

2021-030 _____ BWR Vessel & Internals Project (BWRVIP)

(via e-mail)

March 22, 2021

Document Control Desk
U. S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Attention: Hipolito Gonzalez

Subject: Potential Non-Conservatism in EPRI Report, BWRVIP-100, Rev. 1-A,
3002008388 and Impacted BWRVIP Reports

Reference: 1. BWRVIP-100, Revision 1-A: BWR Vessel and Internals Project, Updated
Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core
Shrouds. EPRI, Palo Alto, CA: 2016. 3002008388.
2. BWRVIP-235: BWR Vessel and Internals Project, Structural Analysis
Software for BWR Internals, DLL Version 3.1. EPRI, Palo Alto, CA: 2009.
1018251.
3. 10 CFR Part 21 – Transfer of Information Notice – Potential Non-
Conservatism in EPRI Software, BWRVIP-235, 1018251, February 19, 2021.
4. Update Regarding 10 CFR Part 21 Transfer of Information Notice – Potential
Non-Conservatism in EPRI Software (BWRVIP-235) and Inspection and
Evaluation Guidance for the BWR Core Shroud (BWRVIP-76 Revision 1-A,
BWRVIP-76 Revision 2, and BWRVIP letter 2016-030)

On February 17, 2021, during an information exchange between NRC management and industry materials issues program leadership, the NRC was made aware of a potential non-conservatism 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 EPRI report BWRVIP-100, Revision 1-A [1]. It was subsequently determined that, although BWRVIP-100, Revision 1-A was not prepared under EPRI's 10 CFR 50 Appendix B nuclear quality assurance (NQA) program, the report had been incorporated into another EPRI product (BWRVIP-235 [2]) that was prepared under EPRI's NQA program. As such, a 10 CFR Part 21 Transfer of Information Notice [3] was sent to EPRI members on February 19, 2021. That transfer of information notice is being provided for your information as [Attachment 1](#) to this letter.

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On March 19, 2021, EPRI issued an update to the original transfer of information notice [4]. This update revised a recommended action in the original notice and informed recipients of additional impacted documents that were identified during EPRI's extent of condition review. The updated transfer of information notice is also being provided for your information as [Attachment 2](#) to this letter. Please note however that the attachments to the update transfer of information notice contain EPRI proprietary information and are not being provided at this time.

If you have any questions or need further assistance, please contact Nathan Palm by telephone at 724-288-4043 or by e-mail at npalm@epri.com.

Sincerely,

The block contains two handwritten signatures. The signature on the left is for Nathan Palm, and the signature on the right is for Timothy Hanley. Both are written in black ink.

Nathan Palm, EPRI BWRVIP Program Manager
Timothy Hanley, Exelon, BWRVIP Chairman

c: Robert Carter, EPRI
Wynter McGruder, EPRI
Robert Villegas, EPRI
Drew Odell, Exelon
Steve Richter, Energy Northwest
Hipolito Gonzalez, USNRC
David Rudland, USNRC
Allen Hiser, USNRC



February 19, 2021

Subject: 10 CFR Part 21 – Transfer of Information Notice – Potential Non-Conservatism in EPRI Software, BWRVIP-235, 1018251

Dear Sir/Madam:

References:

1. BWRVIP-235: BWRVIP-235: BWR Vessel and Internals Project, Structural Analysis Software for BWR Internals, DLL Version 3.1. EPRI, Palo Alto, CA: 2009. 1018251.
2. BWRVIP-100, Revision 1-A: BWR Vessel and Internals Project, Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds. EPRI, Palo Alto, CA: 2016. 3002008388.

This letter is a formal Transfer of Information notification under 10 CFR Part 21.21(b) of a deviation in products supplied by EPRI. EPRI has insufficient information as to the basic product's actual use to determine if the condition described below represents a defect reportable under 10 CFR Part 21. Recipients of this letter should evaluate the condition pursuant to 10 CFR Part 21.21 (a) to determine if it could represent a substantial safety hazard, were it to remain uncorrected.

Identified Problem

BWRVIP-235, named DLL 3.1 [1], is a software code for evaluating flaws in BWR core shrouds and reactor internal piping components that was prepared under EPRI's 10 CFR Appendix B nuclear quality assurance (NQA) program. DLL 3.1 incorporates the methodologies specified in BWRVIP-100, Rev. 1-A [2] for the evaluation of flaws in irradiated core shroud materials. BWRVIP-100, Rev. 1-A was not prepared under EPRI's NQA program.

