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Motivations, Plans, and Status for the Development of PFM Regulatory Guidance

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Public Meeting
Development of Guidance for Probabilistic Fracture Mechanics (PFM)
December 12, 2017
Rockville, MD, USA

Outline

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- PFM Background
- Need for PFM Regulatory Guidance
- PFM Regulatory Guidance Development Project
- Current Progress and Schedule

PFM Background (1/2)

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- Different way of looking at engineering problems
  - Probabilistic and deterministic fracture mechanics both address uncertainty, but differently
  - No longer single deterministic conservative analysis
  - Many deterministic analyses with randomly sampled inputs
  - Statistics performed on collection of outputs to determine probability of an event

- Probabilistic fracture mechanics (PFM) has potential to address technical and regulatory issues in the U.S.
  - Pressurized thermal shock
  - Leak-before-break
  - Alternative nondestructive examination frequencies

PFM Background (2/2)

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- PFM software in the U.S.
  - FAVOR
  - xLPR v2
  - Proprietary industry codes

- Regulatory challenges: difficult for NRC staff to reproduce or verify PFM calculations
  - Complex regulatory review
  - 'Black Box' codes with insufficient vetting of inputs and code: low confidence in output
  - Examples where the documents could not be accepted as regulatory basis for long term inspection programs under NRC rulemaking
    - MRP-105, "Materials Reliability Program Probabilistic Fracture Mechanics Analysis of Pressure-Water Reactor [PWR] Reactor Pressure Vessel Top Head Nozzle Cracking," dated April 2004
    - MRP-113, "Materials Reliability Program Probabilistic Fracture Mechanics Analysis of PWR Reactor Pressure Vessel Top Head Nozzle Cracking," dated July 2004
    - xLPR in part a result of these unsuccessful PFM efforts

- Latest developments at U.S. NRC regarding PFM
  - Improvements to the FAVOR code
  - Release and application of xLPR v2
  - PFM Regulatory Guide development

Need for PFM Guidance

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- With FAVOR v16.1 and xLPR v2.0, NRC expects increase in number of industry PFM submittals
  - PFM calculations with new or modified PFM codes
  - Proposed alternatives to ASME BPVC and ASME Code Cases
  - Relief requests and topical reports

- Need to develop a regulatory guide to better inform applicants using PFM as a technical basis to support relief requests, license amendment requests, and topical reports

- The Regulatory Guide will promote acceptable path for PFM regulatory analyses
  - Technical correctness and rigor
  - Quality Assurance
  - Documentation
  - Transparency

- Objectives of PFM guidance development project:
  - Clearly outline NRC expectations for PFM regulatory applications
  - Increased confidence in PFM analysis results
  - More predictable regulatory outcomes

PFM Regulatory Guidance Development Project Overview and Schedule

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- Project driven by User Need NRR-2016-004

- Phase 1: Technical Letter Report (TLR): now
  - High level document
  - Goal: highlight some important PFM concepts
  - Final Draft available: ADAMS ML17335A048

- Phase 2: Draft Guide (DG) and supporting NUREG technical basis: late 2018 target
  - Version 0 of DG under review and revisions (internal to NRC)
  - NUREG technical basis under development (internal to NRC)
    - To be informed by pilot study lessons-learned, NRR review, and feedback from public meetings

- Phase 3: Pilot study: late 2018 target
  - GOAL: test and correct guidance being developed, as needed
  - Initial definition of pilot study underway
    - xLPR: collection of fictitious piping failure analysis problems
  - Subsequent pilot studies TBD

Summary

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- Increased role of probabilistic methods and PFM for nuclear regulatory applications in U.S.
- PFM regulatory guidance being developed by NRC: acceptable path for PFM regulatory analyses
- Project started in 2016, DG target is late 2018
- 3 phases:
  - TLR
  - DG + NUREG Technical Basis
  - Pilot Study