



SVP-14-049

July 9, 2014

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Quad Cities Nuclear Power Station, Unit 1  
Renewed Facility Operating License No. DPR-29  
NRC Docket No. 50-254

Subject: Deviation from BWR Vessel and Internals Project (BWRVIP) Guidelines –  
Inspection of RB-2 welds

Reference: 1) BWRVIP-41 Revision 3, BWR Jet Pump Assembly Inspection and Flaw  
Evaluation Guidelines. EPRI, Palo Alto, CA: September 2010. 1021000  
2) BWRVIP-94NP, Revision 2: BWR Vessel and Internals Project, Program  
Implementation Guide. EPRI, Palo Alto, CA: 2011. 1024452

Exelon Generation Company, LLC (EGC) is a member of the BWR Vessel and Internals Project (BWRVIP) and has committed to implementing BWRVIP products and to providing notification to the NRC staff if an applicable aspect of a BWRVIP product will not be implemented.

Quad Cities Unit 1 experienced fatigue cracking in the jet pump riser pipe 5/6 and 7/8 in 1993 and 1998 respectively. The cracking was located in the RB-8 and RB-9 welds and in the pipe wall adjacent to the riser brace. Repair clamps were installed on these jet pump riser pipes in 1994 and 1999. The repair clamps replace the RS-8 and RS-9 welds and stabilize the pipes. The repair hardware covers, but does not mechanically replace, the jet pump 5/6 and jet pump 7/8 riser brace RB-2 welds.

BWRVIP-41 Revision 3 (Reference 1) defines the “needed” requirements for inspections of the RB-2 welds. The RB-2 welds are required to have enhanced visual testing (EVT-1) inspections of the weld heat affected zone (HAZ) performed on the following schedule:

- Baseline EVT-1 (previously VT-1) must be completed on all RB-2 welds within two inspection cycles from original issuance of BWRVIP-41 (October 1997).
- Re-inspection of 25% of the RB-2 population every inspection cycle

Contrary to the above requirements, no baseline inspections were performed on JP 5/6 or JP 7/8 RB-2 welds. Additionally, further inspection of these RB-2 welds is not possible due to interference from the repair hardware. Therefore, this constitutes a deviation from “needed” BWRVIP guidelines and a Deviation Disposition is required.

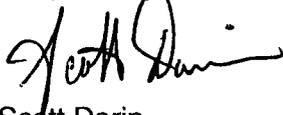
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A Deviation Disposition (enclosed) was prepared in accordance with BWRVIP-94NP, Revision 2 (Reference 2). The Deviation Disposition contains an evaluation documenting the acceptability of not performing the "needed" RB-2 inspections in accordance with BWRVIP-41 Revision 3. The evaluation concluded that it is technically justified to deviation from requirements of BWRVIP-41, Revision 3 (Reference 1) for the Unit 1 jet pump 5/6 and jet pump 7/8 RB-2 welds.

This letter is being transmitted for your information in accordance with Section 3.5 of BWRVIP-94NP Revision 2. This letter is to notify the NRC of the deviation from "needed" BWRVIP guidance. No actions or approvals on the part of the NRC are required as a result of this letter.

There are no regulatory commitments contained in this letter. Should you have any questions, please contact Mr. Wally J. Beck at (309) 227-2800.

Respectfully



Scott Darin  
Site Vice President  
Quad Cities Nuclear Power Station

Enclosure: Technical Justification to Deviate from BWRVIP Inspection Guidance For Unit 1 Jet Pump Riser Brace 5/6 & 7/8 RB-2 Welds

cc: Regional Administrator - NRC Region III  
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station

## ENCLOSURE

Technical Justification to Deviate from BWRVIP Inspection Guidance  
For Unit 1 Jet Pump Riser Brace 5/6 & 7/8 RB-2 Welds

*EC 398095, Rev 1*  
*Technical Justification to Deviate from BWRVIP Inspection Guidance For Unit 1 Jet  
Pump Riser Brace 5/6 & 7/8 RB-2 Welds*

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**REASON FOR EVALUATION / SCOPE:**

**Introduction:**

Quad Cities Nuclear Power Station (QCNPS) Unit 1 has two (2) jet pump riser brace repair clamps installed; one each on jet pump (JP) riser pipes 5/6 and 7/8. The repair hardware covers, but does not structurally replace, the associated RB-2 welds (i.e. Primary Riser Brace Leaf to Yoke Welds). The repair hardware prevents inspection of these RB-2 welds as required by BWR Vessel and Internals Project (BWRVIP) document guidelines.

