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

May 18, 2017

Mr. Steven D. Capps
Vice President – McGuire Site
Duke Energy Carolinas, LLC
McGuire Nuclear Station
12700 Hagers Ferry Road
Huntersville, NC 28078-8985

SUBJECT: MCGUIRE NUCLEAR STATION, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7941 AND MF7942)

Dear Mr. Capps:

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*, 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 report (ADAMS Accession No. ML111861807).

Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their site(s) using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. 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 have been based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 15, 2016 (ADAMS Accession No. ML16355A210, non-publicly available), Duke Energy Carolinas, LLC (Duke, the licensee) submitted its flooding mitigation strategies assessment (MSA) for McGuire Nuclear Station, Units 1 and 2 (McGuire). 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 McGuire MSA.

The NRC staff has concluded that the McGuire 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. MF7941 and MF7942.

If you have any questions, please contact me at 301-415-3809 or at Juan.Uribe@nrc.gov

Sincerely,

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

Docket Nos. 50-369 and 50-370

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for McGuire

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO MITIGATION STRATEGIES FOR MCGUIRE NUCLEAR STATION, UNITS 1 AND 2 AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE RECOMMENDATION 2.1 – FLOODING (CAC NOS. MF7941 AND MF7942)

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 respective site(s) using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. 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 have been 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 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). As discussed in JLD-ISG-2012-01, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the McGuire Nuclear Station, Units 1 and 2 (McGuire) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated March 12, 2014 (ADAMS Accession No. ML14083A415), Duke Energy Carolinas, LLC (Duke, the licensee) submitted its flood hazard reevaluation report (FHRR) for McGuire. By letter dated September 3, 2015 (ADAMS Accession No. ML15230A161), the NRC issued an interim staff response (ISR) letter for McGuire. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for McGuire, which were to be used in conducting the mitigating strategies assessment (MSA), as described in NEI 12-06. For McGuire, the mechanisms listed as not bounded by the CDB in the ISR letter are local intense precipitation (LIP), streams and rivers, failure of dams, and probable maximum storm surge (PMSS). By letter dated October 31, 2016 (ADAMS Accession No. ML16293A666), the NRC issued a FHRR staff assessment, which provided the documentation supporting the NRC staff's conclusions summarized in the ISR letter.

By letter dated December 15, 2016 (ADAMS Accession No. ML16355A210), Duke submitted the McGuire MSA for review by the NRC staff.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A185), Duke submitted the Overall Integrated Plan (OIP) for McGuire in response to Order EA-12-049. At 6 month intervals following the submittal of its OIP, the licensee submitted reports on its progress in complying with Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated January 16, 2014 (ADAMS Accession No. ML13338A406), and October 9, 2014 (ADAMS Accession No. ML14241A454), the NRC staff issued an Interim Staff Evaluation and audit report, respectively, on the licensee's progress. By letter dated December 7, 2015 (ADAMS Accession No. ML15343A010), Duke submitted its compliance letter and the Final Integrated Plan in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated June 20, 2016 (ADAMS Accession No. ML16104A078), the NRC staff issued a safety evaluation documenting the results of the NRC staff's review of the FLEX strategies for McGuire. The safety evaluation concluded that the integrated plans, if implemented as described, should adequately address the requirements of Order EA-12-049.

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

- Operators will take prompt actions to minimize Reactor Coolant System (RCS) inventory losses by isolating potential letdown paths. Decay heat is removed by steaming to the atmosphere from the steam generators (SGs) through the SG power-operated relief valves (PORVs) or main steam safety valves, and makeup to the SGs is initially provided by the turbine-driven auxiliary feedwater (TDAFW). The operators will perform direct current (dc) bus load stripping within 3 hours following event initiation to ensure that safety-related battery life is extended up to 18 hours.

- Following dc load stripping and prior to battery depletion, one 500-kilowatt (kW), 600-volt alternating current (Vac) generator will be deployed from a FLEX storage building (FSB) to each unit. These portable generators will be used to repower essential battery chargers within 18 hours of the extended loss of ac [alternating current] power (ELAP) initiation, as well as repowering containment hydrogen igniters, safety injection accumulator isolation valves, and portable FLEX sump pumps.

