October 17, 2007

Mr. Christopher M. Crane
President and Chief Executive Officer
AmerGen Energy Company, LLC
200 Exelon Way, KSA 3-E
Kennett Square, PA 19348

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 (TMI-1), RELIEF REQUEST 2007-TMI-01, REGARDING STRUCTURAL WELD OVERLAYS ON PRESSURIZER SURGE, PRESSURIZER SPRAY, AND HOT LEG DECAY HEAT DROP LINE NOZZLES, (TAC NO. MD5427)

Dear Mr. Crane:

By letter dated May 1, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML071220466), as supplemented by letter dated August 13, 2007 (ADAMS Accession No. ML072320404), AmerGen Energy Company, LLC submitted Relief Request (RR) 2007-TMI-01 for proposed alternatives to certain requirements of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), Section XI, 1995 edition through the 1996 addenda at TMI-1. The request pertains to the structural weld overlays of dissimilar and similar metal welds of pressurizer surge, pressurizer spray, and hot leg decay heat drop line nozzle dissimilar metal welds. The request also includes the structural weld overlay of certain adjacent welds.

The Nuclear Regulatory Commission (NRC) staff has completed its review of the proposed alternatives as discussed in the enclosed safety evaluation. Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 55a(a)(3)(i), RR 2007-TMI-01 is authorized for the installation of full structural weld overlays on the listed dissimilar and similar metal welds on the basis that the proposed alternative will provide an acceptable level of quality and safety. As requested, the effective period of the structural weld overlay is authorized for the remaining service life of the components including future plant life extension. The proposed alternatives to the inspection requirements of Appendix VIII to the ASME Code, Section XI, are authorized through the end of the third 10-year inservice inspection interval which ends on April 19, 2011.

If you have any questions, please contact the TMI-1 Project Manager, Mr. Peter J. Bamford, at 301-415-2833.

Sincerely,

/ra/

Harold K. Chernoff, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure: As stated

cc w/encl: See next page

If you have any questions, please contact the TMI-1 Project Manager, Mr. Peter J. Bamford, at 301-415-2833.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF REGARDING STRUCTURAL WELD OVERLAYS

RELIEF REQUEST NO. 2007-TMI-01

AMERGEN ENERGY COMPANY, LLC

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

1.0 INTRODUCTION

By letter dated May 1, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML071220466), as supplemented by letter dated August 13, 2007 (ADAMS Accession No. ML072320404), AmerGen Energy Company, LLC, (the licensee) submitted Relief Request (RR) 2007-TMI-01. The submittal proposes an alternative to the requirements of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), Section XI, 1995 edition through the 1996 addenda at Three Mile Island Nuclear Station, Unit 1 (TMI-1). RR 2007-TMI-01 pertains to the structural weld overlays of dissimilar metal welds (DMW) and certain adjacent similar metal welds of pressurizer (PZR) surge, PZR spray, and the hot leg decay heat drop line nozzles.

The alternative proposed in RR 2007-TMI-01 is based, with modifications, on ASME Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1"; Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW [Gas Tungsten-Arc Welding] Temper Bead Technique"; and ASME Code, Section XI, Appendix VIII, Supplement 11, "Qualification Requirements for Full Structural Overlaid Wrought Austenitic Piping Welds," to the 1995 edition with the 1996 addenda of ASME Code, Section XI.

2.0 REGULATORY EVALUATION

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The ISI code of record for TMI-1 for the third 10-year ISI interval is the 1995 edition of the ASME Code, Section XI, through the 1996 addenda.

Pursuant to 10 CFR 50.55a(g)(4)(iv), ISI items may meet the requirements set forth in subsequent editions and addenda of the ASME Code that are incorporated by reference in 10 CFR 50.55a(b), subject to the limitations and modifications listed therein, and subject to U.S. Nuclear Regulatory Commission (NRC) approval. Portions of editions and addenda may be used provided that related requirements of the respective editions and addenda are met.

