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

June 27, 2018

Mr. John Dent, Jr.
Vice President-Nuclear and CNO
Nebraska Public Power District
Cooper Nuclear Station
72676 648A Avenue
P.O. Box 98
Brownville, NE 68321

SUBJECT: COOPER NUCLEAR STATION – FLOOD HAZARD MITIGATING STRATEGIES ASSESSMENT (CAC NO. MF7915; EPID L-2016-JLD-0007)

Dear Mr. Dent:

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, under Title 10 of the *Code of Federal Regulations* (10 CFR), sub-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 dated July 12, 2011(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 the 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 12, 2017 (ADAMS Accession No. ML17355A110), Nebraska Public Power District (NPPD, the licensee) submitted the mitigation strategies assessment (MSA) for Cooper Nuclear Station (Cooper). This submittal replaced in its entirety an earlier version submitted by letter dated April 27, 2017 (ADAMS Accession No. ML17125A328).

Enclosure 1 transmitted herewith contains Security-Related Information and Critical Electric Infrastructure Information (CEII). When separated from Enclosure 1, this document is decontrolled.

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. Therefore, the purpose of this letter is to provide the NRC staff's assessment of the Cooper MSA.

The NRC staff has concluded that the Cooper 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 (ADAMS Accession No. ML15357A163). In addition, the licensee has developed a targeted hazard mitigating strategy which, if appropriately implemented as described, would preserve core cooling and spent fuel cooling against the reevaluated flood hazard conditions for beyond-design-basis events. This closes out the NRC's efforts associated with CAC No. MF7915, EPID L-2016-JLD-0007.

If you have any questions, please contact me at 301-415-1056 or via e-mail at Juan.Uribe@nrc.gov.

Sincerely,

Juan F. Uribe, Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-298

Enclosures:
1. Staff Assessment Related to the Flooding Mitigating Strategies Assessment for Cooper (Non-Public)
2. Staff Assessment Related to the Flooding Mitigating Strategies Assessment for Cooper (Public)

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STAFF ASSESSMENT RELATED TO THE FLOODING MITIGATING STRATEGIES ASSESSMENT FOR COOPER NUCLEAR STATION AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE RECOMMENDATION 2.1 - FLOODING

(CAC NO. MF7915; EPID L-2016-JLD-0007)

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, under Title 10 of the *Code of Federal Regulations* (10 CFR), sub-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 dated July 12, 2011(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 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 report, describing 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 Reevaluat[i]on 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.

Enclosure 2

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 Cooper Nuclear Station (Cooper) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated February 3, 2015 (ADAMS Accession No. ML15041A468), Nebraska Public Power District (NPPD, the licensee) submitted the flood hazard reevaluation report (FHRR) as requested by the 50.54(f) letter. By letter dated December 22, 2015 (ADAMS Accession No. ML15355A416), the NRC staff issued an Interim Staff Response (ISR) letter, providing its assessment of the licensee's FHRR. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Cooper and parameters that are a suitable input for the mitigating strategies assessment (MSA). For Cooper, the mechanisms listed as not bounded by the CDB are local intense precipitation (LIP), Streams and Rivers, failure of dams and onsite water control/storage structures, ice-induced flooding, and channel migration/diversion. By letter dated September 29, 2016, the licensee submitted a revised version of the Cooper FHRR which incorporated, among other things, revised analyses, references, Tables and Figures (ADAMS Accession No. ML16279A421). By letter dated June 1, 2018 (ADAMS Accession No. ML18054B428), the NRC staff issued an assessment of the revised FHRR.

By letter dated December 12, 2017 (ADAMS Accession No. ML17355A110), the licensee submitted the mitigation strategies assessment (MSA) for Cooper. This submittal replaced in its entirety an earlier version submitted by letter dated April 27, 2017 (ADAMS Accession No. ML17125A328). This assessment provides the results of the NRC staff's evaluation of the MSA.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

By letter dated January 4, 2017 (ADAMS Accession No. ML17017A166), the licensee submitted the "Cooper Nuclear Station FLEX Final Integrated Plan [(FIP)]" and reported that full compliance with the requirements of Order EA-12-049 had been achieved.

The NRC staff evaluated Cooper's FLEX strategies and documented its review in the NRC staff's safety evaluation issued by letter dated September 20, 2017 (ADAMS Accession No. ML17226A032). The safety evaluation concluded that the licensee has developed guidance and proposed designs which, if implemented appropriately, will adequately address the requirements of Orders EA-12-049 and EA-12-051.

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

- For Phase 1, the reactor core isolation cooling (RCIC) system provides the credited Reactor Pressure Vessel (RPV) makeup source. Two 50,000 gallon emergency condensate storage tanks (ECSTs) provide a suction source for the RCIC pump. The RCIC system will continue to provide RPV makeup for 4 hours before makeup to the ECSTs is needed from the hotwell. The operators are directed to take steps to minimize the load on the station batteries by shedding unnecessary loads in accordance with station blackout (SBO) procedures. The load shedding is performed to ensure that the station batteries are available for a minimum of 9 hours. The primary method of RPV pressure control is by operation of the safety relief valves (SRVs). The SRVs are powered by the station batteries and utilize the drywell pneumatic system to cycle the necessary valves open and closed throughout Phase 1.

- For Phase 2, the RCIC system continues to provide core cooling supplied from the ECSTs. The hotwell makeup to the ECSTs continues for about 24 hours before the on-site well is used. If the ECSTs are unavailable to provide RPV makeup, a portable FLEX pump is used to draw suction from the on-site well to supply the RPV through the normal residual heat removal service water (RHRSW) crosstie to the Division 1 residual heat removal (RHR) injection flow path. An alternate connection for RPV makeup is available. Control of the SRVs is provided by the FLEX portable air compressor, which is connected to supply the Reactor Building reliable air header. This creates a pneumatic source for the SRVs for continued reactor pressure control. The FLEX 175kW diesel generator (DG) is connected by approximately 5 hours and is sized to power the 'C' 125/250 volts direct current (Vdc) battery chargers and either division of dc busses. An alternate connection is available. The spent fuel pool (SFP) cooling equipment is staged 24 hours after the extended loss of alternating current (ac) power (ELAP) event is initiated. The portable FLEX pump is used to tie into a fuel pool cooling (FPC) system chemical decontamination connection. Valves are aligned to supply makeup through the FPC system to the SFP through the normal fill location.

