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

October 6, 2014

Mr. Thomas Joyce
President and Chief Nuclear Officer
PSEG Nuclear LLC
P.O. Box 236, N09
Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2 - REQUEST FOR RELIEF SC-I4R-140 FROM AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE, SECTION XI REQUIREMENTS REGARDING THE REACTOR VESSEL HEAD FLANGE SEAL LEAK DETECTION PIPING (TAC NOS. MF3898 AND MF3899)

Dear Mr. Joyce:

By letter dated April 8, 2014, as supplemented June 10, 2014,[1] PSEG Nuclear LLC (PSEG or licensee) requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, for pressure testing the reactor vessel head flange seal leak detection piping at Salem Nuclear Generating Station, Units 1 and 2 (Salem Units 1 and 2), for the duration of the fourth 10-year inservice inspection (ISI) interval.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(ii), the licensee requested to use an alternative on the basis that complying with the system leakage test that is required by the ASME Code, Section XI, Table IWB-2500-1, Examination Category B-P; and Table IWC-2500-1, Examination Category C-H, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that PSEG has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(3)(ii). Therefore, the NRC staff authorizes use of the proposed alternative until the end of the forth 10-year ISI interval at Salem Unit 1, currently scheduled to end on May 20, 2021, and Salem Unit 2, currently scheduled to end on November 27, 2023.

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

[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML14098A308, and ML14161A444, respectively.

If you have any questions concerning this matter, please contact the Salem Project Manager, Ms. Carleen Sanders, at (301) 415-1603 or via e-mail at Carleen.Sanders@nrc.gov.

Sincerely,

Meena K. Khanna, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-272 and 50-311

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ALTERNATIVE SC-I4R-140

REACTOR VESSEL HEAD FLANGE SEAL LEAK DETECTION PIPING

PSEG NUCLEAR LLC

SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2

DOCKET NOS. 50-272 AND 50-311

1.0 INTRODUCTION

By letter dated April 8, 2014, as supplemented June 10, 2014,[1] PSEG Nuclear LLC (PSEG or the licensee) requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, for system leakage testing of the reactor pressure vessel head flange seal leak-off lines at Salem Nuclear Generating Station, Units 1 and 2 (Salem Units 1 and 2), for the duration of the fourth 10-year inservice inspection (ISI) interval.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(ii), the licensee proposed an alternative on the basis that complying with the system leakage test that is required by ASME Code, Section XI, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

2.0 REGULATORY REQUIREMENTS

Pursuant to 10 CFR 50.55a(g)(4), the 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.

Pursuant to 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the U. S. Nuclear Regulatory Commission (NRC), if the licensee demonstrates: (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.

[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML14098A308, and ML14161A444.

Based on analysis of the regulatory requirements, the NRC staff concludes that the NRC has the regulatory authority to authorize the licensee's proposed alternative on the basis that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Component Affected

Code Class: 1 and 2
Examination Category: B-P and C-H
Item Number: B15.10 and C7.10
Description: Reactor Vessel Head Flange O-ring Class 1 and 2 leak detection system pressure retaining boundary.
Units: Salem Units 1 & 2
Inspection Intervals: Fourth (4th) 10-Year

At each Salem unit, the reactor vessel head flange leak detection piping consists of 140 feet of Class 1, 3/4 inch nominal pipe size piping and 45 feet of Class 2, 3/8 inch nominal diameter tubing. The design pressure for the system is 2485 pounds per square inch gauge (psig) at 650 degrees Fahrenheit (F). The Class 1 piping is Schedule 160 and is manufactured from SA 376 type TP 316 stainless steel material. Class 1 fittings are manufactured from SA 182 type F 316 stainless steel. The Class 2 tubing is 0.065 inch wall thickness and is manufactured from SA 213 type TP 304 stainless steel material. All tubing connections are welded.

3.2 Applicable Code Edition and Addenda

The applicable Code edition and addenda is the ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection and Testing of Components of Light-Water Cooled Plants," 2004 Edition with no Addenda. For Salem Unit 1, the fourth interval began on May 20, 2011, and is scheduled to end on May 20, 2021, and for Salem Unit 2, the fourth interval began on November 27, 2013, and is scheduled to end on November 27, 2023.

3.3 Applicable Code Requirement

Class 1 Pressure Retaining Components

ASME Code, Section XI, Table IWB-2500-1, Examination Category B-P, Item Number B15.10, requires certain Class 1 pressure retaining components be subject to a system leakage test, in accordance with paragraph IWB-5220, and a VT-2 visual examination in accordance with paragraph IWA-5240, prior to plant startup following each refueling outage.

