



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

April 19, 2021

Mr. Kevin Cimorelli
Site Vice President
Susquehanna Nuclear, LLC
769 Salem Boulevard
NUCSB3
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SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 – RELIEF REQUEST 4RR-02, REVISION 1, REGARDING EXTENSION OF PERMANENT RELIEF FROM ULTRASONIC EXAMINATION OF REACTOR PRESSURE VESSEL CIRCUMFERENTIAL SHELL WELDS (EPID L-2020-LLR-0152)

Dear Mr. Cimorelli:

By letter dated November 30, 2020, Susquehanna Nuclear, LLC (the licensee) submitted Relief Request 4RR-02, Revision 1, to the U.S. Nuclear Regulatory Commission (NRC) for the use of an alternative to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section XI requirements at Susquehanna Steam Electric Station (Susquehanna), Units 1 and 2.

Specifically, pursuant to Section 50.55a(z)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety. The licensee submitted Relief Request 4RR-02, Revision 1, to the NRC-approved alternative 4RR-02, Revision 0, which is part of the fourth inservice inspection program. Relief Request 4RR-02 grants relief from reactor pressure vessel circumferential weld examinations as currently required by the ASME Code, Table IWB-2500-1, through the end of the period of extended operation at Susquehanna, Units 1 and 2.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all the regulatory requirements set forth 10 CFR 50.55a(z)(1) and thus provides an acceptable level of quality and safety. Therefore, relief from reactor pressure vessel circumferential shell weld examinations is authorized for Susquehanna, Units 1 and 2, for the duration of the 20-year term of the renewed operating license, which expires on July 17, 2042, for Susquehanna, Unit 1, and on March 23, 2044, for Susquehanna, Unit 2.

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

K. Cimorelli

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If you have any questions, please contact the Susquehanna project manager, Sujata Goetz, at 301-415-8004 or by e-mail to Sujata.Goetz@nrc.gov.

Sincerely,

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-387 and 50-388

Enclosure:
Safety Evaluation

cc: Listserv



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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST 4RR-02, REVISION 1

REGARDING EXTENSION OF PERMANENT RELIEF FROM ULTRASONIC EXAMINATION

OF REACTOR PRESSURE VESSEL CIRCUMFERENTIAL SHELL WELDS

FOR THE RENEWED OPERATING LICENSE TERM

SUSQUEHANNA NUCLEAR, LLC

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2

DOCKET NOS. 50-387 AND 50-388

1.0 INTRODUCTION

By letter dated November 30, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20335A456), Susquehanna Nuclear, LLC (the licensee) submitted Relief Request 4RR-02, Revision 1, to the U.S. Nuclear Regulatory Commission (NRC) staff approved alternative 4RR-02, Revision 0, dated August 30, 2013 (ADAMS Accession No. ML13247A167), which is part of the fourth inservice inspection (ISI) program plan. Specifically, in proposed alternative 4RR-02, Revision 1, the licensee requested relief from reactor pressure vessel (RPV) circumferential weld examinations as currently required by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section XI, Table IWB-2500-1, through the end of the period of extended operation (PEO) at Susquehanna Steam Electric Station (Susquehanna), Units 1 and 2.

The proposed alternative in 4RR-02, Revision 1, which was made pursuant to the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(z)(1), would eliminate the requirement to inspect the RPV circumferential welds, except for the areas of intersection with the axial welds for the PEO. Such relief was previously granted by the NRC for the fourth ISI interval at Susquehanna, Units 1 and 2, as documented in the NRC safety evaluation (SE) dated June 9, 2014 (ADAMS Accession No. ML14141A073).

The NRC staff-approved alternative 4RR-02 is consistent with the guidance provided in Generic Letter 98-05, "Boiling Water Reactor [BWR] Licensees Use of the BWRVIP-05 [Boiling Water Reactor Vessel Internals Project] Report to Request Relief from Augmented Examination Requirements on Reactor Pressure Vessel Circumferential Shell Welds," dated November 10, 1998 (ADAMS Accession No. ML031430368), for operation under the initial license, and the NRC SE dated October 18, 2001, in BWRVIP-74-A, "BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines for License Renewal" (ADAMS Accession No. ML031710349; non-publicly available), for the PEO.

