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

April 10, 2017

Anthony J. Vitale
Vice President, Operations
Energy Nuclear Operations, Inc.
Indian Point Energy Center
450 Broadway, GSB
P.O. Box 249
Buchanan NY 10511-0249

SUBJECT: INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7935 AND MF7936)

Dear Mr. Vitale:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 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 27, 2016 (ADAMS Accession No. ML16305A331), Entergy Nuclear Operations, Inc. (the licensee) submitted the mitigation strategies assessment (MSA) for Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point). The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazard(s) within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Indian Point MSA.

The NRC staff has concluded that the Indian Point MSA was performed consistent with the guidance described in Appendix G of NEI 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, and that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, 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. MF7935 and MF7936.

If you have any questions, please contact me at 301-415-1132 or at Joseph.Sebrosky@nrc.gov.

Sincerely,

Joseph M. Sebrosky, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for Indian Point

Docket Nos: 50-247 and 50-286

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT RELATED TO THE
MITIGATION STRATEGIES FOR
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
AS A RESULT OF THE REEVALUATED FLOODING HAZARDS REPORT
NEAR-TERM TASK FOR CE RECOMMENDATION 2.1- FLOODING
CAC NOS. MF7935 AND MF7936

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807). Enclosure 2 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 (FIP) 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 (SRM) 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 Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated April 25, 2016 (ADAMS Accession No. ML16112A172), the NRC issued an interim staff response (ISR) letter for Indian Point. The ISR letter provided the reevaluated flood hazards that exceeded the current design basis (CDB) for Indian Point and were suitable input for the mitigating strategies assessment (MSA) (i.e., the mitigating strategies flood hazard information (MSFHI) described in NEI guidance document NEI 12-06). For Indian Point, the mechanisms listed as not bounded by the CDB in the letter (ISR flood levels) are listed below:

- Local intense precipitation (LIP) – the ISR flood level is higher than the CDB level;
- Flooding in streams and rivers – the Hudson River probable maximum flood height ISR flood level exceeded the CDB;
- Dam breeches and failures – the ISR flood level for a dam failure combined with Hudson River probable maximum flood (PMF) exceeded the CDB; and
- Storm surge – the ISR flood level for a combined event coincident with the probable maximum storm surge exceeded the CDB.

By letter dated October 27, 2016 (ADAMS Accession No. ML16305A331), Entergy Nuclear Operations, Inc. (Entergy, the licensee) submitted its MSA for Indian Point. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events.

For LIP and storm surge, the stillwater elevations are not bounded by the FLEX design-basis (DB) elevation of 17.92 ft. MSL. For Phase 2 of the FLEX strategy, credited equipment and actions are protected from wave run-up by the turbine buildings such that only stillwater elevations need to be considered.

For the streams and rivers and dam breaches and failures, the maximum stillwater elevations are bounded by the FLEX DB and FLEX can be implemented as designed.

In its MSA, the licensee documented the measures that have been or will be taken to address these flood hazards that are not bounded by the CDB. Specifically, for the LIP flood hazard, the licensee raised the elevation of two manholes to prevent flooding to the 480 volt (V) Switchgear rooms and sealed conduits in three additional manholes. In addition, for the storm surge flood hazard, the licensee explained that it will perform an Engineering Change (EC) to evaluate and implement additional flood protection features needed, with margin, for four doors that may be pathways for floodwaters into plant structures. These additional flood protection features may be sandbags or permanent modifications to the doors and will be integrated into the licensee's flood preparation procedures.

The ISR letter also stated that NRC staff would evaluate, as applicable, the flood event duration parameters (including warning time and period of inundation) and flood-related associated effects developed by the licensee during the NRC staff's review of the MSA. This is consistent with the guidance provided in Revision 2 of NEI 12-06. Relevant information regarding the flood event duration parameters and associated effects was submitted in two supplemental response letters dated May 19, 2014, and December 9, 2014 (ADAMS Accession Nos. ML14147A379 and ML14356A633, respectively), as well as in the MSA.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff evaluated the Indian Point strategies as developed and implemented under Order EA-12-049, as described in the "Final Integrated Plan Document, Indian Point Energy Center, Units 2 and 3," (Enclosure 2 to Entergy Letter NL-16-089, dated August 12, 2016 (ADAMS Accession No. ML16235A292)). The NRC staff's safety evaluation is dated March 27, 2017 (ADAMS Accession No. ML17065A171). The safety evaluation concluded that the licensee has developed guidance and proposed design that, if implemented appropriately, will adequately address the requirements of Order EA-12-049.

