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Office of Nuclear Regulatory Research

xLPR Version 2 Code Brings State-of-the-Art Probabilistic Analysis Capabilities to Nuclear Power Plant Piping

What Is xLPR Version 2 (V2)?

- A new, production-ready probabilistic fracture mechanics software tool for piping integrity risk analysis
- A joint effort by the NRC's Office of Nuclear Regulatory Research and the Electric Power Research Institute (EPRI)

Public Release

- NRC and EPRI focused working to establish of a suitable framework for public distribution
- Plans to eventually establish a user's group, similar to those created for other NRC codes

Progress

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Probabilistic fracture mechanics analyses, performed using tools such as xLPR V2, allow for the direct representation of uncertainties. They rely on best estimate models and repeated sampling of inputs represented by probability distributions to produce a range of possible results. In this way, probabilistic fracture mechanics permits direct assessment of the impact of uncertainties on the end results, and it gives the user the ability to determine and refine drivers to the problem.

Software Capabilities

xLPR V2 brings a breadth of modeling capabilities for the analysis of potential nuclear power plant piping failures:

- PWSCC
- Thermal and Mechanical Fatigue
- Crack Initiation
- Aleatory and Epistemic Uncertainties
- Leakage Rate Calculations
- Residual Stress Effects
- Water Chemistry
- Ultrasonic Inspections
- Seismic Effects
- Stress and Material Mitigation

Probabilistic fracture mechanics can be used to gain greater insights into the structural integrity of piping and other components.

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State-of-the-Art

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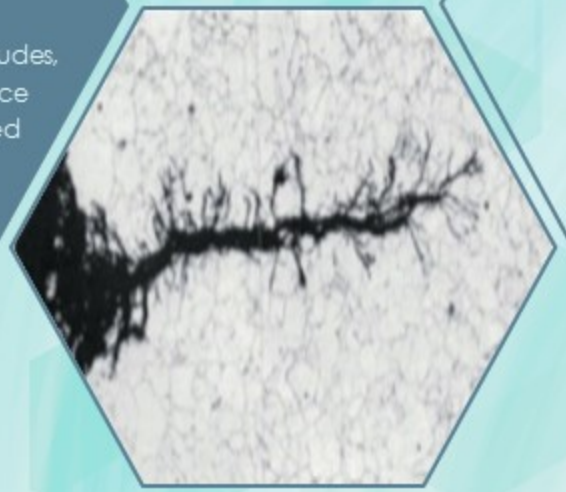
Leak-Before-Break

- Deterministic analyses reviewed against NRC NUREG-0800 Standard Review Plan (SRP) Section 3.6.3
- Allows removal of pipe whip restraints, jet impingement barriers under 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 4

PWSCC

- Degradation mechanism active in pressurized-water reactors after leak-before-break approved
- SRP Section 3.6.3 precludes, but ongoing compliance has been demonstrated qualitatively



xLPR Role

- Provide quantitative insights to ensure long-term safety and GDC 4 compliance

Technical Approach

- Sensitivity studies to determine problem drivers
- Analysis of failure probabilities of real-world piping systems
- Generalization study of pressurized-water reactor fleet
- Development of regulatory guidance

First Safety Application

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