BWRVIP-94NP Revision 2, "*Program Implementation Guide*" (Reference 1), states that deviations from existing BWRVIP guidelines require the submittal of a Deviation Disposition to the BWRVIP and notification to the NRC for documents classified as "mandatory" or "needed".

BWR Vessel and Internals Project document BWRVIP-41 Revision 3, "*BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines*" (Reference 2), specifies that JP welds or components with a Safety Priority rating of Medium (M) have a baseline inspection performed in the first two inspections cycles after the date of issuance of the original BWRVIP-41 (revision 0 issued October 1997) (Reference 3), and reinspection performed at a rate of 25% of the weld population in each inspection cycle. Both of these documents are classified as "needed" per NEI 03-08 (Reference 4).

Specifically, BWRVIP-41 Revision 3, (Reference 2), Table 3-2, *Matrix of Inspection Options*, defines the requirements for inspections of the RB-2 welds. The RB-2 welds are required to have enhanced visual testing (EVT-1) inspections of the weld heat affected zone (HAZ) performed on the following schedule:

- Baseline EVT-1 must be completed on all RB-2 welds within two inspection cycles from original issuance of BWRVIP-41.
- Re-inspection of 25% of the RB-2 population every inspection cycle

Note – A Jet Pump inspection cycle is defined as 6 years, or 3 refueling outages for Quad Cities Station.

Note - The original BWRVIP-41 requirements were for visual testing using VT-1 vice EVT-1.

Per these inspection guidelines, the RB-2 baseline weld inspections were required to be completed by the end of Q1R20 in the spring of 2009. Contrary to the above requirements, no baseline inspections were performed on JP 5/6 or JP 7/8 RB-2 welds. Therefore, this constitutes a deviation from "needed" BWRVIP guidelines and a Deviation Disposition is required.

Additionally, it is not possible to perform the required baseline or re-inspection, of JP 5/6 or JP 7/8 RB-2 welds with current technology unless the repair hardware is removed.

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Repair hardware removal is not practical due to the impact on outage duration, cost, schedule risk, and dose associated with removal and reinstallation. Therefore, QCNPS elects not to inspect these welds at this time. As discussed above, the required baseline inspection is past due. Therefore, this constitutes a deviation from "needed" BWRVIP guidelines and a Deviation Disposition is required.

Finally, BWRVIP-51-A, *Jet Pump Repair Design Criteria*, (Reference 5) defines the requirements for the design of repairs of jet pump components and is designated as "needed". Per BWRVIP-51-A (Reference 5):

*"The repair design shall be such that inspection of reactor internals, reactor vessel, ECCS components and repair hardware is not impaired. The jet pump hardware shall not cover or obstruct and any other system welds that are not structurally replaced by the repair hardware".*

Contrary to the above requirements, the riser brace repair hardware on JP 5/6 and JP 7/8 riser braces impairs the ability to perform the required inspections of the associated RB-2 welds. However, this does not constitute a deviation from "needed" BWRVIP guidelines since in BWRVIP-94, Rev 1, Section 2.3 it states, "...repairs implemented prior to the issuance of BWRVIP guidelines do not need to be evaluated for compliance with the BWRVIP guidance." In this case, both the repairs were designed and installed prior to the required implementation date for BWRVIP-51 (i.e., less than 2 refueling outages after the May 1998 issuance of BWRVIP-51).

This Technical Justification is part of the Deviation Disposition and has been prepared in accordance with ER-AA-4003 Revision 4, "*Materials Degradation Management Process (MDMP) Deviation Guidance*" (Reference 7).

**Background:**

The original construction of the QCNPS jet pumps included a brace on the common 12" NPS recirculation riser pipe that supplies the driving flow to each pair of jet pumps. This riser pipe is a vertical pipe located in the annulus area between the reactor pressure vessel (RPV) shell and the core shroud that runs upward from the N2 inlet nozzle to the jet pump inlet assembly or "Rams Head". The riser brace acts to limit the lateral movement and vibration of the riser pipe while allowing vertical expansion growth. Each riser brace consists of a yoke welded to the riser pipe opposite the RPV shell and a "leaf" on each side of the pipe. The "leaves" are welded to the RPV wall at one end, and to the yoke at the other end. The "leaves" provide the lateral support for the riser pipe by anchoring the pipe to the RPV wall. These "leaf" to yoke welds are generally designated as the RB-2 welds or more specifically as the RB-2a and RB-2b welds. The yoke to pipe upper and lower welds are designated as the RS-8 and RS-9 welds.