Pursuant to 10 CFR 50.55a(a)(3), alternatives to ASME Code requirements may be authorized by the NRC if the licensee demonstrates that: (i) the proposed alternatives provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The licensee submitted RR 2007-TMI-01, pursuant to 10 CFR 50.55a(a)(3)(i).

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Covered by the Proposed Alternative

Code Class: 1
Reference: IWA-4000, "Repair/Replacement Activities"
Examination Category: R-A
Item Number: See Table 1 below
Description: Structural weld overlays (SWOL) of the PZR surge, PZR spray, and hot leg decay heat drop line nozzle DMWs including the SWOL of adjacent welds.
Component Numbers: See Table 1 below

Table 1: COMPONENT IDENTIFICATION						
For TMI-1 PZR and Decay Heat Drop Line SWOL						
Welds Scheduled for Weld Overlay Repair During TMI Outage T1R17*						
Nozzle	Nozzle to safe end weld #	Item #	size	adjacent weld	configuration	Item #
Surge	PR-021BM	R1.15	10"	NA – will not be overlayed	NA	NA
Decay Heat	DH-0001BM	R1.15	12"	DH-498	Safe-end to pipe	R1.20
Welds Scheduled for Examination during TMI-1 Outage T1R17* (Overlay Repair Applicable if Examination Results are Unacceptable)						
Nozzle	Nozzle to safe end weld #	Item #	size	adjacent weld	configuration	Item #
Spray	PR-009BM	R1.14 R1.15	4"	SP-021BM	Safe-end to elbow	R1.11 R1.15

Note: Item numbers reflect Risk-Informed classification per plant risk-informed ISI program.
R1.11: Elements Subject to Thermal Fatigue.
R1.14: Elements Subject to Crevice Corrosion Cracking.
R1.15: Elements Subject to Primary Water Stress Corrosion Cracking (PWSCC).
R1.20: Elements not Subject to a Damage Mechanism.
* T1R17 is the scheduled October 2007 refueling outage

3.2 Applicable Code Edition and Addenda for TMI-1

1. ASME Code, Section XI, 1995 edition through 1996 addenda.
2. PZR Code of Construction, ASME Section III, 1965 edition, through Summer 1967 addenda.
3. USAS B31.7, Nuclear Power Piping, February 1968 Draft including June 1968 errata.
4. USAS B31.1, Power Piping, 1967 edition.

3.3 Applicable Code Requirements Related to RR 2007-TMI-01

1. ASME Code Section XI, 1995 edition through 1996 addenda, IWA-4000, "Repair/Replacement Activities."
2. ASME Code Section XI, 1995 edition through 1996 addenda, Appendix VIII, Supplement 11, "Qualification Requirements for Full Structural Overlaid Wrought Austenitic Piping Welds."
3. ASME Code Case N-504-2, "Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1."
4. ASME Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature machine GTAW Temper Bead Technique, Section XI, Division 1."

The licensee included ASME Code Cases N-504-2, and N-638-1 as applicable code requirements in RR 2007-TMI-1. The NRC staff notes that code cases are not ASME Code requirements but rather an alternative to the Code requirements. Licensees may use the NRC approved code cases as an alternative to repair/replacement activities of piping to satisfy the Code requirements.

3.4 Licensee's Reason for Requesting an Alternative

DMWs primarily consisting of nickel-based Alloy 82/182 weld metal are frequently used in pressurized water reactors (PWR) construction to connect stainless steel pipe and safe-ends to vessel nozzles, generally constructed of carbon or low alloy ferritic steel. These welds have shown a propensity for primary water stress corrosion cracking (PWSCC) degradation, especially in components subjected to higher operating temperatures, such as the PZR.

TMI-1 plans to install SWOLs on the PZR surge nozzle to safe-end weld and the decay heat drop line nozzle to safe-end weld (including the adjacent decay heat drop line similar metal weld) during the T1R17 refueling outage. SWOLs have been used successfully for several years on both boiling water reactors (BWRs) and PWRs to arrest existing or postulated flaws from propogating while establishing a new pressure boundary. TMI-1 is also including a contingent overlay repair of the PZR spray DMWs should results of the planned October 2007 ultrasonic examinations identify a need for SWOL of the nozzle to safe-end or safe-end to elbow DMWs.

