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An Exelon/British Energy Company

10 CFR 50.55a

November 3, 2003
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U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Three Mile Island, Unit 1
Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Proposed Alternative Associated with the Use of a Weld Overlay

Dear Sir or Madam:

In accordance with 10 CFR 50.55a, "Codes and standards," paragraph (a)(3)(i), AmerGen Energy Company, LLC (AmerGen) is submitting a proposed alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components." This proposed alternative would permit the use of a full structural weld overlay repair for an indication identified in the steam generator "A" hot leg surge line nozzle-to-safe end weld.

The Three Mile Island, Unit 1 Third Ten-Year Interval Inservice Inspection (ISI) Program complies with the requirements of the 1995 Edition through 1996 Addenda, of the ASME, Section XI Code. The third 10-year interval began on April 20, 2001 and is projected to end April 19, 2011.

Due the need to obtain approval of this alternative prior to startup of the unit from the current outage, we are requesting your review and approval prior to initial reactor coolant system pressurization, which is currently scheduled to occur on November 14, 2003

If you have any questions, please contact us.

Very truly yours,

Michael P. Gallagher

Michael P. Gallagher
Director, Licensing and Regulatory Affairs
AmerGen Energy Company, LLC

Attachment – Relief Request

cc: H. J. Miller, Administrator, Region I, USNRC
USNRC Senior Resident Inspector, TMI
T. Colburn, USNRC Senior Project Manager
File No. 01086

A047

THREE MILE ISLAND, UNIT 1
REGARDING ALTERNATIVE REPAIR FOR SURGE NOZZLE-TO-SAFE END WELD

ASME CODE COMPONENTS AFFECTED

Code Class:	Class 1
Reference:	ASME Section XI, 1995 Edition, through the 1996 Addenda ASME Section XI, Case N-504-2 ASME Section XI, Case N-638
Examination Categories:	B-J
Item Number:	B9.11
Description:	Alternative Welded Repair For Surge Nozzle-To-Safe End Weld With Alloy 182/82 Weld Filler Material and/or Buttering
Component Numbers:	Surge Nozzle to OTSG "A" Generator Hot Leg

APPLICABLE CODE EDITION AND ADDENDA

The Three Mile Island, Unit 1 Third Ten-Year Interval Inservice Inspection (ISI) Program complies with the requirements of the 1995 Edition through 1996 Addenda, of the ASME, Section XI Code. The third 10-year interval began on April 20, 2001 and is projected to end April 19, 2011.

APPLICABLE CODE REQUIREMENTS

The following paragraphs or statements are from ASME Boiler and Pressure Vessel Code (Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 1995 Edition, through the 1996 Addenda, which identify the specific requirements included in this alternative:

1. IWA-4410 states – Repair/replacement activities shall be performed in accordance with the Owner's Requirements and the original Construction Code of the component or system, except as provided in IWA-4410(b), (c), and (d).

2. IWA-4520 (a) states – Welding or brazing areas and welded joints made for installation of items shall be examined in accordance with the Construction Code identified in the Repair/Replacement Plan.

3. IWA-4530(a) states in part – When portions of items requiring pre-service or inservice inspection are affected by repair/replacement activities, or for items being installed, including welded joints made for installation of items, pre-service inspections shall be performed in accordance with IWB-2200.

4. IWA-4540(a) states – After welding on a pressure retaining boundary or installation of an item by welding or brazing, a system hydrostatic test shall be performed in accordance with IWA-5000.

BACKGROUND

a. Discovery

During the 1R15 ISI examinations, a dissimilar metal weld No. SR0010BM was examined as part of scheduled ISI population. This weld is a Section XI examination category B-J, Item No. B9.11 weld. This weld connects a 10" schedule 140, A-105 Gr 2 carbon steel nozzle, to an A-336 Class F8M stainless steel safe end (similar to type 316). The function of the nozzle is to connect the pressurizer surge line to the OTSG "A" 36" hot leg. Figure 2 identifies the materials of the nozzle-to-safe end.

