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

November 8, 2019

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 68321-0098

**SUBJECT: COOPER NUCLEAR STATION – STAFF ASSESSMENT OF FLOOD HAZARD
INTEGRATED ASSESSMENT (EPID NO. L-2018-JLD-0177)**

Dear Mr. Dent:

The purpose of this letter is to document the staff's evaluation of the Cooper Nuclear Station (CNS, Cooper) flooding integrated assessment (IA) which was submitted in response to the Fukushima Near-Term Task Force (NTTF) Recommendation 2.1 "Flooding." The U.S. Nuclear Regulatory Commission (NRC) has concluded that the results described in the CNS flooding IA and the staff's independent assessment support the NRC's determination that no further response or regulatory actions are required.

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the 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), 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 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). By letter dated February 3, 2015 (ADAMS Accession No. ML15041A523), Nebraska Public Power District (NPPD, the licensee) submitted its flood hazard reevaluation report (FHRR) for CNS. However, by letter dated September 29, 2016 (ADAMS Accession No. ML16279A421), the licensee submitted a revised FHRR, replacing in its entirety the February 3, 2015, submittal.

After reviewing the licensee's FHRR, the NRC staff issued by letter dated December 22, 2015 (ADAMS Accession No. ML15355A416) an interim staff response (ISR) letter to the licensee that provided a summary of its review of Cooper's reevaluated flood-causing mechanisms. The information in the ISR letter was based on the February 3, 2015, FHRR and identified information to be provided in a revision to the FHRR. The revised FHRR information was subsequently provided in the licensee's September 29, 2016, submittal. The NRC staff issued a

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staff assessment by letter dated June 1, 2018 (ADAMS Accession No. ML18054B428), which provided the documentation supporting the NRC staff's conclusions summarized based on its review of the licensee's FHRR submittals dated February 3, 2015, and September 29, 2016.

The information provided in the staff's June 1, 2018, staff assessment supersedes the information provided in the ISR letter. The June 1, 2018, staff assessment noted that the local intense precipitation (LIP), streams and rivers (without dam breach), ice-induced flooding, failure of dams, and channel migration/diversion flood-causing mechanisms at CNS are not bounded by the plant's current design basis, and, therefore, additional assessments of the flood hazard mechanisms are necessary. The staff notes that the June 1, 2018, letter contains an error regarding streams and rivers (without dam breach) being an unbounded mechanism. The same error was found in the flooding mitigation strategies assessment staff evaluation dated June 27, 2018 (ADAMS Accession No. ML18045A052). The streams and rivers (without dam breach) flooding mechanism is bounded by the licensee's current design basis and this letter documents the correction of this error.

By letter dated December 18, 2018 (ADAMS Accession No. ML18365A088), the licensee submitted its IA for CNS. By letter dated July 18, 2019 (ADAMS Accession No. ML19255G789), the licensee provided a revision to the December 18, 2018, IA. The IAs are intended for the NRC to assess the site's capability to cope with the reevaluated hazard and to determine if additional regulatory actions are necessary under the backfit regulation. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the CNS IA.

As set forth in the enclosed staff assessment, the NRC staff has concluded that the CNS IA was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), and consistent with the NRC staff endorsement of that guidance. Guidance document NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301).

The NRC staff has concluded that the licensee has demonstrated that effective flood protection, if appropriately implemented, exists for the LIP and ice-induced flooding mechanisms and that the site is reasonably protected against these flood scenarios.

In addition, the NRC staff has further concluded that, for failure of dams and channel diversion flood-causing mechanisms, the licensee has adequately evaluated the flood hazard using the guidance in NEI 16-05. This determination is primarily based on the following considerations:

1. The licensee has demonstrated to have comprehensive flood protection strategies for both "lower" and "higher" likelihood flooding scenarios.
2. The staff has inspected, audited, and reviewed, as appropriate, pertinent provisions of the licensee's flooding response strategy and found it acceptable.
3. For the "lower" likelihood (less frequent) flood scenario associated with dam failure, the licensee has demonstrated to have a feasible targeted hazard mitigation strategy that is maintained in accordance with the licensee's FLEX and the regulatory commitment programs.

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4. The maintenance and surveillance given to upstream dams, channels, and levees surrounding Cooper provide assurance about their reliability.
5. The frequency of dam failure is estimated to be below the threshold for further analysis per NEI 16-05.
6. The licensee has demonstrated that it has effective flood protection for the site under reevaluated river flood scenarios that do not involve a dam breach event.

Based on the above, the NRC staff concludes that no further regulatory actions are necessary. This closes out the licensee's response for CNS for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID No. L-2018-JLD-0177.

