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

April 18, 2017

Mr. Peter P. Sena, III
President and Chief Nuclear Officer
PSEG Nuclear LLC – N09
P.O. Box 236
Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2 – STAFF REVIEW OF MITIGATION STRATEGIES ASSESSMENT REPORT OF THE IMPACT OF THE REEVALUATED SEISMIC HAZARD DEVELOPED IN RESPONSE TO THE MARCH 12, 2012, 50.54(f) LETTER (CAC NOS. MF7873 AND MF7874)

Dear Mr. Sena:

The purpose of this letter is to provide the U.S. Nuclear Regulatory Commission's (NRC) assessment of the seismic hazard mitigation strategies assessment (MSA), as described in the December 30, 2016, letter (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16365A152), submitted by PSEG Nuclear LLC (PSEG, the licensee), for Salem Nuclear Generating Station, Units 1 and 2 (Salem). The licensee demonstrated that an Alternate Mitigating Strategy (AMS) based on the Individual Plant Examination of External Events (IPEEE) can be implemented to address the impacts of the reevaluated seismic hazard.

BACKGROUND

By letter dated March 12, 2012 (ADAMS Accession No. ML12053A340), the NRC issued a request for information pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The 50.54(f) letter was issued as part of implementing lessons-learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 1 to the 50.54(f) letter requested licensees reevaluate the seismic hazard using present-day methodologies and guidance. Concurrent with the reevaluation of seismic hazards, the NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A736). The order requires holders of operating power reactor licenses and construction permits issued under 10 CFR Part 50 to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling following a beyond-design-basis external event.

By letter dated March 28, 2014 (ADAMS Accession No. ML14090A043), the licensee provided its reevaluated seismic hazard and screening report (SHSR) for Salem in response to the 50.54(f) letter. In addition, the licensee provided an IPEEE adequacy review, included as part of the SHSR, to demonstrate plant seismic capacity at IPEEE high confidence of low probability of failure (HCLPF) spectrum (IHS) acceleration levels. The IHS acceleration levels are higher than the reevaluated seismic hazard acceleration levels, and thus, with the completion of the

adequacy review, the IPEEE results were appropriate for screening Salem out of performing a complete seismic risk evaluation.

On December 10, 2015 (ADAMS Accession No. ML16005A621), the Nuclear Energy Institute (NEI) submitted Revision 2 to NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," including guidance for mitigating strategies assessments regarding reevaluated hazard information. The NRC subsequently endorsed NEI 12-06, Revision 2, with exceptions, clarifications, and additions in Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163). Section 6.1.2 of JLD-ISG-2012-01, Revision 1, lists Salem as a site that is eligible to perform an MSA based on the IHS capacity of the facility.

MITIGATION STRATEGIES ASSESSMENT

By letter dated February 18, 2016 (ADAMS Accession No. ML16041A033), the NRC staff documented its review of the licensee's reevaluated seismic hazard, also referred to as the mitigating strategies seismic hazard information (MSSHI). The NRC staff confirmed the licensee's conclusion that its Ground Motion Response Spectrum (GMRS) for Salem is either bounded by the Safe Shutdown Earthquake (SSE) or by the plant-level IHS over the frequency range of 1 to 10 Hertz (Hz). The SSE used for screening purposes is the SSE ground response spectrum determined from site seismology as specified in Section 2.5 of the Salem updated final safety analysis report (UFSAR). For the frequency range above 10 Hz, the GMRS exceeds the SSE but is bounded by the IHS. Therefore, the staff stated that either a high frequency (HF) confirmation or an IPEEE relay chatter review were merited. The NRC staff concluded that, with the completion of the IPEEE relay chatter review, the licensee met the IPEEE adequacy criteria in accordance with the Screening, Prioritization, and Implementation Details (SPID) (ADAMS Accession No. ML12333A170). In addition, the staff concluded that the GMRS determined by the licensee adequately characterized the reevaluated seismic hazard for the Salem.