Weld No. SR0010BM was examined manually using a Performance Demonstration Initiative (PDI) dissimilar metal qualified ultrasonic testing (UT) procedure and technician for detection. The weld was examined from four directions for detection of circumferential and axial indications, using exam angles 45RL and 60RL. As a result of this examination, an axial indication at approximately 25 degrees clockwise from top dead center looking into the nozzle, was identified. Based on the UT examination, the axial indication extends from the nozzle 182/82 butter to the 182/82 weld. The indication is ID connected. The manual UT method under the PDI rules is not qualified to size the indication's through-wall dimension, however, it does not extend to the OD as verified by a surface examination (PT). The surface examination of the weld surface was performed for 360 degrees of the weld, with no indications identified.

The axial indication and surrounding weld material were ultrasonically investigated using 1MHz and 2MHz, 45° and 60° longitudinal search units and a 1.5MHz, 45° shear wave search unit. Good signal-to-noise (2-to-1) response was obtained from the indication with each probe from two directions. The indication is connected to the inside surface and exhibits unique ultrasonic response features that have been associated with known stress corrosion cracking e.g. multi-faceted, inconsistent time base positions, flaw tip signals, etc. A 0° longitudinal search unit was employed in an attempt to identify ultrasonic responses typical of fabrication flaws. Intensive interrogation in the weld regions surrounding the axial indication did not provide any additional information.

The area of the weld that exhibited a potential circumferential indication of approximately 1" in length was also examined with the techniques defined in the PDI Generic Procedure (PDI-UT-10, Rev. A). The circumferential indication was recorded and dispositioned as being associated with the butter interface and is not indicative of a planar flaw. This indication did not exhibit ultrasonic responses indicative of stress corrosion cracking.

EPRI personnel were requested to provide on-site assistance with an independent review of the hot leg surge line nozzle to pipe weld examinations and results. Results of this evaluation support the vendor's reporting the presence of an axial indication in the hot leg surge line nozzle-to-pipe weld. Evidence to support the evaluation of the axial indication was provided by ultrasonic responses from multiple beam angles, wave modes, and beam directions. EPRI's independent evaluation of the suspected circumferential indication supported the vendor's disposition of this area as being associated with the butter interface and is not indicative of a planar flaw.

An additional 360 degree automated, PDI qualified, UT examination will be performed to verify the previous manual results and to characterize the depth of the axial indication.

b. Degradation Mechanism

The following is a discussion of the degradation mechanism responsible for the indication identified on the surge line to hot leg nozzle weld. The two most probable mechanisms are primary water stress corrosion cracking (PWSCC) or thermal fatigue. As discussed below, evidence suggests that PWSCC, and not thermal fatigue, was the responsible degradation mechanism.

The ultrasonic testing (UT) results indicated that the flaw was oriented axially, multifaceted and confined to the nickel alloy weld metal, i.e., there was no evidence that the indication was present in the adjacent stainless steel or carbon steel. If the flaw was a result of a thermal fatigue mechanism, the above three observations would not have been made, i.e., the flaw would be more likely oriented circumferentially, would be single faceted and not be confined to the nickel weld metal. While nickel-base alloys, stainless steels and carbon steels are susceptible to fatigue degradation in PWR environments, only nickel-base alloys are susceptible to PWSCC.

The location of the indication identified on the surge line to hot leg nozzle weld is not consistent with thermal fatigue.

c. Similar PWR Experience

The observed defect at TMI, Unit 1 is consistent with the documented PWSCC observed at V. C. Summer in October of 2000 where Type 304N stainless steel Reactor Coolant System (RCS) piping was welded to alloy steel nozzle with Alloys 82 and 182. Axial cracks were also discovered at Ringhals 3 and 4 and most recently at Tihange 2. As is the case with TMI, the flaw was axial and confined within the nickel alloy weld metals.

The above discussion and the present results indicate that PWSCC, and not thermal fatigue, was the responsible mechanism for the indication identified at TMI, Unit 1.

d. Technical Approach for Addressing Fatigue Effects for TMI Hot Leg Surge Nozzle Weld Overlay

To address fatigue and fatigue crack growth effects for the weld overlay at the TMI hot leg nozzle, the loadings will be those developed for the B&W Owners Group in responding to NRC Bulletin 88-11.

