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

January 11, 2017

Mr. Bryan C. Hanson
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7958 AND MF7959)

Dear Mr. Hanson:

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 June 30, 2016 (ADAMS Accession No. ML16182A009), Exelon Generation Company, LLC (the licensee) submitted the mitigation strategies assessment (MSA) for Peach Bottom Atomic Station, Units 2 and 3 (Peach Bottom). 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 Peach Bottom MSA.

The NRC staff has concluded that the Peach Bottom 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 Nos. MF7958 and MF7959.

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

Sincerely,

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 Peach Bottom

Docket Nos. 50-277 and 50-278

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO MITIGATION STRATEGIES FOR PEACH BOTTOM ATOMIC STATION, UNITS 2 AND 3, AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING CAC NOS. MF7958 AND MF7959

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).

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). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit to the NRC for review a final integrated plan that describes how compliance with the requirements of Attachment 2 of the order was achieved. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis (CLB) 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.

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 Peach Bottom Atomic Station, Units 2 and 3 (Peach Bottom) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated March 31, 2016 (ADAMS Accession No. ML16091A136), the NRC issued an interim staff response (ISR) letter for Peach Bottom. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Peach Bottom and flood parameters that are suitable input for the mitigating strategies assessment (MSA). For Peach Bottom, the mechanisms listed as not bounded by the CDB in the ISR letter are the local intense precipitation (LIP), storm surge, seiche, and ice-induced flooding. These mechanisms were identified as not bounded because they were not included in the Peach Bottom CDB. By letter dated June 30, 2016 (ADAMS Accession No. ML16182A009), Exelon Generation Company, LLC (the licensee) submitted the Peach Bottom MSA for review by the NRC staff.

3.0 TECHNICAL EVALUATION

3.1 Peach Bottom's FLEX Strategies

A brief summary of Peach Bottom's FLEX strategies are listed below:

- The site has redundant FLEX diesel generators connections that can provide the power required for battery chargers and vital instrumentation. The FLEX diesel fuel supply is provided by on-site fuel oil storage tanks, which are not affected by a flooding event.

- The control room indications of vital instruments are initially powered by the station batteries and eventually by the FLEX diesel generators.

- Core cooling is maintained by ensuring adequate reactor pressure vessel inventory for decay heat removal. Initially, the reactor core isolation cooling system will be used to provide reactor pressure vessel (RPV) makeup. Subsequently, a portable FLEX pump taking suction from the emergency or ultimate heat sinks will makeup to the RPV.

- The primary strategy for maintaining containment integrity will be through venting the containment using the hardened containment vent system.

The licensee states in the Peach Bottom MSA that the site is flood protected up to the level of 135 ft. using Conowingo Datum (C.D.). Although the Peach Bottom FLEX equipment is stored

below this level, the licensee has sufficient warning time and procedures in place to pre-deploy FLEX equipment to locations that are higher than the flood level, thus protecting it from a flood event and allowing the strategies to be implemented.

The Peach Bottom MSA states that the FLEX strategies were designed for the CLB flood, which they state completely bounds the ISR flood levels with the exception of the LIP flood. Therefore, the MSA was performed for the ISR flood levels for LIP and the licensee found they did not need to make any changes to their FLEX strategy. The licensee states that the LIP flood would completely drain from the site prior to the deployment of FLEX equipment. As stated in the Peach Bottom flood hazard reevaluation report (FHRR) (ADAMS Accession No. ML15233A066), LIP would cause some water inundation for less than 2 hours. This timing is consistent with the licensee's sequence of events in its overall integrated plan, submitted on February 28, 2013, and as updated by the revised 6 month updates to that plan. Additionally, the licensee states that the FLEX equipment storage will not be adversely impacted by LIP.

Furthermore, the licensee states that storm surge, seiche, and ice-induced flooding were not considered in the CLB. However, the water levels for these flooding mechanisms do not reach above site grade. Therefore, these flooding mechanisms do not challenge the mitigating strategies. The current FLEX strategies can be successfully deployed as designed for all applicable flood-causing mechanisms including LIP and no further actions, including modifications to FLEX strategies are required.

