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Acting Director
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CNRO-2004-00014

March 4, 2004

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

SUBJECT: Request for Alternative ANO1-R&R-006 - Proposed Alternative to ASME Weld Examination Requirements for Repairs Performed on Reactor Vessel Head Penetration Nozzles

Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

REFERENCES:

1. Entergy Operations, Inc. letter CNRO-2004-00006 to the NRC dated February 23, 2004
2. Entergy Operations, Inc. letter CNRO-2002-00054 to the NRC dated November 26, 2002

Dear Sir or Madam:

In Reference #1, Entergy Operations, Inc., (Entergy) submitted a revision to previously proposed Request for Alternative ANO1-R&R-006, Rev. 0 for use at Arkansas Nuclear One, Unit 1 (ANO-1). Specifically, this request proposes an alternative to the requirement to evaluate actual flaw characteristics as defined in ASME Section III NB-5330(b) and ASME Section XI IWA-3300(b), IWB-3142.4, and IWB-3420. In lieu of fully characterizing any remaining cracks, Entergy proposes to utilize worst-case assumptions to conservatively estimate the crack extent and orientation.

On February 26, 2004, Entergy identified two concerns pertaining to Framatome Calculation 32-5021538, *ANO-1 CRDM Nozzle IDTB J-Groove Weld Flaw Evaluation*, which supports ANO1-R&R-006. (This calculation, also identified as ANO Calculation 86-E-0074-156, was previously submitted to the NRC via Reference #2.) Specifically, Entergy discovered that for evaluating a flaw left in the J-groove weld remnant following the proposed repair:

1. The fracture mechanics model does not adequately evaluate the flaw; and
2. The fracture mechanics analysis does not adequately address residual stresses.

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Therefore, Entergy will perform a new analysis to address these concerns. Entergy will also submit the analysis to the NRC by June 1, 2004. A detailed discussion of each concern is provided in Enclosure 3.

As a result of our discovery, Entergy is submitting a revision to ANO1-R&R-006, which accurately describes the analysis that will be used to support this request. The revised ANO1-R&R-006, which is contained in the enclosure, replaces the previously submitted request in its entirety. Changes are denoted by revision bars in the page margins.

Entergy previously submitted to the NRC ANO Calculations 86-E-0074-160, -161, and -164 via Reference #2, which supported another relief request, ANO1-R&R-004. These calculations are also applicable to ANO1-R&R-006. In addition to these calculations, Enclosure 2 contains Entergy Engineering Report M-EP-2004-002, Rev. 0, which provides the basis and justification for Entergy's decision to forgo water jet conditioning for any nozzles that might be repaired during the upcoming refueling outage as documented in this request.

Entergy requests that the NRC staff authorize use of ANO1-R&R-006 by April 15, 2004 to support preparations for refueling outage 1R18, which is scheduled to begin during the second quarter of 2004.

Should you have any questions regarding this letter, please contact Guy Davant at (601) 368-5756.

This letter contains one new commitment as identified in Enclosure 4.

Very truly yours,

FGB/GHD/ghd

Enclosures:
1. Request for Alternative ANO1-R&R-006, Rev. 0
2. Engineering Report M-EP-2004-002, Rev. 0
3. Concerns with Current Supporting Analysis
4. Licensee-Identified Commitments

cc:

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ENCLOSURE 1

CNRO-2004-00014

REQUEST FOR ALTERNATIVE
ANO1-R&R-006, Rev. 0

ENTERGY OPERATIONS, INC.
ARKANSAS NUCLEAR ONE, UNIT 1
3rd 10-YEAR INTERVAL
REQUEST No. ANO1-R&R-006, Rev. 0

REFERENCE CODE:

The original code of construction for Arkansas Nuclear One, Unit 1 (ANO-1) is ASME Section III, 1965 Edition with Addenda through Summer, 1967. The components (including supports) may meet the requirements set forth in subsequent editions and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a(b) subject to the limitations and modifications listed therein and subject to NRC approval. The codes of record for the repairs described within this request are the 1989 Edition of ASME Section III and 1992 Edition of ASME Section XI codes. ANO-1 is in its third (3rd) 10-Year Inservice Inspection interval.