The evaluations will consider stresses due to a number of different loading sources:

- Moments will be developed at the hot leg nozzle location due to RCS nozzle thermal expansion movements, surge line thermal expansion and surge line stratification.
- The surface and through-wall stresses at the weld overlay location will be developed that occur due to local stratification at the nozzle and local temperature change transients.
- Local residual stresses (including original fabrication repairs) will be determined at the overlay and weld locations due to weld shrinkage and application of the overlay.
- Although expected to be small, piping shrinkage-induced stresses at the hot leg nozzle, due the weld overlay application, will also be determined.
- Pressure stresses will be determined at the weld overlay region.
- Dead weight and seismic loadings will be per the original surge line analysis.
- Thermal striping will be accounted.

Based on these stress distributions, fatigue crack growth analysis will be conducted for a postulated flaw 10% of the pipe thickness with an aspect ratio of 10:1 (l/a) circumferential on the inside surface. The flaw will be assumed to be located in the same region as the axial flaw. The number of operating cycles to grow the flaw to the Code allowable flaw size (just entering the overlay) will be determined.

Similar analysis will be conducted to evaluate the growth of the observed axial flaw. For this flaw, the measured depth will be used as the initial depth. However, since the only driving force is hoop stress pressure cycling, the fatigue crack growth of the axial flaw is not expected to be significant.

To address the potential for fatigue crack initiation at the location near the end of the overlay, a fatigue analysis will be conducted based on the design number of cycles, using the same stresses as described above. The evaluation will consider the location(s) where the stresses are most significantly changed by application of the weld overlay.

REASON FOR REQUEST

The "code acceptable" repair methods specified by ASME Section XI, IWA-4410, IWA-4520(a), IWA-4530(a), and IWA-4540(a) would involve the removal of Primary Water Stress Corrosion Cracking (PWSCC) flaws.

Pursuant to 10 CFR 50.55a(a)(3)(i), an alternative is requested on the basis that the proposed repair will provide an acceptable level of quality and safety.

PROPOSED ALTERNATIVE AND BASIS FOR USE

A full structural weld overlay repair is proposed for the nozzle-to-safe end weldments. The nozzle material is A-105, Gr 2, carbon steel. The safe end is austenitic stainless steel A-336 Type F8M (similar to Type 316). The weld filler material is Alloy 182/82.

The weld overlay will be designed consistent with the requirements of ASME Code Case N-504-2 ("Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping"). The weld overlay will extend around the full circumference of the nozzle-to-safe end weldment location as required by Code Case N-504-2. The specific thickness and length will be computed according to the guidance provided in ASME Section XI, Code Case N-504-2. The overlay will completely cover the indication with highly corrosion resistant Alloy 52 material that is highly resistant to PWSCC.

In order to accomplish this objective, it will be necessary to weld on the carbon steel nozzle material. A temper bead welding approach will be used for this purpose following the guidance of ASME Section XI Code Case N-638 ("Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique"). This code case provides for machine gas tungsten-arc welding (GTAW) temper bead weld repairs to P-No. 1 nozzle material at ambient temperature. The temper bead approach was selected because temper bead welding supplants the requirement for post weld heat treatment (PWHT) of the heat-affected zones in welded carbon steel material. Also, temper bead welding techniques produce excellent toughness and ductility in heat affected zones of welded carbon steel materials, and, in this case, result in compressive residual stresses on the inside surface, which help to inhibit PWSCC.

The same temper bead rules apply to P-No. 3, Group 3 and P-No. 1, Group 2 base materials. However the P-No.3, Group 3 base materials are significantly more susceptible to hardening as compared to the P-No. 1, Group 2 base materials.

The hot leg surge nozzle material (A-105 Grade II, P-No. 1 Group 2 material) upon which temper bead welding is to be performed has a carbon content of 0.31% ladle, 0.315% check If the carbon content were 0.30% or less, USAS B-31.7 would not require temper bead welding, preheat or PWHT for weld thicknesses of 3/4 in. or less on the surge nozzle and ASME III would not require pre-heat or post weld heat treatment for a component 1 ¼ in thick or less with a maximum carbon content of 0.30%. For weld thicknesses of less than 1 ½ inch, 200 degrees F minimum preheat temperature only, without PWHT is required.

A 48-hour post weld hold prior to acceptance inspection is required by the Code case N-638 and will be implemented to assure that no delayed cracking occurs.