- RCS makeup and boration will be initiated within 13 hours of the ELAP with loss of normal access to the ultimate heat sink event. Operators will provide reactor coolant makeup using portable FLEX high-pressure diesel-powered pumps, one per unit, to deliver water drawn from a FLEX connection on each refueling water storage tank (FWST) supply line. There is one FWST per unit.

- Borated water from the FWST will be injected into the RCS through FLEX connections to the safety injection system (one connection on either train). In addition, hoses can be routed from the pump discharge to the residual heat removal system FLEX connection when needed for higher capacity makeup during a shutdown event.

- The operators will provide long-term containment cooling by repowering a lower containment ventilation system fan within 48 hours of ELAP initiation to ventilate the hotter air within the SG and pressurizer enclosures. Within 52 hours, operators will also repower a containment air return fan to mix the colder air in the ice condenser with the rest of containment. These components will be powered using the 4160 Vac diesel generator equipment provided by the National Strategic Alliance for FLEX Emergency Response (SAFER) Response Center (NSRC).

3.2. Evaluation of Current FLEX Strategies Against Reevaluated Hazard(s)

The licensee has assessed the potential impacts of the LIP, streams and rivers, failure of dams, and PMSS flood-causing mechanisms, as described in the ISR letter, against the mitigating strategies designed to meet Order EA-12-049. The purpose of the MSA was to determine if the licensee's mitigating strategies are adequate as-is, need to be modified, or new mitigating strategies need to be developed to address hazard exceedances as described in the ISR letter.

Overall, the licensee determined in its evaluation that LIP, streams and rivers, failure of dams, and PMSS do not impact the site and as such, the current FLEX strategies can be deployed fully with no additional operator actions or pre-staging of additional equipment in order to account for the reevaluated hazards. However, the licensee indicated that the use of warning time is required when using normal plant operating procedures in order to install pre-staged flood protection features that prevent water intrusion into the Auxiliary Building.

3.2.1 Summary of Mitigating Strategies Assessment

The licensee described in its MSA that implementation of the FLEX strategies at McGuire is divided into three phases. In general, the first phase is to initially cope by relying on installed plant equipment and on-site resources, the second phase is to transition from installed plant equipment to the on-site FLEX equipment, and the third phase is to obtain additional capability and redundancy from off-site equipment.

The licensee also stated in its MSA, that the design of the McGuire powerblock yard grade is nominally 760 feet mean sea level (ft MSL). All elevations presented in this evaluation are based on the National Geodetic Vertical Datum 1929 unless specified otherwise. The Yard is protected from upstream flooding from various combinations of postulated licensing basis flood hazard events by the Cowans Ford Dam earth embankment with crest elevation of 775.00 ft MSL and by an earth embankment with crest elevation of 780.00 ft MSL just upstream of the Yard, starting at the western boundary of the Yard perimeter (Dry Cask Storage Yard) and extending to the east past the discharge channel, and ending at natural topography above 780 ft MSL.

For the dam failure and PMSS, the licensee stated in the MSA that these flood causing mechanisms exceeded the current licensing basis and affect the entire watershed, including dams and reservoirs. However, these two flooding events do not inundate the plant yard and have no impact on the storage and deployment of FLEX strategies. As a result, Duke determined that these two mechanisms do not impact the site and were not analyzed in the MSA.

For LIP, the licensee stated in the MSA that the evaluation of this flood-causing mechanism in the FHRR conservatively assumed that all roof drainage was blocked, that no precipitation losses occurred during the entire probable maximum precipitation event or runoff process, and that all drainage from the McGuire site occurred via overland flow (i.e. the yard drain system was considered to be completely blocked). As a result of the reevaluated hazard analysis, LIP causes inundation of the plant site above the CDB passive flood barriers. In response to the hazard exceedance, Duke modified site procedures at McGuire that credit warning time in order to install additional pre-staged flood protection features that prevent water intrusion into the Auxiliary Building.

The licensee also stated that the warning time used for installation of these additional flood protection features is based on guidance from NEI 15-05 and that the barriers are installed per McGuire Procedure OP/0/B/6100/031. Warning time actions begin 72 hours prior to the event based on forecast predictions. The total scope of the temporary flood protection features involves the installation of pre-staged flood barriers on nine single personnel doors and two rollup doors. The MSA also stated that these temporary doors have been implemented per Engineering Change (EC) 111739.