The welding will utilize a mechanized gas tungsten arc welding (GTAW) process and the ambient temperature temper bead method with ERNiCrFe-7A (Alloy 52M) weld metal. Manual GTAW, using Alloy 52, will only be permitted subsequent to the SWOL being essentially completed if local repairs of weld defects are necessary or if additional weld metal is required locally to form the final SWOL contour. Shielded metal arc welding, using Alloy 152, would only be used to repair indications in the existing DMWs prior to initiating the SWOL.

Currently, there is no comprehensive and generic NRC-approved criterion for a licensee to apply a SWOL repair to a DMW that is constructed of Alloy 82/182 weld material. Therefore, approval of repair/replacement activities associated with weld overlays of this type are required to address

materials, weld parameters, personnel radiation exposure concerns, operational constraints, examination techniques, and procedural requirements.

3.5 Licensee's Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee proposes applying SWOLs designed in accordance with Code Case N-504-2 including NRC conditions identified in Regulatory Guide (RG) 1.147, revision 14, with the modifications listed in Table 2 of the licensee's submittal dated May 1, 2007. In addition, Code Case N-638-1, including NRC conditions identified in RG 1.147 with the modifications for temper bead welding, will be used with the modifications proposed in Table 3 of the submittal dated May 1, 2007. Final ultrasonic testing (UT) of the finished SWOL will be performed using UT of the Performance Demonstration Initiative (PDI) program which was developed by Electric Power Research Institute (EPRI) in lieu of the ASME Section XI Appendix VIII Supplement 11.

Code Case N-504-2, is currently approved for use in RG 1.147 with the additional requirement that ASME Code Section XI, 2005 addenda, Appendix Q, be applied when using the code case. The SWOL will extend around the full circumference of the applicable DMW as required by Code Case N-504-2. The specific thickness and length will be determined according to the guidance provided in Code Case N-504-2. The SWOL will completely cover the DMW and the adjacent stainless steel material with Alloy 52M material to the extent that PWSCC susceptible material is mitigated and examination capability is maintained for the adjacent welds. In the case of the decay heat drop line, the SWOL covers the adjacent similar metal weld to provide the weld geometry required to perform the final examinations and obtain the required examination coverage volume.

Prior to installation of the SWOL, TMI-1 will complete a bare metal visual examination of the PZR surge and decay heat drop line nozzles immediately after the insulation is removed in the area around the nozzle and DMW area to ensure that no through-wall cracks exist prior to applying the overlay. The PZR spray nozzle DMWs will receive bare metal visual and ultrasonic examinations and will only be overlay repaired if the examination results indicate that repair is necessary.

In addition, prior to the installation of the SWOL, a liquid penetrant test (PT) will be performed of the overlay area. Indications greater than 1/16" are not permitted. If any indication is found to be greater than 1/16", the indication will be removed or reduced below the acceptance criteria, and the PT performed again. If any indication(s) does require repair, the repair will be completed and the welded area will again be inspected with a PT for final acceptance.

The decay heat drop line adjacent stainless steel weld (DH-498) being overlayed during the October 2007 refueling outage was not selected for examination during the third 10-year ISI interval. Weld DH-498 has not been selected for ASME Section XI examination since initial plant startup. The licensee states that any sample expansion of the examination scope due to unacceptable flaws in the adjacent welds, such as weld DH-498, recorded during the associated SWOL examination will be based on an evaluation of the unacceptable flaw characteristics. This evaluation will include whether other elements in the segment or segments are subject to the same root cause conditions. No additional examinations will be performed if there are no additional elements identified as being susceptible to the same root cause conditions. If the evaluation does identify a common degradation mechanism, then further examinations would be performed.