QCNPS Unit 1 experienced fatigue cracking on the riser pipe in and near the riser brace yoke RS-8 and RS-9 welds on jet pump pairs 5/6 and 7/8 in 1993 and 1998 respectively. Repair clamps were installed on these jet pump riser pipes under EC 22246 (JP 5/6 Q1R13 1994) and EC 23811 (JP 7/8 Q1P02 1999). The repair clamps replace the RS-8

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and RS-9 welds to stabilize the pipe. The repair hardware consists of a set of plates and a replacement yoke that are bolted over the original riser brace yoke to capture the riser pipe and mechanically replace the RS-8 and RS-9 welds. The repair hardware is bolted to the original riser brace yoke and relies on the original "leafs" and RB-2 welds for stability. The repair hardware is not mechanically attached to either "leaf". The riser brace repair hardware covers, but does not mechanically (i.e. structurally) replace, the JP 5/6 or JP 7/8 riser brace RB-2a/b welds. The only portion of the RB-2 weld and HAZ that is potentially visible is the outside vertical edge of the weld located between the top and bottom repair hardware plates.

There is no historic evidence that the required VT-1 inspections were performed on any of the four (4) covered RB-2a/b welds prior to installation of the repair hardware.

The Unit 1 JP 5/6 riser brace repair clamp was installed in July 1994 during Q1R13. This was prior to issuance of BWRVIP-41 Rev 0 (October 1997) (Reference 3) and BWRVIP-51 (May 1998) (Reference 6). No documentation could be found that VT-1 inspections were performed on the RB-2a/b welds prior to the clamp installation. Therefore, no baseline inspection can be credited as required by the BWRVIP-41 requirements, and these welds are not in compliance with the "needed" guidance of BWRVIP-41. This is a legacy issue that pre-dates the BWRVIP Project requirements.

The Unit 1 JP 7/8 riser brace repair clamp was installed in April 1999 during Q2P02. This was shortly after issuance of BWRVIP-41 Rev 0 (October 1997) (Reference 3) and BWRVIP-51 (May 1998) (Reference 6). While a VT-3 inspection was performed and documented during Q1R15 in fall of 1998, no documentation could be found that the required VT-1 inspections were performed on the RB-2a/b welds prior to the clamp installation. The 1998 VT-3 exams were completed with no recordable indications noted. The VT-3 inspection cannot be credited as meeting the requirements of BWRVIP-41. Therefore, no baseline inspection can be credited as required by the BWRVIP-41 requirements and these welds are not in compliance with the "needed" guidance of BWRVIP-41. This is a legacy issue.

An attempt to inspect the Unit 1 JP 7/8 RB-2b weld was made during the most recent refuel outage in 2011 (Q1R21) however, the examiners reported the weld top and bottom length were completely covered by the repair hardware and the examination could not be performed. While the outside edge of each weld is potentially visible, interference from the repair hardware prevented a clear camera view that met EVT-1, or VT-1, standards. Therefore, the BWRVIP-41 required inspections of these RB-2 welds are not possible with current technology or hardware removal.

Furthermore, with the repair hardware installed, no further inspection of the four (4) welds is possible due to interference from the hardware. As discussed above, repair hardware removal is not desired due to the impact on outage duration, cost, schedule risk, and dose associated with removal and reinstallation. Therefore, QCNPS elects not to inspect these welds at this time.

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**Deviation Description:**

This Deviation Disposition is concerned with the following items:

- QCNPS Unit 1 is not meeting the requirements for EVT-1 (previously VT-1) visual examination for Baseline inspection of the riser brace leaf to yoke welds RB-2a/b for jet pump riser 5/6 and 7/8 as stipulated by BWRVIP-41, Revision 3 (Reference 2).
- QCNPS Unit 1 is not meeting the requirements for EVT-1 visual examination for reinspection of the riser brace leaf to yoke welds RB-2a/b for Jet Pump Risers 5/6 and 7/8 as stipulated by BWRVIP-41, Revision 3 (Reference 2).

BWRVIP-94NP Revision 2, "*Program Implementation Guide*" (Reference 1), states that deviations from existing BWRVIP guidelines require the submittal of a deviation disposition to the BWRVIP and notification to the NRC for documents classified as "mandatory" or "needed". This deviation disposition is prepared in accordance with ER-AA-4003, "*Materials Degradation Management Process (MDMP) Deviation Guidance*" (Reference 7). BWRVIP-41 Rev 3 (Reference 2) is considered "needed".