- For Phase 3, equipment from the National SAFER [Strategic Alliance of FLEX Emergency Response] Response Center (NSRC) is transported to the site to continue Phase 2 strategies. Two 4160 VAC SAFER portable DGs are used to supply power for a Division 1 RHR pump in order to place one loop of RHR into the Shutdown Cooling (SDC) mode. The RHR heat exchanger is supplied with river water by a large portable SAFER pump with suction from the Missouri River via the RHRSW piping connection point. An alternate connection for core cooling utilizes the Division 2 components of RHR and RHRSW using the SAFER equipment.

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 onsite water control/storage structures, ice-induced flooding, and channel migration/diversion flooding mechanisms, against the mitigating strategies designed to meet

Order EA-12-049. The purpose of the MSA is to determine: (1) if the licensee's mitigating strategies are adequate as originally developed for Order EA-12-049 compliance, (2) if the licensee's mitigating strategies need to be modified, or (3) whether new mitigating strategies need to be developed to address the revised hazard exceedances.
As part of its MSA review, the NRC staff sought to understand if the reevaluated hazards impacted any of the FLEX storage location(s), any staging areas, haul paths, connection points, activities, timelines, etc. The NRC staff notes that a generic audit plan was issued by letter dated December 5, 2016 (ADAMS Accession No. ML16259A189), which described the NRC staff's intention to conduct audits related to MSAs, as needed. 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 also reviewed the flood hazard elevations in the MSA and notes that two Plant Datums are used interchangeably, as described below. However, the NRC staff confirmed that the elevations (when converted to equivalent Datums) matched the values provided in the NRC staff's ISR letter for the applicable non-bounded mechanisms. Consistent with the ISR letter, all elevations and flood depths discussed by the NRC staff in this assessment are given in feet (ft.) per the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted. With regards to datum conversion, the licensee stated that the site grade of 903 ft. Plant Datum (also referred to as mean sea level (MSL)) is equivalent to 903.4 ft. NAVD88 (rounded from 903.37 ft.); and that the finished floor elevation of all Class I Structures of 903.5 ft. MSL is equivalent to 903.9 ft. NAVD88 (rounded from 903.87 ft.). In summary, NAVD88 is equal to Plant Datum elevation plus 0.37 ft. Conversely, MSL levels correspond to NAVD88 elevations minus 0.37 ft. Elevations in this staff assessment are rounded to the nearest decimal.

Overall, the licensee determined in its evaluation that the current FLEX strategies can be deployed with no substantial modifications in order to account for the unbounded reevaluated hazards, except failure of dams and onsite water control/storage structures. The revised MSA introduced a targeted hazard mitigation strategy (THMS) to address the failure of dams flood causing mechanism. The details of the licensee's evaluation and the NRC staff's review are described below.

3.2.1 Local Intense Precipitation

The ISR letter for Cooper lists a LIP level of 903.9 ft. (903.5 ft. MSL) with negligible wave/runup, resulting in a maximum reevaluated hazard elevation of 903.9 ft. (903.5 ft. MSL). The licensee stated in the MSA that this LIP analysis was conservatively performed assuming that the local storm drainage system (culverts, ditches, storm sewers, etc) was not functional during the LIP event. Because the LIP flood causing mechanism was not included as part of the CDB, it was considered to be not bounded.

The FLEX design-basis is equal to the CDB probable maximum flood (PMF)-based event elevation of 903.4 ft. (903 ft. MSL). Additional details can be found in the Updated Final Safety Analysis Report (UFSAR) Section II-4 and the FLEX safety evaluation. In the MSA, the licensee discussed that the general ground elevation surrounding the Cooper Class I Structures is 903 ft.

MSL (903.4 ft. NAVD88), and that the finished floor elevation of all Class I Structures is placed at elevation 903.5 ft. MSL (903.9 ft. NAVD88), or .5 ft above the PMF event.

With regard to the FLEX equipment and strategy, the licensee stated in the MSA that the reevaluated LIP flood elevation of 903.5 ft. MSL (903.9 ft. NAVD88) is equal to the finished floor elevations of 903.5 ft. MSL (903.9 ft. NAVD88) at the Class 1 structures and the Flexible Storage Buildings (FSBs) locations. As a result, the licensee indicated that no major impact to the FLEX strategies is expected, however, some small amount of seepage may occur past the FSB door seals as a result of the LIP event.

The licensee analyzed the potential impact of the seepage on the FLEX strategy and/or components and determined that the major pieces of FLEX equipment are pumps, generators, and air compressors that are "Over-The-Road" capable, meaning that they are mounted on trailers and/or stored on shelves above the floor. In addition, the licensee stated that the LIP flood peak height (903.5 ft. MSL (903.9 ft. NAVD88)) occurs and recedes within an hour of rainfall. When compared to the established FLEX strategy, the licensee determined that there is sufficient time to allow the LIP flood waters to recede from the Class 1 structures and FSBs before the need to use and deploy the equipment, and therefore, no impact is expected.

In addition, the licensee determined that (a) connections needed for FLEX strategies would not be affected by the LIP flood event since the connections are located inside the Class 1 structures; and (b) no flood barriers would be needed for the LIP flood event response given the negligible amount of ponding as compared to the finished floor elevation of the Class 1 structures and FSBs, coupled with the short duration of the flood period. Based on the above information, the licensee concluded in the MSA that the revised LIP flood event would not have any impact on the overall strategy and that FLEX works as designed.

The NRC staff reviewed the licensee's analysis of the revised LIP flood event's impact on FLEX strategies. The NRC staff agrees that the flood height and short duration of the LIP flood event is not expected to impact any permanent plant equipment necessary for the success of the FLEX strategy, portable FLEX equipment, or established connection points given that these items are either located higher, or are protected from, the projected maximum LIP flood elevation. As a result, the NRC staff agrees that the critical structures and FSBs are reasonably protected against the impacts of a LIP event. In addition, the NRC staff notes that the FLEX strategy calls for deployment of FLEX equipment near the 5 hour mark after ELAP initiation, which is well after the time that the LIP flood waters are expected to have receded. Furthermore, the conservatisms assumed in the licensee's analysis and the high likelihood that the LIP event does not cause an ELAP or a loss of ultimate heat sink (LUHS), provides additional assurance that FLEX strategies are protected against the impacts of the reevaluated LIP event. No additional operator actions were identified for the protection of the critical structures and FSBs due to the amount of LIP rainfall expected and the short duration of time needed for water to recede from the Cooper site. Additional details regarding recession time and other flood event duration parameters are described in more detail in Sections 3.3 and 3.4 of this NRC staff assessment.