For the streams and rivers (combined event of Probable Maximum Flood (CE/PMF) with wind wave effects and upstream dam failure), the licensee stated in its MSA that the evaluation of this flood-causing mechanism in the FHRR conservatively assumed that all roof drainage was blocked, no precipitation losses occurred during the entire combined event scenario or runoff process, and that all drainage from the McGuire site occurred via overland flow (i.e. no drainage from the yard drainage system was considered).

As a result of this hazard exceedance, permanent flood barriers were evaluated (per McGuire calculations MCC-1103.01-00-0014, Rev. 0; MCC-1103.01-00-0015, Rev. 0; and MC-1022-09.00, Rev. 16) and installed (per McGuire EC 112499) on the embankment north of the Dry Cask Storage area in order to prevent erosion and failure of the embankment during the combined event. The licensee stated in its MSA that the placement of the flood barriers does not allow the earthen embankment north of the west end of the power block yard to be overtopped (overtopping was assumed to occur at an elevation of 778.5 ft MSL in the FHRR).

Based on the modifications, overtopping would only occur west of the barriers and out of the main power block and Dry Cask areas. Consequently, inundation times and flood levels in this west plant yard and Dry Cask Storage areas are no longer valid, but instead would be very similar to flood levels and inundation times for the east portion of the plant yard. The licensee also stated in its MSA that this combined event results in a representative maximum water surface elevation in the McGuire yard around the main complex (i.e. Auxiliary, Reactor, and Turbine Buildings) of 760.7 ft MSL (from FHRR Section 2.1.4).

Finally, the licensee stated in its MSA, that the inundation levels of the plant site above the CDB passive flood barriers are prevented from impacting the auxiliary building by using warning time in order to install additional pre-staged flood protection features to prevent water intrusion. The warning time used for installation of these additional flood protection features is based on guidance from NEI 15-05. These flood barriers are installed per McGuire Procedure OP/0/B/6100/031 and were implemented per EC 111739. The total scope of the temporary flood protection features involves the installation of pre-staged flood barriers on nine single personnel doors and two rollup doors.

3.2.2. Summary of Technical Evaluation

The NRC staff has reviewed the information presented in the MSA, as well as supporting documentation. This included:

- Review of licensing documents and previous NTTF flooding submittals;
- Review of the topographical features of the site; and
- Review and documentation of existing mitigating strategies under Order EA-12-049.

The NRC staff reviewed the flood hazard elevations in the MSA in order to confirm if the elevations matched the values provided in the McGuire ISR letter. The ISR letter identified the following reevaluated flood-causing mechanisms as not bounded by the CDB: LIP, streams and rivers, dam failure combined with PMF, and PMSS. In its MSA, the licensee stated that only the LIP and the combined dam failure flood-causing mechanisms would be analyzed since the other two mechanisms (streams and rivers and PMSS) were bounded by the combined dam failure flood-causing mechanism. The NRC staff reviewed the licensee's selection of the two beyond-design-basis events and concludes that the approach is consistent with guidance provided in Appendix G of NEI 12-06, Revision 2.

For LIP, the NRC staff confirmed that the water surface elevation reported in the MSA matches the value in the ISR letter of 761.1 ft MSL. The NRC staff also evaluated if the reevaluated LIP hazard impacted any of the storage location(s) of FLEX equipment, any staging areas, haul paths, connection points, activities, etc. The staff agrees that, based on a period of inundation of 2.5 hours, this event would not impact the Phase 1 FLEX response or Phase 2 FLEX response (RCS makeup and boration), since Phase 2 is expected to begin no later than 13 hours after the ELAP event with loss of normal access to the ultimate heat sink event. As a

result, the staff agrees that there appears to be sufficient time for flood waters to recede prior to the Phase 2 FLEX response activity taking place and therefore, no impact is expected to occur as a result of the reevaluated LIP hazard. The NRC staff notes that RCS makeup and boration activities have been previously reviewed by the NRC and documented in the June 20, 2016, safety evaluation (Section 3.2.3.2 "Thermal-Hydraulic Analyses).