If you have any questions, please contact Milton Valentin at 301-415-2864, or by e-mail at Milton.Valentin@nrc.gov

Sincerely,

/RA/

Gregory F. Suber, Deputy Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No: 50-298

Enclosures:

1. Staff Assessment Related to the
.... Flooding Integrated Assessment for Cooper (non-public)
2. Staff Assessment Related to the
.... Flooding Integrated Assessment for Cooper (public)

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO THE INTEGRATED ASSESSMENT
FOR COOPER NUCLEAR STATION
AS A RESULT OF THE REEVALUATED FLOODING HAZARD
NEAR-TERM TASK FORCE RECOMMENDATION 2.1 - FLOODING
EPID NO. L-2018-JLD-0177

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), Section 50.54(f), hereafter referred to as the "50.54(f) letter." The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective 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). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's current licensing basis (CLB) flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter states that an integrated assessment (IA) should be submitted and described the information that the IA should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Project Directorate (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). Language in COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CLB. By letter dated September 1, 2015 (ADAMS Accession No. ML15174A257), the NRC informed all affected licensees of the plan to use a graded approach in addressing the reevaluated flood hazard.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), was issued by NEI to describe a method of applying a graded approach to address the reevaluated flood hazards. It has been endorsed by the NRC as an appropriate methodology for licensees to use in response to the 50.54(f) letter.

Enclosure 2

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The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). Therefore, NEI 16-05, Revision 1, as endorsed, describes acceptable methods for Cooper Nuclear Station (CNS, Cooper) to address their response to the reevaluated flood hazard mechanisms.

The NRC staff described how the licensee's assessment of reevaluated hazards would be reviewed to determine if further regulatory action should be taken, such as backfitting additional safety enhancements, in an internal memorandum dated September 21, 2016 (ADAMS Accession No. ML16237A103). This memorandum describes the formation of a Senior Management Review Panel (SMRP) consisting of division directors from the Office of Nuclear Reactor Regulation that are expected to reach a decision for each plant submitting an IA. The SMRP is supported by NRC technical staff who are responsible for consolidating relevant information and developing recommendations for the consideration of the panel. In presenting recommendations to the SMRP, the supporting technical staff is expected to recommend placement of each flooding IA plant into one of three groups:

- 1) **Group 1** will include plants for which available information indicates that further regulatory action is not warranted. For flooding hazards, Group 1 will include plants that have demonstrated (1) effective protection for severe flood hazards, and (2) that consequential flooding is expected to occur only for hazards with a sufficiently small mean annual frequency of exceedance.
- 2) **Group 2** will include plants for which further regulatory action should be considered under the NRC's backfit provisions. This group may include plants that are unable to protect against relatively frequent flood hazards such that the event frequency in combination with other factors result in a risk to public health and safety for which a regulatory action is expected to provide a substantial safety enhancement.
- 3) **Group 3** will include plants for which further regulatory action may be needed, but for which more thorough consideration of both qualitative and quantitative risk insights is needed before determining whether a formal backfit analysis is warranted.

The evaluation process performed to provide the basis for the staff's grouping recommendation to the SMRP for CNS is described below. Based on its evaluation, the staff recommended that CNS be classified as a **Group 1** plant and therefore, no further regulatory action is warranted.

2.0 BACKGROUND

This document provides the final NRC staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, this background section includes a summary description of the reevaluated flood information provided by the licensee and the associated assessments performed by the NRC staff. The reevaluated flood information includes: 1) the flood hazard reevaluation report (FHRR); 2) the flooding mitigation strategies assessment (MSA); and 3) the IA. Also, because the CLB for the site is important background information, a summary of the work done to complete the NTTF 2.3 flooding walkdown is provided.

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Flood Hazard Reevaluation Report

By letter dated February 3, 2015 (ADAMS Accession No. ML15041A523), Nebraska Public Power District (NPPD, the licensee), submitted its FHRR for CNS. After reviewing the licensee's FHRR, the NRC staff issued by letter dated December 22, 2015 (ADAMS Accession No. ML15355A416), an interim staff response (ISR) letter to the licensee that provided a summary of its review of Cooper's reevaluated flood-causing mechanisms. The information in the ISR letter was based on the February 3, 2015, FHRR and identified information to be provided in a revision to the FHRR. This information was subsequently provided in the licensee's September 29, 2016, submittal (ADAMS Accession No. ML16279A421).

