This letter forwards proprietary information in accordance with 10 CFR 2.390. The balance of this letter may be considered non-proprietary upon removal of Attachment 5.

CENG[SM]
a joint venture of Constellation Energy / eDF

P.O. Box 63
Lycoming, NY 13093

NINE MILE POINT
NUCLEAR STATION

March 4, 2011

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: Nine Mile Point Nuclear Station
Unit No. 1; Docket No. 50-220

Request to Utilize an Alternative to the Requirements of 10 CFR 50.55a(g) for the Repair of Control Rod Drive Housing Penetrations for the Remainder of the License Renewal Period of Extended Operation

REFERENCES:

(a) Letter from J. A. Spina (NMPNS) to Document Control Desk (NRC) dated November 30, 2005, Amended License Renewal Application (ALRA) – Responses to NRC Requests for Additional Information Regarding ALRA Parts 1, 2 and 3 (TAC Nos. MC3272 and MC3273)

(b) Letter from N. L. Salgado (NRC) to S. L. Belcher (NMPNS), dated August 3, 2009, Nine Mile Point Nuclear Station, Unit No. 1 – Request to Utilize the Alternative of Applying ASME Code Case N-730 for the Repair and Inservice Inspection of Control Rod Drive Bottom Head Penetrations for the License Renewal Period of Extended Operation (TAC No. MD9604)

On October 31, 2006, the NRC issued the Renewed Operating License for Nine Mile Point Unit 1 (NMP1), with an expiration date of August 22, 2029. As part of the application for the renewed operating license for NMP1 (Reference a), Nine Mile Point Nuclear Station, LLC (NMPNS) committed to implement a permanent zero leakage roll repair method for leaking Control Rod Drive (CRD) penetrations utilizing American Society of Mechanical Engineers (ASME) Code Case N-730, as conditioned by the NRC, for the 20-year period of extended operation. NMPNS subsequently submitted a 10 CFR 50.55a request to utilize Code Case N-730, with a variation, and the NRC approved the request by letter dated August 3, 2009 (Reference b).

As part of the application for the renewed operating license for NMP1 (Reference a), NMPNS also committed to implement one of the following zero leakage permanent repair strategies in the event that a zero leakage condition is not achieved for a CRD housing penetration (stub tube) that has been roll-repaired in accordance with the provisions of Code Case N-730:

A047
NRR

This letter forwards proprietary information in accordance with 10 CFR 2.390. The balance of this letter may be considered non-proprietary upon removal of Attachment 5.

(1) A welded repair consistent with BWRVIP-58-A, "BWRVIP Internal Access Weld Repair," and Code Case N-606-1, as endorsed by the NRC in Regulatory Guide 1.147.
(2) A variation of the welded repair geometry specified in BWRVIP-58-A subject to the approval of the NRC using Code Case N-606-1.
(3) A future developed mechanical/welded repair method subject to the approval of the NRC.

NMPNS has chosen to develop a repair strategy consistent with the second option. This will assure that the repair strategy is available in the event that a zero leakage condition is not achieved for a CRD housing penetration that has been roll-repaired in accordance with the provisions of Code Case N-730.

The purpose of this letter is to request NRC approval of the alternative weld repair strategy proposed by NMPNS, as described in 10 CFR 50.55a Request Number 1ISI-004 provided in Attachment 1. This alternative repair strategy includes a variation of the CRD housing penetration welded repair geometry specified in BWRVIP-58-A, and variations from the requirements of the ASME Code, Section XI, and ASME Code Case N-606-1. Consistent with the NMPNS license renewal commitment, descriptions of the variations from the BWRVIP-58-A guidelines and their justifications are provided in Attachment 2. Additional supporting analyses are provided in Attachment 3 (non-proprietary) and Attachment 5 (proprietary). This request would allow use of the proposed alternative for the remaining term of the NMP1 renewed operating license, which expires on August 22, 2029.

Attachment 5 is considered to contain proprietary information exempt from disclosure pursuant to 10 CFR 2.390. Therefore, on behalf of AREVA NP, Inc. (AREVA), NMPNS hereby makes application to withhold this attachment from public disclosure in accordance with 10 CFR 2.390(b)(1). The affidavit from AREVA detailing the reasons for the request to withhold the proprietary information is provided in Attachment 4.

NMPNS requests approval of this request for alternative by February 28, 2012 to support future CRD housing penetration weld repair contingency planning. This letter contains no new regulatory commitments.

Should you have any questions regarding the information in this submittal, please contact John J. Dosa, Director Licensing, at (315) 349-5219.

Very truly yours,

Joseph E. Pacher
Manager Engineering Services

JEP/DEV

Attachments:

1. Nine Mile Point Nuclear Station, Unit 1, 10 CFR 50.55a Request Number 1ISI-004
2. Nine Mile Point Nuclear Station, Unit 1, CRD Housing Penetration Repair - Descriptions and Justifications for Variations from the BWRVIP-58-A Guidelines
3. AREVA Document No. 32-9138066-000, NMP-1 CRD Housing IDTB Weld Anomaly Analysis (Non-Proprietary)
4. Affidavit from AREVA NP Inc., Justifying Withholding Proprietary Information
5. AREVA Document No. 32-9138065-001, NMP-1 CRD Housing IDTB Weld Anomaly Analysis (Proprietary)

cc: Regional Administrator, Region I, NRC
Project Manager, NRC
Resident Inspector, NRC

ATTACHMENT 1

NINE MILE POINT NUCLEAR STATION, UNIT 1

10 CFR 50.55a REQUEST NUMBER 1ISI-004

Nine Mile Point Nuclear Station, LLC
March 4, 2011

Proposed Alternative
In Accordance with 10 CFR 50.55a(a)(3)(i)

A. COMPONENT IDENTIFICATION:

System: Control Rod Drive (CRD) Bottom Head Penetrations

Code Class: Quality Group A, ASME Code Class 1

Description: Penetrations for the CRD housings are located in the lower head of the reactor vessel (RV). Stainless steel stub tubes are welded to the penetrations and CRD housings are welded to the stub tubes. The general configuration of the CRD housing penetrations is shown in Figure 1, and the component materials are summarized in Table 1.

Components Affected: RV Bottom Head and CRD Housing Penetrations

TABLE 1 – MATERIALS

Vessel Bottom Head	CRD Housing	Stub Tube	CRD Housing-to-Stub Tube Weld
SA-302, Gr. B	SA-312 or SA-376, TP304	SA-182, F304	308 or 308L

B. APPLICABLE CODE REQUIREMENTS:

The reactor pressure boundary was designed and certified in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Sections I and VIII, 1959 Edition with Addenda through Winter 1963, and ASME Code Cases 1270N and 1273N. The CRD housing was designed to ASME Code Section III, 1965 Edition, no Addenda.

ASME Code, Section XI, 2004 Edition, no Addenda (Reference 1), is applicable for repair/replacement activities for the Nine Mile Point Unit 1 (NMP1) fourth 10-year inservice inspection (ISI) interval. The fourth 10-year ISI interval began on August 23, 2009, concurrent with the NMP1 license renewal period of extended operation.

ASME Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique for BWR CRD Housing/Stub Tube Repairs" (Reference 2), provides requirements for automatic or machine Gas Tungsten-Arc Welding (GTAW) of Class 1 components without the use of preheat or post-weld heat treatment. The technique described in the Code Case is applicable for welding on ferritic low alloy steel, with the condition specified in Regulatory Guide (RG) 1.147, Revision 16 (Reference 3).

The following are specific code requirements that pertain to this 10 CFR 50.55a request.

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4221(a) states:

  "An item to be used for repair/replacement activities shall meet the Owner's Requirements. Owner's Requirements may be revised, provided they are reconciled in accordance with IWA-4222. Reconciliation documentation shall be prepared."

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4221(b) states:

  "An item to be used for repair/replacement activities shall meet the Construction Code specified in accordance with (1), (2), or (3) below."

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4221(c) states in part:

  "As an alternative to (b) above, the item may meet all or portions of the requirements of different Editions and Addenda of the Construction Code, or Section III when the Construction Code was not Section III, provided the requirements of IWA-4222 through IWA-4226, as applicable, are met. ....."

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4400 provides welding, brazing, metal removal, and installation requirements related to repair/replacement activities.

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4411 states:

  "Welding, brazing, and installation shall be performed in accordance with the Owner's Requirements and, except as modified below, in accordance with the Construction Code of the item."

