



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

October 2, 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
ASSESSMENT OF FLOODING FOCUSED EVALUATION (CAC NOS. MG0034
AND MG0035)

Dear Mr. Sena:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), "Conditions of Licenses" (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). By letter dated March 11, 2014 (ADAMS Accession No. ML14071A401), PSEG Nuclear LLC (the licensee) responded to this request for Salem Nuclear Generating Station, Units 1 and 2 (Salem).

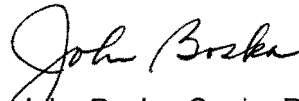
After its review of the licensee's response, by letter dated September 10, 2015 (ADAMS Accession No. ML15238B704), the NRC issued an interim staff response (ISR) letter for Salem. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Salem and parameters that are a suitable input for the mitigating strategies assessment (MSA). As stated in the letter, because the local intense precipitation (LIP) flood-causing mechanism at Salem was not bounded by the plant's CDB, additional assessments of the flood hazard mechanism are expected to be performed by the licensee.

By letter dated June 30, 2017 (ADAMS Accession No. ML17181A221), the licensee submitted the focused evaluation (FE) for Salem. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. The purpose of this letter is to provide the NRC's assessment of the Salem FE.

As set forth in the attached staff assessment, the NRC staff has concluded that the Salem FE was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). The NRC staff has further concluded that the licensee has demonstrated that effective flood protection, if appropriately implemented, exists for the LIP flood mechanism during a beyond-design-basis external flooding event. This closes out the licensee's response for Salem for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with CAC Nos. MG0034 and MG0035.

If you have any questions, please contact me at 301-415-2901 or at John.Boska@nrc.gov.

Sincerely,



John Boska, Senior Project Manager
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Flooding Focused Evaluation for Salem

Docket Nos: 50-272 and 50-311

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO THE FOCUSED EVALUATION FOR
SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2
AS A RESULT OF THE REEVALUATED FLOODING HAZARD
NEAR-TERM TASK FORCE RECOMMENDATION 2.1 - FLOODING
(CAC NOS. MG0034 AND MG0035)

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, 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 request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's current design basis (CDB) flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter stated that an integrated assessment should be submitted, and described the information that the integrated assessment should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes a graded approach in which licensees with hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation (FE). As part of the FE, licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the focused evaluation in response to the 50.54(f) letter. The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force

Recommendation 2.1, Flood Hazard Reevaluation” (ADAMS Accession No. ML16162A301). Therefore, NEI 16-05, Revision 1, as endorsed, describes acceptable methods for demonstrating that Salem Nuclear Generating Station, Units 1 and 2 (Salem) has effective flood protection.

2.0 BACKGROUND

This provides the final NRC staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter.

Therefore, this background section includes a summary description of the reevaluated flood information provided by the licensee and the associated assessments performed by the NRC staff. The reevaluated flood information includes: 1) the flood hazard reevaluation report (FHRR); 2) the mitigation strategies assessment (MSA); and 3) the FE.

Flood Hazard Reevaluation Report

By letter dated March 11, 2014 (ADAMS Accession No. ML14071A401), PSEG Nuclear LLC (the licensee) submitted the FHRR for Salem. After reviewing the licensee’s response, by letter dated September 10, 2015 (ADAMS Accession No. ML15238B704), the NRC issued an interim staff response (ISR) letter for Salem. The ISR letter discusses the reevaluated flood hazard mechanisms that exceeded the CDB for Salem and parameters that are a suitable input for the MSA. As stated in the ISR letter, because the local intense precipitation (LIP) flood-causing mechanism at Salem is not bounded by the plant’s CDB, additional assessment of the LIP flood hazard is necessary. The NRC staff conducted an audit of the information in the FHRR and issued an audit report dated January 8, 2016 (ADAMS Accession No. ML15364A073). The NRC staff issued a final staff assessment of the FHRR in a letter dated October 7, 2016 (ADAMS Accession No. ML16265A085). The NRC staff’s conclusion regarding LIP exceeding the Salem CDB remained unchanged from the information provided in the ISR letter.

Mitigation Strategies Assessment

By letter dated December 30, 2016 (ADAMS Accession No. ML16365A151), the licensee submitted the MSA for Salem for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigation strategies for beyond-design-basis external events. By letter dated July 13, 2017 (ADAMS Accession No. ML17186A360), the NRC issued its assessment of the Salem MSA. The NRC staff has concluded that the Salem MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute (NEI) 12-06, Revision 2, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide” (ADAMS Accession No. ML16005A625). The NRC’s endorsement of NEI 12-06, Revision 2, is described in 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). The NRC staff further concluded that the licensee has demonstrated that its mitigation strategies, if appropriately implemented, are reasonably protected from the reevaluated flood hazard conditions for beyond-design-basis external events.