The licensee will address flaw evaluations in accordance with Code Case N-504-2(g) Item 2 and shrinkage stress effects analyses in accordance with Code Case N-504-2(g) Item 3 through the

approved overlay designs that are currently in development. These documents will be completed and approved by the licensee for use prior to application at TMI-1.

In the submittal dated May 1, 2007, the licensee included a discussion addressing recent industry experience concerning hot cracking of the nickel alloy 52M weld overlay on austenitic stainless steel base materials containing greater than 0.020 weight percent sulfur. TMI-1 will use a barrier layer prior to performing the SWOL on all stainless steel components with a sulfur content greater than 0.010 weight percent and may opt to use a barrier layer on all stainless steel components. The barrier layer will use ER309L on the stainless steel and Alloy 82 on the stainless steel area near the DMW to stainless steel fusion zone only. No structural credit will be taken for the barrier layer in determining the required minimum thickness of the SWOL.

The barrier layer welding will be performed in accordance with ASME Code, Section IX qualified welding procedure specifications. PT will be performed on the barrier layer surface and its volume will be included in the final UT of the overlay.

3.6 Commitments

Within 30 days after the completion of the last ultrasonic examination of the weld overlays during refueling outage T1R17, the licensee commits to provide the results of the UT of the SWOLs on the TMI-1 PZR spray nozzle to safe-end weld, the decay heat drop line nozzle to safe-end weld including the adjacent decay heat drop line similar metal weld, and if the overlay is performed on the PZR spray nozzle safe-end weld and the adjacent weld, to the NRC. The results will include:

- A listing of indications detected (The licensee notes that the recording criteria of the UT procedure to be used for the testing of the TMI-1 overlays (PDI-UT-8) requires that all indications, regardless of amplitude, be investigated to the extent necessary to provide accurate characterization, identity and location. Additionally, the procedure requires that all indications, regardless of amplitude, that cannot be clearly attributed to the geometry of the overlay configuration, be considered flaw indications).

- The disposition of all indications using the standards of ASME Section XI, Nonmandatory Appendix Q criteria and,

- The type and if possible, nature of the indications (the licensee notes that UT procedure PDI-UT-8 requires that all suspected flaw indications are to be plotted on a cross sectional drawing of the weld and that the plots should accurately identify the specific origin of the reflector).

Also, included in the results will be a discussion of any repairs to the overlay material and/or base metal and the reason for the repair.

3.7 Duration of the Proposed Alternative

The licensee proposed that the duration of the proposed alternatives associated with the SWOL is the remaining service life of the components including future plant life extension. Relief from the Appendix VIII inspection requirements is requested through the end of the third 10-year ISI interval at TMI-1. Subsequent inservice examinations of the SWOLs will be scheduled and performed in accordance with the requirements of Nonmandatory Appendix Q or alternate schedules as approved by the NRC.

3.8 Evaluation

The staff focused its evaluation on the proposed modification to Code Cases N-504-2 and N-638-1 and the differences between the PDI program and Supplement 11 of Appendix VIII to the ASME Code, Section XI. The staff also reviewed the licensee's modifications to address recent industry experience concerning hot cracking of Alloy 52M weld overlay on austenitic stainless steel base materials with higher sulfur content.

3.8.1 NRC Staff Evaluation of Modification to Code Case N-504-2

The purpose of Code Case N-504-2 is to repair degraded austenitic stainless steel piping by deposition of weld reinforcement (weld overlay) on the outside surface of the pipe. However, the licensee will be applying Code Case N-504-2 for the weld overlay of the carbon or low alloy ferritic steel (P1) nozzle material, nickel alloy (F43/P43) weld material and a safe-end, and austenitic stainless steel (P8) safe ends, a piping elbow and weld material.