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4411(a) states in part:

  "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). ....."

- ASME Code Section XI, 2004 Edition, no Addenda, IWA-4610(a) states in part:

  "... Thermocouples and recording instruments shall be used to monitor the process temperatures. ..."

- ASME Code Section III, 2004 Edition, no Addenda, NB-5331 states:

  "All imperfections which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all such imperfections and evaluate them in terms of acceptance standards given in (a) and (b) below."

- ASME Code Section III, 2004 Edition, no Addenda, NB-5331(b) states:

  "Indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length."

- Code Case N-606-1, paragraph 1(f) states:

  "Peening may be used, except on the initial and final layers."

- Code Case N-606-1, paragraph 3(d) states:

  "The maximum interpass temperature for field applications shall be 350°F regardless of the interpass temperature during qualification."

- Code Case N-606-1, last sentence in the "*Reply*" states in part:

  "... welds, may be made by the automatic or machine GTAW temper bead technique...., and without the nondestructive examination requirements of the Construction Code, provided the requirements of para. 1 through para. 5, and all other requirements of IWA-4000, are met."

- Code Case N-606-1, paragraph 4(a) states:

  "The final weld surface and the band around the area defined in para. 1(d) shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I."

C. REASON FOR REQUEST FOR RELIEF:

Stainless steel stub tubes were welded to the RV bottom head during shop fabrication of the RV. The RV bottom head was subjected to post weld heat treatment at some point after the stub tubes were welded therein. As a result of the post weld heat treatment, the stainless steel stub tubes became furnace sensitized and therefore susceptible to intergranular stress corrosion cracking (IGSCC). A number of CRD housing penetrations have developed leaks due to IGSCC of the furnace sensitized stainless steel and/or the Alloy 82/182 stub tube-to-vessel weld.

The NRC staff informed Nine Mile Point Nuclear Station, LLC (NMPNS) during the License Renewal Application process that the staff did not consider the then-applicable plant-specific roll repair process to be acceptable for permanent repair of leaking CRD penetrations (Reference 4). As a result, NMPNS committed to implement ASME Code Case N-730, "Roll-Expansion of Class 1 Control Rod Drive Bottom Head Penetrations in BWR's, Section XI, Division 1," during the license renewal period, which began August 23, 2009. NMPNS requested relief to use Code Case N-730, and the NRC approved the request by their letter dated August 3, 2009 (Accession No. ML091980454).

Roll expansion repair is the preferred strategy for the license renewal period to maintain zero leakage at CRD penetrations. However, the license renewal commitment also stated that during the period of extended operation, should a CRD housing penetration (stub tube) rolled in accordance with the provisions of the Case N-730 resume leaking, NMPNS will implement a zero leakage permanent repair prior to startup from the outage in which the leakage was detected. The permanent repair selected by NMPNS will consist of a variation of the welded repair geometry specified in BWRVIP-58-A (Reference 5) using Code Case N-606-1, as endorsed by the NRC in RG 1.147. The ambient temperature inside diameter temper bead (IDTB) welding method will be used to restore the pressure boundary of the CRD penetration(s). The IDTB welding method is performed with a remotely operated weld tool, utilizing the machine Gas Tungsten-Arc Welding (GTAW) process and ambient preheat temperature temper bead method with 50°F minimum preheat temperature and no post weld heat treatment. The repair will be conducted in accordance with ASME Section XI, 2004 Edition, no Addenda, Code Case N-606-1, and the alternative requirements discussed below. The repair will seal a leaking CRD housing penetration and provide a new reactor coolant system (RCS) pressure boundary weld, as shown in Figure 2.

Pursuant to 10 CFR 50.55a(a)(3)(i), NMPNS requests approval to vary from the requirements of ASME Section XI and Code Case N-606-1 described in Section B above. The proposed alternative requirements and associated justifications are described in Section D below. NMPNS has determined that the proposed alternative provides an acceptable level of quality and safety and satisfies the requirements of 10 CFR 50.55a(a)(3)(i).

D. BASIS FOR RELIEF AND ALTERNATIVE EXAMINATIONS:

The proposed alternative described in this section involves the implementation of an IDTB weld repair of CRD housings at NMP1 that is similar to the internal access weld repair described in BWRVIP-58-A. The purpose of the repair is to provide a new RCS pressure boundary weld, utilizing weld material that is highly resistant to IGSCC. BWRVIP-58-A documents the development, qualification, and demonstration of an internal access weld repair for a leaking CRD housing. The NRC staff has reviewed BWRVIP-58-A and determined that the report is acceptable for providing guidance for the repair of CRD housing penetration welds inside the RV (Reference 6).

In accordance with 10 CFR 50.55a(a)(3)(i), NMPNS proposes to implement an IDTB weld repair using Code Case N-606-1, with the condition specified in RG 1.147, Revision 16, and the alternate provisions described below.

1A. Proposed Alternative: Acceptance Examination Area

Code Case N-606-1, Paragraph 4(a), requires the final weld surface and the preheated band around the area defined in paragraph 1(d) to be examined using surface and ultrasonic methods.

NMPNS requests relief from examination of the area defined in Code Case N-606-1, Paragraph 4(a). In lieu of Code Case N-606-1 Paragraph 4(a), final examination of the new weld and immediate surrounding area within the bore will be performed. The nondestructive examination (NDE) volumes and areas will be similar to those described in BWRVIP-58-A, as discussed in Attachment 2.

Figure 2 depicts the areas for liquid penetrant (PT) examination and ultrasonic examination (UT) of the modified CRD penetration.

1B. Basis for Relief:

Code Case N-606-1, Paragraph 1(d), defines the area to be welded and the band around the area (at least 1½ times the component thickness or 5 inches, whichever is less) to be preheated. The band around the repair weld area, as defined in Code Case N-606-1, Paragraph 1(d), cannot be examined as specified in Code Case N-606-1, Paragraph 4(a). Access restrictions and the final configuration of the repair weld do not allow UT examination or PT examination of the ferritic steel 5 inch band. This is illustrated in Figures 1 and 2, which show that the surface of the ferritic steel vessel bottom head penetration is blocked by the CRD housing and the completed weld, such that access for PT examination and UT examination of the vessel surface is not possible.

The band includes an annular area extending 5 inches above and below the area to be welded in the penetration bore that extends onto the outside surface of the RV bottom head. This examination requirement was intended for situations wherein the original flaw creating the leak path is being repaired and it is necessary to confirm complete removal of the original flaw. For the proposed weld repair method, the original flaw remains as-is and the repair creates a new pressure boundary weld remote from the original flaw locations.

The exposed ferritic steel portion of the CRD housing penetration at the root of the repair weld and the weld preparation bevel on the end of the remaining portion of the CRD housing lower section are PT examined prior to welding. This examination provides assurance that no flaws exist on the surfaces in the bore in the region to be welded.

The final examination of the new weld and immediate surrounding area within the bore will be sufficient to verify that defects have not been induced in the low alloy steel bottom head material due to the welding process and will assure the integrity of the CRD housing and the new weld. Figure 2 depicts the areas for PT examination and UT examination of the modified CRD housing penetration. The PT area includes the new weld surface and ½ inch minimum distance below the weld. UT will be performed by scanning from the inner diameter (ID) surface of the CRD housing and weld. The UT examination is qualified to detect flaws in the new weld and base metal interface beneath the new weld. UT acceptance criteria are in accordance with NB-5331, as modified by BWRVIP-58-A. The extent of the examination is consistent with Construction Code requirements. The volume of interest for UT examination includes the new weld, the bottom head low alloy steel base material heat affected zone (HAZ), the CRD housing to weld interface, and the CRD housing base material beneath the weld. Limited UT coverage of the low alloy steel volume beneath the weld taper or the weld taper volume can be accomplished due to the weld geometry and the ultrasonic beam angles that are used for examination.

The basis for excluding surface and volumetric examination of the region around the final weld surface is BWRVIP-58-A, which has been approved by the NRC. The NDE procedures were developed and demonstrated to provide an acceptable level of quality for the CRD internal access weld repair. The alternative proposes to perform similar NDE as was approved in BWRVIP-58-A (see Attachment 2).

2A. Proposed Alternative: 48-Hour Hold

Code Case N-606-1, Paragraph 4(a), requires the surface and volumetric examinations to be performed at least 48 hours after the completed weld has been at ambient temperature.