ASME Code, Section XI, subparagraph IWB-5221(a) states: "[t]he system leakage test shall be conducted at a pressure not less than the pressure corresponding to 100% rated reactor power."

ASME Code, Section XI, subparagraph IWB-5221(b) states: "[t]he system test pressure and temperature shall be attained at a rate in accordance with the heat-up limitations specified for the system."

ASME Code, Section XI, subparagraph IWB-5222(a) states: "[t]he pressure retaining boundary during the system leakage test corresponds to the reactor coolant boundary, with all valves in the position required for normal reactor operation startup. The visual examination shall, however, extend to and include the second closed valve at the boundary extremity."

ASME Section XI, subparagraph IWB-5222(b) states: "[t]he pressure retaining boundary during the system leakage test conducted at or near the end of each inspection interval shall extend to all Class 1 pressure retaining components within the system boundary."

Class 2 Pressure Retaining Components

ASME Code, Section XI, Table IWC-2500-1, Category C-H, Item Number C7.10, requires a system leakage test in accordance with paragraph IWC-5220 and a VT-2 visual examination in accordance with paragraph IWA-5240, during each inspection period.

ASME Section XI, paragraph IWC-5221 states: "[t]he system leakage test shall be conducted at the system pressure obtained while the system, or portion of the system, is in service performing its normal operating function or at the system pressure developed during a test conducted to verify system operability(e.g., to demonstrate system safety function or satisfy technical specification surveillance requirements)."

ASME Section XI, subparagraph IWC-5222(a) states: "[t]he pressure retaining boundary includes only those portions of the system required to operate or support the safety function up to and including the first normally closed valve (including a safety or relief valve) or valve capable of automatic closure when the safety function is required."

3.4 Duration of the Proposed Alternative

The duration of the request for proposed alternative for Salem Unit 1 is through the end of the fourth interval currently scheduled to end on May 20, 2021; and for Salem Unit 2, the duration is through the end of the fourth interval currently scheduled to end on November 27, 2023.

The licensee stated that it will perform its proposed alternative testing at Salem Unit 1, during Cycle 23 refueling outage scheduled for fall 2014 (i.e., the first refueling outage of the second period). The licensee stated that it will credit the performance of the proposed alternative during Cycle 23 towards the first period of the fourth 10-year ISI interval at Salem Unit 1. Subsequently, the licensee will schedule the proposed alternative testing in the second period to comply with the ASME Code requirement.

3.5 Proposed Alternative

The licensee proposed alternatives to IWB-5221(a), IWB-5221(b), IWB-5222(a), and IWB-5222(b) requirements for system leakage testing of the Class 1 piping of the reactor pressure vessel (RPV) head flange seal leak-off lines. In addition, the licensee proposed an alternative to

the IWC-5221 requirement for system leakage testing of the Class 2 tubing of the RPV head flange seal leak-off lines. In lieu of the required reactor coolant system (RCS) normal operating pressure and temperature, the licensee proposes to use a static pressure head of 10 psig at ambient temperature. These conditions will be achieved when the refueling cavity is flooded to a depth of 23 feet with borated water. The licensee stated that it will perform the required VT-2 visual examination of the accessible portions of Class 1 piping and Class 2 tubing of the leak detection system after the system is subjected to the above static pressure head for at least 4 hours. The licensee also stated that the proposed alternative test would occur each refueling outage.

In the letter dated June 10, 2014, the licensee stated that the Class 1 piping of the RPV leak-off lines at Salem Unit 1 is not insulated. The licensee also stated that there is approximately 2 feet of the Class 1 piping of the RPV leak-off lines, just upstream of isolation valves 2RC2 and 2RC3, at Salem Unit 2 that is insulated for personnel burn protection. The Class 1 piping that is not insulated is accessible for direct VT-2 visual examination, except where it penetrates the bio-shield wall and the portion closest to the reactor vessel flange that passes through cold leg reactor pressure vessel nozzle inspection plugs (also known as sandboxes). The licensee's VT-2 visual examination of inaccessible areas will include inspection of the surrounding areas below the lines, at ends of penetration sleeves, and at the bottom of the reactor vessel annular gap for evidence of leakage according to IWA-5241 and IWA-5242. Additionally, the portion of leak-off lines that is inaccessible inside the sandboxes will receive a VT-2 visual examination any time the sandboxes are opened for piping weld examination or gasket replacement, typically at least once during each 10-year ISI interval. The licensee stated that all of the Class 2 tubing is encased in insulated tubing trays, but is readily accessible for VT-2 visual examination. The licensee noted that any leakage would be observed by evidence of leakage emanating from the tubing tray joints. The licensee stated that it will examine all Class 2 tubing according to IWA-5242(b).