BWRVIP-100, Rev. 1-A, published in 2016, was developed to support the evaluation of in-service flaws in BWR core shrouds. It provides fracture toughness relationships as a function of neutron fluence for BWR core shrouds. Research was carried out from 2016 to 2020 to obtain additional fracture toughness data on irradiated stainless steels with an emphasis on weld metal.¹ A preliminary evaluation of results from this testing program, as well as the results of other applicable testing programs, indicates that the relationships published in BWRVIP-100, Rev. 1-A are non-conservative in the fluence range from $5E20$ n/cm² to $3E21$ n/cm² when considering the newly acquired weld metal data. Specifically, the lower bound fracture toughness of 50 ksi-√in specified in BWRVIP-100, Revision 1-A may be reached at a fluence of $5E20$ n/cm² as opposed to the previously defined threshold of $3E21$ n/cm². This non-conservatism extends to the analysis methods contained in DLL 3.1 for evaluating flaws in irradiated core shroud materials, thus necessitating this 10 CFR Part 21 Transfer of Information.

¹ Prior evaluations of fracture toughness data published in BWRVIP-100 did not distinguish between base metal, HAZ and weld, and were considered to be appropriately conservative.

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Recommended Actions

1. As a consequence of this Transfer of Information, 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/cm² ($E > 1\text{MeV}$).
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/cm² to $3E21$ n/cm².
3. If BWRVIP-100, Rev. 1-A was implemented without the use of BWRVIP-235, the specific requirements associated with this 10 CFR Part 21 Transfer of Information may not be applicable. However, the potential non-conservatism of BWRVIP-100, Rev. 1-A would still need to be evaluated.

Corrective Actions to Be Taken by EPRI

The BWRVIP will be working with its members to address the potential non-conservatism associated with BWRVIP-235 and BWRVIP-100, Rev. 1-A, which may include future revisions to these EPRI products. In the interim, these products have been removed from www.epri.com and are no longer available for download.

If you have any technical questions, please contact Bob Carter at bcarter@epri.com or 704-595-2519 or Nathan Palm at npalm@epri.com or 724-288-4043.

If you have received this letter, it is because our records indicate that you or a staff member in your organization have received BWRVIP-235. If this is incorrect, then please promptly provide this correspondence to the correct staff in your organization and notify Robert Villegas at rvillegas@epri.com or 704-595-2787.

Sincerely,

Rick Way
Quality Assurance Manager
1300 West WT Harris Blvd, Charlotte NC 28262
704-595-2679 (w) - 980-228-7613 (c)
rway@epri.com

c: R. Baranwal
S. Swilley
K. Edsinger
N. Palm



March 19, 2021

Subject: Update Regarding 10 CFR Part 21 Transfer of Information Notice – Potential Non-Conservatism in EPRI Software (BWRVIP-235) and Inspection and Evaluation Guidance for the BWR Core Shroud (BWRVIP-76 Revision 1-A, BWRVIP-76 Revision 2, and BWRVIP letter 2016-030)

Dear Sir/Madam:

References:

1. 10 CFR Part 21 – Transfer of Information Notice – Potential Non-Conservatism in EPRI Software, BWRVIP-235, 1018251, February 19, 2021.
2. BWRVIP-235: BWR Vessel and Internals Project, Structural Analysis Software for BWR Internals, DLL Version 3.1. EPRI, Palo Alto, CA: 2009. 1018251.
3. BWRVIP-100, Revision 1-A: BWR Vessel and Internals Project, Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds. EPRI, Palo Alto, CA: 2016. 3002008388.
4. BWRVIP-76, Revision 1-A: BWR Vessel and Internals Project: BWR Core Shroud Inspection and Flaw Evaluation Guidelines. EPRI, Palo Alto, CA: 2015. 3002005566.
5. BWRVIP-76, Revision 2: BWR Vessel and Internals Project: BWR Core Shroud Inspection and Flaw Evaluation Guidelines. EPRI, Palo Alto, CA: 2014. 3002003095
6. BWRVIP Letter 2016-030, Core Shroud Off-Axis Cracking Interim Inspection & Flaw Evaluation Guidance, March 4, 2016.

