

TOPICS FOR THE 9-10-2015 TELECONFERENCE WITH THE BWRVIP ON

BWRVIP-100 RAI 8 and BWRVIP-42, REVISION 1 RAI RESPONSES

BWRVIP-100, RAI 8

Figure 7 of the July 15, 2015 response to RAI 8 related to BWRVIP-100, Rev. 1 shows the margin against failure by ductile crack extension using EPFM for a 1-inch deep, inside surface 360-degree circumferential crack. The figure shows the case based on the BWRVIP-100, Rev. 1 bounding "C" curve, and also the estimated 90% and 95% bound "C" curves. This appears to be the same case (1-inch deep 360 degree crack) that is evaluated in Figure 3-9 of BWRVIP-100, Rev. 1. However, the curve in RAI 8 Figure 7 for the BWRVIP-100, Rev. 1 base case, looks very different from the EPFM curve in Figure 3-9 of BWRVIP-100, Rev. 1. (Figure 3-9 also shows LEFM and limit load margins which are not shown in Figure 7, but this is not a problem since Figure 7 only compares the EPFM margins for different bounding "C" curves.) The Figure 3-9 curve dips down sharply at fluences above 1×10^{21} n/cm² while the Figure 7 curve only trends down slightly in this range.

BWRVIP-42

1.0 TOPIC 1: CASS MATERIAL FRACTURE TOUGHNESS

For aging embrittlement, Section 2.1.3 of the LTR states, "conditions that favor [IGSCC (low ferrite)] are opposite to the conditions that promote [aging embrittlement (high ferrite)]. Thus....[aging embrittlement] is not expected to be a significant issue for the LPCI coupling." RAI-2 requested for quantitative data to substantiate the claim: the range of ferrite contents for all LPCI components, the range of neutron fluence values for all LPCI components, and the estimated bounding reduction of fracture toughness for LPCI components based on the quantitative data. RAI-2 also questioned why this reduced level of fracture toughness will not become an issue.

The BWRVIP's response to RAI-2 stated that, "thermal embrittlement is not a concern for LPCI coupling components. The rationale for this position is described in BWRVIP-234 (Reference 1) which is currently under review by the NRC.... However, if the ultimate review of BWRVIP-234 by the NRC determines that thermal embrittlement may be a concern for LPCI components, BWRVIP-42 will be reevaluated to appropriately address the issue."

The NRC staff noted that Section 2.2.1 of the LTR documented all potential failure locations for BWR/4/5 and BWR/6 plants, but only 7 locations have CASS materials and only some of them need to be addressed because the rest are of little concern due to redundancy or negligible impact on functionality. Considering the above, the on-going review of BWRVIP-234, and input from the BWRVIP, the NRC staff is considering one of the following to proceed:

- (1) Due to the reduced number of concerned CASS locations and the OE which indicates no cracking to date, the NRC staff could impose Condition 1 on the flaw evaluation to reflect a very conservative CASS fracture toughness: For flaws detected in these locations, the applicant must conservatively assume that a factor of 0.5 applies to the allowable flaw size that is determined in accordance with Section 5.1.2.1.4 of the LTR.

- (2) The NRC staff could impose Plant-Specific Action Item 1: For flaws detected in these locations, the applicant must consider the SE for BWRVIP-234, including the lower $J_{0.1}$ -_{inch} for the CASS materials discussed in the SE, to adjust the Z factor of Section 5 of the LTR in the proposed elastic plastic fracture mechanics analysis.
- (3) The NRC staff could stop effort related to BWRVIP-42, Revision 1 until the SE for BWRVIP-234 is issued and the BWRVIP revises its position on evaluation of CASS materials in the LTR.

2.0 TOPIC 2: EVENT REPORTING AND SUCCESSIVE INSPECTION OF NEW AND OLD FLAWS

2.1 Flaw Evaluation and Leakage Assessment Reporting

Section 3.9.1 provides a two-step process for managing inaccessible welds: (1) to determine [the start time] of the inspection interval, and (2) to determine [the length] of the inspection interval. The NRC staff has concerns for both steps and issued RAI-3, requesting justification for (a) establishing the [75%] criterion for cracked accessible welds, and (b) using the [average calculated times] for the [75%] population of cracked accessible welds to determine the next inspection interval.

The BWRVIP's response to RAI-3 is satisfactory. However, when [50%] and [75%] of accessible similar welds are cracked in the future, the NRC staff believes that the OE then, especially crack growth rate, may be very different from the current one with no cracking. Therefore, the NRC staff will impose Condition 2(a) requiring the applicant inform the NRC Office of Nuclear Reactor Regulation by letter about these two events within 90 days of confirmation of these events for the NRC staff to reassess the overall inspection strategy and determine the need to review the latest information on OE, flaw evaluation, and leakage assessment for future safe operation of the LPCI couplings.

2.2 Successive Inspection of Newly and Previously Detected Flaws

The LTR does not address successive inspection of newly and previously detected flaws in LPCI coupling components. Therefore, unless the BWRVIP provides necessary clarification, the NRC staff is considering imposition of Condition 2(b) requiring that when any new cracking or a defect is observed during the future inspections, re-inspections shall be conducted at every refueling outage until the crack has been stabilized (i.e., the CGR is below the proposed bounding CGR for two consecutive outages) for two consecutive outages. For previously detected flaws, the NRC staff is considering imposition of Condition 2(c) requiring that the applicants confirm that the measured CGRs (i.e., the calculated CGR based on the current and the last inspection flaw sizes) for all previously detected flaws are below the proposed CGR. If the measured CGR of any previously detected flaw exceeds the proposed CGR, the flaw must be re-inspected in each successive outage until they become stable for two consecutive outages.

3.0 TOPIC 3: GENERAL FLAW EVALUATION ISSUES

3.1 Annulus Pressurization (AP) Loads

The BWRVIP's response to RAI-10 regarding consideration of AP loads stated that, "The potential impact on BWRVIP-42 Revision 1 would be a revision of the flaw analysis method contained in Section 5. However, the inspection requirements, which are not based fundamentally on flaw tolerance, would not be impacted." The NRC staff noted that the inspection requirements are not based fundamentally on flaw tolerance. However, considering the AP loads would affect the flaw evaluation results and the estimated time to the next inspection, the staff determined that all flaw evaluations to be performed in the future in accordance with Section 5 of this LTR must also consider AP loads. Unless the BWRVIP provides necessary clarification, the NRC staff is considering imposition of the above as Condition 3(a).

3.2 Flaw Evaluation Acceptance Criterion

Section 5.1.1.1.5 of the LTR provides an equation to calculate the time to reach the minimum acceptable structural margin based on the allowable flaw size that was determined by the proposed limit load analysis. However, the LTR does not state that for a detected flaw, the calculated time must be greater than or equal to the time to the next proposed scheduled inspection. Unless the BWRVIP provides necessary clarification, the NRC staff is considering imposition of the above as Condition 3(b).

3.3 Leakage Assessment Acceptance Criterion

Section 5.1.3 of the LTR provides a limit on the leakage rate. Accordingly, the leakage from all detected flaws in the accessible welds and assumed flaws in the inaccessible welds for a [BWR/6] plant need be limited to [0.1%] of normal core flow. The limit was established by the acceptable increase in the calculated value of [peak cladding temperature], which is a part of the plant-specific LOCA analysis. For [BWR/4/5] plants, since the allowable leakage is not established in the LTR, the NRC staff conservatively use a leakage, which is 80% of that for a [BWR/6] plant, for them. Unless the BWRVIP provides necessary clarification, the NRC staff is considering imposition of the above as Condition 3(c).