3.6 Licensee's Reason for Request

The licensee stated, in part, that:

> PSEG recently determined, through issuance of NRC Information Notice 2014-02, *Failure to Properly Pressure Test Reactor Vessel Flange Leak-Off Lines*, that Salem is susceptible to the concern regarding compliance with ASME Section XI for examination pressure of the reactor vessel flange leak-off piping. Salem currently performs VT-2 examinations on all Class 1 and 2 portions of the reactor vessel head flange O-ring leak-off lines each refueling outage during Mode 3 Class 1 walkdown but only at reactor coolant drain tank system pressure.
>
> In accordance with the provisions of 10 CFR 50.55a(a)(3)(ii), Salem requests relief from the Section XI code requirement for system leakage tests of the reactor vessel flange O-ring leak-off lines on the basis that compliance with the Code specified pressure test requirement to test the leak-off lines at system operating pressure would result in undue hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The ASME Code Section XI, 2004 Edition with no Addenda requires that Class 1 pressure retaining boundary during the system leakage test conducted at or near the end of each inspection interval to extend to all Class 1 pressure retaining components within the system boundary and the Class 2 pressure retaining boundary includes only those portions of the system required to operate or support the safety function up to and including the first normally closed valve (including a safety or relief valve) or valve capable of automatic closure when the safety function is required.

3.7 Licensee's Technical Basis

The licensee stated that the RPV flange seal leak detection system piping is separated from the RCP boundary by one passive metallic seal, the inner O-ring. The pressure tap for the leak detection system piping is located on the vessel flange mating surface. A second O-ring is located on the outside of the pressure tap in the vessel flange. Failure of the inner O-ring is the only condition under which these lines are pressurized, and the reactor vessel flange seal leak detection piping would function as a pressure boundary. If the inner O-ring should leak during the operating cycle, it will be identified by an increase in temperature of the leak-off lines above ambient temperature. This leak detection piping has a temperature indicator in the Control Room and is monitored procedurally with compensatory actions, when required. If any significant leakage does occur in the leak detection piping during the time of pressurization, it would exhibit boric acid accumulation that would be discernible during VT-2 visual examination. During normal operation, the lines are typically pressurized to Reactor Coolant Drain Tank pressure (less than 5 psig). The lines are designed to 2485 psig at 650° F.

The licensee stated that the configuration of this piping precludes the ASME Code required system leakage testing while the vessel head is removed because the pressure tap would have to be plugged. This would require a design modification to install a plug into the pressure tap on the vessel flange. The licensee stated that it would need to install a threaded pressure test type plug in the flange face to act as a pressure boundary for system leakage testing of the line, and then remove the plug after the test. The installation of the mechanical modification and performance of the ASME Code system leakage test would cause personnel to incur excessive radiation dose (radiation level at the RPV flange is estimated at 30 to 40 milli-roentgen equivalent man per minute (mrem/min)). Installation and handling of the small diameter plug that would be needed to complete a leakage test at the RCS normal operating pressure would present a foreign material exclusion issue.

The licensee stated that the configuration of the RPV leak-off lines also preclude pressurizing the lines externally with the head installed. The closure head contains two concentric grooves that hold the inner and outer O-rings. The O-rings are held in place by a series of retainer clips that are housed in recessed cavities in the flange face. If a pressure test were to be performed with the head installed, the inner O-ring would be pressurized in a direction opposite to its design function. This test pressure would result in a net inward force on the inner O-ring that would tend to push it into the recessed cavity that houses the retainer clips. The thin O-ring material could be damaged by the inward force. Purposely failing or not installing the inner O-ring in order to perform a pressure test would require a new O-ring set to be installed. The time and radiation exposure associated with removing and reinstalling the closure head, replacing the outer O-ring and re-cleaning of the vessel flange mating surface prior to head

installation would be an undue hardship. In the letter dated June 10, 2014, the licensee stated that the estimated radiation dose accrual by personnel performing the above activities would be totaled at 6.331 rem each refueling outage. The licensee also stated that the system leakage testing with the RPV head on would require a reactor coolant system heat-up and cool down cycle.