A brief summary of the licensee's FLEX strategies are as follows:

- For Phase 1, immediately following the occurrence of an extended loss of alternating current power/loss of ultimate heat sink (ELAP/LUHS) event, the reactor will trip and the plant will initially stabilize at no-load reactor coolant system (RCS) temperature and pressure conditions, with reactor decay heat removal via steam release to the atmosphere through the steam generator (SG) atmospheric dump valves (ADV) or main steam safety valves (MSSV). The turbine driven auxiliary boiler feed (TDABF) pump will provide flow to the SGs to make up for steam release, with suction from either the unit's Condensate Storage Tank (CST) or the site's city water storage tank. Under ELAP conditions, RCS inventory will diminish gradually due to leakage through reactor coolant pump seals and other leakage points. Some passive injection from the nitrogen-pressurized accumulators would occur as the RCS is depressurized below the accumulator cover gas pressure. The licensee determined that sufficient reactor coolant inventory is available throughout Phase 1 without crediting the active injection of RCS makeup. Load stripping of non-essential loads will begin within 30 minutes after the occurrence of an ELAP/LUHS and will be completed within 2 hours into the event. This extended load shedding will extend the battery powered monitoring function to at least 8 hours following the event initiation.

- For Phase 2, the primary strategy for core cooling would be to continue using the SGs as a heat sink, with makeup water supplied by the CST or city water storage tank (CWST). Operators will deploy a trailer-mounted, diesel-driven FLEX inventory transfer pump at each unit to refill the CST preferentially from other available water sources. Prior to commencing the second cooldown that will be completed within the first 24 hours, a portable, diesel-driven FLEX SG makeup pump, with suction from the CSTs or the fire water storage tanks (FWST), is connected to provide makeup to the SGs in place of the TDABF pump. In order to maintain sufficient borated RCS inventory in Phase 2, a diesel-driven high-pressure FLEX pump would be deployed at each unit to inject borated makeup water from the unit's refueling water storage tank (RWST). FLEX diesel generators (480 Vac) will be deployed from the FLEX equipment storage building to the transformer yard. The FLEX DGs will be placed into service to supply power to the key instrumentation within 8 hours of the initiation of the ELAP event. The FLEX DGs will repower the 480 Vac emergency distribution system to allow powering of battery chargers or other essential and optional loads.

- For Phase 3, the equipment from a National SAFER Response Center (NSRC) will be transported to staging area B and will utilize the same deployment pathways as Phase 2 equipment. In the MSA, the licensee indicated that deployment of the NSRC equipment is bounded by Phase 2 and will not be impacted since Phase 3 starts 24 hours into the event, at the earliest, and is not required to be implemented until 72 hours, at which time any LIP, PMF, or storm surge event would have receded.

3.2 Evaluation of Current FLEX Strategies

By letter dated October 27, 2016 (ADAMS Accession No. ML16305A331), the licensee submitted its MSA for Indian Point. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazard(s) within their mitigating strategies for beyond-design-basis external events.

For the streams and rivers and dam breaches and failures, the maximum stillwater elevations are bounded by the FLEX DB and FLEX can be implemented as designed.

For LIP and storm surge, the stillwater elevations are not bounded by the FLEX design-basis (DB) elevation of 17.92 ft. mean sea level (MSL). For Phase 2 of the FLEX strategy, credited equipment and actions are protected from wave run-up by the turbine buildings such that only stillwater elevations need to be considered.

In its MSA, the licensee documented the measures that have been or will be taken to address these flood hazards that are not bounded by the CDB. Specifically, for the LIP flood hazard the licensee modified (i.e., raised the elevation) two manholes to prevent flooding to the 480 V Switchgear rooms and sealed conduits in three additional manholes. In addition, for the storm surge flood hazard, the licensee explained that it will perform an EC to evaluate and implement additional flood protection features needed, with margin, for four doors that may be pathways for floodwaters into plant structures. These additional flood protection features may be sandbags or permanent modifications to the doors and will be integrated into the licensee's flood preparation procedures.