I. System/Component(s)

a) Name of component:

Reactor Pressure Vessel (RPV) head nozzles (There are 69 nozzles welded to the RPV head.)

b) Function:

These welds serve as the pressure boundary weld for the RPV head nozzle and RPV head.

c) ASME Code Class:

The RPV head and RPV head nozzles are ASME Class 1.

d) Category:

Examination Category B-E, Pressure Retaining Partial Penetration Welds in Vessels; Item No. B4.12

II. Code Requirements

IWA-4310 requires in part that "*Defects shall be removed or reduced in size in accordance with this Paragraph.*" Furthermore, IWA-4310 allows that "*...the defect removal and any remaining portion of the flaw may be evaluated and the component accepted in accordance with the appropriate flaw evaluation rules of Section XI.*" The ASME Section XI, IWA-3300 rules require characterization of flaws detected by inservice examination.

Paragraph IWB-3420 requires the characterization of flaws in accordance with the rules of IWA-3300. However, none of the nondestructive evaluation techniques that can be performed on the remnant of the J-groove weld that will be left on the RPV head can be used to characterize flaws in accordance with any of the paragraphs or subparagraphs of IWA-3300. In lieu of those requirements, a conservative worst case flaw shall be assumed to exist and appropriate fatigue analyses will be performed to establish the minimum remaining service life of the RPV head.

Subsubparagraph IWB-3142.4 allows for analytical evaluation to demonstrate that a component is acceptable for continued service. It also requires that components found acceptable for continued service by analytical evaluation be subject to successive examination during the next three inspection periods. Analytical evaluation of the worst case flaw referred to above will be performed to demonstrate the acceptability of continued operation. However, because of the impracticality of performing any subsequent inspection that would be able to characterize any remaining flaw, successive examination will not be performed. In addition, Entergy plans to replace the ANO-1 RPV head during refueling outage 1R19, which is scheduled to begin during the fall of 2005. 1R19 will occur before the end of the next inspection period obviating the need for successive inspections of the J-groove weld remnant.

Section III Subsection NB-5330(b) requires that "Indications characterized as cracks, lack of fusion, or incomplete penetrations are unacceptable regardless of length." Entergy is requesting relief from the requirements of NB-5330(b). The new pressure boundary weld that will connect the remaining portion of the RPV head nozzles to the low alloy RPV head contains a material "triple point." The triple point is at the root of the weld where the Alloy 600 nozzle will be welded with Alloy 690 (52) filler material to the SA-533 Grade B, Class 1 Mn-Mo low alloy steel plate (See Figures 1 and 2). Experience has shown that during solidification of the Alloy 52 weld filler material, a lack of fusion (otherwise known as a welding solidification anomaly) area may occur at the root of the partial penetration welds.

III. <u>Proposed Alternatives</u>

Entergy has determined that compliance with the specified requirements would result in unusual difficulty or hardship without a compensating increase in the level of quality. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), Entergy proposes the following alternatives to IWB-3420/IWA-3300, IWB-3142.4, and NB-5330(b).

The planned repair for the subject RPV head nozzles does not include removing any cracks discovered in the remaining J-groove partial penetration welds. Therefore, per the requirements of IWA-4310, the cracks must be evaluated using the appropriate flaw evaluation rules of Section XI. No additional inspections are planned to characterize the cracks. Thus, the actual dimensions of the flaw will not be fully determined as required by IWA-3300. In lieu of fully characterizing the existing cracks, Entergy will use worst-case assumptions to conservatively estimate the crack extent and orientation. The postulated crack extent and orientation will be evaluated using the rules of IWB-3600. This evaluation will also justify leaving the remnant weld in place without performing successive examinations in accordance with IWB-3142.4.

If a weld triple point anomaly occurs in any of the repair welds as discussed above, it must also be evaluated in accordance with the appropriate flaw evaluation rules of Section XI. Calculations will be completed to justify this welding solidification anomaly.

IV. <u>Basis for Relief</u>

Inspections of the RPV head will be performed in accordance with NRC Order EA-03-009, *Issuance of Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors.* These inspections may identify conditions that indicate a need to repair flaws discovered in the RPV head penetrations. The use of any of the alternatives permitted by the applicable ASME Codes for repairs will result in increased radiation dose with no compensating increase in quality or safety. The post-weld heat treatment (PWHT) parameters required by NB-4622 would be difficult to achieve on a RPV head in containment and would pose significant risk of distortion to the geometry of the RPV head and vessel head penetrations. In addition the existing J-groove welds would be exposed to PWHT for which they were not qualified. This request applies to repair of any or all of the noted penetrations and to others that may be identified by subsequent inspections during the outage.

