



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

March 15, 2016

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

SUBJECT: PILGRIM NUCLEAR POWER STATION - ISSUANCE OF RELIEF REQUEST
NO. PRR-51 - RELIEF FROM CERTAIN ASME CODE, TABLE IWB-2500-1,
REACTOR VESSEL CIRCUMFERENTIAL WELD EXAMINATION
REQUIREMENTS (CAC NO. MF6361)

Dear Sir or Madam:

By letter dated June 4, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15166A037), as supplemented by letter dated October 21, 2015 (ADAMS Accession No. ML15301A255), Entergy Nuclear Operations, Inc. (the licensee) submitted Relief Request Nos. PRR-50 and PRR-51 to the U.S. Nuclear Regulatory Commission (NRC) for relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI requirements at the Pilgrim Nuclear Power Station (Pilgrim). (The October 21, 2015, letter was relative only to Relief Request No. PRR-50.) On January 5, 2016, the NRC issued a safety evaluation (SE) to the licensee for Relief Request No. PRR-50 (ADAMS Accession No. ML15338A309).

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(z)(1), the licensee requested to use proposed alternative Relief Request No. PRR-51 on the basis that the alternative provides an acceptable level of quality and safety. The licensee proposed an alternative to reactor vessel (RV) circumferential weld examinations as currently required by the ASME Code, Table IWB-2500-1, through the period of extended operation (PEO).

The NRC staff finds that the information submitted by the licensee related to the RV circumferential welds supports the determination that the conditional probability of failure at the end of the PEO is bounded by the limiting conditional probability of failure for a Combustion Engineering-fabricated RV. Therefore, the staff finds that the licensee has met the two plant-specific conditions described in Generic Letter 98-05, "Boiling Water Reactor Licensees Use of the BWRVIP-05 Report to Request Relief from Augmented Examination Requirements on Reactor Pressure Vessel Circumferential Shell Welds," which are required to obtain relief from inspection of circumferential RV welds.

As set forth in the enclosed SE, the NRC staff concludes that the alternatives proposed in Relief Request No. PRR-51 will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(z)(1), the request for proposed alternative, PRR-51, is authorized for use during the remainder of the PEO for Pilgrim, which began May 29, 2012, and ends June 8, 2032.

Vice President, Operations

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All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this proposed alternative Relief Request No. PRR-51, remain in effect.

If you have any questions, please contact the project manager, Booma Venkataraman, at (301) 415-2934 or Booma.Venkataraman@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Travis L. Tate". The signature is fluid and cursive, with a long horizontal stroke at the end.

Travis L. Tate, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-293

Enclosure:
Safety Evaluation

cc w/enclosure: Distribution via Listserv



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PROPOSED ALTERNATIVE RELIEF REQUEST NO. PRR-51

ENTERGY NUCLEAR OPERATIONS, INC.

PILGRIM NUCLEAR POWER STATION

DOCKET NO. 50-293

1.0 INTRODUCTION

By letter dated June 4, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15166A037), as supplemented by letter dated October 21, 2015 (ADAMS Accession No. ML15301A255), Entergy Nuclear Operations, Inc. (Entergy or the licensee) submitted Relief Request Nos. PRR-50 and PRR-51 to the U.S. Nuclear Regulatory Commission (NRC) for relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI requirements at the Pilgrim Nuclear Power Station (Pilgrim). (The October 21, 2015, letter was relative only to Relief Request No. PRR-50.) On January 5, 2016, the NRC issued a safety evaluation (SE) to the licensee for Relief Request No. PRR-50 (ADAMS Accession No. ML15338A309).

In its June 4, 2015, letter (ADAMS Accession No. ML15166A037), Entergy submitted a request to the NRC for relief. Pilgrim Relief Request No. PRR-51 requested relief from reactor vessel (RV) circumferential weld examinations as currently required by the ASME Code, Table IWB-2500-1, through the end of the period of extended operation (PEO) for Pilgrim. The request for the proposed alternative relief was made pursuant to the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(z)(1), for the remainder of Pilgrim's PEO, which will end on June 8, 2032. The ASME Code of record for Pilgrim's fourth 10-year in-service inspection (ISI) interval is the 2001 Edition through the 2003 Addenda.

The proposed alternative would eliminate the requirement to inspect the circumferential welds, except for the areas of intersection with the axial welds, consistent with the guidance provided in Generic Letter (GL) 98-05, "Boiling Water Reactor Licensees Use of the BWRVIP-05 Report to Request Relief from Augmented Examination Requirements on Reactor Pressure Vessel Circumferential Shell Welds" (ADAMS Accession No. ML031430368), and the NRC staff's SE for Electric Power Research Institute report, "BWR Vessel and Internals Project [BWRVIP], BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations (BWRVIP-05)" (BWRVIP-05) (ADAMS Legacy Accession No. 9808040037).