The licensee stated that during the LIP and storm surge flood hazards the credited equipment and actions for Phase 2 of its FLEX strategy are protected from wave run-up by the Turbine Buildings; however, the stillwater elevations are not bounded by the FLEX DB. Specifically, three flooding scenario parameters (max stillwater elevation, period of inundation, and period of recession) for the LIP flood hazard are not bounded by the FLEX strategy. Five flooding scenario parameters (max stillwater elevation, max wave run-up elevation, max hydrodynamic/debris loading, period of inundation, and period of recession) for the storm surge flood hazard are not bounded by the FLEX DB.

Furthermore, the licensee stated in its MSA that for the dam breach and failure, the flood hazard maximum stillwater elevation and a wave run-up is bounded by the current FLEX DB of 17.92 ft. MSL.

Finally, for the Hudson River PMF, the maximum stillwater elevation of 16.5 ft. MSL is also bounded by the FLEX DB, and the FLEX strategies can be implemented as designed; however, one flooding scenario parameter (Max Hydrodynamic/Debris Loading) is not bounded by the FLEX strategy.

In accordance with NEI 12-06, Rev. 2, Section G.4.1, "Assessment of Current FLEX Strategies," the MSA should address whether the FLEX strategies can be implemented based on the MSFHI. For Indian Point, the MSA addresses the LIP flood hazard, flooding in streams and rivers (Hudson River PMF), and the storm surge flood hazard. The staff's review of each of these non-bounded flood hazards is discussed below:

Local Intense Precipitation

Per Section 2.3.1.1 of the MSA, three flooding parameters for LIP are not bounded by the FLEX strategy: maximum stillwater elevation, period of inundation, and period of recession. The LIP stillwater elevations of 19.5 ft.[1] MSL and 19.3 ft. MSL for Unit 2 and 3, respectively, are not bounded by the FLEX DB elevation of 17.92 ft. MSL. The licensee identified that the sills for Doors 213 and 215 (located in the Unit 3 Transformer Yard and lead to the Aux Boiler Feed Pump Room) are at an elevation of 18.6 ft. MSL and 18.7 ft. MSL, respectively. Door 213 and Door 215 are also referred to as Doors U3-ABFP-1, and U3-ABFP-2, respectively. The staff's MSFHI letter uses the U3-ABFP-1, and U3-ABFP-2 door designation for these doors.

The staff noted that the licensee credits the TDABF pump during Phase 1 of its FLEX strategy to provide feedwater to the SGs for decay heat removal. Although the door sill elevations are below the maximum stillwater elevation, the local ponding depths at Doors 213 and 215 are 18.3 ft. MSL and 18.5 ft. MSL, respectively (per the NRC staff's interim response letter). Based on the elevation of the sills at Door 213 and 215 being above the local ponding depth from the LIP flood hazard, the staff finds it reasonable that the TDABF pump will not be impacted by floodwaters and is adequately protected from the LIP flood hazard.

Prior to the MSA, the licensee used preliminary LIP floodwater levels of up to 24 inches above the transformer yard grade in an evaluation to address flooding through manholes into conduits that penetrate the 480 V Switchgear rooms. As a result of this review, the licensee raised two manholes to 30 inches above the transformer yard grade (18 ft. MSL) to prevent flooding to the 480 V Switchgear rooms. The licensee also sealed conduits in three other manholes. In preparing its MSA, the licensee reviewed this evaluation. The manhole modifications provide at least 12 inches of margin above the maximum LIP elevation of 19.5 ft. MSL. The evaluation did not identify additional pathways that required modification based on the analyzed flood levels and the MSFHI.

---

[1] The licensee's October 27, 2016, MSA reports the LIP stillwater evaluations as 19.5 ft. MSL and 19.3 ft. MSL for Units 2 and 3, respectively. The NRC staff's April 25, 2016, ISR provides LIP still water elevations for several locations of interest at both units. For the purposes of this assessment, the NRC staff uses the 19.5 ft. MSL and 19.3 ft. MSL values for ease of reference instead of the multiple values that are provided in the NRC staff's April 25, 2016, letter.

