Entergy

Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-4710

David B. Bice
Acting Manager, Licensing
Arkansas Nuclear One

1CAN041004

April 12, 2010

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Supplemental Information to Fourth 10-Year Inservice Inspection Interval Request for Alternative ANO1-R&R-013
Repairs to the Pressurizer Instrumentation Penetrations
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

REFERENCE: Entergy letter to NRC dated April 5, 2010, "Fourth 10-Year Inservice Inspection Interval Request for Alternative ANO1-R&R-013"

Dear Sir or Madam:

By letter dated April 5, 2010, Entergy Operations, Inc. (Entergy) requested approval of alternatives, pursuant to 10 CFR 50.55a(a)(3)(i), to the requirements associated with repair of components of the Arkansas Nuclear One, Unit 1 (ANO-1) Pressurizer.

The current examination requirement for the ANO-1 Pressurizer instrument penetrations is specified in 10 CFR 50.55a(g)(6)(ii)(E). This requires visual examination of these penetrations in accordance with Table 1 Item Number B15.180 of American Society of Mechanical Engineers (ASME) Code Case N-722 as conditioned by 10 CFR 50.55a(g)(6)(ii)(E)(2) through (4).

During this examination one instrument penetration, RC-1001 A/B, was found to have signs of leakage consisting of some rust colored stains and a minor amount of boron residue.

Entergy proposed to repair the penetration by installing a welded pad using Ambient Temperature Temper Bead (ATTB) welding in accordance with ASME Code Case N-638-1.
As an alternative to performing the Code Case N-638-1 surface and ultrasonic examinations at least 48 hours after the completed weld has reached ambient temperature, Entergy proposed performing the surface and ultrasonic examinations at least 48 hours after the third weld layer is completed.

A047
NRR

In support of the flaw evaluation and application of applicable acceptance criteria, ASME Code Paragraphs IWB-3420 and IWB-3600 require characterization of the flaw in the penetration. Additionally, if a component is accepted for continued service in accordance with IWB-3142.4, the areas containing flaws or relevant conditions are required to be re-examined 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 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. As an alternative to performing the NDE required to characterize the flaw in penetration RC-1001 A/B, Entergy proposes analyzing a maximum postulated flaw that bounds the range of flaw sizes that could exist in the J-groove weld and nozzle.

Following initial NRC review of the referenced letter, the NRC provided individual requests for information via emails dated April 6 and April 7, 2010. Attachment 1 provides the Entergy responses to the RAIs. The NRC also requested the analyses performed to verify the maximum postulated flaw that bounds the range of flaw sizes be provided to the NRC. Analysis ANO-43Q-301, Revision 2 is included in Attachment 2 of this letter. Two of the analyses are proprietary in nature (ANO-34Q-326, Revision 1 and ANO-34Q-330, Revision 0) and are included in Attachments 3 and 4 of this letter. Attachments 5 and 6 contain affidavits providing justification for withholding these analyses documents from public disclosure.

Attachments 7 and 8 contain non-proprietary versions of the aforementioned documents.

This letter contains no new commitments.

Entergy requests approval of the proposed alternatives in order to support the return to service from the current ANO-1 refueling outage (1R22). Entergy currently anticipates approval will be required as early as April 13, 2010.

If you have any questions or require additional information, please contact me.

Sincerely,

DBB/rwc

Attachments:

1. Response to Requests for Additional Information Related to ANO1-R&R-013
2. EPFM Evaluation of Potential Remnant Crack in Pressurizer Level Sensing/Sampling Nozzle (No Existing Pad) Repair
3. Pressurizer Level Sensing/Sampling Nozzle (No Existing Pad) Repair Fracture Mechanics Analysis - Proprietary
4. Fatigue Crack Growth Analysis of Pressurizer Level Sensing/Sampling Nozzle (No Existing Weld Pad) Repair - Proprietary
5. Affidavit to Withhold Analyses from Public Disclosure – Structural Integrity
6. Affidavit to Withhold Analyses from Public Disclosure – AREVA
7. Pressurizer Level Sensing/Sampling Nozzle (No Existing Pad) Repair Fracture Mechanics Analysis – Non-Proprietary
8. Fatigue Crack Growth Analysis of Pressurizer Level Sensing/Sampling Nozzle (No Existing Weld Pad) Repair – Non-Proprietary

cc: Mr. Elmo E. Collins
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
612 E. Lamar Blvd., Suite 400
Arlington, TX 76011-4125

NRC Senior Resident Inspector
Arkansas Nuclear One
P. O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Mr. Kaly Kalyanam
MS O-8 B1
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Mr. Bernard R. Bevill
Arkansas Department of Health
Radiation Control Section
4815 West Markham Street
Slot #30
Little Rock, AR 72205

Attachment 1 to

1CAN041004

Response to Requests for Additional Information

Related to ANO1-R&R-013

Response to Requests for Additional Information Related to ANO1-R&R-013

Relief Request ANO1-R&R-013

1. Discuss why there are three different editions of the ASME Code, Section III, that are applicable to the ANO-1 pressurizer. (1) Clarify whether the affected component, RC-1001 A/B, identified under Section 1 of the relief request is the only instrument nozzle or a group of instrument nozzles that need to be repaired. (2) Confirm that the affected nozzle is an ASME Code Class 1 component.

