171 Circumferential Cracking in Supercritical Walls

Program Overview

Program Description
This program addresses causes and solutions of circumferential cracking of supercritical waterwalls. Although the issue of circumferential cracking is not new and can be attributed to a variety of factors (all of which will be addressed by this program), the deployment of low-NO_x systems and utilization of weld overlays have exacerbated both the severity and the extent of the problem in recent years. The program will acquire data from units exhibiting this problem, and identify the primary mechanisms and root causes through analysis and performance testing at specific sites. Potential solutions will be demonstrated, which may include both combustion as well as steam-side considerations, and guidelines will be developed for issue mitigation and avoidance.

Industry Needs and Issues Addressed
- Methods to extend the availability, reliability, and life-expectancy of the existing boiler fleet
- Minimization of waterwall damage, the leading failure mechanism in supercritical boilers
- Minimization of cracking incidences occurring in weld overlays installed to mitigate fireside corrosion
- Identification of specific root causes and solutions for specific units, as a function of unit design, operation, and fuel quality

Impact
- Improved unit reliability, availability, and longevity
- Elimination of repeat tube failures due to tube cracking
- Extended boiler tube life
- Comprehensive understanding of the major root causes and solutions

Key Accomplishments
- Database of impacted units—including unit design, operating parameters, weld overlay type, and fuel quality—maintained and enhanced as additional data becomes available
- Comprehensive state-of-knowledge report and analysis of root causes
- Findings from demonstrations at specific sites, using advanced temperature and heat flux mapping

Current Year Objectives
- Information about first-order causes at specific sites as a function of design, operation, and fuel quality
- Data analysis and assessment of mitigation methods though changes in unit operation

Industry Involvement
- Estimated 2009 funding: $0.9M

Program Technical Lead
Anthony Facchiano, 650-855-2494, afacchia@epri.com

Summary of Projects

Project Number	Project Title	Value
P171.001	Development of Solutions for Circumferential Cracking	This project will acquire and analyze field data on the causes of circumferential cracking in supercritical waterwalls. Solutions will be demonstrated at specific sites and results documented and disseminated to funders.

Project Descriptions

P171.001 Development of Solutions for Circumferential Cracking (063569)

Issue
Circumferential cracking in supercritical boilers, although not new, has been exacerbated in recent years by the deployment of low-NO_x systems and utilization of weld overlays. As power producers seek ways to extend the availability, reliability, and life expectancy of their existing coal-fired boiler fleet, methods to mitigate or at least minimize the severity of tube cracking need to be developed and demonstrated.

Description
The first step of this undertaking involved an investigation into the primary causes responsible for tube cracking. An ongoing data base of impacted units, together with field assessments (e.g., using advanced methods to map absolute and differential tube temperatures and heat fluxes), will continue to yield understanding of and insights into first-order mechanisms and causes. Going forward, this program will focus on the development and demonstration of methods to mitigate, or at least minimize, cracking severity, consistent with maximum unit longevity.

Value
- Improve supercritical boiler reliability, availability, and longevity.
- Minimize the number of costly boiler tube failures.
- Develop and apply tools to quantify absolute and differential temperatures and heat fluxes, and quantify cracking occurrences (e.g., both with respect to size and number).
- Develop and apply guidelines to address all aspects of tube cracking.
- Provide input for design specification for new and retrofitted supercritical plants to minimize cracking risks.

How to Apply Results
Utility staff responsible for boiler systems reliability and performance can use this project's findings to help mitigate circumferential cracking occurrences at their coal-fired facilities. Application of mitigation methods developed will pertain to boiler operations (both combustion and steam side), material-based considerations, and fuel quality.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Advanced NDE Procedures: This project will demonstrate advanced crack depth estimation techniques.	12/31/2009	Technical Update

Product Title & Description	Planned Completion Date	Product Type
Demonstration of Coating Technology: This project will demonstrate alternative measures to protect existing weld overlays from fireside corrosion. These measures may include ceramic or thermal spray coatings or advanced (e.g., thinner, advanced materials) overlays.	12/31/2009	Technical Report
Model for Thermal Fatigue: An advanced model will be developed that includes both steam and fireside parameters. Input will include heat flux and thermocouple data, as well as fluid flow and thermal-hydraulic parameters. The model will provide insight into crack initiation and growth.	12/31/2009	Technical Update
Data Base of Units Impacted by Circumferential Cracking: The circumferential cracking database will be updated as new information becomes available. Information will include both combustion and steam-side parameters, and will yield insights into root causes and mitigation methods, and serve as a predictive tool for assessing the impacts of unit design, operation, and fuel quality.	12/31/2009	Technical Resource
Onsite Assessments and Demonstrations: Advanced thermal and heat flux mapping systems, as well as steam-side heat transfer measurement methods, will be deployed on specific units for extended periods to assess operating conditions that yield high thermal transients and peaks. Changes in unit operation will yield insights into ways to mitigate these transients and peak thermal loads to minimize circumferential cracking.	12/31/2009	Technical Update
Summary of Causes and Corrective Actions: A document summarizing P171 results for several years will include primary causes of circumferential cracking formation and mitigation methods. The document will detail the interrelationship between the primary mechanisms of thermal fatigue, high temperature creep, and corrosion.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Data Base of Units Impacted by Circumferential Cracking: This project will continue the circumferential cracking database, including both combustion and steam-side parameters.	2010	Technical Resource
Predictive tool for circumferential cracking: This project will develop a predictive tool based on unit design, operation, fuel and ash constituents, and tube and overlay materials.	2010	Technical Report
Advanced NDE Procedures: This project will provide final documentation of demonstrations of advanced crack depth estimation techniques.	2010	Technical Report

Product Title & Description	Planned Completion Date	Product Type
Circumferential Cracking Causes and Solutions: A comprehensive report of findings will be produced, including causes and mitigation methods.	2011	Technical Report