Based on documents reviewed during the Order EA 12-049 audit, as described in the October 9, 2014, audit report, the NRC staff understands that the elevations of the FLEX storage buildings are as follows: Building 1: 770.54 ft MSL, Building 2: 763.40 ft MSL, and Building 3: 779.5 ft MSL. Therefore, the reevaluated LIP level of 761.1 ft MSL is not expected to impact the FLEX storage buildings at McGuire.

For the combined dam failure flood-causing mechanism, the licensee used an updated maximum flood level of 760.7 ft MSL in its MSA, which is lower than the ISR value of 778.5 ft MSL. Therefore, the staff reviewed the updated flood elevation for the combined dam failure flood-causing mechanism, as discussed below.

The licensee stated in its MSA report that the combined dam failure flood-causing mechanism can no longer overtop the earthen-embankment section of the Cowans Ford Dam located north from the plant site due to the recent installation of permanent concrete flood barriers on top of the earthen embankment. The installation of these barriers is captured in McGuire FHRR Regulatory Commitment CE/PMF-1 and were installed per EC-112499. Figure 3.2.2-1 of this document illustrates the layout of the embankment and plant site.

The licensee stated in its MSA submittal that the new concrete flood barriers are capable of withstanding the FHRR's reevaluated maximum flood elevation in Lake Norman of 778.5 ft MSL, and that the existing earthen embankment will remain stable against the potential hydrostatic/hydrodynamic loads created by the combined dam failure flood–causing mechanism. In addition, the pre-staged engineered flood barriers will be installed on the Auxiliary Building doors by site procedures that credit advanced warning time. These concrete and engineered barriers will protect the site from floods on the west powerblock and the Dry Cask Storage areas (i.e., spent fuel handling installation), which were previously calculated to flood before the barriers were installed. The staff notes that it did not perform a structural review to confirm the capacity of these flood barriers, including any design margin, to withstand the hydrostatic and hydrodynamic loads as part of the MSA review, but confirmed that the licensee performed the installation in accordance with existing site procedures.

With the flood protection barriers in place, the power block area can only be inundated by locally-generated runoff during the dam failure event. Therefore, the licensee used a revised maximum flood elevation of 760.7 ft MSL for the combined dam failure flood-causing mechanism in the MSA submittal. This updated flood elevation is based on the result of the reevaluated maximum LIP flood elevation, which would occur at the northeast corner of the Unit 2 Turbine Building. The licensee used the 2-dimensional numerical model described in FHRR Section 2.1 to determine this maximum flood elevation. The NRC staff had previously reviewed the modeling of this locally-induced flood during its review of FHRR Section 2.1.4 and concluded in the FHRR staff assessment that the licensee's modeling used present-day methodologies and regulatory guidance. Based on the above analysis, the NRC staff concludes that the licensee's updated flood elevation of 760.7 ft MSL for the combined dam failure flood-causing mechanism is acceptable for use in the MSA.

For the combined events, the NRC staff evaluated if the reevaluated hazard impacted any of the storage location(s) of FLEX equipment, any staging areas, haul paths, connection points, activities, etc. The licensee stated in its MSA that all necessary equipment stored for FLEX response and paths needed to access this equipment are located on the east side of the plant yard. Furthermore, the licensee had previously stated in its FHRR (Table 2.8.1-1) that the worst case inundation duration on the east side (Unit 2 side) of the plant yard is 15 minutes.

Based on the installation of the flood barriers that prevent overtopping of the embankment on the north end of the site and the revised CE/PMF level of 760.7 ft MSL, the licensee stated that the 15 minute inundation duration is the time period appropriate for consideration in the MSA for the entire power block area. This allows the west side of the plant yard to be consistent with the east side. Similar to LIP, the staff agrees that, based on a period of inundation of 15 minutes, the CE/PMF event would not impact the Phase 1 FLEX response or Phase 2 FLEX response (RCS makeup and boration), since Phase 2 is expected to begin no later than 13 hours after the ELAP event with loss of normal access to the ultimate heat sink event.

As a result, the staff agrees that there appears to be sufficient time for flood waters to recede prior to the Phase 2 FLEX response activity taking place and therefore, no impact is expected to occur as a result of the reevaluated CE/PMF hazard.