As a result of the above, the NRC staff concludes that that the licensee's FLEX strategies, if adequately implemented as described, are reasonably protected against the revised LIP flood event and should be expected to perform their intended functions.

3.2.2 Streams and Rivers

The ISR letter for Cooper lists a Streams and Rivers level of 903.6 ft. (903.2 ft. MSL) with a wind/wave runup of 0.5 ft., resulting in a maximum reevaluated hazard elevation of 904.1 ft. (903.7 ft. MLS) at the embankments surrounding the Cooper Main Building Complex. Similarly, the ISR letter lists a streams and river level of 903 ft. (902.6 ft. MSL) with a wave/runup of 5.4 ft., for a total reevaluated hazard elevation of 908.4 ft. (908 ft. MSL) on the vertical wall of the Intake Structure.

~~(CEII)~~ With regards to the CDB, the licensee stated in the FHRR that [[redacted]] The licensee also stated that wave action will not affect the plant since the nearest building, other than the intake structure, is located about 200 ft. from the river edge and is located at elevation 903.4 ft. (903 ft. MSL). As a result, the licensee added that wave energy would be dissipated before reaching any of the main buildings. In addition, wave action at the Intake Structure will not affect the safe shutdown of the plant since the service water pumps and controls are protected by massive reinforced concrete walls and a slab up to elevation 919.6 ft. (919.2 ft. MSL) for the Intake Structure and 906.4 ft. (906 ft. MSL) for the Main Building Complex.

In the FHRR, the licensee also stated that the protection of building openings up to 906.4 ft. (906 ft. MSL) is accomplished by deploying temporary flood control barriers. These barriers are deployed at critical grade level openings around and within the Main Building Complex. In addition to the engineered flood barriers used, sandbags are also available for contingencies, as needed.

When comparing the CDB flood protection at the Main Building Complex of 906.4 ft. (906 ft. MSL) against the reevaluated hazard of 904.1 ft. (903.7 ft. MSL); and the CDB flood protection at the Intake Structure of 919.6 ft. (919.2 ft. MSL) against the reevaluated hazard of 908.4 ft. (908 ft. MSL), the NRC staff agrees that the reevaluated flood hazard PMF flood levels at both locations is lower than the current flood protection levels and therefore, no impact is expected to occur.

Similar to the CDB flooding strategy discussed above, Cooper relies on existing flooding procedures and preemptive site preparations in order to address the reevaluated Streams and Rivers flood causing mechanism. The flooding procedure directs operators to install temporary flood barriers that provide protection to plant equipment up to a water level of 906.4 ft. (906 ft. MSL) near the Main Building Complex and FSBs. Specifically, once monitoring of the Missouri River water surface elevation (WSE) reaches 895.4 ft. (895 ft. MSL), then flooding procedure "5.1FLOOD" is entered. If the river WSE continues to increase, the first line of flood barriers would be constructed when the Missouri River WSE reaches 898.4 ft. (898 ft. MSL), or is forecast to be greater than elevation 902.4 ft (902 ft. MSL) within 36 hrs. A second line of flood barriers will be constructed when the Missouri River WSE reaches 900.4 ft (900 ft. MSL).

With regard to the FSBs, the licensee indicated in the MSA that leakage from the PMF rainfall may present a small amount of leakage through the door due to wave runup. Similar to the LIP flood event, the licensee noted that FLEX equipment and components are either located on shelves or mounted onto trailers in order to avoid any effects from any water ingress from the

FSB doors as a result of the PMF flood event. The licensee also indicated that the deployment of FLEX equipment and connection points would also remain unaffected due to their individual location and the installation of the temporary flood barriers.

The NRC staff reviewed the licensee's analysis for the reevaluated Streams and Rivers PMF flood event and agrees that the Cooper strategy of relying on an existing flooding procedure (which is part of the CDB) in order to systematically implement additional flood protection at the site, is adequate. The procedure is triggered by the river level rising to 895.4 ft (895 ft. MSL) from a predicted rainfall and calls for the installation of temporary flood barriers. This would not be changed for the FLEX strategies since the temporary flood barriers are capable of shielding the peak flood level from the PMF event up to 906.4 ft. (906 ft. MSL). Because of the additional protection that these barriers provide, or their inherent location relative to site grade when compared to the expected flooding conditions, the NRC staff also agrees that no impacts are expected to occur at the intake structure and/or around the Main Building Complex given that the current site flood protection exceeds the reevaluated hazard levels. As a result, the reevaluated PMF level is not expected to impact the FLEX strategies and/or plant equipment.

The NRC staff concludes that it is reasonable to expect that the FLEX strategy, using existing FLEX procedures, equipment, and personnel, can be implemented as intended for the revised Streams and Rivers PMF event.

3.2.3 Failure of Dams and Onsite Water Control/Storage Structures

The licensee used JLD-ISG-2013-01, "Guidance for Assessment of Flooding Hazards Due to Dam Failure" (ADAMS Accession No. ML13151A153) as the basis for determining flooding effects at Cooper due to upstream dam failures. [[redacted].]] As previously stated, the NRC staff has reviewed the September 29, 2016 revised FHRR and documented the results of its evaluation in a staff assessment dated June 1, 2018 (ADAMS Accession No. ML18054B428). In the staff's assessment, the NRC staff concluded that the information provided in the revised FHRR was suitable input for use in additional assessments of plant response, such as the MSA.

(CEII)

The NRC staff reviewed the revised upstream dam failure analysis in the MSA. The revised flood levels exceed the site grade elevation; therefore, the FLEX strategies, as designed, cannot be successfully implemented for this flood scenario. The licensee indicated in the MSA that a THMS will be needed. Section 3.2.6 of this staff assessment describes the THMS in detail for the revised upstream dam failure flood event.

