

TECHNICAL REPORT 3002023754 BWRVIP-138, REVISION 2

BWR VESSEL AND INTERNALS PROJECT,

UPDATED JET PUMP BEAM INSPECTION

AND FLAW EVALUATION GUIDELINES

**REQUESTS FOR ADDITIONAL INFORMATION (RAIS) **

DOCKET NO. 99902016

~~PROPRIETARY~~

Introduction:

By letter dated October 25, 2023 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23298A078), Electric Power Research Institute (EPRI) submitted for U.S. Nuclear Regulatory Commission (NRC) review and approval topical report (TR), “BWRVIP-138, Revision 2: BWR Vessel and Internals Project, Updated Jet Pump Beam Inspection and Flaw Evaluation Guidelines,” EPRI Report 3002023754. This report updates the inspection and flaw evaluation guidelines of jet pump holdown beams in boiling water reactors (BWRs) as part of the BWR Vessel and Internals Project (BWRVIP).

As part of its review, the NRC staff participated in an audit of the TR and associated background documents with the EPRI and BWRVIP personnel in Spring 2024. The audit plan is shown in ADAMS Accession No. ML24023A690. Based on the audit, the NRC staff concluded that additional information is needed to complete the review. Accordingly, the NRC staff requests for additional information (RAI) as shown below. Many of the RAI questions are based on the staff's questions raised during the audit.

Regulatory Basis:

The BWRVIP guidance regarding jet pump beam (JPB) inspections is a voluntary program pursued by industry in order to address past failures in BWR units. These failures could cause damage to surrounding internal components. If a failure occurs, existing jet pump operability surveillance procedures required by plant technical specifications will detect a beam failure and require a reactor shut down. The purpose of this inspection guideline is to avoid mid-cycle failures and possible damage to reactor internals. The creation of the BWRVIP was, at least in part, motivated by a desire to demonstrate that no increased specificity in NRC regulation for BWR internals aging management would be necessary.

The NRC has approved initial license renewal applications for many domestic nuclear power plants in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54. Some of the nuclear plants have entered the period of extended operation. As such, the regulation in 10 CFR 54.21(a)(3) requires that, for each structure and component determined to be subject to an aging management review, a BWR licensee must demonstrate that the effects of aging of the reactor vessel internal components such as JPBs will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis (CLB) for the relevant period of extended operation.

Thus, the regulatory basis for managing aging of jet pump holdown beams through implementation of a BWRVIP is established to satisfy 10 CFR Paragraph 54.21(a)(3) aging management requirement and the terms and conditions that are defined in the first renewed or subsequent renewed operating license.

Proprietary Marking: The staff's request contains some proprietary materials. The proprietary contents are identified using a **[[yellow highlighted, bolded, double bracketed]]** text format. Consistent with the Commission proprietary withholding criteria in 10 CFR 2.390, the staff is protecting the identified proprietary material from public disclosure. For the redacted version, publicly available version of the RAI, the protected material will be deleted from the bolded brackets (i.e., designated by a blank **[[]]** bracketed format).

Request for Additional Information (RAI):

RAI T1: TR Table 1-2 shows that **[[[REDACTED]]]**

1. Discuss whether all domestic BWRs have been inspected at least one time in their Group 2 or Group 3 beams.
2. Discuss the size of indications, if indications were detected in Group 2 or Group 3 beams in these two plants.
3. Discuss results of inspections that have been performed such as degradation mechanisms and indications that remain in service.
4. Provide the width, length and thickness of BB-1, BB-2 and BB-3 regions for Group 2 and Group 3 beams, and the inside diameter of the bolt hole in Group 2 and Group 3 beams.

RAI T3-1: TR Section 3.1 discusses the failure of the JPB at two BWR/3 plants which resulted in partial ejections of the inlet mixers. TR Section 3.2 discusses the failure of the BB-2 region and the sequence of the event at a plant.

1. Describe and discuss the potential sequence of failure, if a beam fails, , e.g.,
 - a. the trajectory of the loose parts from the failed beam and from other parts of the jet pump assembly as a result of the beam failure, and
 - b. the impact of loose parts damaging other reactor vessel internal components,
2. Discuss the safety implications of a beam failure, e.g.,
 - a. the impact on the thermal hydraulic of the coolant flow inside the reactor (i.e., impact on the coolability of the reactor core),
 - b. impact on the operation of the reactor vessel and on the timely safe shutdown capability of the reactor.
 - c. Discuss whether control room operators will receive a warning on the control room panel indicating the beam failure such that the operators can take timely corrective action.

RAI T4-1: TR Section 4.1 discusses the nondestructive examination (NDE) methods such as enhanced visual examination (EVT-1), eddy current testing (ET) and ultrasonic testing (UT). TR Section 4.2.1 states that "...UT is currently the primary technique used to inspect the BB-1 and BB-2 regions...The UT methods can interrogate the tapered region (BB-3)..." It appears that TR

Section 4 does not provide specific recommendation on which NDE method should be used to inspect JPBs.

1. Discuss the specific NDE method that the TR recommends for the inspections of the BB-1, BB-2, and BB-3 regions of the Group 2 and Group 3 beams.
2. When an licensee inspects the JPBs per the TR, discuss whether the TR recommends all JPBs in the reactor be inspected during the same refueling outage.

RAI T4-2: TR Section 4.3.3, page 4-7, first paragraph states that the intent of the exclusion zone is to define a region where any visual indications can be accepted for one additional cycle of operation (up to 24 months). A visual indication in the exclusion zone could be long (transversely extended from one edge to the other edge of the beam). Also, a visual inspection will not be able to detect the depth of an indication which could be 100 percent through wall. Justify why the visual indication is acceptable to remain in service for an additional cycle of operation.