NMPNS requests relief from the 48-hour hold defined in Code Case N-606-1, Paragraph 4(a). In lieu of the Code Case N-606-1, Paragraph 4(a) requirement, the final examination of the new weld and immediate surrounding area within the bore will occur at least 48 hours after the completion of the third temper bead layer.

2B. Basis for Relief:

Hydrogen cracking is a form of cold cracking. It is produced by the action of internal tensile stresses acting on low toughness material weld heat affected zones. The internal stresses are produced from localized build-ups of monatomic hydrogen. Monatomic hydrogen forms when moisture or hydrocarbons interact with the welding arc and molten weld pool. The monatomic hydrogen can be entrapped during weld solidification and tends to migrate to transformation boundaries or other microstructure defect locations. As concentrations build, the monatomic hydrogen recombines to form molecular hydrogen, thus generating localized internal stresses at these internal defect locations. If these stresses exceed the fracture toughness of the material, hydrogen induced cracking occurs. This form of cracking requires the presence of hydrogen and low toughness materials. It is manifested by intergranular cracking of susceptible materials and typically occurs within 48 hours of welding.

The machine GTAW process is inherently free of hydrogen. Unlike the shielded metal arc welding process, GTAW filler metals do not rely on flux coverings that may be susceptible to moisture absorption from the environment. The GTAW process utilizes dry inert shielding gases that cover the molten weld pool from oxidizing atmospheres. Any moisture on the surface of the component being welded is vaporized ahead of the welding torch. The vapor is prevented from being mixed with the molten weld pool by the inert shielding gas that blows the vapor away before it can be mixed. Furthermore, modern filler metal manufacturers produce weld wires having very low residual hydrogen. This is important because filler metals and base materials are the most realistic sources of hydrogen for the automatic or machine GTAW temper bead process. Therefore, the potential for hydrogen-induced cracking is greatly reduced by using the machine

GTAW process. Extensive research has been performed by the Electric Power Research Institute (EPRI). EPRI Report 1013558, "Repair and Replacement Applications Center: Temperbead Welding Applications 48-Hour Hold Requirements for Ambient Temperature Temperbead Welding" (Reference 7) provides justification for starting the 48-hour hold after completing the third temper bead weld layer rather than waiting for the weld overlay to cool to ambient temperature.

3A. Proposed Alternative: Acceptance NDE

Code Case N-606-1, Paragraph 4(a), requires UT examination to be in performed in accordance with Appendix I, and Paragraph 4(d) specifies acceptance criteria in accordance with ASME Code Section XI, IWB-3000.

IWB-3000 does not have any acceptance criteria that directly apply to the partial penetration weld configuration. Therefore, NMPNS requests relief from examination requirements as specified in Code Case N-606-1 Paragraphs 4(a) and 4(d). The alternative proposes to perform NDE in accordance with ASME Code Section III similar to that specified in BWRVIP-58-A (see Attachment 2), except that the 2004 Edition with no Addenda (Reference 8) will be used in lieu of the 1995 Edition, including Addenda through 1995 (Reference 9).

3B. Basis for Relief:

The acceptance criteria of NB-5331 in ASME Code Section III, 2004 Edition with no Addenda, will apply to all flaws identified within the new weld volume, as modified by and similar to that specified in BWRVIP-58-A.

Section III, NB-5245 requires incremental and final surface examination of partial penetration welds. Due to the welding layer disposition sequence (i.e., each layer is deposited parallel to the penetration centerline), the specific requirements of NB-5245 cannot be met. The Construction Code requirement for progressive surface examination is because volumetric examination is not practical for conventional partial penetration weld configurations.

The new weld is suitable for UT examination, and a final surface PT examination will be performed. UT examination will be performed by scanning from the inner diameter surface of the housing and weld. The UT examination is qualified to detect flaws in the new weld and base metal interface beneath the new weld. UT examination acceptance criteria are in accordance with NB-5331 as modified by BWRVIP-58-A. The extent of the examination is consistent with Construction Code requirements and similar to that specified in BWRVIP-58-A, as discussed in Attachment 2.

The volume of interest for UT examination, which will be covered to the maximum extent practical, includes the new weld, the bottom head low alloy steel base material heat affected zone beneath the weld, the CRD housing to weld interface, and the CRD housing base material beneath the weld. Limited UT coverage of the low alloy steel volume beneath the weld taper or the weld taper volume can be accomplished due to the weld geometry and the ultrasonic beam angles that are used for examination.

The final examination of the new weld and immediate surrounding area will be sufficient to verify that defects have not been induced in the ferritic low alloy reactor vessel bottom head due to the welding process. UT examination will be performed by scanning from the ID surface of the weld and the adjacent portion of the CRD housing. The UT examination is qualified to detect flaws in the new weld and base metal interface in the modified configuration, to the maximum extent practical.

4A. Proposed Alternative: Triple Point Anomaly

UT examination is proposed to be performed in accordance with ASME Code Section III, 2004 Edition with no Addenda, as modified by and similar to that specified in BWRVIP-58-A (see Proposed Alternative 3A above). ASME Section III NB-5330 acceptance criteria (see Section B above) apply, including NB-5331(b), which states that indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

As discussed in BWRVIP-58-A, in some cases a solidification anomaly has been observed at the weld root and may be detected when performing the UT examination. Analyses described in BWRVIP-58-A concluded that these anomalies are not detrimental to the repair weld design if they are less than 0.05 inches extending from the triple point. NMPNS requests relief to permit anomalies in the weld not exceeding 0.10 inches long for the full circumference at the triple point. If these anomalies are determined to be less than or equal to 0.10 in. long emanating in any direction from the weld root triple point and extending around the penetration for the full circumference or less, they will be acceptable and repair will not be required.

4B. Basis for Relief:

An artifact of the ambient temperature temper bead repair weld is an anomaly in the weld at the triple point. The triple point is where there is a confluence of three materials: the stainless steel CRD housing, the stainless steel weld, and the low alloy steel RV bottom head. The location of the triple point anomaly is shown in Figure 2. This anomaly consists of an irregularly shaped very small void. Mock-up testing has verified that the anomalies may exist and do not exceed 0.10 inch in length.

A fracture mechanics analysis has been performed to provide justification, in accordance with the ASME Code Section XI, for operating with the postulated triple point anomaly. The anomaly is modeled as a 0.10 inch, "crack like" defect, extending 360° around the circumference at the triple point location. The analysis includes a prediction of fatigue crack growth in an air environment, since the anomaly is located on the outside surface of the new weld. Several potential flaw propagation paths are considered in the flaw evaluation. The results of the analysis demonstrate that the 0.10 inch weld anomaly is acceptable. In accordance with ASME Section XI, IWB-3134(b), the results of the analysis are provided in Attachment 3 (non-proprietary) and Attachment 5 (proprietary).

5A. Proposed Alternative: Interpass Temperature Monitoring

ASME Code Section XI, IWA-4610(a), requires the use of thermocouples and recording instruments to monitor process temperatures.

NMPNS requests relief from using thermocouples for interpass temperature monitoring as specified in IWA-4610(a). In lieu of using thermocouples to monitor and verify process temperatures, maximum interpass temperature verification is proposed to be accomplished by performing heat transfer calculations or by performing temperature measurement on a test coupon that is no thicker than the bottom head and CRD housing wall thickness. The test coupon welding would use the maximum heat input permitted by the applicable welding procedure specification.

5B. Basis for Relief:

Direct interpass temperature measurement is impractical to perform during welding operations from inside the CRD housing penetration bores. Interpass temperature measurements cannot be accomplished due to the physical configuration and the inaccessibility of the weld region during welding.

For this repair, the maximum interpass temperature will be determined by one of the following methods:

(1) Heat-flow calculations, using at least the variables listed below:
   (a) Welding heat input
   (b) Initial base material temperature
   (c) Configuration, thickness, and mass of the item being welded
   (d) Thermal conductivity and diffusivity of the materials being welded
   (e) Arc time per weld pass and delay time between each pass
   (f) Arc time to complete the weld

(2) Measurement of the maximum interpass temperature on a test coupon that is no thicker than the item to be welded. The maximum heat input of the welding procedure shall be used in welding the test coupon.