Focused Evaluation

By letter dated June 30, 2017 (ADAMS Accession No. ML17181A221), the licensee submitted the FE for Salem. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood

mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. These 3 options associated with performing an FE are referred to as Path 1, 2, or 3, as described in NEI 16-05, Revision 1. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Salem FE.

3.0 TECHNICAL EVALUATION

The licensee stated that its FE followed Path 2 of NEI 16-05, Revision 1, and utilized Appendices B and C for guidance on evaluating the site strategy. The Salem FE addresses the LIP flooding mechanism, which was found to exceed the plant's CDB as described in the FHRR and the ISR letter. The licensee's modeling of the LIP event was previously reviewed and approved by the NRC staff in the final staff assessment of the FHRR in a letter dated October 7, 2016 (ADAMS Accession No. ML16265A085). This technical evaluation will address the following topics: characterization of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin; reliability of flood protection features; and overall site response.

3.1 Characterization of Flood Parameters for LIP

The focused evaluation uses the water surface elevation for LIP which was stated in the NRC's ISR letter. Associated effects (AE) and flood event duration (FED) parameters were assessed by the licensee in its MSA for flooding. These parameters have already been reviewed by the NRC, as summarized by the NRC assessment letter dated July 13, 2017. The licensee used the AE and FED parameters as input to the Salem FE and concluded that the site's flood strategy is effective in protecting structures, systems, and components (SSCs) that support key safety functions. The licensee supported its conclusion of adequate flood protection by demonstrating adequate available physical margin and reliable flood protection features for LIP. In its MSA and FE for Salem, the licensee indicated that personnel need to close certain watertight doors before the water level reaches the level of the doors; therefore, an evaluation of the overall site response was also performed.

All elevations in this document use the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted, which is approximately the height above mean sea level. Some of the licensee's documents also use a vertical datum specific to the licensee, known as the Public Service Datum (PSD). As described in the Salem FE, the correlation between the two is that given the NAVD88 height, add 89.8 feet to get the PSD height. The elevations for the reevaluated flood mechanism (LIP) are in the following table. For the LIP condition, the licensee relies on permanent passive flooding protection features and watertight doors that must be closed to demonstrate that adequate protection is available.

Table 1: Reevaluated LIP Flood Hazard Elevations (in NAVD88)

	Approximate Grade Level of Powerblock (Salem FHRR)	CDB LIP Flood Height (ISR letter)	Reevaluated LIP Flood Height (ISR Letter)
Units 1 and 2	9.7 feet	None	12.2 feet

3.2 Evaluation of Flood Impact Assessment for LIP

3.2.1 Description of Impact of Unbounded Hazard

The Salem FE identified the potential impacts on key SSCs as a result of water ponding due to LIP. The licensee stated in the FE that both units are designed for flood protection, with the watertight doors closed, to a height of 115 feet PSD. This corresponds to about 15.5 feet above grade. The LIP event results in water ponding in certain areas near safety-related structures to a depth of about 2.5 feet above grade. The licensee's response is to close the applicable watertight doors prior to the water level reaching the door sill.

The NRC staff reviewed the information provided by the licensee in order to ensure that adequate flood parameters were used for the calculation of water surface elevations. Specifically, the NRC staff verified that the assumed water surface elevation and duration of flooding above grade elevation was consistent with previous information reviewed by the staff for the Salem FHRR (ADAMS Accession No. ML14071A401).

3.2.2 Evaluation of Available Physical Margin for LIP

The licensee relies on passive features and existing watertight doors to justify that there is available margin using a deterministic approach. The licensee stated that personnel would close the applicable watertight doors in the powerblock prior to any ingress of water. Watertight doors in the service water intake structure (SWIS) are not required to be closed in response to a LIP event because the watertight doors at the SWIS are significantly above LIP flood elevations. With the watertight doors at the powerblock closed, the powerblock has flood protection to a height of 15.5 feet above grade, compared to the LIP water surface elevation of about 2.5 feet above grade. The flood protection elevation at the SWIS is about 12.5 feet above grade with the watertight doors open. There is a considerable physical margin available of about 13 feet at the powerblock and 10 feet at the SWIS. Therefore, the NRC staff concludes that the licensee has demonstrated that there is sufficient physical margin available, as described in Appendix B of NEI 16-05, Rev 1, which can provide flood protection for key SSCs from the LIP event.

