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Mr. Daniel G. Stoddard
Senior Vice President and
Chief Nuclear Officer
Virginia Electric and Power Company
Innsbrook Technical Center
5000 Dominion Blvd
Glen Allen, VA 23060-6711

SUBJECT: NORTH ANNA POWER STATION, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7948 AND MF7949)

Dear Mr. Stoddard:

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

Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 16, 2016 (ADAMS Accession No. ML16357A405), Virginia Electric and Power Company (the licensee) submitted the mitigating strategies assessment (MSA) for North Anna Power Station, Units 1 and 2 (North Anna). 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 North Anna MSA.

The NRC staff has concluded that the North Anna 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 condition for beyond-design-basis external events.

This closes out the NRC's efforts associated with CAC Nos. MF7948 and MF7949.

If you have any questions, please contact me at 301-415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

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

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for North Anna

Docket Nos. 50-338 and 50-339

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO MITIGATION STRATEGIES FOR NORTH ANNA POWER STATION, UNITS 1 AND 2, AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING CAC NOS. MF7948 AND MF7949

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 (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 North Anna Power Station, Units 1 and 2 (North Anna) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated September 25, 2015 (ADAMS Accession No. ML15238A844), the NRC issued a staff assessment of the licensee's flood hazard reevaluation report (FHRR) (ADAMS Accession No. ML13074A925) and subsequent supplements for North Anna. The North Anna FHRR staff assessment included the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for North Anna and parameters that are a suitable input for the mitigating strategies assessment (MSA). The following mechanisms are listed as not bounded by the CDB in the North Anna FHRR staff assessment:

- Local intense precipitation (LIP) – the reevaluated probable maximum flood (PMF) level is higher than the CDB level;

- Stream and river flooding – the reevaluated Lake Anna PMF level, including associated wind effects, is slightly higher than the CDB level; and

- Dam failure – the reevaluated flood hazard for failure of upstream dams on the North Anna River results in a stillwater elevation on Lake Anna of 264.7 ft National Geodetic Vertical Datum of 1929 (NGVD29). This mechanism had been reviewed and screened out in the licensee's CDB.

Since these flood-causing mechanisms were not bounded by respective current plant design-basis hazards, the FHRR staff assessment noted that in order to complete its response to the information requested by Enclosure 2 to the 50.54(f) letter, the licensee is expected to submit an integrated assessment or a focused evaluation, as appropriate, to address these reevaluated flood hazards, as described in NRC letter, "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events," (ADAMS Accession No. ML15174A257). This letter describes the changes in the NRC's approach to the flood hazard reevaluations that were approved by the Commission in its Staff Requirements Memorandum to COMSECY-15-0019 "Mitigating Strategies and Flooding Hazard Reevaluation Action Plan" (ADAMS Accession No. ML15153A104).

By letter dated December 16, 2016 (ADAMS Accession No. ML16357A405), Virginia Electric and Power Company (the licensee) submitted the North Anna MSA for review by the NRC staff. 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. In the North Anna MSA, the licensee stated that they had developed a site-specific LIP analysis and generated site-specific reevaluated LIP flood hazard information, which they considered to be more accurate than the LIP flood hazard information recorded in the North Anna FHRR and

previously assessed by the NRC staff. The updated LIP model reduced the maximum flood elevation by 0.1 ft relative to the value reported in the North Anna FHRR. The NRC staff determined that the updated LIP flood elevations are acceptable for use in the North Anna MSA.

The North Anna FHRR staff assessment also stated that the 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 North Anna MSA. This is consistent with the guidance provided in Revision 2 of NEI 12-06.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff evaluated the North Anna strategies as developed and implemented under Order EA-12-049, as described in the licensee's Final Integrated Plan (FIP) dated May 19, 2015 (ADAMS Accession No. ML15149A143). The NRC staff's safety evaluation for North Anna is dated January 15, 2016 (ADAMS Accession No. ML15324A341). The North Anna 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 North Anna's FLEX strategies, as described in the FIP, is listed below:

- 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) power-operated relief valves (PORVs) or main steam safety valves (MSSVs). The turbine driven auxiliary feedwater pump (TDAFWP) will provide flow to the SGs to make up for steam release, with suction from the unit's Emergency Condensate Storage Tank (ECST) and, when the ECST volume is depleted, the protected portion of the fire protection (FP) system. The FP system would be pressurized by the installed diesel-driven fire pump (DDFP) taking suction from the protected service water (SW) reservoir. 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 one hour after the occurrence of an ELAP/LUHS and will be completed within 90 minutes into the event. This extended load shedding will extend the battery-powered monitoring function up to 8 hours.

