

May 3, 2001

Mr. Harold W. Keiser
Chief Nuclear Officer & President
PSEG Nuclear LLC - X04
Post Office Box 236
Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNIT NO. 1 - RELIEF FROM
ASME CODE REQUIREMENTS RELATED TO THE INSERVICE INSPECTION
PROGRAM, SECOND 10-YEAR INTERVAL, RELIEF REQUEST RR-B11
(TAC NO. MB1234)

Dear Mr. Keiser:

By letter dated February 6, 2001, as supplemented by letters dated April 13 and 23, 2001, PSEG Nuclear LLC (PSEG) submitted a request for relief from the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (the Code), Section XI, requirements for certain inservice inspections (ISI) involving the Reactor Pressure Vessel (RPV) vessel-to-flange weld at Salem Nuclear Generating Station (Salem), Unit No. 1. In your letters, you requested use of alternative requirements by performing ultrasonic (UT) examination of the RPV vessel-to-flange weld from the vessel shell side in accordance with ASME Code, Section XI, Division 1, 1995 Edition, 1996 Addenda, Appendix VIII, Supplements 4 and 6, as amended by the *Federal Register* Notice dated September 9, 1999 (64 FR 51370), in lieu of ASME Code, Section V, Article 4, requirements. Relief was requested for Salem, Unit No. 1, for the second 10-year interval vessel examination scheduled for the spring 2001 refueling outage.

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of the subject relief request. The NRC staff's Safety Evaluation (SE) is enclosed. Our SE concludes that the proposed alternative will provide reasonable assurance of structural integrity. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed alternative for Salem, Unit No. 1, for the second 10-year ISI interval, on the basis that the proposed alternative provides an acceptable level of quality and safety.

Sincerely,

/RA/

James W. Clifford, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-272

Enclosure: Safety Evaluation

cc w/encl: See next page

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ACCESSION NUMBER: ML011060083

TEMPLATE = NRR-028

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE ULTRASONIC EXAMINATION OF

REACTOR PRESSURE VESSEL (RPV) VESSEL-TO-FLANGE WELD

IN ACCORDANCE WITH RELIEF REQUEST RR-B11

PSEG NUCLEAR LLC

SALEM NUCLEAR GENERATING STATION, UNIT NO. 1

DOCKET NO. 50-272

1.0 INTRODUCTION

The inservice inspection (ISI) of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Class 1, 2, and 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 written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Pursuant to 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), Director of the Office of Nuclear Reactor Regulation, 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) shall meet the requirements, except the design and access provisions and the pre-service 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 components (including supports) may meet the requirements set forth in subsequent editions and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a(b) subject to the limitations and modifications listed therein and subject to Commission approval.

By letter dated February 6, 2001, as supplemented by letters dated April 13 and 23, 2001, PSEG Nuclear LLC (PSEG) submitted a request for relief from the ASME Code, Section XI,

ENCLOSURE

requirements for certain inservice inspections (ISI) involving the Reactor Pressure Vessel (RPV) vessel-to-flange weld at Salem Nuclear Generating Station (Salem), Unit No. 1. In the letters, PSEG requested use of alternative requirements by performing ultrasonic (UT) examination of the RPV vessel-to-flange weld from the vessel shell side in accordance with ASME Code, Section XI, Division 1, 1995 Edition, 1996 Addenda, Appendix VIII, Supplements 4 and 6, as amended by the *Federal Register* Notice dated September 9, 1999 (64 FR 51370), in lieu of ASME Code, Section V, Article 4, requirements.

Relief was requested for Salem, Unit No. 1, for the second 10-year interval ISI scheduled for the spring 2001 refueling outage.

2.0 BACKGROUND

2.1 Component Description

Salem, Unit No. 1, ASME Section XI, Class 1, Category B-A Pressure Retaining Welds In RPV Item No. B1.30 shell-to-flange weld.

2.2 ASME Code Examination Requirement for which Relief is Requested

ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 1983 Edition with Summer 1983 Addenda, Subsection IWA-2232, requires UT examination of the RPV-to-flange weld to be in accordance with ASME Code, Section V, Article 4. In addition, Regulatory Guide (RG) 1.150, Revision 1, "Ultrasonic Testing Of Reactor Vessel Welds During Preservice and Inservice Examinations," serves as regulatory guidance for the UT examination of RPV welds.