3.2.4 Ice-Induced Flooding

The ISR letter for Cooper lists a reevaluated hazard elevation for ice-induced flooding of 896.9 ft. (896.5 ft. MSL). The licensee described this mechanism as flooding resulting from ice blockage upstream or downstream from the Cooper site. The wind/wave runup is not applicable for this mechanism as discussed in Section 3.3.4 of this staff assessment. The licensee's analysis of the revised flooding resulting from an upstream ice jam break has a peak flood level of 896.8 ft. (896.4 ft. MSL). The revised flooding resulting from the backwater due to the downstream ice jam of the river is 896.8 ft. (896.4 ft. MSL). Neither ice jam flooding event exceeds the site grade of 903.4 ft. (903 ft. MSL) and is bounded by the revised LIP and PMF flood events. The licensee determined that the current FLEX strategies can be implemented as designed for the ice-induced flood events due to the flood levels remaining significantly lower than the site grade of the Class 1 structures and FSBs.

The NRC staff reviewed the licensee's analysis of the revised ice-induced flood event. The estimated downstream and upstream flood levels do not reach the CDB site grade and the placement of the FLEX equipment and plant equipment inside the Class 1 structures and FSBs provide additional flood protection due to their elevations being higher than the site grade level. The NRC staff concludes that it is reasonable to expect that the FLEX strategy, using existing FLEX procedures, equipment, and personnel, can be implemented as intended for the revised ice-induced flood event.

3.2.5 Channel Migration/Diversion

For the channel migration/diversion flood event, the Cooper FHRR described the flood event as the Missouri River diverting away from the current navigational channel during the PMF or upstream dam failure flooding events. [[redacted].]]

~~(CEII)~~

The NRC staff reviewed the licensee's revised channel migration/diversion flood event. The NRC staff acknowledges that the reevaluated flood scenario projects a condition in which flooding would impact the Cooper site if existing flood protections were not in place. [[redacted].]] The licensee does not call for any additional operator actions, such as installation of temporary flood barriers for the channel migration/diversion flood event. The NRC staff concludes that it is reasonable to expect that the FLEX strategy, using existing FLEX procedures, equipment, and personnel, can be implemented as intended for the revised channel migration/diversion flood event.

~~(CEII)~~

3.2.6 Targeted Hazard Mitigation Strategy (THMS)

NEI 12-06, Revision 2 defines an Alternate Mitigating Strategy (AMS) as an event-specific functional approach taken to maintain or restore core cooling, containment, and SFP cooling capabilities in which an ELAP and LUHS are not assumed unless they are caused by the specified event. The THMS is defined as a strategy that is developed similar to an AMS, with the main difference being the need to open containment as a preemptive strategy element, and therefore only core cooling and SFP cooling are maintained. The THMS should only be deployed in specific scenarios where (a) FLEX strategies, as designed, would not be expected to perform their intended functions; and (b) it is impractical to modify existing FLEX strategies or develop another effective strategy, such as an AMS.

As described in Section 3.2.3 above, the licensee's revised analysis of the dam failures upstream from the Cooper site shows inundation throughout the Missouri River valley/flood plain, including the Cooper site, and the licensee concluded that the original FLEX strategies cannot be implemented due to the impact of the revised upstream dam failure flood event. The licensee's basis for the development of a THMS is discussed below.

3.2.6.1 Targeted Hazard Mitigation – Assessment

In accordance with Section G.4.4 in NEI 12-06, the licensee provided justification in the MSA regarding the selection and development of a THMS strategy in which it would maintain core cooling and SFP cooling, but would not maintain the containment function. Specifically, the plant will be shutdown, placed in Mode 5 with the drywell and RPV heads removed and the reactor cavity flooded prior to the arrival of the flood waters on-site. In this condition, the probability and consequences of a design-basis accident are reduced, and therefore the primary containment function is not required to be operable, as reflected in the plant technical specifications. In addition, there will be about 470,000 gallons of water above the reactor core. The reactor recirculation system will be isolated preventing inventory loss due to normal pump seal leakage. The reactor will be able to be maintained in cold shutdown for the duration of the event through natural circulation and water makeup. The Dam Accident Mitigation System (DAMS) will utilize the existing water in the Torus and later the flood water inside the Reactor Building to maintain the core cooling and SFP cooling functions throughout the upstream dam failure event.

3.2.6.2 Targeted Hazard Mitigation –Strategy Overview

In the MSA, the licensee stated that in the event of a significant dam breach and resulting inundation of the Missouri River valley/flood plain (with river levels expected up to the reevaluated hazard levels), a new temporary water makeup system will be provided in order to maintain the SFP and reactor cavity water level above the top of fuel in the SFP. This temporary water makeup system is referred to as the DAMS and is the key component in the THMS.

The licensee indicated that the DAMS has the capability to maintain core and SFP water levels for greater than 30 days without external water (other than water stored in the Torus) while plant recovery activities continue. This duration bounds the inundation and recession times for this flood event, as shown in Table 3.4-1.

3.2.6.3 Targeted Hazard Mitigation Strategy – Initial Site Conditions

In the MSA, the licensee specified that the upstream dam failure is considered the initiating event leading to a THMS response at the site. Prior to the initiating event, initial plant conditions were assumed to be that the reactor had been operating at Mode 1 (100% rated thermal power) for at least 100 days with the turbine generator tied to the grid, or had just been shut down from such a power history as required by plant procedures in advance of the impending event.
~~(CEII)~~ Based on the licensee's evaluation, [[redacted])]] is the approximate time needed for the floodwaters to reach the site.

The licensee's procedures will remove all ac and dc power from plant systems before the floodwaters reach Cooper. As part of the analysis, the licensee stated in the MSA that all design-basis installed sources of emergency on-site ac power and station blackout alternate ac-power sources are assumed to not be available or imminently recoverable. The licensee also stated that the station batteries and dc busses will be removed from service and not utilized.