This EC provides the technical justification to support the BWRVIP deviation as described above.

**Applicable BWRVIP Guidelines:**

- BWRVIP-41 Revision 3, "*BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines*" (Reference 2).

**Expected Duration:**

This modification and deviation will remain in place for the lifetime of the Quad Cities Unit 1 first extended license date of 12/31/2032, unless examination techniques are developed to inspect the welds with the repair hardware in place, or the repair hardware is removed to allow access to the welds, or BWRVIP inspection requirements change.

## **DETAILED EVALUATION:**

### **Component Description**

The original construction of the QCNPS jet pumps included a brace on the common 12" NPS recirculation riser pipe that supplies the driving flow to each pair of jet pumps. This riser pipe is a vertical pipe located in the annulus area between the reactor pressure vessel (RPV) shell and the core shroud that runs upward from the N2 inlet nozzle to the jet pump inlet assembly or "Rams Head". The riser brace acts to limit the lateral movement and vibration of the riser pipe while allowing vertical expansion growth. Each riser brace consists of a yoke welded to the riser pipe opposite the RPV shell and a "leaf" on each side of the pipe. The "leaves" are welded to the RPV wall at one end, and to the yoke at the other end. The "leaves" provide the lateral support for the riser pipe by anchoring the pipe to the RPV wall. These "leaf" to yoke welds are generally designated as the RB-2 welds or more specifically as the RB-2a and RB-2b welds. The yoke to pipe upper and lower welds are designated as the RS-8 and RS-9 welds.

The riser brace attaches the riser pipe to pads which are welded to the RPV wall. The main function of the riser brace is to limit the vibration of the riser pipe and maintain the design configuration of the jet pump assembly. The riser brace "leaves" are designed to be flexible enough to accommodate the differential thermal expansion between the stainless steel Riser pipe and the carbon steel RPV. This flexibility allows expansion of the components without damage.

### **Deviation**

QCNPS Unit 1 is not meeting the requirements for EVT-1 visual examination for Baseline of the Riser Brace Leaf (Arm) to Yoke welds (welds RB-2a and b) for Jet Pump Risers 5/6 and 7/8 as stipulated by BWRVIP-41, Revision 3 (Reference 2).

QCNPS Unit 1 is not meeting the requirements for EVT-1 visual examination for reinspection of the riser brace leaf to yoke welds (welds RB-2a and b) for jet pump risers 5/6 and 7/8 as stipulated by BWRVIP-41, Revision 3 (Reference 2).

### **Technical Acceptability of the Deviation:**

As discussed in BWRVIP-41 Rev 3 (Reference 2), the jet pump riser brace is loaded during normal operation primarily by thermal loads and vibration. The thermal loads arise from the differential thermal expansion between the low alloy steel pressure vessel and the stainless steel jet pump assembly. The vibration loads are primarily a result of flow induced vibration of the entire jet pump assembly.

Additionally, Jet pump riser braces can suffer from two forms of environmentally assisted cracking, IGSCC of stainless steel heat affected zones (HAZs) and fatigue. Fatigue crack growth can be a significant degradation mechanism for the riser brace. High cycle fatigue caused by resonance of the riser brace leaves with the recirculation pump vane

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passing frequency (VPF) is one possible cause of degradation. The degree of susceptibility is, however, difficult to quantify and is dependent on plant-specific factors such as jet pump natural frequency, recirculation pump VPF, hardware geometry and stiffness. Collectively, this vibration mechanism is known as Flow Induced Vibration (FIV).

Failure of the riser brace would cause a significant change in the response of the jet pump assembly to flow induced vibration. It is possible that this change in vibration response could result in increased fatigue loading, and potentially fatigue failure, of other components in the assembly, such as the riser pipe or jet pump beam. Failures of these other components could result in jet pump disassembly.

Riser brace degradation or complete failure is not immediately detectable during normal operation. Therefore, cracking of the riser brace welds put the jet pump assembly in a vulnerable state. The loads generated during a recirculation line Loss of Coolant Accident (LOCA) can be large enough to severely damage a jet pump assembly with a significantly degraded riser brace, resulting in a potential safety concern.

Since the riser brace is constructed of multiple pieces joined by welds, the lateral support it provides to the Jet Pump assembly is not dependant on a single weld. However, complete failure of one of the RB-2a/b welds would reduce the stiffness of the Jet Pump assembly and increase the vibration loads on the other welds of the riser brace. While the repair hardware replaces the RS-8 and RS-9 welds, it relies on the original riser brace, including the "leafs" and RS-1 and RS-2 welds, for structural stability.

