

**EPRI Questions on Probabilistic Fracture Mechanics (PFM) Public Meeting Held on  
12/12/2017 (08:00 – 11:00 EST)**

- Q1: What are the specific reasons that a PFM Regulatory Guide (RG) is needed other than because it is in response to an NRC Office of Nuclear Reactor Regulation (NRR) User Need Request? We do not understand the need for PFM guidance any more than we see a need for guidance for other technical areas, such as “finite element analysis (FEA) guidance.”

*NRC Response: NRC expects an increase in the number of regulatory applications using PFM as a technical basis. Past experience with PFM submittals is that reviews have been long and challenging, resulting in many rounds of RAIs. This is in part due to the lack of guidance for PFM analyses, which has resulted in inconsistent degrees of quality in the submittals, as well as inconsistent scope of associated reviews. NRC is working towards the creation of a Regulatory Guide on PFM analyses to increase consistency in both applications and reviews related to PFM, and to reduce regulatory uncertainty. The guidance will cover the level of quality that should be met when developing PFM codes, as well as the methodology to be used when performing PFM analyses.*

- Q2: The Technical Letter Report (TLR) identifies several EPRI MRP reports that the NRC had difficulty in reviewing. Some of these reports, such MRP-335, seem to clearly address the aspects identified in the TLR as being needed to establish confidence in a PFM application. Can the NRC provide an example list of documents that the NRC believes were inadequate from a PFM perspective and clearly articulate a list of the NRC's perceived shortcomings for each document?

*NRC Response: Many past industry submittals have included PFM analyses. These analyses were not directly used by NRC as the sole factors in regulatory decisionmaking. Instead the NRC staff used the probabilistic analyses in combination with deterministic analyses to confirm reasonable assurance of the acceptability of the application. Some issues that have been identified in past PFM submittals include incomplete uncertainty characterization, lack of review of the PFM code, incomplete PFM code technical basis, incomplete code V&V, lack of acceptance criteria for the PFM code and analyses, and ignoring the tenets of risk-informed decisionmaking.*

- Q3: The NRC Office of Nuclear Regulatory Research (RES) previously had an internal work action associated with their Extremely Low Probability of Rupture (xLPR) Project to develop a RG. An early draft of a “Leak Before Break (LBB) RG” was prepared by NRC staff in the early 2000s, and that RG was put on hold pending completion of the xLPR Project. The NRC’s internal work action plan was to re-visit the older “LBB RG” and complete it, perhaps changing it into an “xLPR RG”. Since xLPR is a PFM Code, by nature the “xLPR RG” would need to address PFM methods. Is the RG that the NRC described during this public meeting and the associated TLR the same RG, or is it a different RG? If it is a different RG, is the NRC still planning to develop the “xLPR RG” and, if so, why is there a need for two PFM RGs?

*NRC Response: The PFM Regulatory Guide discussed at the public meeting is separate from the LBB Regulatory Guide that may be associated with xLPR. The PFM regulatory*

*guide deals with the mechanics and use of any PFM code for regulatory applications. The LBB Regulatory guide, if deemed necessary, will focus on the analyses and acceptance criteria needed to satisfy the GDC-4 criteria for dynamic effects of pipe breaks, which will reference the PFM Regulatory guide. Work on the LBB Regulatory Guide has not formally started, and a final decision on whether such a Regulatory guide is needed or will be produced will be made once the ongoing research program on LBB is complete. The ongoing research program is being performed cooperatively with EPRI under a Memorandum of Understanding.*

Q3, Part 2: Assuming the proposed PFM RG is different than the “xLPR RG,” and since we understand the purpose of RGs is to provide guidance on existing regulations, what regulation does the PFM RG provide guidance on?

*NRC Response: The PFM Regulatory Guide is broader than a single regulation, and is to provide general guidance on the use of PFM codes and PFM analyses for regulatory applications that may use PFM as a technical basis.*

*Examples of such applications include PTS demonstrations for RPVs, potential future LBB demonstrations for systems with active degradation mechanisms, and peening for RPV upper heads (MRP-335). This type of regulatory guide is similar to that developed for the adequacy of PRA assessments, i.e., RG1.200*

