UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 10, 2012

Site Vice President, Operations
Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360-5508

SUBJECT: PILGRIM NUCLEAR POWER STATION RE: RELIEF REQUEST (PRR)-21 REVISION 4 TO INSTALL A WELD OVERLAY ON RPV-N14-1 STANDBY LIQUID CONTROL SAFE-END NOZZLE WELD AT PILGRIM (TAC NO. ME7959)

Dear Sir or Madam:

By letter dated January 23, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12032A135), and superseded by letter dated April 5, 2012 (ADAMS Accession No. ML12128A152), Entergy Nuclear Operations, Inc., requested relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) requirements at Pilgrim Nuclear Power Station (Pilgrim). As an alternative to the ASME Code requirements, the licensee proposes to implement a weld overlay (WOL) repair in accordance with ASME Code Case N-504-4, Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1. The alternatives proposed in Pilgrim Relief Request (PRR)-21, revision 4 (Rev. 4) would be used to perform a WOL on the RPV-N14-1 Standby Liquid Control Safe-End Nozzle Weld at Pilgrim

The Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittal and determined that the proposed alternative will provide an acceptable level of quality and safety. Therefore, pursuant to paragraph 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations*, the NRC staff authorizes the use of PRR-21, Rev. 4 at Pilgrim for use during the remainder of the unit's fourth 10-Year inservice inspection interval which ends June 30, 2015.

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

If you have any questions, please contact Richard Guzman, the NRC's Project Manager for Pilgrim at (301) 415-1030 or email richard.guzman@nrc.gov.

Sincerely,

George A. Wilson, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-293

Enclosure:
Safety Evaluation

cc: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PILGRIM RELIEF REQUEST (PRR)-19

INSERVICE INSPECTION PROGRAM REQUEST FOR ALTERNATIVE FOR

PILGRIM NUCLEAR POWER STATION

ENTERGY NUCLEAR OPERATIONS, INC.

DOCKET NUMBER 50-293

1.0 INTRODUCTION

By letter dated January 23, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12032A135), and superseded by letter dated April 5, 2012 (ADAMS Accession No. ML12128A152), Entergy Nuclear Operations, Inc. (Entergy, the licensee), requested relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) requirements at Pilgrim Nuclear Power Station (Pilgrim or PNPS). As an alternative to the ASME Code requirements, the licensee proposes to implement a weld overlay (WOL) repair in accordance with ASME Code Case N-504-4, Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1, as modified by the licensee in its submittal letter. The alternatives proposed in Pilgrim Relief Request (PRR)-21, revision 4 (Rev. 4) would be used to perform a WOL on the RPV-N14-1 Standby Liquid Control Safe-End Nozzle Weld at Pilgrim.

2.0 REGULATORY REQUIREMENTS

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), paragraph 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 code of record for the current fourth PNPS ISI interval is the 1998 Edition with 2000 Addenda of the ASME Code, Section XI.

Pursuant to 10 CFR 50.55a(a)(3), alternatives to requirements may be authorized by the Nuclear Regulatory Commission (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 the subject relief request, pursuant to 10 CFR 50.55a(a)(3)(i), which proposed an alternative to the implementation of the ASME Code, Section XI requirements based on ASME Code Case N-504-4 as modified by the licensee for the deposition of a WOL for the remaining service life of the identified component. Regulatory Guide (RG) 1.147, Inservice Inspection Code Case Acceptability, ASME Code, Section XI, Division 1, lists the code cases that are acceptable to the NRC for application in licensee's ASME Code, Section XI ISI programs. A licensee may use a code case specified in the RG without prior approval by the NRC if it meets the conditions specified for the code case.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Component Affected