Failure of the RB-2a and/or b weld(s) would not, by itself, result in jet pump disassembly. However, the riser brace provides the only lateral support for the jet pump assembly above the riser inlet elbow. Total loss of this support could result in severe vibration loads on the jet pump assembly which could result in jet pump damage. This vibration would most likely show up first in the main wedge assembly (WD-1) as wear, or the RB-1 weld on the leaf with the intact RB-2 weld as fatigue cracking. Fatigue cracking of other components/welds would occur later and would most likely be bounded by the wear in the main wedge assembly. Jet pump damage could result in loss of core cooling by allowing water to bypass or leak from the core area and affect the ability to maintain core coverage at 2/3 core height. Significant jet pump damage would be detected via the periodic jet pump flow surveillance that is performed daily by the Control Room Operators.

Per the QCNPS IVVI Program Basis Document, the Unit 1 jet pump 5/6 and 7/8 riser brace repair hardware will each be examined every six (6) years using visual inspection (VT-3) to verify the repair hardware is intact and performing its function as designed. The visual inspection (VT-1/ VT-3) includes visual verification that the tack welds of the repair hardware are intact and to an inspection for evidence of hardware movement and/or degradation. An examination of the hardware was last performed in spring 2009

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(Q1R20); both clamps were inspected to VT-3 standards and all hardware was reported as no recordable indications (NRI). The next examination of the repair hardware on both these Jet Pump assemblies is scheduled for 2019 (Q1R25).

Damage resulting from a failure of the RB-2 welds could result in rapid FIV related damage. This damage would most likely show up as fatigue cracking or rapid mechanical wear in the following locations:

- Fatigue Cracking:
  - In the previously cracked and repaired RS-8 and RS-9 welds, extending above and below the welds (and repair clamps)
  - In the jet pump riser pipe RB-1a/b welds, especially on the side with the intact RB-2 weld
- Mechanical wear:
  - On the main wedge (WD-1).
  - Between the wedge rod (WD-1) and the guide tube.

The JP05, 06, 07, and 08 were last inspected at the following locations on the dates shown:

- |            |                     |                     |
|------------|---------------------|---------------------|
| • RS-1     | JP5/6 - Spring 2011 | JP7/8 - Spring 2011 |
| • RS-2     | JP5/6 - Spring 2011 | JP7/8 - Spring 2011 |
| • RS-3     | JP5/6 - Spring 2011 | JP7/8 - Spring 2011 |
| • RS-4     | JP5/6 - Spring 2009 | JP7/8 - Spring 2009 |
| • RS-5     | JP5/6 - Spring 2009 | JP7/8 - Spring 2009 |
| • RB-1a/b  | JP5/6 - Spring 2009 | JP7/8 - Spring 2009 |
| • WD-1/Rod | JP5/6 - Spring 2011 | JP7/8 - Spring 2011 |

All the above exams were completed with no recordable indications noted.

The following inspection points will be added, in addition to the normal BWRVIP needed guidance each inspection period (i.e. once every 6 years) in order to monitor the condition of JP5, 6, 7, and 8 for potential degradation resulting from failure of the RB-2 welds (note-addition of these inspections into the Quad Cities IVVI basis Document will be tracked under A/R 1639170-19):

- RB-1a/b      EVT-1
- WD-1/Rod    VT-1

Additionally, BWRVIP guidance for inaccessible (hidden) welds was recently incorporated in BWRVIP-41 Revision 3 (Reference 2). This new guidance provides “needed” guidance for indirect monitoring of original construction jet pump welds that are inaccessible or “hidden” for the purposes of direct examination. In summary, the new guidance requires that the station identify a population of welds that are “similar” to the inaccessible weld(s) and monitor this “similar” population for cracking. When 75% of the “similar” welds have evidence of cracking, specific actions are required per BWRVIP-41

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Revision 3 (Reference 2) to assume probable cracking in the inaccessible/hidden welds. Although this methodology is intended for welds hidden by the original design (e.g., recirculation inlet nozzle thermal sleeve welds), and thus does not alleviate the need for this Deviation Disposition, it can be used to indirectly monitor the hidden RB-2 welds for cracking. In this case, the population of welds "similar" to the JP 5/6 and 7/8 RB-2 welds are the remaining sixteen (16) RB-2a/b welds on the eight (8) un-repaired riser brace assemblies. These 16 welds will continue to be monitored for cracking in accordance with BWRVIP-41 Revision 3 guidance (Reference 2).