During the staff's review of the Pilgrim license renewal application, the staff requested additional information to determine whether the licensee intended to apply for relief from the ASME Code RV circumferential weld examination requirements for the PEO. By letter dated October 6, 2006

Enclosure

(ADAMS Accession No. ML062910173), the licensee indicated that a request for alternative under the provisions of 10 CFR 50.55a would be submitted to exclude the RV shell circumferential welds from examination. Therefore, the proposed alternative addresses the NRC staff's expectation that relief would be requested as described in Section 4.2.5 of NUREG-1891, "Safety Evaluation Report Related to the License Renewal of Pilgrim Nuclear Power Station" (ADAMS Accession No. ML073241016).

2.0 REGULATORY REQUIREMENTS

The ISI of the ASME Code, Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as required by 10 CFR 50.55a(g). Section 50.55a(z)(1) of 10 CFR states that alternatives to the requirements of paragraph (g) may be used when authorized by the NRC if the "proposed alternatives would provide an acceptable level of quality and safety."

Pursuant to 10 CFR 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 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.

Pursuant to 10 CFR 50.55a(z)(1), alternatives to requirements may be authorized by the NRC if the licensee demonstrates that the proposed alternatives provide an acceptable level of quality and safety. The licensee submitted the subject request for authorization of an alternative, pursuant to 10 CFR 50.55a(z)(1), and proposed relief from RV circumferential weld examinations as currently required by the ASME Code, Table IWB-2500-1, through the end of the PEO for Pilgrim.

For RV circumferential welds, the NRC staff's final SE for Topical Report (TR) BWRVIP-05, dated July 28, 1998, concluded that elimination of the ISI of the RV circumferential welds for boiling-water reactors (BWRs) is justified, since the failure frequency for circumferential welds in BWR plants is significantly below the criterion specified in Regulatory Guide (RG) 1.154, "Format and Content of Plant-Specific Pressurized Thermal Shock Safety Analysis Reports for Pressurized Water Reactors," dated January 1987 (ADAMS Accession No. ML003740028). The NRC staff notes that RG 1.154 was withdrawn on January 14, 2011 (76 FR 2726), for general application to future licensee relief requests. However, the acceptability of the use of BWRVIP-05, specifically for Pilgrim, was previously affirmed in the NRC staff technical evaluation presented in Section 4.2.5 of NUREG-1891.

GL 98-05 provided recommendations for licensees planning to request permanent relief from the ISI requirements of 10 CFR 50.55a(g) for the volumetric examination of circumferential RV welds (ASME Code Section XI, Table IWB-2500-1, Examination Category B-A, Item 1.11,

Circumferential Shell Welds). The recommendations were based on the NRC staff's final SE of TR BWRVIP-05 and included the need for licensees to perform their required inspections of "essentially 100 percent" of all axial welds. These recommendations were only applicable to the remaining term of operation under the initial existing license. Section 4.2.5 of NUREG-1891, however, noted the NRC staff's expectation that relief would be requested for the PEO utilizing neutron fluence calculations consistent with RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," dated March 2010 (ADAMS Accession No. ML010890301), to demonstrate that limiting neutron fluence values will not be reached during the PEO. Neutron fluence projections are needed to support the determination that the conditional failure probability of the welds for which relief is requested remains bounded by the limiting conditional failure probability described in the NRC staff's final SE of TR BWRVIP-05. RG 1.190 describes methods and assumptions acceptable to the NRC staff for determining the RV neutron fluence.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Component Affected

The ASME Code components affected by the licensee's proposed alternative are listed below:

Code Class:	1
Weld Numbers:	RPV-C-1-344, RPV-C-9-338, RPV-C-3-339A, and RPV-C-3-339B
Examination Category:	B-A
Item Number:	B1.11

3.2 ASME Code Requirements

The ASME Code, Section XI, 2007 Edition through 2008 Addenda, Table IWB-2500-1, Examination Category B-A, Item B1.11, requires a volumetric examination of all (essentially 100 percent) of the circumferential shell welds each interval.

3.3 Licensee's Proposed Alternative to the ASME Code

The licensee's proposed alternative is permanent relief from the ISI requirements of 10 CFR 50.55a(g) for the volumetric examination of circumferential RV welds (ASME Code, Section XI, Table IWB-2500-1, Examination Category B-A, Item B1.11). This is based on the probabilistic risk analysis of BWRVIP-05, combined with the continued implementation of operator procedures and training to limit the frequency of cold overpressure events in accordance with the recommendations of GL 98-05. The licensee will continue to perform their required inspections of "essentially 100 percent" of all axial welds.

