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1CAN041002

April 5, 2010

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

SUBJECT: 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

Dear Sir or Madam:

Pursuant to 10 CFR 50.55a(a)(3)(i), Entergy Operations, Inc. (Entergy) hereby requests approval of proposed alternatives 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 proposes 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 proposes performing the surface and ultrasonic examinations at least 48 hours after the third weld layer is completed.

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.

In accordance with 10 CFR 50.55a(a)(3)(i), the proposed alternatives may be approved by the NRC provided an acceptable level of quality and safety are maintained. Entergy believes the proposed alternatives meet this requirement.

This relief requests includes 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 that final approval would be needed by as early as April 13, 2010. However, verbal approval with regard to the acceptability of the proposed 48-hour hold will be required by Tuesday, April 6, 2010, in order to support the current repair schedule.

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

Sincerely,

DBB/rwc

Attachment: Request for Alternative ANO1-R&R-013

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Attachment to

1CAN041002

REQUEST FOR ALTERNATIVE

ANO1-R&R-013

REQUEST FOR ALTERNATIVE

ANO1-R&R-013

1. ASME Code Component(s) Affected

Component/Number:	RC-1001 A/B
Description:	Pressurizer Instrument Penetration - 1" Level Tap Nozzle
Code Class: I	Examination Category B15.180 (Code Case N-722)
Unit / Inspection Interval:	Arkansas Nuclear One - Unit 1 (ANO-1) / Fourth (4th) 10-Year Interval

2. Applicable Code Edition and Addenda

- ASME Code, Section XI, 2001 Edition through 2003 Addenda
- ASME Code Section III, 1965 Edition / Summer 1967 Addenda
- ASME Code Section III, 1989 Edition / No Addenda
- ASME Code Section III, 1992 Edition / No Addenda
- ASME Code Case N-638-1, *Similar and Dissimilar Metal Welding using Ambient Temperature Machine GTAW Temper Bead Technique*
- ASME Code Case N-722, *Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated With Alloy 600/82/182 Materials*

3. Applicable Code Requirements

The following ASME Code Section XI requirements are applicable to this relief request.

- Code Case N-722 as conditioned by 10 CFR 50.55a(g)(6)(ii)(E) provides visual examination requirements for Class 1 pressure retaining welds fabricated with Alloy 600/82/182 materials.
- IWB-3522 provides acceptance criteria for Code Case N-722 Item B15.180 visual examinations.
- IWB-3522.1 states "…relevant conditions that may be detected during the conduct of system pressure tests shall require correction to meet the requirements of IWB-3142 and IWA-5250 prior to continued service …"
- 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, 3142.3, or 3142.4."

- 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-5250(a)(3) states "Components requiring correction shall have repair/replacement activities performed in accordance with IWA-4000."
- 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."
- IWA-4411(a) states "Later Editions and Addenda of the Construction Code, or a later different Construction Code, either in its entirety or portions thereof, and Code Cases may be used provided the substitution is as listed in IWA-4221(c)."
- Code Case N-638-1 establishes requirements for performing ambient temperature temper bead welding as an alternative to the preheat and post-weld heat treatment (PWHT) requirements of the Construction Code. The NRC has conditionally approved this Case in Regulatory Guide (RG) 1.147 with the following condition:

  "UT volumetric examinations shall be performed with personnel and procedures qualified for the repaired volume and qualified by demonstration using representative samples which contain construction type flaws. The acceptance criteria of NB-5330 in the 1998 Edition through 2000 Addenda of Section III apply to all flaws identified within the repaired volume."

4. Reason for Request

During the present ANO-1 refueling outage and as a result of leakage indications on the pressurizer instrument penetration RC–1001 A/B, Entergy will replace this existing nozzle assembly with a nozzle penetration that is resistant to Primary Water Stress Corrosion Cracking (PWSCC). The new penetration consists of the application of a welded pad to the outside surface (OD) of the pressurizer using PWSCC resistant nickel Alloy 52M (ENiCrFe-7A) filler metals and will be welded using the machine gas tungsten arc welding (GTAW) ambient temperature temper bead (ATTB) welding technique. 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. The original partial penetration attachment weld and a remnant of the original nozzle will remain in place. The original weld and nozzle remnant contain the flaw that resulted in the observed leakage. A fracture mechanics analysis has been performed to demonstrate the acceptability of leaving the original partial penetration attachment weld, with a maximum postulated flaw, in place.