Enclosure

The proposed alternative is for the 20-year term which will end on July 17, 2042, for Susquehanna, Unit 1, and March 23, 2044, for Susquehanna, Unit 2. The ASME Code of record for the fifth and sixth 10-year ISI intervals is the 2007 Edition through the 2008 Addenda. RPV circumferential weld examination relief was reviewed as a time-limited aging analysis during the NRC staff's review of the Susquehanna, Units 1 and 2, license renewal application. This time-limited aging analysis was addressed in NUREG-1931, "Safety Evaluation Report Related to the License Renewal of Susquehanna Steam Electric Station," dated November 2009 (ADAMS Accession No. ML093170786).

2.0 REGULATORY EVALUATION

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). The regulation at 10 CFR 50.55a(z)(1) states that alternatives to the requirements of paragraph (g) may be used when authorized by the NRC if the "proposed alternative 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 120-month 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(a) and subjected to the conditions listed in 10 CFR 50.55a(b), 12 months prior to the start of the 120-month interval.

For RPV circumferential welds, the July 28, 1998, SE for BWRVIP-05 (ADAMS Accession No. ML20236V551), concluded that elimination of the ISI of the RPV circumferential welds for 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 Susquehanna, was previously affirmed in the NRC staff's technical evaluation presented in Section 4.2.4, "Reactor Vessel Circumferential Weld Examination Relief," of NUREG-1931.

Generic Letter 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 RPV circumferential 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 July 28, 1998, SE for 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. The SE in BWRVIP-74-A specified similar recommendations for the PEO.

Section 4.2.5 of NUREG-1931 noted that the anticipated changes in metallurgical conditions expected over the PEO require an additional analysis for 54 effective full power years (EFPY) to be reviewed and approved by the NRC staff.

The NRC staff relies on RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," dated March 2001 (ADAMS Accession No. ML010890301), to evaluate the neutron fluence at 54 EFPY for Susquehanna, Units 1 and 2. RG 1.190 describes methods and assumptions acceptable to the NRC staff for determining the RPV 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

Component Weld Identification Numbers: AA, AB, AC, AD, and AE

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 for all RPV circumferential shell welds each interval.

3.3 Duration of the Alternative

The licensee requested use of the proposed alternative for the 20-year term of the renewed operating license which expires on July 17, 2042, for Susquehanna, Unit 1, and March 23, 2044, for Unit 2.

3.4 Licensee's Proposed Alternative to the ASME Code

The licensee's proposed alternative requests relief from the ISI requirements of 10 CFR 50.55a(g) for the volumetric examination of RPV circumferential welds (ASME Code, Section XI, Table IWB-2500-1, Examination Category B-A, Item B1.11) through July 17, 2042, for Susquehanna, Unit 1, and March 23, 2044, for Susquehanna, Unit 2. The licensee stated that axial seam welds (Examination Category B-A Item B1.12) and their intersections with associated circumferential weld seams will be examined (covering approximately 2 to 3 percent of the circumferential welds). The licensee stated that these inspections are being proposed as an alternative to the ISI requirements for circumferential welds in ASME Code, Section XI.

3.5 Licensee's Basis for Alternative

The technical basis for supporting the requested alternative was based on the July 28, 1998, SE for BWRVIP-05 and included the need for licensees to perform their required inspections of

“essentially 100 percent” of all axial welds. The two conditions addressed in the SE for BWRVIP-05 are: (1) at the end of the license period, the circumferential RPV beltline welds shall satisfy the limiting conditional failure probability, and (2) the licensee must implement operator training and operating procedures to limit the frequency of cold overpressure events to the amount specified.

Compliance with these conditions ensures that the Susquehanna, Units 1 and 2, will operate safely with acceptably low probability of failures in the RPV circumferential welds through the end of the license period. For the 20 years of PEO, the NRC staff’s SE for the BWRVIP-74 stipulates additional plant-specific evaluation requirements which should be complied with by an applicant for the NRC staff to authorize an inspection alternative for the RPV circumferential welds. The criteria for plant-specific evaluation are addressed in Action Item 11 of the SE for BWRVIP-74-A, which requires that applicants demonstrate that

- At the end of the renewal period, the circumferential welds will satisfy the limiting conditional failure frequency for circumferential welds in Appendix E of the BWRVIP-05 SE, and
- They have implemented operator training and established procedures that limit the frequency of cold overpressure events to the amount specified in the BWRVIP-05 SE.

