December 4, 2001

Mr. Mark E. Warner
Vice President - TMI Unit 1
AmerGen Energy Company, LLC
P.O. Box 480
Middletown, PA 17057

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 (TMI-1) - SAFETY EVALUATION FOR THE THIRD 10-YEAR INSERVICE INSPECTION (ISI) INTERVAL REQUEST FOR RELIEF NO. RR 01-18 (TAC NO. MB3177)

Dear Mr. Warner:

By your application dated October 16, 2001, as supplemented October 18, 2001, AmerGen Energy Company, LLC (the licensee), submitted ISI RR 01-18 for TMI-1. The Nuclear Regulatory Commission (NRC) staff has evaluated the relief request and found it to be acceptable. Thus, the licensee's proposed alternative in RR 01-18 is authorized pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i), on the basis that it would provide an acceptable level of quality and safety.

Because TMI-1 is currently in a refueling outage, and immediate implementation of this relief request was necessary to prepare for possible weld repairs, which can only be conducted during a refueling outage, verbal approval of the relief request alternative was authorized on Friday, October 19, 2001, at 3:30 p.m. Delays in granting approval would have resulted in delays in critical path efforts which would have delayed reactor startup. The information contained in the enclosed safety evaluation is consistent with the verbal approval.

Details of the NRC staff's evaluation and the applicable duration of this alternative are delineated in the enclosed safety evaluation.

Sincerely,

/RA/
L. Raghavan, Acting Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO INSERVICE INSPECTION RELIEF REQUEST NO. RR 01-18

AMERGEN ENERGY COMPANY, LLC

THREE MILE ISLAND NUCLEAR STATION, UNIT 1 (TMI-1)

DOCKET NO. 50-289

1.0 INTRODUCTION

The inservice inspection (ISI) of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Class 1, Class 2, and Class 3, components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). The regulations in 10 CFR 50.55a(a)(3) state, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the Nuclear Regulatory Commission (NRC), if the licensee demonstrates that: (i) the proposed alternatives would 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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code, Class 1, 2, and 3, components (including supports) will 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 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) twelve 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 is the 1995 Edition with the 1996 Addenda of Section XI of the ASME Code. The third 10-year interval for TMI-1 began April 20, 2001.

By letter dated October 16, 2001, as supplemented October 18, 2001, AmerGen Energy Company, LLC (AmerGen), the licensee, submitted a request to use Relief Request RR 01-18, "Ambient Temperature Temper Bead Repair Technique," for repairs to reactor vessel closure head (RVCH) penetration J-groove attachment welds which may be required when 1/8-inch or less of non-ferritic weld deposit exists above the original fusion line, at TMI-1. Relief Request RR 01-18 allows the use of the machine gas tungsten arc welding temper bead technique

Enclosure

without the specified preheat or post-weld heat treatment of the Construction Code and as an alternative to the temper bead welding process described in the ASME Code, Section XI, 1995 Edition with 1996 Addenda, provided the requirements of RR 01-18, and all other requirements of the ASME Code, Section XI, and the original Construction Code are met.

Pursuant to 10 CFR 50.55a(a)(3)(i), AmerGen is requesting to use RR 01-18, “Ambient Temperature Temper Bead Repair Technique,” as an alternative to the temper bead welding process described in the ASME Code, Section XI, 1995 Edition with 1996 Addenda for repairs to RVCH penetration J-groove attachment welds.

2.0 BACKGROUND

There have been several recent instances of cracking in RVCH penetrations constructed of Alloy 600 welds in pressurized water reactor nuclear power plants. In response to the reactor vessel penetrations cracking concern and NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Vessel Head Penetration Nozzles," dated August 3, 2001, AmerGen performed inspections of the reactor vessel head penetrations during the fall refueling outage for TMI-1. For some of the repairs that are required as a result of these inspections, AmerGen is requesting the use of alternative repair techniques, instead of the1995 Edition of ASME Code with 1996 Addenda repair requirements, pursuant to 10 CFR 50.55a(a)(3)(i).

3.0 EVALUATION

3.1 Licensee's Basis for RR 01-18

AmerGen performed visual examinations of the RVCH penetration nozzles during their refueling outage in the fall of 2001. If the examinations identified any flaws that required repair, AmerGen desired to have the option of using the methods described in RR 01-18 for some of the repairs.

As described in Reference 1, the repair process would remove the portion of the nozzle that extends below the inner surface of the head. A new weld application surface would be prepared at a point above the heat affected zone of the original pressure boundary weld, within the bore through which the nozzle is installed. A new nozzle-to-head weld would be installed within the head bore by remote machine welding. The original weld is not part of the new pressure boundary weld. The original weld is left in place at the junction of the head nozzle bore to head inside surface, and analyzed for acceptability.

