RAI 8: Potential Nonconservative Toughness Prediction

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BWRVIP-100, Revision 2 Licensing Topical Report Review

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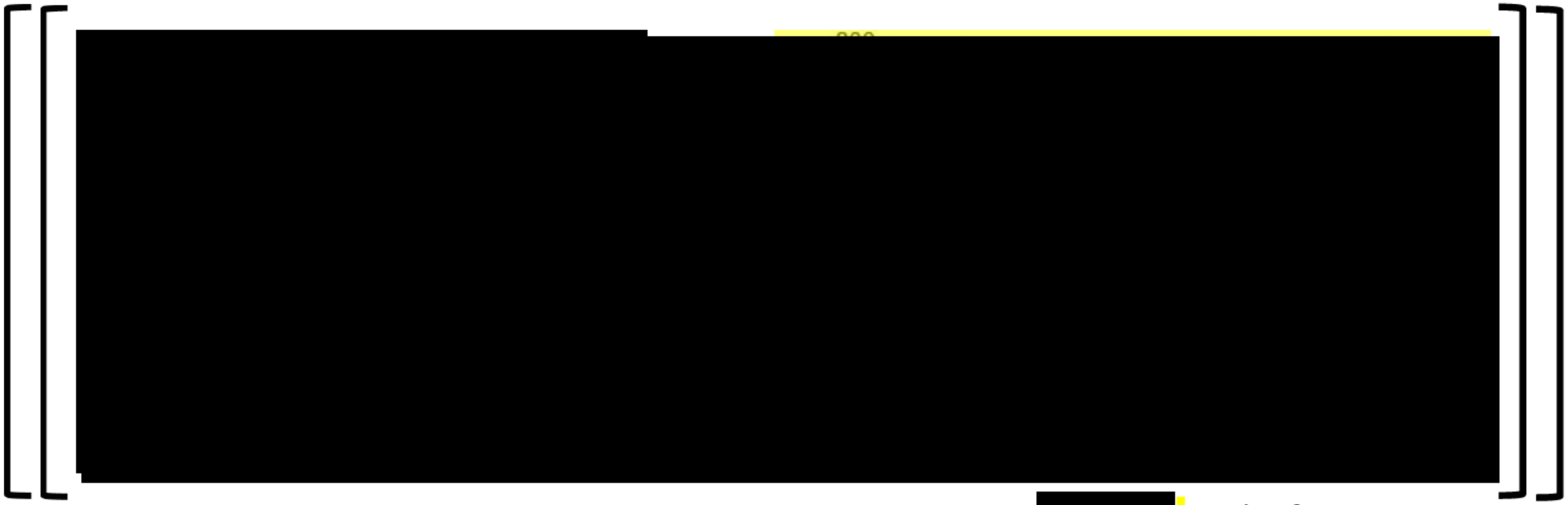
RAI 8



- Staff requested justification for the potential nonconservatism at [[ ]] n/cm^2
- The BWRVIP position is that the data point is not consistent with the apparent trend in the dataset
- The BWRVIP stated that they will look for more data

Data Sparsity

- Large gap in the data below [[ ]] n/cm^2

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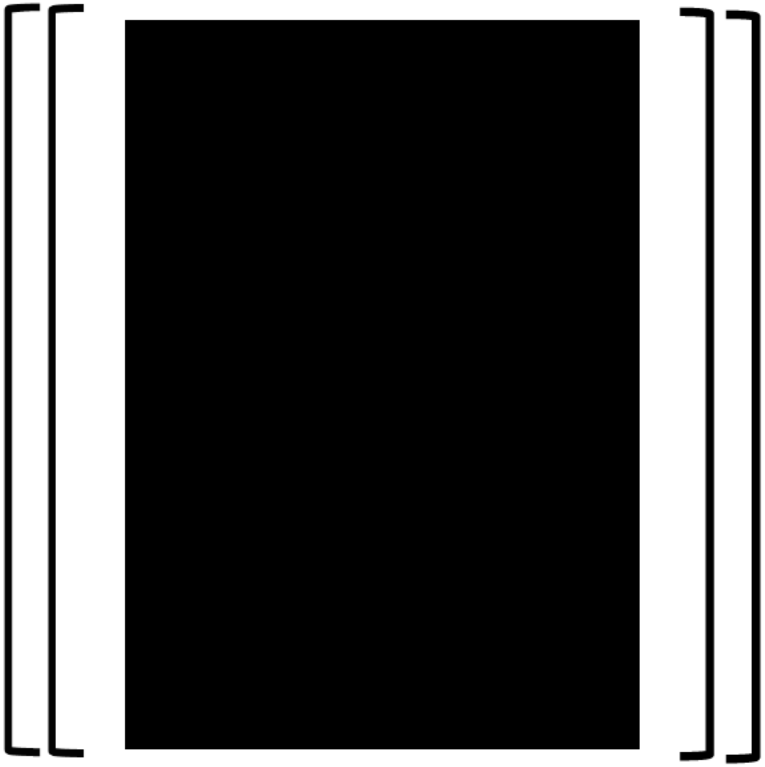
- Large gap in the data below [[ ]] n/cm^2
- Only six data points between fluence levels of [[ ]] n/cm^2 and [[ ]] n/cm^2
- Current judgment about the trends is highly influenced by the high-fluence data

Data Fitting Approach



- n correlations were not developed in a consistent manner
- In response to RAI 6, the BWRVIP explained that the toughness prediction should drive the decision-making
- However, in RAI 8, the BWRVIP makes an argument based upon the apparent C trends
- The logic is inconsistent
  - Do we care about the toughness prediction?
  - Do we care about the C and n data?
  - Which is it?