Q5: Slide 15 of the NRC’s presentation entitled, “Overview of Draft Technical Letter Report on Important Aspects of Probabilistic Fracture Mechanics (PFM) Analyses” that was presented during the public meeting discusses Verification and Validation (V&V) associated with PFM computer codes. The NRC’s message is contradictory. The implication from this slide is that PFM codes should be developed in accordance with 10 CFR 50 Appendix B/ASME NQA-1 Quality Assurance (QA) programs. However, the NRC has published Federal Regulations (e.g., 10 CFR 50.61a, the Alternate PTS Rule) using their FAVOR PFM code. The NRC does not have an established QA Program in accordance with 10 CFR 50 App. B/ASME NQA-1, nor was FAVOR developed in accordance with such a program. Therefore, it appears based on this past example that there are ways to develop PFM codes without stringent QA requirements. Please articulate clearly what the NRC is advocating with regard to QA requirements for their planned PFM guidance and how that QA guidance is consistent with the NRC’s past use of PFM computer codes.

*NRC Response: In general, the level of QA should be commensurate with the safety significance of the application of the PFM code. The levels of QA that will be recommended in the Regulatory Guide have yet to be defined and agreed upon. However, it is important that aspects such as transparency, repeatability, reliability, verification and validation are addressed and properly documented to aid the regulatory acceptance of any computer code used in safety significant regulatory applications.*

Q6: In reviewing the NRC’s TLR, there are several other terms that are very important to PFM that are missing in the “Definitions” section, nor are these terms discussed anywhere in the TLR. For example, “Acceptance Criteria,” “Core Damage Frequency (CDF),” “Large Early Release Frequency (LERF),” etc. Furthermore, the NRC indicated during the December 12<sup>th</sup> public meeting that identification of appropriate acceptance

criteria is one of their significant challenges in acceptance of PFM. Any discussion regarding acceptance criteria seems notoriously absent from the TLR. Why aren't terms such as these, which seem basic to PFM evaluation, included? Furthermore, how does the NRC intend to address issues regarding acceptance criteria if they are not addressed in the proposed RG?

*NRC Response: The proposed PFM Regulatory Guide does not focus on acceptance against any particular metric; instead it focuses on developing a robust and defensible PFM analysis. Acceptance criteria will be application-specific, and it is not practicable to specify such acceptance criteria in a Regulatory Guide aimed at all possible applications of PFM.*

- Q7: Why is the xLPR Code the only PFM Code listed in the “Definitions” section of the TLR? This and other content in the TLR leads us to believe that the NRC is developing an “xLPR-centric RG,” which is disconcerting because it implies that the xLPR Code is the standard by which all PFM codes will be measured. Such a standard would not promote use of PFM in the industry because of the significant time and cost that would be necessary to match the xLPR standard.

*NRC Response: NRC agrees that the xLPR code should not be the only one listed in the definitions and will delete this definition. However, it should be noted that xLPR is an example of a code development that meets the expectations described in the TLR.*

- Q8: In the past, individual NRR staff members have been very reluctant to adopt PFM practices. This has led to roadblocks in obtaining NRC review of risk-based submittals. In a meeting with PWROG Executives during the week of the Regulatory Information Conference (RIC) in March 2015, the NRR Office Director (Bill Dean) openly responded to a question about industry risk studies stating that the NRC's largest hurdle in implementing the Commission's directive to use more risk-based regulation is the NRC staff's reluctance and unwillingness to accept the use of risk methods over deterministic methods. EPRI has also experienced repeated NRR staff questions as a part of the xLPR project that indicate a pre-disposition on the part of the NRR staff to use deterministic methods rather than probabilistic methods. So, it seems that a major deterrent associated with any development of PFM guidance is the mindset of the NRR staff towards the use of probabilistic methods. Even an outstanding PFM submittal in accordance with the standards implied by the TLR, if reviewed by NRC staff with limited knowledge of probabilistic methods and thus reluctant to undertake a thorough review, has a low probability of acceptance. How does NRC RES intend to address this? Does NRC RES have any plans to further promote PFM use and provide training to NRC NRR staff as a part of their PFM guidance project?

*NRC Response: NRC staff is well aware of past challenges. The development of a PFM Regulatory Guide is part of the strategy to eliminate challenges associated with acceptance of probabilistic methods, on both the regulatory and industry sides. Thorough and consistent guidance for the development of PFM codes and the use of PFM codes in regulatory applications will provide the NRC staff with a high degree of assurance and confidence that applications that follow this guidance are sound and can be used as a strong basis for regulatory applications. SRM-M170511 and SECY-17-*

*0112 describe NRC plans to broaden the use of risk and risk insights across the agency, including new guidance, training and tools for the regulatory staff.*