In order to conduct the repairs efficiently, relief from portions of the ASME Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components,” 1995 Edition with 1996 Addenda, is requested. Pursuant to 10 CFR 50.55a(a)(3)(i), AmerGen requested approval of this RR 01-18.

RR 01-18 proposes performing the repair with a remotely operated weld tool using the machine Gas Tungsten-Arc Welding (GTAW) process and the ambient temperature temper bead method with 50 °F minimum preheat temperature and no post-weld heat treatment.

The proposed alternative repair technique has been demonstrated as an acceptable method for performing reactor pressure vessel repairs. The ambient temperature temper bead technique

has been approved by the ASME Code Committee per Code Case N-638. The ambient temperature temper bead technique has been approved by the NRC as having an acceptable level of quality and safety and was successfully used at several sites (Duane Arnold Energy Center, Nine Mile Point Nuclear Station, and James A. FitzPatrick Nuclear Power Plant).

As shown in "Framatome-ANP Procedure Qualification Record," FRA-ANP PQR 7164, (which was used to qualify the proposed machine GTAW ambient temperature temper bead weld process) when using P-No. 3, Group No. 3, base materials, the heat affected zone (HAZ) exhibited improved Charpy V-notch properties from both absorbed energy and lateral expansion perspectives, compared to the unaffected base material. The absorbed energy, lateral expansion, and percent shear were significantly greater for the HAZ than the unaffected base material at both test temperatures. It is clear from these results that the GTAW temper bead process has the capability of producing acceptable repair welds.

Based on FRA-ANP prior welding procedure qualification test data using machine GTAW ambient temperature temper bead welding, quality temper bead welds can be performed with 50 °F minimum preheat and no post-heat treatment. Additional FRA-ANP qualifications were performed at room temperature with cooling water to limit the maximum interpass temperature to a maximum of 100 °F. The qualifications were performed on the same P-No. 3, Group No. 3, base material using the same filler material (Alloy 52 AWS Class ERNiCrFe-7) with similar low heat input controls as will be used in the repairs. Also, the qualifications did not include a post-weld heat soak. The qualification of the ambient temperature temper bead welding process demonstrates that the proposed alternative provides an acceptable level of quality and safety.

Therefore, based on the discussion above, AmerGen has determined pursuant to 10 CFR 50.55a(a)(3)(i) that the proposed alternatives would provide an acceptable level of quality and safety.

4.0 STAFF EVALUATION

The NRC staff has evaluated the licensee's request and supporting information on the proposal to perform repairs to RVCH penetration J-groove attachment welds that require repair when 1/8 inch or less of nonferritic weld deposit exists above the original fusion line, in accordance with Relief Request RR 01-18, "Ambient Temperature Temper Bead Repair Technique," at TMI-1. The NRC staff concludes that the licensee has chosen to implement its proposed alternative on the basis that performing the Code-required preheat and post-weld heat treatment requirements would constitute a hardship or unusual difficulty without a compensating increase in the level of quality and safety, rather than an inability to perform the repair in accordance with the original Construction Code or different Construction Code (The ASME Code, Section III).

The data from welding procedure qualification tests using the machine GTAW ambient temperature temper bead welding technique, shows that quality temper bead welds can be performed with a 50°F minimum preheat and no post-weld heat treatment. The data that resulted from FRA-ANP PQR 7164 shows that when using P-No. 3, Group No. 3 base materials, the HAZ exhibited improved Charpy V-notch properties from both absorbed energy and lateral expansion perspectives, compared to the unaffected base material. The absorbed energy, lateral expansion, and percent shear were significantly greater for the HAZ than the unaffected base material at both test temperatures used in the tests on FRA-ANP PQR 7164.

With respect to compliance with the applicable ASME Code requirements, the ASME Code, Section XI, 1995 Edition through 1996 Addenda, subparagraph IWA-4410, states that "Repair/replacement activities shall be performed in accordance with the Owner's Requirements and the original Construction Code of the component or system ...," and that "Later Editions and Addenda of the construction Code or a later different Construction Code ... may be used ...." If repair welding can not be performed in accordance with these requirements, the Code states that "Alternatively, the applicable requirements of IWA-4600 may be used for welding ...." The licensee has proposed relief from ASME Section XI, subparagraph IWA-4600 to perform reactor pressure vessel (RPV) control rod drive mechanism (CRDM) nozzle penetration repairs. In lieu of the Code-required repair requirements, the licensee has proposed to perform the repair with a remotely operated weld tool, utilizing the machine Gas Tungsten-Arc Welding (GTAW) process and the ambient temperature temper bead method with 50°F minimum preheat temperature and no post-weld heat treatment.