Industry experience gained from earlier repairs of RPV head nozzles indicates that removal and repair of the defective portions of the original J-groove partial penetration welds were time consuming and radiation dose intensive. The prior repairs indicated that more automated repair methods were needed to reduce radiation dose to repair personnel. For the present ANO-1 repairs, a remote semi-automated repair method will be used for each of the subject nozzles. Using a remote tool from above the RPV head, each of the nozzles subject to this repair will first receive a roll expansion into the RPV head base material to insure that the nozzle will not move during subsequent repair operations. Second, a semi-automated machining tool from underneath the RPV head will remove the lower portion of the nozzle to a depth above the existing J-groove partial penetration weld. This operation will sever the existing J-groove partial penetration weld from the subject RPV head nozzles. Third, a semi-automated weld tool, utilizing the machine GTAW process, will then be used to install a new Alloy 690 pressure boundary weld between the shortened nozzle and the inside bore of the RPV head base material (see Figures 1 and 2). It was intended, as a part of the new repair methodology and to reduce radiation dose to repair personnel that the original J-groove partial penetration welds would be left in place. These welds will no longer function as pressure boundary RPV head nozzle to RPV head welds. However, the possible existence of cracks in these welds mandates that the flaw growth potential be evaluated.

The requirements of IWA-4310 allow two options for determining the disposition of discovered cracks. The subject cracks are either removed as part of the repair process or left as-is and evaluated per the rules of IWB-3600. The repair design specifies the inside corner of the J-groove weld be progressively chamfered from the center to outermost penetrations to maintain an acceptable flaw size. Section III paragraph NB-3352.4(d)(3) requires that the corners of the end of each nozzle to be rounded to a radius of ½ t_n or ¾ inch which ever is smaller. A 1/8-inch minimum chamfer considered equivalent to the radius specified in NB-3352.4(d)(3) will be incorporated on the bottom corner of the repaired RPV head nozzle penetrations in lieu of the radius. The radius is specified to reduce the stress concentration that might occur at a sharp corner; however, since the original partial penetration weld that remains in this area is analyzed assuming through weld cracks exist therein the presence or absence of a radius or chamfer at this location is not significant with respect to stress concentration. The primary purpose of the chamfer is to assure that any remaining cracks are no larger than those assumed for the analysis.

The assumptions of IWB-3600 are that the cracks are fully characterized to be able to compare the calculated crack parameters to the acceptable parameters addressed in IWB-3500. In the alternative being proposed, the acceptance of the postulated crack is calculated based on the two inputs of expected crack orientation and the geometry of the weld. Typically, an expected crack orientation is evaluated based on prevalent stresses at the location of interest. In these welds, operating stresses are obtained using finite element analysis of the RPV head. Since hoop stresses will be the dominant stress as determined by calculations, it is expected that radial type cracks (with respect to the penetration) will occur. Using worst case (maximum) assumptions with the geometry of the as-left weld, the postulated crack will be assumed to begin at the intersection of the RPV head inner diameter surface and the RPV head nozzle bore and propagate slightly into the RPV head low alloy steel. The depth and orientation are worst-case assumptions for cracks that may occur in the remaining J-groove partial penetration weld configuration.

The original nozzle-to-RPV head weld configuration is extremely difficult to UT due to the compound curvature and fillet radius as can be seen in Figures 1 and 2. These conditions preclude ultrasonic coupling and control of the sound beam in order to perform flaw sizing with reasonable confidence in the measured flaw dimension. Therefore it is impractical, and presently, the technology does not exist, to characterize flaw geometries that may exist therein. Not only is the configuration not conducive to UT but the dissimilar metal interface between the Ni-Cr-Fe weld and the low alloy steel RPV head increases the UT difficulty. Furthermore, due to limited accessibility from the RPV head outer surface and the proximity of adjacent nozzle penetrations, it is impractical to scan from this surface on the RPV head base material to detect flaws in the vicinity of the original weld. Entergy proposes to accept these flaws by analysis of the worst case that might exist in the J-groove. Since the worst case condition is to be analyzed as described below, no future examinations of these flaws is planned.

As previously discussed, after the boring and removing the nozzle end, the remaining weld will be chamfered to assure the remaining weld metal is thinner than the maximum allowable flaw size. Since it has been determined that through-wall cracking in the J-groove weld will most likely accompany a leaking RPV head nozzle, it must be assumed that the "as-left" condition of the remaining J-groove weld includes degraded or cracked weld material.

Since the hoop stresses in the J-groove weld are generally about two times the axial stress at the same location, the preferential direction for cracking is axial, or radial relative to the nozzle. A radial crack in the Alloy 182 weld metal is postulated to propagate by primary water stress corrosion cracking (PWSCC) through the weld and butter, to the interface with the low alloy steel RPV head.

