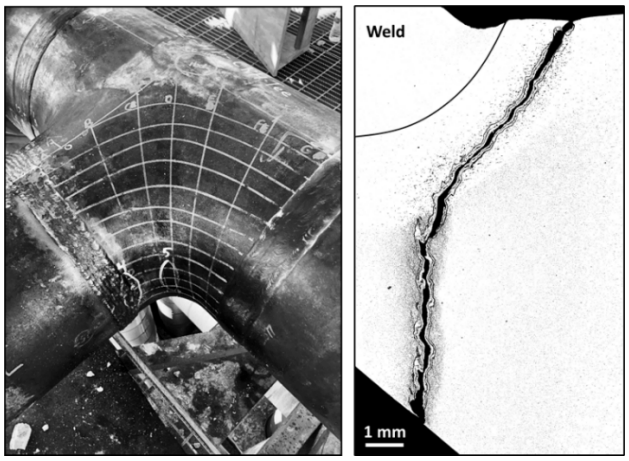
Integrated Life Management of Tee Intersections in High Temperature High Energy Piping Systems



- Establish an informed and technically defensible strategy for screening large populations of tee intersections in a plant or fleet
- Assemble comprehensive database of components and service experience to inform improved guidelines for replacement components
- Transfer important learnings and/or simplified approaches for future design requirements to the relevant Code or Standard

Background, Objectives, and New Learnings

More than 5 leaks have occurred over the last year in seamless tee intersections installed in high energy piping systems (main steam or hot reheat) operating for ~35,000 to 100,000 hours, and in grade 91 or 92 steels. Initial investigations performed by EPRI confirm the primary concern is the evolution of creep-dominated damage in the branch weld HAZ (tee or branch-side), the main run HAZ (tee or pipe-side), the tee crotch, and potentially the tee flank (or saddle) position. The widespread nature of damage suggests these components are not fit for purpose.

The primary objective of this supplemental project is to develop a comprehensive life management methodology empowering project members to identify at-risk tees across a fleet, prioritize future inspection(s), clarify relevant inspection or analysis technique(s), database failures, and issue improved guidelines for replacement components.

Benefits

The research generated from this supplemental project is expected to increase the future reliability and safe operation of replacement components, and to inform inspection prioritization for the existing fleet. EPRI has a recent and well-established track record of issuing publicly available life management guidelines or specification documents for public use to reduce the uncertainty in future component performance.

Members who fund this effort will obtain the necessary insight, guidance, and documents to implement an integrated life management strategy specific to tee intersections. This information will greatly reduce the risk to continued operation of at-risk components while providing the critical information to inform targeted and/or widespread replacement of affected tees.

Project Approach and Summary

Task 1 – Case studies. The identification, collection and population of well-pedigreed case studies are essential to informing procedures and assumptions for screening large populations of at-risk components. With respect to tee intersections, it is essential to address the following aspects of an integrated life management strategy:

- Hot reheat versus main steam
- Local geometric details of the weld profiles, tee reinforcement, etc. A database of actual geometries is critical to bound the population.
- Metallurgical risk
- Assessment of damage in ex-service tees, including consideration of damage through the HAZ thickness in the branch and run welds, the midwall crotch position and the near-surface flank or saddle position
- The association of damage with stress state, including consideration of local or average input values and comparison to simplified approaches which may include but not be limited to reference stress solutions, allowable stress values, stress intensity factors, etc.

Task 2 – Macro-screening tools/methodologies. It is imperative that macro-screening be validated and/or benchmarked by actual field failures for which an increasing number of examples are being made available to EPRI. A

macro-screening procedure may include a simple spreadsheet tool with inputs for hourly operating data for temperature and pressure, a simplified stress value informed by Task 1, metallurgical risk based on composition and damage summation on an hourly basis.

Task 3 – Specification. Replacement parts will be required to ensure the safe and reliable future operation of high energy piping systems. To inform this task it is anticipated to perform the following:

- Gap analysis of the available language in governing codes and standards including ASME B31.1, ASME B31.3, ASME B16.9, ASME Section VIII, ASME Section I, etc.
- Workshop(s) with stakeholders (codes and standards, suppliers, end-users, designers) to define what is being supplied, practical constraints for improved tee manufacturing and socialization of field observations
- Parametric design study to inform improved geometries for operation in the creep regime
- Development of simplified design rules (if existing language cannot be used)

Task 4 – Technology transfer. Existing tees are being fabricated by a number of suppliers around the world. This task will involve not only taking forward information to the relevant codes and standards, but also to ensure that the supply chain is sufficiently informed of the challenges and can produce fittings to the recommendations provided in Task 3.

Task 5 – Additional implications. As funding permits, extension of findings to cursory review of other fittings like elbows or reducers to ensure additional fitting geometries are not at an increased risk to damage development within the plant operational life. Such considerations may also be extended to issues in welded intersections that have been well-documented in the energy industry.

Deliverables

The expected deliverables from this project may include:

- Recommended inspection protocol(s)
- Development of a robust database of case studies
- Tools (e.g., spreadsheet or web-based tool) allowing for the screening of large populations of at-risk components
- Replacement component specification

Regular project updates will be hosted by participating members and/or EPRI. These updates are expected to include opportunities for information exchange face-to-face or in a web-based or hybrid platform.

Price of Project

The project is $30,000 per year for a total commitment of three years of $90,000. The project qualifies for self-direct funding (SDF) and tailored collaboration (TC).

Project Status and Schedule

The project was initiated in August 2022. Five members are necessary to formally start the project. This project will require 36 months to execute.

Who Should Join

An end-user who has a modern supercritical coal fired unit or combined cycle plant and has seamless tee intersections operating >1,000°F (540°C).

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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