RAI T4-3: TR Section 4.3.3, page 4-7, first paragraph states that

“...Based on the fracture mechanics analysis (see TR Section 6 and Appendices A and B), the crack growth rate is such that any flaws on the upper surface of the beam will propagate to the edges of the beam before penetrating to a sufficient depth to be of concern. As such, a visual inspection of the edges of the beam (the area within 0.5 inches (13 mm) of the edge), is sufficient to justify operation for one additional cycle of operation without inspection of the entire region...”

1. Discuss whether the one additional cycle of operation considered if an embedded flaw that could not be detected by the visual inspection but grows to 100% through wall based on the updated crack growth rate could be detected.

2. [[[REDACTED]]]

RAI T5-1: TR Section 5.1 states [[[REDACTED]]]

1. Discuss whether there is a limit imposed on the applied stress for the Group 2 and Group 3 beams beyond which the proposed inspection intervals for the beams cannot be used. If there is a limit, provide the limit and the basis for the limit.
2. TR Sections 5.1 and 6.2 present information [[[REDACTED]]]. Please submit [[[REDACTED]]] for information on the docket.

RAI T5-2: TR Section 5.4 states that a Group 2 beam has a maximum stress of [([REDACTED]])

[REDACTED]

RAI T5-3: TR Figure 5-5 shows that the [([REDACTED]])

RAI T5-4: TR Section 5.5 discusses [([REDACTED]] TR Section 5.5 states that the Group 2 and Group 3 beams [([REDACTED]])

RAI T5-5: TR Table 8-1 of the TR provides inspection intervals for Group 2 beams. Footnote Number 1 to Table 8-1 states that [([REDACTED]] Clarify the following scenarios.

[([REDACTED]])

RAI T8-1: TR Section 8.1 states that [[[REDACTED]]]

1. Discuss the longest operating years of Group 2 and Group 3 JPBs that have not been inspected.
2. Discuss the longest operating years of Group 2 and Group 3 beams that have been inspected using UT and have not detected any flaws.
3. If a Group 3 beam does fail, discuss how would BWRVIP revise the initial inspection and reinspection intervals of Group 3 beams.

RAI T8-2: TR Section 8.1 states that [[[REDACTED]]]

TR Section 8.2 states that [[[REDACTED]]]

TR Section G.6 states that [[[REDACTED]]]

It appears that a discrepancy exists among Sections 8.1, 8.2 and G.6 because Section 8.1 recommends that [[[REDACTED]]]

Clarify the discrepancy and whether Group 3 beams will be inspected.

RAI T8-3: TR Section 8.2 states that [[[REDACTED]]]

[REDACTED]

RAI T8-4: TR Section 8.2 states that [[[REDACTED]]]

TR Section 8.3, page 8-2 states that [[[REDACTED]]]

[REDACTED]

The NRC staff noted that the TR does not provide guidance on [[[REDACTED]

[REDACTED]

RAI T8-5. TR Section 8.1 states that [[[REDACTED]

[REDACTED]

RAI TG-1: TR Section G.3 states that [[[REDACTED]

[REDACTED]

RAI TG-2: TR Section G.5, page G-7 lists several conservatisms that have been used in the evaluation to obtain [[[REDACTED]

1. The NRC staff observed that [[[REDACTED]

2. TR Section 6.2 states that [[

[REDACTED]

3. The NRC staff understands that [[

[REDACTED]

RAI TG-3: TR Section G.2 states [[

[REDACTED]

RAI TG-4: TR Section G.5, page G-7 states that [[

[REDACTED]]] The NRC staff notes that the sizes of detected cracks in the field as discussed in Section 3 appear to be large flaws. As such, a large flaw will take less time to reach the allowable flaw size than a small flaw. Discuss why the crack growth calculation did not use the large flaw detected in the field as the initial flaw size.

RAI TP-1:

1. Discuss the protocol for the plant owner to implement the reinspection intervals if cracking does occur in the Groups 2 or Group 3 beams.
2. When performing the initial inspection or reinspection, discuss whether all the beams will be inspected, regardless of whether indications are detected.
3. It seems that the TR provides guidelines, not requirement for the inspection intervals. As such, discuss whether an owner is required to use or implement the TR.
4. If an owner is required to use the TR, discuss the protocol to implement the inspection intervals.
5. Discuss whether an owner is permitted to use BWRVIP-138, Revision 1-A in lieu of the TR.

6. Discuss whether an owner can use both the TR and BWRVIP-138 Revision 1-A concurrently.
7. If a nuclear plant implements but deviates from the TR, discuss the BWRVIP's protocol to ensure the TR guidance is met at that facility.

RAI TP-2:

1. If a beam fails after an owner implements the TR inspection intervals, would the TR initial inspection intervals and reinspection intervals be revised?
2. If affirmative, discuss how the revision would be implemented and how the NRC would be notified.
3. If the TR's initial inspection intervals and reinspection intervals will not be revised after a beam failure, provide justification.

RAI TP-3: [[

[REDACTED]

RAI TP-4: For those BWRs that have NRC-approved renewed operating license, the owner is required to follow the BWR Vessel Internals aging management program (AMP). The Generic Aging Lessons Learned Report (GALL), NUREG-1801, Revision 2, Volume 2 specifies that licensees should follow BWR Vessel Internals AMP XI.M9, including aging management of jet pump assembly. Discuss how the TR recommended initial inspection intervals and reinspection intervals of the JPBs are processed (tracked or monitored) within the BWR Vessel internal AMP during the period of extended operation.