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

May 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: HOPE CREEK GENERATING STATION– FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NO. MF7934)

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). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 29, 2016 (ADAMS Accession No. ML16364A217), PSEG Nuclear LLC (the licensee) submitted the mitigation strategies assessment (MSA) for Hope Creek Generating Station (Hope Creek). The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Hope Creek MSA.

The NRC staff has concluded that the Hope Creek MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, and that the licensee has demonstrated that the mitigation strategies are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC No. MF7934.

If you have any questions, please contact me at 301-415-6197 or at Tekia.Govan@nrc.gov.

Sincerely,

Tekia V. Govan

Tekia Govan, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for Hope Creek

Docket No. 50-354

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO MITIGATION STRATEGIES FOR

HOPE CREEK GENERATING STATION

AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE

RECOMMENDATION 2.1- FLOODING CAC NO. MF7934

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), "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).

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The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of flood hazards. The NRC staff described this issue and provided recommendations to the Commission on integrating these related activities in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flood Hazards," dated November 21, 2014 (ADAMS Accession No. ML14309A256). The Commission issued a staff requirements memorandum on March 30, 2015 (ADAMS Accession No. ML15089A236), affirming that the Commission expects licensees for operating nuclear power plants to address the reevaluated flood hazards, which are considered beyond-design-basis external events, within their mitigating strategies.

Nuclear Energy Institute (NEI) 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625), has been endorsed by the NRC as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated flood hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 2, and Appendix G in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. The NRC's endorsement of NEI 12-06, including exceptions, clarifications, and additions, is described in NRC 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). Therefore, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Hope Creek Generating Station (Hope Creek) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated September 10, 2015 (ADAMS Accession No. ML15238B655), the NRC issued an interim staff response (ISR) letter for Hope Creek. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Hope Creek and parameters that are a suitable input for the mitigating strategies assessment (MSA). For Hope Creek, the mechanism listed as not bounded by the CDB in the ISR letter is local intense precipitation (LIP). By letter dated December 29, 2016 (ADAMS Accession No. ML16364A217), PSEG Nuclear LLC (the licensee) submitted the Hope Creek MSA for review by the NRC staff.

3.0 TECHNICAL EVALUATION

3.1 Hope Creek's FLEX Strategies

A brief summary of Hope Creek's FLEX strategies are listed below:

- For Phase 1, the initial injection of cooling water into the reactor pressure vessel will be accomplished using the reactor core isolation cooling (RCIC) and high pressure coolant injection (HPCI) systems. Both the RCIC and HPIC pump suctions are initially lined up to the condensate storage tank and they will pump water into the core from the condensate storage tank automatically. If the condensate storage tank is not available, RCIC and HPIC pump suctions will automatically transfer to the suppression pool. In order to minimize suppression pool heat-up operators will secure the HPCI system when the RCIC system is capable of maintaining reactor pressure vessel water inventory. Pressure control of the reactor pressure vessel is accomplished using the safety relief valves. Direct current load shedding is initiated after approximately 30 minutes and completed within 1.5 hours after the initiation of the extended loss of alternating current power (ELAP) event to extend the battery capacity to power the Phase 1 systems and instruments. Installed batteries can maintain necessary voltage for at least 5 hours. Prior to battery depletion, FLEX diesel generators are deployed and used to recharge the division I and division II batteries.

- For Phase 2, station operators will connect a 600 kW, 480 Vac FLEX generator to the 250 and 125 Vdc battery chargers to ensure uninterrupted power to critical components from the dc electrical system. The primary strategy for core cooling will continue to be

provided by the use of the RCIC or HPCI system to provide water to the reactor pressure vessel. As a contingency, a portable diesel-driven FLEX pump is deployed and will take suction from the Delaware River with the discharge hose routed to either the A or B service water header. Water will flow from the service water header to the residual heat removal (RHR) header via the service water to the RHR emergency makeup line and river water will be injected to the reactor pressure vessel inside the shroud and above the fuel. The portable diesel-driven FLEX pump will also be used to replenish torus water level as necessary by supplying water to the torus spray header or the RHR test return valve. In the event of flooding which prevents the deployment of the portable diesel-driven FLEX pump the licensee will connect a FLEX electric motor-driven alternate header pump that will take suction on the torus and inject water into the reactor pressure vessel via a primary or alternate connection.