~~(CEII)~~ Assuming that the loss of plant systems occurs approximately [[redacted]], the licensee estimated that the SFP and reactor cavity heat loading would be such that without shutdown cooling in service, the heat-up rate would be approximately 14.5 °F/hour, with a decreasing trend as the decay heat level drops. In order to eliminate and address uncertainty, the analysis assumed that the combined reactor cavity, SFP, and dryer/separator pit begins to boil when flood waters reach the site. Based on the above conditions, the licensee developed a response timeline to implement the THMS as described in the following Sections of this staff assessment.

3.2.6.4 Targeted Hazard Mitigation Strategy – Site Response Timeline

The licensee stated in the MSA that after an assessment of the initiating event and current plant conditions, the trigger points specified in procedure EDP-48 "Flood Hazard Re-Evaluation Interim Action Monitoring and Trigger Points" and notification of an upstream dam failure will direct the operators in the emergency response organization (ERO) to enter into site flooding emergency procedure "5.1FLOOD." Entry into procedure "5.1FLOOD" is expected to occur 1-hour after the initiating event. At this point, the ERO will be staffed and available for THMS implementation.

Procedure "5.1FLOOD" will direct entry into FLEX Support Guideline (FSG) 5.10FLEX.32, Dam Accident Mitigation System, which in turn will direct shutdown of the plant following Operating Procedure 2.1.4.1 "Rapid Shutdown"; and transition to Procedure 2.1.4 "Normal Shutdown." Disassembly and flooding of the reactor cavity will begin using Operating Procedure 2.1.20.3 "RPV Refueling Preparation (Wet Lift of Dryer and Separator)," and Maintenance Procedure 7.4DISSASEMBLY "Reactor Vessel Disassembly." In addition to the above activities, ERO personnel are also directed to begin delivery of a mobile crane needed in order to support the
~~(CEII)~~ THMS. The implementation of these shut-down activities is intended to bring the Cooper plant down to Mode 4, [[redacted]] All these activities would be performed prior to the flood waters causing an ELAP and loss of access to the ultimate heat sink.

~~(CEII)~~ Approximately [[redacted].]] In the MSA, the licensee stated that the DAMS equipment is to be deployed from an onsite commercial building and onto the rooftops of the Controlled Corridor and Control Building, as well as inside the Reactor Building. The DAMS installation and operation is governed by plant procedures. With the reactor and SFP cavities flooded and hydraulically connected, water from the suppression pool and within the Reactor Building will be utilized to provide makeup to compensate for boil-off. The Cooper site will utilize current flood emergency procedure "5.1FLOOD" for FLEX design-basis, beyond-design-basis, and current design basis flood events, including flood induced ELAP and LUHS in conjunction with FSG 5.10FLEX.32. This procedure will be initiated upon one of several triggers: (a) indication of river level of 895.37 ft. (895 ft. MSL), (b) notification of an upstream dam failure, (c) if river level is forecast to be 902.37 ft (902 ft. MSL) or greater within 36 hours, or (d) notification of an upstream emergency spillway gate opening. The NRC staff notes that in the event of a potential dam failure, a dam failure warning is issued to utilities by the USACE. NPPD site procedure EDP-48 provides guidance to communicate to the Control Room and initiate a plant shutdown per normal operating procedure when [[redacted].]] (CEII)

(CEII) Approximately [[redacted]] after the initiating event, the DAMS equipment is expected to be staged on the designated rooftops and within the Reactor Building. The licensee stated in the MSA that the majority of the components would be sufficiently cooled by outside air, or submerged in the Torus/floodwaters. The booster pumps will be cooled by ambient air, portable fans may also be utilized to increase outside air exchange with the Reactor Building and further reduce temperatures in areas that operators will frequent.

The completed assembly of the DAMS is expected to occur approximately [[redacted]] after the initiating event, followed by a testing period of 6 hours to ensure that the equipment is functional. The testing activities are governed by Engineering Report 2016-039 "Timing for Setup of Beyond-Design-Basis Flooding Equipment." Therefore, the site would be prepared for the predicted arrival of flood waters that reach the site approximately [[redacted]] after the initiating event. (CEII)

3.2.6.5 Targeted Hazard Mitigation Strategy – Operability of the Dam Accident Mitigation System

In general, the DAMS is comprised of two redundant trains, each of which contains a submersible pump, booster pump, and filter with the intended function of replenishing the water level in the reactor cavity and SFP in the event that a THMS is implemented. Specifically, the plant conditions needed for DAMS to be used as part of the THMS are:

- Reactor in Mode 5 with RPV head removed.
- The Dryer and Moisture Separator remain in the RPV.
- The reactor cavity and dryer separator pool are filled with water.
- The Fuel Pool gates are removed.
- Shutdown of all other plant systems, including all ac power sources.

After establishment of the above conditions, site procedures will control the implementation of the THMS in advance of the floodwaters arriving on-site. The licensee described in the MSA that the DAMS is comprised of the following equipment:

- One distribution panel located on the Controlled Corridor roof.
- One submersible pump starter and control panel for both pumps located on the Controlled Corridor roof.
- Two booster pump starter and control panels located on the Controlled Corridor roof.
- Two 175 kilo-watt (kW) FLEX diesel generators located on the Control Building roof or one 1000kW turbine diesel generator delivered from the NSRC.
- Portable 6 kW FLEX generators located on Controlled Corridor roof.
- Five 1600 gallon diesel fuel tanks located on the Control Building roof.
- Two submersible pumps; one located within the Torus and one located within the Torus Area.
- ~~(CEII)~~ Two mechanical filters located in the northwest corner on the [[redacted])]] elevation of the Reactor Building.
- Two 2x3-6, 5.75 in. impeller- 15 horse-power booster pumps located in the northwest corner on the [[redacted])]] elevation of the Reactor Building.
- One 2000 pound Davit Crane located on the 903.9 ft. (903.5 ft. MSL) elevation of the Reactor Building, near the Torus hatch.

Once DAMS has been installed, the core and SFP cooling can be accomplished with one of two available trains. However, the flooding procedure will direct operators to make dual hose runs and control either train as needed from the control panels on the Controlled Corridor rooftop.