All welders and welding procedures will be qualified in accordance with ASME Section IX and any special requirements from Section XI or applicable code cases. A manual shielded metal arc weld (SMAW) procedure will be qualified to facilitate localized repairs if required, and to provide a seal weld as necessary during the repair activities.

Code Case N-504-2 was approved for generic use in Regulatory Guide 1.147, Revision 13, and was developed for austenitic stainless steel material. An alternate application for nickel-based and carbon materials is proposed due to the specific configuration of the subject weldments. Therefore, we intend to follow the methodology of Code Case N-504-2, except for the following:

1. Paragraph (b) of Code Case N-504-2 requires that the reinforcement weld metal shall be low carbon (0.035%) maximum austenitic stainless steel. In lieu of the stainless steel filler material, a consumable welding wire highly resistant to Primary Water Stress Corrosion Cracking (PWSCC) has been selected for the overlay weld material. This material is a nickel-based alloy weld filler material, commonly referred to as Alloy 52, and will be applied using the machine gas tungsten arc welding (GTAW-AU) process. Alloy 52 contains about 30% chromium that imparts excellent corrosion resistance to this material. This filler material is suitable for welding over the carbon steel nozzle, Alloy 182/82 weld and the stainless steel safe end.

2. Paragraph (e) of Code Case N-504-2 requires as-deposited delta ferrite measurements of at least 7.5 FN for the weld reinforcement. Delta ferrite measurements will not be

performed for this overlay because weldment of Alloy 52 is 100% austenitic and contains no delta ferrite due to the high nickel composition (approximately 60% nickel).

3. Paragraph (h) of Code Case N-504-2 requires a system hydrostatic test of the completed repair if the flaw(s) penetrated the original pressure boundary or if there is any observed indication of the flaw penetrating the pressure boundary during repair. The ASME Section XI code requirements or alternatives approved by the NRC for pressure testing will be used in lieu of Paragraph (h).

Code Case N-638 was approved for generic use in Regulatory Guide 1.147, Revision 13, and was developed for similar and dissimilar metal welding using ambient temperature machine GTAW temper bead technique. We intend to follow the methodology of Code Case N-638, except for the following:

1. Paragraph 1(a) of Code Case N-638 requires the maximum finished area of an individual weld to be limited to 100 sq. in. and the depth of the weld to be not greater than one-half the ferritic base metal thickness. This condition may not be met because the design of the overlay weld may result in exceeding the Code Case limitations.

2. Paragraph 1(b) of Code Case N-638 limits repair/replacement activity on a dissimilar metal weld to those along the fusion line of a non-ferritic weld to ferritic base material on which 1/8 inch, or less of non-ferritic weld deposit exists above the original fusion line. This requirement is not applicable because the original circumferential groove weld will remain.

3. Section 4(b) of Code Case N-638 requires that the final weld surface and the band around the area of at least one and one-half times the component thickness or 5 in., whichever is less, be examined using a surface (PT) and ultrasonic method (UT). PT and UT of the weld overlay repair will be performed in accordance with the proposed pre-service inspection below.

In-process, pre-service inspection, and inservice inspection nondestructive examinations required for the weld overlay are identified in Tables 1, 2, and 3, respectively.

TABLE-1
IN-PROCESS NONDESTRUCTIVE EXAMINATION (NDE) REQUIREMENTS

Examination Description	**Method**	**Technique**	**Reference**	**Acceptance Standards**
Safe end, weld, and nozzle overlay surface preparation exam	PT	Liquid Penetrant	N-504-2, N-638	N-504-2, Paragraph (c)
1st/2nd layer of deposited weld reinforcement	Surface Exam.	PT	N-504-2	N-504-2, Paragraph (c)
Thickness measurement of the deposited weld reinforcement	Volumetric	UT-0°L	N-504-2, Repair Plan	Per weld overlay design