3.2.3 Evaluation of Reliability of Flood Protection Features for LIP

Salem relies on permanent passive flooding protection features such as walls and on permanent active features (watertight doors) to provide protection for flooding from LIP. The ability of these engineering features to withstand the design-basis flood conditions were evaluated as satisfactory during the initial licensing of the plant. As described in the licensee's FE, condition monitoring of structures per plant procedure ER-AA-310-101, "Condition Monitoring of Structures," provides assurance that concrete structural elements such as walls and slabs remain capable of performing their design function. The FE also states that plant preventive maintenance instruction SC.MD-PM.ZZ-0036, "Watertight Door Inspection and Repair," is used to perform inspections and maintenance of watertight doors, and SC.FP-SV.FBR-0026, "Flood and Fire Barrier Penetration Seal Inspection," is used for the inspection of penetration seals.

Because increased focus has been placed on flood protection since the accident at Fukushima, licensees and NRC inspectors have identified deficiencies with equipment, procedures, and analyses relied on to either prevent or mitigate the effects of external flooding at a number of licensed facilities. Recent examples include those found in Information Notice 2015-01, "Degraded Ability to Mitigate Flooding Events" (ADAMS Accession No. ML14279A268). In

addition, the NRC is cooperatively performing research with the Electric Power Research Institute to develop flood protection systems guidance that focuses on flood protection feature descriptions, design criteria, inspections, and available testing methods in accordance with a memorandum of understanding dated September 28, 2016 (ADAMS Accession No. ML16223A495). The NRC staff expects that licensees will continue to maintain flood protection features in accordance with their current licensing basis. The NRC staff further expects that continued research involving flood protection systems will be performed and shared with licensees in accordance with the guidance provided in Management Directive 8.7, "Reactor Operating Experience Program," (ADAMS Accession No. ML122750292) as appropriate.

The NRC staff concludes that the Salem flood protection features for the LIP event meet the criteria for reliability as described in Appendix B of NEI 16-05, Rev 1.

3.2.4 Evaluation of Overall Site Response for LIP

The licensee relies on personnel actions to close certain watertight doors in response to the LIP event. The Salem FE states that the Control Room Supervisor monitors the National Weather Service for storm warnings at least once per shift per plant procedure OP-SA-112-101-1001, "Shift Turnover Responsibilities." If storm warnings are broadcast, the Control Room Supervisor implements plant procedure OP-AA-108-111-1001, "Severe Weather and Natural Disaster Guidelines." Procedure OP-AA-108-111-1001 has instructions to monitor the National Weather Service Probabilistic Quantitative Precipitation Forecast (PQPF). If the PQPF predicts greater than 6 inches of rain in the next 24 hours for Salem County, operators are advised to close the appropriate watertight doors, as specified in procedure SC.OP-AB.ZZ-0001, "Adverse Environmental Conditions." The licensee stated in the FE that no specialized equipment is required to close the doors, and the doors can be accessed by walking inside plant structures. Therefore, external environmental conditions will not have an adverse impact on the ability of the operators to close the doors. The Salem FE states that a simulation of watertight door closure took approximately 1 hour and 7 minutes using one operator. The watertight doors are also required to be closed within 2 hours by Salem Technical Specification 3.7.5.1 if the river water level exceeds 10.5 feet above mean sea level using United States Geological Survey datum.

The NRC staff concludes that that the overall Salem site response for LIP meets the criteria for an adequate response strategy as described in Appendix C of NEI 16-05, Rev. 1.

4.0 AUDIT REPORT

The NRC staff previously issued a generic audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452), that described the NRC staff's intention to conduct audits related to the focused evaluations and issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. Staff activities have been limited to performing the reviews described above. Because this staff assessment appropriately summarizes the results of those reviews, the NRC staff concludes that an audit report is not necessary, and that this document serves as the final audit report described in the July 18, 2017, letter.

5.0 CONCLUSION

The NRC staff concludes that the licensee performed the Salem FE in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, and that the licensee has demonstrated that effective flood protection exists from the reevaluated flood hazard. Furthermore, the NRC staff concludes that Salem screens out of performing an

integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2 – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION DATED October 2, 2017

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