Relief was requested for Salem, Unit No. 1, for the second 10-year interval ISI scheduled for the spring 2001 refueling outage.

2.3 PSEG's Proposed Alternative to ASME Code

PSEG proposes to perform a UT examination of the RPV vessel-to-flange weld from the vessel shell side in accordance with ASME Code, Section XI, Division 1, 1995 Edition, 1996 Addenda, Appendix VIII, Supplements 4 and 6, as amended by the *Federal Register* Notice dated September 9, 1999 (64 FR 51370), in lieu of ASME Code, Section V, Article 4, requirements.

2.4 PSEG's Basis for the Proposed Alternative

In its letter dated April 13, 2001, PSEG provided its revised basis for requesting relief (as stated):

PSEG Nuclear Salem Unit 1 is required to perform in-service examination of the RPV flange weld in accordance with the requirements of ASME Section V Article 4 and the subsequent guideline requirements of Regulatory Guide 1.150 Rev 1.

Federal Register Notice 64 FR 51370 through 51400, dated September 22, 1999, revised the 1999 Edition of 10 CFR 50.55(a) [sic] Codes and Standards.

This revision requires that ASME Section XI, Appendix VIII, Supplements 4, *Qualification Requirements For The Clad/Base Metal Interface of Reactor Vessel*, and Supplement 6, *Qualification Requirements For Reactor Vessel Welds Other Than Clad/Base Metal Interface*, be implemented for most of the RPV welds by Nov 22, 2000. The RPV vessel-to-flange weld is the only RPV circumferential weld not included in Appendix VIII.

This relief is requested to allow the use of a PDI qualified procedure to complete the UT examination of the RPV vessel-to-flange weld from the vessel side of the weld in accordance with ASME Section XI, Div. 1, 1995 Edition, 1996 Addenda, Appendix VIII Supplement 4 and 6 as amended by the Federal Register Notice 64 FR 51370 through 51400, dated September 22, 1999 in lieu of ASME Section V Article 4.

During the upcoming ten (10) year RPV weld examinations, we will be employing personnel, procedures and equipment, demonstrated and qualified by a Performance Demonstration Initiative (PDI) and in accordance with ASME Section XI, Div. 1, 1995 Edition, 1996 Addenda, Appendix VIII Supplements 4 and 6 as amended by the Federal Register Notice 64 FR 51370 through 51400, dated September 22, 1999 for the adjacent welds.

The remote examinations will be performed using the Framatome Technologies, Inc. (FTI) remote RPV manipulator ("URSULA") and their "ACCUSONEX™" UT system in accordance with a PDI qualified procedure. The Framatome procedure 54-ISI-800-03, *Remote Ultrasonic Examination of Reactor Vessel Welds in Accordance with ASME Section XI, Appendix VIII, Supplements 4 and 6*, was demonstrated at the PDI qualification session dated June 7, 1996 (Performance Demonstration Qualification Sheet (PDQS) No. 310). The procedure complies with ASME Section XI, Appendix VIII, 1995 edition, 1996 Addenda as modified in final rule. []

Appendix VIII was developed to ensure the effectiveness of UT examinations within the nuclear industry by means of a rigorous, item specific performance demonstration. The performance demonstration was conducted on a RPV mockup containing flaws of various sizes and locations. The demonstration established the capability of equipment, procedures and personnel to find flaws that could be detrimental to the integrity of the RPV.

Although Appendix VIII is not a requirement for this weld, the qualification process to Appendix VIII criteria demonstrates that the examination and evaluation techniques are equal or surpass the requirements of paragraph IWA-2232, "Ultrasonic Examination" of Section XI of the ASME Code and the guidance in RG 1.150.

A comparison between the ASME Section V Article 4 based UT methods and the procedures developed to satisfy the PDI/Appendix VIII can be best described as a comparison between a compliance-based procedure (ASME Section V Article 4) and a results-based procedure (PDI/Appendix VIII). ASME Section V procedures use an amplitude-based technique and a known reflector. The

proposed alternate UT method was established independently from the acceptance standards for flaw size found in ASME Section XI.