To date, no cracks have been identified on any the 16 unobstructed RB-2 welds on unit 1 at QCNPS. Additionally, no FIV damage has been identified to-date on Unit 1 jet pumps 5, 6, 7, or 8. Therefore, there is reasonable assurance that the Unit 1 JP 5/6 and 7/8 RB-2 welds most likely do not contain cracks and are intact.

Finally, the operating crew performs daily jet pump surveillances, as required by Technical Specifications, to monitor for jet pump integrity. Failure of the RB-2 weld(s) and resultant jet pump FIV damage would likely show itself during this surveillance. Failure of the jet pump surveillance requires a manual reactor shutdown.

**BWRVIP Precedence:**

BWRVIP Deviation Disposition DD-57, Browns Ferry Nuclear Plant, "Deviation Disposition for Variance from BWRVIP Guidelines for Examination of Jet Pump Welds RB-2a,b,c,d" dated 12 Dec. 2010.

DD-57 was also submitted to document deviation from "needed" inspection of RB-2 welds made inaccessible for examination due to riser brace repair hardware interferences.

**CONCLUSIONS / FINDINGS:**

QCNPS will not perform baseline inspection or reinspection per EVT-1 standards of the Unit 1 JP 5/6 and 7/8 RB-2 welds as required by BWRVIP-41 Rev 3, Table 3-2. This is a deviation for an NEI 03-08 needed requirement.

The technical justification for the acceptability of the deviation is:

- No cracking has been found at similar RB-2 locations.
- No FIV damage has been found on jet pumps 5, 6, 7, and 8 indicating that significant degradation at the RB-2 locations for JP 5/6 and 7/8 has not occurred.
- Monitoring of other locations will confirm that RB-2 locations for JP 5/6 and 7/8 do not have significant degradation.
  
- QCNPS will examine the Unit 1 JP 5/6 and 7/8 Riser Brace repair hardware every 6-years in lieu of the RB-2 welds for these locations.
  
- QCNPS will monitor the remaining unobstructed RB-2a/b welds on Unit 1 (16 total) for signs of cracking. Based on these results, cracking may need to be

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assumed on the JP 5/6 and 7/8 RB-2 welds if cracking is found on the population of unobstructed welds.

- QCNPS will monitor additional points on jet pump 5, 6, 7, and 8 as outlined above every six (6) years for signs of damage caused by FIV that could be attributed to a failure of the RB-2 welds.

This deviation will be in force for the remainder of Unit 1 life until the date of 12/31/2032, unless new examinations methods are developed that allow inspection of the RB-2 welds with the repair hardware in place, or the clamp is removed and access to the RB-2 welds is gained, or BWRVIP guidance changes alleviate the need to examine these welds.

This engineering technical evaluation provides the technical justification for deviation from requirements of BWRVIP-41, Revision 3 (Reference 2) and meets the requirements of BWRVIP-94NP Revision 2 (Reference 1) and ER-AA-4003 Revision 3.

#### **REFERENCES**

1. BWRVIP-94NP, Revision 2: BWR Vessel and Internals Project, Program Implementation Guide. EPRI, Palo Alto, CA: 2011. 1024452.
2. BWRVIP-41 Revision 3, BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines. EPRI, Palo Alto, CA: September 2010. 1021000.
3. BWRVIP-41 Revision 0, BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines. EPRI, Palo Alto, CA: October 1997. TR 108728.
4. Nuclear Energy Institute (NEI) 03-08, "Guideline for the Management of Material Issues"
5. BWRVIP-51-A, Jet Pump Repair Design Criteria. EPRI, Palo Alto, CA: September 2005. 1012116.
6. BWRVIP-51, Jet Pump Repair Design Criteria. EPRI, Palo Alto, CA: May 1998. TR 108718.
7. ER-AA-4003 Revision 4, "*Materials Degradation Management Process (MDMP) Deviation Guidance*"

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**Technical Review:**

The detailed evaluation was verified to be correct and the associated conclusions are deemed reasonable through the use of a independent review of this EC Evaluation. Minor comments have been resolved and incorporated into this evaluation. The requirements of HU-AA-1212 were reviewed and no independent third party review brief is required. See passport for e-signature of reviewer listed below.

**Preparer:** Chris Hebel Date: See electronic routing

**Independent Reviewer:** Robert Testin Date: See electronic routing

**Approver:** Mathew Rice Date: See electronic routing