operation and maintenance (O&M) costs. Efforts focus on advanced inspection techniques for early and accurate identification of component damage; analytical tools to predict remaining life and risk of in-service failure; and decision-support tools to help balance risk and benefit under a variety of operating scenarios.

Research Value

Power generators need to balance the risks and costs of the largest, most costly equipment in the power plant, and focus on using proven technologies to create solutions. By using the results of the R&D in this program, plant owners and operators can:

- Reduce the costs of lost availability due to boiler tube failures from greater than $10,000/MW/yr to less than $1,000/MW/yr when program results are applied comprehensively;
- Increase the safety of high-energy and high-temperature piping systems; and
- Increase safety through control of flow-accelerated corrosion (FAC) in fossil plants.

Approach

The program portfolio includes guidelines, reports, software code, and tools applicable to all boilers, focused on the goal of optimal availability and performance.

- Research for Boiler Component Inspection and Monitoring (P63.001) develops reliable and cost-effective nondestructive evaluation (NDE) techniques to reduce O&M costs and improve life-management options. NDE developments in other industries also are evaluated for application to fossil plants.
- Tools for Boiler Component Life Management (P63.002) provides a comprehensive approach to creating technical bases for minimizing in-service component damage and for component remaining-life assessment. Both areas are critical for high reliability and maximum equipment life.
- High-Energy Steam and Water Piping Safety and Life Management (P63.003) addresses safety and reliability of high-energy piping systems in fossil power plants. Information is provided on how damage mechanisms affect piping components and on remaining life tools. Tools are developed that allow engineers to more accurately predict the remaining life of piping systems.

Accomplishments

EPRI's Boiler Life and Availability Improvement program has created and successfully demonstrated a world-recognized program to reduce boiler tube failures by understanding damage mechanisms, their root causes, and corrective options for root causes. Highlights include:

- Development of the most comprehensive suite of guidelines and analysis tools for boiler component life management;
- Leading guidance, training, and analysis tools for FAC management in fossil plants; and
- Leadership in developing and demonstrating NDE technologies for boilers, high-energy piping, and FAC.

Current Year Activities

The program R&D will focus on developing life-assessment technologies for piping and header base metal degradation. Specific efforts will include:

- Development of small sample removal and testing procedures to predict remaining life of seamless pressure parts;
- Guidance to address damage from evolving operating modes within current fossil fleet, including fuel switching, cycling, low load, and environmental constraints; and
- Technology and information to support reliable operation of new and advanced fossil boiler designs.

Estimated 2014 Program Funding

$4.5M

Program Manager

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Summary of Projects

Project Number	Project Title	Description
P63.001	Research for Boiler Component Inspection and Monitoring	This project provides technology, tools, and application support to maximize safety and reliability of boiler components and to determine optimal timing for repair or replacement, and investigates new technologies for NDE.
P63.002	Tools for Boiler Component Life Management	This project focuses on the technology and tools required to cost-effectively minimize boiler tube failures and addresses life management issues associated with high-cost and high-impact boiler components such as tubes, headers, and drums.
P63.003	High-Energy Steam and Water Piping Safety and Life Management	This project provides information about damage mechanisms, their root causes, and appropriate responses to ensure safe operation of high-energy steam and water piping systems.

P63.001 Research for Boiler Component Inspection and Monitoring (103518)

Description

Maximizing safety and reliability of boiler components and determining optimal timing for repair or replacement require accurate and timely detection of service-generated damage. New technologies for NDE might allow faster examination of boiler components at lower cost, resulting in shorter outages. This project provides the technology, tools, and application support via R&D, applications, workshops, and training required.

Approach

To achieve longer intervals between inspections and overhauls of boiler components, power producers need to detect service-related damage at an early stage. EPRI will develop new NDE techniques or new applications for existing techniques to detect damage sooner than currently possible. This detection is intended to identify a multiyear period during which the power producer must take action to avoid significant risk of failure during service. EPRI also will pursue screening techniques and NDE alternatives that are faster, better, or cheaper than traditional techniques. Guidance will be developed to ensure effective use of NDE tools.