The licensee performed a walkdown around the transformer yards to evaluate if any additional penetrations, such as air intakes and louvers, could be a pathway for floodwaters. Based on its walkdown, the licensee did not identify any additional penetrations, other than doors, below 20 ft. MSL, providing at least 6 inches of margin above the maximum stillwater elevations. Based on the licensee's review and the modifications performed to the conduits and manholes, the staff finds it reasonable that the 480 V Switchgear rooms will not be impacted by LIP floodwaters and that the FLEX strategy can still be implemented as designed.
In addition to the max stillwater elevation from the LIP flood hazard not being bounded by the FLEX strategy, Section 2.3.1.1 of the MSA indicates that the period of inundation and the period of recession are not bounded by the FLEX strategy. The staff's review of these two flood scenario parameters are documented in Section 3.2.1.

<u>Stream and Rivers</u>

Per Section 2.3.1.2 of the MSA, one flooding scenario parameter is not bounded by the FLEX strategy: Max Hydrodynamic/Debris loading. The maximum reevaluated hazard stillwater elevation of 16.5 ft. MSL is less than the FLEX DB elevation of 17.92 ft. MSL; thus, the staff finds it reasonable that the FLEX strategies can be implemented, as intended, based on the reevaluated stillwater elevation from the streams and rivers flood hazard. The turbine buildings shield the transformer yard and buildings credited for FLEX from the effects of wave run-up and debris. The foundations of the turbine buildings are built into bedrock, and the licensee stated that the structural pieces remain intact throughout the event. Therefore, the FLEX strategies can still be implemented as intended. The staff's review of this flooding scenario factor is documented in Section 3.2.2.

<u>Storm Surge</u>

Per Section 2.3.1.4 of the MSA, four flooding scenario parameters for storm surge are not bounded by the FLEX strategy: maximum stillwater elevation, maximum wave run-up elevation, period of inundation and period of recession. As discussed above, Doors 213 and 215 are only protected to 18.6 ft. MSL and 18.7 ft. MSL, respectively, which is less than the storm surge maximum stillwater elevation of 18.9 ft. MSL. Thus, the licensee determined that additional flood protection will be required for Doors 213 and 215. In addition, internal Doors 234 and 235 leading into the Unit 2 Switchgear room are currently only protected to 18 ft. MSL via an additional 3 ft. of temporary flood protection features. Thus, with a maximum storm surge stillwater elevation of 18.9 ft. MSL, the licensee determined that additional flood protection features will be required for Doors 234 and 235. The staff's review of the additional flood protection is provided in Section 3.2.3. The staff's review of the licensee's modified FLEX strategies is provided in Section 3.3.

In addition to the max stillwater elevation and max wave run-up elevation not being bounded by the FLEX DB, the max hydrodynamic/debris loading, period of inundation, and period of recession are also not bounded by the FLEX strategy. The staff's review of these three flood scenario parameters is documented in Sections 3.2.1 and 3.2.2.

3.2.1 Evaluation of Flood Event Duration

Relevant information regarding the flood event duration (FED) parameters was submitted in two supplemental response letters dated May 19, 2014, and December 9, 2014 (ADAMS Accession Nos. ML14147A379 and ML14356A633, respectively), as well as in the MSA. The staff reviewed information provided by Entergy regarding the FED parameters needed to perform the

MSA for flood hazards not bounded by the CDB at Indian Point. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 3.2.1-1.

3.2.1.1 Local Intense Precipitation

The licensee reported in its flood hazard reevaluation report (FHRR) (ADAMS Accession No. ML14356A633), that the warning time for LIP-related flooding was 24 hours[2]; this time estimate will be obtained from the National Weather Service and is based on the qualitative precipitation forecast. The staff notes the licensee also has the option to use NEI 15-05 (ADAMS Accession No. ML15104A158) to estimate warning time for LIP.

The maximum water surface elevations generated during the LIP event at multiple (11) locations within the IPEC powerblock are described in Table 2 of the ISR letter. Depending on the location, the duration of inundation ranges from about 0.25 hours (hrs) to about 6 hrs. Similarly, the licensee reports that depending on the location within the powerblock, the time necessary for the flood waters to recede from the site can range from 0.75 hrs to 6 hrs.

The licensee used results from 2-dimensional numerical modeling, as described in the FHRR, to determine the inundation and recession periods. Based on this review, the staff determined that the licensee's FED parameters for LIP are reasonable and acceptable for use in the MSA.