3.8 NRC Staff Evaluation

The NRC staff has evaluated relief request SC-I4R-140 pursuant to 10 CFR 50.55a(a)(3)(ii). The NRC staff focuses on whether compliance with the specified requirements of 10 CFR 50.55a(g), or portions thereof, would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

The NRC staff determined that during system leakage test of Class 1 piping of the RPV head flange seal leak-off lines, compliance with the pressure requirement of IWB-5221(a) and IWB-5221(b) and the boundary requirement of IWB-5222(a) and IWB-5222(b) would result in hardship. Furthermore, the NRC staff determined that during system leakage test of Class 2 tubing of the RPV head flange seal leak-off lines, compliance with the pressure requirement of IWC-5221 would result in hardship. The basis for the hardship is as follows: The licensee would have to modify the existing vessel flange taps to facilitate the ASME Code required system leakage test of Class 1 piping and Class 2 tubing of the leak-off lines during refueling outage when the reactor head is removed. The modification of taps involves machining threads to install a plug to facilitate pressurizing and testing the lines for leaks. The time spent for modifications, preparing and pressurizing the lines to perform the ASME Code required leakage test, and removal of plugs after completion of the test, would expose personnel to excessive radiation dose. Activities that include machining threads and installing the plugs and removing them after completing the test could introduce foreign materials into the reactor pool, as well as the lines. Pressurizing the leak-off lines while the RPV head is installed would not be possible due to design and configuration of the RPV head flange taps and the inner O-ring. The inner O-ring is designed to withstand pressure in one direction only. Pressurizing the inner O-ring from the opposite direction would damage the inner O-ring and could result in unsuccessful test and the replacement of the O-rings. Activities associated with leakage testing of the lines and O-ring replacement expose personnel to excessive radiation dose. Therefore, the NRC staff determines that concerns from the Foreign Material Exclusion program, and an as low as is reasonably achievable criteria constitute a hardship.

The NRC staff finds that the licensee's proposed system leakage test will subject the Class 1 piping and the Class 2 tubing of the RPV flange seal leak-off lines to the highest pressure that is obtainable without major design modifications to existing configurations of both the vessel flange face and the leak-off lines. Specifically, the licensee will use the static pressure head of 10 psig developed from the elevation of borated refueling water above the vessel flange during cavity flood-up to pressurize the leak-off lines (both piping and tubing) to perform system leakage test. By performing the VT-2 visual examination (according to IWA-5240) of the accessible area of the piping and tubing of the leak-off lines, the licensee will be able to detect any leakage originating from an existing flaw after maintaining the static test pressure. For portions of the piping and tubing of the leak-off lines that are inaccessible, insulated, or both, the licensee will perform the VT-2 visual examination in accordance with IWA-5241 and IWA-5242 to detect evidence of any leakage such as boric acid residue and staining by observing the

surrounding area of the lines. The NRC staff determined that any evidence of leakage, if it originated from an existing flaw in the subject lines, will be identified by the VT-2 visual examination.

The licensee stated that there has not been any documented history of degradation of the RPV flange leak-off lines within its fleet and the industry. The NRC staff review of operating experience, including Salem Units 1 and 2, did not identify any documented known degradation mechanism such as stress-corrosion cracking and fatigue in the RPV flange leak-off lines.

Furthermore, the NRC staff determined that the existing reactor coolant leakage detection systems are sufficient to provide warning to the Control Room operator in an unlikely event of a through-wall leak in the RPV leak-off lines piping and tubing. The NRC staff finds that if the subject piping and tubing developed a through-wall flaw, the reactor coolant leakage detection systems will be able to identify the leakage during normal operation, and the licensee will take appropriate corrective actions in accordance with the plant technical specifications.

Based on the above analysis, the NRC staff finds that the proposed alternative will provide reasonable assurance of the structural and leak tight integrity of the subject components and that, when compared to the proposed alternative, following the requirements of the ASME Code would result in a hardship without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the proposed alternative, "Reactor Pressure Vessel Head Flange Seal Leak Detection Piping - Relief Request No. SC-I4R-140," provides reasonable assurance of structural integrity and leak tightness, and that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(ii) and therefore authorizes use of the proposed alternative SC-I4R-140 until the end of the fourth 10-year ISI interval at Salem Unit 1, currently scheduled to end on May 20, 2021, and at Salem Unit 2, currently scheduled to end on November 27, 2023.

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

Principal Contributor: Ali Rezai

Date: October 6, 2014

If you have any questions concerning this matter, please contact the Salem Project Manager, Ms. Carleen Sanders, at (301) 415-1603 or via e-mail at Carleen.Sanders@nrc.gov.

Sincerely,

/RA/ Robert Schaaf for

Meena K. Khanna, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-272 and 50-311

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Safety Evaluation

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