Entergy Response:

The three editions of the ASME Section III Code identified in Section 1 of the request are applicable in the following ways.

- The 1965 Edition / Summer 1967 Addenda is the original code of record for the ANO-1 pressurizer.
- The new penetration configuration is designed in accordance with the 1989 Edition / No Addenda. Likewise, nondestructive examinations (NDE) performed on the new instrument nozzle attachment weld (partial penetration J-weld) will be performed in accordance with ASME Section III 1989 / No Addenda.
- As a condition of 10 CFR 50.55a(b)(2)(xx), the NDE provision in IWA-4540(a)(2) of the 2002 Addenda of Section XI must be applied when performing system leakage tests after repair and replacement activities performed by welding. According to IWA-4540(a)(2) of the 2002 Addenda of Section XI, all welds and weld areas subject to a system leakage test shall be nondestructively examined in accordance with the methods and acceptance criteria of the 1992 or later Edition of the ASME Section III Code. To comply with 10 CFR 50.55a(b)(2)(xx), Entergy will use the NDE methods and acceptance criteria of the 1992 Edition / No Addenda of ASME Section III.

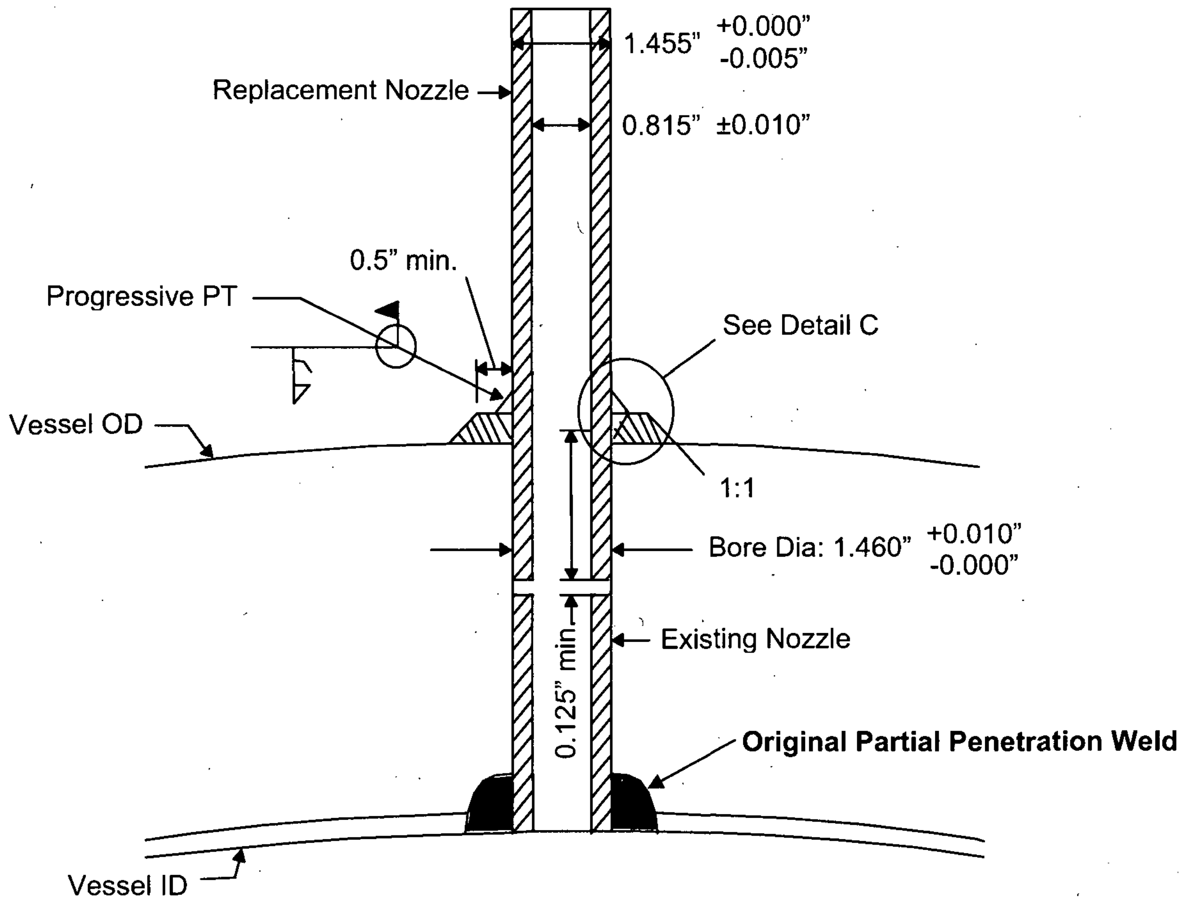
With reference to Part (1) of the above question, the request is applicable to only one penetration. This penetration is a one-inch piping connection used for measuring the water level in the pressurizer. The penetration is identified as RC-1001 A/B because the first components on the piping from this penetration are valves with tag numbers RC-1001A and RC-1001B.

