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PFM Regulatory Guide Update

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Purpose

- Provide update on PFM Regulatory Guide status
- Provide thoughts on EPRI 3002014590 with respect to PFM minimum expectations

PFM Reg Guide Update

- PFM TLR final version published 09/18/2018
- Draft technical basis PFM NUREG draft being prepared for internal review
  - Tiered approach for PFM quality still under discussion based on BWRVIP 2019-016 white paper
- Draft report titled “Application of Probabilistic Analysis Techniques in Probabilistic Fracture Mechanics” under internal review
  - Illustration of PFM analysis techniques via simple examples
  - Support for PFM NUREG
- Draft RG under development
  - Early draft needs to be updated to incorporate tiered approach concepts based on BWRVIP 2019-016 white paper
- Publication target for draft reports and draft RG: October 2019
  - NRC will request comments from public on all three documents

EPRI 3002014590

- EPRI Document was sent to NRC staff for information
- Document provides basis for SG Nozzle weld and inner radius inspection intervals
- Did a quick comparison (not thorough review) between document content and BWRVIP 2019-016 – in the context of the PFM Reg Guide
- Highlights are presented here

Models

- EPRI docs states: Document the model or models to a sufficient level of detail that a competent analyst already familiar with the relevant subject area could independently implement the model(s). Provide a basis for all significant aspects of the model(s)
- Flaw distribution: PVRUF used during BWRVIP-05
  - Shows distribution, flaw length, shows equations 
  - Points to SI document for evaluation procedure? 
  - Flaw assumed were previously approved by NRC 
- WRS
  - 1993 paper, assumes constant, no data shown, no uncertainty, no discussion 
- How is POD model used? Like xLPR? 

Inputs

- EPRI doc says: The inputs to the PFM analysis must be documented in detail. The reason why the input basis is considered sufficiently reliable for the PFM analysis application should be provided. If the input basis comes from another document, the reference should be clearly defined
- Transients
  - FE was used to develop stresses, ✓
  - Basis for distribution is unknown, some places says constant, others random ?
- Fatigue Crack Growth
  - refers to xLPR for inputs ✓
  - but does not explicitly list threshold values used. ?
- Toughness
  - Basis for toughness is not clear – is it conservative? Uses VIP-108 as basis, but is 200ksi-in^0.5 appropriate? Why put standard dev on conservative value? ?

Convergence

- EPRI doc says: Explicitly demonstrate convergence for all temporal and spatial discretizations, as well as statistical convergence of the Monte Carlo simulation
  - Not mentioned much. 10million realization for probabilities <1e-6 ?
  - One sensitivity study, looked at critical case with prob =1e-6

Software/QA/V&V

- EPRI doc says: Identify the applicable QA program, plan, and/or procedures, as well as the QA standards met. Include confirmation that the verification and validation cover the ranges of input values considered in the submittal
  - Report says all complete, but no details in report, are references available?
  - Is there a self-contained tech basis document? Users manual, software plan, testing report all available
  - Benchmarking with two cases – enough?

Uncertainties

- EPRI doc says: This should include descriptions of the pseudo-random number generation, sampling methods, sampling frequencies, and applied spatial or temporal discretization
  - Not really mentioned. Provide sampling details for all reported runs?
- EPRI doc says: Discuss the basis for any conservative treatments of input values or models
  - If inputs are conservative (toughness), does it make sense to make them random? What is the impact on output uncertainty?
  - Basis/impacts for assuming surface breaking flaws?

- EPRI doc says: Include a summary discussion of key uncertainties or biases stemming from assumptions and simplifications to make real world phenomena tractable, based, at a minimum, upon qualitative assessment
  - Not really discussed

Sensitivity Analyses/Studies

Sensitivity Analyses

- EPRI doc says: The PFM submittal should include an assessment of input importance, with the objective to identify the subset of inputs that have the greatest impact on the analysis results or conclusions. ✓
  - Used degree of separation
  - Analyses look good, but why was toughness lowered? ✓
  - What was the multiplier on stress and how was it random?
  - Why bias an input in sensitivity analyses? That will bias the importance factor ?

Sensitivity Studies

- EPRI docs says: Revisit the most important inputs and discuss how the values or distributions for the most important inputs were confirmed to be treated appropriately ✓
  - Looked at all relevant variables
  - But some details/basis are lacking.. why were choices made? ?
  - Poisson distribution… what is it?
  - App L POD?
  - Why was aspect ratio set to 1

Other Thoughts

- Self-contained basis – details can be added to make the discussion more self-contained and not just reference documents

- Consistency throughout. Example: Transients - 8.2.2.4 suggests random, base case suggests constant

- Random variables: Still difficult to follow what was random and what parameters were used for each case: Table of inputs might help (including distributions and values used)

Next Steps

- More detail is needed to fully describe how work meets expectations
- What are EPRI plans for this (3002014590) document?
- If we want to get into more detail, suggest separate public meeting