~~(CEII)~~ The water to be used for both RPV and SFP boil-off makeup will come from water contained in the combined reactor cavity and SFP storage pools, a fully filled suppression pool, and flood water from within the Reactor Building. The licensee stated that the hose routing for both trains of the DAMS will begin at the individual submersible pumps in the Torus or Torus area, and will lead up to the 903.9 ft (903.5 ft. MSL) elevation northwest corner of the Reactor Building. The hose routing will continue up the northwest stairwell to [[redacted])]] elevation and provide the suction source for the booster pumps. The discharge of the booster pumps will then be routed through a filter and up the northwest stairwell to the [[redacted])]] elevation, where it will discharge within the combined SFP, reactor cavity, and dryer/separator pit volume. The hose routing is configured so that any leaks in the hosing will allow the water to be routed back to the Torus Area through the floor drain system.

With regard to the fuel needed to operate the DAMS equipment, the diesel fuel source (fuel tanks) will be placed on the rooftop of the Control Building and can supply up to 25 days of fuel for the operation of the DAMS before offsite refueling is needed. This is well beyond the 24 hours needed to coordinate and receive external resources from the NSRC. As a result, there is a reasonable amount of time to coordinate helicopter transport and provide SAFER equipment and additional diesel fuel to the fuel tanks on the rooftops.

~~(CEII)~~ Operators will be able to access the building roofs and the SFP refueling floor by ladder and scaffolding through the [[redacted])]] elevation of the Reactor Building ventilation louvers and northwest stairwell. A boat will be necessary for site access and relief personnel after the flooding inundates the Cooper site. The licensee stated that the boat to be used is stored on-site and is located in the parking lot north of the 345 kilo-volt (kv) yard.

The DAMS does not require any power from the site's distribution systems since the two 175 kW FLEX DGs on the Control Building roof (or, one 1000 kW turbine DG from NSRC) will

provide the power needed for the DAMS operation throughout the flood event. Ventilation for
(~~CEII~~) the DAMS booster pumps on the [[redacted]]] elevation of the Reactor Building will be provided by the ambient air, which will be influenced by the temperature of the combined reactor cavity and SFP, floodwater temperature, and outside air temperature. The Reactor Building roof hatch and various outside doors will be opened to create a chimney effect to reduce the temperature inside of the Reactor Building.

Finally, the licensee stated that DAMS equipment will be included in the Cooper Preventative Maintenance Program (similar to other FLEX equipment) in order to provide maintenance and testing, and assure that FLEX reliability is being achieved.

3.2.6.6 Targeted Hazard Mitigation Strategy – NRC Staff Evaluation

The NRC staff reviewed the licensee's proposed THMS in the Cooper MSA along with the guidance in Section G.4.4 of NEI 12-06, Revision 2. Based on the information provided, the
(~~CEII~~) NRC staff agrees that there is a sufficient amount of time [redacted])]] available prior to the arrival of floodwaters, which would allow the licensee to shut down the reactor and implement the THMS (which includes the DAMS) at the site, and thus ensure that core cooling and SFP cooling functions are maintained throughout the duration of the flood event. Because of the available time before the flood waters arrive, the NRC staff agrees that there is sufficient time to bring the necessary staff to the site and complete the disassembly of the containment and RPV, flood the reactor cavity, and configure the DAMS for operation.

During the audit process, the NRC staff reviewed the licensee's engineering report 2016-039, "Timing for Setup of Beyond Design Basis Flooding Equipment" in order to confirm the timing provisions of the installation of the DAMS equipment and that the hose runs and pump equipment are capable of supplying the water needed for RPV and SFP makeup as required from their locations throughout the flood event. The NRC staff did not identify any issues with the engineering report. The NRC staff also notes that the DAMS has redundant trains to support the core cooling and SFP makeup function even though only one train is needed. This provides reasonable assurance that the DAMS will be able to perform its intended function and is reasonably protected from the flood mechanism.

The NRC staff notes that the licensee has made provisions for supplying diesel fuel for the DAMS equipment and additional FLEX equipment (for equipment cooling and lighting) for up to 25 days throughout the flood event. The staff agrees that this fuel capacity provides considerable margin and flexibility before refueling from external fuel sources is needed. As part of its strategy, the licensee will establish communications with the NSRC for additional equipment and diesel fuel refueling by helicopter throughout the flood event, as needed.

The licensee also stated that additional validations of the THMS will be made in accordance with NEI 12-06, Revision 2, and the Cooper FLEX program document. The NRC staff notes that validations of the DAMS installation and testing, and potential for flooding procedural revisions described in the Cooper MSA may be subject to future NRC inspection.

Based on the above evaluation, the NRC staff concludes that the licensee's proposed THMS for the upstream dam failure is reasonable due to the ability of the DAMS to perform the core cooling and SFP makeup functions throughout the flood event. In addition, the redundancy of trains provides reasonable assurance that core cooling and SFP cooling will be achieved and maintained. The NRC staff also finds that the justification for the opening of containment to support the DAMS operation is acceptable due to the need to access the drywell to remove the RPV head in order to allow the reactor cavity to flood, and the need to open the Torus hatch in order to deploy the submersible pumps.

3.3 Evaluation of Associated Effects

The NRC staff reviewed the information provided in the licensee's FHRR and MSA regarding the associated effects (AE) parameters needed to perform the additional assessments of plant response for flood hazards not bounded by the CDB. The AE parameters not directly associated with water surface elevation are summarized in Table 3.3-1 and discussed below.

3.3.1 Local Intense Precipitation

For the LIP flood-causing mechanism, the licensee concluded in its MSA letter that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, and sediment loads, would induce minimal impacts to plant operations due to the low LIP water depths and velocities. They also concluded that other AEs, including sediment deposition and erosion, concurrent site conditions, and effects on groundwater intrusion are insignificant at the plant site. The licensee used the Hydrologic Engineering Center- River Analysis System (HEC-RAS) hydraulic model described in the FHRR to characterize the flooding from LIP.

The NRC staff reviewed the LIP modeling as part of reviewing the revised FHRR and concluded that the modeling approach used present-day methodologies and regulatory guidance (ADAMS Accession No. ML18051A652). Correspondingly, the staff determined that the licensee's assessment of the AE parameters for the LIP flood-causing mechanism are acceptable for use in the MSA.

