Non-Proprietary BWRVIP Responses to NRC Conditions Stated in the NRC Draft SE on BWRVIP-183

Responses to NRC Conditions Stated in the NRC Draft SE on BWRVIP-183

NRC SE Condition 1

183 **The flaw evaluation methodology in the BWRVIP-183 report is based on the methodology of**
184 **Appendix B of BWRVIP-26-A, where the applied K values were developed from a single edge-**
185 **crack plate model. Use of the single edge-crack plate flaw evaluation model requires that the**
186 **crack is free from the effect of sudden geometry changes. As such, this methodology is**
187 **applicable only when the flaws are located at grid beam locations away from notches and slots.**
188 **The NRC staff has reflected this limitation on the use of the BWRVIP-183 flaw evaluation**
189 **methodology in Section 4.0 of this SE as Condition 1 on the use of BWRVIP-183.**
190

384 **Condition 1 – Use of the flaw evaluation methodology in BWRVIP-183, Section 4 may only be**
385 **applied when a detected flaw is sufficiently far from geometric discontinuities like notches or**
386 **slots such that the stress condition in the vicinity of the flaw is consistent with that for a single**
387 **edge-crack plate. Applicants must demonstrate that any detected flaws being evaluated using**
388 **the flaw evaluation methodology of Section 4 of BWRVIP-183 meet this criterion. If this cannot**
389 **be demonstrated, appropriate applied K values which account for the effects of geometric**
390 **discontinuities must be used and justified in the flaw evaluation.**

BWRVIP Response to NRC SE Condition 1

In BWRVIP-183, the stress intensity factor is calculated based on the actual stress profile at the section through the notch as shown in Figure 1. The stress profile is post-processed from the finite element analyses for relevant loading conditions. In addition, the width, W, for the flaw single edge cracked plate model is taken as the width of the top guide beam minus the depth of the notch, also shown in Figure 1. Thus, the stress intensity factor in BWRVIP-183 accounts for the effect of the notch on the stress profile.

Consequently, the single edge cracked plate model proposed in BWRVIP-183 can be conservatively used at a notch or any other crack location. The through-section stresses are developed at the discontinuities using the finite element model, thus including the effect of the notches on stress. The effective thickness used in the flaw model that provides additional conservatism in the stress intensity can be eliminated and thus not include the constraint by the material around the notch behind the crack front.