This methodology is consistent with the associated requirements specified in Code Case N-638-4. Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 16, dated October 2010, lists ASME Code Case N-638-4 as a conditionally accepted ASME Code Section XI code case. The approval conditions noted in the regulatory guide do not impact requirements for performing maximum interpass temperature verification as described in Code Case N-638-4 and herein.

6A. Proposed Alternative: Rotary Peening

Code Case N-606-1, Paragraph 1(f), prohibits peening of the final weld layer.

NMPNS requests relief from this restriction to allow portions of the final weld surface and the heat affected zone in the lower CRD housing to be rotary peened after acceptance NDE has been performed. The rotary peening process will decrease the susceptibility of the weld and adjacent stainless steel CRD housing base material heat affected zone to intergranular stress corrosion cracking (IGSCC).

6B. Basis for Relief

Stainless steel is particularly susceptible to IGSCC in the CRD housing weld heat affected zone due to the potential for sensitization and high residual stresses from welding. The CRD housing is Type 304 stainless steel with a maximum allowable carbon content of 0.08 wt% and thus the heat-affected zone due to the repair weld is susceptible to sensitization. Tensile residual stresses created during welding are minimized by controlling the heat input. After welding and machining, the CRD housing heat affected zone exposed to the BWR environment will undergo a rotary peening remediation process to create a layer of compressive stress at the surface. The vertical face of the weld will also be subjected to the rotary peening.

X-ray diffraction testing of a mock-up of the proposed CRD housing repair was performed to determine the depth of the peening effects and to confirm the presence of residual compressive surface stresses in the CRD housing heat affected zone. Additionally, boiling magnesium chloride testing performed during qualification testing confirmed that the residual compressive stresses were sufficient to prevent IGSCC in the CRD housing heat-affected zone. Micro-hardness testing in the stainless steel weld metal and the stainless steel base material was also used to demonstrate the effectiveness of the rotary peening process. X-ray diffraction testing of the rotary peened mockup samples, one thermally aged and one not subjected to thermal aging, verified that the imparted residual compressive stresses are not significantly reduced due to BWR operating conditions.

E. IMPLEMENTATION SCHEDULE

Pursuant to 10 CFR 50.55a(a)(3)(i), NMPNS requests relief for the remaining term of the NMP1 renewed operating license, which expires on August 22, 2029. NMPNS has demonstrated that the criteria specified herein provide an acceptable level of quality and safety and therefore, the requested duration of the proposed alternative is justified.

F. PRECEDENTS:

Many precedents similar to that proposed for use at NMP1 on the use of the ambient temperature temper bead weld repair of control rod drive mechanism (CRDM) penetrations have occurred in the industry for pressurized water reactor (PWR) closure heads. A recent safety evaluation report (SER) was issued to Palisades Nuclear Plant (Accession No. ML060790061) and encompassed inspection limitations of the base metal adjacent to the new repair weld. Precedents for starting the 48-hour hold after the third temper bead layer have been established by various weld overlays, as documented in the SERs issued for San Onofre, Units 2 & 3 pressurizer surge line nozzle overlay relief request (ML073240437); Palo Verde, Units 1, 2, & 3 pressurizer spray, safety, and surge line nozzle overlays (ML071560008); and Diablo Canyon, Unit 2, pressurizer safety and surge line nozzle overlays (ML080110001).

G. REFERENCES:

1. ASME Boiler and Pressure Vessel Code, Section XI, 2004 Edition, no Addenda
2. Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique for BWR CRD Housing/Stub Tube Repairs," dated September 24, 1999
3. Regulatory Guide 1.147, Revision 16, Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1, October 2010
4. Letter from N. B. Le (NRC) to J. A. Spina (NMPNS), "Request for Additional Information for the Review of Nine Mile Point Nuclear Station, Units 1 and 2, Amended License Renewal Application (TAC Nos. MC3272 and MC3273)," dated November 2, 2005.
5. BWRVIP-58-A, "BWR Vessel and Internals Project, CRD Internal Access Weld Repair," EPRI, Palo Alto, CA, October 2005. 1012618
6. NRC Approval Letter for BWRVIP-58-A, "BWR Vessel and Internals Project, CRD Internal Access Weld Repair," dated March 10, 2006
7. EPRI Report 1013558, "Repair and Replacement Applications Center: Temperbead Welding Applications, 48-Hour Hold Requirements for Ambient Temperature Temperbead Welding," EPRI, Palo Alto, CA: 2006. (Accession No. ML070670060)
8. ASME Boiler and Pressure Vessel Code, Section III, 2004 Edition, no Addenda
9. ASME Boiler and Pressure Vessel Code, Section III, 1995 Edition, including Addenda through 1995