3.2.1.2 Streams and Rivers

As noted in the MSA, the licensee has an abnormal operating procedure (AOP) to be implemented when impending riverine flooding conditions are anticipated. The staff determined that the flood warning time the licensee used in the MSA report of 48 hours is acceptable, as National Oceanic and Atmospheric Administration (NOAA's) hurricane forecasts reliably predict hurricanes more than 48 hours in advance of landfall.

To estimate the inundation time and recession time due to the Hudson River PMF, the staff relied on the input and output files developed by the licensee for use with the U.S. Army Corps of Engineers' (USACE) Hydrologic Engineering Center (HEC) River Analysis System (HEC-RAS) computer code used to prepare the ISR table. Using those simulation results, the staff estimates that the duration of the PMF inundation period is approximately 14 hrs whereas the recession time attributed to that flood is approximately 60 hrs. Based on this review, the staff determined that the licensee's FED parameters for the streams and rivers flood-causing mechanism are reasonable and acceptable for use in the MSA.

3.2.1.3 Dam Failure

The licensee chose to evaluate the potential hydrologic failure of the upstream dam with the largest capacity in the watershed. The FHRR's dam failure scenario is assumed to occur in parallel with the PMF on the Hudson River. As the warning time for the PMF event is 72 hrs, a like amount of time was assumed by the licensee for the purposes of the dam failure warning time. As the peak water elevation for this flood-causing mechanism is bounded by the streams and rivers flood-causing mechanism, the licensee chose to not provide separate periods of inundation and recession for the dam failure flood-causing mechanism. The staff agrees with the licensee's approach related to defining the FED parameters for dam failure; they are

---

[2] For a LIP event in excess of 5 inches (in.).

bounded by the streams and rivers flood-causing mechanism. This approach is consistent with guidance provided by Appendix G of NEI 12-06, Revision 2.

3.2.1.4 Storm Surge

As mentioned above, the licensee implements an AOP that directs specific actions when impending flooding conditions at the IPEC site are predicted 48 hrs prior to a hurricane making potential landfall. The staff found this to be acceptable since NOAA's hurricane forecasts reliably predict hurricanes more than 48 hours in advance.

The licensee reported that the duration of flooding due to storm surge was less than 4 hrs and no recession time was reported. The staff is aware that the licensee relied on the **AD**vanced **CIRC**ulation (ADCIRC) computer code developed to estimate the period of inundation due to storm surge. The staff independently reviewed the model-generated storm surge hydrograph provided by the licensee in the FHRR and found that the period of recession would be approximately 5 hrs. Therefore, based on a review of the storm surge numerical model results, the staff conclude that the licensee's FED parameters are acceptable and reasonable for use as part of the MSA review.

3.2.1.5 Conclusions

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

3.2.1.6 Effect on Mitigating Strategies

Local Intense Precipitation

Table 1 of the MSA notes that certain areas of the plan become inundated during a LIP event. In addition to assessing the local ponding depths from a LIP flood hazard on doorways and equipment credited for FLEX, the licensee also assessed the deployment routes from the FLEX Equipment Storage Building to the staging areas during a LIP flood hazard. The licensee cross-referenced the deployment routes with the maximum LIP flooding depths and determined that the flood depths do not challenge staging or deployment of the FLEX equipment. The licensee explained that these maximum flood depths are expected to recede in the first 2 hours, as shown in Figures 3.1-2 and 3.1-3 of the FHRR. The staff noted that based on the sequence of events in the licensee's FIP dated August 12, 2016, deployment of FLEX equipment is not expected until 3 hours after the initiating event for the ELAP. Furthermore, the FIP identifies that there are primary and alternate deployment routes that can be used based on the conditions following a beyond-design-basis external event. Based on the expected ponding depths, the availability of diverse deployment routes and the expected decrease in floodwaters prior to the deployment of FLEX equipment, the staff finds it reasonable that the LIP floodwaters will not affect the licensee's FLEX strategy, and its ability to deploy FLEX equipment.

Storm Surge

Table 4 of the MSA indicates that although the site is protected from wave run-up by the turbine buildings, the period of inundation and period of recession flood parameters are evaluated because the stillwater elevation is not bounded by the FLEX DB.

Section 2.3.1.4 of the MSA states the storm surge maximum stillwater elevation of 18.9 ft. MSL is not bounded by the FLEX DB elevation of 17.92 ft. MSL. The licensee confirmed that this increase in stillwater elevation results in relatively low ponding depths, which will not impact deployment and operation of the staged FLEX equipment, including in the transformer yards. The staff reviewed the licensee's sequence of events timeline in its FIP dated August 12, 2016, and noted that actions in the transformer yards to deploy cables are not required to be complete until 8 hours after the initiation of the ELAP event.