With reference to Part (2) of the above question, the penetration nozzle is an ASME Class 1 component and is identified in the ASME N-1 Manufacturers Data Report. Due to the vintage of the ASME Code of Record for the pressurizer vessel, the Manufacturers Data Report identifies it as a “Class A” vessel, which was changed to “Class 1” in later ASME Code editions.

2. Section 4 states that the original partial penetration attachment weld and a remnant of the original nozzle will remain in place. Figure 1 of the relief request shows that a weld pad is installed at the outside surface of the pressurizer shell. Clarify the location of the original partial penetration attachment weld using the diagram in Figure 1 of the relief request.

Entergy Response:

The original partial penetration weld is located at the inside surface of the pressurizer between the original penetration nozzle and the pressurizer vessel, as shown on Figure 1 below.



3. Section 5(A) discusses a flaw evaluation for a postulated flaw in the J-groove weld and nozzle. Section 5(B) discusses a flaw evaluation for a postulated flaw in penetration RC-1001 A/B. (1) Discuss the difference between the flaw evaluations in Sections 5(A) and 5(B). (2) Discuss whether a postulated flaw is assumed to propagate from the J-groove weld or the nozzle into the pressurizer shell wall and that the flaw in the pressurizer wall is demonstrated to be within the allowable flaw size of the pressurizer shell. (3) Submit the flaw evaluations.

Entergy Response:

With reference to Part (1) of the above question, Section 5(A) and 5(B) refer to the same partial penetration weld, and the same flaw evaluation applies to both Section 5(A) and Section 5(B). The flaw evaluation that qualifies the maximum postulated flaw is used as an alternative to two different ASME Code requirements. The first Code requirement is associated with performing a flaw evaluation to determine the acceptability of leaving a flaw in place, and the second Code requirement is associated with the need to perform future NDE to determine if the evaluated flaw is growing, so that it can be verified that the flaw evaluation remains valid. Since there are no qualified and demonstrated volumetric examination techniques that can accurately determine the size and orientation of the flaw, the flaw analysis postulates a maximum flaw size that bounds the limits of primary water stress corrosion cracking (PWSCC) that could occur (100% of the PWSCC susceptible weld material is assumed to be cracked), plus additional fatigue growth of the PWSCC flaw into the low alloy steel. This flaw analysis bounds the maximum size flaw that could occur, such that it provides an acceptable alternative to both of the Code requirements.

With reference to Part (2) of the above question, the maximum postulated flaw, which assumes that the entire partial penetration weld is cracked, is assumed as the initial flaw. The analysis then calculates how much the initial flaw will propagate into the carbon steel base metal of the pressurizer wall during the remaining life of the plant. It is shown that the final flaw size after fatigue crack growth results in a flaw that is bounded by the flaw size(s) that were analyzed.

With reference to Part (3) of the above question, one non-proprietary flaw evaluation and two proprietary flaw evaluations were informally transmitted to the NRC on April 6, 2010. These analyses are included in Attachments 2, 3, and 4 of this letter.

4. The licensee states that the Alloy 690 nozzle will be attached to the new weld pad with a partial penetration weld using a non-temper bead manual welding technique. Discuss the non-temper bead welding process in detail, e.g., which ASME Code this welding procedure is qualified to, the filler weld material, and the welding process.

Entergy Response:

The partial penetration weld between the new Alloy 690 nozzle and the weld pad will be performed utilizing a manual gas tungsten arc welding (GTAW) process and a welding procedure specification (WPS) qualified in accordance with NB-4000 of the ASME Code Section III, 1989 Edition / No Addenda, and the ASME Section IX Code requirements. The Alloy 52M (ERNiCrFe-7A) weld filler material conforms to the requirements of ASME Section II, Part C SFA 5.14, 2004 Edition / 2006 Addenda and ASME Section III, Subsection NB-2400, 1989 Edition / No Addenda. The partial penetration weld will be examined as required by NB-5245 of ASME Section III, 1989 Edition / No Addenda.