3.4 Licensee's Basis for Alternative

As its technical basis for relief from inspection of the RV circumferential welds, the licensee cited information from Section 4.2.5 of NUREG-1891. In the license renewal application and NUREG-1891, relief from the circumferential weld examination was evaluated as a time-limited aging analysis (TLAA). The licensee provided plant-specific information to demonstrate that the RV will remain bounded by the assumptions of BWRVIP-05 for the PEO.

During review of the Pilgrim license renewal application, the staff found the RV neutron fluence TLAA evaluation in Section 4.2.1 of the original application unacceptable, due to lack of benchmarking data in support of the plant-specific neutron fluence calculations. This was identified as Open Item (OI) 4.2. As stated in the June 4, 2015, submittal:

To close the OI, PNPS [Pilgrim Nuclear Power Station] proposed an alternative analysis to address all fluence related TLAAs for the extended operating period.

The alternative analysis assumed increasing fluence levels until an ASME Code or regulatory limit is reached based on the projected changes in material properties. Changes in the vessel (ferritic) steel material properties are measured by an increase in adjusted reference temperature or a decrease in Charpy upper-shelf energy. The effects of increasing fluence on the austenitic stainless steel core shroud and internals was also considered. By assuming increasing fluence levels, the analysis identifies the maximum fluence that can be experienced while meeting the Code and regulatory criteria. This analysis also shows that there is a large margin available to this limiting fluence at the end of the PEO.

The analysis determined that the limiting fluence value was set by a maximum mean RT_{NDT} value for the axial weld failure probability of 114 EF, in order for the axial weld failure frequency to remain below 5×10^{-6} per reactor operating year. The corresponding maximum allowable inner diameter (ID) fluence for the RV axial welds was determined to be 3.37×10^{18} n/cm². If the fluence remains below this limiting value during the PEO, the fluence will result in acceptable results for all fluence-related TLAAs. To confirm that the limiting fluence will not be reached during the PEO and consequently that all of the fluence-related TLAAs remain valid, Commitment 48, was added, but subsequently superseded by [License Renewal Condition] LRC 4.2.6.

The staff issued License Condition 4.2.6: On or before June 8, 2010, the applicant (Entergy) will submit to the NRC correctly benchmarked RV neutron fluence calculations, consistent with RG 1.190, that will confirm that the neutron fluence for the lower intermediate shell axial welds, at the inner surface of the RV, will not reach the limiting value of 3.37×10^{18} n/cm² ($E > 1.0$ Me V) by the end of the period of extended operation (54 EFPY [effective full-power year]).

LRC 4.2.6 was addressed by PNPS letter dated January 24, 2010, "Proposed License Amendment to Technical Specifications: P-T Limit Curves and Relocation of Pressure- Temperatures (P-T) Curves to the Pressure and Temperature Limits Report (PTLR)." In part, information provided to the staff in response to LRC 4.2.6 stated:

Pilgrim has been a participant in the NRC approved BWRVIP Integrated Surveillance Program as authorized by License Amendment No. 209. As such, Pilgrim opted to use the Monticello Nuclear Power Plant, a BWR/3 class plant, benchmarking evaluation to produce benchmarked Pilgrim-specific fluence and ART values, and revised P-T curve. Entergy has determined that Monticello reactor pressure vessel fluence calculation for a BWR/3 provides an acceptable benchmark for Pilgrim fluence data to support revised P-T Curves for Pilgrim Operating Cycle 18 and beyond. This information was discussed with the NRC Staff on or about October 17, 2008. The NRC staff concurred with the Entergy approach to use Monticello fluence for benchmarking Pilgrim RAMA fluence calculation (as documented in NRC ADAMS Accession Number ML090370920) and to submit Pilgrim revised P-T curves for NRC approval.

3.5 Duration of the Alternative

The licensee requested use of the proposed alternative for the entire PEO for Pilgrim, which ends June 8, 2032.

3.6 NRC Staff Evaluation of the Alternative

Section 4.2.5 of NUREG-1891 documents the NRC staff's evaluation of the RV circumferential weld TLAA. In accordance with the requirements from the NRC staff's SE of BWRVIP-05 for plants to be granted relief from inspection of circumferential welds, the NRC staff concluded that the conditional failure probability of the Pilgrim RV circumferential welds would be bounded by the limiting conditional probability of failure for RVs fabricated by Combustion Engineering for the duration of the PEO. The staff evaluation in Section 4.2.5 of NUREG-1891 states:

Section A.4.5 of the BWRVIP-74 Report indicates that the staff's SER of the BWRVIP-05 report conservatively evaluated the BWR RVs to 64 EFPY, 10 EFPY greater than realistically expected for the end of the license renewal period. In its SE on the BWRVIP-05 Report dated July 28, 1998, the staff used the mean RT_{NDT} value to evaluate the failure probability of BWR circumferential welds at 32 and 64 EFPY. The neutron fluence in this evaluation was that at the RV inner diameter clad-weld interface.