EPRI will research the science and application of continuous monitoring technologies that provide the largest amount of information on damage initiation and progression. In conjunction with remaining-life models developed under P63.002 and P63.003, these approaches will support optimal decisions for component repair or replacement with minimal risk of failure during the service life.

Impact

- Improved reliability and lower O&M costs via reduced risk of service failures
- Extended intervals between examinations through more sensitive and more accurate NDE applied to boiler components
- Reduced O&M costs via more efficient NDE techniques for damage detection
- Demonstration of NDE personnel and technology proficiency, providing companies with more accurate examination results

How to Apply Results

Research results to develop new or improved NDE techniques generally will be licensed to commercial NDE companies that will offer the technology for sale or performed as a service. Larger companies might use the results directly via in-house NDE organizations. Guideline reports to support correct application of NDE technology can be used by members as training guides and for process or procedure improvements with an eye to improving reliability while lowering O&M costs. Technologies will be presented to members via regional workshops, in association with EPRI programs or interest group meetings.

P63.002 Tools for Boiler Component Life Management (103519)

Description

Boiler tube failures (BTFs) consistently are the leading cause of lost availability for fossil power plants, with equipment availability losses due to BTFs averaging around 3% worldwide. Headers and boiler internal piping continue to age and degrade. This project will continue to focus on the technology and tools required to cost-effectively minimize boiler tube failures. The project also will address life management issues associated with high-cost and high-impact boiler components such as tubes, headers, and drums. The project includes support for implementing a boiler tube failure reduction (BTFR) program, life management of headers and drums, and peer-to-peer communications on boiler issues through the Boiler Reliability Interest Group (BRIG).

Approach

Projects will advance the understanding of boiler tube and other pressure component damage mechanisms and their root causes, while establishing programs and corrective actions to control risks of in-service failures. This science and information will be captured in practical guides for fossil plant personnel. As needed, tools for more accurate remaining-life analysis will be created to support the life-management objectives.

Impact

- Improve boiler availability through fewer boiler tube failures
- Lower O&M costs through longer operating lives for major boiler components
- Reduce risk of in-service failures in tubes, headers, and drums

How to Apply Results

Guidance on boiler tubing, headers, and drums can be used by members to establish a BTFR program and perform life-management analyses. Peer-to-peer communications on boiler issues—optimally, through attendance at the Boiler Reliability Interest Group (BRIG) meetings—allow members to take advantage of industry lessons learned. Analytical tools may be licensed to commercial vendors to market the technology, allowing members to apply the tools directly or via a service. Targeted workshops with EPRI staff bring worldwide expertise to members, increasing the benefit of implementing these research results.

P63.003 High-Energy Steam and Water Piping Safety and Life Management (060364)

Description

High-energy steam and water piping failures are among the most important safety and availability issues in fossil power plants. EPRI research has identified key damage mechanisms such as creep, fatigue, and corrosion that can lead to piping failure. Flow-accelerated corrosion (FAC) is a major safety issue in fossil plants. Research continues to refine the understanding of these damage mechanisms and how they are affected by component aging and variation in operating modes for the plant. Safe and reliable operation of piping systems requires active damage prevention, periodic inspection, remaining-life assessment, and repair or replacement programs. These activities require a proactive life-management approach. This project will provide information about damage mechanisms, their root causes, and appropriate responses to ensure safe operation of these piping systems.

Approach

Projects will improve the understanding of damage mechanisms and their root causes, and will establish programs and corrective actions to control risks of in-service failures. Tools for more accurate and cost-effective analysis of damage rates will be created. This project will begin to develop life-assessment tools to address aging of base metal in traditional and advanced ferritic piping systems.

