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

Quad Cities Nuclear Power Station, Unit 2
Renewed Facility Operating License No. DPR-30
NRC Docket No. 50-265

Subject: Response to Request for Additional Information Regarding Relief Request I4R-19 Associated with the Reactor Pressure Vessel Nozzle Repairs

References:
1) Letter from P. R. Simpson (Exelon Generation Company, LLC) to NRC, "Relief Request I4R-19 Associated with the Reactor Pressure Vessel Nozzle Repairs," dated April 6, 2012

2) Email from Joel Wiebe (NRC) to D. M. Gullott (Exelon Generation Company, LLC), "Final RAIs Regarding Quad Cities, Unit 2 Relief Request I4R-19," dated April 11, 2012

In Reference 1, in accordance with 10 CFR 50.55a, "Codes and standards," paragraph (a)(3)(i), Exelon Generation Company, LLC (EGC), requested NRC approval of a relief request associated with the Fourth Inservice Inspection (ISI) Interval for Quad Cities Nuclear Power Station (QCNPS), Unit 2 . Note that the fourth interval of the QCNPS ISI program complies with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, 1995 Edition with addenda through 1996.

As noted in Reference 1, during a recent pressure test of the reactor pressure vessel, one instrument penetration, N-11B, was found to have approximately 60 drops per minute of leakage. Currently there is not a qualified or demonstrated technique to perform volumetric non-destructive examination (NDE) 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; therefore, as an alternative to performing the NDE required to characterize the flaw in penetration N-11B, EGC proposed analyzing a maximum postulated flaw that bounds the range of flaw sizes that could exist in the J-groove weld and nozzle.

During review of the subject relief request, the NRC concluded that additional information would be needed to complete their review. The NRC transmitted the Request for Additional Information (RAI) to EGC in Reference 2. This request contains 10 individual items; however, during a telephone conversation between J. Wiebe (NRC) and D. M. Gullott (EGC), it was

agreed that RAIs 1-7 would be addressed in this submittal; and RAIs 8-10 would be addressed in a separate near term submittal. Therefore, Attachment 1 to this letter provides the responses to RAIs 1-7.

There are no regulatory commitments contained in this letter.

Should you have any questions concerning this letter, please contact Mr. Joseph A. Bauer at (630) 657-2804.

Respectfully,

David M. Gullott
Manager – Licensing
Exelon Generation Company, LLC

Attachment 1: Response to Request for Additional Information Regarding Relief Request I4R-19 Associated with the Reactor Pressure Vessel Nozzle Repairs

**ATTACHMENT 1**

**Response to Request for Additional Information Regarding Relief Request I4R-19 Associated with the Reactor Pressure Vessel Nozzle Repairs**

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As noted in Reference 1, during a recent pressure test of the reactor pressure vessel, one instrument penetration, N-11B, was found to have approximately 60 drops per minute of leakage. Currently there is not a qualified or demonstrated technique to perform volumetric non-destructive examination (NDE) 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; therefore, as an alternative to performing the NDE required to characterize the flaw in penetration N-11B, EGC proposed analyzing a maximum postulated flaw that bounds the range of flaw sizes that could exist in the J-groove weld and nozzle.

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1. ***How has it been established that the flaw is not a threat to vessel integrity?***

   a. ***Justify any assumptions regarding the nature of the flaw,***

      ***i. Location,***
      ***ii. Cause,***
      ***iii. Extent,***

      Response

      The location of the flaw is at the reactor vessel penetration N-11B, used for reactor vessel level instrumentation. Industry operating experience indicates that the flaw is in the J-groove weld which is located on the inside surface of the reactor vessel or the cold worked Alloy 600 nozzle. Based on prior industry operating experience, as documented in BWRVIP-60-A, intergranular stress corrosion cracking (IGSCC) of Alloy 600 and/or 182 weld metal is the most likely cause for the N-11B leakage. This experience has shown the IGSCC propagates through the weld metal, but arrests at the low alloy steel fusion line without penetrating into the ferritic metal. Although this experience limits IGSCC to the weld metal, the potential for fatigue crack growth into the low alloy steel is assessed per the requirements of ASME Section XI, Appendix A.

Based on the fabrication records for the N-11B nozzle, this nozzle had been damaged after heat treatment. Chicago Bridge & Iron removed the damaged nozzle leaving a 3/16" minimum of the original Alloy 182 weld metal to act as a buttering layer for the J-groove weld of the replacement nozzle. There was no heat treatment after welding the replacement nozzle. Unlike, the other instrument nozzles, the cold work in this replacement nozzle and the weld residual stress in the J-groove weld were not reduced by heat treatment making this nozzle significantly more susceptible to IGSCC.