The 1989 Edition of the ASME Code, Section III, paragraph NB-4622, discusses Post Weld Heat Treatment (PWHT) requirements, and subparagraph NB-4622.11, "Temper Bead Weld Repair to Dissimilar Metal Welds or Buttering," (NB-4622.11) addresses the requirements which must be followed whenever PWHT is impractical or impossible. Essentially, the licensee has proposed an alternative in lieu of the NB-4622 requirements. Since the licensee cites specific ASME Section III, 1989 Edition criteria for certain aspects of their proposed alternative, the staff's evaluation of the licensee's proposed alternative has been reviewed against the requirements of the 1989 Edition of ASME Section III.

The 1989 Edition of ASME Section III, paragraph NB-4622.11, states that whenever PWHT is impractical or impossible, limited weld repairs to dissimilar metal welds of P-No. 1 and P-No. 3 material or weld filler metal A-No. 8 (Section IX, QW-442) or F-No. 43 (Section IX, QW-432) may be made without PWHT or after the final PWHT provided the requirements of the subparagraphs NB-4622.11(a) through (g) are met.

The requirements of paragraphs NB-4451, 4452, 4453, and 4622 of the 1989 Edition of ASME Section III are also applicable to the contemplated repairs. As an alternative to the PWHT time and temperature requirements of NB-4622, the requirements of Relief Request RR 01-18, "Ambient Temperature Temper Bead Repair Technique" will be used. The proposed alternatives are being evaluated against the following subparagraphs of ASME Section III, NB-4622:

NB-4622.1 establishes the requirement for PWHT of welds including repair welds. In lieu of the requirements of this subparagraph the licensee proposes to utilize an ambient temperature temper bead weld procedure, obviating the need for post weld stress relief.

NB-4622.2 establishes requirement for time at temperature recording of the PWHT and their availability for review by the inspector. This requirement of the subparagraph will not apply because the proposed alternative does not involve PWHT.

NB-4622.3 discusses the definition of nominal thickness as it pertains to time at temperature for PWHT. The subparagraph is not applicable in this case because the proposed alternative involves no PWHT.

NB-4622.4 establishes the holding times at temperature for PWHT. The subparagraph is not applicable in this case because the proposed alternative involves no PWHT.

NB-4622.5 establishes PWHT requirements when different P-number materials are joined. This subparagraph is not applicable because the proposed alternative involves no PWHT.

NB-4622.6 establishes PWHT requirements for nonpressure retaining parts. The subparagraph is not applicable in this case because the potential repairs in question will be to pressure retaining parts. Furthermore, the proposed alternative involves no PWHT.

NB-4622.7 establishes exemptions from mandatory PWHT requirements. Sub-subparagraphs 4622.7(a) through 4622.7(f) are not applicable in this case because they pertain to conditions that do not exist for the proposed repairs. Sub-subparagraph NB-4622.7(g) discusses exemptions to weld repairs to dissimilar metal welds if the requirements of subparagraph NB-4622.11 are met. This sub-subparagraph does not apply because the ambient temperature temper bead repair is being proposed as an alternative to the requirements of subparagraph NB-4622.11.

NB-4622.8 establishes exemptions from PWHT for nozzle to component welds and branch connection to run piping welds. Sub-subparagraph 4622.8(a) establishes criteria for exemption of PWHT for partial penetration welds. This is not applicable to the proposed repairs because the criteria involve buttering layers at least 1/4-inch thick which will not exist for the welds in question. Sub-subparagraph NB-4622.8(b) also does not apply because it discusses full penetration welds and the welds in question are specially designed pressure boundary, structural welds.

NB-4622.9 establishes requirements for temper bead repairs to P-No. 1 and P-No. 3 materials and A-Nos. 1, 2, 10, or 11 filler metals. The subparagraph does not apply in this case because the proposed repairs will involve F-No. 43 filler metals.

NB-4622.10 establishes requirements for repair welding to cladding after PWHT. The subparagraph does not apply in this case because the proposed repair alternative does not involve repairs to cladding.

NB-4622.11 discusses temper bead weld repair to dissimilar metal welds or buttering and would apply to the proposed repairs as follows:

Sub-subparagraph NB-4622.11(a) requires surface examination prior to repair in accordance with NB-5000 (NB-4622.11(d)(3)). The proposed alternative will include surface examination prior to repair consistent with NB-5000.

