REQUEST FOR ADDITIONAL INFORMATION
ON AGING MANAGEMENT PROGRAM FOR THE
BWR-41, REVISION 4: BWR VESSEL INTERNALS PROJECT,
BWR JET PUMP ASSEMBLY INSPECTION AND FLAW EVALUATION GUIDELINES
(TAC NO. MF4887)

In a letter dated September 24, 2014, the Boiling Water Reactor (BWR) Vessel Internals Project (BWRVIP) submitted a Topical Report (TR), BWRVIP-41, Revision 4, "BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines," which included inspection recommendations and flaw evaluation guidelines for the jet pump assembly welds. This revised version included updated guidance for inspection of high priority locations and a reduction in inspection frequency for the medium and low priority locations. The technical basis for this reduction in the inspection frequency was addressed in BWRVIP-255, "Technical Bases for Revision of the BWRVIP-41 Jet Pump Inspection Program," dated October 2014. The BWRVIP-255 was submitted to the U.S. Nuclear Regulatory Commission (NRC) staff for information only. The NRC staff reviewed the BWRVIP-41, Revision 4 and BWRVIP-255 reports, and developed the following request for additional information (RAI) questions.

Loading and Flaw Evaluation Methodology:

RAI-1

In Section 5.1.2.1.3, the TR proposed an alternative limit load methodology with Reference 30 (a GE report dated 1995) as an alternative. The staff notes that Section 5.1.2 in BWRVIP-18, Revision 2, used BWRVIP-76 as the reference for the same alternative. Please confirm the correct reference, BWRVIP-76 or the 1995 GE report.

RAI-2

Section 2.3.10.3 of the TR discusses the loading on the diffuser and tailpipe, which includes strong acoustic waves that could be generated by an instantaneous pipe break. The NRC is aware of some safety communications (SC) from General Electric-Hitachi that would increase the annulus pressurization (AP) loads acting on the reactor vessel internal components due to a pipe break.

The NRC staff requests that the BWRVIP address whether the AP loads and associated calculations included in BWRVIP-41, Revision 4, properly reflect the correct hydrodynamic loads in response to the SC.

Susceptibility to Intergranular Stress Corrosion Cracking (IGSCC):

RAI-3

Background: The staff notes that for license renewal [Ref. 1], a minimum ferrite content of 7.5% is specified in pressurized water reactor (PWR) piping systems to ensure resistance to IGSCC. Furthermore, recent information on cast austenitic stainless steel (CASS) reactor vessel internal (RVI) components [Refs. 2 and 3] indicate that RVI components are often fabricated from CASS materials where the calculated ferrite content is less than 7.5%.

Issue: In Section 2.2.1.2, the TR discusses the materials used in the jet pump assembly and states [

] Table 3-1 lists several weld locations, both high and medium priority locations, where no inspections are recommended because CASS materials are used on one or both sides of a weld. Section 3.2.7.2.1 includes a separate susceptibility category for CASS materials in consideration of the inaccessible weld inspection program, but does not differentiate between CASS with < 7.5% ferrite and CASS > 7.5% ferrite.

Request: The staff asks the BWRVIP to discuss the uncertainty related to the ferrite content and what effect that has on the potential for IGSCC cracking in jet pump welds and the need to inspect welds with CASS material on one or both sides.

RAI-4

Background: The staff notes that MRP-175, Figure B-2, shows that failures in BWRs related to irradiation-assisted stress corrosion cracking (IASCC) start to occur when the fluence reaches about 5×10^{20} n/cm^2. The staff notes that some jet pump components in a foreign BWR have been exposed to fluence above 5×10^{20} n/cm^2 [Ref. 4].

Issue: The recommended inspections and guidelines in the TR do not address the susceptibility to IASCC.

Request: The staff asks the BWRVIP to include a discussion of IASCC and how the neutron exposure of the jet pump assembly in the US domestic BWR fleet varies with location within the vessel and over the expected 60 year service life.

Jet Pump Beam and BWRVIP-138, Rev. 1:

RAI-5

Background: Section 5.2 of the TR states the following*:*

[

]

Issue: The staff notes that this text is carried over from BWRVIP-41, Rev. 1, dated September 2005, and does not reflect the text in BWRVIP-138, Rev. 1 (Reference 8 in the TR, dated 2008).

