

Boiler Life and Availability Improvement Program - Program 63

Program Overview

Program Description

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 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 are among the most important safety issues at fossil plants and must be managed reliably through the aging process.

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 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

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

- Reduce cost 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 safety of high-energy and high temperature piping systems.
- 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, with the goal of optimal availability and performance.

- Research for Boiler Component Inspection and Monitoring (P63.001): Develops accurate and cost-effective nondestructive evaluation (NDE) to reduce operation and maintenance (O&M) costs and improve life management options. NDE developments in other industries will also be 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 on how damage mechanisms affect piping components and remaining life tools will be provided. Tools will be developed that allow utilities to more accurately predict 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 source of guidance, training, and analysis tools for flow-accelerated corrosion (FAC) management in fossil plants.
- World leader in developing and demonstrating NDE technologies for boilers, high-energy piping, and FAC.

Current Year Activities

The program R&D for 2010 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.
- Technology and information to support reliable operation of new and advanced fossil boiler designs.

Estimated 2010 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)

Key Research Question

Maximizing safety and reliability of boiler components and determining optimal timing for repair or replacement require accurate and timely detection of service-generated damage. Additionally, 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, it is necessary to detect service-related damage at an early stage. EPRI will develop new NDE techniques for detecting damage sooner than currently is 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 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 highest degree of information on damage initiation and progression. In conjunction with remaining-life models developed under P63.002 and P63.003, these approaches will allow 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 provides utilities 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 utilities 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. Technology will be presented to members via workshops conducted regionally, in association with EPRI programs or interest group meetings.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Inspection Methods for Boiler Tubing Ceramic Coating: Many companies now offer ceramic coatings for boiler tube protection and ash removal. It is unclear how long the usable life of these coatings is. Methods need to be developed to determine remaining thickness of these coatings, so repairs or replacements of the coating may be scheduled. This project will evaluate examination methods for coating life prediction.	03/31/10	Technical Update
Drum Damage Detection and Sizing Guideline: Drum cracking is occurring more frequently as units age and experience cyclic operation. Predicting remaining life and crack propagation requires an accurate assessment of the extent of existing damage. Inspection from the drum's internal surface is difficult because of drum furniture and because multiple cracks may mask larger damage. Inspection from the outside is difficult due to tube locations and dirtiness of the steels used in older drums. Improved crack detection and sizing capabilities are warranted. This project will investigate methods to characterize, measure, and document damage.	03/31/10	Technical Report

Product Title & Description	Planned Completion Date	Product Type
Advanced NDE Systems for Boiler Components: Development of new NDE methods for boiler components. This work may be an application of existing technology, development of new technology, or a combination in which an existing technology is augmented with new hardware in order to apply it to a previously inaccessible location.	12/31/10	Hardware
Workshop on Boiler Component Inspection and Monitoring: The workshop materials developed in 2009 will be packaged as a formal workshop that can be conducted regionally; in association with EPRI programs or user or interest group meetings; or otherwise, based on interest.	12/31/10	Workshop, Training, or Conference