3.2. Evaluation of Associated Effects

The NRC staff reviewed the Peach Bottom FHRR information provided by the licensee regarding associated effects parameters for flood hazards not bounded by the CDB. Associated effects parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by the NRC staff, and were transmitted to the licensee in the ISR. 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 event, the licensee stated in the Peach Bottom FHRR that hydrostatic and hydrodynamic loads were estimated using guidelines provided in Federal Emergency Management Agency (FEMA) P-259. The estimated loads shown in Peach Bottom FHRR Table 3.10.3.1.1 are not significant at all monitoring points except at the diesel generator building. At this building, the total of the hydrostatic and hydrodynamic loads is 1,620 lb per linear foot. The licensee states in the Peach Bottom FHRR supplemental information that all other associated effects are not applicable due to small inundation depth, low flow velocity, and limited fetch length. The NRC staff confirmed these statements by reviewing the licensee-provided LIP FLO-2D model's input and output files. The NRC staff found that the estimated inundation depths and flow velocities are acceptable and that the modeling is reasonable for use in the MSA. The NRC staff agrees with the licensee's conclusion that the associated effects parameters for LIP are either minimal or that there are no impacts to the plant facilities.

For the river flood event, the licensee provided associated effects parameters for the bounding dam failure flood-causing mechanism instead of developing associated effects parameters for storm surge, seiche, and ice-inducing events separately. Sections 3.10.3.8 and 3.10.3.10 in Peach Bottom FHRR discuss the estimation of hydrostatic, hydrodynamic, and wave loads based on a maximum stillwater depth for the combined riverine flood event of 12.49 ft. For

riverine debris load, the licensee considered a tree log debris following guidelines by American Society of Civil Engineers 7-10 (ASCE 7-10) and with the following characteristics: 1,000 lb in weight, 30 ft in length, and 1 ft in diameter. The maximum estimated floodwater velocity of 1.39 ft/s was used as the traveling velocity of the log. The NRC staff confirmed that the hydrostatic, hydrodynamic, and wave loads for the bounding riverine flood, as well as the maximum flood depth and velocity used to calculate the loads are accurate and acceptable for use as part of the Peach Bottom MSA review. The NRC staff reviewed the licensee's calculation of the debris load and maximum velocity. The NRC staff found that the load calculation is accurate and the assumptions are reasonable for use as part of the Peach Bottom MSA review. The NRC staff also confirmed that the postulated log debris follows the present Federal guidelines ASCE 7-10. Therefore, the NRC staff concluded that the licensee's estimation of the debris load is acceptable for use as part of the Peach Bottom MSA review, and this hazard has no impact on FLEX strategies.

By letter dated October 4, 2016 (ADAMS Accession No. ML16278A530), the licensee discussed additional associated effects parameters for seiche and ice-induced flooding events as summarized below:

- Maximum hydrodynamic and debris loadings are not applicable because most structures, systems, and components are located above the maximum flood elevations for these events, the wave is expected to break and dissipate before reaching low-lying structures, and large debris is not expected to reach these structures.

- Effects of sediment deposition and erosion are not applicable because the shores along the Conowingo Pond are protected with riprap revetment, the site is largely paved so any wave runup is not expected to cause surface erosion, and floodwater is expected to carry negligible amounts of sediment, so deposition is minimal.

- Effects of groundwater ingress is not applicable because all critical structures essential to a safe shutdown of the plant are flood protected to the elevation 134.87 ft NAVD88 and the estimated stillwater levels from these flood causing mechanisms are well below the design based protection level.

- High winds could be generated concurrent to these flood causing mechanisms, but they will not impact the plant's flood response during the flooding events.

- No other associated effects from these flood causing mechanisms was identified.

Based on the above, the licensee maintains that the associated effects parameters for storm surge, seiche, and ice-induced flooding are bounded by the design basis and the river dam failure event. Therefore, the licensee concluded that further development of the associated effects parameters for these flood mechanisms (i.e., seiche and ice-induced flooding) are not required. The NRC staff agrees with the licensee's conclusion and note the approach is consistent with guidance provided by Appendix G of NEI 12-06, Revision 2.

In summary, the NRC staff determined the licensee's methods were appropriate and the provided associated effects parameters are reasonable for use in the MSA. The NRC staff has determined that associated effects have no impact on FLEX strategies.

3.3 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by the licensee in the Peach Bottom FHRR regarding the flood event duration (FED) parameters needed to perform the 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.