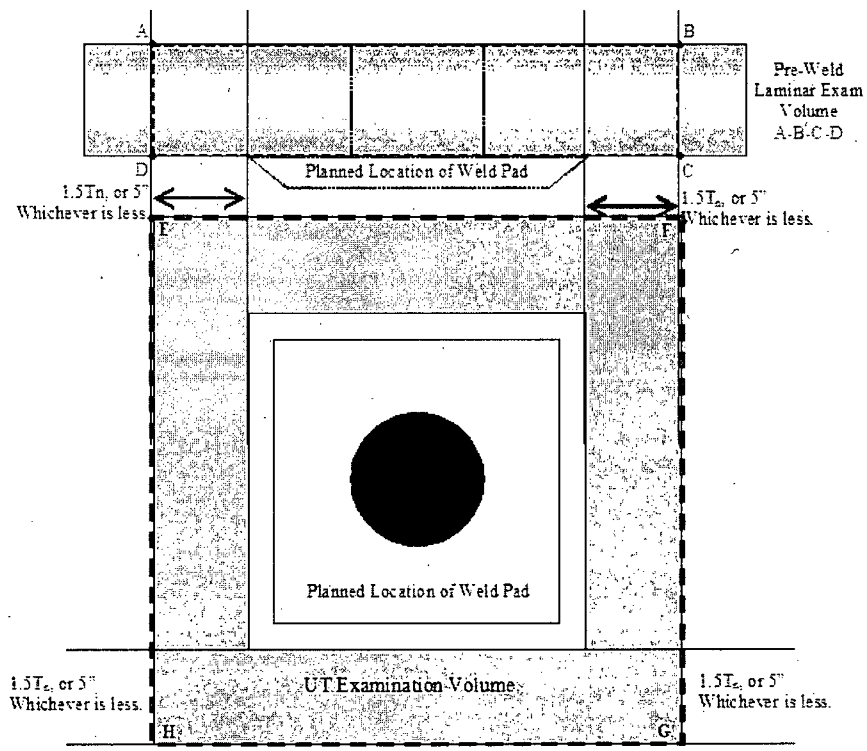
5. Page 4, Item (2), states that a surface and ultrasonic examination will be used to inspect the base metal before application of the weld pad. (1) Provide the exact surface area and volume that will be inspected (use a diagram similar to Figure 1 in the relief request to indicate the examination surface area and volume). (2) Discuss the qualification of the ultrasonic examination (reference the appropriate ASME Code section and subsections). (3) Discuss whether there be a surface and ultrasonic examination performed on the penetration bore after a portion of the original nozzle is removed. (4) Discuss whether the surface of the penetration bore will be cleaned after a portion of the original nozzle is removed and before the new nozzle is inserted.

Entergy Response:

With reference to Part (1) of the above question, the nondestructive examination procedures require examination of the weld pad location and adjacent areas prior to welding as described below:

A. Liquid penetrant examination of the base material of the weld pad footprint and 5" around the pad location is performed. This Volume is E F G H as shown in the figure below.

B. The base material of the weld pad footprint and 5" around the pad location is ultrasonically examined with the Phased Array laminar examination technique (-15° to +15° sectorial scan). This Volume is A B C D E F G H as shown in the figure below.



With reference to Part (2) of the above question, the ultrasonic examination procedure was qualified by demonstration to the ANII and Entergy NDE Level III, using representative samples which contain construction type flaws; as directed in Regulatory Guide 1.147, Revision 15 and as required in ASME Code Case N-638-1.

With reference to Part (3) of the above question, Entergy believes that a visual examination of the penetration bore is acceptable based on the following:

A. According to IWA-4410 of ASME Section XI, "mechanical metal removal not associated with defect removal is not within the scope of this Subarticle" (i.e., IWA-4400). In other words, mechanical metal removal activities, such as machining, that are performed to make minor dimensional alterations and/or remove minor surface flaws, such as surface corrosion or pitting, are not considered ASME Section XI repair/replacement activities since they do not involve defect removal. This point is made clear in the following ASME Section XI interpretations:

   <u>XI-1-98-08</u>

   Question: Is it a requirement of IWA-4100 that machining of a pressure boundary component's sealing surface to remove pitting or other surface irregularity identified through normal maintenance be considered a repair activity?

   Response: No, provided the pitting or other surface irregularity is not a defect.

   <u>XI-1-98-20R</u>

   Question: When a flaw meeting the acceptance criteria of Section XI (i.e., not a defect) is corrected by mechanical metal removal only (no subsequent welding, brazing, or replacement activities), must the work be performed in accordance with IWA-4000?

   Response: No. However, if the metal removal activity affects a previous preservice or inservice examination record, a new preservice examination in accordance with Section XI shall be performed and documented following the completion of the mechanical metal removal activity.

   Machining operations associated with nozzle RC-1001A/B did not involve defect removal. They were performed to (a) partially remove the existing nozzle and (b) reestablish the bore diameter to facilitate installation of the new half nozzle in accordance with ASME Section III design requirements. Accordingly, the phrase "unacceptable corrosion" in paragraph B.2 on page 4 of the relief request refers to conditions that could affect the diametrical clearance requirements of NB-3337 (design) rather than "material defects." Furthermore, there is no evidence of defects or reason to believe there could be defects in the subject nozzle bore.