Impact

- Reduce risk of high-consequence failures of high-energy steam and water piping systems by applying tools and guidance developed by this project
- Eliminate FAC as a safety issue in fossil plants
- Reduce O&M costs associated with piping life management by improving inspection accuracy and efficiency
- Reduce O&M costs by lessening very conservative assumptions of piping life and providing more accurate assessment of timing for pipe replacements

How to Apply Results

This program will help members establish a proactive life-management approach to high-energy piping systems and FAC control. It will provide information about damage mechanisms, their root causes, and appropriate responses to ensure safe operation of these piping systems, and will include workshops and training to ensure proper application of life management processes. Advanced analysis tools developed in the project may also be licensed to third parties for application to fossil plants.

Supplemental Projects

Conducting Generation NDE Proficiency Demonstrations and Annual Updates (073385)

Background, Objectives, and New Learning

Advances in NDE technology are leading to the availability of new equipment with the advanced capabilities to perform examinations with better sensitivity and higher resolution at a less expensive cost. Because of this, NDE service companies are beginning to offer advanced NDE in cases in which they historically had only offered conventional NDE. Examples of some of these advancements include phased-array ultrasonic examination, time-of-flight ultrasonic examination, ultrasonic guided wave examination, and digital radiography.

While the industry has some individuals who are quite experienced with the advanced NDE technologies (some were involved in the development), others are being asked to adapt to the newer equipment with little or no training. Some NDE technicians have arrived at power plants with very limited knowledge of setup and calibration of the newer instruments and were unaware of how to evaluate data in the new formats.

This project aims to improve industry NDE capabilities and develop new NDE techniques and procedures. Proficiency demonstrations can assess the current status of industry NDE capability and then improve the current capability by providing constructive feedback to NDE practitioners. New protocol and procedures will be developed for new technologies based on input from utilities, NDE vendors, and NDE service providers. Protocol also will describe how to accommodate demonstrations for international members.

Project Approach and Summary

This project will update existing protocol to accommodate changes for existing technologies, and add new technologies when they become available for demonstrations. Protocol modifications will be distributed to the project participants for review and comment.

The protocol will describe how:

- Demonstrations will be conducted for both U.S. and international members.
- True flaw and sample information will be maintained.
- Results of demonstrations will be evaluated.
- Successful demonstration will be determined.

Proficiency demonstrations will be conducted based on the protocol. A statistical summary of demonstration results will be published at the end of each year, along with any new improvements regarding technologies and procedures.

Design of additional samples also will be part of this project. While the fabrication of new samples will not be covered in this project, the design will be prepared so that individual programs, depending on the components, can then have the samples fabricated.

Benefits

This collaborative effort can improve the industry's NDE capabilities by providing a means for an individual NDE operator to successfully demonstrate proficiency for examination of a certain range of components with a given NDE procedure. New technologies and procedures will be developed based on feedback from demonstrations, utilities, and NDE vendors.

Generation Advanced NDE Development (073626)

Background, Objectives, and New Learning

The majority of fossil plants worldwide are more than 35 years old and are experiencing increased demand for operational flexibility while addressing age-related issues for major components. Safety and availability loss due to pressure part failures are two key issues driving research and development (R&D) on major fossil power plant components, especially in older plants.

The focus of this project is development and application of advanced nondestructive evaluation (NDE) techniques that are not already being addressed by the various Electric Power Research Institute (EPRI) Generation programs related to the major components.

EPRI's Generation Advanced NDE development R&D uses international collaboration to develop technologies and guidance on safe management of power plant component life to ensure high reliability and reduce operations and maintenance (O&M) costs for components. Efforts focus on advanced NDE techniques for early and accurate identification of component damage; analytical tools to predict remaining life and risk of in-service failure; and decision-support tools to help balance risk and benefit under a variety of operating scenarios.

This project provides new technology, tools, and application support to maximize safety and reliability of power plant components and to determine optimal timing for repair or replacement.

Project Approach and Summary

This project will provide R&D for advanced NDE technologies for projects identified by members which are not being addressed by the component-based programs within EPRI. Strong coordination with the EPRI program managers will be maintained in order to ensure that there is no duplication of efforts.

Benefits

Maximizing safety and reliability of power plant components and determining optimal timing for repair or replacement requires accurate and timely detection of service-generated damage. New technologies for NDE might allow faster examination of power plant components at lower cost, resulting in shorter outages.