For the LIP event, the licensee did not provide warning time, but states that NEI 15-05, "Warning Time for Local Intense Precipitation Events" (ADAMS Accession No. ML15104A158) can be used to evaluate LIP warning time. The LIP levels creating the maximum water elevations and inundation periods for different door locations across the power block are listed in Table 3.10.3.6.1 in the Peach Bottom FHRR. The licensee used the 2-dimensional numerical modeling described in the Peach Bottom FHRR to determine these inundation duration parameters. The NRC staff noted from the table that the inundation periods range from 0.2-hours to 1-hour. Figure 3.10.3.6.1 in Peach Bottom FHRR shows periods of recession for a 1-hr probable maximum precipitation (PMP) flooding event generally ranging from 0.2- to 0.4-hours. The NRC staff confirmed that the licensee's reevaluation of the inundation periods for LIP and associated drainage used present-day methodologies and regulatory guidance.

For storm surge, seiche, and ice-induced floods, the licensee determined the FED parameters using the bounding PMF-driven hydrologic dam failure event. As documented in the Peach Bottom FHRR, the riverine flood event is bounded by the corresponding CDB that bounds storm surge, seiche, and ice-induced floods. The NRC staff agree with the licensee's approach for determining only one set of the riverine FED parameters as this approach is consistent with the guideline provided by Appendix G of NEI 12-06, Revision 2. For the bounding riverine flooding, the licensee determined the following FED parameters:

- The warning time from initiation of rainfall to beginning of inundation is 126 hours.
- The period of inundation for floodwaters above the site grade is approximately 60 hours.
- The period of recession when flood water completely recedes from the site continues to be in a safe and stable mode is 22 hours.

To determine the adequacy of the FED parameters, the NRC staff reviewed the licensee's hydrologic and hydraulic models and resulting hydrographs as presented in Peach Bottom FHRR. Based on this review, the NRC staff determined that the licensee's FED parameters are reasonable and acceptable for use in the MSA and that they have no impact on FLEX strategies.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Peach Bottom MSA related to the 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.

- Associated effects and FED are reasonable and acceptable for use in the Peach Bottom 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, storm surge, seiche, and ice-induced flood-causing mechanisms, including associated effects and flood event duration.

Table 3.2.1-1. 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 [1]	Time for Water to Recede from Site
Local Intense Precipitation and Associated Drainage	Not Provided, But May Use NEI 15-05	0.2~1 hour	0.2~0.4 hour
Storm Surge [1]	126 hours	60 hours	22 hours
Seiche [2]	Not Applicable	Not Applicable	Not Applicable
Ice-Induced Flooding [2]	Not Applicable	Not Applicable	Not Applicable

Source: (Peach Bottom FHRR; and Peach Bottom FHRR, Supplemental Response)

Notes:

(1) FED parameters for storm surge were defined for precipitation-driven hydrologic dam failure as a bounding riverine flood event as presented in FHRR Table 4.0.3.
(2) The licensee did not define the FED parameters for these flood-causing mechanism because the reevaluated flood level for these events are bounded by that for storm surge.

Table 3.2.2-1. Associated Effects Parameters not Directly Associated with Total Water Height for Flood-Causing Mechanisms not Bounded by the CDB.

	Flooding Mechanism			
Associated Effects Parameter	**Local Intense Precipitation**	**Storm Surge (Defined for Precipitation-Driven Hydrologic Dam Failure)**	**Seiche**	**Ice-Induced Flooding**
Hydrodynamic loading at plant grade	1,620 lb/lft at Diesel Generator Building	4,867 lb/lft for hydrostatic load 47 lb/lft for hydrodynamic load 2,462 lb/lft for wave load	Not Applicable	Not Applicable
Debris loading at plant grade	Minimal	Assume a tree log debris of 1,000 lb in weight, 30 ft in length, and 1 ft in diameter traveling at 1.39 ft/s	Not Applicable	Not Applicable
Sediment loading at plant grade	Minimal	Minimal	Not Applicable	Not Applicable
Sediment deposition and erosion	Minimal	Minimal	Not Applicable	Not Applicable
Concurrent conditions, including adverse weather	Minimal	Not Applicable	Not Applicable	Not Applicable
Groundwater ingress	Minimal	Not Applicable	Not Applicable	Not Applicable
Other pertinent factors (e.g., waterborne projectiles)	Minimal	Not Applicable	Not Applicable	Not Applicable

Source: (Peach Bottom FHRR; and Peach Bottom FHRR, Supplemental Response)

Notes:

(1) Lb/lft stands for pounds per linear feet of structure in length.

PEACH BOTTOM ATOMIC POWER STATION, UNITS 2, AND 3 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED January 11, 2017

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