Sub-subparagraph NB-4622.11(b) contains requirements for the maximum extent of repair. The proposed alternative includes the same limitations on the maximum extent of repair.

Sub-subparagraph NB-4622.11(c) discusses the repair welding procedure and welder qualification in accordance with ASME Section IX and the additional requirements of Article NB-4000. The proposed alternative will satisfy these requirements. In addition, NB-4622.11(c) requires the Welding Procedure Specification include the following requirements:

NB-4622.11(c)(1) requires the area to be welded be suitably prepared for welding in accordance with the written procedure to be used for the repair. The proposed alternative will satisfy this requirement.

NB-4622.11(c)(2) requires the use of the shielded metal arc welding (SMAW) process with covered electrodes meeting either the A-No. 8 or F-No. 43 classifications. The proposed alternative utilizes gas tungsten arc welding (GTAW) with bare electrodes meeting either the A-No. 8 or F-No. 43 classifications.

NB-4622.11(c)(3) discusses requirements for covered electrodes pertaining to hermetically sealed containers or storage in heated ovens. These requirements do not apply because the proposed alternative uses bare electrodes that do not require storage in heated ovens since bare electrodes will not pick up moisture from the atmosphere.

NB-4622.11(c)(4) discusses requirements for storage of covered electrodes during repair welding. These requirements do not apply because the proposed alternative utilizes bare electrodes, which do not require any special storage conditions to prevent the pickup of moisture from the atmosphere.

NB-4622.11(c)(5) requires preheat to a minimum temperature of 350°F prior to repair welding. The proposed ambient temperature temper bead alternative does not require elevated temperature preheat.

NB-4622.11(c)(6) establishes requirements for electrode diameters for the first, second, and subsequent layers of the repair weld and requires removal of the weld bead crown before deposition of the second layer. Because the proposed alternative uses weld filler metal much smaller than the 3/32, 1/8, and 5/32-inch electrodes required by NB-4622.11(c)(6), the requirement to remove the weld crown of the first layer is unnecessary and the proposed alternative does not include the requirement.

NB-4622.11(c)(7) requires the preheated area to be heated from 450 °F - 660 °F for a period of 4 hours minimum. The proposed alternative does not require this heat treatment because the use of the extremely low hydrogen GTAW temper bead procedure does not require the hydrogen bake-out.

NB-4622.11(c)(8) requires welding subsequent to the hydrogen bake-out of NB-4622.11(c)(7) be done with a minimum preheat of 100 °F and maximum interpass temperature of 350 °F. The proposed alternative limits the interpass temperature to 350 °F and requires the area to be welded be at least 50 °F prior to welding. These limitations have been demonstrated to be adequate to produce sound welds.

NB-4622.11(d)(1) requires a liquid penetrant examination after the hydrogen bake-out described in NB-4622.11(c)(7). The proposed alternative does not require the hydrogen bake-out nor does it require the in-process liquid penetrant examination.

NB-4622.11(d)(2) requires liquid penetrant and radiographic examinations of the repair welds after a minimum of 48 hours at ambient temperature. Ultrasonic inspection is required if practical. The proposed alternative includes the requirement to inspect after a minimum of 48 hours at ambient temperature. The geometry of the RPV head and the

orientation of the inner bore of the CRDM nozzles make effective radiographic examination impractical. The thickness of the RPV head limits the sensitivity of the detection of defects in the new pressure boundary weld. The density changes between the base and weld metal and residual radiation from the base metal would render the film image inconclusive. Therefore, examinations by the ultrasonic method will be used in lieu of examinations by the radiographic method defined by IWA-4533.

NB-4622.11(e) establishes the requirements for documentation of the weld repairs in accordance with NB-4130. The proposed alternative will comply with that requirement.

NB-4622.11(f) establishes requirements for the procedure qualification test plate. The proposed alternative complies with those requirements, except that the root width and included angle of the cavity are stipulated to be no greater than the minimum specified for the repair. In addition, the location of the V-notch for the Charpy test is more stringently controlled in the proposed alternative than in NB-4622.11(f).

NB-4622.11(g) establishes requirements for welder performance qualification relating to physical obstructions that might impair the welder's ability to make sound repairs which is particularly pertinent to the SMAW manual welding process. The proposed alternative involves a machine GTAW process and requires welding operators be qualified in accordance with ASME Section IX. The use of a machine process eliminates concern about obstructions, which might interfere with the welder's abilities since these obstructions will have to be eliminated to accommodate the welding machine.