The licensee stated that the chemistry values, cumulative fluence value, and the extent of neutron embrittlement of the bounding weld (addressed above) at the end of license (EOL) are bounded by the NRC staff analyses, valid for 64 EFPY, as addressed in the staff’s SE for the BWRVIP-05 report.

The licensee stated that the NRC staff previously reviewed the operator training as part of the relief request and approved the license renewal with the proviso that a new application would be submitted in the PEO consistent with the earlier relief request.

Furthermore, the licensee stated that it will perform essentially 100 percent of axial welds and essentially zero percent (approximately 2 to 3 percent) of circumferential welds at their points of intersection with the axial welds. These inspections were proposed as an alternative to the ISI requirements.

3.6 NRC Staff Evaluation of the Alternative

The NRC staff reviewed the licensee’s technical basis for requesting the alternative which allows the licensee to eliminate ISI examination of the RPV beltline circumferential welds throughout the PEO for Susquehanna, Units 1 and 2. The licensee conservatively evaluated the extent of neutron embrittlement in the RPV beltline circumferential welds for both Units 1 and 2 at Susquehanna. This review is consistent with the staff’s July 28, 1998, SE for BWRVIP-05 which includes conservative evaluation of the neutron embrittlement in the RPV beltline circumferential welds to 64 EFPY, 10 EFPY greater than realistically expected for the end of the PEO for Susquehanna, Units 1 and 2. In order to obtain approval for the PEO, the licensee is additionally required to comply with two conditions imposed in the staff’s SE for the BWRVIP-05, and comply with Action Item 11 of the BWRVIP-74-A SE. The conditions of the BWRVIP-05 SE are:

Condition 1: At the end of the license period, the circumferential RPV beltline welds shall satisfy the limiting conditional failure probability. The variables that affect this

criterion are chemistry requirements of the limiting weld and neutron fluence value of the weld at the end of the license period. These variables provide information on the extent of neutron embrittlement on the limiting circumferential weld at the end of the license period;

Condition 2: The licensee must implement operator training and operating procedures to limit the frequency of cold overpressure events to the amount specified.

The relevant information associated with chemistry composition of the limiting circumferential weld both Units 1 and 2, the cumulative neutron fluence EOL at 54 EFPY and the extent of neutron embrittlement of this weld at EOL is addressed in Table 4.2-8, of the NRC staff-approved SE for the license renewal application addressed in NUREG-1931. The following table includes the aforementioned information.

Parameter Description	Susquehanna, Units 1 and 2 Comparative Parameters at 54 EFPY for the Bounding Circumferential Weld Wire Heat/Lot, Unit 2 (bounds Unit 1) 624263/E204A27A	USNRC Limiting Plant-Specific Analyses Parameters at 64 EFPY (BWRVIP-05 SE Table 2.6-5)
Cu wt. %	0.06	0.10
Ni wt. %	0.89	0.99
CF	82.0	109.5
EOL ID Fluence x 10^{19} n/cm ² (E > 1 MeV)	0.0941	1.02
ΔRT_{NDT} °F	30.9	135.6
$RT_{NDT(U)}$ °F	-20	-65
Mean RT_{NDT} °F	10.9	70.6

The NRC staff accepted the Susquehanna Units 1 and 2 54 EFPY mean reference temperature (Nil Ductility Transition) (RT_{NDT}) value because: (1) Section 4.2.4 of NUREG-1931 indicates that the staff confirmed the validity of the data for the copper and nickel contents and the initial RT_{NDT} values for the limiting RPV beltline circumferential weld, and (2) Section 4.2, "Reactor Vessel Neutron Embrittlement," of NUREG-1931 indicates that the neutron fluence at 54 EFPY is acceptable. Section 4.2.1 concludes that the fluence calculation was carried out using staff approved methodologies (i.e., adheres to the guidance set forth in RG 1.190) and accounted for projected core operating conditions. In addition, the calculation is conservative because the applicant-predicted end of license irradiation is expected to be less than the 54 EFPY that was calculated. Therefore, the Susquehanna units' 54 EFPY mean RT_{NDT} value is valid and can be used in this evaluation.