As reported in SE Section 4.2, the staff found that the applicant correctly applied the 64 EFPY mean RT_{NDT} value of 128.5 °F [degrees Fahrenheit] from Table 2.6-5 of the staff SER on the BWRVIP-05 Report in the back-calculation of

the maximum allowable 54 EFPY fluence for this TLAA. The staff used this mean RT_{NDT} value in its evaluation of the BWRVIP-05 Report for determining an acceptable circumferential weld conditional failure probability. The 128.5 °F 64 EFPY mean RT_{NDT} value from the staff SER on the BWRVIP-05 Report is characteristic of welds by Combustion Engineering, which fabricated the circumferential welds in the RV.

During the original license renewal review, the staff concluded that due to the lack of benchmarking data in support of the plant-specific RAMA neutron fluence calculations, it was not able to approve the 54 EFPY fluence values for use in support of the TLAA for the RV circumferential weld inspection relief. License Condition 4.2.6 was imposed to confirm the results of the applicant's calculations regarding the RV circumferential weld examination relief TLAA as projected through the PEO.

By letter dated January 24, 2010 (ADAMS Accession No. ML 100270054), as supplemented by letters dated September 7, 2010, and November 4, 2010 (ADAMS Accession Nos. ML102580240 and ML103200208, respectively), the licensee submitted modifications to the Pilgrim Technical Specifications (TSs), Section 1.0, "Definitions"; Section 3.6, "Primary System Boundary," Specification 3.6.A; and Section 5.5, "Programs and Manuals," to include reference to the Pressure and Temperature Limits Report (PTLR) in addressing LRC 4.2.6. The staff SE dated January 26, 2011 (ADAMS Accession No. ML110050298), approved the changes, including revised neutron fluence calculations, which the staff determined were based upon acceptable benchmarking data.

The NRC staff performed a confirmatory calculation of the mean RT_{NDT} for the limiting circumferential weld using the cited neutron fluence, copper, and nickel values, and obtained the same results as the licensee. The NRC staff concludes that the licensee has demonstrated that the conditional failure probability of the Pilgrim RV, with no circumferential weld examinations, will remain bounded through the end of the PEO. This is in accordance with the limiting conditional failure probability from the NRC staff's final SE of BWRVIP-05, since the mean RT_{NDT} values will remain bounded by the generic mean RT_{NDT} value for an RV fabricated by Combustion Engineering. Therefore, the NRC staff finds the licensee's alternative to be acceptable for the duration of the PEO.

4.0 CONCLUSION

The NRC staff finds the information submitted by the licensee related to the RV circumferential welds supports the determination that the conditional probability of failure at the end of the PEO is bounded by the limiting conditional probability of failure for a Combustion Engineering-fabricated RV. This finding is based on the projected mean RT_{NDT} of the limiting circumferential weld material for Pilgrim, which is a function of the chemistry and projected neutron fluence for this material. The projected mean RT_{NDT} values for Pilgrim are less than the mean RT_{NDT} value associated with the limiting conditional failure probability for a Combustion Engineering-fabricated RV cited in the NRC staff's SE of BWRVIP-05. Additionally, the licensee will continue to implement operator training and procedures to limit the frequency of cold overpressure events to the amount specified in the NRC staff's SE for the BWRVIP-05 report issued on July 28, 1998. Therefore, the licensee has met the two plant-specific conditions described in GL 98-05 that are

required to obtain relief from inspection of circumferential RV welds.

On this basis, the NRC staff concludes that the proposed alternative for relief from inspection of RV circumferential welds provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(z)(1), the request for proposed alternative, PRR-51, from the requirements of the ASME Code, Section XI, Table IWB-2500-1, Examination Category B-A, Item B1.11, pertaining to RV circumferential shell welds is authorized for Pilgrim for the duration of the PEO as defined in Section 3.5 of this SE.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this proposed alternative, Relief Request No. PRR-51, remain in effect.

Principal Contributor: Carolyn Fairbanks

Date: March 15, 2016

Vice President, Operations

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All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this proposed alternative Relief Request No. PRR-51, remain in effect.

If you have any questions, please contact the project manager, Booma Venkataraman, at (301) 415-2934 or Booma.Venkataraman@nrc.gov.

Sincerely,

/RA/

Travis L. Tate, 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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*by memo

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