- 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 TDAFWP and DDFP. Operators will also deploy a portable beyond-design basis (BDB) high capacity pump, drawing from Lake Anna, to provide suction for the TDAFWP. Additionally, a portable diesel-driven BDB AFW [auxiliary feedwater] pump can be deployed as an alternative to use of the TDAFWP; this pump would take suction from Lake Anna and discharge directly to the SGs. In order to maintain sufficient borated RCS inventory in Phase 2, a portable diesel-driven high-pressure BDB RCS injection pump would be deployed at each unit to inject

borated makeup water from the unit's refueling water storage tank (RWST) or, as a contingency, portable boric acid mixing tanks. FLEX diesel generators (120/240 Vac) will be deployed from the BDB storage building to the alleyways on the east and west sides of the Auxiliary building. The FLEX DGs will be placed into service to supply power to the key instrumentation within 6 hours of the initiation of the ELAP event. The FLEX DGs will repower the vital 120 Vac buses to power required instruments. The 480 Vac DGs are available as an alternate power supply if the 120/240 Vac DGs are not available.

- For Phase 3, the equipment from a National SAFER [Strategic Alliance of FLEX Emergency Response] Response Center (NSRC) will be transported to staging area B, near the BDB storage building, and will utilize the same deployment pathways as Phase 2 equipment.

3.2 Evaluation of Current FLEX Strategies

By letter dated December 16, 2016 (ADAMS Accession No. ML16357A405), the licensee submitted its MSA for North Anna. 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 stream and river flooding, the maximum reevaluated flood hazard water level (267.4 ft NGVD29, including 3.3 ft for associated wind effects) is 0.1 ft higher than the CDB flood elevation. However, this flood level is still below the powerblock elevation (271 ft NGVD29) with a margin of 3.6 ft. Therefore, this reevaluated flood mechanism will have no impact on safety-related operations, and FLEX strategies can be implemented as designed.

For upstream dam failure, the licensee's analysis in the North Anna FHRR assumed that this flood-causing mechanism would be most critical during a PMF event. The maximum reevaluated flood hazard stillwater level (264.7 ft NGVD29) is not bounded by the CDB PMF stillwater level of 264.3 ft NGVD29. The licensee's FHRR did not incorporate associated effects, stating that additional refinement of the analysis was not necessary due to sufficient margin in their initial conservative analysis. In its staff assessment of the North Anna FHRR, the NRC staff estimated a maximum reevaluated flood hazard water level of 267.93 ft NGVD29 for a combination of dam failure and PMF with wind effects. This level is below the powerblock elevation (271 ft NGVD29). The licensee also considered flooding caused by failure of the service water reservoir impounding dike, and concluded that this flooding mechanism was not credible. The NRC staff's review of this mechanism confirmed that failure of the service water reservoir impounding dike would not inundate the plant site. Therefore, the NRC staff concludes that dam failure will have no impact on safety-related operations, and FLEX strategies can be implemented as designed.

For LIP, the maximum reevaluated flood elevations are not bounded by the CDB elevations of 271 ft NGVD29 in the protected area and 256.1 ft NGVD29 in the west basin. The maximum reevaluated LIP flood elevations are 274.4 ft and >257.0 ft NGVD29, in the protected area and west basin respectively.

In the North Anna MSA, the licensee documented the "Modified FLEX" strategies that have been or will be developed to address the impact of the reevaluated LIP flood hazard. Specifically, the licensee has revised its abnormal weather procedure to direct installation of temporary flood protection for the Unit 1 AFW pump house to prevent flood levels inside the

pump house from impeding operator actions which are required in the first hour of the ELAP event. The licensee also states in the North Anna MSA that it may revise its abnormal weather procedure to include severe weather triggers for calling in two additional operators to take station in the two AFW pump houses prior to the one-hour LIP peak, which is assumed to prevent travel between the control room and the AFW pump houses.

Additionally, the licensee is considering a revision to its FLEX procedures for ELAP response when one or both units are in Mode 5 or 6. The considered revision would include abnormal weather procedure severe warning triggers to direct operator actions that would place the reactor core of the Mode 5/6 unit(s) in the safest possible configuration and protect the pre-deployed BDB AFW pump(s). Finally, the licensee will enhance flood protection for the emergency switchgear room (ESGR) by implementing flood protection modifications of the decontamination bay to prevent flood volume in the decontamination bay from transferring to the fuel building and auxiliary building basements.