Based on documents reviewed during the Order EA 12-049 audit, as described in the October 9, 2014, audit report, the NRC staff understands that the elevations of the FLEX storage buildings are as follows: Building 1: 770.54 ft MSL, Building 2: 763.40 ft MSL, and Building 3: 779.5 ft MSL. Therefore, the reevaluated CE/PMF level of 760.7 ft MSL is not expected to impact the FLEX storage buildings at McGuire.

3.3 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by Duke regarding the flood event duration (FED) parameters for flood-causing mechanisms not bounded by the CDB. The FED parameters for these flood-causing mechanisms are summarized in Table 3.3-1. For the LIP event, the licensee stated in its MSA report that warning time procedures follows the alternative trigger method consistent with the guidance set forth in NEI 15-05. The staff notes that NEI 15-05 was originally a white paper titled, "Warning Time for Maximum Precipitation Events," dated April 8, 2015 (ADAMS Accession No. ML15104A157). This white paper was endorsed by the NRC on April 23, 2015 (ADAMS Accession No. ML15110A080), and subsequently issued by NEI on May 1, 2015, as NEI 15-05, "Warning Time for Local Intense Precipitation Events." Specifically, the licensee noted a LIP warning time of 72 hours in the MSA. This warning time was calculated under the assumption that a monitoring trigger is established 72 hours in advance if the rainfall depth over a 24-hour period is predicted to exceed the Probabilistic Quantitative Precipitation Forecast at the 95th percentile of 5.35 inches. The MSA report provides the period of inundation of 2.5 hours, which includes water recession time from the site. The licensee used the 2-dimensional numerical model described in the FHRR to determine the periods of inundation and recession.

For LIP flood causing mechanism, the staff confirmed that the warning time meets the guidelines provided by NEI 15-05, that the licensee's estimation of the period of inundation is acceptable for use in the MSA, and that the period of recession is based on a review of the licensee-simulated hydrographs presented in the FHRR.

For the combined dam failure flood-causing mechanism, the licensee reported a warning time of 72 hours in its FHRR and a period of inundation of 0.3 hours, which includes the period of recession. The licensee states in the MSA submittal that the period of inundation was determined based on the 2-dimensional numerical model. The NRC staff determined, based on review of the modeling results for the updated combined dam failure event, that the licensee's estimation of the FED parameters for the combined dam failure flood-causing mechanism are acceptable for use in the MSA.

The licensee stated in its MSA submittal that the reevaluated flood elevations for streams and rivers and storm surge flood-causing mechanisms are not bounded by the CDB but are bounded by the reevaluated dam failure flood-causing mechanism. Therefore, they concluded the FED parameters for these two flood-causing mechanisms are not applicable in the MSA. The staff determined that this approach is acceptable and that it is consistent with guidance provided by Appendix G of NEI 12-06, Revision 2.

In summary, the staff concludes that the licensee's FED parameters defined in the FHRR and MSA reports are reasonable and acceptable for use in the MSA.

3.4 Evaluation of Associated Effects

The staff reviewed the information provided by Duke in the FHRR, ISR, and MSA submittals regarding associated effects (AEs) parameters for flood hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by staff, and were transmitted to the licensee via the ISR letter. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.4-1.

For the LIP flood-causing mechanism, the licensee computed a hydrostatic load of 15.3 lb/ft and a minimal value for the hydrodynamic load in its FHRR and MSA submittals. These water-borne loads would have a negligible effect on safety-related structures on the site. Loads were estimated using the 2-dimensional numerical model simulation described in the FHRR. Any debris loads associated with the LIP event would also be negligible due to: (1) the absence of debris sources at the plant site; (2) low water velocities and depths; and (3) vehicle barriers and security fences which significantly minimize intrusion of potential debris into the power block area. The licensee stated in its MSA report that significant erosion is not expected for the LIP event due to low water velocities, and also noted that the ground is covered with concrete and gravel. Other associated effects including groundwater ingress, concurrent conditions, and other associated effects for the LIP event would also be minimal or not applicable due to low water velocities and depths. The staff determined in the FHRR staff assessment that the estimation of the AE load parameters for the LIP event uses present-day methodologies and regulatory guidance.