RPV-N14-1 Standby Liquid Control Safe-End Nozzle Weld

3.2 ASME Code Requirements

ASME Code, Section XI, Subparagraph IWA-4421(a) and Subarticle IWA-4520 require that repair/replacement activities be performed and examined in accordance with the Owner's Requirements and the original Construction Code of the component or system. Alternatively, IWA-4421(b) and (c) allow use of later Editions/Addenda of the Construction Code (or a later different Construction Code such as ASME Code Section III) and revised Owner Requirements. IWA-4430 and IWA-4600(b) provide alternative welding methods such as temper bead welding when the requirements of Paragraph IWA-4421 cannot be met. IWA-4520 requires that welds and weld repairs be performed in accordance with the Construction Code identified in the Repair/Replacement Plan. IWA-4530(a) requires the performance of pre-service examinations based on Subarticle IWB-2200 for Class 1 components. Table IWB-2500 prescribes inservice inspection requirements for Class 1 butt welds in piping.

As an alternative to the above, ASME Code, Section XI Code Case N-504-4 specifies requirements for performing the following:

ASME Code Case N-504-4 provides alternative requirements to reduce a defect to a flaw of acceptable size in austenitic stainless steel materials by deposition of a structural WOL on the outside surface of the pipe or component. The NRC has conditionally approved this Code Case in RG 1.147, revision 16 with the following condition:

> The provisions of [ASME Code,] Section XI, Nonmandatory Appendix Q, "Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments," must be met. In addition, the following conditions shall be met: (a) the total laminar flaw area shall not exceed 10 percent of the weld surface area, and no linear dimension of the laminar flaw area shall exceed the greater of 3 inches or 10 percent of the pipe circumference; (b) the finished overlay surface shall be 250 micro-inch (6.3 micrometers) root mean square or smoother; (c) the

surface flatness shall be adequate for ultrasonic examination; and (d) radiography shall not be used to detect planar flaws under or masked by laminar flaws.

3.3 Duration of the Alternative

The repair performed using this relief request is applicable to the fourth 10-Year ISI interval for PNPS which began July 1, 2005, and will end June 30, 2015.

3.4 Licensee's Proposed Alternatives for ASME Code Case N-504-4

3.4.1 ASME Code Case N-504-4 and ASME Code, Section XI Appendix Q apply strictly to austenitic stainless steel piping and weldments. As an alternative, Entergy proposes to use Code Case N-504-4 and ASME Code, Section XI Appendix Q to perform WOL welding on SB-166 (nozzle body), Alloy 82 welds, and austenitic stainless steel (nozzle safe end) using Alloy 52M (ERNiCrFe-7A) filler metals.

3.4.2 ASME Code Case N-504-4, paragraph (b) and ASME Code, Section XI Appendix Q, Subparagraph Q-2000(a) require that weld metal used to fabricate WOLs below carbon steel (0.035%) austenitic stainless steel. As an alternative, Entergy proposes to perform WOL welding using Alloy 52M (ERNiCrFe-7A). Therefore, this requirement does not apply.

3.4.3 ASME Code Case N-504-4, paragraph (e) and ASME Code, Section XI Appendix Q, paragraph Q-2000(d) require that as-deposited austenitic weld metal used to fabricate WOLs have a delta ferrite content as depicted by a ferrite number (FN) of at least 7.5. As an alternative, Entergy proposes to perform WOL welding using Alloy 52M (ERNiCrFe-7A) which is purely austenitic. Therefore, this delta ferrite requirement does not apply.

3.4.4 ASME Code Case N-504-4, paragraph (f)(1) and Appendix Q, paragraph Q-3000(b)(2) require that the end transition slope of the WOL "not exceed 45°." As an alternative, Entergy proposes to allow the end transition slope to exceed 45° provided the following condition is met: The as-built configuration of the WOL is analyzed by Finite Element Analysis to demonstrate compliance with the applicable stress limits of the Construction Code.

3.4.5 ASME Code Case N-504-4, paragraph (h) requires that a system hydrostatic test be performed in accordance with IWA-5000. As an alternative, Entergy proposes to perform a system leakage test in accordance with IWA-5000 and ultrasonic testing (UT) acceptance examination in accordance with the requirements and acceptance criteria of Appendix Q, Section Q-4000.