B. According to NB-4121.3 of ASME Section III (1989 Edition), component surfaces requiring machining shall be reexamined by magnetic particle or liquid penetrant examination when (a) a surface examination was originally required by NB-2500 and (b) the amount of material removed from the surface exceeds the lesser of 10% of the minimum required thickness or 1/8" whichever is less. The amount of material removed during the machining operation of the subject nozzle bore was approximately 0.040" and significantly below the NB-4121.3 thickness criteria. Therefore, a surface examination of the nozzle bore was not required.

In conclusion, a surface or volumetric examination of the nozzle bore is not required by either ASME Section XI or ASME Section III. Therefore, Entergy believes that the proposed visual examination of the nozzle bore is acceptable.

With reference to Part (4) of the above question, prior to installing the new Alloy 690 nozzle, the penetration bore will be cleaned by a combination of air nozzle vacuum and wiped down with a damp cloth.

6. Page 4, Item (3) states that a weld pad will be installed on the outside surface of the pressurizer. (1) Clarify whether the weld pad is a metal plate that is welded to the outside surface of the pressurizer or a pad that is fabricated by depositing weld layers at the penetration on the outside surface of the pressurizer. (2) Provide the dimensions (length and width) of the weld pad. (3) Discuss the post-weld inspection of the weld pad and associated welding, including acceptance criteria and qualification for the ultrasonic examination.

Entergy Response:

With reference to Part (1) of the above question, the weld pad does not utilize plate material. The weld pad is 100% deposited weld metal, built up by installing multiple layers of weld passes. The Alloy 52M weld pad (F-No. 43 weld material) is installed on the carbon steel (P-No. 1 base material) vessel using the Ambient Temperature Machine Gas Tungsten Arc Welding (GTAW) Temper Bead Technique per Code Case N-638-1. Installing the Alloy 52M weld pad allows welding the Alloy 690 nozzle to the Alloy 52M weld pad without the need for post weld heat treatment.

With reference to Part (2) of the above question, the weld pad is square with as-built dimensions at the full thickness of 3.375 inches by 3.3125 inches, and as-built dimensions at the interface with the carbon steel of 4.6875 inches by 4.6875 inches. The as-built thickness of the pad is 0.5875 inches. The maximum area of the weld pad adjoining the surface of the pressurizer is less than 100 square inches and complies with paragraph 1.0(a) of Code Case N-638-1.

With reference to Part (3) of the above question, the weld pad and the base metal area around the weld pad is volumetrically examined using the ultrasonic examination procedure with qualification as described and discussed in response to Question 5 above. A penetrate test (PT) examination is performed on the weld pad and surrounding base metal, as described in the response to Question 5 Part A above. As a condition for using Code Case N-638-1 in Regulatory Guide 1.147, Revision 15, the ultrasonic acceptance criteria of NB-5330 in the 1998 Edition through 2000 Addenda of Section III will apply to all flaws identified within the repaired volume. Acceptance criteria for the surface examination of the partial penetration weld is NB-5350 of the ASME Code Section III 1989 / 1989 Addenda. In addition, the acceptance criteria for the surface examination of the partial penetration weld will also satisfy NB-5350 of the ASME Code Section III 1992 / No addenda, as discussed in the response to Question 1 above.

7. Page 4, Item (6), states that the new partial penetration attachment weld is examined in accordance with the Construction Code and includes a progressive penetrate [sic] test (PT) examination. (1) Discuss the details of the post-weld examination, such as the acceptance criteria for potential fabrication defects. (2) Discuss whether an ultrasonic examination will be performed on the new partial penetration attachment weld. If not, provide justification.

Entergy Response:

With reference to Part (1) of the above question, as discussed in response to question 1, NDE of the new instrument nozzle attachment weld (partial penetration J-weld) will be performed in accordance with ASME Section III 1989 / No Addenda.

With reference to Part (2) of the above question, an ultrasonic examination will not be performed on the new partial penetration attachment weld. The ASME Code paragraph NB-5245 specifies progressive surface examination for this weld type and configuration. Also as discussed in the response to question 3 above, there are no qualified and demonstrated volumetric examination techniques available for a partial penetration weld of this configuration.

8. Discuss whether a gap or crevice exists between the end of the replacement (new) nozzle and the end of the existing nozzle inside the penetration. If a gap or crevice exists, discuss the potential for corrosion in that region of the penetration.

Entergy Response:

A gap with a minimum separation of 0.125" exists between the replacement nozzle and the remnant.

Because of this gap between the replacement nozzle and the remnant nozzle, primary system water can come in contact with the carbon steel in the area of the annulus between the new Alloy 690 nozzle and the pressurizer carbon steel base metal. The potential for carbon steel degradation due to contact with primary water in a configuration such as this has previously been evaluated for similar modifications. These calculations evaluate the corrosion rates for carbon steel materials in contact with borated primary water. Also, San Onofre repaired a hot leg nozzle in 1993 using a half-nozzle type repair that included a gap between the new nozzle and the original nozzle remnant which exposed the carbon steel base metal to the primary coolant. The new nozzle was removed after five years to inspect the carbon steel, and the corrosion rate was determined to be between 0.001 and 0.002 inches per year. During the current ANO-1 outage (1R22), Entergy removed the nozzle from the pressurizer penetration that was repaired during the 1R9 refueling outage (almost 20 years ago) and inspected the carbon steel base metal. That repair used a half-nozzle type repair that included a gap between the new nozzle and the original nozzle remnant which exposed the carbon steel base metal to the primary coolant. After nearly 20 years in service, there was no measurable corrosion on the exposed carbon steel. Based on these calculations and actual results from industry experience, only minimal corrosion of the carbon steel base metal is expected to occur during the remaining life of the plant.