For the combined dam failure flood-causing mechanism, the licensee concluded in its MSA report that all AE parameters are either minimal or not applicable because: (1) the plant site would be protected by concrete and engineered flood barriers; and (2) the inundation depths caused by locally-generated runoff during the combined dam failure event would be small (e.g., water depths of less than 0.2 ft). The staff determined that the licensee's assessment of the AE parameters for the combined dam failure event are reasonable and acceptable for use in the MSA.

In its MSA submittal, the licensee did not provide AE parameters for the streams and rivers and the storm surge flood-causing mechanisms because these mechanisms are bounded by the combined dam failure flood-causing mechanism. The staff determined that the licensee's approach is acceptable and consistent with guidelines provided by Appendix G of NEI 12-06, Revision 2. In summary, the staff concludes that the licensee's AE parameters defined in the MSA are appropriate and reasonable for use in the MSA.

3.5 Conclusion

The NRC staff has reviewed the information provided in the McGuire MSA related to the original FLEX strategies, as assessed against the reevaluated hazards. The staff concludes that the licensee has reasonably demonstrated the capability to implement FLEX strategies, as designed, against the reevaluated hazards described in the ISR letter.

The NRC staff made its determination based upon:

- The availability of warning time, which was determined using accepted methodology and its incorporation into plant procedures. This warning time allows the installation of passive flood protection at several locations for the LIP and CE/PMF event.

- Consideration that FLEX storage building elevations are not impacted when compared against LIP and CE/PMF reevaluated hazard elevations.

- All Phase 1 and 2 strategies, as currently designed, contain sufficient margin to allow local floodwaters to recede prior to any established FLEX actions or equipment deployment. As a result, implementation timelines should not be impacted.

- Two flood-causing mechanisms (streams and rivers and PMSS) that were determined to be not bounded in the ISR letter were appropriately screened out of further review in the MSA given that those events were bounded by the combined dam failure flood-causing mechanism. This approach was consistent with guidance provided in Appendix G of NEI 12-06, Revision 2 (Section G.2).

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to implement the original FLEX strategies, as designed, under the conditions associated with the reevaluated LIP, streams and rivers, PMSS and CE/PMF floods, including associated effects and flood event duration, as described in NEI 12-06, Revision 2, and JLD-ISG-2012-01, Revision 1.

4.0 CONCLUSION

The NRC staff has reviewed the information presented by the licensee in the MSA for McGuire. The NRC staff confirmed that the licensee's flood hazard MSA for McGuire was performed consistent with the guidance in Appendix G of NEI 12-06, Revision 2, as endorsed by JLD-ISG-2012-01, Revision 1. Based on the licensee's use of the hazards characterized in the NRC staff's ISR letter, the methodology used in the McGuire MSA evaluation, and the description of its current FLEX strategy in the McGuire MSA and supporting documentation, the NRC staff concludes that the licensee has demonstrated that the mitigation strategies appear to be reasonably protected from reevaluated flood hazards conditions.

Figure 3.2.2-1 Site layout for the McGuire Nuclear Station, Units 1 and 2 (from FHRR staff assessment).