Figure 1 – Typical CRD Housing/Stub Tube Configuration

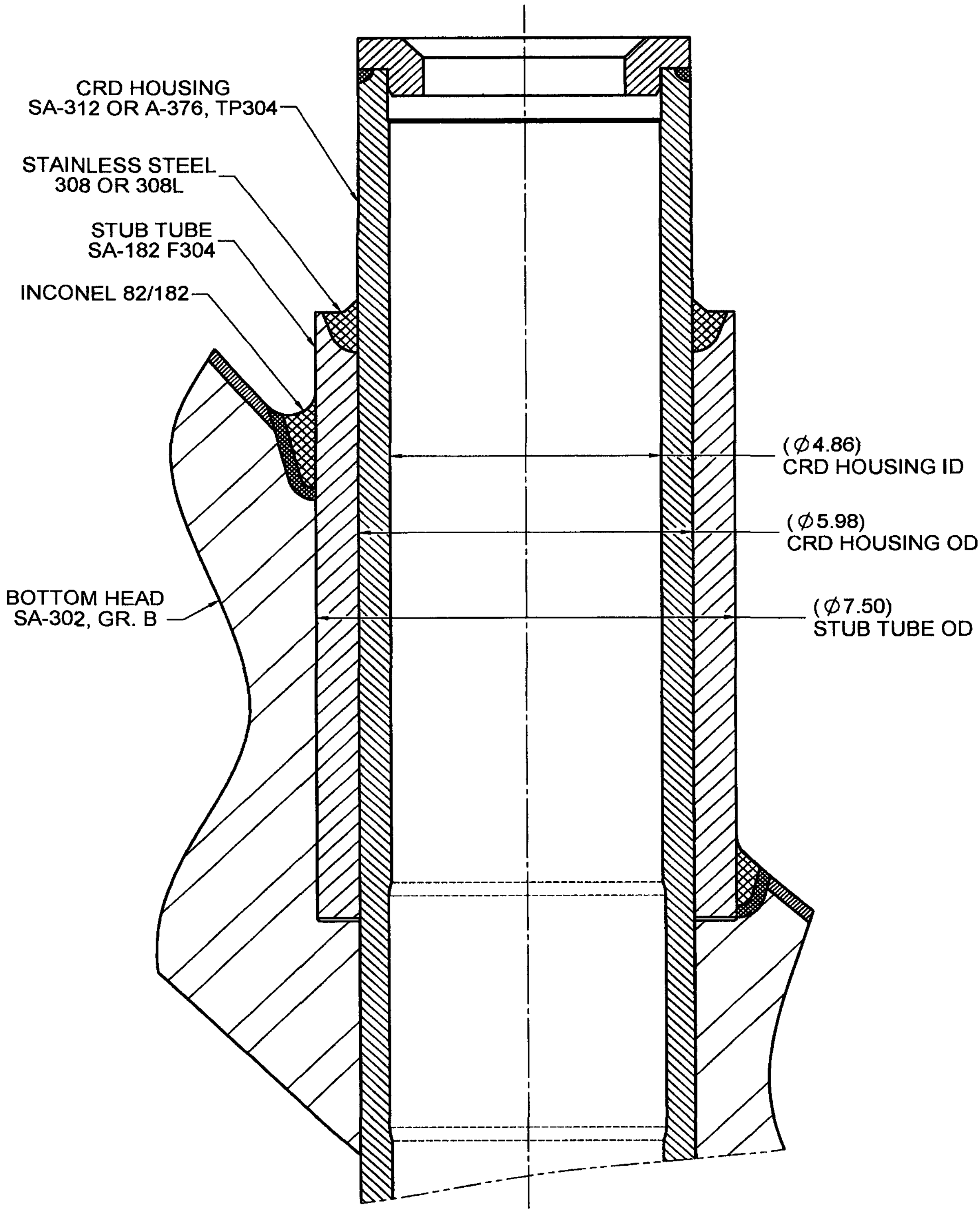
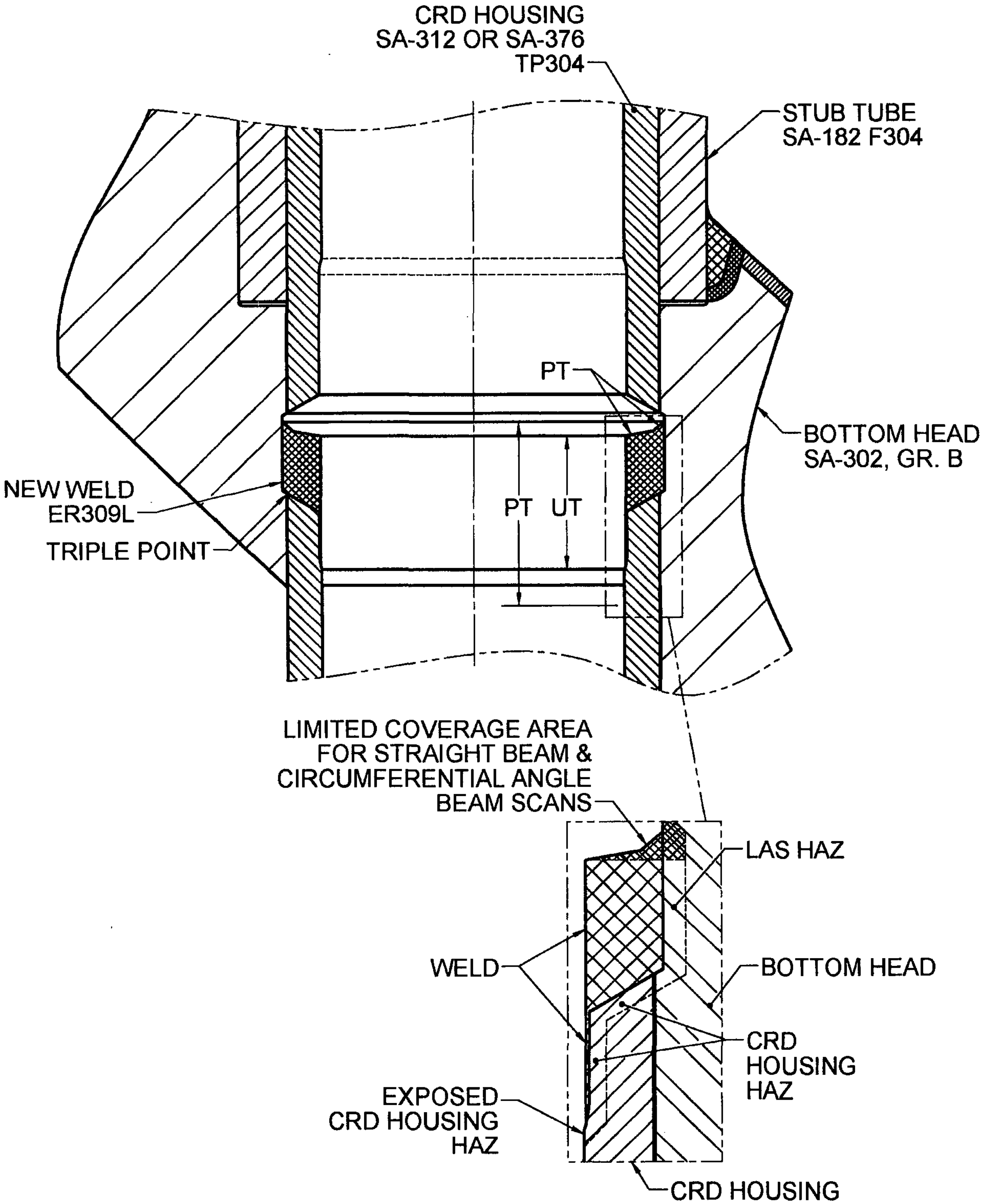


Figure 2 – Modified CRD Housing



ATTACHMENT 2

NINE MILE POINT NUCLEAR STATION, UNIT 1

CRD HOUSING PENETRATION REPAIR

DESCRIPTIONS AND JUSTIFICATIONS FOR

VARIATIONS FROM THE BWRVIP-58-A GUIDELINES

Nine Mile Point Nuclear Station, LLC
March 4, 2011

Purpose

This attachment provides the technical justifications for specific variations to BWRVIP-58-A (Reference 1). This attachment is applicable to the Control Rod Drive Housing (CRDH) penetration repair in the reactor vessel (RV) bottom head to be implemented, if necessary, during future plant outages at Nine Mile Point Unit 1 (NMP1).

Discussion

There are one hundred twenty-nine (129) CRDH penetrations in the bottom head of the NMP1 RV. Each penetration consists of a stainless steel stub tube that is attached to the inside surface of the RV bottom head with a NiCrFe weld and an inner stainless steel CRDH attached to the top end of the stub tube with a stainless steel weld. During RV fabrication, the stainless steel stub tube became furnace sensitized due to a post weld stress relief heat treatment. Through-wall cracking has occurred in some stub tubes during service. The cracking has resulted in reactor coolant leakage from the RV through the gap between the CRDH outside surface and the RV bottom head penetration bore. Repairs have been previously performed by roll expanding the CRDH in the bore to eliminate the gap and stop or limit the reactor coolant leakage. In the event that roll expansion does not seal the CRDH penetration and stop the leak, a repair shall be performed based on BWRVIP-58-A as depicted in Figure 1 with variations thereto as discussed and justified herein.

The CRDH penetration repair consists of a new pressure boundary weld being established on the inside surface of the groove machined through the existing CRDH wall thickness. A new weld is applied, attaching only the top of the lower portion of the severed CRDH and the RV bottom head penetration bore. The new weld is dissociated from the existing upper portion of the CRDH as depicted in Figure 2. The upper portion of the CRDH remains in place.

Variations and Justifications

Each of the specific variations to BWRVIP-58-A, the justification supporting each variation, and the impact of BWRVIP-58-A are provided in Table 1.

References

1. BWRVIP-58-A: BWR Vessel and Internals Project, CRD Internal Access Weld Repair, EPRI, Palo Alto, CA: 2005. 1012618
2. AREVA NP, Inc. Document No. 32-9036481 (Revision 001), "NMP Stub Tube Repair Thermal Cycling"
3. AREVA NP, Inc. Document No. 33-9143510 (Revision 000), "Nine Mile Point Unit 1, CDR for Control Rod Drive Housing Dissociated Weld Repair"
4. AREVA NP, Inc. Document No. 32-9138065 (Revision 001), "NMP1, CRD Housing IDTB Weld Anomaly Analysis"
5. American Society of Mechanical Engineers, Boiler and Pressure Vessel Code Section III, Rules for Construction of Nuclear Power Plant Components, 2004 Edition, no Addenda
6. ASME Code Case N-730, "Roll Expansion of Class 1 Control Rod Drive Bottom Head Penetrations in BWRs, Section XI, Division 1"
7. American Society of Mechanical Engineers, Boiler and Pressure Vessel Code Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 2004 Edition, no Addenda
8. AREVA NP, Inc. Document No. 32-9137580 (Revision 000), "NMP1 CRDH Repair – CRD Design Function Assessment"
9. AREVA NP, Inc. Document No. 32-9146490 (Revision 002), "NMP-1 CRDH Environmentally-Assisted Fatigue Analysis"
10. Materials Reliability Program: Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application (MRP-47, Revision 1). EPRI, Palo Alto, CA: 2005
11. Code Case N-606-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique for BWR CRD Housing/Stub Tube Repairs, Section XI, Division 1"
12. American Society of Mechanical Engineers, Boiler and Pressure Vessel Code Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition, no Addenda
13. American Society of Mechanical Engineers, Boiler and Pressure Vessel Code Section III, Rules for Construction of Nuclear Power Plant Components, 1995 Edition, including Addenda through 1995
14. AREVA NP, Inc. Document No. 51-9139652 (Revision 001), "Nine Mile Point 1 – CRDH Stub Tube Repair – Roto Peening Test Plan"
15. AREVA NP, Inc. Document No. 51-9133971(Revision 001), "Corrosion Evaluation for Nine Mile Point Unit 1 Control Rod Drive Housing Modification"
16. BWRVIP-60-A: BWR Vessel and Internals Project, Evaluation of Stress Corrosion Crack Growth in Low Alloy Steel Vessel Materials in the BWR Environment, EPRI, Palo Alto, CA: 2003. 1008871
17. AREVA NP, Inc. Document No. 55-WP3/8/F6TBSCa3 (Revision 001), "Welding Procedure Specification"
18. AREVA NP, Inc. Document No. 32-9146818 (Revision 000), "NMP-1 LAS SCC/SICC Evaluation"