[[

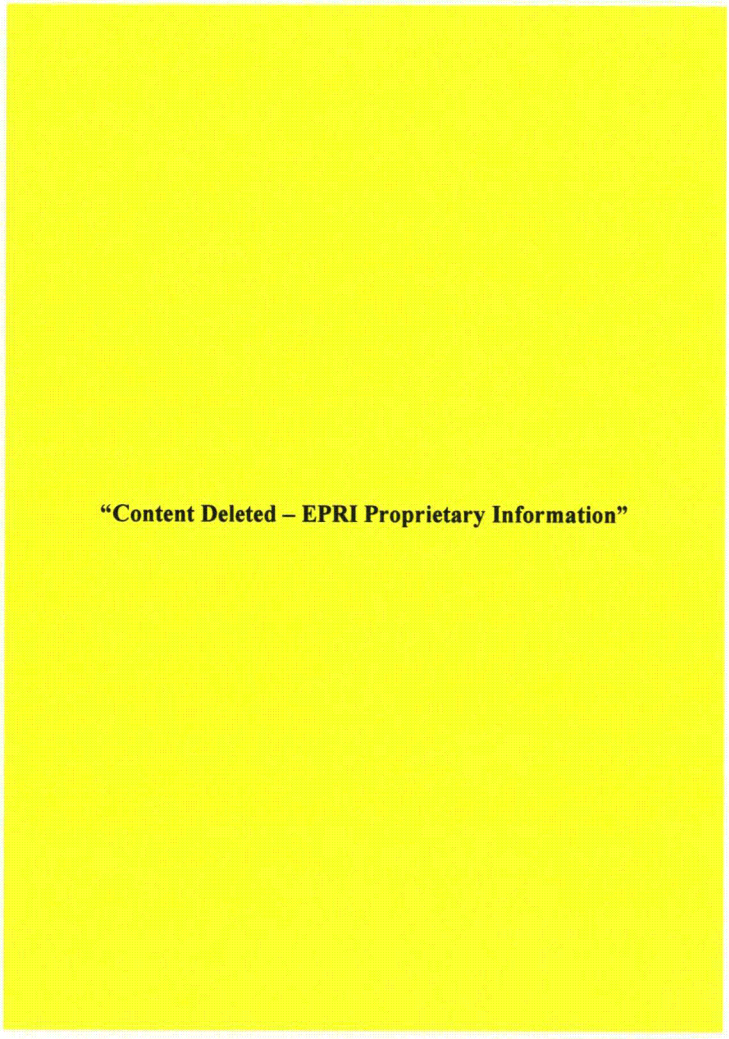

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Figure 1: Crack Model for Top Guide

NRC Condition 2

A licensee utilizing the BWRVIP-183, Section 4 flaw evaluation methodology must therefore inspect known top guide grid beam flaws at each refueling outage and reevaluate the acceptability of leaving such flaws in service over every individual operating cycle. Once a licensee has acquired sufficient plant operating experience (i.e., crack length measurements over time with which to benchmark the accuracy of the flaw evaluation methodology), a licensee may request NRC approval to apply the BWRVIP-183, Section 4 methodology to justify plant operation for more than one cycle at a time. This is Condition 2.

As stated in Section 3.2, the NRC staff is concerned that the BWRVIP-183 flaw evaluation methodology could be underpredicting the expected growth of known flaws. Therefore, Condition 2 is imposed to address the difference between the analytical predictions of insignificant growth of grid beam flaws and the operating experience showing long flaws. Condition 2 – Use of the BWRVIP-183, Section 4.0 flaw evaluation methodology may be applied to justify continued facility operation on a cycle-by-cycle basis. A licensee may seek NRC approval to use the BWRVIP-183, Section 4 flaw evaluation methodology to justify continued facility operation for more than one cycle if a licensee has acquired sufficient plant operating experience to support such an application. Such operating experience would include crack length measurements of detected top guide grid beam flaws at a sufficient number of refueling outages to benchmark the accuracy of the flaw evaluation methodology.

BWRVIP Response to NRC SE Condition 2

Inspection of known flaws every outage would create unnecessary outage delays and dose with little, if any, increase in safety. It is important to point out that multiple inspections have been conducted at Nine Mile Unit 1 and Oyster Creek over many years. While Nine Mile Unit 1 and Oyster Creek have multiple indications in the top guide, all are relatively short. The vast majority of the indications are under [["Content Deleted – EPRI Proprietary Information"]] and only a few are on the order of [["Content Deleted – EPRI Proprietary Information"]]. A qualitative evaluation of repeat visual inspections at Oyster Creek shows that many flaws are either not growing at all or are growing at a very slow rate. Repeat UT inspections at Nine Mile Point 1 performed in 2005 and 2015 of approximately [[ ]] indications showed no change after 10 years. For this reason, inspections every outage are not necessary. Given the relatively short observed crack lengths (compared to the overall beam lengths of [["Content Deleted – EPRI Proprietary Information"]] inches for BWR/2 through BWR/5 units), the small observed crack growth rates and the high flaw tolerance of the top guide, the BWRVIP believes that the reinspection intervals specified in BWRVIP-183 are appropriate. TS TS TS TS

The BWRVIP conducted an extensive survey of top guide inspections since issuance of BWRVIP-183 in 2007. This activity to collect and evaluate operating experience is consistent with the guidance contained in BWRVIP-94NP, Rev. 2 which states, "In addition to meeting the intent of all BWRVIP guidelines, each BWRVIP member shall also review and consider relevant operating experience and information contained in applicable NRC notices and other industry documents when evaluating the need to improve existing vessel and internals programs." The results of these inspections are summarized in Table 1.

All plants have completed the required initial inspections per BWRVIP-183. It is noteworthy that the results demonstrate that no indications of any significance have been detected in BWR/3 through BWR/6 models since implementation of BWRVIP-183. The BWRVIP member utilities

continue to carry out these inspections and monitor crack growth. Any new information obtained from BWRVIP-183 inspections is factored into the BWRVIP inspection guidance and adjusted accordingly. Inspection results associated with all components that are within the auspices of the BWRVIP program are routinely communicated to the NRC in bi-annual reports such as docketed in BWRVIP Letter 2015-043.