Code Case N-504-2 is accepted for use in the current NRC RG 1.147, Rev. 14 with conditions, and has been used extensively in primary system piping of BWR plants. More recently, N-504-2 has been applied to pressurized water reactor applications for the weld overlay repair of DMWs with known flaws or to apply SWOL as a PWSCC mitigation technique. Industry operating experience has shown that PWSCC in Alloy 82/182 will blunt at the interface with stainless steel base metal, ferritic base metal, or Alloy 52M weld metal. The 360 degree full structural weld overlay will control growth in any PWSCC crack and maintain weld integrity. The applied SWOL will also induce compressive stress in the existing DMW or similar metal weld, thus potentially impeding growth of any reasonably shallow cracks. Furthermore, the SWOL will be sized to meet all structural requirements without considering the presence of the existing welds.

Paragraph (b) of Code Case N-504-2 requires that reinforcement weld metal be low carbon (0.035 percent maximum) austenitic stainless steel applied 360 degrees around the circumference of the pipe, and be deposited in accordance with a qualified welding procedure specification identified in the [plant's] Repair Program. In lieu of Paragraph (b) requirement, the licensee proposed to use an austenitic nickel alloy (28 percent Chromium minimum) weld metal using a welding procedure specification for groove welding which has been qualified in accordance with the Repair/Replacement Code requirements, the Owner's requirements and is identified in the Repair/Replacement Plan at TMI-1.

The NRC staff notes that the use of Alloy 52/52M/152 material is consistent with weld filler material used to perform similar weld overlays at operating BWR facilities. The NRC staff finds that the proposed use of weld material Alloy 52/52M/152 for the full structural overlays provides an acceptable level of quality and safety and is, therefore, acceptable.

Paragraph (e) of Code Case N-504-2 requires that the weld reinforcement consists of a minimum of two weld layers having as-deposited delta ferrite content of at least 7.5 ferrite number (FN). The first layer of weld metal with delta ferrite content of at least 7.5 FN shall constitute the first layer of the weld reinforcement design thickness.

In lieu of Paragraph (e) requirement, the licensee will not measure delta ferrite for weld overlay repairs because the deposited Alloy 52M is 100 percent austenitic and contains no delta ferrite due to the high nickel composition (approximately 60 percent nickel). The austenitic nickel alloy weld overlay shall consist of at least two weld layers deposited from a filler material with a chromium content of at least 28 percent. When welding over an austenitic base material or austenitic filler metal material weld and the associated dilution zone from an adjacent ferritic base

material, a diluted first layer of at least 24 percent chromium is acceptable, provided the chromium content of the deposited weld metal is determined by chemical analysis of a representative coupon. Alternatively, the first weld layer may be considered "sacrificial," and will not be credited for the reinforcement design thickness.

The NRC staff finds that paragraph (e) of Code Case N-504-2 is not applicable to proposed alternative in RR 2007-TMI-01 because the delta ferrite requirement does not apply to the Alloy 52M weld metal that will be used for the weld overlay.

Paragraph (h) of Code Case N-504-2 requires that the completed repair be pressure tested in accordance with ASME Section XI, IWA-5000. If the flaw penetrated the original pressure boundary prior to welding, or if any evidence of the flaw penetrating the pressure boundary is observed during the welding operation, a system hydrostatic test shall be performed in accordance with IWA-5000. If the system pressure boundary has not been penetrated, a system leakage, inservice, or functional test shall be performed in accordance with IWA-5000. Nonmandatory Appendix Q (mandated through RG 1.147, Revision 14, as a condition of using Code Case N-504-2) states, "Ultrasonic examination personnel shall be certified in accordance with the Owner's written practice. Procedures and personnel shall be qualified in accordance with Appendix VIII."

In lieu of performing a hydrostatic test, the licensee proposed to perform a system leakage test at system nominal operating pressure in accordance with IWA-5000 as modified by Code Case N-416-3 in accordance with the TMI-1 ISI Program. Prior to the system leakage test, UT of the finished SWOL using EPRI PDI demonstrated weld overlay examination procedures and qualified examiners shall be performed.