BWRVIP-58-A Requirement & Variation Description	TABLE 1 Reason for Variation, Technical Justification, and Impact to BWRVIP-58-A
ITEM 1 **Requirement** Weld attaches both upper and lower portions of the CRDH to the RV bottom head penetration bore. **Variation** Modified weld attaches lower portion only of the CRDH to the RV bottom head penetration bore.	**Reason** 1. The triple point solidification anomaly susceptibility at the intersection of the top of the weld and the low alloy steel (LAS) bottom head and the stainless steel upper portion of the CRDH has been removed and therefore its exposure to the BWR coolant due to leakage past the roll expanded portion of the CRDH has been eliminated. 2. The upper portion of the CRDH is no longer axially restrained at both ends. **Justification** 1. The probability of anomaly growth is reduced since the upper triple point has been eliminated and therefore not exposed to the BWR coolant. 2. Many similar repairs have been performed successfully on PWR RV closure head control rod drive mechanism (CRDM) nozzle penetrations. 3. CRDH dimensional requirements are established to provide for proper CRD performance. 4. Appropriate distortion and displacement measurements recorded during welding on representative mockups verify compliance with dimensional requirements. 5. Appropriate evaluations [Ref. 8] have been performed to verify the necessary structural integrity of the upper portion of the CRDH using its roll expanded length and its capability to provide the necessary alignment to provide for proper CRD performance. 6. Thermal mixing due to the modified configuration has been evaluated and verified not to be a credible event and does not adversely affect the structural integrity [Ref. 2]. 7. Stress analyses [Ref. 3] and flaw growth evaluations [Ref. 4] have been performed for the dissociated weld configuration to verify its structural integrity as follows: a) The primary stress intensities P_m and (P_m+P_b) are shown to comply with the ASME Code Section III [Ref. 5] allowables. b) The (Primary + Secondary) stress intensity ranges for the vessel and CRDH are shown to comply with the ASME Code allowable limit of $3S_m$, after removing the thermal bending per ASME Section III, NB-3228.5. The Primary + Secondary stress intensity range for the new weld exceeds the allowable stress intensity range of $3S_m$ by a small amount, after removal of thermal bending and is therefore justified using ASME Section III, NB-3228.4. c) The highest usage factor is acceptable (less than unity) as specified in ASME Section III, NB-3222.4. d) The requirement of ASME Section XI Code Case N-730 [Ref. 6] with regard to remaining upper CRDH roll expanded length is shown to be satisfied. e) No leakage paths occur in the roll expanded length due to transients. f) Several potential flaw propagation paths are considered in the flaw evaluations. Flaw acceptance is based on the Section XI [Ref. 7] criteria for applied stress intensity factor (IWB-3612) and limit load (IWB-3642). g) The analysis demonstrates that the 0.10 inch weld anomaly is acceptable for a 30 year design life. h) The minimum fracture toughness margins exceed the code required margins of $\sqrt{10}$ for normal/upset conditions and $\sqrt{2}$ for emergency/faulted conditions per IWB-3612. i) A limit load analysis with stable crack extension (Z-factors) has been performed considering the ductile repair weld material. The analysis shows that for the postulated circumferential flaw the minimum margin is based on applied stress and for the axial flaw the minimum margin is based on flaw depth. In both cases the results comply with the limits specified in IWB-3642.

BWRVIP-58-A Requirement & Variation Description	**TABLE 1 Reason for Variation, Technical Justification, and Impact to BWRVIP-58-A**
ITEM 1 (CONT'D)	j) An assessment of environmentally-assisted fatigue (EAF) was performed [Ref. 9] using the bounding F_{en} methodology presented in MPR-47 [Ref. 10]. The EAF adjusted fatigue usage factors are below the limit of 1.0. 8. The potential for stress corrosion cracking of the RV bottom head LAS was evaluated [Ref. 18] and verified to maintain the structural integrity of the modified configuration for the remaining NMP1 service life. Crack growth rates were determined based on review of existing crack growth rate models from Section XI [Ref. 7] for fatigue and BWRVIP-60-A [Ref. 16] for strain induced corrosion cracking (SICC). 9. Corrosion evaluation [Ref. 15] was performed considering all potentially applicable corrosion mechanisms that may adversely affect the design life of the modified configuration and were considered in the stress analyses and fracture mechanics analyses. 10. An Operability Assessment [Ref. 8] was performed. Operability of the CRD as impacted by the weld repair of the CRDH was assessed. The assessment considered the effects of the following: a) The structural integrity of the weld-repaired configuration, b) Alignment of the CRD path, c) Seismic displacements, d) Flow-induced vibration, e) Design Basis Accident events, and f) CRD coolant bypass/leakage. Based on this assessment, it is concluded that CRD functionality/operability will be maintained with the welded CRDH repair in place, including in the condition with a postulated 360° through-wall crack in the stub tube. **<u>Impact of the Variation on Meeting the Intent of the BWRVIP Guidance</u>** None.

BWRVIP-58-A Requirement & Variation Description	TABLE 1 Reason for Variation, Technical Justification, and Impact to BWRVIP-58-A
ITEM 2 **Requirement** The weld filler metal is ERNiCrFe-7. Welding procedure qualification is in accordance with Code Case N-606-1 [Ref. 11] and IWA-4630, Section XI, 1995 Edition, no Addenda [Ref. 12]. **Variation** The modified weld filler metal is ER309L. Welding procedure qualification is in accordance with Code Case N-606-1 and IWA-4630, Section XI, 2004 Edition, no Addenda.	**Reason** The ER309L welding filler metal has superior weldability characteristics for this application when compared to ERNiCrFe-7. **Justification** 1. Since the weldability characteristics of this filler metal are superior to ERNiCrFe-7, there is increased probability of higher weld quality resulting from its use. 2. The ER309L is not prone to cracking because of its ferrite level, even on high sulfur austenitic stainless steel. 3. ER309L has a lower propensity to hot cracking. It is not prone to stress corrosion cracking because of its high chrome and delta ferrite content. 4. Stress analysis [Ref. 3] and flaw growth evaluation [Ref. 4] have been performed to verify the structural integrity of the modified weld configuration based on this material's S_m values and flaw growth characteristics. 5. The welding procedure specification is qualified [Ref. 17] with the ER309L weld filler metal consistent with the qualification performed in BWRVIP-58-A for the ERNiCrFe-7 weld filler metal. 6. The Section XI welding procedure qualification requirements are the same for both Section XI versions. 7. Stresses on the weld during plant operation have been verified acceptable by stress analysis [Ref. 3] using the lower S_m values for stainless steel ER309L versus ERNiCrFe-7 for the weld and lower portion of the CRDH. **Impact of the Variation on Meeting the Intent of the BWRVIP Guidance** None.

BWRVIP-58-A Requirement & Variation Description	TABLE 1 Reason for Variation, Technical Justification, and Impact to BWRVIP-58-A
ITEM 3 **Requirement** The postulated triple point solidification anomaly to be evaluated is 0.05 in. in length at both the upper and lower triple points. This size is within the detection and sizing capabilities of the applicable ultrasonic examination procedure. **Variation** The postulated triple point solidification anomaly to be evaluated is 0.10 in. in length at the lower triple point. The acceptance criterion has been changed to permit solidification anomaly sizes of 0.10 in. at the lower triple point.	**Reason** The increased solidification anomaly size is to further minimize the possibility of weld repairs being needed during the repair activities. **Justification** 1. When using ER309L weld filler metal, solidification anomalies are expected to be smaller and occur less frequently than when using ERNiCrFe-7 weld filler metal, for this application. However, to increase conservatism, a solidification anomaly flaw size of 0.10 in. long has been evaluated [Ref. 4] to verify acceptability. 2. ASME Section III NB-5000 acceptance criteria generally apply. All indications greater than 20% of the reference level (Distance Amplitude Curve - DAC) are recordable regardless of location and evaluated to NB-5330 acceptance standards. However, recordable indications at the triple point that extend up to 0.10 in. in any direction are bounded by analysis [Ref. 4] and are therefore acceptable. Indications at the triple point that extend greater than 0.10 in. are rejectable. **Impact of the Variation on Meeting the Intent of the BWRVIP Guidance** None. The intent of BWRVIP-58-A has been met since flaw growth evaluations for the postulated flaws have been performed to verify the structural integrity of the modified configuration for the design life with a postulated flaw size of 0.10 in. instead of 0.05 in. that was postulated in BWRVIP-58-A.