Fracture Toughness Testing

- In response to RAI 7, the BWRVIP explained that a certain data point came from an unreliable test
- The BWRVIP did not discuss experimental aspects in the response to RAI 8
- What do we know about the test at **[[** [redacted] **]]** n/cm^2?
- Is there an experimental reason to doubt that data point?

Conclusions

- The BWRVIP makes an argument based upon data trends, even though the current dataset may not support drawing strong conclusions
- The BWRVIP presented inconsistent logic on the criteria for developing the correlations
- The BWRVIP did not present an experimental reason why the data at **[[** [redacted] **]]** n/cm^2 may be disregarded
- Overall, the case is weak for excluding the apparent outlier, which may lead to difficulties in NRC accepting the current BWRVIP position in the SE

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BWRVIP-100 Rev. 2: Fluence Concerns

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Background

- BWRVIP-100 Rev. 2 incorporates materials data from the Zorita and Barsebäck Unit 2 nuclear power plants as a function of neutron fluence
  - The topical report (TR) does not include details of the how the fluence was estimated for the new datasets
  - Argonne National Laboratory (ANL) report ANL 19/45, "Crack Growth Rate and Fracture Toughness Tests on Irradiated Ex-Plant Materials," which is referenced in the TR, states that the fluence was calculated in proprietary report, MRP-392, "Materials Reliability Program: Zorita Internals Research Project: Radiation and Temperature Analysis of Zorita Baffle Plate and Core Barrel Weld Material (MRP-392)"

Relevant Guidance

- RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence"
  - In the extended beltline, the methods that RG 1.190 recommends for beltline fluence estimates may require refinement, because the geometry becomes more complex, the neutron transport distance is longer, and the neutron energy spectrum changes.
    - The materials in BWRVIP-100 Rev. 2 are outside of the reactor pressure vessel beltline

NRC Concerns on BWRVIP-100 Rev. 2 Fluence

- No information on the Barsebäck Unit 2 fluence calculations was included in the TR or could be found elsewhere
- For Zorita, MRP-392 (proprietary) appears to contain the fluence calculations, but this has not been reviewed by the NRC or submitted for NRC review as a part this TR review or any previous review.
  - MRP-392 appears to be based on a methodology that has not been qualified

NRC Request for Additional Information (RAI) #9

- The NRC issued RAI #9 (MLXXXXXX):
  - "BWRVIP-100, Revision 2, does not provide any details as to how the neutron fluence was calculated for the materials at either plant. As a result, the staff is unable to assess the accuracy and associated uncertainty of the fluence estimates and therefore cannot determine the acceptability of the fluence estimates to the Zorita and Barsebäck materials provided in the topical report."
  - "Please justify the adequacy of the fluence estimates (e.g., comparison to experimental data, other codes, etc.) and provide estimates of associated uncertainties for the Zorita and Barsebäck irradiated materials."
- EPRI response (MLXXXXXX):
  - "BWRVIP-100, Rev. 2 provides 25 new irradiated base metal data points and 22 new irradiated weld metal data points. The prior revisions of this document, reviewed and approved by the NRC, contained 65 irradiated base metal data points and 22 irradiated weld metal data points from testing performed in the U.S. and internationally.
  - Regarding the methods used to calculate the fluence estimates for the Zorita and Barseback data points, to EPRI's knowledge these fluence estimates were prepared using methods consistent with industry standards within the country that they were performed. The pedigree of these fluence estimates is comparable to the pedigree of all prior data incorporated into BWRVIP-100, Rev. 1-A.
  - EPRI believes that the approach of taking a lower bound of the available fracture toughness data results in a sufficiently conservative estimate of fracture toughness, as demonstrated in the plots provided in BWRVIP-100, Rev. 2, Appendix A, such that specific quantification of the uncertainty in the historical fluence calculation methodology for every data point is not necessary."

NRC Concerns with Response to RAI #9

- EPRI did not provide any information for the NRC to judge the acceptability of the fluence calculations of the Zorita and Barsebäck Unit 2 materials
  - The validity of the fluence estimates is pivotal for the correlations to be acceptable
- Meeting standards in other countries may not equate to meeting NRC standards.

Path Forward

- The NRC staff needs information on the fluence calculations to review in order to come to evaluate whether they are acceptable
  - An audit of the fluence calculations may be beneficial