If new flaws are discovered, the flaw acceptance criteria in BWRVIP-183 for flaws located in the middle of the plate are conservative and as such there is reasonable assurance based on the Nine Mile Point Unit 1 and Oyster Creek experience that such flaws would not propagate to a significant length during the inspection period cited in BWRVIP-183. [[

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]] This is consistent with all other BWRVIP I&E Guidelines approved by the NRC. An example of such an approval is contained in the NRC SE for BWRVIP-18, Revision 1. This SE does not require any plant-specific analyses to be submitted to the NRC for review.

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The BWRVIP proposes to add re-inspection guidance to BWRVIP-183 which should address the NRC's concern. This is discussed in the additional information provided following the response to Condition 4. The BWRVIP feels the proposed inspection interval are reasonable based on the data collected to date and the inherent margin to CGRs based on the likely mitigation benefits plants are gaining from hydrogen water chemistry (HWC), NobleChem™ and Online NobleChem™.

Furthermore, the BWRVIP is convinced that the condition to seek NRC approval to return to BWRVIP-183 guidance after a flaw is demonstrated to be stable creates an undue administrative hardship to both the utilities and the NRC without significant increase in safety. Based on the operating experience presented above, the response to NRC SE Condition 1 and the commitment to add re-inspection guidance, the BWRVIP feels that any top guide beam degradation is adequately managed to avoid a failure such as severance of a beam. Per BWRVIP-94NP, Revision 2, Section 3.5 procedures, the NRC is notified of any utility deviation from BWRVIP guidance and has the opportunity to follow-up on their concerns through review of the utility's Corrective Action Process.

NRC SE Condition 3

The NRC staff reviewed Section 5 and determined that the severed beam location and the seismic loads to be used are highly plant-specific, hence, the seismic analysis and results presented in this section have very little generic implication. The BWRVIP stated in its response to NRC RAI 3 that, "a plant-specific analysis is required to address the issue of control rod insertion for design basis transients." The NRC staff thus determined that future plant-specific analyses should be the focus of the NRC staff review, and questions regarding acceptable beam deflections which would not interfere with CRD operations can be deferred to the plant-specific reviews.

281 **For any application demonstrating that a flawed beam will not become a severed beam during**
282 **the proposed period of operation, a plant-specific severed beam analysis must be performed**
283 **and submitted for staff review to demonstrate that even if the beam severed (the worst-case**
284 **scenario), the CRD operations will not be compromised by the maximum local and global**
285 **deflection of the top guide grid beams. This is Condition 3.**

410 **Condition 3 – When applying the flaw evaluation methodology in BWRVIP-183, Section 4,**
411 **a licensee must also perform a severed beam evaluation consistent with BWRVIP-183,**
412 **Section 5. The severed beam analysis is needed to demonstrate that even if a completely**
413 **severed beam were to occur, it would not be expected to interfere with the ability of the CRD**
414 **system to insert control rods.**

BWRVIP Response to NRC SE Condition 3

Consistent with the BWRVIP response to the NRC RAI dated March 3, 2011 (BWRVIP Letter 2011-046), the BWRVIP position is that a plant-specific severed beam analysis is required only if a plant-specific flaw analysis predicts severance to occur between inspection intervals or if any severed grid beam is found during an inspection. The response to the SE Conditions 1 and 2 above supports this position for predicted severance of a beam. The BWRVIP believes that a severed grid beam analysis should not be required until the critical flaw size is reached. Imposing a requirement to assume a severed beam for all flaws in the same fuel cells when plant-specific flaw evaluations do not predict the critical flaw size will be reached could potentially require unnecessary repairs. With the inclusion of guidance to consider CRD insertion in all severed beam evaluations the BWRVIP feels that the NRC's concern is addressed and similar to other BWRVIP Inspection and Evaluation guidelines plants should not be required to submit their flaw evaluations to the NRC unless they deviate from the BWRVIP I&E guidelines. This will result in consistency in BWRVIP implementation and alleviate unnecessary exceptions and administrative burden on both the utilities and the NRC.