The licensee contends that the TMI-1 third 10-year ISI program uses the 1995 edition of Section XI through the 1996 addenda along with Code Case N-416-3 (approved for use through RG 1.147, Rev. 14) for nondestructive examination (NDE) and pressure testing of welded repair/replacement activities. Code Case N-416-3 permits a system leakage test in lieu of a hydrostatic test, provided that NDE is performed in accordance with the methods and acceptance criteria of the applicable Subsection of the 1992 edition of ASME Section III. The 1992 edition of ASME Section III, Subsection NB, does not address the structural weld overlay configuration. The licensee states that the NDE requirements of Nonmandatory Appendix Q performed using EPRI PDI demonstrated procedures with qualified examiners will be used. In addition, the bare metal visual and PT of the existing DMW and adjacent base metal prior to applying the SWOL will be used to verify that there are no flaws penetrating the pressure boundary that may require hydrostatic testing.

The NRC staff finds the use of Code Case N-416-3 as an alternative to paragraph (h) of Code Case N-504-2 is acceptable because Code Case N-416-3 requires a combination of a volumetric examination and system pressure test to verify the integrity of the weld overlay thereby providing an acceptable level of quality and safety.

3.8.2 NRC Staff Evaluation of Modification to Code Case N-638-1

Paragraph (a) of Code Case N-638-1 requires that the maximum area of an individual weld on the ferritic material based on the finished surface be 100 square inches, and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness. The licensee proposed that the maximum area of an individual weld based on the finished surface over the ferritic material shall not exceed 300 square inches. If any of the TMI-1 SWOL repairs exceed 300 square inches over the ferritic material, additional relief will be requested. In addition, the licensee stated that

the one-half base metal thickness limitation applies only to excavation repair and is not applicable to this application.

The licensee stated that although the final design for the SWOL has not been completed at the time of development of this relief request, it is anticipated that the SWOL will require welding on more than 100 square inches of surface on the carbon steel base material. The SWOL will extend to the transition taper of the carbon steel nozzle to provide an adequate weld geometry so that qualified UT of the required volume can be performed. There have been a number of temper bead SWOL repairs successfully applied to safe-end to nozzle welds in the nuclear industry, and an SWOL repair having a 300-square-inch surface area was approved for the Susquehanna Steam Electric Station (ADAMS Accession No. ML051220568).

The NRC staff notes that the technical justification for allowing weld overlays on ferritic materials with surface areas up to 500 square inches is provided in the white paper supporting the changes in ASME Code Case N-638-3 and EPRI Report 1011898, *Justification for the Removal of the 100 Square Inch Temper bead Weld Repair Limitation*. The EPRI report cites evaluations of a 12-inch diameter nozzle weld overlay to demonstrate adequate tempering of the weld heat affected zone, residual stress evaluations demonstrating acceptable residual stresses in weld overlays ranging from 100 to 500 square inches, and service history in which weld repairs exceeding 100 square inches were NRC approved and applied to DMW nozzles in several BWR and PWR applications. Some of the cited repairs are greater than 15 years old, and have been inspected several times with no evidence of any continued degradation. The above theoretical arguments and empirical data have been verified in practice by extensive field experience with temper bead weld overlays, with ferritic material coverage ranging from less than 10 square inches up to and including 325 square inches.

The NRC staff finds that the proposed 300-square inch weld area on the ferritic material is acceptable because the stress analysis presented in EPRI Report 1011898 shows that the structural integrity of ferritic material is not adversely affected by a 300-square inch weld overlay area. In addition, the NRC staff finds that the one-half base metal thickness limitation of paragraph (a) of Code Case N-638-1 applies only to excavation repair and is not applicable to RR 2007-TMI-01 which is related to deposit welds on the outside surface of piping components.

Paragraph 4.0(b) of Code Case N-638-1 requires that the final weld surface and the band around the area defined in paragraph 1.0(d) shall be examined using 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 [of the ASME Code, Section XI].