Detailed analyses, including residual stress evaluation and fracture mechanics, are being performed to establish the chamfer design that will result in an applied stress intensity factor (SIF), at the interface between Inconel alloy 600 butter weld and the low alloy steel reactor vessel head, which is below the ASME Code Section XI allowable limit for normal-upset and accident condition. The analyses will be performed for an outermost nozzle penetration location (38.5°), which will provide a bounding analysis for the other nozzles in the RPV head.

The residual stress analyses will be performed using finite element methods that have been developed by Dominion Engineering Inc. for evaluating RPV head penetration J-groove weld residual stresses. The analyses being performed are similar to those that supported various relaxation requests to NRC Order EA-03-009 that have been approved by the NRC staff.[1] The analyses will simulate the original installation of the RPV head penetration nozzle. The process will include the installation of the butter layer followed by a post-weld heat treatment, J-groove welding of the nozzle followed by a Code hydro-test and subsequent steady state operation. Upon achieving ambient conditions the nozzle will be removed. At this point, variations in chamfering depths will be modeled. Each model will be subjected to a normal heat-up followed by a steady state condition and then a cooldown to ambient. Two additional transient conditions, starting from an initial steady state condition, representing a reactor trip (normal and upset condition) and rod withdrawal (accident condition) will be analyzed. This

[1] See letters to Entergy from the NRC dated October 9, 2003, November 7, 2003, and November 12, 2003.

will complete the full spectrum of the required analysis for performing finite element based fracture mechanics evaluations.

The fracture mechanics analysis will use a finite element model similar to that used in the residual stress analysis. The finite element model will have a refined mesh that will include crack tip elements along the interface between the Inconel alloy 600 butter weld and the low alloy carbon steel vessel head. This model will simulate a fully cracked J-groove weld including the butter layer. The fracture mechanics analysis will be performed using a linear elastic superposition method. Relaxing the residual stresses due to cracking will not be utilized since the analysis will use a liner elastic formulation. The SIFs will be obtained at several locations along the postulated crack front. The stresses obtained from the residual stress analysis will be entered as crack face pressure. Reactor vessel internal pressure on the crack face will be added to the pressure distribution obtained from the residual stress analysis.

The stress plots at selected locations in the finite element residual stress model for non-steady state operation (i.e., heat-up, cool-down, reactor trip, and rod withdrawal) will be reviewed to capture the maximum stress during the specific condition. In this manner, the SIF will be maximized for use in the fatigue evaluations. The SIF during the heat-up ramp is needed to obtain the SIF range for use in the subsequent fatigue crack growth analysis.

The fracture mechanics analysis will produce SIFs along the crack front for the conditions evaluated. The conditions to be evaluated are:

1) Normal steady state operation;

2) Normal heat-up from ambient condition;

3) Normal cool-down from steady state condition;

4) Reactor trip from steady state condition; and,

5) Rod withdrawal accident from steady state condition.

The obtained SIFs will be compared to the applicable ASME Code Section XI value for the specified condition of operation. The final design for the chamfer will be based on meeting the allowable stress intensity factor limit.

Entergy will submit the analyses described above to the NRC staff by June 1, 2004.

An additional evaluation was performed to determine the potential for debris from a cracking J-groove partial penetration weld.[2] As noted above, radial cracks were postulated to occur in the weld due to the dominance of the hoop stress at this location. The possibility of occurrence of transverse cracks that could intersect the radial cracks was considered remote since there are no forces that would drive a transverse crack. The radial cracks would relieve the potential transverse crack driving forces. Hence, it is unlikely that a series of transverse cracks could intersect a series of radial cracks resulting in any fragments becoming dislodged.[3]

[2] See ANO Calculation E-86-0074-164 submitted to the NRC via Entergy letter CNRO-2002-00054 dated November 26, 2002.
[3] ANO Calculation E-86-0074-164, page 4

The cited evaluations provide an acceptable level of safety and quality in insuring that the RPV head remains capable of performing its design function for a sufficient number of heat-up/cool-down cycles to support one (1) operating cycle, with flaws existing in the original J-groove weld.

For the reasons described above, areas containing flaws accepted by analytical evaluation were not be reexamined as required by IWB-3142.4. Additionally, Entergy plans to replace the ANO-1 RPV head during 1R19, which is scheduled to begin in the fall of 2005.

