
Request for Permanent Relief for Unit 2 Reactor Pressure Vessel Penetration N-11B Repair In Accordance with 10 CFR 50.55a(a)(3)(i) Alternative Provides Acceptable Level of Quality and Safety

---

1. ASME Code Component(s) Affected:

Code Class:	1
Reference:	IWB-2500, Table IWB-2500-1
Examination Category:	B-P
Item Number:	B15.10
Description:	Reactor Pressure Vessel (RPV) Water Level Instrument Penetration – 2" Nominal Pipe Size
Component Number:	RPV Penetration N-11B

2. Applicable Code Edition and Addenda:

The code of record for the fifth 10-year Inservice Inspection (ISI) Program interval at Quad Cities Nuclear Power Station (QCNPS) is the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, 2007 Edition through 2008 Addenda. The fifth 10-year interval is currently scheduled to begin on April 2, 2013.

The code of record for the fourth 10-year ISI Program interval at QCNPS is the ASME Code, Section XI, 1995 Edition through 1996 Addenda.

The code of construction for the RPV is the ASME Code, Section III, 1965 Edition through Summer 1965 Addenda.

The code of construction for the instrument penetration nozzle is the ASME Code, Section III, 1965 Edition through Summer 1969 Addenda.

3. Applicable Code Requirement:

The specific ASME Code requirements for which use of the proposed alternative is being requested are listed below. These requirements are in the 2007 Edition through 2008 Addenda of the ASME Code. However, as discussed in Section 5 below, the repair and supporting flaw analysis were both completed during the fourth 10-year ISI Program interval and the governing code for the fourth interval was the 1995 Edition through 1996 Addenda.

Flaw Removal

- IWA-5250(a)(3) states "Components requiring corrective action shall have repair/replacement activities performed in accordance with IWA-4000 or corrective measures performed where the relevant condition can be corrected without a repair/replacement activity."

- IWA-4412 states "Defect removal shall be accomplished in accordance with the requirements of IWA-4420."

- IWA-4421(d) states "Defect removal or mitigation by modification shall be in accordance with IWA-4340."

- IWA-4340 states:

  Modification of items may be performed to contain or isolate a defective area without removal of the defect, provided the following requirements are met.

  (a) The defect shall be characterized using nondestructive examination and evaluated to determine its cause and projected growth.

  (b) The modification shall provide for the structural integrity of the item such that it no longer relies on the defective area, including projected growth. The modification shall meet the Construction Code and Owner's Requirements for the item in accordance with IWA-4220.

  (c) In lieu of reexamination of the defective area in accordance with IWA-4530(a), the Owner shall prepare a plan for additional examinations to detect propagation of the flaw beyond the limits of the modification, and when practicable, to validate the projected growth. The frequency and method of examination shall be determined by the Owner.

- IWA-4611.1(a) states "Defects shall be removed in accordance with IWA-4422.1. A defect is considered removed when it has been reduced to an acceptable size."

- N-528 of Section III, 1965 Edition through Summer 1965, requires repair of weld defects including removal of defects detected by leakage tests.

<u>Flaw Evaluation</u>

- IWB-3522.1 states "A component whose visual examination (IWA-5240) detects any of the following relevant conditions shall meet IWB-3142 and IWA-5250 prior to continued service..."

  1. IWB-3142.1(b) states "A component whose visual examination detects the relevant conditions described in the standards of Table IWB-3410-1 shall be unacceptable for continued service, unless such components meet the requirements of IWB-3142.2, IWB-3142.3, or IWB-3142.4."

  2. IWB-3142.4 states "A component containing relevant conditions is acceptable for continued service if an analytical evaluation demonstrates the component's acceptability. The evaluation analysis and evaluation acceptance criteria shall be specified by the Owner. A component accepted for continued service based on analytical evaluation shall be subsequently examined in accordance with IWB-2420(b) and (c)."