Since the Susquehanna units' 54 EFPY mean RT_{NDT} value is bounded by the 64 EFPY mean RT_{NDT} value for the Chicago Bridge and Iron (CB&I) weld in the July 28, 1998, SE for BWRVIP-05, the NRC staff concludes that the probability of failure value due to a low-temperature overpressure protection event at 54 EFPY for the limiting Susquehanna, Units 1 and 2, RPV circumferential weld is less than the value from the July 28, 1998, SE. Therefore, the licensee has satisfied the Condition 1 requirement addressed in the staff's SE for

the BWRVIP-05 report during the PEO period and consequently also meets the corresponding portion of Action Item 11.

Regarding the Condition 2 requirement addressed in the staff's SE for the BWRVIP-05 report, the NRC staff verified the validity of the licensee's statement regarding operator training and plant procedures introduced in Section 3.5 of this SE. The licensee stated that for the PEO will continue to apply the same operator training and procedures that are approved by the NRC staff for the current licensing period. These procedures will limit RPV cold overpressure events during the PEO. Based on this review, the NRC staff determined that the licensee has satisfied the Condition 2 requirement for the PEO, and consequently meets that portion of Action Item 11 of the BWRVIP-74-A SE.

Further, the July 28, 1998, SE for BWRVIP-05 requires that examination of the limiting RPV circumferential shell welds be performed if the corresponding volumetric examinations of the RPV axial shell welds revealed any presence of an age-related degradation mechanism. As indicated in Section 4.2.5.2 of NUREG-1931, the licensee confirmed that no recordable indications of cracking were identified during the previous volumetric examinations of the RPV axial welds. Therefore, the NRC staff determined that the volumetric examination of the circumferential welds need not be performed at Susquehanna, Units 1 and 2, during the PEO.

Since both the BWRVIP-74-A SE, Action Item 11 requirements regarding RPV circumferential weld inspection relief during the PEO are satisfied, as discussed above, the NRC staff concludes that the licensee's proposed alternative provides an acceptable level of quality and safety. Therefore, the NRC staff finds the licensee's proposed 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 RPV 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 CB&I-fabricated RPV. This finding is based on the projected mean RT_{NDT} of the limiting circumferential weld material for Susquehanna Units 1 and 2, which is a function of the chemistry and projected neutron fluence for this material. The projected mean RT_{NDT} values for Susquehanna Units, are less than the mean RT_{NDT} value associated with the limiting conditional probability of failure for a CB&I-fabricated RPV 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 BWRVIP-05. Therefore, the licensee has satisfactorily addressed the two plant-specific requirements described in the SE in BWRVIP-74-A (Action Item 11), to obtain relief from inspection of circumferential RPV welds for the PEO.

The NRC staff concludes that the proposed alternative in Relief Request 4RR-02, Revision 1, for relief from inspection of RPV circumferential welds provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(z)(1), the request for proposed alternative in Relief Request 4RR-02, Revision 1, from the requirements of the ASME Code, Section XI, Table IWB-2500-1, Examination Category B-A, Item B1.11, pertaining to RPV circumferential shell welds is authorized for Susquehanna for the duration of the 20-year term of the renewed operating license, which expires on July 17, 2042, for Susquehanna, Unit 1, and on March 23, 2044, for Susquehanna, Unit 2.

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

Principal Contributor: Ganesh S. Cheruvenki

Date of Issuance: April 19, 2021

SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 – RELIEF REQUEST 4RR-02, REVISION 1, REGARDING EXTENSION OF PERMANENT RELIEF FROM ULTRASONIC EXAMINATION OF REACTOR PRESSURE VESSEL CIRCUMFERENTIAL SHELL WELDS (EPID L-2020-LLR-0152) DATED APRIL 19, 2021

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