In the case of the RPV head nozzle inside diameter (ID) temper bead repair, the term "anomaly" is applied to the unusual solidification patterns that result along the low alloy steel / Alloy 600/Filler Metal 52 interface of the repair weld. The anomalies originate along the low alloy steel (RPV head) to Alloy 600 (original nozzle) interface where melting occurs and generally extend back towards the center of the weld bead. These anomalies are typical for welds that involve a "lap joint" type interface, such as typical partial penetration weld geometries, in the weld joint design. Cross sections of nickel alloy welds made utilizing similar joint designs with Alloy 600 base materials and Alloy 82 filler metals have exhibited these phenomena consistently.

This phenomenon is compounded by the different solidification rates for the base materials and weld metal used in performing the repair. Other suspected factors in the anomaly occurrence are the size of the interface gap, gap cleanliness and position of the welding arc relative to the edge of the interface. The molten weld puddle simply freezes back to each side of the interface and follows the interface into the weld as solidification of the weld puddle take place. Weld root anomalies have been observed on several mockups with configurations simulating the repair weld. UT methods have been developed based on the characteristics of this anomaly so that verification to the prescribed acceptance criteria can be performed. The defect is treated like a crack, which is worst case. Two types of flaws are common in this area. The first is localized melting away of the feathered end of the beveled nozzle weld prep leaving occasional small voids. The second type flaw is caused due to an inherent problem during solidification of high Ni-Cr alloys in the presence of a notch such as a partial penetration weld. This type of flaw is in fact often called a "solidification anomaly" to differentiate it from what it is not – a crack.

IWA-4170 mandates that the repair design meets the original construction code or the adopted ASME Section III Code. As noted, the 1989 ASME Section III code has been adopted for qualification of the described repairs. Subsection NB-5330(b) stipulates that no lack of fusion area be present in the weld. A fracture mechanics analysis was performed to demonstrate compliance with Section XI of the ASME Code, for operating with the postulated weld anomaly described above.[4] The anomaly was modeled as a 0.1 inch semi-circular "crack-like" defect, 360 degrees around the circumference at the "triple point" location. Full-size mockups using coupons from the Midland RPV head were metallographically evaluated. Both flaw types were occasionally found as expected and were less than the analyzed maximum allowed of 0.100 inch.[5]

Based on the fact that this anomaly is predictable as discussed herein, the anomaly can be detected by UT within the prescribed acceptance criteria and evaluated for fatigue and flaw growth using applicable ASME Sections III and XI methods. Therefore, the intent of the

[4] See ANO Calculations 86-E-0074-160 and 86-E-0074-161 submitted to the NRC via Entergy letter CNRO-2002-00054 dated November 26, 2002.
[5] ANO Calculation 86-E-0074-160, page 2 and ANO Calculation 86-E-0074-161, page 4

ASME Codes will be met. The ASME Section III analysis conservatively assumes a reduction in weld area (along the new weld-to-ferritic steel penetration fusion line) due to the anomaly and the ASME Section XI analysis assumes the anomaly is a crack-like defect.

Postulated flaws could be oriented within the anomaly such that there are two possible flaw propagation paths, as discussed below.

Path 1:

Flaw propagation path 1 traverses the RPV head tube wall thickness from the outside diameter (OD) of the tube to the ID of the tube. This is the shortest path through the component wall, passing through the new Alloy 690 weld material. However, Alloy 600 tube material properties or equivalent are used to ensure that another potential path through the heat affected zone (HAZ) between the new repair weld and the Alloy 600 tube material is bounded.[6]

For completeness, two types of flaws are postulated at the outside surface of the tube. A 360 degree continuous circumferential flaw, lying in a horizontal plane, is considered to be a conservative representation of crack-like defects that may exist in the weld anomaly. This flaw is subjected to axial stresses in the tube. An axially oriented semi-circular outside surface flaw is also considered since it would lie in a plane normal to the higher circumferential stresses. Both of these flaws would propagate toward the inside surface of the tube.[7]

Path 2:

Flaw propagation path 2 runs down the outside surface of the repair weld between the weld and RPV head. A semi-circular cylindrically oriented flaw is postulated to lie along this interface, subjected to radial stresses with respect to the tube. This flaw may propagate through either the new Alloy 690 weld material or the low alloy steel RPV head material.[8]