The PDI qualified sizing method is considered more accurate than the method used in ASME Section V Article 4. The proposed alternate UT examination technique provides an acceptable level of quality and examination repeatability as compared to the Article 4 requirements

The PDI Program's PDQS No. 310 attests that FTI procedure 54-ISI-800-03 is in compliance with the detection and sizing tolerance requirements of Appendix VIII. The PDI qualification method is based on [a] group of samples, which validate the acceptable flaw sizes in ASME Section XI. The sensitivity to detect these flaws is considered to be equal to or greater than the sensitivity obtained through ASME Section V Article 4 because the Framatome 54-ISI-800-03 procedure relies on a smaller scan index and a higher scan sensitivity for the detection of the UT signals.

The examination and sizing procedure use echo-dynamic motion and tip diffraction characteristics of the flaw instead of the amplitude characteristics required by ASME Section V Article 4. The search units interrogate the same examination volume as depicted by ASME Section XI, Figure IWB 2500-4, *Shell-to-Flange Weld Joint*.

The use of procedures for satisfying the requirements of ASME Section V Article 4 for the UT examination of the RPV to flange weld from the vessel shell has not received the same qualifications as PDI qualified procedure.

The use of Appendix VIII Supplements 4 and 6 for the completion of the RPV vessel-to-flange weld from the shell side (which PDI has qualified) is expected to reduce examination time, which translates to reduce personnel radiation exposure.

Additionally, this relief would allow a smooth transition to the welds adjacent to the RPV circumferential and longitudinal welds (welds B1.11 and B1.12) which do require an examination in accordance with Appendix VIII Supplement 4 and 6. This would eliminate the need to switch to the different calibration, procedure and technique required by ASME Section V Article 4 and the Regulatory Guide 1.150 Rev 1. This would result in a reduction in transition time to the different calibration, procedure and technique required which translates to reduce personnel radiation exposure and is more cost effective.

3.0 EVALUATION

The 1983 Edition of Section XI requires the examination of vessel welds to comply with Article 4 of Section V as amended by IWA-2232 of Section XI. PSEG is requesting relief from the Code-required examination and examination coverage for the RPV-to-flange weld. PSEG performed an ASME Code UT examination of the weld from the flange, and proposed a performance-based UT technique alternative to the prescriptive UT technique required by Code

for examination from the vessel. Examination coverage is the sum of the volume examined from the flange and vessel sides of the weld.

In its letters dated April 13 and 23, 2001, PSEG stated that an acceptable partial examination of the RPV-to-flange weld was performed from the flange surface during the 2nd period of the 2nd ISI interval according to the requirements of ASME Section V, Article 4. The coverage was 100% from the flange side of the weld. In order to complete the examination from the vessel side of the weld, PSEG proposed using procedures and personnel qualified according to the 1995 Edition with 1996 Addenda of the Code, Section XI, Appendix VIII, Supplements 4 and 6. These are the same procedures that were used to examine the RPV shell welds. The licensee stated that 90% of the volume as depicted in Figure IWB-2500-4 was examined from the vessel side of the weld. Therefore, with the combined coverage from the flange and vessel sides of the weld, PSEG obtained full coverage of the RPV-to-flange weld (essentially 90%).

The staff has reviewed and evaluated PSEG's alternative to use a UT technique (personnel, equipment, and procedures) qualified to Appendix VIII, Supplements 4 and 6 (See Table 1). The Appendix VIII criteria was developed to ensure the effectiveness of UT examinations within the nuclear industry by means of a rigorous, item specific performance demonstration. The performance demonstration was conducted on RPV mockups containing flaws of various sizes and locations. The demonstration established the capability of equipment, procedures, and personnel to find flaws that could be detrimental to the integrity of the RPV. The performance demonstration showed that the proposed UT technique is equal to or surpasses the requirements of the Code and the recommendations of RG 1.150. Therefore, the staff has determined that the alternative provides an acceptable level of quality and safety. Pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative is authorized for the RPV-to-flange weld examination from the vessel shell side of the weld for the second 10-year ISI interval at Salem, Unit No. 1.

4.0 CONCLUSION

Based on its review, the NRC staff finds that the proposed alternative described in PSEG's letters dated February 6, April 13, and April 23, 2001, provides an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the proposed alternative for Salem, Unit No. 1, ASME Section XI, Class 1, RPV-to-flange weld examination for the second 10-year ISI interval.