In accordance with NEI 12-06, Rev. 2, Section G.4.2, "Assessment of Current FLEX Strategies," the MSA should address whether the FLEX strategies can be implemented based on the FHRR staff assessment. For North Anna, the MSA addresses the site-specific reevaluated LIP flood hazard. The staff's review of this non-bounded flood hazard is discussed below:

Local Intense Precipitation

Per Section 2.3.1 of the North Anna MSA, the licensee assessed the impact of the site-specific reevaluated LIP flood hazard on FLEX mitigating strategies for an ELAP/LUHS event occurring when both units are at power (Modes 1 through 4) and with one or both units in shutdown/ refueling modes (Modes 5 and 6). The assessment was performed for both an ELAP that begins concurrent with or after the 1-hour LIP peak, and also an ELAP assumed to begin prior to the 1-hour LIP peak. The assessment assumed that during that 1 hour of peak rainfall intensity, no outdoor operator action or travel could occur. The licensee's assessment concluded that:

- The reevaluated LIP flood hazard did not impact FLEX equipment storage, FLEX equipment haul paths or deployment locations, or staging areas for NSRC equipment in Phase 3;

- The reevaluated LIP flood hazard had minimal impact on mitigating strategies for Modes 5 and 6 due to operator actions already directed by the site's abnormal weather procedure. The licensee did note, however, that it may elect to enhance the procedures directing the Modes 5 and 6 FLEX response; and

- The reevaluated LIP flood hazard does impact some FLEX mitigating strategy actions for Modes 1 through 4, which are described below.

At the initiation of the ELAP/LUHS event, the TDAFWP at each unit starts automatically and begins discharging SG makeup water to only one of three SGs. An operator must manually realign AFW flow so that all three SGs receive AFW flow, in order to prevent one SG from overfill and the other two from dryout. The licensee's FLEX strategy assumes that an operator can travel from the control room to the AFW pump house to perform this alignment in the first hour of the ELAP; if this is concurrent with the peak hour of rainfall intensity and flooding, this will not be possible. Furthermore, the Unit 1 AFW pump house floor is susceptible to flooding to a maximum depth of 1.2 ft; the Unit 2 pump house maximum flood depth is 0.1 ft. The licensee

states that this interior flooding will not impact the operability of the TDAFWP, nor would it prevent the necessary realignment of AFW flow; however, realignment and control of AFW flow would be significantly more difficult under such conditions.

As a result of this assessment, the licensee revised its abnormal weather procedure to include a direction to install temporary flood protection at the Unit 1 AFW pump house doors prior to the LIP, which would prevent water from entering the pump house. The maximum flood depth of interior flooding in the Unit 2 AFW pump house was assessed to have negligible impact on operator actions, but will be further addressed in the licensee's focused evaluation. To address the impact of the reevaluated LIP flood hazard on an operator's ability to travel from the control room to the pump house during the peak hour of rainfall intensity and maximum flooding, the licensee is considering revising its abnormal weather procedure to include severe weather triggers for calling two additional operators to the site, and stationing an operator in each AFW pump house prior to the LIP. The NRC staff finds it reasonable that these procedural revisions, if implemented and validated, would ensure that AFW flow can be aligned and controlled locally as required by the licensee's FLEX mitigating strategies.

The licensee's analysis of the reevaluated LIP flood hazard also identified that the decontamination bay, which is at a lower elevation than the nominal site grade, could receive flood water from site flooding. Flood water could then pass from the decontamination building basement to the fuel building and auxiliary building basements, and eventually to the turbine building basement. Flooding in the turbine building basement above the ESGR flood protection wall could threaten the operability of the plant emergency power distribution system, thereby impacting FLEX strategies which credit the use of FLEX key instrumentation and other equipment powered by the emergency power distribution system. The licensee's analysis concluded that flood levels would not overtop the ESGR flood protection wall, in part based on the assumption that flood protection modifications would be implemented to prevent flood water from passing from the decontamination bay to the decontamination building basement. Therefore, to ensure the validity of this conclusion, the licensee states that flood protection modifications for the decontamination bay will be developed and implemented, as expected in a focused evaluation. The NRC staff finds it reasonable that such flood protection modifications would protect the ESGR from LIP floodwaters entering via the decontamination building basement, and that the North Anna FLEX strategy could still be implemented as designed.