The staff finds it reasonable that the licensee's FLEX strategy is not impacted by the period of inundation and period of recession flood parameters from the reevaluated storm surge event because the maximum floodwater elevation is not significant enough to impede operators from deploying and staging FLEX equipment in the area of the transformer yard, the time constraint to deploy cables into the area of the transformer yard is several hours after the initiation of an ELAP event, and the licensee's existing procedures that provide at least 48 hours of warning time for potential hurricane impact to begin flood preparations.

3.2.2 Evaluation of Flood Associated Effects

Relevant information regarding the associated effects (AE) was submitted in two supplemental response letters dated May 19, 2014, and December 9, 2014 (ADAMS Accession Nos. ML14147A379 and ML14356A633, respectively), as well as in the MSA. The staff reviewed information provided by the licensee regarding AE parameters for flood hazards not bounded by the CDB. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2.2-1.

3.2.2.1 Local Intense Precipitation

For the LIP event, the licensee stated that the associated effects of LIP flooding are not considered credible (i.e., they are minimal) due to the relative-low flow velocities and limited debris effects within the protected area. The staff confirmed this statement by reviewing the licensee-provided LIP model input and output files. The staff found that the estimated inundation depths and flow velocities are acceptable and that the modeling is reasonable for use in the MSA. The staff agrees with the licensee's conclusion that the AE parameters for LIP are either minimal or will have no impact on the safety-related plant facilities.

3.2.2.2 Riverine Flooding

For riverine flooding, the licensee selected the PMF event combined with wind effects as a bounding event and only evaluated the AE parameters for this flood-causing mechanism. The licensee reported a hydrodynamic load of 1,825 pounds/foot (lb/ft) in the FHRR. The licensee also noted that its hydrodynamic load calculations relied on steady-state flow velocities, consistent with the recommendations of the Federal Emergency Management (FEMA). In the FHRR the licensee reported a debris impact load of 27,456 lbs, assuming a debris weight of 2,000 lbs to represent the hydrodynamic impact of a typical floating tree log on the exterior portion of Indian Point structures, per the guideline by the American Society of Civil Engineers (ACSE). The licensee noted that it calculated the magnitude of the debris load impact consistent with the recommendations of FEMA.

The staff reviewed the licensee's calculation of the debris impact load and maximum debris velocity. The staff noted that the licensee's assumption of tree log debris meets the guidelines by ACSE standard ASCE/SEI 7-10 with the following characteristics: 1,000 lb in weight, 30 ft in length, and 1 ft in diameter. The staff found that the load calculation is accurate and the assumptions are reasonable for use as part of the MSA review.

3.2.2.3 Dam Failure

For dam failure, the licensee stated that the AEs associated with dam failure are bounded by the riverine PMF event. The staff agrees with the licensee's conclusion that the AE parameters for this flood-causing mechanism are bounded by the respective riverine values. This approach is consistent with the guidance provided by Appendix G of NEI 12-06, Revision 2.

3.2.2.4 Storm Surge

For storm surge, the licensee reported a hydrodynamic load of 1,825 lb/ft and a debris impact load of 27,456 lbs., while the other AE parameters are not applicable because this hazard is also bounded by the streams and rivers flood-causing mechanism. The staff agrees with the licensee's conclusion for the storm surge and also note the approach is consistent with guidance provided by Appendix G of NEI 12-06, Revision 2.

3.2.2.5 Conclusions

In summary, the staff determined that the licensee's methods were appropriate and the provided AE parameters are reasonable for use in the MSA.

3.2.2.6 Effect on Mitigating Strategies

Section 2.3.1.2 of the MSA, states the turbine buildings shield the transformer yards and the buildings credited for FLEX (located east of the turbine buildings) from wave run-up and debris. The staff noted that this is consistent with the ISR response letter, which identifies a wave run-up of 0.0 ft. for the locations east of Unit 2 and 3 turbine buildings. The licensee states that although there may be damage to the riverside exterior of the turbine buildings from hydrodynamic and debris forces, these buildings are assumed to be fully flooded. The licensee also notes that the foundation of the buildings are built into the bedrock; thus, it is reasonable to conclude that the structural pieces will remain intact and can shield debris and wave run-up throughout the duration of the event.