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

Key Research Question

Boiler tube failures (BTFs) are consistently 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 program, performing life management of headers and drums, and facilitating 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 boiler tube failure reduction (BTFR) program and perform life-management analyses. Peer-to-peer communications on boiler issues — optimally, through attendance at the Boiler Reliability Interest Group (BRIG) — allows members to take advantage of industry lessons learned. Analytical tools may be licensed to commercial vendors to take the technology to market, allowing members to apply the tools directly or via a service. Targeted workshops with EPRI staff bring worldwide expertise to members, to increase the likelihood of implementing these research results.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Effect of Operational Variables, Final Report: EPRI has been evaluating the effect of different operational variables on boiler remaining life. Some of these variables include ramp rate during start-up and shutdown, number of cycles, chemistry, and topping off drums on shutdowns. Units have been instrumented to determine the stress caused by these operational variables. Information developed during the last two years will be compiled into a final report.</p>	12/31/10	Technical Report
<p>Update of Boiler Tubing Life Assessment Software: Two software packages have been the industry standard for predicting boiler tubing remaining life in superheaters and reheaters, and both are based on the oxide thickness methodology developed by EPRI. The original package, Tubelife, provided tools to determine remaining life of boiler tubing deterministically and provided good graphical output to guide utilities on tubing replacement. A later software development, Tulip, provided methods to probabilistically predict damage to boiler tubing, but is more suited to single-tube evaluations. This update will incorporate the best from both prior software packages to allow batch processing of oxide thickness data and provide deterministic or probabilistic failure predictions while providing a database for oxide measurements. Improved report output will also be developed.</p>	12/31/10	Software
<p>Boiler Condition Assessment Guideline—Update: EPRI has developed a guideline for boiler components that is the industry standard for determining the amount of time that a component may be operated. This update will provide new information on inspection technologies and remaining-life calculations for specific boiler components and will include information on new materials.</p>	12/31/10	Technical Report
<p>International Conference on Advances in Condition and Remaining Life Assessment for Fossil Power Plants: EPRI conducts the International Conference on Advances in Condition and Remaining Life Assessment of Boiler Components every three years. This conference will present the latest information on managing boiler assets.</p>	12/31/10	Workshop, Training, or Conference
<p>Guideline for Cold Air Balancing for Fly Ash Erosion Control: EPRI has pioneered the use of cold air velocity tests (CAVT) for minimizing flyash erosion damage. Many advances with this technology have been demonstrated since the last guideline was published, including computational fluid dynamics, which may simplify installation of flow control devices used to minimize fly ash erosion. This report will document advancements in the field of CAVT for flyash damage prevention.</p>	12/31/10	Technical Report
<p>Boiler Reliability Interest Group Meetings and Information Exchange: Boiler Reliability Interest Group (BRIG) meetings are conducted during the second weeks of June and December. This meeting provides informal peer-to-peer interfaces to discuss industry issues, new services, and equipment, and to introduce vendors to utility engineers and managers.</p>	12/31/10	Technical Resource

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

Key Research Question

High-energy steam and water piping failures are one of 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 cost 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 replacement.

How to Apply Results

This program will help members establish a proactive life-management approach to high-energy piping systems and FAC control. This project 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.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Development of Creep Indentation Test Methods for Life Assessment: Many hot reheat and main steam piping systems have reached or exceeded design life, yet these systems continue to be operated. A method is needed to predict when these systems will develop risk of failure. A new method of more accurately predicting remaining life will be developed around recently developed small sample creep testing, particularly impression creep tests. Using this test method, small 1-inch (25-mm) samples will be removed from each piping system and tested via impression creep test equipment. Comparison with databases developed by this project will allow utilities to determine if their piping system is at risk.</p>	12/31/10	Technical Update

Product Title & Description	Planned Completion Date	Product Type
Workshop on High-Energy Steam Piping: Regional two-day workshop on high-energy piping life management including traditional and advanced materials.	12/31/10	Workshop, Training, or Conference
Guideline on Piping Stress Analysis and Hanger Testing: As piping systems age, damage accumulates at welds. This damage is accelerated by excessive bending loads that may result from improper piping system design and maintenance of hanger systems. This guideline will include detailed assumptions made in performing a piping system stress analysis, and will show benefits for life assessment of piping systems. The guideline will also provide information about pipe hanger testing and the importance of hanger operation on piping stress.	12/31/10	Technical Update
Cold Reheat Piping and Attemperator Inspection Guideline: The guideline will describe options for inspection of cold reheat lines, desuperheater sprays, and liners. It builds on the cold reheat inspection guidelines. Desuperheater nozzle design and control logic will also be included.	12/31/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Update to High-Energy Piping: Theory and Practice: "High-Energy Piping: Theory and Practice" was issued in 2007. This report will provide an updated guideline on high-energy piping damage mechanisms and remaining life tools that have been developed in the last three years. New inspection techniques will also be included.	03/31/11	Technical Report