- IWA-3300(a) states in part "Flaws detected by the preservice and inservice examinations shall be sized..."

- IWA-3300(b) states in part "Flaws shall be characterized in accordance with IWA-3310 through IWA-3390, as applicable..."

- IWB-3610(b) states "For purposes of evaluation by analysis, the depth of flaws in clad components shall be defined in accordance with Fig. IWB-3610-1..."

- IWB-3420 states "Each detected flaw or group of flaws shall be characterized by the rules of IWA-3300 to establish the dimensions of the flaws. These dimensions shall be used in conjunction with the acceptance standards of IWB-3500."

4. Reason for Request:

During QCNPS Unit 2 refueling outage Q2R21 (i.e., Spring 2012), and as a result of leakage indications on the RPV penetration N-11B, Exelon Generation Company, LLC (EGC) partially replaced this existing nozzle assembly with a nozzle penetration that is resistant to Intergranular Stress Corrosion Cracking (IGSCC). This repair was performed in accordance with ASME and construction codes applicable at the time, except as noted in Relief Request I4R-19 submitted for NRC review on April 6, 2012.

As described in I4R-19, a welded pad was applied to the outside surface (OD) of the RPV using IGSCC resistant nickel Alloy 52M (ERNiCrFe-7 or -7A) filler metals and was welded using the machine gas tungsten arc welding (GTAW) ambient temperature temper bead (ATTB) welding technique. An IGSCC resistant nozzle was attached to the new weld pad with a partial penetration weld using a non-temper bead manual welding technique. The original partial penetration attachment weld and a remnant of the original nozzle remained in place. A failure assessment was completed prior to startup from refueling outage Q2R21 to demonstrate the acceptability of leaving the original partial penetration attachment weld, with a maximum postulated flaw, in place for the current operating cycle, which is currently scheduled to end in April 2014.

This request for alternative (i.e., I5R-11) is being submitted to demonstrate the acceptability of leaving the original partial penetration attachment weld, with a maximum postulated flaw, in place through the remainder of the current plant life (i.e., through December 14, 2032).

IWA-4412 and IWA-4611 contain requirements for the removal of, or reduction in size of defects. The defect on N-11B will not be removed; therefore, relief is sought from these requirements.

IWB-3400 and IWB-3600 were written with the expectation that nondestructive examination techniques such as ultrasonic testing (UT) would be used to determine the flaw size and shape. In support of the flaw evaluation and application of applicable acceptance criteria, paragraphs IWA-3300, IWB-3420, and IWB-3600 require characterization of the flaw in the leaking penetration. Currently, there is not a qualified or demonstrated technique to perform volumetric nondestructive examination of the partial penetration weld in this

configuration that can be used to accurately characterize the location, orientation, or size of a flaw in the weld.

IWB-2420(b) and (c) require that if a component is accepted for continued service in accordance with IWB-3132.3 or IWB-3142.4, the areas containing flaws or relevant conditions shall be reexamined during the next three inspection periods. These subsequent examinations are intended to identify growth of the actual flaw over time. Currently, there is not a qualified or demonstrated technique to perform volumetric nondestructive examination of the partial penetration weld in this configuration that can be used to accurately determine flaw growth.

The repair was performed by installing a welded pad using ATTB welding in accordance with ASME Code Case N-638-4. The NRC has conditionally approved ASME Code Case N-638-4 to allow ATTB welding of ferritic materials without the requirement for preheat or post-weld heat treatment.

5. Proposed Alternative and Basis for Use:

Proposed Alternative

In accordance with 10 CFR 50.55a(a)(3)(i), EGC proposes the following alternatives to the ASME Code Section XI requirements specified in Section 3 above.

A. As an alternative to flaw removal or reduction in size to meet the applicable acceptance standards, EGC implemented an OD repair of the RPV instrument nozzle N-11B utilizing an OD weld pad as described below in the discussion of the repair of nozzle penetrations.