Request: The staff asks the BWRVIP to revise the text in Section 5.2 to reflect the current NRC-approved version of BWRVIP-138, Rev. 1-A, dated October 2012 [Ref. 5].

Inspection Requirements:

RAI-6

Background: Section 3.2.3 of the TR covers plant-specific analyses to modify/eliminate inspection requirements. This section was the subject of Item 2 from the staff's initial Safety Evaluation (SE) to Revision 0 of the TR [Ref. 6]. On November 17, 2000, the BWRVIP responded with a proposed revision to the TR that the staff approved in the final SE of Revision 0 [Ref. 7].

Issue: In the subsequent revisions to the TR, the final sentence of the BWRVIP response to Item 2 was dropped. That sentence stated:

> *Results of these plant-specific analyses should be submitted to the NRC for review and approval.*

Request: The staff asks the BWRVIP to revise Section 3.2.3 of the TR to include the complete text from the November 17, 2000 BWRVIP response or provide a rationale for why it was dropped from the revision.

RAI-7

Background: Section 3.2.8.1 of the TR covers scope expansion for accessible and partially accessible weld. Section 3.2.8.1.2 includes an exemption from expanding the scope of inspections for specific weld locations.

Issue: The details related to when expansion of the scope for inspections will occur are not clear to the staff. Should this be applied the same for both ultrasonic (UT) and enhanced visual (EVT-1) inspection techniques? It appears to the staff that there would be significant differences if the re-inspection used UT (as done in the baseline) vs. EVT-1. Specifically, there is no mention of how inspection coverage and history of hydrogen water chemistry mitigation is taken into account when determining if the observed cracking is consistent with fleet operating experience. Two examples are suggested for consideration.

First, consider a case where a flaw 2 inches long is detected with an EVT-1 inspection (20% coverage) at the AD-3a,b location from a BWR/4 with the legs configuration that had previously been inspected with UT (100% coverage). The UT inspection found no indication and was performed while the plant was under noble metal chemistry addition. During the more recent EVT-1 inspection, the plant was operating under online noble chemistry injection (OLNC). The staff could interpret the text in Section 3.2.8.1.2 as allowing no scope expansion.

Second, consider a case where a flaw 2 inches long is detected with an EVT-1 inspection (15% coverage) at a AD-2 location from a BWR/5 with the legs configuration that had previously been inspected with UT (50% coverage). The UT inspection found no indication and was performed while the plant was under modified hydrogen water conditions. During the more recent EVT-1 inspection, the plant was operating under OLNC. Again, the staff could interpret the text in Section 3.2.8.1.2 as allowing no scope expansion.

Request: Provide a discussion of how Section 3.2.8.1.2 would be applied for the examples cited above. If no expansion of inspection is the intended outcome, explain how not expanding the inspection scope will allow determination of whether the degradation observed is consistent

with past operating experience. Consider more explicit description of what inspection results would be exempt from scope expansion.

References

[1] NUREG-1801, Rev. 2, "The Generic Aging Lessons Learned (GALL) Report," December 2010.

[2] *BWRVIP-234: BWR Vessel and Internals Project, Thermal Aging and Neutron Embrittlement Evaluation of Cast Austenitic Stainless Steels for BWR Internals.* EPRI, Palo Alto, CA: 2009, TR1019060.

[3] PWROG-15032-NP, Revision 0, "PA-MSC-1288 Statistical Assessment of PWR RV Internals CASS Materials," Westinghouse Electric Company LLC, November 2015.

[4] *Materials Reliability Program: A Review of Radiation Embrittlement of Stainless Steels for PWRs (MRP-79) – Revision 1,* EPRI, Palo Alto, CA: 2004. TR1008204.

[5] *BWRVIP-138, Revision 1-A: BWR Vessel and Internals Project, Updated Jet Pump Beam Inspection and Evaluation Guidelines.* EPRI, Palo Alto, CA: 2012, TR1025319.

[6] Initial SE for BWRVIP-41, Revision 0, dated June 20, 2000, ADAMS Accession No. ML003725033.

[7] BWRVIP response, dated November 17, 2000, to Initial SE for BWRVIP-41, Revision 0, ADAMS Accession No. ML003770389.