In summary, the NRC staff determined that the licensee-provided AE parameters for the LIP flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.3.2 Streams and Rivers

For the rivers and stream flood-causing mechanism, the licensee stated in its MSA letter that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, and sediment loads, would induce negligible impacts to plant operations and flood barriers due to the shallow water depths, low velocities and negligible wave action. The NRC staff agrees with the licensee's evaluation and also concluded that other AEs, including sediment deposition and erosion, concurrent site conditions, and effects on groundwater intrusion, are insignificant at the plant site. The NRC staff also confirmed that the flood barriers are only subject to minimal flood-loading due to the shallow depths of flooding.

In summary, the NRC staff determined that the licensee-provided AE parameters for the Streams and Rivers flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with the guideline provided by Appendix G of NEI 12-06, Revision 2.

3.3.3 Failure of Dams and Onsite Water Control Structures

~~(CEII)~~ [[redacted].]] The staff reviewed the assumed size of the barge and found it to be reasonable for the size of the river. The licensee also concluded that other AEs, including sediment deposition and erosion, concurrent site conditions, and effects on groundwater intrusion are insignificant at the plant site.

The NRC staff reviewed the hydraulic models used by the licensee as part of the staff's FHRR review and found them to be acceptable (ADAMS Accession No. ML18051A652). The NRC staff also confirmed the parameter value used by the licensee for wind speed.[1] Additionally, the NRC staff reviewed the effects on groundwater intrusion, sediment deposition and erosion and found them to be minimal due to the low flood level.

In summary, the NRC staff determined that the licensee-provided AE parameters for the dam failure flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.3.4 Ice-Induced Flooding

For the Ice-induced flood-causing mechanism, the licensee stated in its MSA letter that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, and sediment loads are not applicable since the flood from this mechanism does not leave the river banks. The licensee also concluded that other AE, including sediment deposition and erosion, concurrent site conditions, and effects on groundwater intrusion are also not applicable for the same reason.

The NRC staff reviewed the hydraulic models used by the licensee as part of the staff's FHRR review and found them to be acceptable (ADAMS Accession No. ML18051A652). The NRC staff also confirmed that, based on the information provided, the site is not inundated and therefore the ice-induced flooding mechanism is not applicable.

In summary, the NRC staff determined that the licensee-provided AE parameters for the ice-induced flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

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[1] American National Standards Institute/American Nuclear Society 2.8, 1992, "Determining Design Basis Flooding at Power Reactor Sites."

3.3.5 Channel Migration and Diversion

For the Channel Migration and Diversion flood-causing mechanism, the licensee stated in its MSA letter that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, and sediment loads, sediment deposition and erosion, concurrent site conditions, and effects on groundwater intrusion are not applicable to plant operations since the Channel Migration and Diversion flood causing mechanism does not reach site grade.

The NRC staff reviewed the hazard analysis and agrees with the licensee that the Channel Migration and Diversion hazard mechanism does not reach site grade and therefore is not applicable.

In summary, the NRC staff determined that the licensee-provided AE parameters for the channel migration and diversion flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.4 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by the licensee in the FHRR and MSA 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 3.4-1 and discussed below.

3.4.1 Local Intense Precipitation

For the LIP flood-causing mechanism, the licensee stated in its MSA that the plant response to a LIP flood event does not credit warning time because no actions are required to protect the plant. The MSA states that there is no period of inundation for LIP due to the topography of the site which allows water to flow away quickly from the site. The licensee used the HEC-RAS hydraulic model described in the revised FHRR to characterize the flooding from LIP. The NRC staff reviewed the licensee's LIP model during its review of the revised FHRR. The NRC staff concluded that the licensee's modeling and the estimation of the FED parameters are acceptable for use in the MSA as they used present-day methodologies and applicable regulatory guidance (ADAMS Accession No. ML18051A652).

In summary, the NRC staff determined that the licensee-provided FED parameters for the LIP flood-causing mechanism are acceptable, and the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.4.2 Streams and Rivers

The licensee stated that trigger point for entering into flood protection procedures is a Missouri River Water Surface WSE of 895.4 ft. (895 ft. MSL). The first line of flood barriers would be constructed when the Missouri River WSE reaches 898.4 ft. (898 ft. MSL) or is forecast to be greater than elevation 902.4 ft. (902 ft. MSL) within 36 hrs. A second line of flood barriers will be constructed when the Missouri River WSE reaches 900.4 ft. (900 ft. MSL). The licensee stated in its MSA that the site would therefore not be inundated by the rivers and streams flood-causing mechanism, so the period of inundation is 0 hours. The bounding (shortest) warning time of 3 to 12 hours is based on a probable maximum precipitation (PMP) event occurring with an initial Missouri River WSE of 895.4 ft. (895 ft. MSL). In addition, the licensee stated in its MSA that the period of recession is 456 hours which reflects the amount of time needed for the floodwaters to recede from an elevation of 904 ft. (903.6 ft. MSL) to 895.4 ft. (895 ft. MSL).

The NRC staff reviewed the hydraulic models used by the licensee as part of its FHRR review and found them to be acceptable (ADAMS Accession No. ML18051A652). The NRC reviewed the FED parameters related to the Streams and Rivers flood-causing mechanism and found them to be acceptable as they are in agreement with those in the revised FHRR. The NRC staff also reviewed the parameter values and finds them to be reasonable based present-day methodologies.

In summary, the NRC staff determined that the licensee-provided FED parameters for the Streams and Rivers flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.4.3 Failure of Dams and Onsite Water Control Structures

(~~CEII~~) [[[redacted]).]]

(~~CEII~~) [[[redacted] .]]

The NRC staff reviewed the hydraulic models used by the licensee as part of the staff's FHRR review and found them to be acceptable (ADAMS Accession No. ML18051A652). The NRC staff reviewed the hazard parameters in the MSA and found them to be in agreement with those in the revised FHRR.

In summary, the NRC staff determined that the licensee-provided FED parameters for the Failure of Dams and Onsite Water Control Structures flood-causing mechanism are acceptable and that the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.4.4 Ice-Induced Flooding

The licensee stated in its MSA that the ice-induced flood-causing mechanism does not reach site grade and therefore the warning time, period of inundation, and recession period are not applicable.