The licensee's IPEEE was performed as a focused-scope Seismic Probabilistic Risk Assessment (SPRA) using NUREG -1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities" (ADAMS Accession No. ML063550238). As documented in the IPEEE adequacy review, the licensee committed to upgrade its IPEEE to a full-scope assessment. The IPEEE SPRA demonstrated seismic capacity of structures, systems, and components (SSCs) in the two IPEEE safe shutdown paths and concluded that Salem, Units 1 and 2, can maintain or restore core cooling and containment capabilities for a beyond-design-basis seismic event up to the level of the IHS, which envelopes the GMRS in the 1 to 10 Hz range. The licensee relied on these results to develop an AMS and demonstrate robustness of the SSCs to the MSSHI following the guidance in Revision 2 of NEI 12-06, Appendix H, Section H.4.3. The licensee also relied on its SSE design-basis response spectrum, described in UFSAR, Section 3.7.1, to demonstrate additional seismic margin. This spectrum corresponds to the time history used in the design and evaluation of all Seismic Category 1 SSCs and bounds the SSE spectrum (used for screening purposes) and the GMRS in the 1 to 10 Hz frequency range.

According to NEI 12-06, Section H.4.3, in order to provide a complete AMS, licensees should provide the following: (1) information regarding the IPEEE upgrade to full scope; (2) an assessment of limitations that are based on the 72-hour coping duration; (3) a spent fuel pool cooling evaluation; and (4) a high frequency evaluation. As documented below, this information

was provided by the licensee by letter dated December 30, 2016 (ADAMS Accession No. ML16365A152).

By letter dated December 5, 2016 (ADAMS Accession No. ML16259A189), the NRC staff had issued a generic audit plan to perform regulatory audits of licensees' MSAs on an as-needed basis in order to support the NRC staff's review of the MSAs and issuance of the associated NRC staff assessments. As a result, this was the mechanism used to exchange information with PSEG for Salem, consistent with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction, LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195).

Indefinite Coping

Licensees that relied on Seismic Margin Assessment (SMA) or SPRA-based IPEEEs were requested to evaluate their IPEEE results for limitations based on coping durations of less than 72 hours for meeting the intent of mitigating strategies to cope indefinitely.

The licensee stated that a review of its SPRA-based IPEEE concluded that its results were not sensitive to coping duration. However, the licensee stated that several consumable items, such as water and fuel oil inventories, were evaluated to determine whether they require re-supply to obtain sufficient resources to sustain functions indefinitely. The licensee identified several alternative water and diesel fuel oil supplies that may be available to support extended coping. Additionally, consistent with Sections 3.3 and 12 of NEI 12-06, the licensee stated that additional supplies can be delivered to the site to support extended coping and continued maintenance of the safe shutdown condition and concluded consumable water and fuel oil supplies would not adversely affect IPEEE conclusions.

IPEEE Upgrade

In order to use the IPEEE results, licensees were required to perform a full-scope IPEEE. Licensees that had performed focused-scope IPEEEs were allowed to upgrade their IPEEEs to be consistent with a full-scope IPEEE by performing a series of enhancements detailed in the SPID. Specifically, the SPID requested licensees to perform a full-scope, detailed review of relay chatter and a full evaluation of potential soil failures such as liquefaction, slope stability, and settlement.

The licensee stated that the focused-scope IPEEE for Salem was upgraded to a full-scope IPEEE. Details regarding this upgrade were provided by the licensee as part of their SHSR, and a brief summary was provided as part of the MSA submittal. As stated in the seismic hazard staff assessment (ADAMS Accession No. ML16041A033), the NRC staff reviewed this information and concluded that Salem met the IPEEE program adequacy criteria in the SPID, provided that the IPEEE relay chatter review be completed. The licensee stated that a low ruggedness relay review, performed as part of the IPEEE, concluded that relay chatter is not significant to safe shutdown or containment performance after a seismic event at Salem. As stated in the SHSR, low ruggedness relays were either replaced with higher seismic capacity relays or were screened out from further consideration because they were not associated with safe shutdown or containment function components or were determined to have a capacity greater than the IHS. In order to confirm this assessment and to justify not performing the full scope IPEEE relay chatter review, the licensee stated that all relays in safety-related circuits are required to be evaluated to the SSE design-basis response spectrum, which bounds the GMRS in the 1 to 10 Hz frequency range. Additionally, in order to address exceedances above 10 Hz, the licensee referenced their HF confirmation of potentially sensitive devices in the IPEEE

scope (the licensee's HF confirmation results and the staff assessment of the confirmation is provided below).