EPRI recently provided a 10 CFR Part 21 Transfer of Information Notice [1] regarding a potential non-conservatism in BWRVIP-235 [2], which is a software code that was developed under EPRI's 10 CFR Appendix B nuclear quality assurance (NQA) program. This notification was necessitated by the identification of potential non-conservatisms in BWRVIP-100, Revision 1-A [3] that were incorporated into BWRVIP-235. For reference, BWRVIP-100 Revision 1-A was not developed under EPRI's NQA program and does not formally require reporting under 10 CFR Part 21 except that information from this product was used in other EPRI products that were produced under EPRI's NQA program, including BWRVIP-235. The purpose of this letter, as an update to reference [1], is to:

- Revise a recommended action in [1] concerning BWRVIP-235 [2].
- Inform recipients of additional impacted documents that were identified during EPRI's extent of condition review.

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BWRVIP-235

The original Transfer of Information Notice [1] stated that 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 $5E20 \text{ n/cm}^2$ ($E > 1 \text{ MeV}$). EPRI has concluded that, as long as acceptable workarounds are implemented, BWRVIP-235 may continue to be used to evaluate flaws in the weld

region of reactor internals where the accumulated fluence is greater than $5E20 \text{ n/cm}^2$ ($E > 1 \text{ MeV}$). Acceptable workarounds are provided in Attachment 1.

Additional Impacted Documents

As described in Reference 1, a preliminary evaluation of results from fracture toughness testing conducted since 2016 indicates that the relationships published in BWRVIP-100, Rev. 1-A are non-conservative in the fluence range from $5E20 \text{ n/cm}^2$ to $3E21 \text{ n/cm}^2$. Specifically, the lower bound fracture toughness of $50 \text{ ksi-}\sqrt{\text{in}}$ specified in BWRVIP-100, Revision 1-A may be reached at a fluence of $5E20 \text{ n/cm}^2$ as opposed to the previously defined threshold of $3E21 \text{ n/cm}^2$. While performing an extent of condition review, EPRI has determined that three additional EPRI products are also impacted by the potential non-conservatism in BWRVIP-100. These are BWRVIP-76, Revision 1-A [4], BWRVIP-76, Revision 2 [5], and BWRVIP Letter 2016-030 [6].

BWRVIP-76, Revision 1-A [4] and BWRVIP-76, Revision 2 [5] provide criteria for inspection of BWR core shroud welds and the evaluation of flaws found that may be identified while performing these inspections. The methods and acceptance criteria contained in [4, 5] have been determined to use the potentially non-conservative fracture toughness values contained in BWRVIP-100, Revision 1-A. Therefore, BWRVIP-76, Revision 1-A and BWRVIP-76, Revision 2 cannot be used¹, in their entirety, as written. Attachment 2 contains details of the specific impacted elements of BWRVIP-76, Revision 1-A along with recommended actions.

BWRVIP letter 2016-030 contains interim guidance for the evaluation of off-axis cracking identified in BWR core shroud welds. Off-axis flaws are those flaws that are not oriented parallel to the weld. BWRVIP letter 2016-030 contains acceptance criteria for off-axis flaws and it has been determined that these acceptance criteria were developed using the potentially non-conservative fracture toughness values contained in BWRVIP-100, Revision 1-A. Attachment 3 contains details of the specific impacted elements of BWRVIP letter 2016-030 along with recommended actions.

¹ For clarity, BWRVIP-76, Rev. 1 was prepared under EPRI's 10 CFR 50 Appendix B program and has been approved for implementation by the U.S. NRC. BWRVIP-76, Rev. 2 was not prepared under EPRI's 10 CFR 50 Appendix B program and has not been approved by the U.S. NRC and further states in Section 1.4 that the inspection recommendations in this report shall not be implemented immediately upon issuance of the report. However, since BWRVIP-76, Rev. 2 does contain criteria from BWRVIP-100, Rev. 1-A, it is included with this update.

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Corrective Actions to Be Taken by EPRI

The BWRVIP is working with its members to address the potential non-conservatism associated with BWRVIP-235, BWRVIP-76, Rev. 1-A, BWRVIP-76, Rev. 2 and BWRVIP letter 2016-030, along with BWRVIP-100, Rev. 1-A that may result in future revisions to these EPRI products. In the interim, these products have been removed from www.epri.com and are no longer available for download.

If you have any technical questions, please contact Bob Carter at bcarter@epri.com or 704-595-2519 or Nathan Palm at npalm@epri.com or 724-288-4043.

If you have received this letter, it is because our records indicate that you or a staff member in your organization have received BWRVIP-235, BWRVIP-76, Rev. 1-A, BWRVIP-76, Rev. 2 and/or BWRVIP letter 2016-030. If this is incorrect, then please promptly provide this correspondence to the correct staff in your organization and notify Robert Villegas at rvillegas@epri.com or 704-595-2787.

Sincerely,

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