9. Discuss the inservice inspection of the repaired nozzle (e.g., inspection frequency, method, and acceptance criteria).

Entergy Response:

After mitigation, the pressure retaining weld on this penetration will no longer contain Alloy 600/82/182; therefore, ASME Code Case N-722 will no longer be applicable. The repaired nozzle will be examined in accordance with Table IWB-2500-1, Category B-P, Item B15.10.

10. Relief is being requested for only instrumentation nozzle, RC-1001 A/B. (1) Discuss whether all nozzle penetrations at the bottom of the pressurizer shell have been visually examined in light of the degraded instrumentation nozzle. (2) Discuss why relief is not required for the half nozzle repair of the other pressurizer nozzles.

Entergy Response:

With reference to Part (1) of the above question, all of the instrument penetrations on the ANO-1 pressurizer were visually examined in accordance with ASME Code Case N-722 as conditioned by 10 CFR 50.55a(g)(6)(ii)(E) during the current refueling outage, and only one penetration, RC-1001 A/B, was found to be leaking. The ANO-1 pressurizer penetrations that had Alloy 600/82/182 dissimilar metal butt welds have been mitigated by application of full structural weld overlays. At the start of the current refueling outage (1R22), the only remaining unmitigated Alloy 600/82/182 penetrations were the nine instrument penetrations. These nine penetrations consist of seven penetrations that are one-inch (nominal pipe size) nozzles that are attached to the pressurizer with a partial penetration weld located at the inside surface of the pressurizer. The other two penetrations consist of a 1.5-inch diameter thermowell that is attached to the pressurizer with a partial penetration weld located at the inside surface of the pressurizer, and a smaller thermowell that was installed through a spare penetration that was originally a one-inch nozzle similar to the other seven discussed above. All nine of these penetrations are being mitigated with half-nozzle type modifications this outage. After these nine penetrations are mitigated, there will be no unmitigated Alloy 600/82/182 penetrations on the ANO-1 pressurizer.

With reference to Part (2) of the above question, a relief is not required for the eight other pressurizer half-nozzle modifications for the following reasons:

A. Unlike the instrument nozzle for RC-1001A/B, the half nozzle modifications for the other eight pressurizer instrument nozzles are being installed preemptively since none of the nozzles exhibited any evidence of a defect (e.g., boric acid leakage or build-up) in the attachment weld or nozzle at the time of installation. As such, these preemptive half-nozzle modifications are not repairs. They also do not fall under the jurisdiction of IWA-4340 of ASME Section XI since they are not being installed to mitigate a defect. However, if a defect had been identified (e.g., boric acid leakage or build-up) in any of these eight instrument nozzle welds or nozzles prior to installation of the half-nozzle modifications, then Entergy would have initiated a relief request for these repairs since the examination limitations would have been present in those penetrations also.

B. In the relief request for RC-1001A/B, Entergy proposed to perform the surface and ultrasonic examinations at least 48 hours after the third weld layer was completed as an alternative to paragraph 4.0(b) of Code Case N-638-1. However, for the other eight pressurizer instrument nozzles, Entergy will perform final surface and ultrasonic examinations at least 48 hours after the completed weld has reached ambient temperature as required by paragraph 4.0(b) of Code Case N-638-1. Since Entergy will be complying with paragraph 4.0(b) of Code Case N-638-1, a relief request was not required.