The staff finds it reasonable that the FLEX strategy can be implemented as designed and is not affected by the hydrodynamic and debris loading from the streams and rivers and storm surge flood hazards, because the turbine building shields locations to the east of the building (i.e., areas for FLEX activities) and prevent wave run-up that would otherwise impede deployment of FLEX equipment, hoses, and cables.

3.2.3 Evaluation of Flood Protection Features

Doors 213 and 215 are protected to 18.6 ft. MSL and 18.7 ft. MSL, respectively, and require additional protection against the maximum storm surge stillwater elevation of 18.9 ft. MSL.

Internal Doors 234 and 235 are protected to 18 ft. MSL by an additional three feet of temporary flood protection features (sandbags) and require additional protection against the maximum storm surge stillwater elevation of 18.9 ft. MSL. These doors are internal to existing structures and thus only the storm surge elevation is applicable.

As noted in the FHRR, the engineering change EC 42514 package previously evaluated temporary flood protection features required for the postulated LIP event and storm surge. A comparable EC will evaluate additional flood protection features needed for these doors. The specific flood protection features have not yet been decided, but could be temporary measures (such as sandbags) or permanent modifications. Implementation of these barriers will be integrated into the appropriate flood preparation procedures, as necessary.

The NRC staff finds that it is reasonable that the FLEX strategy, using current FLEX procedures, equipment, and personnel, can be implemented as intended if flood protection (either temporary or permanent) for Doors 213, 215, 234 and 235 is provided as discussed in the MSA. The staff notes that the EC flood protection modifications that the licensee describes in its MSA are subject to future NRC inspection.

3.2.4 Conclusion

The NRC staff has reviewed the information provided in the Indian Point MSA related to the original FLEX strategies, as evaluated against the reevaluated hazards described in Section 2 of this Staff Assessment, and found that for the LIP flood hazard, streams and rivers PMF, and the dam breaches and failures PMF:

- the sequence of events for the FLEX strategies is not affected by the impacts of the MSFHI (including impacts due to the environmental conditions created by the MSFHI) in such a way that the FLEX strategies cannot be implemented as currently developed, and

- the validation performed for the deployment of the FLEX strategies is not affected by the impacts of the MSFHI.

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to deploy the original FLEX strategies, as designed, against a postulated beyond-design-basis event for the LIP, stream and rivers PMF, and the dam breaches and failure PMF flood-causing mechanisms, including associated effects and flood event duration, as described in NEI 12-06, Revision 2 and ISG-2012-01, Revision 1.

In addition, the NRC staff found that for the storm surge flood hazard:

- the sequence of events for the FLEX strategies is affected by the impacts of the ISR flood level in such a way that the FLEX strategies cannot be implemented as currently developed, and

- the validation performed for the deployment of the FLEX strategies is affected by the impacts of the ISR flood levels.

As a result of the information provided in the MSA, the NRC staff agrees with the conclusion that FLEX strategies, as designed, cannot be demonstrated to be effectively deployed to mitigate against a postulated beyond-design-basis event for the storm surge flood water surface elevation. Therefore, the licensee is expected to modify the original strategy to address the impacts of the storm surge flood hazard level at the site.

3.3 Evaluation of Modified FLEX Strategies

The licensee stated in its MSA, that the overall plant response strategies to an ELAP and LUHS event using the current FLEX procedures, equipment, and personnel can be implemented as intended provided an EC is performed to evaluate and implement additional flood protection features needed, with margin, for Doors 213, 215, 234, and 235. The licensee stated that at a minimum, these doors need to be protected against the storm surge stillwater elevation of 18.9 ft. MSL. The staff notes that the EC flood protection modifications that the licensee describes in its MSA are subject to future NRC inspection.

Consistent with NEI 12-06, Section G.4.2, the licensee identified the impacts of the reevaluated flood hazard to the FLEX strategies (i.e., flooding at Doors 213, 215, 234, and 235), determined the minimum flood protection level at these doors and confirmed that a revised sequence of events and FLEX procedures are not required once flood preparation procedures are revised accordingly. Since warning time is available prior to the onset of the storm surge event at the site (e.g. 48 hours based on the existing site procedures), the NRC staff finds that it is reasonable that the FLEX strategy, using current FLEX procedures, equipment, and personnel, can be implemented as intended if flood protection (either temporary or permanent) for Doors 213, 215, 234 and 235 is provided as discussed in the MSA.