B. As an alternative to performing the nondestructive examination required to characterize the flaw under IWB-3420 and IWB-3610(b) in RPV instrument nozzle N-11B, EGC proposes analyzing a maximum postulated flaw that bounds the range of flaw sizes that could exist in the J-groove weld and nozzle.

C. As an alternative to performing the subsequent nondestructive examination required by IWB-3142.4 in accordance with IWB-2420(b) and (c) to assess potential growth of the flaw in RPV instrument nozzle N-11B, EGC proposes analyzing a maximum postulated flaw that bounds the potential growth of the existing flaw.

Basis for Use

A. Background

The QCNPS Unit 2 RPV is manufactured from SA-302, Grade B, modified by Code Case 1339, carbon steel that is clad with stainless steel. The RPV water level instrument penetrations are fabricated with Alloy 600 components. IGSCC of Alloy 600 components and welds exposed to boiling water reactor cooling water has been observed in the nuclear industry over the recent past. In particular, dissimilar metal

welds (DMWs) made with nickel Alloy 182 weld metal exposed to elevated operating temperatures, such as nozzle J-groove welds, pose a heightened propensity to IGSCC.

During refueling outage Q2R21 (i.e., Spring 2012), EGC discovered a leak in a water level instrument penetration nozzle N-11B located on the RPV upper shell. The examination that detected the defect consisted of a visual examination in which active leakage was observed at the nozzle interface with the reactor vessel OD during the Class 1 system leakage test. This observation necessitated the repair of this water level instrument nozzle using the methodology described herein.

B. Repair of Nozzle Penetration

EGC replaced the existing nozzle assembly with a nozzle penetration that is resistant to IGSCC, meeting Section XI and Code Case N-638-4 as conditionally approved by the NRC in Regulatory Guide 1.147, Revision 16. Figure 1 provides a diagram of a typical RPV water level instrument nozzle repair. A welded pad was applied to the OD of the RPV using IGSCC resistant nickel Alloy 52M (ERNiCrFe-7 or -7A) filler metals and was welded using the machine GTAW ATTB welding technique. The IGSCC resistant nozzle was attached to the new weld pad with a partial penetration weld using a non-temper bead manual welding technique. The original partial penetration attachment weld and a remnant of the original nozzle are currently remains, and will continue to remain, in place. A weld flaw evaluation using Finite Element Analysis (FEA) was completed to demonstrate the acceptability of leaving the original partial penetration attachment weld, with a maximum postulated flaw, in place through the remainder of the plant life (i.e., through December 14, 2032).

C. Flaw Evaluation

A flaw evaluation based on a combination of Linear Elastic Fracture Mechanics (LEFM) supplemented with Elastic Plastic Fracture Mechanics (EPFM) analysis was used to determine acceptability of the postulated flaws in the remnant J-groove weld through the remainder of the plant life (i.e., through December 14, 2032). This flaw evaluation is documented in AREVA NP Inc. Document No. 32-9193800-000, "Quad Cities Unit 2 Instrument Nozzle J-Groove Weld Flaw Evaluation using Finite Element."

A twenty-three (23) year acceptance requirement was used, as the analysis is being used to determine if the flaw may be left in place through the remainder of plant life, assuming the failure initiated sometime immediately after the last successfully completed Class 1 system pressure test in refueling outage Q2R20 (i.e., Spring 2010). As shown in the flaw evaluation, LEFM analysis showed a postulated circumferential flaw was determined to be acceptable for 23 years of plant operation, while the postulated axial flaw was determined to be acceptable for only 14 years of plant operation. The postulated axial flaw condition was then analyzed in more detail using EPFM methodology, which determined acceptability in this condition for 23 years of plant operation.