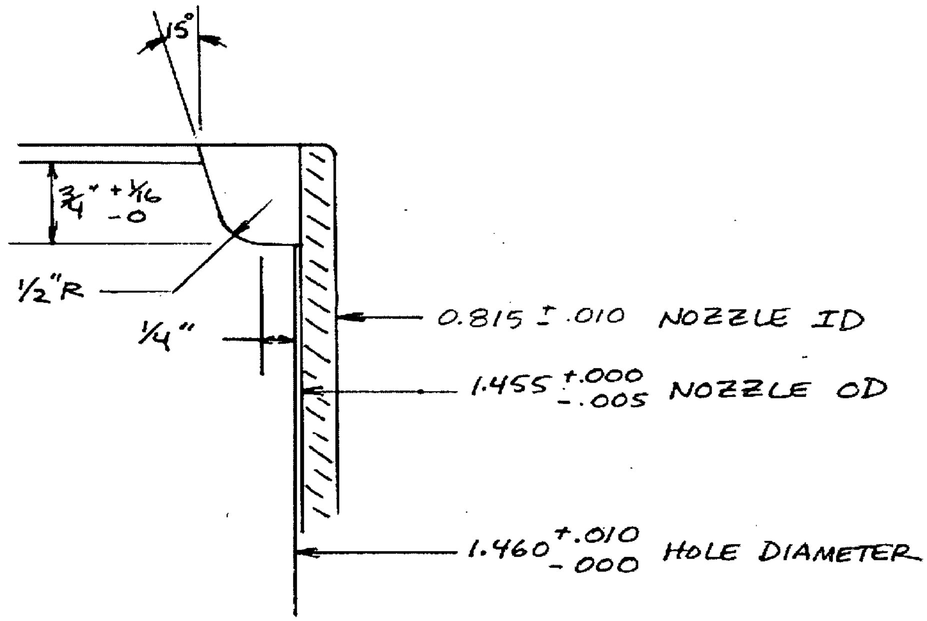
Flaw Evaluations

11. The licensee submitted three flaw evaluations, ANO-34Q-326, Revision 1, ANO-43Q-301, Revision 2, and ANO-34Q-330, Revision 0. The staff noted that these evaluations were performed in December 2006 and March 2007. These evaluations state that the analyses are applicable to two upper level sensing nozzles (no existing pad), two lower level sensing nozzles, one sampling nozzle, and one modified level sensing nozzle with thermowell replacement. However, these evaluations do not provide the dimension (wall thickness and diameter) of the nozzles being analyzed. (1) Discuss whether the three flaw evaluations are applicable to the instrumentation nozzle, RC-1001 A/B, in Relief Request ANO1-RR-013. (2) Provide the nozzle sizes (wall thickness and diameter) that were analyzed.

Entergy Response:

With reference to Part (1) of the above question, Calculations ANO-34Q-326, Revision 1, ANO-43Q-301, Revision 2, and ANO-34Q-330, Revision 0 are applicable to the ANO-1 pressurizer level sensing penetration RC-1001 A/B. Although RC-1001 A/B is not specifically mentioned by its tag number in calculations ANO-34Q-326, Revision 1, ANO-43Q-301, Revision 2, and ANO-34Q-330, Revision 0, all three calculations state that the repairs are applicable to the "two upper level sensing nozzles (no existing pads)." The two upper level sensing nozzles with no existing pads are RC-1000 A/B and RC-1001 A/B.

The configuration of the partial penetration weld on the RC-1001 A/B level sensing penetration is shown in Detail D on Entergy drawing number M1G-32. The dimensions of the RC-1001 A/B level sensing nozzle are shown on Entergy drawing number M1G-67. These dimensions are summarized in the sketch below.



The nominal cladding thickness is 3/16 inches as shown on Entergy drawing number M1G-1.

With reference to Part (2) of the above question, the nozzle nominal outside diameter is 1.455", the nominal inside diameter is 0.815", and the wall thickness is 0.32".

12. (1) Figure 1 in ANO-34Q-326, Revision 1, shows three postulated flaws No. 1, 2 and 3 for the clad/vessel interface location. Discuss the locations of the crack tip of these flaws (e.g., is the crack tip located at the J-groove weld and clad interface, clad and vessel interface, or x distance inside the pressurizer shell wall). (2) Confirm that the three postulated flaws in the penetration bore location are located in the pressurizer shell wall along the axial direction of the penetration bore. (3) Confirm that only axial flaws were postulated for the penetration bore location and clad/vessel interface location. (4) Discuss why circumferential flaws were not postulated in these locations. (5) Confirm that the flaw sizes postulated are consistent with the dimensions of the instrumentation nozzle RC-1001 A/B. (6) Provide the length of the J-groove weld in the circumferential (along the circumference of the pressurizer) and axial (along the nozzle axial) direction (Reference: Figure 1 in ANO-34Q-326, Revision 1).

Entergy Response:

With reference to Part (1) of the above question, the crack tip for Flaw 1 is at the interface between the J-groove weld and the carbon steel vessel material. Flaw 1 encompasses the entire face of the J-groove weld, the adjacent remnant nozzle wall, and the adjacent cladding. Crack tips for Flaws 2 and 3 follow the shape of Flaw 1, and encompass the remnant nozzle wall, penetrate a distance into the carbon steel pressurizer base metal. Along the nozzle bore, Flaw 2 penetrates 0.375 inches into the carbon steel, and Flaw 3 penetrates 0.696 inches into the carbon steel, as measured from the J-groove weld/carbon steel interface. Along the interface between the cladding and the carbon steel, Flaw 2 penetrates 0.388 inches into the carbon steel, and Flaw 3 penetrates 0.721 inches into the carbon steel, as measured from the J-groove weld/carbon steel interface.