The result of the analysis demonstrated that a 0.10-inch weld anomaly is acceptable for 25 years, which is beyond 2005 when the ANO-1 RPV head is scheduled to be replaced.[9] Residual stresses and stresses due to operation were considered. Significant fracture toughness margins were expected for both of the flaw propagation paths considered in the analysis. The minimum calculated fracture toughness margins were required to be greater than the required margin of $\sqrt{10}$ per ASME Section XI IWB-3612. Based on similar analysis, fatigue crack growth was expected to be minimal. The maximum final flaw size was small considering both flaw propagation paths. A limit load analysis was also performed considering the ductile Alloy 600/Alloy 690 materials along flaw propagation path 1. The analysis was required to show limit load margins for normal/upset conditions and emergency/faulted conditions greater than the required margins of 3.0 and 1.5 for normal/upset conditions and emergency/faulted conditions, respectively, per ASME Section XI, IWB-3642.[10]

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[6] ANO Calculation 86-E-0074-161, page 7
[7] Ibid.
[8] Ibid.
[9] ANO Calculation 86-E-0074-161, page 38
[10] ANO Calculation 86-E-0074-161, pages 22, 23, and 38

Acceptance of the repair will be based on this evaluation in accordance with ASME Section XI and will demonstrate that for the intended service life of the repair, the fatigue crack growth is acceptable and the crack-like indications remain stable. These two findings will satisfy the Section XI criteria but do not include considerations of stress corrosion cracking such as PWSCC. However, since the crack-like indications in the weld triple point anomaly are not exposed to the primary coolant and the air environment is benign for the materials at the triple point, the time-dependent crack growth from PWSCC is not applicable.

For the reasons described above, areas of J-groove welds containing flaws accepted by analytical evaluation will not be reexamined as required by IWB-3142.4. Although solidification anomalies may occur in the new repair weld, volumetric examination of these welds during a subsequent refueling outage is not required since Entergy plans to replace the ANO-1 RPV head during 1R19. (1R19 is scheduled to begin during the fall of 2005.)

Justification for Proposed Alternative:

Removing the cracks in the existing J-groove partial penetration welds would incur excessive radiation dose for repair personnel. With the installation of the new pressure boundary welds previously described, the original function of the J-groove partial penetration welds is no longer required. It is well understood that the cause of the cracks in the subject J-groove welds is PWSCC. As shown by industry experience, the low alloy steel of the RPV head impedes crack growth by PWSCC. Entergy believes the alternative will provide an acceptable level of quality and safety when compared to the code requirements in IWB-3500 to characterize the cracks left in service. Using an assumed worst-case crack size, the analysis will ensure that the initial flaw size is controlled by the size of the chamfer to maintain compliance with ASME Section XI and that unacceptable flaw growth into the RPV head does not occur within the next operating cycle. Thus, the RPV head can be accepted per the requirements of IWA-4310.

Based on extensive industry experience and Framatome-ANP direct experience, there are no known cases where flaws initiating in an Alloy 82/182 weld have propagated into the ferritic base material. The surface examinations performed associated with flaw removal during recent repairs at Oconee 1 and 3 on RPV head penetrations, Catawba 2 steam generator channel head drain connection penetration, ANO-1 hot leg level tap penetrations and the V. C. Summer hot leg pipe to primary outlet nozzle repair (reference MRP-44: Part I: Alloy 82/182 Pipe Butt Welds, EPRI, 2001 TP-1001491) all support the assumption that the flaws would blunt at the interface of the Ni-Cr-Fe weld to ferritic base material. Additionally, the Small Diameter Alloy 600/690 Nozzle Repair Replacement Program (CE NPSD-1198-P) provides data that shows PWSCC does not occur in ferritic pressure vessel steel. Based on industry experience and operation stress levels, there is no reason for service related cracks to propagate into the ferritic material from the Alloy 82/182 weld.

Eliminating the weld triple point anomaly would require use of an entirely different process than that proposed for use on ANO-1. The only qualified method currently available would involve extensive manual welding that would result in radiation doses estimated to be in excess of 30 REM per nozzle as compared to the 5 REM estimated for each nozzle repaired by the proposed process.

Compliance with the specified Code requirements would result in excessive radiation exposure: a hardship or unusual difficulty without a compensating increase in the level of quality and safety.

V. Duration of the Proposed Alternative

Entergy plans to replace the ANO-1 RPV head during Refueling Outage 1R19, which is scheduled to begin during the fall of 2005. Therefore, this request will be limited to one operating cycle.