The repair and supporting flaw analysis were both completed during the QCNPS fourth 10-year ISI interval, and therefore based on the code of record for the fourth 10-year ISI

interval (i.e., ASME Code, Section XI, 1995 Edition through 1996 Addenda). A code reconciliation was completed for the final flaw evaluation between the 1995 Edition through 1996 Addenda, and the 2007 Edition through 2008 Addenda of the ASME Code, Section XI. The reconciliation concluded that the final flaw evaluation is generally consistent with or conservative when compared to the 2007 Edition through 2008 Addenda. A summary of the code reconciliation results is provided below.

1. Flaw Stability Criteria

   In paragraph IWB-3610 of the 1995 Edition through 1996 Addenda, flaw acceptance under normal and upset loading conditions is based upon the material toughness defined by the parameter KIa. This criterion is the basis for part of the AREVA calculation. If the same analysis were to be done under the 2007 Edition through 2008 Addenda, the corresponding criterion is the material toughness KIc. In general, use of KIa is equivalent or conservative as compared to use of KIc. Therefore, use of the criteria from the 2007 Edition through 2008 Addenda is not expected to change the conclusions of the calculation.

2. Fatigue Crack Growth

   The fatigue crack growth criteria for the 1995 Edition through 1996 Addenda and the 2007 Edition through 2008 Addenda are the same, so reconciling the two codes results in no change to the calculation.

3. Structural Margins/Safety Factors

   In general, the safety factors between the 1995 Edition through 1996 Addenda and the 2007 Edition through 2008 Addenda are either the same or the 2007 Edition through 2008 Addenda margins are lower. Therefore incorporating the 2007 Edition through 2008 Addenda requirements would result in either the same results, or greater margin would be demonstrated.

4. Use of IWB-3613

   The AREVA calculation quotes alternate criteria from IWB-3613. The criteria as quoted in the calculation are consistent with the 2007 Edition through 2008 Addenda, but are not directly in line with the 1995 Edition through 1996 Addenda text in IWB-3613. Therefore, the calculation as written conforms to the 2007 Edition through 2008 Addenda.

5. Use of EPFM

   EPFM was not directly addressed in the 1995 Edition through 1996 Addenda, but is widely permitted in the 2007 Edition through 2008 Addenda. The AREVA EPFM methods as written in the calculation are consistent with the 2007 Edition through 2008 Addenda.

D. Conclusion

10 CFR 50.55a(a)(3) states: "Proposed alternatives to the requirements of paragraphs (c), (d), (e), (f), (g), and (h) of this section, or portions thereof, may be used when authorized by the Director, Office of Nuclear Reactor Regulation... The applicant shall demonstrate that:

(i) The proposed alternatives would provide an acceptable level of quality and safety; or

(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

EGC concludes that the proposed alternatives of this request provide an acceptable level of quality and safety. The weld pad on the RPV was installed using Nickel Alloy 52M filler metal using a qualified ATTB welding procedure. The RPV penetration was replaced with an IGSCC resistant nozzle welded to the OD of the RPV with Alloy 52M. The supporting flaw evaluation demonstrates that the RPV is acceptable without removal of the original nozzle remnant and partial penetration weld through the remainder of plant life (i.e., through December 14, 2032). Use of a maximum postulated flaw in the flaw evaluation is an acceptable alternative to nondestructive examination characterization of the actual flaw at this time, and in place of future nondestructive examination. Therefore, EGC requests that the NRC authorize the proposed alternative in accordance with 10 CFR 50.55a(a)(3)(i).

6. Duration of Proposed Alternative:

Relief is requested through the remainder of plant life (i.e., through December 14, 2032).