BWRVIP-58-A Requirement & Variation Description	TABLE 1 Reason for Variation, Technical Justification, and Impact to BWRVIP-58-A
ITEM 4 **Requirement** Ultrasonic examination (UT) scanning includes scanning from the entire weld face and from the inside surface of the CRDH interrogating the weld and most of the LAS bottom head heat affected zones (HAZ). UT was performed on the mockup using NB-5000, Section III, 1995 Edition, 1995 Addenda [Ref. 13] acceptance criteria. **Variation** Due to the modified weld configuration UT scanning and coverage is reduced. Scanning from the inside surface of the lower portion only of the CRDH results in more limited interrogation of the weld and LAS bottom head HAZ. UT will be performed using NB-5000, Section III, 2004 Edition, no Addenda acceptance criteria.	**Reason** Limited UT coverage of the LAS volume beneath the weld taper or the weld taper volume can be accomplished due to the weld geometry and the ultrasonic beam angles that are used for examination. Also, only single-sided UT scanning from the weld ID and the ID of the lower CRDH can be performed. Tables 2 and 3 list the coverage for the weld configuration to be used at NMP1. Table 2 lists the coverage provided by each of the beam angles that were used for the original UT procedure demonstration for CRDH repair per BWRVIP-58-A. Table 3 lists the coverage provided by each of the beam angles that were used for the UT procedure demonstration for PWR RV CRDM nozzle penetration repairs. The CRDM nozzle penetration repair configuration is very similar to the dissociated configuration for NMP1; therefore, the same beam angles will be used. It should be noted that the combination of beam angles used together for each demonstrated procedure provide maximum coverage of the examination zone. The radial beam directions (listed in Tables 2 and 3 as the 0 degree probe angle) provide for detection of laminar type flaws such as inter-bead lack of fusion and under-bead cracking. Complete coverage of the CRDH HAZ is accomplished. However, only partial coverage of the weld and LAS HAZ is accomplished. A blind zone exists beneath the tapered region of the weld for both the weld and the LAS HAZ because transducer contact in this region cannot be achieved (see Figure 3). The circumferential beam directions (listed in Tables 2 and 3 as the clockwise and counter clockwise direction) provide for detection of axially oriented flaws. Complete coverage of the CRDH HAZ is accomplished, but only partial coverage of the weld and LAS HAZ is accomplished. A blind zone exists beneath the tapered region of the weld for both the weld material and the LAS HAZ because transducer contact in this region cannot be achieved (see Figure 3). The axial beam directions (listed in Tables 2 and 3 as the up and down beam directions) provide for detection of circumferentially oriented flaws. Complete coverage of the weld and CRDH HAZ is accomplished. However, only partial coverage of the LAS HAZ is accomplished. Even though the "down" beam direction shows limitations on coverage of the weld and housing HAZ it can be demonstrated that detection of the relevant flaws can be accomplished with the combination of the up and down axial beam directions. **Justification** 1. The UT and supplemental surface examination, that covers the entire weld surface and HAZ exposed to the BWR environment, provides sufficient assurance of weld quality. Furthermore, the reduced UT coverage has been accepted by the NRC for similar PWR RV closure head CRDM nozzle penetration repair configurations. 2. The axial scan angles using 45 degree and 70 degree transducers are essentially the same as the 52 degree and 60 degree angle transducers used for axial scanning in BWRVIP-58-A. **Impact of the Variation on Meeting the Intent of the BWRVIP Guidance** There is no impact of this deviation on meeting the intent of the BWRVIP guidance. Although the UT coverage is reduced as compared to the BWRVIP-58-A coverage, adequate coverage exists to demonstrate structural integrity of the repair.

BWRVIP-58-A Requirement & Variation Description	**TABLE 1** **Reason for Variation,** **Technical Justification, and Impact to BWRVIP-58-A**
ITEM 5 **Requirement** Abrasive waterjet machining (AWJM) is used for severing, weld prep forming and final machining. **Variation** Conventional machining will be used for severing, weld prep forming and final machining. Rotary peening will be performed.	**Reason** 1. Improved dimensional controls are more readily achievable using conventional machining methods. 2. The abrasive waste is eliminated. 3. Rotary peening is performed on the final machined surfaces of the new weld and lower portion of the CRDH, extending to below the roll expanded transition of the lower portion of the CRDH, to impart residual compressive stresses thereon. Rotary peening reduces susceptibility to stress corrosion cracking, in the BWR environment, of austenitic stainless steel weld HAZ where high tensile stresses exist. **Justification** 1. Conventional machining is qualified consistent with the AWJM qualification in BWRVIP-58-A. 2. Rotary peening has been properly qualified in accordance with a test plan [Ref. 14] and included the following on representative mockups using insitu machining, welding and rotary peening parameters as applicable: a) Magnesium chloride testing to demonstrate SCC resistance of rotary peened surfaces. b) X-ray diffraction (XRD) measurements to quantify magnitudes and associated depths of residual compressive stress resulting from rotary peening. c) Micro-hardness testing in the stainless steel weld metal and the stainless steel base material was also used to demonstrate the effectiveness of the rotary peening process. d) X-ray diffraction testing performed on rotary peened mockup samples, one that was subjected to thermal aging (550°F for 100 hr) after rotary peening and the other that had not been subjected to thermal aging, verified that the imparted residual compressive stresses are not significantly reduced due to BWR operating conditions. **Impact of the Variation on Meeting the Intent of the BWRVIP Guidance** None.

Table 2 – UT Coverage Limitations for Original CRD Procedure Beam Angles				
Probe Angle	**Beam Direction**	**Examination Area Estimated Coverage**		
		Weld	**CRDH & HAZ***	**LAS HAZ****
0°	Radial	92%	100%	73%
45°	CW/CCW	92%	100%	73%
52°	Up	100%	100%	73%
52°	Down	49%	100%	0%
60°	Up	100%	100%	64%
60°	Down	42%	98%	0%

Table 3 – UT Coverage Limitations for Current CRD Procedure Beam Angles				
Probe Angle	**Beam Direction**	**Examination Area Estimated Coverage**		
		Weld	**CRDH & HAZ***	**LAS HAZ****
0°	Radial	92%	100%	73%
45°	CW/CCW	92%	100%	73%
45°	Up	100%	100%	82%
45°	Down	58%	100%	5%
70°	Up	98%	100%	41%
70°	Down	30%	88%	0%

Notes:
*CRDH full thickness extending to 1 inch below weld prep bevel.
** ¼ inch depth beneath weld.