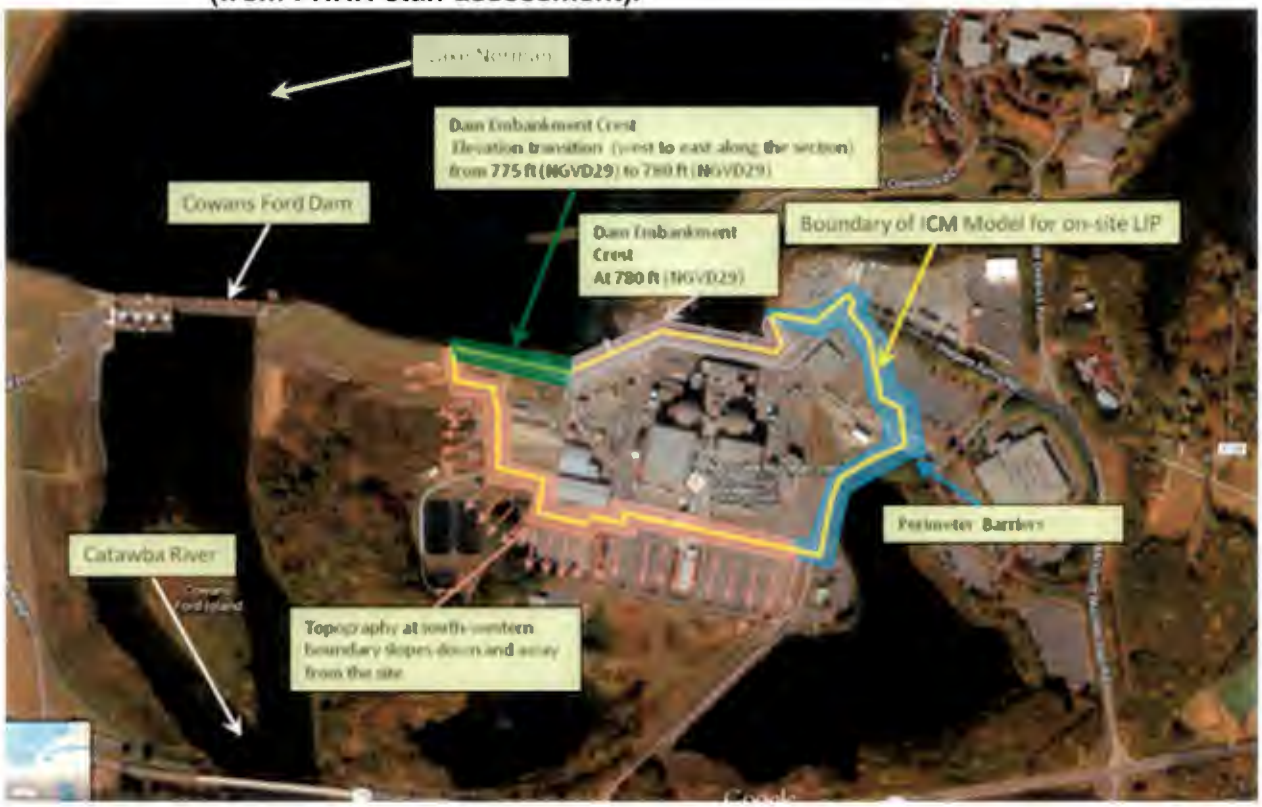

Table 3.3-1. Flood Event Durations for Flood-Causing Mechanisms Not Bounded by the CDB

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	72 hours	2.5 hours	Minimal
Streams and Rivers [1]	Not Applicable	Not Applicable	Not Applicable
Failure of Dams and Onsite Water Control/Storage Structures (Combined with PMF)	72 hours	0.3 hours	Minimal
Storm Surge[1]	Not Applicable	Not Applicable	Not Applicable

Source: Duke Energy FHRR and MSA

1. The licensee stated in the MSA report that the FED parameters for these flood-causing mechanisms are bounded by the combined dam failure flood-causing mechanism. Based on Appendix G of NEI 12-06, Revision 2, FED parameters for these mechanisms have been appropriately considered as not applicable.

Table 3.4-1. Associated Effects Parameters Not Directly Associated With Total Water Height for Flood-Causing Mechanisms Not Bounded By the CDB

Associated Effects Parameter	Flooding Mechanism			
	Local Intense Precipitation and Associated Drainage	Streams and Rivers [1]	Failure of Dams and Onsite Water Control/Storage Structures (Combined with PMF)	Storm Surge[1]
Hydrodynamic loading at plant grade	Minimal	Not Applicable	Minimal	Not Applicable
Debris loading at plant grade	Minimal	Not Applicable	Minimal	Not Applicable
Sediment loading at plant grade	Minimal	Not Applicable	Minimal	Not Applicable
Sediment deposition and erosion	Minimal	Not Applicable	Not Applicable	Not Applicable
Concurrent conditions, including adverse weather - Winds	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Groundwater ingress	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Other pertinent factors (e.g., waterborne projectiles)	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Source: Duke Energy, FHRR and MSA

1. The licensee stated in its MSA report that the AE parameters for these flood-causing mechanisms are bounded by the combined dam failure flood-causing mechanism. Based on Appendix G of NEI 12-06, Revision 2, AE parameters for these mechanisms are appropriately considered not applicable.

MCGUIRE NUCLEAR STATION, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED MAY 18, 2017

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