3.2.1 Evaluation of Flood Event Duration

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

For the LIP flood-causing mechanism, the licensee determined a warning time of "up to 36 hours or greater" for the North Anna MSA. The licensee also stated in the North Anna MSA that the warning time will be re-assessed for the focused evaluation or integrated assessment using the guidelines provided by NEI 15-05. The licensee reported in the North Anna MSA that the period of inundation was 6 hours and the period of recession was 0 hours. The licensee used a numerical modeling approach to evaluate the periods of inundation and recession. The staff reviewed the hydrographs provided by the licensee as part of reviewing the North Anna FHRR, and concluded that the FED parameters are acceptable for use in the North Anna MSA.

The licensee stated that the excess of LIP runoff may fill in the west basin and then enter into the turbine building basement. Based on results from the updated LIP modeling, the licensee determined that the estimated inundation level inside the turbine building basement would not exceed the crest elevation of the safety-related ESGR flood protection wall. That is, the top of the ESGR flood protection wall has about 0.4 ft of margin above the turbine building basement maximum stillwater flood level. Correspondingly, the licensee concluded the FED parameters for the LIP flood-causing mechanism for the west basin area are not applicable. The staff agrees with the licensee's conclusion, as the licensee's re-evaluation of the LIP flooding in the west basin area was accepted in the site's FHRR staff assessment.

The licensee concluded that the FED parameters for streams and rivers and dam failure flood-causing mechanisms are not applicable because the site will not be inundated by these flood-causing mechanisms. The staff agrees with the licensee's conclusion on the FED parameters for these flood-causing mechanisms, as their approach is consistent with the guidelines provided by Appendix G of NEI 12-06, Revision 2.

In summary, the NRC staff concludes that the licensee's FED parameters are reasonable and acceptable for use in the North Anna MSA.

3.2.2 Evaluation of Flood Associated Effects

The staff reviewed the information provided by the licensee regarding reevaluated associated effects (AE) 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 run-up effects) were previously reviewed by staff. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2.2-1 of this assessment.

For the LIP flood-causing mechanism, the licensee stated in the North Anna MSA letter that the AE parameters, including hydrodynamic and debris loads, sediment deposition and erosion, concurrent site condition, groundwater ingress, and other factors are minimal due to the low flow depths and slow water velocities. This conclusion is based on the simulation of a one-dimensional numerical model. The NRC staff confirmed the flood depths and flow velocities from the licensee-provided model output files provided as part of the FHRR staff assessment review. Correspondingly, the NRC staff agrees with the licensee's conclusion that the AE parameters for the LIP flood-causing mechanism are minimal. The licensee stated in the North Anna MSA that the AE parameters for the west basin LIP flooding are not applicable because the estimated LIP inundation level inside the turbine building basement would not exceed the crest elevation of the safety-related ESGR flood protection wall. The NRC staff agrees with the licensee's conclusion, as the licensee's re-evaluation of the LIP flooding in the west basin area was accepted in the North Anna FHRR staff assessment.

The licensee also stated that AE parameters for the streams and rivers and the dam failure flood-causing mechanisms are not applicable because the site is not inundated by these flood-causing mechanisms. The NRC staff determined that this approach is acceptable as it is consistent with the guidelines provided by Appendix G of NEI 12-06, Revision 2.

In summary, the NRC staff concludes that the licensee's methods were appropriate and the AE parameter results are reasonable for use in the North Anna MSA.

3.2.3 Evaluation of Flood Protection Features

The NRC staff finds that it is reasonable that the North Anna FLEX strategy, using current FLEX procedures, equipment, and personnel, can be implemented as intended if flood protection (either temporary or permanent) for the AFW pump houses and decontamination bay are provided as discussed in the North Anna MSA. As described by the licensee, the proposed flood protection features sound reasonable and effective to protect equipment and ensure the success of the FLEX strategy. The staff notes that the flood protection modifications that the licensee describes in the North Anna MSA are subject to future NRC inspection.

3.2.4 Conclusion

The NRC staff has reviewed the information provided in the North Anna MSA related to the original FLEX strategies, as evaluated against the reevaluated hazards described in Section 3 of this staff assessment, and found that for the streams and rivers and the dam failure PMFs,:

- The sequence of events for the FLEX strategies is not affected by the impacts of the flooding mechanisms described in the North Anna FHRR staff assessment (including impacts due to the environmental conditions created by the North Anna FHRR staff assessment) in such a way that the FLEX strategies cannot be implemented as currently developed; and

- The validation performed for the deployment of North Anna FLEX strategies is not affected by the impacts of the Mitigating Strategies Flood Hazard Information described in the North Anna FHRR staff assessment..