- For Phase 3, the equipment provided by a National SAFER [Strategic Alliance for FLEX Emergency Response] Response Center (NSRC) will be used in conjunction with installed plant equipment to restore shutdown cooling. Electrical power from four 4.16 kV generators and a distribution system will be used to restore one division of emergency core cooling system equipment. The NSRC-provided low-pressure high-flow diesel-driven pump would be used to pump water from the ultimate heat sink and through the safety auxiliaries cooling system heat exchanger to restore the heat sink function. A mobile water treatment system will be provided from the NSRC for water purification.

3.2 NRC's Evaluation

The licensee explained in the Hope Creek MSA that the FLEX design-basis (DB) flood is primarily based on the plant's CDB flood but also incorporates aspects of the ISR letter. Furthermore, the LIP event is the only flood hazard for which the reevaluated maximum water surface elevation (WSE) exceeds its CDB WSE. The licensee explained that the reevaluated LIP event produces a maximum flood level at critical door locations of 102.6 ft Public Service Datum (PSD); however, the plant's minimum flood-protected elevation is 121 ft PSD. Nevertheless, the licensee compared the CDB, FLEX DB, and ISR letter for the LIP event.

Based on this comparison, the licensee confirmed that the FLEX DB stillwater elevation bounds the ISR letter and that the LIP maximum stillwater elevation was considered when determining the outdoor FLEX storage areas and FLEX diesel generator location. The licensee explained that the hydrodynamic and hydrostatic loads during a LIP event are considered negligible when compared to the loads on systems, structures, and components (SSCs) analyzed in the DB due to the storm surge event. Furthermore, the licensee determined that the debris load is negligible based on the low flow velocity and water depths produced by the LIP event. Based on the licensee's comparison and assessment of its FLEX DB and ISR letter for the LIP event, the NRC staff finds it reasonable that the reevaluated flood levels, including associated effects, from the LIP event will not impact the licensee's ability to implement its FLEX strategies.

The licensee also assessed the reevaluated LIP flood event duration (i.e., period of inundation and period of recession) and its impact on the FLEX strategies. The licensee stated that the period of inundation during the reevaluated LIP event is one hour and is bounded by the FLEX DB (duration). The NRC staff noted if an ELAP event occurs as a result of the reevaluated LIP event, the period of inundation would not impact the FLEX strategies because permanent installed safety-related plant equipment would be relied upon early in the ELAP event (i.e., FLEX Phase 1) and is protected by permanent plant features. The licensee stated that the

period of recession during the reevaluated LIP event is less than eleven hours and is bounded by the FLEX DB flood. The licensee explained that following a 1-hour LIP event, waters recede from critical door locations in less than two hours. The licensee indicated that minor standing water remains around the site eleven hours following the conclusion of the LIP event; however, the outdoor FLEX storage areas are accessible and critical FLEX deployment routes are passable. In addition, the FLEX diesel generators are permanently located on the roof of the Unit 2 reactor building and are not affected by LIP period of recession. Based on the low levels of standing water around the site and the FLEX DB bounding the information in the ISR letter, the NRC staff finds it reasonable the licensee can successfully access and deploy its FLEX equipment during an ELAP event.

The licensee explained that following the submittal of its Hope Creek FHRR, it revised its operating procedure that directs operators to close all watertight doors. Specifically, this procedure was revised to include actions to close watertight doors if the National Weather Service predicts LIP to exceed 6 inches over the next 24 hours; thus, ensuring that safety-related systems, structures, and components are protected from floodwaters. The NRC staff noted that this procedural revision was made even though the reevaluated LIP event bounds the FLEX DB, including associated effects and flood event duration, and the plant's minimum flood-protected elevation bounds the maximum LIP flood levels. Thus, the NRC staff finds this procedural revision to be a precaution that further ensures that permanent safety-related plant equipment is protected from floodwaters.

3.2.1 Evaluation of Associated Effects

The NRC staff reviewed the information provided in the Hope Creek MSA for the associated effects parameters for flood hazards not bounded by the CDB. The associated effects parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by NRC staff, and were transmitted to the licensee via Hope Creek ISR letter. Associated effects parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2.2-1 of this staff assessment.