IWB-3400 and IWB-3600 were written with the expectation that NDE 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, the ASME Code paragraphs 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 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.

The ASME Code Section XI IWB-2420(b) and (c) require that if a component is accepted for continued service in accordance with 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 NDE of the partial penetration weld in this configuration that can be used to accurately determine flaw growth.

The proposed repair will be performed by installing a welded pad using ATTB welding in accordance with ASME Code Case N-638-1. The NRC has conditionally approved ASME Code Section XI Code Case N-638-1 to allow ambient temperature temper bead welding of ferritic materials without the requirement for preheat or post-weld heat treatment. This revision of the Code Case requires that the completed weld be at ambient temperature for at least 48 hours prior to NDE. Technical justification has been developed to allow the 48-hour time clock to begin after the third layer of the ATTB weld has been completed.

5. Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(a)(3), Entergy proposes the following alternatives to the ASME Code Section XI requirements specified in Section 4 above.

A. As an alternative to performing the NDE required to characterize the flaw under IWB-3420 and IWB-3610(b) 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.

B. As an alternative to performing the subsequent NDE required by IWB-3142.4 to assess potential growth of the flaw in penetration RC-1001 A/B, Entergy proposes analyzing a maximum postulated flaw that bounds the potential growth of the existing flaw.

C. As an alternative to performing the 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, Entergy proposes to perform the surface and ultrasonic examinations at least 48 hours after the third weld layer is completed.

Basis

A. Background

The ANO-1 pressurizer is manufactured from SA-516, Grade 70, carbon steel that is clad with stainless steel. Pressurizer instrument penetrations are fabricated with Alloy 600 components. PWSCC of Alloy 600 components and welds exposed to pressurized water reactor (PWR) primary coolant has become a growing concern in the nuclear industry over the recent past. In particular, dissimilar metal welds (DMWs) made with nickel Alloy 82 and 182 weld metal exposed to elevated operating temperatures, such as pressurizer nozzle J welds, pose a heightened propensity to PWSCC.

During the current refueling outage (1R22), Entergy discovered a leak in level tap nozzle RC-1001A/B located on the pressurizer upper side shell. The examination that detected the defect consisted of a visual examination in which some rust-like streaking was observed at the nozzle along with boron deposits. This observation has necessitated the repair of this level tap nozzle using the relief request proposed herein.

B. Repair of Nozzle Penetrations

Entergy will replace this existing nozzle assembly with a nozzle penetration that is resistant to PWSCC. The new penetration consists of the application of a welded pad to the OD of the pressurizer using PWSCC resistant nickel Alloy 52M (ENiCrFe-7A) filler metals and will be welded using the machine GTAW ATTB welding technique. 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. The original partial penetration attachment weld and a remnant of the original nozzle will remain in place. The original weld and nozzle remnant contain the flaw that resulted in the observed leakage. A fracture mechanics analysis has been performed to demonstrate the acceptability of leaving the original partial penetration attachment weld, with a maximum postulated flaw, in place.

Entergy will use this proposed alternative for OD repair of the pressurizer instrument nozzle RC–1001 A/B utilizing an OD weld pad as described below. The flaw will not be removed. The process for the weld pad repair is as follows:

(1) The existing nozzle is cut at or near the outside surface of the pressurizer and then removed by machining to a depth near mid-wall. A small remnant of the existing nozzle and the original partial penetration attachment weld are left in place.

(2) Visual examination will be performed on the nozzle base material and bore area to ensure unacceptable corrosion has not occurred. A surface and ultrasonic examination will be used to inspect the base metal prior to application of the weld pad.

(3) A non-ferritic weld pad utilizing Alloy 52M weld filler metal, will be installed on the OD of the pressurizer using the ATTB welding process as illustrated in Figure 1. The weld pad is examined in accordance with Code Case N-638-1 as conditionally approved by the NRC in RG 1.147, with one exception. As an alternative to performing the surface and ultrasonic examinations at least 48 hours after the completed weld has reached ambient temperature, Entergy proposes to start the 48-hour time clock after the third weld layer is completed. An ultrasonic examination will be performed on the weld pad after the 48-hour hold.