TABLE-2
PRE-SERVICE INSPECTION REQUIREMENTS

Examination Description	**Method**	**Technique**	**Reference**	**Acceptance Standards**
Completed weld overlay for complete bonding and minimum thickness	Volumetric	UT-0°L	N-504-2	Per weld overlay design
Examination of completed weld overlay and examination of the "band" 2 inches outward from the toe of the weld around the entire circumference of the nozzle after 48 hours	Surface Exam	PT	N-504-2, N-638	N-504-2, Paragraph (i), N-638, Paragraph 4.0(e)
Completed weld overlay and outer 25% of original nozzle and safe end thickness	Volumetric	UT angle beam per PDI procedure. Volume includes PDI volume, and additional 25% under the overlay as shown in Figure 1.	N-504-2, N-638	N-504-2, Paragraph (i), N-638, Paragraph 4.0(e)

TABLE-3
INSERVICE INSPECTION REQUIREMENTS

Examination Description	Method	Technique	Reference	Acceptance Standards	Re-inspection Frequency
Weld overlay and upper 25% of original nozzle & safe end base material	Volumetric	UT-Angle beam per PDI procedure, and exam volume per PDI procedure	ASME Section XI, Appendix VIII	No planar flaw extending into the structural weld overlay.	Exam next two refueling outages, and re-evaluate based on inspection results.
Surface examination of complete weld overlay surface	Surface Exam	PT	ASME Section XI	N-504-2, Paragraph (i), N-638, Paragraph 4.0(e)	Exam next two refueling outages, and re-evaluate based on inspection results.

Weld overlays have been used widely in the nuclear industry (BWRs) as an acceptable method to repair flawed welds. Similar proposed alternatives have been approved by the NRC for Nine Mile Point Unit 2, as discussed in a letter dated March 30, 2000, and for James A. Fitzpatrick Nuclear Power Plant in a letter dated October 26, 2000.

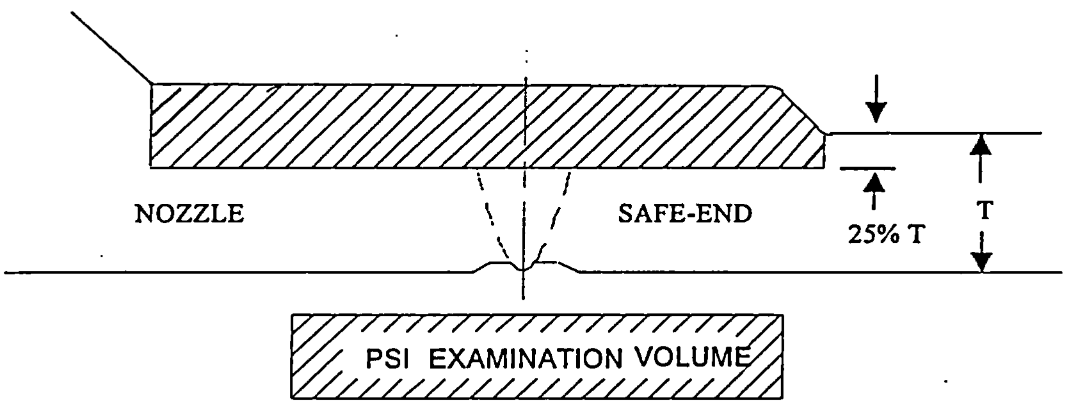
The use of overlay filler material that provides excellent resistance to PWSCC develops an effective barrier to crack extension by corrosion processes. Also, temper bead welding techniques produce excellent toughness and ductility in heat affected zones of welded carbon steel materials, and, in this case, result in compressive residual stresses on the inside surface, which help to inhibit PWSCC. The design of the overlay for the nozzle-to-safe end weldment uses methods that are standard in the industry. There are no new or different approaches in this overlay design which are considered first of a kind or inconsistent with previous approaches. The overlay will be designed as a full structural overlay in accordance with Code Case N-504-2. The temper bead welding technique that will be implemented in accordance with Code Case N-638 will produce a tough corrosion resistant overlay.

AmerGen concludes that the alternative repair approach described above presents an acceptable level of quality and safety to satisfy the requirements of 10CFR50.55a(a)(3)(i).

DURATION OF THE PROPOSED ALTERNATIVE

This alternative repair is requested for the remainder of the third ten-year interval.

Figure 1 – PSI Volumetric Examination Volume



(Note 1)

Note 1: The defined PSI examination volume shall be examined by angle beam in four directions in accordance with PDI procedure for Weld Overlay Examination to the maximum degree allowable by the weld overlay configuration.