

Talking Points

Objective of Call

- Provide Ralph with information about activity on the subject of ballooning and rupture models that has occurred since 2009.
- Describe in a general way how NUREG-0630 is used by vendors today.
- Seek feedback on whether we have fully understood his technical concern.
- Present actions related to ballooning and rupture models that are being considered by the staff.

Outline of Discussion

Main Message: We believe that one argument in Ralph's letter is that *in light of the increased significance of equivalent cladding reacted (ECR) calculations in showing compliance to 50.46c, we should re-convince ourselves that vendor approaches to calculate ECR in the balloon region continue to be acceptable*. Although Ralph's letter was not accepted as a 2.206 petition, we agree with this underlying argument. Further, we agree we should consider the need to more formally communicate an updated position on the use of NUREG-0630 ballooning models.

- We understand the concern about the accuracy of NUREG-0630 models and looked into the issue in 2011.
 - A 2009 NRR User Need Request included a task related to cladding rupture conditions and burst strains, specifically requesting review of the models described in NUREG-0630 and their relevancy for new cladding alloys and high burnup fuel.
 - PNNL evaluated a large amount of proprietary and non-proprietary data available since NUREG-0630 for ballooning and burst behavior of M5™, ZIRLO™ and Optimized ZIRLO™ to determine if there was a need for alloy specific or fabrication specific LOCA balloon and rupture models in FRAPTRAN.
 - The evaluation of a large amount of data did not indicate a clear difference in ballooning and rupture behavior in comparison with existing models. The conclusion had a lot to do with the fact that rupture strain data is very scattered.
- Today most vendors do not use NUREG-0630 ballooning models "off the shelf."
 - Even though the requirements in AppK and the guidance in RG 1.157, which state that ballooning and rupture models need to be based on applicable data (App. K indicating that the incidence of ballooning and rupture shall not be underestimated), may suggest that NUREG-0630 contains acceptable models, in practice vendors are required to provide ballooning and burst data for their alloys and demonstrate their chosen ballooning and rupture model, NUREG-0630 or otherwise, is appropriate for their material. Most vendors have alloy-specific models for ballooning and rupture that are supported by proprietary data.
- We consider ballooning models to be one part of a set of models and assumptions that create a methodology for calculating the regulatory criteria of peak cladding temperature (PCT) and ECR (or maximum local oxidation, MLO), including in the balloon region. Considering that ballooning and rupture is an instability phenomenon, it could be acceptable to combine a high-uncertainty model with complementary conservative assumptions.
 - Each vendor formulates a different case for the appropriateness of their evaluation of parameters in the balloon region. ~~In deference to the high uncertainty associated with ballooning and rupture models, vendors tend to model these phenomena in such a way as to predict an early rupture and longer period of two-sided oxidation.~~ The models are based on broad data sets and include alloy-specific data.
- We agree that it would be valuable to communicate an updated position on the use of NUREG-0630 ballooning models for ECR calculations. We consider the most appropriate place to be a new section in a revision of RG-1.157.
 - RG-1.157 should be updated to address many aspects of connection with 50.46c. We agree that it is appropriate to add guidance about ballooning models when writing this revision.
 - However, it is important to note that each vendor already has submitted LOCA methodologies slated to be used for 50.46c and therefore there are no immediate schedule drivers for the revision to RG 1.157.
- We also agree that it would be beneficial to examine the sensitivity of ECR and PCT to ballooning parameters, specifically to perform a sensitivity study to quantify the implications of uncertainty in ballooning predictions. RES is looking into performing such work in conjunction with an existing NRR User Need to examine the sensitivity of TRACE predictions to other fuel design parameters.