For the upcoming 1R18 refueling outage, Entergy has evaluated the need to employ water jet conditioning and has determined such activities are not required. Entergy has performed an evaluation to determine the time for a postulated crack to grow 75% through-wall in the Alloy 600 nozzle material above the repair weld without employing water jet conditioning, as documented in Engineering Report M-EP-2004-002, Rev. 0, which is contained in Enclosure 2 of this letter.

The evaluation considers RPV head nozzles in the as-repaired condition and encompasses initiation and crack growth due to primary water stress corrosion cracking (PWSCC). This evaluation found that nozzle axial stresses are considerably lower than nozzle hoop stresses. Because of this, the likelihood of axial cracking is greater than the likelihood of circumferential cracking; therefore, only axial crack conditions were analyzed.

The analysis indicates that a crack will not grow to 75% through-wall in a time period of 4 years. This estimate is based on the following assumptions:

1. After PT and UT examination of the repaired ID surface, an undetected axial crack 0.157 inch long and 0.0679 inch deep (11% wall thickness) is assumed present.[11]
2. The crack growth rate under operating conditions was determined using the MRP-55 recommended curve modified for a crack growth amplitude (α) that represents B&W material data.[12]
3. The minimum wall thickness of the CRDM nozzle repair is 0.6175.[13]
4. Water jet conditioning is not applied.

Since Entergy plans to replace the ANO-1 RPV head during 1R19, which is prior to the end of 4 years, water jet conditioning is not necessary.

Given these expected results, the proposed inspection schedules given above, and the planned replacement date for the ANO-1 RPV head, Entergy believes the proposed alternatives to the ASME Code requirements are justified. The proposed alternatives are applicable to the repairs and examinations after repair to any ANO-1 RPV head nozzle.

VI. Implementation Schedule

This request will be implemented during upcoming refueling outage 1R18, which is scheduled to begin during the second quarter of 2004. Entergy plans to replace the ANO-1 RPV head during Refueling Outage 1R19, which is scheduled to begin during the fall of 2005.

[11] Engineering Report M-EP-2004-002, Rev. 0, Attachment 2 of Appendix C, page 2 of 17
[12] Engineering Report M-EP-2004-002, Rev. 0, Appendix B
[13] Engineering Report M-EP-2004-002, Rev. 0, Appendix A gives nozzle ID and OD dimensions.

