U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Extremely Low Probability of Rupture (xLPR)

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Background

- Purpose: Determine whether the deterministic approach for evaluating leak-before-break, as outlined in the "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (NUREG-0800), Section 3.6.3, continues to ensure that the probability of piping system rupture is extremely low when considering the presence of primary water stress-corrosion cracking (PWSCC).

- Collaborative effort between NRC/RES and the Electric Power Research Institute, Inc. (EPRI) culminating in xLPR Versions 1 and 2

xLPR Version 2 Key Developmental Documentation

- Supports NRR review
  - Completed xLPR Version 2 Code
  - User Manual
  - User Training
  - External Review Board Reports
  - Primary Water Stress-Corrosion Cracking Initiation Model Parameter Development, Confirmatory Analyses, and Validation
  - Verification and Validation Testing Results
  - Sources and Treatment of Uncertainty
  - Summary NUREG

Maintenance and Distribution

- NRC/RES and EPRI completed Addendum to their Memorandum of Understanding on Cooperative Nuclear Safety Research to provide for code maintenance, support, and distribution
- Maintenance
  - Conduct under rigorous quality assurance program as in code development
- Distribution
  - Domestic: Finalizing arrangements with third-party distributor/maintainer
  - International: Parameters being developed

Version 2 Code Leak-Before-Break Applications

- Sensitivity Studies
  - Focus: Identify which models and inputs contribute most to uncertainty and spread in the output
  - NRC/RES approach developed and exercised through study of V.C. Summer and Tsuruga
    - Findings: Top 3 parameters (all are inputs to PWSCC initiation models)
      - Proportionality constant
      - Proportionality constant multiplier
      - Welding residual stress at the inside diameter
  - NRC/RES approach compared to EPRI-sponsored approaches
    - The following methods were considered adequate and provided similar results:
      - Structural Integrity Associates: Most Probably Failure Point Direction Cosines, Degree of Separation
      - Dominion Engineering: Machine learning: Gradient Boosting Decision Trees, Random Forest Decision Trees, Linear Support Vector Machines
      - Engineering Mechanics Corporation of Columbus: Linear or Rank Stepwise Regression, Recursive Partitioning, Multivariate Adaptive Regression Splines

- Piping Systems Analyses
  - Focus:
    - Generate system-level leak-before break results (i.e., consider multiple welds)
    - Exercise proposed acceptance criteria
    - Assess effects of enhanced inspection and mitigation techniques
  - NRC/RES results to be compared with independently generated results sponsored by EPRI