4.0 CONCLUSION

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

- impacts to the FLEX strategies have been adequately identified;
- revised sequence of events and FLEX procedures are not required to account for the reevaluated storm surge flood hazard provided flood preparation procedures are revised; and
- the licensee has provided an adequate description and justification of flood protection features necessary to implement the FLEX strategy to account for the reevaluated storm surge flood hazard.

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to deploy modified FLEX strategies against a postulated beyond-design-basis event for the storm surge flood-causing mechanism(s), including associated effects and flood event duration, as requested in the COMSECY-14-0037, and affirmed in the corresponding SRM. The NRC staff has reviewed the information presented in the MSA by Entergy for Indian Point, Unit Nos. 2 and 3. The NRC staff confirmed that the licensee's flood hazard MSA 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 appropriate hazard characterization, methodology used in the MSA evaluation, and the description of its combination of strategies (i.e., current FLEX strategy and modified FLEX strategy); the staff concludes that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazard conditions.

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**	**Time for Water to Recede from Site**
Local Intense Precipitation and Associated Drainage	24 h (1)	< 6 h (2)	< 6 h (2)
Streams and Rivers (Cool Season PMF with Snow Pack Coincident with 25-year Storm Surge and 10% Exceedance High Tide)	48 h (3)	≈ 14 h (4)	≈ 60 h (4)
Failure of Dams and Onsite Water Control/Storage Structures	48 h (3)	Bounded (5)	Bounded (5)
Storm Surge (Combined Event)	48 h (1)	≈ 4 h	≈ 5 h

(1) From FHRR and RAI response.
(2) Estimated using FLO-2D hydrograph in FHRR (Figure 3.1-2)
(3) From MSA .
(4) Estimate based on staff's review of the licensee's HEC-RAS model.
(5) Inundation and recession periods are bounded by those for the streams and rivers flood-causing mechanism.

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**	**Streams and Rivers**	**Dam Failure (1)**	**Storm Surge**
Hydrodynamic loading at plant grade	Minimal	1,825 lb/ft (2)	Bounded	1,825 lb/ft
Debris impact loading at plant grade	Minimal	27,456 lbs	Bounded	27,456 lbs
Sediment loading at plant grade	Minimal	Minimal	Bounded	Bounded
Sediment deposition and erosion	Minimal	Minimal	Bounded	Bounded
Concurrent conditions, including adverse weather	Minimal	Not Applicable	Bounded	Bounded
Groundwater ingress	Minimal	Not Applicable	Bounded	Bounded
Other pertinent factors (e.g., waterborne projectiles)	Minimal	Not Applicable	Bounded	Bounded

Source: MSA

Notes:

(1) AE parameters for dam failure are not bounded by those of the streams and rivers flood-causing mechanism.

(2) lb/ft refers to pounds per linear foot of structure in length.

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED APRIL 10, 2017

DISTRIBUTION:
Public
JLD R/F
RidsNRRJLD Resource
RidsNrrDorllpl1 Resource
RidsNrrDorl Resource
RidsNrrPMIndianPoint Resource
RidsNrrlaSLent Resource
RidsOgcMailCenter Resource
RidsOpaMail Resource
RidsAcrsAcnw MailCtr Resource
RidsNroDsea Resource
RidsRgn1MailCenter Resource
SBailey, NRR
MHalter, NRR
GBowman, NRR
JSebrosky, NRR
JHughey, NRR

ADAMS Accession No. ML17059C227 *via email

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRR/JLD/JOMB/BC(A)	NRR/JLD/JERB/BC	NRO/DSEA/RHM2*
NAME	RBernardo	SLent	JBoska	SBailey	MLee
DATE	2/10/17	3/1/17	3/8/17	3/13/17	2/1/2017
OFFICE	NRO/DSEA/RHM2*	NRO/DSEA/RHM2/BC*	NRR/JLD/JHMB/BC	NRR/JLD/JHMB/PM	
NAME	HAhn	CCook	NSanfilippo	JSebrosky	
DATE	2/1/2017	2/1/2017	4/4/2017	4/10/2017	

OFFICIAL RECORD COPY