(4) A new partial penetration weld prep is machined into the welded pad on the pressurizer.

(5) The new nozzle is welded to the pad.

(6) The new partial penetration attachment weld is examined in accordance with the Construction Code and includes a progressive penetrate test (PT) examination.

(7) An IWB-3600 fracture mechanics evaluation is performed on the original (inside diameter) partial penetration weld. Because the weld cannot be volumetrically examined, the weld is assumed to be completely cracked, as a worse case, to ensure that the flaw in the original weld will not adversely affect the pressurizer.

C. Flaw Evaluation

Entergy has performed fracture mechanics analyses to confirm the acceptability of the postulated bounding ID flaw in this penetration. The evaluations show that potential remnant defects in the pressurizer J-groove weld assumed for this nozzle are acceptable based on either the linear-elastic fracture mechanics (LEFM) or elastic-plastic fracture mechanics (EPFM) principles of Section XI of the ASME Code. For those flaw sizes and load cases that did not meet the acceptance criteria for LEFM, additional analysis using EPFM was performed which indicated that the flaw is acceptable. Fatigue crack growth analyses show that the postulated remnant flaws in the pressurizer nozzle penetrations evaluated herein are acceptable for a 60-year plant operating period.

Finite element models were developed, using the program ANSYS, for stress intensity factor calculations and for determination of residual stresses for the nozzle repair. For fracture mechanics analyses, a three-dimensional finite element model is used which includes high-order solid elements at the crack fronts. Three crack fronts are modeled, representing a flaw at the weld to carbon steel interface, and two slightly larger flaws penetrating into the carbon steel to evaluate fatigue growth of the postulated flaw in the weld. The finite element models are developed to facilitate the simulation of the deposition of weld beads, the post-weld heat treatment, the installation of the nozzle and associated J-groove weld, and the hydrotest. The model includes the pressurizer shell, the cladding, the replacement nozzle, the existing nozzle remnant, the original J-groove weld, and the OD pad repair with associated J-groove and cover fillet repair welds.

The initial flaw assumes that the J-groove weld is completely cracked. Crack tip elements are created along the contour of the existing J-groove weld. The crack tip elements are created such that the resulting crack is in the axial plane with respect to the pressurizer vessel because the vessel hoop stress is typically the dominant stress. Additional crack tip paths are also included, assuming self-similar growth from the J-groove weld.

The initial flaw is then grown into the carbon steel base metal by fatigue. The methodology of the ASME Code, Section XI, 2001 Edition / 2003 Addenda, Subarticle A-4300 was used to perform the fatigue crack growth evaluation. Fatigue crack growth analyses show that the postulated remnant flaw in the pressurizer nozzle penetration is acceptable for a 60-year plant operating period.

The actual flaw is considered to be the result of PWSCC. The PWSCC cracking is limited to the susceptible material (Alloy 600/82/182), and is typically limited to that portion of the component where the stress levels will support the PWSCC. Because the carbon steel base metal is not susceptible to PWSCC, the maximum size PWSCC flaw is limited to the Alloy 600 material. The Code allows evaluation of the actual flaw size with subsequent examination to monitor crack growth. As an alternative, this flaw evaluation qualified the largest PWSCC flaw that the crack could grow to, and then qualified additional fatigue crack growth into the carbon steel. By using the bounding flaw size, this analysis provides an acceptable level of quality and safety.

D. Suitability of Proposed Ambient Temperature Temperbead Technique

The ATTB technique of ASME Section XI Code Case N-638-1 has been conditionally approved by the NRC in RG 1.147. Entergy intends to install the non-ferritic weld pad in accordance with the ATTB welding technique of Code Case N-638-1, with one exception. As an alternative to performing the surface and ultrasonic examinations at least 48 hours after the completed weld has reached ambient temperature, Entergy proposes to start the 48-hour time clock after the third weld layer is completed. The basis for this alternative is provided below.