***b. Justify lack of examination to even qualitatively describe flaw through direct observation,***

Response

After the nozzle was cut in preparation for installation of the replacement nozzle, the remnant nozzle segment was visually examined using a non-articulating video probe (4-eye). Evidence of two indications was observed. The indications are axially oriented (i.e., in the direction parallel to the nozzle remnant axis) and appear to terminate prior to reaching the end of the Alloy 600 nozzle remnant on the reactor vessel side inside diameter. However, visual examination was not performed on the J-groove weld surface due to the lack of visual examination equipment that can be articulated to reasonably interrogate the J-groove weld surface area while providing adequate resolution. Articulating borescope was considered but due to its lack of rigidity and the need extend into the reactor vessel near the steam dryer would require the use of additional tools/parts, which would introduce the potential of loose parts into the vessel.

The flaw analysis, using bounding flaw conditions, demonstrate that the postulated flaw will not be a threat to the reactor vessel integrity.

***c. Justify the lack of examination to demonstrate the flaw/leak path is not through the vessel steel rather than the J-groove weld or nozzle.***

Response

Based on prior industry operating experience, as documented in BWRVIP-60-A, IGSCC of Alloy 182 weld metal is the most likely cause for the N-11B leakage. This experience has shown that the IGSCC propagates through the weld metal, but arrests at the low alloy steel fusion line without penetrating into the ferritic metal. Although this experience limits IGSCC to the weld metal, the potential for fatigue crack growth into the low alloy steel is assessed per the requirements of ASME Section XI, Appendix A to further demonstrate that the postulated flaw will not be a threat to the reactor vessel integrity.

**ATTACHMENT 1**

**Response to Request for Additional Information Regarding Relief Request I4R-19 Associated with the Reactor Pressure Vessel Nozzle Repairs**

2. ***Specify the ASME specifications to which the repair materials (nozzle, weld metal, etc.) adhere (SA-XXX, etc.).***

Response

The repair material being used for this repair includes the following:

- the nozzle material is SB-166, UNS N06690 (Alloy 690); and
- the weld pad and partial penetration weld are ERNiCrFe-7A, UNS N06054 (Alloy 52M).

3. ***Describe the steps of the proposed repair in detail, including the machining, preparation, and examinations.***

Response

The detail steps of the proposed repair are given below:

(1) Cut the existing nozzle outboard of the Reactor Vessel
(2) Install foreign material exclusion (FME) plug
(3) Prepare outer vessel wall for surface exam
(4) MT and UT Reactor Vessel outer surface at capacitor discharge stud locations
(5) Bore to partially remove existing nozzle
(6) Measure and PT the counterbore
(7) Installation / attachment of studs
(8) MT and UT of the Reactor Vessel outer surface in preparation for the weld pad
(9) Removal of FME plug
(10) Installation of the weld dam
(11) Deposit weld pad (code case N-638-4)
(12) Start 48 hour hold after completed of third layer
(13) Post weld grinding of weld pad
(14) Bore weld pad to remove weld dam
(15) Installation of FME plug
(16) Bore weld pad to final size
(17) Measure and PT final bore
(18) Machine and PT replacement nozzle
(19) Dimensional inspection of weld pad
(20) PT of weld pad and radial band around weld pad
(21) UT of weld pad and radial band around weld pad
(22) Machine J-prep in weld pad and PT
(23) Removal of FME plug
(24) Installation and welding of replacement nozzle (PT at ½ maximum welded joint dimension and after weld completed)

(25) Removal of studs

(26) MT of Reactor Vessel outer surface at stud attachment locations

(27) Installation / attachment of couplings and piping (PT on 2" side of reducing coupling weld)

4. ***Clarify why Code Case N-638-4 is acceptable for use on the Q2 RV, stated in the application as being made of SA-302, Grade B, when N-638-4 states "this Case shall not be used to repair SA-302, Grade B, unless..."***

Response

In accordance with the N1A Manufacturer's data report for the subject plate (i.e., serial # 6-122-22), the material is SA-302, Grade B modified by Code Case 1339. Review of the certificate of test for this plate shows that it contains Nickel content of 0.55% with a fine grain practice, quenching and tempering. Therefore, this plate meets the requirements specified in Section 1, "General Requirements," paragraph (a) of Code Case N-638-4.

5. ***Specify the nature of the manual non-temper bead welding technique used to attach the new nozzle to the weld pad. Specifically,***

   a. ***By which edition and addenda of the ASME Code will the procedure be qualified,***

   Response

   The procedure is qualified in accordance with Section NB-4000 of ASME Section III (2007 Edition through 2008 Addenda) and the current ASME Section IX code requirements (2010 Edition with 2011 Addendum).

   b. ***What filler material will be used,***

   Response

   Alloy 52M (ERNiCrFe-7A, UNS N06054) 3/32" Rod

   c. ***Provide a discussion of the welding process,***

   Response

   The partial penetration weld between the new Alloy 690 nozzle and the weld pad will be performed utilizing a manual gas tungsten arc weld (GTAW) process in accordance with the welding procedure discussed in Response 5.a.