In lieu of the paragraph 4.0(b) requirements, the licensee proposed the two following modifications: (a) for the SWOLs, full UT of the 1.5T [thickness] band will not be performed. Instead, UT will be performed on the actual weld overlay, meeting the requirements of ASME Section XI, Nonmandatory Appendix Q-4100, and (b) when austenitic filler materials are used, the SWOL will be examined using the surface and ultrasonic methods after three tempering weld layers (i.e., layers 1, 2, and 3) are completed and have been in place for at least 48 hours.

The licensee stated that later editions of the code as well as later revisions to the code case (N-638-2 and later) removed the requirement for the 1.5T examination band. This is in line with the less restrictive requirements for UT of the ferritic nozzle because hydrogen cracking away from the temper bead weld is not considered a concern in later editions of the code and Code Case N-638. The code case applies to any type of welding where a temper bead technique is to be employed (which includes weld repairs of excavated flaws) and is not specifically written for an SWOL repair. However, it is believed that for this type of repair, any major base material

cracking would take place in the heat-affected zone directly below the weld overlay or in the underlying Alloy 82/182 weld deposit and not in the required 1.5T examination band of material out beyond the overlay. If this type of cracking were to occur, it should be detected by the UT of the SWOL using PDI demonstrated procedures with PDI qualified inspectors.

The NRC staff notes that the post weld overlay area, as defined under ASME Code, Section XI, Nonmandatory Appendix Q, is one-half inch on either side of the overlay for surface examination and the completed overlay for UT examination. In RG 1.147, Revision 14, the NRC staff imposes a condition on Code Case N-504-2 which requires that when N-504-2 is used, the requirements of Appendix Q to the ASME Code, Section XI must be followed. The issues of cracking and/or distortion of the weld and base metal were not specifically addressed in the ASME Code case development work. Since the weld overlays are fabricated from austenitic materials with inherent toughness, no cracking in the overlays is expected to occur due to the shrinkage associated with the weld overlay. With respect to the ferritic portion of the overlays, many temper bead weld overlays have been applied in the nuclear industry at these nozzles to safe-end locations. The stiffness and high toughness inherent in the low-alloy steel material is expected to protect against any cracking and limit any distortion that might occur in the low-alloy steel material. Code Case N-504-2 requires that impact of axial shrinkage on the weld and piping system shall be measured and evaluated after the weld overlay is deposited. In addition, any cracking that might occur should be detected by the final NDE of the weld overlay required under Appendix Q, which provides additional assurance of the deposition of a defect-free, structurally sound overlay. The assessment of the shrinkage stresses on the piping, and post-weld NDE volumes under Appendix Q, provides reasonable assurance that defect-free welds will result in continued structural integrity of the piping. The NRC staff finds that the alternative testing under Appendix Q will provide an acceptable level of quality and safety. Therefore, the NRC staff authorizes the licensee's proposed alternative to the 1.5T band UT examination requirement under N-638-1.

With regard to the 48-hour hold time, the licensee stated that EPRI's white paper (*Repair and Replacement Applications Center: Temperbead Welding Applications 48-Hour Hold Requirements for Ambient Temperature Temperbead Welding*, EPRI, Palo Alto, CA, 2006, 1013558) provides the technical basis for the 48-hour hold time prior to final NDE will start upon completion of the third temper bead weld overlay layer.

The licensee stated that TMI-1 will be applying the alternate hold time to weld overlays only; this alternative will not be applied to excavations requiring repair by temper bead welding. The referenced EPRI white paper addresses previous concerns regarding the 48-hour hold time prior to final NDE. Areas of concern imposing the 48-hour hold time addressed through this report include material microstructure; sources for hydrogen introduction; tensile stress and temperature; and diffusivity and solubility of hydrogen in steels. The report concludes that there is no technical basis for waiting 48 hours after the weld overlay cools to ambient temperature before beginning to perform final NDE of the completed weld overlay. The licensee indicated that past and recent experience performing NDE on temper bead weld overlays has not found any indication of hydrogen cracking of these welds either during initial NDE after the 48-hour hold time or subsequent ISI examinations. The licensee stated further that ultrasonic examinations will be performed using EPRI PDI weld overlay demonstrated examination procedures with PDI qualified inspectors.