Based on the above discussions, the staff has determined that the proposed alternative to use the ambient temperature temper bead process in lieu of the code-required temper bead process will produce sound, permanent repair welds to assure adequate structural integrity, and that compliance with the specified Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the proposed alternative is acceptable.

For the repair welds, in lieu of the progressive surface examinations required by subparagraph NB-4453.4, the licensee indicated that examination of the repair weld will include liquid penetrant and ultrasonic examinations. ASME Section III, 1989 Edition paragraph NB-5245 gives the NDE requirements for partial penetration welds. The requirements are to conduct progressive magnetic particle or liquid penetrant examinations. The finished surface is also to be examined by one of these methods. However, the licensee has proposed to eliminate the progressive surface examinations, and to conduct a surface examination and a UT examination of the finished surface after the completed weld has been at ambient temperature for at least 48 hours. The staff finds that the progressive examinations would be difficult to conduct because of interferences caused by the presence of the automatic GTAW welding equipment. As discussed in the staff's evaluation for Relief Request RR 01-15, the surface examinations will identify any surface penetrating flaws. The UT examinations should find construction and repair-related flaws when performed using appropriately demonstrated and qualified processes and personnel.

The staff has concluded that NB-5245 is not the appropriate Code section that applies to the repair since the weld configuration is not that of a partial penetration weld. The repair weld is actually a specially designed pressure boundary, structural weld used to reestablish the pressure boundary between the CRDM nozzle and RPV head. The weld configuration is not

addressed by the ASME Code. For analysis purposes, the licensee has evaluated the weld to meet the structural requirements of a partial penetration weld, and for integrity purposes, the weld is surface and volumetrically examined. The licensee has proposed that the surface examination acceptance criteria of NB-5350, and the ultrasonic examination criteria of NB-5330 be utilized. The NRC staff has determined that the proposed surface and volumetric examinations of the repair welds will be sufficient to detect any weld flaws that could compromise the weld integrity. Thus, the NRC staff finds that the proposed surface and volumetric examinations are acceptable.

The licensee indicated that "Additional acceptance criteria may be specified by the Owner to account for differences in weld configuration." The staff's acceptance of the proposed repair method, and associated examinations, is only for the configuration proposed by this relief request. Any other "difference in weld configuration" contemplated by the licensee must meet the requirements of the ASME Code, or relief must be requested from the applicable ASME Code requirements.

IWA-4710(a) and IWA-5214 state that after a repair weld is made on a pressure retaining boundary or the installation of a replacement by welding, a system hydrostatic test shall be performed in accordance with IWA-5000. The licensee has not requested relief from this requirement. This is acceptable.

Based on the above evaluation, the staff finds that compliance with certain Code-required in-process and post-repair examination requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety, and that the licensee's proposed alternative to perform post-repair surface and ultrasonic examinations as discussed, in lieu of the Code-required repair examination requirements is acceptable. Therefore, the proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii).

Per the 1989 edition of ASME Section XI, paragraph IWB-2200(a), no preservice examination is required for repairs to the J-groove welds between the vessel head and its penetrations (Examination Category B-E). However, the NDE performed after welding will serve as a preservice examination record if needed in the future. Furthermore, the inservice inspection requirement from Table IWB-2500-01, "Examination Category B-E...," is a VT-2 visual inspection of the external surfaces of 25% of the nozzles each interval with IWB-3522 as the acceptance standard. Currently, the licensee performs visual examination, VT-2, of 100% of the nozzles each refueling outage. Bulletin 2001-01 and ongoing deliberations in Code committees will be monitored to determine the necessity of performing any additional or augmented inspections.

5.0 CONCLUSION

Based on the discussion above, the staff concludes that the licensee's proposal to perform repairs to the reactor vessel closure head penetration J-groove attachment welds, in accordance with Relief Request RR 01-18, "Ambient Temperature Temper Bead Repair Technique," at TMI-1 will assure adequate structural integrity, and that the in-process and post-repair examinations as described by the licensee provides an acceptable alternative to the Code required examinations. The NRC staff finds that imposition of the Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the proposed alternative is authorized pursuant to the 10 CFR 50.55a(a)(3)(ii) for the third 10-year interval.

6.0 REFERENCES

1. AmerGen letter to NRC Dated September 12, 2001, “ASME Section XI Relief Requests Associated with Reactor Vessel Head Repair”, Revision 2

Principal Contributor: E. Andruszkiewicz

Date: December 4, 2001