Principal Contributors: R. Fretz
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Date: May 3, 2001

TABLE 1 - COMPARISON OF REACTOR PRESSURE VESSEL SHELL WELD EXAMINATION TECHNIQUES

Description (Code Reference)	ASME Section V, Article 4, 1983 Summer Edition ASME Section XI, 1983 Summer Edition NRC Regulatory Guide 1.150, Revision 1, 1983	FTI Examination Procedure 54-ISI-800-03 Requirements
Examination Angle	Section V, Article 4, T-441 requires the volume of weld and adjacent base material to be scanned by straight and angle beam techniques. Two angle beams, having nominal angles of 45 and 60 degrees with respect to a perpendicular to the examination surface, shall generally be used. Other pairs of angle beams are permitted provided the measured difference between the angles is at least 10 degrees.	Examination was conducted with angles of 45 degrees shear wave and 45 degrees longitudinal wave transducers. Additionally a 70 degree longitudinal wave transducer was used for examining the near surface region. These examination angles were successfully qualified under PDI protocol using the PDI program test blocks.
Instrument Calibrations	Section V, Article 4, T-431 requires that instrument screen height and amplitude linearity be evaluated at least every three months. Section XI, IWA-2232 requires that these screen height and linearity checks be performed at the beginning and end of the weld examination performed on a vessel during one outage.	Instrument screen height and amplitude linearity are checked prior to and following completion of the examinations of the Salem Unit No. 1 reactor vessel.
System Calibrations	Section V, Article 4, T-432 requires that the original system calibration be performed on the Code basic calibration block. T-432 allows the use of different types of reference blocks and electronic simulators to perform system calibration verifications.	Initial calibration of the data acquisition system was performed on the Code basis calibration block. Periodic system checks and final calibration check are performed using simulator blocks as permitted by Section V, Article 4, T-432.
Scanning Sensitivity	Section V, Article 4, T-425 permits scanning to be performed at the reference level when electronic distance-amplitude correction (DAC) is used with automated recording.	Scanning is performed at 10% of DAC.

TABLE 1 - CONTINUED

Description (Code Reference)	ASME Section V, Article 4, 1983 Summer Edition ASME Section XI, 1983 Summer Edition NRC Regulatory Guide 1.150, Revision 1, 1983	FTI Examination Procedure 54-ISI-800-03 Requirements
Recording Level	<p>Section V, Article 4, T-441 requires recording and evaluation of reflectors that produce a response equal to or greater than 50% DAC.</p> <p>Regulatory Guide 1.150 requires recording and evaluation at 20% DAC for the inner 25% of material thickness.</p>	<p>In the near surface region, non-geometric indications with a maximum amplitude greater than or equal to 20% DAC were recorded.</p> <p>In the subsurface region, non-geometric indications which have a maximum amplitude greater than 10% DAC for the 45° shear wave were recorded</p>
Scan Index and Pulse Repetition Rate	<p>Section V, Article 4, T-425 requires each pass of the search unit overlap a minimum of 10% of the transducer piezoelectric element dimension perpendicular to the direction of the scan.</p> <p>Section XI, IWA-2232 requires each pass of the search unit overlap at least 50% of the transducer piezoelectric element dimension perpendicular to the direction of the scan.</p> <p>NRC Regulatory Guide 1.150 requires a 25% maximum overlap for detection and 0.25-inch maximum increments for sizing.</p>	<p>A scan index of 0.50" is used for flaw detection.</p> <p>A scan index of 0.20" is used for additional sizing.</p> <p>This scan index meets the requirements of T-425, IWA-2232 and Regulatory Guide 1.150.</p>
Flaw Sizing and Evaluation	<p>Section V, article 4, T-441 requires amplitude based sizing at 50% DAC.</p> <p>Section V, Article 4, T-451 permits evaluation to alternative standards.</p>	<p>All recorded indications are elevated and categorized as either geometric or non-geometric indications.</p> <p>Tip diffraction or satellite signals are used for measuring flaw through wall dimension. If the flaw image cannot identify evidence of flaw tips or satellite signals, amplitude based sizing techniques are used. Length sizing is performed using amplitude-based techniques.</p>