



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
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November 17, 2021

MEMORANDUM TO: Brian W. Smith, Director  
Division of New and Renewed Licenses  
Office of Nuclear Reactor Regulation

FROM: Angela R. Buford, Chief /RA/  
Vessels and Internals Branch  
Division of New and Renewed Licenses  
Office of Nuclear Reactor Regulation

SUBJECT: TECHNICAL ASSESSMENT OF NONCONSERVATIVE  
FRACTURE TOUGHNESS IN BOILING WATER REACTOR  
VESSEL AND INTERNALS PROJECT TOPICAL REPORT,  
BWRVIP-100, REVISION 1-A

In accordance with the Office of Nuclear Reactor Regulation (NRR) Instruction LIC-504, Revision 5, "Integrated Risk-Informed Decision-Making Process for Emergent Issues," dated March 4, 2020, the staff of the U.S. Nuclear Regulatory Commission (NRC) has performed a risk-informed evaluation of the potential safety significance of a fracture toughness nonconservatism in BWRVIP-100, Revision 1-A.

On February 17, 2021, during an information exchange meeting between NRC management and industry materials issues program leadership, the NRC was made aware of a potential nonconservatism in Boiling-Water Reactor Vessel and Internals Project (BWRVIP) guidance on fracture toughness values for evaluation of irradiated stainless steel reactor internals components. This guidance is contained in Electric Power Research Institute (EPRI) report BWRVIP-100, Revision 1-A and describes recommendations for fracture toughness and evaluation of flaws in a boiling water reactor core shroud.

EPRI subsequently determined that, although BWRVIP-100, Revision 1-A was not prepared under EPRI's Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," nuclear quality assurance (NQA) program, the report had been incorporated into another EPRI product (BWRVIP-235) that was prepared under EPRI's NQA program. As such, a 10 CFR Part 21, "Reporting of Defects and Noncompliance," Transfer of Information Notice was sent to EPRI members on February 19, 2021 (modified on March 19, 2021). EPRI transmitted a copy of this notice (BWRVIP-2021-030) to the NRC on March 22, 2021 (Agencywide Documents Access and Management System ML21084A164).

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As a result of the initial investigation, EPRI recommended the following to its members:

1. The BWRVIP-235 software should not be used going forward to evaluate flaws in the weld region of reactor internals where the accumulated fluence is greater than  $5E20$  n/cm<sup>2</sup> (E>1MeV).
2. Recipients should evaluate their use of these EPRI products to determine if any flaw evaluations could be impacted, possibly resulting in either a reduction in structural margins or changes in inspection frequencies, specifically those components having an accumulated fluence in the range of  $5E20$  n/cm<sup>2</sup> to  $3E21$  n/cm<sup>2</sup>.
3. If BWRVIP-100, Revision 1-A was implemented without the use of BWRVIP-235, the specific requirements associated with the 10 CFR Part 21 Transfer of Information may not be applicable. However, the potential nonconservatism of BWRVIP-100, Revision 1-A would still need to be evaluated.

The enclosure to this memorandum summarizes the NRC staff's analysis of the safety implication of the nonconservative fracture toughness values in BWRVIP-100, Revision 1-A. The NRC staff assessment concludes that the safety significance of the nonconservative fracture toughness in BWRVIP-100, Revision 1-A is low for U.S. plants.

The options considered by staff include the following:

1. Issue Shut Down Orders — This option requires shut down of some or all operating reactors, through a regulatory process such as an order, until inspections, analyses and mitigation are conducted to provide reasonable assurance that the calculated risk levels are acceptable.
2. Leverage NRC Inspection Programs — EPRI has initiated communications with impacted licensees, describing the potential nonconservatism and how licensees may need to adjust their plant-specific programs. This option leverages existing Regional inspection programs to target licensee corrective actions to address the BWRVIP-100, Revision 1-A nonconservatism.
3. Take no Action — In this option, the agency takes no action or programmatic approach to verify licensee corrective actions.

Option 1 is not justified in light of the low risk associated with the BWRVIP-100, Revision 1-A nonconservatism. While failure of the core shroud might impact safe shutdown capability, the low loads on the shroud during normal operation make core shroud failure a highly unlikely event. Therefore, the staff judges that immediate regulatory action is unwarranted.

While Option 3 has the least impact on NRC and industry resources, it also provides no independent oversight of plant-specific programs. The NRC would be entirely relying on the interactions with EPRI and the limited information available to staff, without observing actual licensee corrective actions and drawing independent conclusions about their efficacy. Therefore, the staff does not recommend Option 3.

Option 2 provides appropriate oversight of licensee corrective actions without negatively impacting NRC and industry resources. Focused inspection activities within the Reactor Oversight Process (or some similar process) will provide information to the staff about plant-

specific reactor vessel internal inspection programs and will serve as an independent check on licensee activities related to the BWRVIP-100, Revision 1-A nonconservatism.

Therefore, given the risk determination, and the uncertainty associated with the plant-specific action, the NRC staff recommends Option 2.

Enclosure:  
Technical Assessment of  
Nonconservative Fracture  
Toughness In BWRVIP-100,  
Revision 1-A

SUBJECT: TECHNICAL ASSESSMENT OF NONCONSERVATIVE FRACTURE  
TOUGHNESS IN BOILING WATER REACTOR VESSEL AND INTERNALS  
PROJECT TOPICAL REPORT, BWRVIP-100, REVISION 1-A  
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**\*via e-mail**

**NRR-106**

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