



THETA TECHNOLOGIES
GAME CHANGING NDT

Grade 91 Steel Early-Stage Creep Damage Detection

Requirements for power plants to operate at higher temperatures and to withstand more frequent cycling have resulted in increased usage of Creep Strength Enhanced Ferritic (CSEF) steels such as P91. The benefits of P91 steel include greater strength, allowing increased safety margins, longer component life, and reduced wall thickness for lower thermal stress during cycling. These power plants can operate at increased steam temperatures and pressures, helping to improve thermal efficiency and reduce CO₂ emissions.

However, the superior creep properties of this grade of steel are largely dependent on its microstructure, so its handling, operating and fabrication requirements are much stricter than for the chromium-molybdenum alloy steels it replaces. **Inspections of critical power plant components sometimes detect premature material failures caused by creep well before the expected service life of the component.**

Doosan Babcock commissioned Theta Technologies (Theta) to investigate whether our uniquely sensitive non-linear acoustic NDT techniques could detect early-stage creep damage within the Heat Affected Zone (HAZ) of cross-welded P91 samples¹.

Early-stage creep damage begins as microvoids at grain boundaries within the material, which join under continued stress to form microcracks. **In P91 steel these voids and cracks are below the surface, and are too small to be detected by conventional ultrasonic testing.**

The samples were taken to Theta's laboratory in Exeter, UK, where they were scanned with our unique and patented non-linear acoustic NDT capability. **Figure 1 shows a sample of the variation in non-linear behaviour around the weld, clearly demonstrating our ability to detect changes in the material microstructure.**

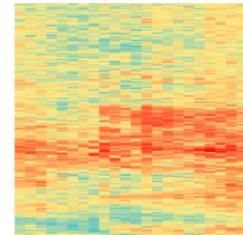


Figure 1 – 'Heat map' of non-linear behaviour within the HAZ of a welded P91 sample.

To find out how we can help you, or to book a demonstration, please contact us:

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¹ Samples provided by EPRI – the Electric Power Research Institute, Inc.