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 streams 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 reevaluated LIP flood hazard:

- The sequence of events for the FLEX strategies is affected by the impacts of the reevaluated 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 reevaluated flood levels.

As a result of the information provided in the North Anna 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 BDB event for the reevaluated LIP flood hazard. Therefore, the licensee is expected to modify the original strategy to address the impacts of the reevaluated maximum LIP flood level at the site.

3.3 Evaluation of Modified FLEX Strategies

The licensee stated in the North Anna MSA that the overall plant response strategies to an ELAP/LUHS event using the current FLEX procedures, equipment, and personnel can be implemented as intended provided that:

- The abnormal weather procedure is revised to include directions to install temporary flood protection at the Unit 1 AFW pump house doors prior to the LIP, which would prevent water from entering the pump house;

- The abnormal weather procedure is revised to include severe weather triggers for calling two additional operators to the site, and stationing an operator in each AFW pump house prior to the LIP, or some other procedural or physical modification is implemented to ensure that operator actions in the AFW pump houses can be performed under LIP conditions; and

- Flood protection modifications are implemented to prevent flood water from passing from the decontamination bay to the decontamination building basement.

The staff notes that the procedural revisions and 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 North Anna FLEX strategies and confirmed that a revised sequence of events and FLEX procedures are not required once flood preparation procedures are revised and flood protection modifications are implemented accordingly. Since warning time is available prior to the onset of the LIP event at the site, 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 the site abnormal weather procedure is revised as discussed in the North Anna MSA.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the North Anna MSA related to current FLEX strategies, as evaluated against the reevaluated hazard(s) described in Section 3 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 LIP flood hazard provided flood preparation procedures are revised and flood protection modifications are implemented; 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 LIP flood hazard.

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to deploy modified FLEX strategies against a postulated BDB event for the LIP 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 confirmed that the North Anna 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 flood hazard characterization, methodology used in the North Anna MSA evaluation, and the description of its combination of strategies (i.e., current FLEX strategy and modified

FLEX strategy), the NRC 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	Protected area	up to 36 hours or greater (or NEI 15-05 (NEI, 2015))	6 hours	0 hours
	West basin [(1)]	Not Applicable	Not Applicable	Not Applicable
Streams and Rivers (Lake Anna) [(2)]		Not Applicable	Not Applicable	Not Applicable
Failure of Dams and Onsite Water Control/Storage Structure (Lake Anna) [(2)]		Not Applicable	Not Applicable	Not Applicable

Source: Virginia Electric and Power Company (2016).

Notes:
(1) The FED parameters for the West basin LIP flooding are not applicable because the estimated LIP inundation level inside the Turbine building basement would not exceed the crest elevation of the safety-related ESGR flood protection wall.

(2) The FED parameters are not applicable because the site is not inundated by this 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

Associated Effects Factor	Flood-Causing Mechanism			
	Local Intense Precipitation and Associated Drainage		Streams and Rivers (Lake Anna) [2]	Failure of Dams and Onsite Water Control/Storage Structure (Lake Anna) [2]
	Protected area Outside the West basin	West basin [1]		
Hydrodynamic loading at plant grade	Minimal	Not Applicable	Not Applicable	Not Applicable
Debris loading at plant grade	Minimal	Not Applicable	Not Applicable	Not Applicable
Sediment loading at plant grade	Minimal	Not Applicable	Not Applicable	Not Applicable
Sediment deposition and erosion	Minimal	Not Applicable	Not Applicable	Not Applicable
Concurrent Conditions, including adverse weather	Minimal	Not Applicable	Not Applicable	Not Applicable
Groundwater ingress	Minimal	Not Applicable	Not Applicable	Not Applicable
Other pertinent factors (e.g., waterborne projectiles)	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Source: Virginia Electric and Power Company (2016)

Notes:

(1) The AE parameters for the West basin LIP flooding are not applicable because the estimated LIP inundation level inside the Turbine building basement would not exceed the crest elevation of the safety-related ESGR flood protection wall.

(2) The AE parameters are not applicable because the site is not inundated by this flood-causing mechanism.

SUBJECT: NORTH ANNA POWER STATION – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED JUNE 29, 2017

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