***d. Explain how the partial penetration surface put into the weld pad will be inspected to ensure that no flaws in the weld-pad will contact the non-temper bead manual welding material.***

Response

The partial penetration surface of the weld pad bore and J-groove weld prep will be examined via liquid penetrant (PT) examination.

***6. Discuss the potential of increased localized stresses on the reactor vessel shell at the nozzle penetration location when the weld pad is installed. Provide the dimensions of the planned weld pad: shape, thickness, width, and height.***

Response

The stresses at the nozzle penetration location where the new weld pad is installed are expected to increase locally due to material discontinuity as well as local structural discontinuity. Although it is difficult to estimate how much the stresses will be increased locally, based on industry experience with similar repairs, stresses are not expected to be significantly higher than the stresses were at the original weld site. In fact, stress ranges typically decrease when the weld is moved to the outer diameter (OD) of the vessel. The changes to the stress profiles will be evaluated in the ASME Section III Subsection NB-3000 qualification analysis. The welded pad is essentially the frustum of a right circular cone, except that the base follows the contour of the reactor pressure vessel. The cylindrical diameter at the base of the pad after grinding will be approximately 5-1/2 inches. The cylindrical diameter of the outer surface of the pad will be 4-3/4 inches (+3/16" -0"). The pad thickness will be 3/4 inches (+3/16" -0").

***7. Describe the pre and post-repair inspections and testing that will be performed as part of the repair process including the required demonstration for ultrasonic examination of the repaired volume required by condition (1) of Regulatory Guide 1.1.47 on Code Case N-638-4. Specifically,***

***a. What examinations/inspections will be performed, reference specific ASME Code requirements under which the examinations will be performed,***

***b. The nature of the examinations/inspections (PDI-qualified UT, ASME Section XXXX VT-1, etc.),***

***c. What are the acceptance criteria, reference specific ASME Code requirements,***

Response

Vendor procedures establish acceptance criteria in support of ASME Section XI (1995 Edition through 1996 Addenda) and Section III (2007 Edition through 2008 Addenda) in support of the modification as well as Section III 1992 Edition. Base metal exams are in accordance with original construction code acceptance criteria at a minimum.

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Base Metal Weld Area Prior to Attaching Temporary Tooling:

1. According to N-638-4, prior to welding, surface examination shall be performed on the weld area.
2. Acceptance criteria shall be in accordance with Section III, 1965 Edition, Summer 1965 Addenda.

After Temporary Tooling Removal:

1. According to N-638-4, surface examination shall be performed on the area after removal of temporary tooling.
2. Acceptance criteria shall be in accordance with Section III, 1992 Edition.

Base Metal Weld Area Prior to Temper Bead Weld Build-up Pad:

1. According to N-638-4, prior to welding, surface examination shall be performed on the weld area.
2. Acceptance criteria shall be in accordance with Section III, 1965 Edition, Summer 1965 Addenda.

Temper Bead Weld Build-up Pad:

1. Volumetric (UT) and Surface examinations required of final weld build-up pad in accordance with Code Case N-638-4, paragraph 4(a)(2) for using austenitic materials.
   a. Weld shall be nondestructively examined after the three tempering layers (i.e. layers 1, 2, and 3) have been in place for at least 48 hours.
2. Acceptance criteria shall be in accordance with Section III, 1992 Edition.
3. Vendor is using portions of PDI overlay techniques in volumetric examination of the weld pad.

J-Grove and Inside Diameter Machining:

1. Surface exam to be performed after final machining of J-groove and inside diameter.
2. Acceptance criteria shall be in accordance with Section III, 1992 Edition.

Temper Bead Weld Build-up Pad to Nozzle Weld:

1. Surface examination required in accordance with Section III, 1992 Edition according to Code Case N-416-3.
   a. Examination shall be performed at one-half of the maximum welded joint dimension measured parallel to the center line of the connection and on weld in final condition.
2. Acceptance criteria shall be in accordance with Section III, 1992 Edition.

Reducer to Nozzle Weld:

1. Installation of the socket weld shall be installed in accordance with Code Case N-405-1.
2. Surface examination required of final weld in accordance with Section III, 1992 Edition according to Code Case N-416-3.
3. Acceptance criteria shall be in accordance with Section III, 1992 Edition.

***d. It appears that the only examination for the installation of the weld pad is progressive penetrant testing. Discuss why a volumetric examination will not be performed on the weld pad as part of acceptance (pre-service) examination.***

Response

A volumetric examination will be performed on the weld pad as part of the acceptance examination in accordance with Code Case N-638-4.

## REFERENCES

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