xLPR Update Planned/Proposed Industry Uses

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xLPR Update Agenda

- Leak-Before-Break (LBB) Application
- Estimation of LOCA Frequency for Fuels
 - Public Meeting
- Small Line LBB
- MRP-456
- New and Future xLPR Projects

	PR-2.1.gsp)			- 0
xLPR G	lobal Settings Dash	board		Version
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Sample Size 1 (Display only) 1 Related Epistemic Sampling Inputs (Display Only) Importance Sampling Internal		Sample Size (Display only) 20 Related Aleatory Sampling Inputs (Display Only) Importance Sampling Adaptive Sampling None No		Run TIFFANY When Excel Input Set opens, select 'Enable the add-in for this session only: 'Double check all values highlighted in pink to see if they have changed. Go to the
Discretization No	Number of Strata* 1 Number of strata must be an integer greater than 1 and less than the	Discretization No	Number of Strata* 10 "Number of strata must be an integer greater than 1 and less than the aleatory sample size	top ribbon and select XLPR Preprocessing' click on 'Run TIFFANY: Pre-Mitigation State' and let the code run. Click on 'Run TIFFANY: Post-Mitigation State' and let the code run. (Optional) Click on 'Inspect SDF Database' to check the output generated/input used.
	epistemic sample size			



LBB Application Update

- EPRI-MRP is developing a series of MRP reports documenting various xLPR application studies and recommendations
 - 1. xLPR-LBB Application Summary documentation of collaboration work with NRC RES (2022)
 - Include index and summary of all xLPR runs made in the single weld analysis and generalization study (not just NRC runs in the TLR)
 - General discussion on combining single weld results into a system or plant wide conclusion
 - 2. Correlation between Deterministic LBB and Probabilistic LBB (2023)
 - 3. Small Line LBB (2022/2023)
 - Additional details later in presentation
 - 4. Use these individual reports to build a compendium of significant considerations, lessons learned, and recommendations for probabilistic applications (2023)
 - Additional discussion/guidance on PFM acceptance criteria
 - Potentially revising the report from time to time to include additional insights as the relevant experience base from application projects expands



Estimation of LOCA Frequency for Fuels Application

- An EPRI study to determine alternative licensing approaches for high burnup fuels (EPRI 3002018457) identified two topics in which input from the xLPR code is desired
 - 1. Probability of Large and Medium Break LOCAs in PWRs
 - 2. Whether leakage may be detected in sufficient time to allow reactor shutdown precluding rupture
- To inform these topics EPRI has embarked on a two-phase project
 - Objective: Perform Probabilistic Fracture Mechanics (PFM) evaluation using xLPR to calculate the probabilities of LOCAs in PWRs as a function of line size and develop statistics on time between detectable leakage and rupture





Estimation of LOCA Frequency for Fuels Application

Phases

- Phase 1 complete
 - <u>EPRI 3002020358</u>, "An Assessment of xLPR Estimation of Loss-of-Coolant Accident Frequencies" was <u>published</u> in October 2021
 - Investigated the feasibility of using xLPR to develop analytically derived LOCA frequency estimates to complement and compare against those in NUREG-1829
 - Compiled estimates of time from leak-to-rupture
 - "Proof-of-concept" assessment to develop methodology
- Phase 2
 - Extend the methodology to a variety of other lines included in the scope of NUREG-1829
 - Currently gathering inputs and creating the run matrix for the PWR lines in NUREG-1829 that remain unanalyzed
 - Chemical volume and control system
 - Residual heat removal
 - Safety relief valve lines
 - Pressurizer spray lines
 - Once data gathering is complete the case matrix will be finalized and new runs can begin
 - Use the soon to be released xLPR V2.2 code



Public Meeting

- A public meeting is planned to discuss further details on EPRI's use of xLPR in support of the broader Fuels Alternate Licensing Strategy
 - June 14th, 1:00 PM
- Topics to be discussed include:
 - Alternative Licensing Strategy Overview
 - Scoping Study Overview and Key Outcomes
 - Phase 2 Scope Description
 - Case Matrix Development
 - Inputs Development
 - Schedule



EPRI

Small Line LBB

- Objective: Explore LBB applicability to smaller line sizes below what is currently supported under US regulations by deterministic LBB – NPS 6 (DN 150) – using the xLPR code
 - Focused on PWSCC-susceptible DM welds
 - The evaluations considered a single initial surface crack as well as multiple cracks that have coalesced to form one long circumferential crack and the effect of mitigation by Weld Overlay
- Results
 - The study demonstrated the limitations in the underlying assumptions of deterministic LBB (e.g., throughwall flaw) and the broader insights that can be derived from a probabilistic methodology
 - Highlighted limitations in applying LBB to small diameter DM welds in the presence of PWSCC since rupture by surface cracks instead of through-wall cracks cannot be summarily dismissed (break-beforeleak)
 - WRS profile used in the evaluation has strong influence on the probability of rupture
 - In agreement with several other xLPR projects
 - When mitigated by Weld Overlay the occurrence of rupture is nearly zero
- EPRI report to be published late 2022/early 2023

Summary to be published in PVP2022-86180



Assessment of Small Diameter DM Weld Inspection Intervals Using xLPR (MRP-456)

- Purpose: Utilize xLPR with MRP-420 crack growth rates to assess the prospect of aligning all unmitigated dissimilar metal (DM) butt welds at Cold Leg temperatures to the same inspection interval
- The PFM conclusions are summarized as follows:
 - The proposed 10-year inspection interval for the Medium DM butt welds met the acceptance criteria
 - The proposed 10-year inspection interval for the Small DM butt welds were conditional on two 7-year inspections having been previously performed
- The DFM evaluations indicate that sufficient margin exists to support an extended exam interval
 - Plants must demonstrate plant-specific applicability to the analysis
- <u>Materials Reliability Program: Evaluation of Cold Leg Piping</u> <u>Dissimilar Metal Butt Weld Inspection Frequencies (MRP-456)</u>

Small Weld	< NPS 8
Medium Weld	>NPS 8 (< RCL)



New and Future xLPR Projects

- Identification of efficiency improvement options for the xLPR Framework
 - Goal of improving code efficiency allowing for simplified analyses and more diverse options for new applications
- Evaluate incorporation of IGSCC for BWR applications
 - Identify changes needed for xLPR to accommodate IGSCC
- Identification of Large Break LOCA Reduction Opportunities
 - Goal of identifying opportunities where xLPR can be used in a similar manner to the High Burnup Fuels alternate licensing approach to reduce the burden associated with Large Break LOCA
- Build on inspection optimization opportunities and expand on MRP-456
 - Results for several projects, although limited, show the probability of rupture after mitigation is extremely low



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