- Code Case N-638-1 requires the 48-hour hold for performing NDE to start after a temper bead repair cools to ambient temperature when performing ambient temperature temperbead welding. This 48-hour hold is specified to allow sufficient time for hydrogen cracking to occur (if it is to occur) in the heat affected zone (HAZ) of ferritic materials prior to performing final NDE. However, based on extensive research and industry experience, EPRI has provided a technical basis for starting the 48-hour hold after completing the third temperbead weld layer rather than waiting for the entire temperbead repair to cool to ambient temperature. Weld layers beyond the third layer are not designed to provide tempering to the ferritic HAZ when performing ATTB welding. EPRI has documented their technical basis in Technical Report 1013558, *Temper Bead Welding Applications – 48 Hour Hold Requirements for Ambient Temperature Temper Bead Welding*. The technical data provided by EPRI in their report is based on testing performed on SA-508, Class 2 low alloy steels and other P-Number 3, Group 3 materials; therefore, the conclusions are bounding and applicable to the pressurizer repairs.

  After evaluating the issues relevant to hydrogen cracking such as microstructure of susceptible materials, availability of hydrogen, applied stresses, temperature, and diffusivity and solubility of hydrogen in steels, EPRI concluded the following on Page 5-2 of the report: "There appears to be no technical basis for waiting 48 hours after cooling to ambient temperature before beginning the NDE of the completed weld. There should be no hydrogen present, and even if it were present, the temper bead welded component should be very tolerant of the moisture." Page 5-2 of the report also notes that over 20 weld overlays and 100 repairs have been performed using temper bead techniques on low alloy steel components over the last 20 years. During this time, there has never been an indication of hydrogen cracking by the NDE performed after the 48-hour hold or by subsequent inservice inspection.

  In addition, the ASME Code has approved Revision 4 to Code Case N-638 to allow the 48-hour hold to begin after completing the third weld layer when using austenitic filler metals. Paragraph 4(a)(2) of Code Case N-638-4 states in part: "When austenitic materials are used, the 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." In addition, the use of the 48-hour hold time after the third weld layer was recently approved by the NRC in a Letter to Davis-Besse on January 21, 2010 (TAC No. ME0478 – reference Pages 7, 8, and 9 of the associated NRC Safety Evaluation Report).

6. Conclusion

10 CFR 50.55a(a)(3) states:

> "Proposed alternatives to the requirements of (c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the 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."

Entergy believes that the proposed alternatives of this request provide an acceptable level of quality and safety. The weld pad on the pressurizer will be installed using Nickel Alloy 52M filler metal that is resistant to PWSCC using a qualified ATTB welding procedure. The pressurizer penetration will be replaced with PWSCC resistant Alloy 690 welded to the OD of the pressurizer with PWSCC resistant Alloy 52M. An EPRI evaluation and the current revision of ASME Code Case N-638 both show that performing the NDE 48 hours after completion of the third layer of welding is an acceptable alternative. Flaw evaluation analyses previously discussed in this relief request shows that the pressurizer is acceptable without removal of the original nozzle remnant and partial penetration weld. Use of a maximum postulated flaw in the flaw evaluation is an acceptable alternative to NDE characterization of the actual flaw at this time, and in place of future NDE. Therefore, Entergy requests that the NRC staff authorize the proposed alternative in accordance with 10 CFR 50.55a(a)(3)(i).

7. Duration of Proposed Alternative

The proposed alternatives apply to the remainder of the fourth ISI interval for ANO-1, scheduled to end on June 1, 2017.

8. Precedents

The NRC has approved installation of half nozzle repairs for many utilities. A relief request similar to this request was previously approved for Crystal River Unit 3 in a letter dated November 15, 2007 (ADAMS Accession No. ML073100991).

Starting the 48-hour hold time after the third weld layer was most recently approved by the NRC in a letter to Davis-Besse on January 21, 2010 (ADAMS Accession No. ML100080573).