With reference to Part (2) of the above question, Flaws 1, 2, and 3 are in an axial-radial plane with respect to the penetration nozzle, and are oriented in the axial-radial plane of the pressurizer shell. Figure 4 of calculation ANO-34Q-326, Revision 1 illustrates the flaw orientation by showing the pressure applied to the crack face for Flaw 3, and is typical of Flaw 1 and Flaw 2.

With reference to Part (3) of the above question, the only crack orientation analyzed is that described in response to question 12(2) above.

With reference to Part (4) of the above question, circumferentially oriented cracks were not analyzed because the dominant applied stress in the pressurizer vessel wall is in the hoop direction, which would drive axially oriented flaw growth. Consistent with the approach taken for all small bore nozzle repairs, including RPV top head CRDM repairs, an axial-radial flaw is assumed.

With reference to Part (5) of the above question, comparison with the dimensions provided in the response to Question 11 above confirms that the flaw sizes postulated in the analysis are consistent with the dimensions of penetration RC-1001 A/B.

With reference to Part (6) of the above question, the J-groove length (measured from the J-groove/nozzle interface along the free surface of the cladding on the inside surface of the pressurizer vessel) in the plane that is perpendicular to the axis of the pressurizer and contains the axis of the penetration, is 0.900 inches. The J-groove length (measured from the inside surface of the vessel along the penetration nozzle bore) at the plane formed by the penetration axis and the pressurizer vessel axis, is 0.938 inches.

13. ANO-43Q-301, Revision 2, Table 1, shows stress intensity factor summary. (1) Explain why the K_{total} for the penetration bore location is progressively lower from Flaw No. 1 to Flaw No. 3, whereas, the K_{total} for the clad/vessel interface location is progressively higher from Flaw No. 1 to Flaw No.3. (2) Explain why the K_{It} (stress intensity factor due to thermal and residual stresses) for the penetration bore location is gradually lower as the flaw size increases.

<u>Entergy Response</u>:

As seen in Table 1 of calculation ANO-43Q-301, Revision 2, K_{Ip} is due to pressure increasing progressively with larger flaw sizes, as expected, at the penetration bore and at the clad/vessel interface. This trend is also observed in Figures 18 and 19 at locations 108 and 144 in ANO-34Q-326, Revision 1.

At the bore region, residual effects decrease as the crack tip moves deeper into the vessel thickness from Flaw 1 to Flaw 3, as shown in Figure 20, location 108 of calculation ANO-34Q-326, Revision 1. This accounts for the downward trend of K_{total} in the penetration bore region as the flaw gets larger. The high value of residual stress K (Figure 20, location 108 of calculation ANO-34Q-326, Revision 1) at the bore for Flaw 1 is a result of the triple point effect, i.e., the intersection on the weld, carbon steel, and nozzle.

At the clad/interface points, which are at a constant depth from the inside surface of the vessel, the residual stress K has little variation (Figure 20, location 144 of calculation ANO-34Q-326, Revision 1). The upward trend is due to the internal pressure K and small variations in the thermal transient Ks.

14. Explain why the flaw sizes for the clad/vessel location in Table 1 of ANO-43Q-301, Revision 2, and in Table 2 of ANO-34Q-330, Revision 0, are not the same as the flaw sizes for the clad/vessel location in Figure 1 of ANO-34Q-326, Revision 1.

Entergy Response:

The dimensions shown in Figure 1 of calculation ANO-34Q-326 Revision 1 are measured from the interface between the nozzle OD and the J-groove weld to a point on the free surface of the cladding on the inside surface of the pressurizer vessel. These dimensions are appropriate for describing the model geometry. However, for this analysis, the stress intensity factor at the crack tip in the carbon steel (not in the cladding) is of interest. The "Clad/Vessel Interface" dimensions shown in Table 1 of calculation ANO-43Q-301, Revision 2 and in Table 2 of calculation ANO-34Q-330 are representative of locations of the crack tip in the carbon steel, and are measured from the interface between the nozzle OD and the J-groove weld to a point along the interface between the cladding and the carbon steel vessel material. The two sets of dimensions are correct, but measured at different end points. Figure 5 of calculation ANO-34Q-330, Revision 0 illustrates the flaw sizes for the clad/vessel locations used in Table 1 of ANO-43Q-301, Revision 2, and in Table 2 of ANO-34Q-330, Revision 0.

15. In the flaw evaluations, the transient of cooldown with insurge was included in loading. However, the staff did not see a discussion of the out-surge transient. Discuss whether the out-surge transient was included in the analysis. If not, provide justification.

Entergy Response:

Insurge and outsurge transients are not applicable to RC-1001A/B since this nozzle is located in the steam space above the RCS level. For evaluating the cooldown transient a composite transient (a portion of which includes insurge) was conservatively used for the flaw evaluation of RC-1001A/B. Outsurge transients are not defined and not included.

16. Discuss whether seismic loads were considered in the flaw evaluations.

Entergy Response:

Stresses due to seismic loads are negligible and are not included. This is discussed in Section 4.4 of calculation ANO-34Q-326 Revision 1.