3.5 Licensee's Basis for Alternatives to Code Case N-504-4

3.5.1 ASME Code Case N-504-4 and Appendix Q apply strictly to austenitic stainless steel piping and weldments. As an alternative, Entergy has proposed to use Code Case N-504-4 and Appendix Q to perform WOL welding on SB-166, Alloy 82 welds, and

austenitic stainless steel using Alloy 52M (ERNiCrFe-7A) filler metals. This proposed alternative is acceptable because the WOL design, fabrication, examination, and preservice/inservice inspection requirements of Code Case N-504-4 and Appendix Q may also be applied to nickel alloy WOLs of non-austenitic stainless steels such as low alloy steels and nickel alloys. While some material requirements in Code Case N-504-4 and Appendix Q may only apply to austenitic stainless steels, Entergy has identified these requirements and proposed alternatives to appropriately address them.

3.5.2 ASME Code Case N-504-4, paragraph (b) and Appendix Q, paragraph Q-2000(a) require that weld metal used to fabricate WOLs below carbon steel (0.035%) austenitic stainless steel. This requirement was included in Code Case N-504-4 and Appendix Q to reduce the sensitization potential of the austenitic stainless steel WOL, thereby reducing its susceptibility to intergranular stress-corrosion cracking (IGSCC). As an alternative, Entergy has proposed to perform WOL welding using Alloy 52M (ERNiCrFe-7A) weld metal. While carbon content is not a critical factor in assessing resistance of nickel alloys to IGSCC, the chromium content is. This point has been clearly documented in Section 2.2 of EPRI Technical Report MRP-115, "Materials Reliability Program Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 82, 182, and 132 Welds."

> The only well explored effect of the compositional differences among the weld alloys on IGSCC is the influence of chromium. Buisine, et al. evaluated the IGSCC resistance of nickel-based weld metals with various chromium contents ranging from about 15 percent to 30 percent chromium. Testing was performed in doped steam and primary water. Alloy 182, with about 14.5 percent chromium, was the most susceptible. Alloy 82 with 18-20 percent chromium took three or four times longer to crack. For chromium contents between 21 and 22 percent, no stress corrosion crack initiation was observed...

To conclude, Alloy 52M weld metal has high chromium content (28 -31.5%); therefore, it has excellent resistance to IGSCC.

3.5.3 ASME Code Case N-504-4, paragraph (e) and Appendix Q, paragraph Q-2000(d) require that as-deposited austenitic weld metal used to fabricate WOL have a delta ferrite content of at least 7.5 FN. This requirement was included in Code Case N-504-4 and Appendix Q to reduce the sensitization potential of the austenitic stainless steel WOL, thereby reducing its susceptibility to IGSCC. As an alternative, Entergy has proposed to perform WOL welding using Alloy 52M (ERNiCrFe-7A) weld metal which has a purely austenitic microstructure. Therefore, the requirement to measure delta ferrite does not apply in this application. The susceptibility of nickel alloys to IGSCC is dependent on its chromium content as explained above. Furthermore, the chromium content of the first layer of Alloy 52M weld metal could be reduced due to dilution with the underlying base and weld materials. Because this is the case, Entergy has self-imposed the following restriction on the first layer of the WOL:

> The first layer of Alloy 52M weld metal deposited may not be credited toward the required thickness. Alternatively, a diluted layer may be

credited toward the required thickness, provided the portion of the layer over the austenitic base material, austenitic weld, and the associated dilution zone from an adjacent ferritic base material contains at least 20 percent chromium. The chromium content of the deposited weld metal may be determined by chemical analysis of the production weld or from a representative coupon taken from a mockup prepared in accordance with the WPS [Welding Procedure Specification] (or a representative WPS) for the production weld.