The NRC staff reviewed the hydraulic models used by the licensee as part of the staff's FHRR review and found them to be acceptable (ADAMS Accession No. ML18051A652). The NRC staff agrees with the licensee that the ice-induced flood causing mechanism does not reach site grade and is therefore not applicable.

In summary, the NRC staff determined that the licensee-provided FED parameters for the ice-induced flood-causing mechanism are acceptable, and that the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

3.4.5 Channel Migration and Diversion

The licensee stated in its MSA that the channel migration and diversion flood-causing mechanism does not reach site grade and therefore the warning time, period of inundation, and recession period are not applicable.

The NRC staff reviewed the hazard analysis and agrees with the licensee that the channel migration and diversion flood-causing mechanism does not reach site grade and therefore the FED parameters are not applicable. In summary, the NRC staff determined that the licensee-provided FED parameters for the channel migration and diversion flooding flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with Appendix G of NEI 12-06, Revision 2.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Cooper MSA related to the original FLEX strategies, as evaluated against the reevaluated hazards described in Section 3.2 of this staff assessment, and found that the licensee has adequately assessed the mitigation strategies flood hazard for the reevaluated LIP, Streams and Rivers, ice-induced flooding, and channel migration/diversion flood events to determine that the FLEX strategy can be implemented as currently designed. The NRC staff made its determination based upon:

- The available physical margin between the expected interior flood levels and the key structures, systems of components or credited FLEX equipment;
- The short inundation period for the LIP event, which recedes from the Cooper site prior to the deployment of FLEX equipment;
- Temporary flood barriers being utilized for the Streams and Rivers PMF that can protect up to 906.4 ft.(906 ft. MSL);
- The Class 1 structures and FSB having a higher floor elevation than the revised maximum flood level for the ice-induced flood event;
- (~~CEII~~) [[redacted]]]

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, Streams and Rivers, ice-induced flooding, and channel migration/diversion, including AEs and FEDs, as described in NEI 12-06, Revision 2 and ISG-2012-01, Revision 1.

Further, the NRC staff concludes that the licensee's proposed THMS is appropriate for use in the dam failure flooding scenario. This determination is based on:

(~~CEII~~)
- Implementation of the THMS before flooding from an upstream dam failure reaches the Cooper site grade elevation, [[redacted]] after the initiating event (this includes putting the plant into Mode 5 with the drywell and RPV head removed, filling the reactor cavity, and deploying and configuring the DAMS equipment).

The NRC staff concludes that the licensee has demonstrated the ability to maintain or restore core cooling and spent fuel pool cooling capabilities for the entire event.

TABLE 3.3-1. ASSOCIATED EFFECTS PARAMETERS NOT DIRECTLY ASSOCIATED WITH TOTAL WATER HEIGHT FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB.[1]

Associated Effects Factor	Local Intense Precipitation	Streams and Rivers	Failure of Dams and Onsite Water Control Structures	Ice Induced (1)	Channel Migration / Diversion (1)
Hydrodynamic loading at plant grade	Minimal	Not Applicable. See Dam Failure	See Debris Loading	Not Applicable	Not Applicable
(CEII) Debris loading at plant grade	Minimal	Not Applicable. See Dam Failure	[[redacted])]]	Not Applicable	Not Applicable
Sediment loading at plant grade	Minimal	Not Applicable	Minimal	Not Applicable	Not Applicable
Sediment deposition and erosion		Not Applicable	Minimal	Not Applicable	Not Applicable
Concurrent Conditions, including adverse weather	Minimal	55 mph Wind	55 mph Wind	Normal Winter Flows	Not Applicable
Groundwater ingress	Minimal	Not Applicable	Minimal	Not Applicable	Not Applicable
Other pertinent factors (e.g., waterborne projectiles)	Minimal	Not Applicable. See Dam Failure	See debris load above	Not Applicable	Not Applicable

1. Information provided in the MSA.
2. AE parameters for Streams and Rivers, Ice induced flooding and channel migration or diversion flood-causing mechanisms are not applicable because they would not inundate the plant site.

Table 3.4-1. Flood Event Durations for Flood-Causing Mechanisms Not Bounded by the CDB

Flood-Causing Mechanism	Time Available for Preparation for Flood Event	Duration of Inundation of Site	Time for Water to Recede from Site
Local Intense Precipitation and Associated Drainage	Not Applicable (1)	Minimal	Minimal
Streams and Rivers	3-12 hours	Not Applicable	456 hours
(CEII) Failure of Dams and Onsite Water Control Structures	[[redacted]	[redacted]	[redacted]]]
Ice Induced Flooding (2)	Not Applicable	Not Applicable	Not Applicable
Channel Migration / Diversions (2)	Not Applicable	Not Applicable	Not Applicable

Source: Cooper revised MSA

1. The licensee has the option to use NEI guideline 15-05 "Warning Time for Local Precipitation Events" (ADAMS Accession No. ML115104A158) to estimate the warning time, if necessary, for flood preparation.
2. FED parameters for ice-induced flooding and channel migration or diversion flood-causing mechanisms are not applicable because they would not inundate the plant site.

SUBJECT: COOPER NUCLEAR STATION – FLOOD HAZARD MITIGATING STRATEGIES ASSESSMENT (CAC NO. MF7915; EPID L-2016-JLD-0007) DATED June 27, 2018

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RidsACRS_MailCTR Resource
RidsNroDsea Resource
RidsRgn4MailCenter Resource
EBowman, NRR
LKGibson, NRR
GArmstrong, NRR
TBrown, NRR
JUribe, NRR
PBamford, NRR

ADAMS Accession Nos.: Pkg ML18040A653; ML18040A654 (Enclosure - NON-PUBLIC); ML18045A052 (Cover Letter - PUBLIC)

OFFICE	NRR/DLP/PBMB/PM	NRR/DLP/PBMB/LA	NRR/DLP/PBEB/BC	OGC
NAME	LKGibson	SLent	TBrown	NLO (STurk)
DATE	2/15/18	2/14/18	2/16/18	5/ 29 /18
OFFICE	NRR/DLP/PBMB/PM	NRR/DLP/PBMB/BC (A)	NRR/DLP/PBMB/PM	
NAME	PBamford	BTitus	JUribe	
DATE	4/18/18	6/20 /18	6/27/18	

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