9. Attachments

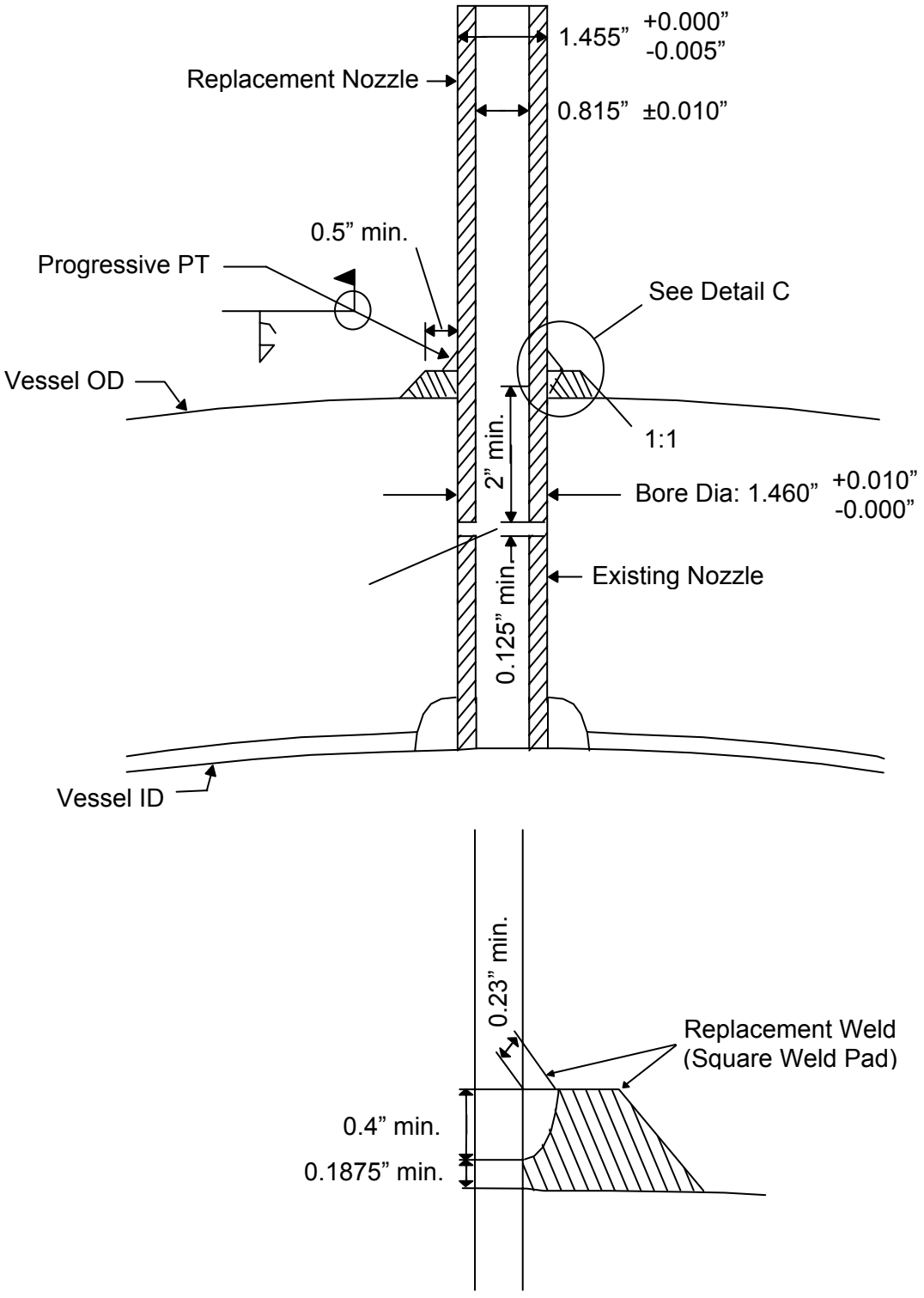
None

10. References

1. ASME Code Section XI, 2001 Edition through 2003 Addenda
2. ASME Code Section III, 1989 Edition / no Addenda
3. ASME Section III, 1992 Edition / no Addenda
4. ASME Code Section III, 1965 Edition / Summer 1967 Addenda (Original)
5. ASME Code Section XI, Code Case N-638-1, *Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique*
6. ASME Code Case N-722, *Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated With Alloy 600/82/182 Materials*
7. EPRI Report 1013558, *Temper Bead Welding Applications – 48 Hour Hold Requirements for Ambient Temperature Temper Bead Welding*
8. CEP-ISI-101, Arkansas Nuclear One - Unit 1 Inservice Inspection Plan

Figure 1

Typical Pressurizer Instrument Nozzle Repair



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