3.5.4 ASME Code Case N-504-4, paragraph (f)(1) and Appendix Q, paragraph Q-3000(b)(2) require that the end transition slope of the WOL "not exceed 45°". It is Entergy's intent to comply with this requirement. However, the close proximity of the WOL to the instrument lines of the Jet Pump Instrument Penetration Seal Assembly limits Entergy's ability to lengthen the WOL along the penetration seal assembly. This interference could necessitate the design and installation of an end transition slope that exceeds 45°. Should this condition exists, Entergy will analyze the as-built configuration of the WOL using Finite Element Analysis to demonstrate compliance with the applicable stress limits of the Construction Code or ASME Section III.

3.5.5 Code Case N-504-4, paragraph (h) requires that a system hydrostatic test be performed in accordance with IWA-5000 when a flaw penetrates the full thickness of the pressure boundary. For non-through-wall flaw conditions, Code Case N-504-4 allows performance of a system leakage test. Pressure testing is not addressed by Appendix Q. As an alternative, Entergy proposes to perform a system leakage test in accordance with IWA-5000. This proposal is consistent with the pressure testing requirements of IWA-4540 and Code Case N-416-3, except that, the non-destructive examination (NDE) requirements of IWA-4540 and N-416-3 would not apply to a WOL. The WOL acceptance examination will include both liquid penetrant and UT examinations. Liquid penetrant examinations will be performed in accordance with ASME Section III while the UT examination will be performed in accordance with Appendix VIII, Supplement 11 of ASME Section XI as implemented by the Performance Demonstration Initiative (PDI). The UT acceptance standards are as specified in Tables IWB-3514-2 and 3.

3.6 NRC Staff Evaluation of Alternatives to Code Case N-504-4

Under the rules of ASME Code, Section XI, IWA-4421, repairs shall be performed in accordance with the Owner's Requirements and the original Construction Code. Later editions and addenda of the Construction Code or of ASME Code, Section III, either in their entirety or portions thereof, and ASME Code Cases may be used. Code Case N-504-4, as modified by the identified alternatives, will be used by the licensee for installation of a weld overlay on the RPV-N14-1 Standby Liquid Control Safe-End Nozzle Weld. Code Case N-504-4 was conditionally approved by the NRC staff for use under RG 1.147, Revision 16. Therefore, the use of Code Case N-504-4 as an alternative to the mandatory ASME Code repair provisions is acceptable to the NRC staff, provided that all conditions and provisions specified in RG 1.147, Revision 16 are complied with.

The requests for alternative shown in paragraphs 3.5.1, 3.5.2, and 3.5.3 above all relate to the same topic, i.e., application of Code Case N-504-4 and ASME Code, Section XI,

Appendix Q to SB-166, Alloy 82 welds, and austenitic stainless steel using Alloy 52M (ERNiCrFe-7A) filler metals instead of strictly austenitic stainless steel piping and weldments. Therefore, the bases for paragraph 3.6.1 below apply to paragraphs 3.6.2 and 3.6.3 also.

The licensee's proposed implementation of ASME Code, Section XI, Appendix Q for the ISI and subsequent additional examinations of the WOL is acceptable since RG 1.147, Revision 16 requires this condition to be met when using ASME Code Case N-504-4. ASME Code, Section XI, Appendix Q, provides an alternative to the requirements of IWA-4420, IWA-4520, IWA-4530, and IWA-4600 for making repairs to, and the examination of, Class 1, 2, and 3 austenitic stainless steel pipe weldments by deposition of a weld overlay on the outside surface of the pipe.

3.6.1 The first and second proposed modifications to the Code Case N-504-4 and ASME Code, Section XI, Appendix Q, provisions involve the use of a nickel-based alloy weld material rather than austenitic stainless steel. The licensee stated that Paragraph (b) of Code Case N-504-4 requires that the reinforcement weld material shall be low carbon (0.035% maximum) austenitic stainless steel and ASME Code, Section XI, Appendix Q is for Weld Overlay Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping Weldments. In lieu of the stainless steel weld material, Alloy 52M, a consumable welding wire, which is highly resistant to SCC, was proposed for the overlay weld material. The NRC staff notes that the use of Alloy 52M material is consistent with weld materials used to perform similar WOLs at other operating boiling water reactor (BWR) facilities. The NRC staff also notes that the licensee is performing the subject WOL on dissimilar metal welds made of Alloy 82/182 material. For material compatibility in welding, the NRC staff considers that Alloy 52M is a better choice of filler material than austenitic stainless steel material for this weld joint configuration. Alloy 52M contains about 30 percent chromium which would provide excellent resistance to SCC if exposed to the reactor coolant environment. This material is identified as F-No. 43 filler metal and has been previously approved by the NRC staff for similar applications. Therefore, the licensee's proposed use of Alloy 52M for the WOL as a modification to the requirements of Code Case N-504-4, Paragraph (b) and ASME Code Section XI, Appendix Q is acceptable as it will provide an acceptable level of quality and safety.