For the LIP flood-causing mechanism, the licensee stated that the associated effects of LIP-related flooding, including hydrodynamic and debris loads, erosion and sedimentation, groundwater, concurrent site conditions, and other effects, are minimal due to the relatively-slow water velocities and low water depths for a LIP event and limited sources of debris and sediment within the power block area. The NRC staff confirmed this statement by reviewing the licensee-provided LIP model input and output files. The NRC staff found that the estimated inundation depths and water velocities presented in the Hope Creek FHRR are acceptable and that the modeling is reasonable for use in the Hope Creek MSA. The NRC staff reviewed the potential for debris load at the Hope Creek site and conclude that there are no significant sources of material (trees, vegetation, etc.) that would contribute to debris loads at the site. The NRC staff agrees with the licensee's conclusion that the associated effects parameters for the LIP flood-causing mechanism are either minimal or will have no impact on the safety-related plant facilities.

In summary, the staff determined the licensee's methods were appropriate and the provided associated effects parameters are reasonable for use in the Hope Creek MSA.

3.2.2 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by the licensee in the Hope Creek MSA regarding the flood event duration (FED) parameters needed to perform the Hope Creek MSA for flood hazards not bounded by the CDB. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 3.2.1-1 of this staff assessment.

The licensee states that warning time for site preparation is not credited (not applicable) in the flood protection strategy for LIP flood since only permanent/passive flood protection measures are relied on, and therefore, was not considered as part of the Hope Creek MSA. In addition, the licensee states in the Hope Creek MSA that SSCs important to safety are currently protected by means of permanent passive measures and permanent active features (i.e., watertight doors). The watertight door closure can be performed well within the LIP warning time provided by the 24-hour National Weather Service's Probabilistic Quantitative Precipitation Forecast (NWS PQPF). The Hope Creek flooding walkdown report documents actual closure in approximately one hour of exceeding a high river water level trigger, based on operating experience. Therefore, they determined that the period of site preparation for an anticipated LIP event based on the current watertight door closure procedure with 24-hour NWS PQPF is adequate. The NRC staff notes that the approach, to determine LIP warning time and site preparation time, is consistent with guidance provided by Appendix G of NEI 12-06, Revision 2. The NRC staff notes the licensee also has the option to use NEI 15-05 to estimate warning time (as needed) for further analyses.

The licensee calculated maximum WSEs for the LIP flood-causing mechanism at multiple locations within the Hope Creek powerblock; those locations and their corresponding WSEs are described in Table 6.1-2 of the Hope Creek ISR letter. In its Hope Creek MSA, the licensee reported that the period of inundation is about 1 hour. The time necessary for LIP-related flood waters to recede from the Hope Creek site is less than 11 hours. The NRC staff confirmed these FED parameters by reviewing the licensee-provided LIP model input and output files. Based on this review, the NRC staff determined that the licensee's FED parameters for the LIP flood-causing mechanism are reasonable and acceptable for use in the Hope Creek MSA.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Hope Creek MSA related to the original FLEX strategies, as evaluated against the reevaluated hazard(s) described in Section 2 of this staff assessment, and found that:

- The FLEX strategies are not affected by the impacts of the ISR flood levels (including impacts due to the environmental conditions created by the ISR flood levels);

- The deployment of the FLEX strategies is not affected by the impacts of the ISR flood levels; and

- Associated effects and FED are reasonable and acceptable for use in the MSA, and have been appropriately considered in the MSA.

Therefore, the NRC staff concludes that the licensee has followed the guidance in NEI 12-06, Revision 2, and demonstrated the capability to deploy the original FLEX strategies, as designed,

against a postulated beyond-design-basis event for the LIP flood-causing mechanisms, including associated effects and flood event duration.

Table 3.2.1-1. Hope Creek's Flood Event Durations for Flood-Causing Mechanisms Not Bounded by the CDB

FLOOD-CAUSING MECHANISM	TIME AVAILABLE FOR PREPARATION FOR FLOOD EVENT	DURATION OF INUNDATION OF SITE	TIME FOR WATER TO RECEDE FROM SITE
Local Intense Precipitation and Associated Drainage	Not Applicable (or use NEI 15-05)	1 hr (1)	< 11 hrs (1)
(1) Hope Creek MSA Submittal			

HOPE CREEK GENERATING STATION– FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED May 18, 2017

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