NRC Condition 4 (Not identified specifically as SE Condition 4, but implied by lines 377-382)

375 **4.0 CONDITIONS AND LIMITATIONS**
376
377 **Depending on the inspection findings of the top guide grid beams, licensees may need to**
378 **perform certain plant-specific evaluations in accordance with the BWRVIP-183 report. There**
379 **are two major categories of inspection findings: (1) flaws cracked through the beam and**
380 **(2) flaws of limited length. The licensees are required to repair or replace cracked through**
381 **(severed) top guide grid beams. For beams with flaws of limited length, the proposed flaw**
382 **evaluation, as limited by Condition 1, may be used to demonstrate continued operation.**

BWRVIP Response to NRC SE Condition 4

It is the position of the BWRVIP that if the analysis of a severed beam shows acceptable results, a repair is not required. Thus, the BWRVIP believes that sufficient guidance is contained in BWRVIP-183 to conduct the analysis and determine if the results of a severed beam are acceptable.

Additional Information Provided by the BWRVIP (not related to the NRC SE).

If the proposed BWRVIP responses to the SE Conditions cited above are accepted by the NRC, the following additional changes to BWRVIP-183 are proposed.

1. Delete Section A.6 as the results of the analysis are not pertinent to the overall report.
2. Revise Section 8.3 as follows

Reinspection Guidelines

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Table 1. Top Guide Grid Beam Exams Since Implementation of BWRVIP-183,[1,2]

Plant	2009	2010	2011	2012	2013	2014	2015	Total Cells
Plant A, NRI[3]						10		10
Plant B, NRI[3]			2		3		5	10
Plant C, NRI[3]		5				5		10
Plant D, NRI[3]		3		7		3		13
Plant E, NRI[3]	3				7			10
Plant F (BWR/6), NRI[3]		Rim & 2						2
Plant G, NRI[3]	8				12			20
Plant H, NRI[3]	8		2					10
Plant I, NRI[3]			18					18
Plant J, NRI[3]				18				18
Plant K, NRI[3]		6						6
Plant L, NRI[3]	5			5				10
Plant M, NRI[3]		8						8
Plant N (BWR/6), RI[4,5]				Rim & 2				2
Plant O, NRI[3]		21						21
Plant P, NRI[3]			8					8
Plant Q, NRI[3]	4	2		4				8
Plant R, RI[4,6]				10				10
Plant S, NRI[3]			19					19
Plant T, NRI[3]				10				10
Plant U, NRI[3]			5		14			19
Plant V, NRI[3]			8					8
Plant W, RI[4,7]	3		2		7			12
Plant X, NRI[3]		6		3		4		13
Plant Y, RI[4,7]		7						7

Plant	2009	2010	2011	2012	2013	2014	2015	Total Cells
Plant Z, NRI[3]				19				19
Plant AA, NRI[3]	5		14					19
Plant BB (BWR/6), NRI[3]		Rim & 2						2
Plant CC, NRI[3]			8					8
Plant DD, NRI[3]	9							9
Plant EE, NRI[3]		9						9
Plant FF, NRI[3]							Rim & 4	4
Plant GG, NRI[3]		9				9		18
Plant HH, RI[4,8]	3		6		10			19
Plant II, NRI[3,9]	5 (2008)							5
Total:								394

Notes:

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[[2. "Content Deleted – EPRI Proprietary Information"]] TS

3. NRI stands for "No Recordable Indications."
4. RI stands for "Recordable Indications."
5. Plant N has one recordable indications that is a ½" linear indication in the heat affected zone of the intersecting weld in one cell.
6. Plant R has no cracking, but recorded one cell that had metal slivers.
7. Plants W and Y have grid beam cracking that was identified prior to the issuance of BWRVIP-183. Re-examination of the cells with cracking is in accordance with License Renewal commitments. Inspection of the flawed cells is not reflected in the table's numbers. Reinspections of the cracked cells have not shown any significant growth and inspections of other cells in accordance with BWRVIP-183 have not identified any new recordable indications.
8. Plant HH has one cell with two ¼" linear indications assumed to be cracks.
9. Plant II is now permanently shutdown.