The third proposed modification is to Code Case N-504-4 Paragraph (e) and ASME Code Section XI, Appendix Q which require as-deposited delta ferrite measurements of at least 7.5 FN for the weld reinforcement. The licensee proposed that delta ferrite measurements will not be performed for this overlay because the deposited Alloy 52M material is 100 percent austenitic and contains no delta ferrite due to the high nickel composition (approximately 60 percent nickel). Code Case N-504-4 and ASME Code Section XI, Appendix Q are designed for WOL repair of austenitic stainless steel piping. Therefore, the material requirements regarding the delta ferrite content of at least 7.5 FN, as delineated in Code Case N-504-4, Paragraph (e), and ASME Code Section XI, Appendix Q for an austenitic stainless steel WOL material are not applicable to Alloy 52M, a nickel-based material which would be used for the WOL. Therefore, the NRC staff finds that the requested alternative will provide an acceptable level of quality and safety.

3.6.2 Same as 3.6.1.

3.6.3 Same as 3.6.1.

3.6.4 The fourth proposed modification is to Code Case N-504-4, paragraph (f)(1) and ASME Code, Section XI, Appendix Q, Subparagraph Q-3000(b)(2) which require that the end transition slope of the WOL "not exceed 45°." The licensee intends to comply with this requirement. However, the primary purpose of this weld overlay is to make the weld configuration able to be UT inspected, but due to the geometry of the configuration of the weldment and interferences from other equipment the licensee may not be able to comply with this requirement. The licensee will demonstrate compliance with the applicable stress limits of the Construction Code or ASME Code, Section III on this weld configuration. Therefore, since the weld configuration will meet the applicable stress limits of the original Construction Code or ASME Code, Section III, the NRC staff finds that the requested alternative will provide an acceptable level of quality and safety.

3.6.5 The licensee's proposed modification to Paragraph (h) of Code Case N-504-4 is to perform leak testing in accordance with ASME Code, Section XI, IWA-5000. Use of a leak test at normal operating temperature and pressure in lieu of a hydrostatic test has been incorporated in ASME Code, Section XI beginning in the 1998 Edition with the 1999 Addenda. Pilgrim is currently in its fourth 10-year ISI interval and the ISI Code of record for the fourth 10-year ISI interval is the 1998 Edition with 2000 Addenda of the ASME Code, Section XI. As the licensee's alternative is consistent with the current practice, the NRC staff finds the licensee's basis for this alternative as acceptable.

4.0 CONCLUSION

Based on the discussion above, the NRC staff concludes that the alternatives proposed in PRR-21, Rev. 4 to perform a WOL on the RPV-N14-1 Standby Liquid Control Safe-End Nozzle Weld dissimilar metal weld will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes PRR-21, Rev. 4 for the installation of a WOL on the RPV-N14-1 Standby Liquid Control Safe-End Nozzle Weld dissimilar metal weld. This relief request is authorized for use during the remainder of the unit's fourth 10-Year ISI interval which ends June 30, 2015.

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.

Principal Contributor: E. Andruszkiewicz

Date: July 10, 2012

Please contact me at (301) 415-1711, or the Project Manager, Richard V. Guzman, at (301) 415-1030, if you have any questions.

Sincerely,

/ra/

George A. Wilson, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-293

Enclosure:
Safety Evaluation

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