Based on the information provided, which included a confirmation by the licensee that the safety-related relays are designed to the SSE design-basis response spectrum and the results of the HF confirmation (discussed below), the NRC staff concludes that sufficient information was provided in order to address the potential for relay chatter. Therefore, the SPID IPEEE adequacy criteria has been met.

Spent Fuel Pool Cooling Evaluation

Licensees were requested to ensure that the credited SFP cooling capability is maintained by demonstrating robustness to the MSSHI of the SFP makeup equipment.

The licensee stated that the Salem SFP Cooling System for Unit 1 and Unit 2 is seismically rugged to the MSSHI levels since the SFP cooling system components and piping are evaluated to the Salem SSE design-basis response spectrum, which completely envelopes the GMRS from 1 to 10 Hz.

As part of the audit process, the NRC staff asked the licensee to confirm that all SSCs relied upon for SFP cooling were designed and qualified to the SSE design-basis response spectrum. As part of their response, the licensee emphasized that all Seismic Category 1 SSCs were designed to the SSE design-basis response spectrum; however, the original SFP cooling system design relied on SSCs that were not Seismic Category 1. The licensee stated that, as part of an SFP cooling system seismic upgrade (described in UFSAR Section 9.1.3.3), these SSCs were subsequently evaluated against the SSE design-basis response spectrum. The licensee referenced previous evaluations that supported this statement and described the seismic design and evaluation of SSCs that are relied upon for SFP cooling.

The staff reviewed this information and the licensee's confirmation that the SFP cooling system is evaluated to the SSE design-basis response spectrum and concludes that the SFP cooling-related SSCs are seismically adequate in accordance with NEI 12-06, Appendix H.

High Frequency Evaluation

Licensees with HF exceedances (GMRS>IHS above 10 Hz) were requested to perform a HF evaluation of potentially sensitive devices in the IPEEE scope. For Salem, the GMRS exceeds the SSE by a slight amount, but is bounded by the IHS above 10 Hz. As stated in the seismic hazard staff assessment, the licensee was given the option to either perform a HF confirmation or an IPEEE relay chatter review. The licensee performed a HF confirmation and as documented in the NRC staff letter dated February 18, 2016 (ADAMS Accession No. ML15364A544), the staff reviewed this limited exceedance and concluded that this exceedance falls within the narrow-band-exceedance criteria specified in Section 3.1.2 of the Electric Power Research Institute Report 3002004396, "High-Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation" (ADAMS Accession No. ML15223A100). As such, it does not represent a concern and does not warrant additional evaluations to confirm the functionality of control devices in the HF range. Therefore, the staff concludes that HF evaluation of potentially sensitive devices in the IPEEE scope was perform consistent with Revision 2 of NEI 12-06, Appendix H, Section H.4.3.

Availability of FLEX Equipment

Appendix H.4.3 of NEI 12-06 states that with the exception of SFP cooling, an IPEEE-based AMS does not rely upon the availability of FLEX equipment. The licensee stated that the AMS does not rely upon the availability of FLEX equipment. However, in order to demonstrate additional mitigating capability, the licensee emphasized its capability to obtain portable FLEX equipment from off-site sources.

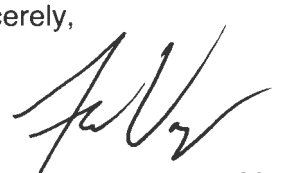
CONCLUSION

The NRC staff has reviewed the seismic hazard MSA for Salem. The NRC staff confirmed that the licensee's seismic hazard MSA is consistent with the guidance in Appendix H.4.3 of NEI 12-06, Revision 2, as endorsed by JLD-ISG-2012-01, Revision 1. Therefore, the methodology used by the licensee was appropriate to perform an assessment of the mitigation strategies that address the reevaluated seismic hazard.

The NRC staff concludes that the IPEEE-based AMS evaluation demonstrates that SSCs relied upon for mitigation strategies have seismic capacity to levels higher than the GMRS, safe shutdown of the plant can be accomplished, and any consequences can be appropriately mitigated.

If you have any questions, please contact me at (301) 415-1617 or via e-mail at Frankie.Vega@nrc.gov.

Sincerely,



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Office of Nuclear Reactor Regulation

Docket Nos. 50-272 and 50-311

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