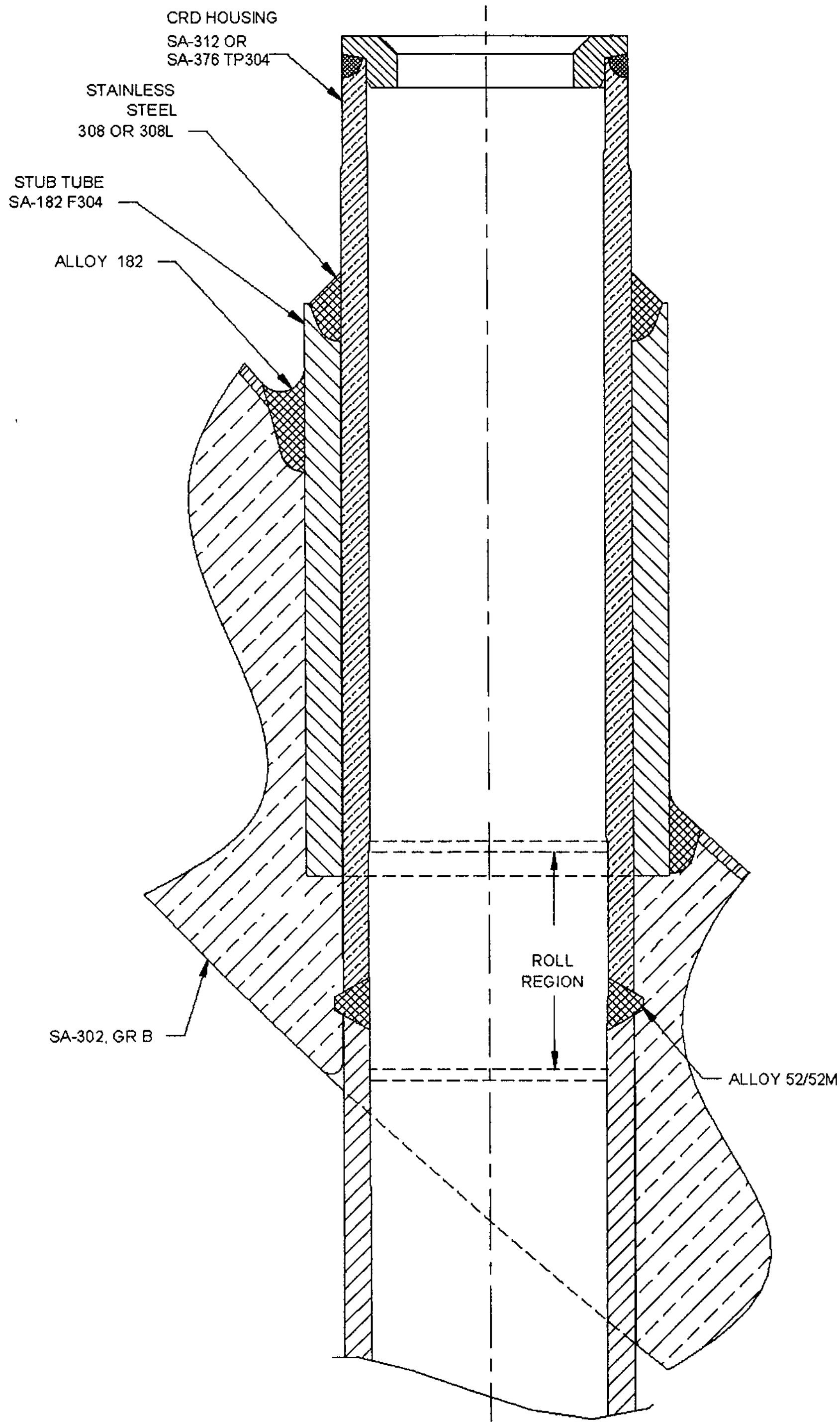


FIGURE 1 – BWRVIP-58-A CRDH Internal Access Weld Repair

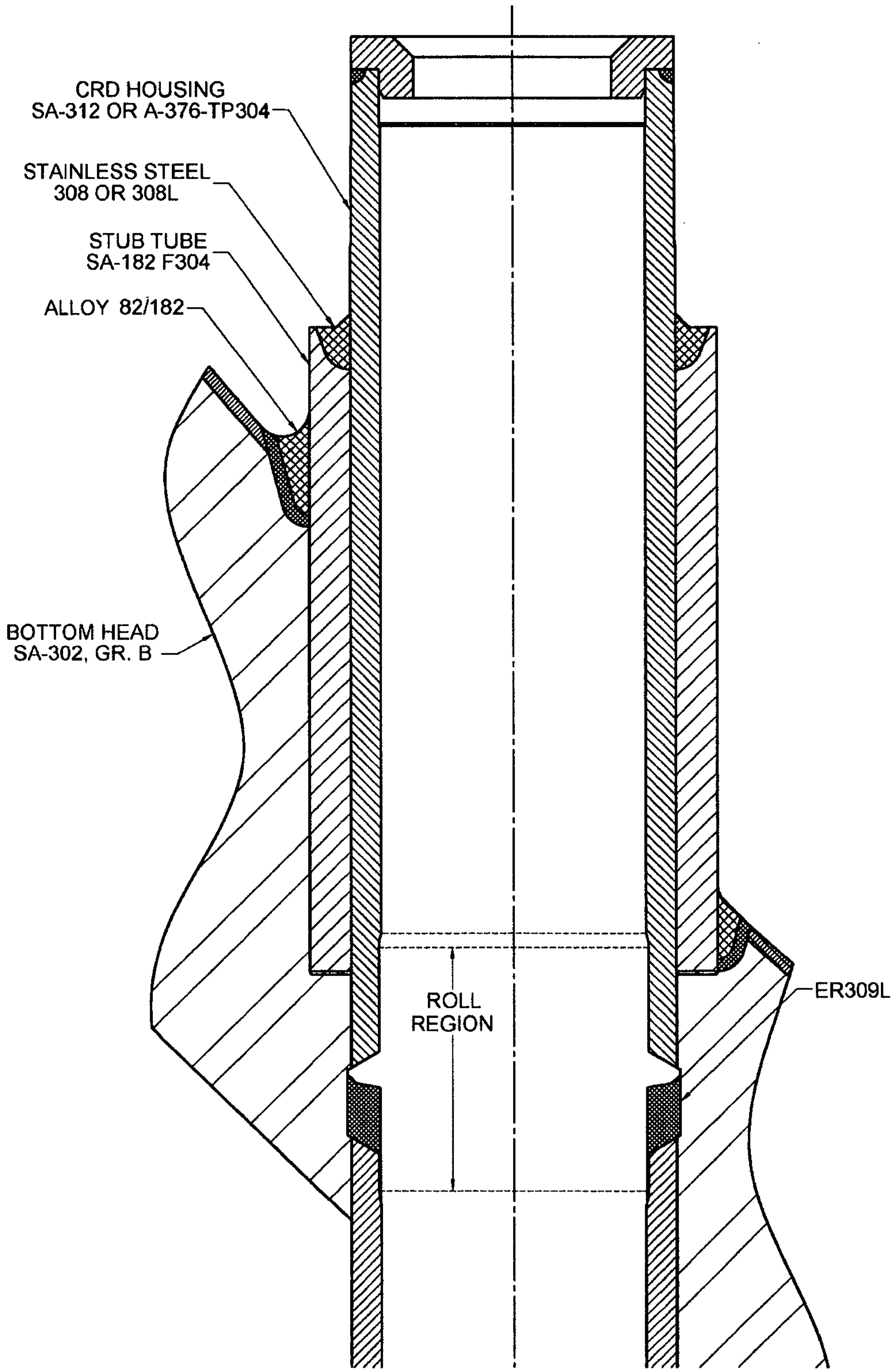


FIGURE 2 – Dissociated BWRVIP-58-A CRDH Internal Access Weld Repair

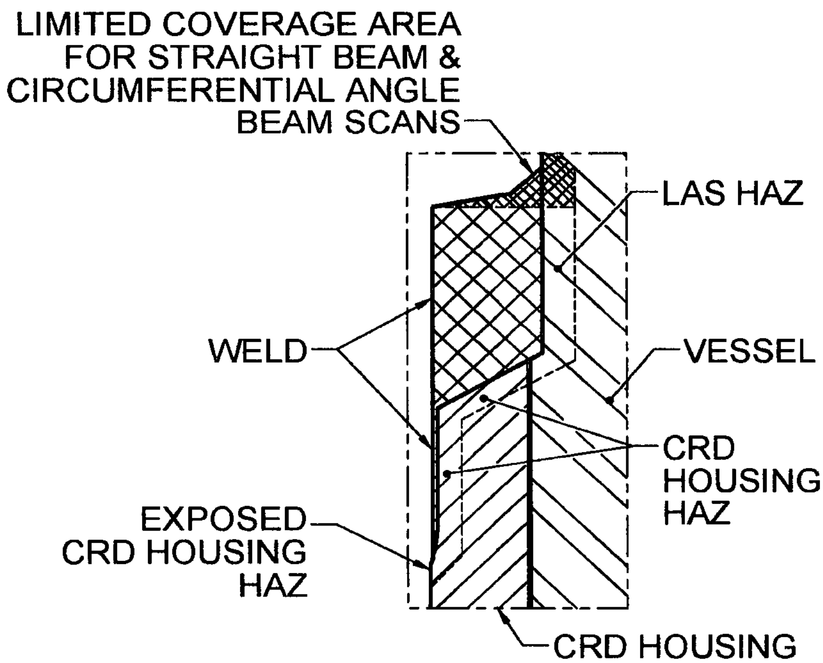


FIGURE 3 – Illustration of Examination Zones for UT