The NRC staff finds that the licensee has provided sufficient technical basis to support performing NDEs after the 48-hour hold time starting from the third temper bead overlay layer. Therefore it is acceptable that the proposed 48-hour hold time will begin after completion of the third weld layer.

Based on the above evaluation, the NRC staff finds that the proposed alternatives to the requirements of N-504-2 and N-638-1 for preemptive weld full structural overlay of the subject welds are acceptable, because they will provide an acceptable level of quality and safety.

3.8.3 NRC Staff Evaluation of Alternatives to Appendix VIII to Section XI of the ASME Code

The licensee's proposed alternative in RR 2007-TMI-01 includes an alternative to the requirements of ASME Code, Section XI, Appendix VIII, Supplement 11. In lieu of the requirements of ASME Code, Section XI, Appendix VIII, Supplement 11, the licensee proposes to use the PDI program as described in the submittal dated May 1, 2007. The duration of this portion of RR 007-TMI-01 is for the remainder of the third 10-year ISI interval at TMI-1 for the requested weld overlays.

The U.S. nuclear utilities created the PDI program to implement performance demonstration requirements contained in Appendix VIII of Section XI of the ASME Code. To this end, the PDI program has developed a program for qualifying equipment, procedures, and personnel in accordance with the UT criteria of Appendix VIII, Supplement 11. Prior to the Supplement 11 program, EPRI was maintaining a performance demonstration program (the precursor to the PDI program) for weld overlay qualification under the Tri-party Agreement with the NRC, BWR Owner's Group, and EPRI, in the NRC letter dated July 3, 1984 (ADAMS Accession No. 8407090122). This NRC letter to EPRI defined a coordination plan for training and qualification activities of NDE personnel employed in performance of ultrasonic examination of piping weldments during ISI of BWR power plants. Instead of having two programs with similar objectives, the NRC staff recognized the EPRI PDI program for weld overlay qualifications as an acceptable alternative to the Tri-party Agreement as stated in a letter dated January 15, 2002, to the PDI Chairman (ADAMS Accession No. ML020160532). The purpose of this letter was to inform the PDI program that the PDI's performance demonstration program for weld overlays was an acceptable alternative to the performance demonstration recommendations of NRC Generic Letter (GL) 88-01, "NRC Position on IGSCC [Intergranular Stress Corrosion Cracking] in BWR Austenitic Stainless Steel Piping," dated January 25, 1988.

Although the PDI program for weld overlay examinations was initially developed for ISIs at BWR plants, the program is applicable to the weld overlay qualification for PWR plants. This is because the weld overlays at BWR plants are the same as weld overlays at PWR plants.

The PDI program is routinely assessed by the NRC staff for consistency with the current ASME Code and proposed changes. The PDI program does not fully comport with the existing requirements of Supplement 11. PDI representatives presented the differences at public meetings in which the NRC participated. Based on the discussions at these public meetings, the staff determined that the PDI program provides an acceptable level of quality and safety.

The NRC staff evaluated the differences between the PDI program and Supplement 11 that the licensee identified in the submittal dated May 1, 2007. The NRC staff concludes that the licensee's proposed alternative provides an acceptable level of quality and safety and, therefore, the proposed alternative to use the PDI program is acceptable.

4.0 CONCLUSION

The NRC staff has reviewed the licensee's submittal and determined that the proposed alternatives to the requirements of the ASME Code, Section XI, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the use of the alternative in RR 2007-TMI-01 for the installation of full SWOLs on the subject

dissimilar and similar metal welds of the pressurizer nozzles and the hot leg decay heat drop line nozzle at TMI-1.

As requested, the effective period of the SWOL is authorized for the remaining service life of the components including future plant life extension. The proposed alternatives to the inspection requirements of Appendix VIII to the ASME Code, Section XI, are authorized through the end of the third 10-year ISI interval which ends on April 19, 2011.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this Relief Request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

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