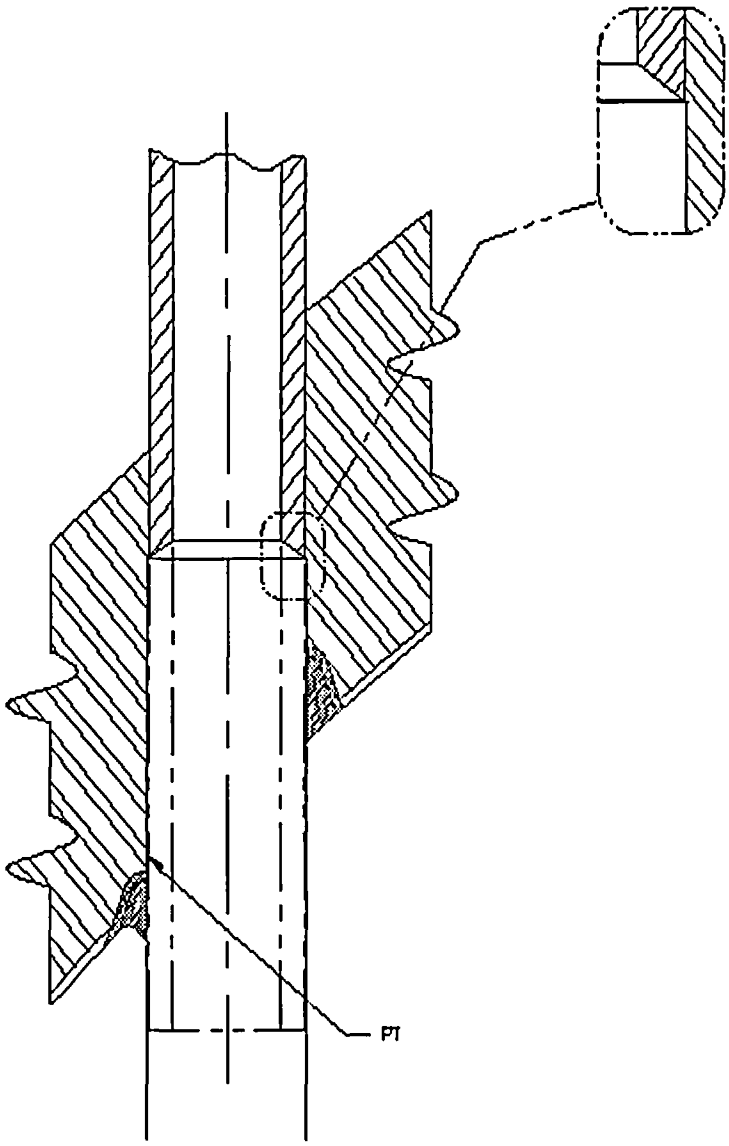

FIGURE 1
New ANO-1 RPV Head Nozzle

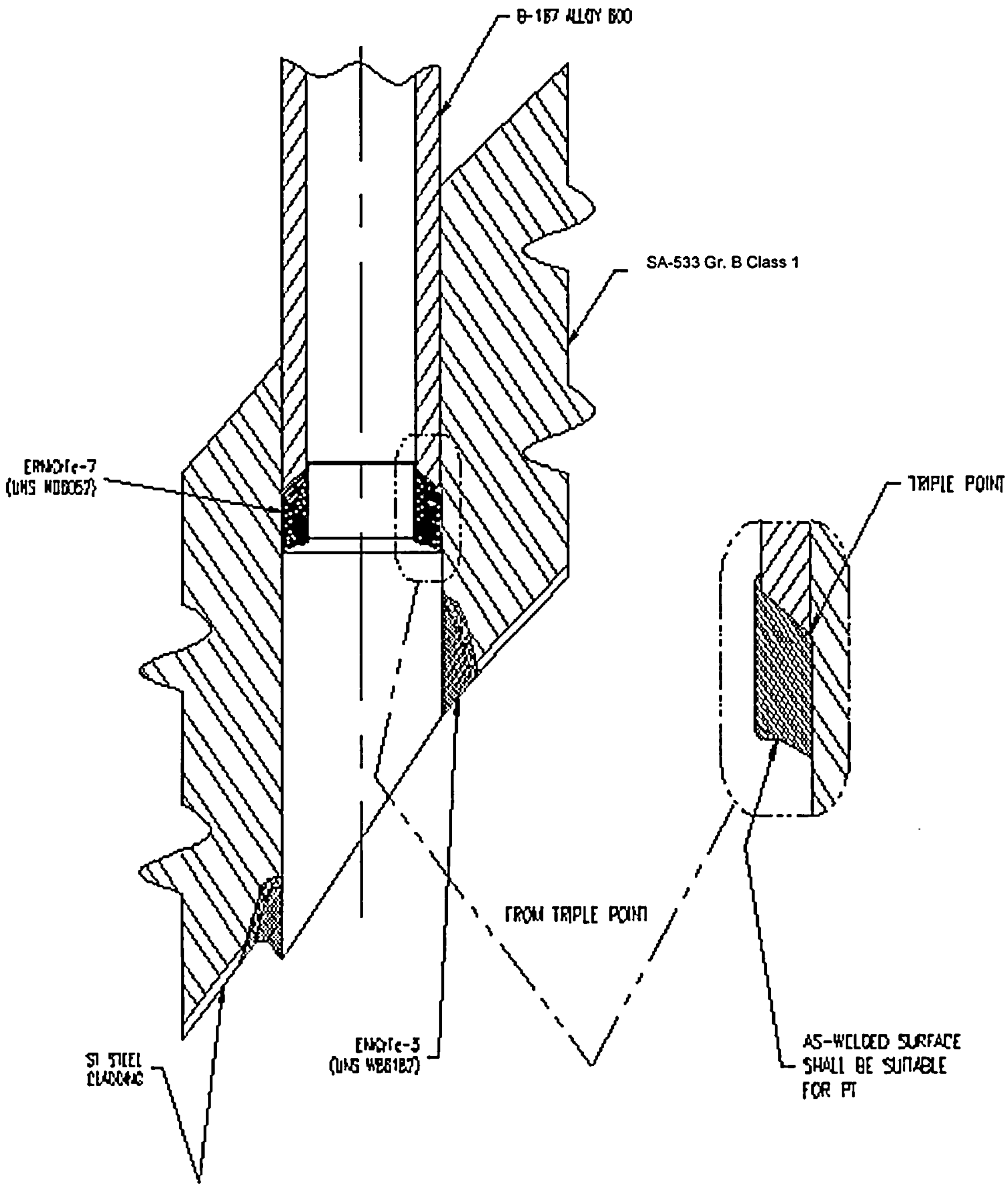

FIGURE 2
ANO-1 New RPV Head Pressure Boundary Welds