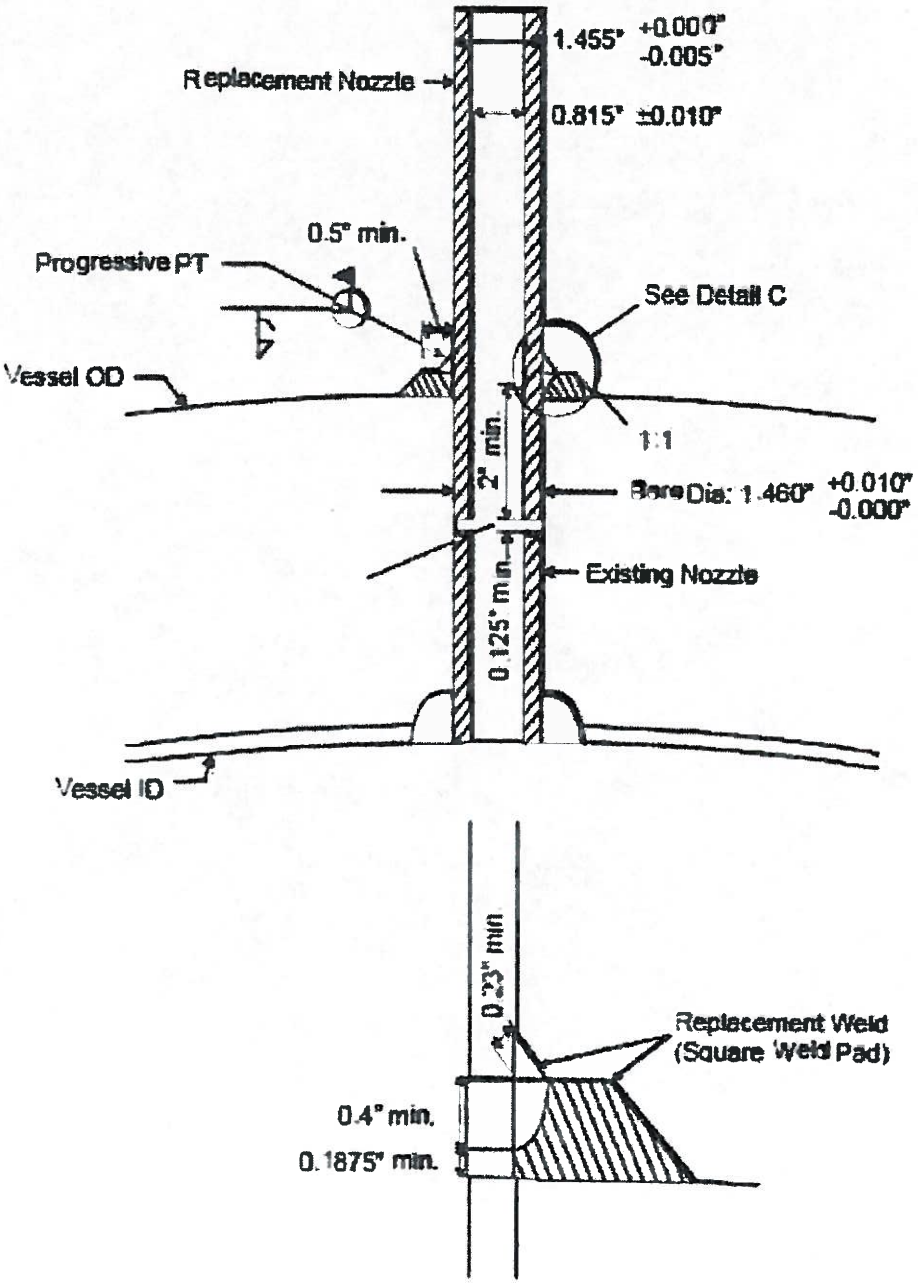
7. Precedents:

A similar relief request was previously approved for Shearon Harris Nuclear Power Plant, Unit 1. Third ISI Interval Relief Request I3R-09, was authorized for use by the NRC in a Safety Evaluation dated October 2, 2012.

A similar relief request was previously approved for Arkansas Nuclear One, Unit 1. Fourth ISI Interval Relief Request ANO1-R&R-013, was authorized for use by the NRC in a Safety Evaluation dated January 10, 2011.

Figure 1

Typical Reactor Pressure Vessel Water Level Instrument Nozzle Repair



Detail C