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

May 25, 2017

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

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2– FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF6107 AND MF6108)

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 October 17, 2016 (ADAMS Accession No. ML16291A445), Exelon Generation Company, LLC (Exelon, the licensee) submitted the mitigation strategies assessment (MSA) for Limerick Generating Station, Units 1 and 2 (Limerick). 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 Limerick MSA.

The NRC staff has concluded that the Limerick 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. MF6107 AND MF6108.

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 Limerick

Docket Nos. 50-352 and 50-353

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO MITIGATION STRATEGIES FOR

LIMERICK GENERATING STATION, UNITS 1 AND 2,

AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM

TASK FORCE RECOMMENDATION 2.1- FLOODING CAC NOS. MF6107 AND MF6108

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 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 Limerick Generating Station, Units 1 and 2 (Limerick) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated December 24, 2015 (ADAMS Accession No. ML15357A517), the NRC issued an interim staff response (ISR) letter for Limerick. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Limerick and parameters that are suitable input for the mitigating strategies assessment (MSA). For Limerick, the mechanism listed as not bounded by the CDB in the ISR letter is local intense precipitation (LIP) flooding. By letter dated October 17, 2016 (ADAMS Accession No. ML16291A445), Exelon Generation Company, LLC (Exelon, the licensee) submitted the Limerick MSA for review by the NRC staff.

3.0 TECHNICAL EVALUATION

3.1 Limerick's FLEX Strategies

The licensee stated in the Limerick MSA that the FLEX strategy is based upon the Limerick program document CC-LG-118, "Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program." The FLEX strategy accounted for flood levels that bound the re-evaluated levels for all flood events except LIP. LIP results in a higher water level near the diesel generator building (DGB).

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

- In an extended loss of alternating current [ac] power (ELAP) event, the reactor core isolation cooling (RCIC) system will be actuated and take suction from the suppression pool, while power to the plant is provided by the installed Division 1 and 2 safety-related batteries.

- Portable FLEX pumps will be aligned to supply makeup water to the reactor pressure vessel, suppression pool and/or the spent fuel pool. The FLEX pumps will take suction from the spray pond, and discharge through hoses into residual heat removal service water system.

- Portable FLEX generators will be aligned to the Division 1 and 2 electrical busses to re-energize 125 V [volt] /250 Vdc [direct current] battery chargers and selected 480 Vac components.

- Plant equipment and FLEX equipment are used to maintain safety functions with backup equipment and supplies available as required from the Strategic Alliance for FLEX Emergency Response (SAFER) offsite location.

3.2 Evaluation of the Local Intense Precipitation Event

The Limerick MSA indicates that the CDB flood level is 217 feet. The FLEX storage locations and deployment of most FLEX equipment will be on higher elevations throughout the site. The only exception is the LIP, which reaches 217.1 feet at the DGB. Flooding at this location could affect the deployment and connections of FLEX electrical cables because the FLEX DGs are deployed outside the DGB doors. The licensee described the current LIP flood as being about 3 to 4.5 inches of floodwater inundation around the DGB for about 10 to 15 minutes. The floodwater then decreases to about 1 to 2 inches and will be below the site level (217 feet) about 1 hour after the LIP event. This timing is accounted for in the current FLEX strategy. During a NRC audit of the strategies held on December 8, 2016 (ADAMS Accession No. ML17109A307), the licensee stated that further validations were performed for the FLEX strategy outside the DGB. The licensee determined that the current FLEX strategy would provide margin of 2.5 hours to allow the LIP floodwater to recede around the DGB before the deployment of the FLEX equipment. The licensee indicated in the Limerick MSA that the safety equipment inside the DGB would remain protected from water intrusion due to the water entering through undercuts in the doors being directed and contained in the diesel pits such that the water will not affect the connection points for the FLEX DGs. No flood barriers or features are being proposed due to the reevaluated LIP flood since the licensee has indicated that the LIP floodwater would recede within 2.5 hours before the FLEX electrical equipment will be needed for deployment and staging for Phase 2 operation.

The NRC staff reviewed the licensee's FLEX strategy and confirmed that the transition from Phase 1 to Phase 2 would allow for a 2.5 hour delay in deployment of the FLEX electrical equipment to the DGB. The NRC staff also confirmed that the existing FLEX equipment and storage location would not be affected from the LIP flood, that the water diversion setup inside of the DGB would handle any water intrusion coming from the DGB outside doors, and that no safety equipment will be affected. Further, the remaining FLEX strategies for Phase 2 can be completed without further incident. Based on the Limerick site layout for the remaining areas of FLEX equipment deployment, the water diversion capability within the DGB, and the storage and deployment location of FLEX equipment and connection points, the NRC staff finds the licensee has adequately assessed the information in the ISR letter for the LIP flood event and the overall FLEX strategy can be implemented as currently designed.

3.3 Evaluation of Associated Effects

Flood-related associated effects for Limerick were assessed during the NRC staff's review of the Limerick flood hazard reevaluation report (FHRR) (ADAMS Accession No. ML16280A382). In its staff assessment, the NRC staff reviewed the associated effect parameters and confirmed the licensee's conclusion that associated effects from LIP would be minimal. The NRC staff agrees with the licensee's determination that associated effects have no impact on FLEX strategies.

3.4 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by the licensee in the Limerick MSA regarding the flood event duration (FED) parameters. The FED parameters not bounded by the CDB are summarized in Table 3.4-1 of this staff assessment.

For the LIP flood-causing mechanism at the DGB, the licensee stated that the maximum water elevation remains above ground elevation for an inundation period up to 1 hour after the start of rainfall. The licensee assumed that there is no warning time and that the period of recession is 7 hours, as shown in hydrographs for the DGB. The licensee did not credit LIP warning time because no preparatory actions are required since the site's DGB pit area is designed to contain the water that seeps under the DGB doors. The maximum water elevations and inundation periods for different locations at doors around the DGB are provided in the Limerick MSA. The licensee used results from a two-dimensional numerical model, as described in the Limerick FHRR, to quantitatively estimate the inundation duration and period of recession parameters. The NRC staff confirmed that the licensee's reevaluation of the inundation periods for LIP and associated drainage uses present-day methodologies and regulatory guidance.

The NRC staff agrees with the licensee's conclusion related to determining the FED parameters as the approach is consistent with guidelines provided by Appendix G of NEI 12-06, Revision 2. Based on this review, the NRC staff determined that the licensee's FED parameters are reasonable and acceptable for use in the MSA.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Limerick 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 Limerick 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 3.4-1. 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	Time for Water to Recede from Site
Local Intense Precipitation and Associated Drainage (at Diesel Generator Building)	0 hour	1 hour	7 hours

Source: Limerick MSA

LIMERICK GENERATING STATION, UNITS 1 AND 2– FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED May 25, 2017

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