The NRC staff issued a staff assessment by letter dated June 1, 2018 (ADAMS Accession No. ML18054B428), which provided the documentation supporting the NRC staff's conclusions summarized based on its review of the licensee's FHRR submittals dated February 3, 2015, and September 29, 2016. The information provided in the staff's June 1, 2018, staff assessment supersedes the information provided in the ISR letter. The June 1, 2018, staff assessment noted that the local intense precipitation (LIP), streams and rivers (without dam breach), ice-induced flooding, failure of dams, and channel migration/diversion flood-causing mechanisms at CNS are not bounded by the plant's current design basis, and, therefore, additional assessments of the flood hazard mechanisms are necessary. The staff notes that the June 1, 2018, letter contains an error regarding streams and rivers (without dam breach) being an unbounded mechanism. The streams and rivers (without dam breach) flooding mechanism is bounded by Cooper's CLB and this letter documents the correction of this error.

Mitigation Strategies Assessment

By letter dated December 12, 2017 (ADAMS Accession No. ML17355A142), the licensee submitted the CNS flooding MSA for review by the NRC staff. The MSAs were intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events that were put in place to meet NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events." The NRC staff's safety evaluation for the licensee's compliance plans for Order EA-12-049 was issued on September 20, 2017 (ADAMS Accession No. ML17226A032). By letter dated June 27, 2018 (ADAMS Accession No. ML18045A052), the NRC staff issued its evaluation of the CNS flooding MSA.

In SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events [MBDBE] (RIN 3150-AJ49)," (ADAMS Accession No. ML16291A186) provisions were proposed that would have required mitigation strategies to address the reevaluated flood hazard information on a generic basis. As reflected in the Affirmation Notice and Staff Requirements Memorandum (SRM) dated January 24, 2019 (ADAMS Accession No. ML19023A038), the Commission determined that sites addressing the reevaluated hazards on a generic basis was not needed for adequate protection of public health and safety but should instead be assessed on a plant-specific, case-by-case basis under the requirements of 10 CFR Section 50.109, "Backfitting," and Section 52.98, "Finality of combined licenses; information requests."

The Commission directed in the Affirmation Notice and SRM dated January 24, 2019, that the staff use the 50.54(f) process to ensure that the NRC and its licensees will take the needed actions, if any, to ensure there is no undue risk to public health and safety due to the potential effects of the reevaluated flood hazards. The SRM further directs that the staff should continue

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these efforts, utilizing existing agency processes to determine whether an operating power reactor license should be modified, suspended, or revoked in light of the reevaluated hazard.

In a letter dated August 20, 2019 (ADAMS Accession No. ML19067A247), the NRC staff provided a path forward to treat the reevaluation of flood hazards in light of the Commission's direction in the January 24, 2019 Affirmation Notice and SRM. The staff assessment documented in this letter was performed in accordance with the information in the August 20, 2019, staff letter including a plant-specific determination on whether additional regulatory actions are warranted to address the reevaluated hazard.

The licensee stated in its December 12, 2017, MSA that a targeted hazard mitigation strategy (THMS) was needed to address dam failures upstream from CNS. In this THMS, the licensee stated that containment would have to be opened as a preemptive strategy element, and therefore only reactor core make-up and spent fuel pool (SFP) cooling would be maintained or restored. This strategy was evaluated by the NRC staff and found appropriate for use, as documented in the MSA staff evaluation dated July 27, 2018. In the same MSA staff evaluation, the NRC staff concluded that the licensee demonstrated its capability to deploy the original FLEX strategies, as designed, for the rest of the unbounded flooding mechanisms. Following the conclusions of the FHRR staff assessment, the MSA staff evaluation treated the rivers and streams (without dam breach) flooding mechanism as unbounded, when in reality this mechanism is bounded by the CLB, as previously explained. This record serves as the correction for the MSA staff evaluation.

Integrated Assessment

By letter dated December 18, 2018 (ADAMS Accession No. ML18365A088), the licensee submitted its IA for CNS. By letter dated July 18, 2019 (ADAMS Accession No. ML19255G789), the licensee provided a revision to the December 18, 2018, IA. The IAs are intended for the NRC to assess the site's capability to cope with the reevaluated flood hazards and to determine if additional regulatory actions are necessary. These regulatory actions would be taken in accordance with 10 CFR 50.109, "Backfitting." To facilitate its review, the NRC staff issued an audit plan by letter dated July 18, 2017 (ADAMS Accession No. ML17192A452), stating its intention to review additional relevant information and supporting documentation, as needed.

Flooding Walkdowns

In addition to the assessments described above associated with the reevaluated hazards, the licensee also performed flooding walkdowns at the plant in response to Enclosure 4, "Recommendation 2.3: Flooding," to the 50.54(f) letter. In the Enclosure, licensees were requested to identify and address degraded, nonconforming, or unanalyzed conditions using the corrective action process, verify the adequacy of monitoring and maintenance procedures, and report the results to the NRC with regards to the CLB flood hazard levels for all flood-causing mechanisms, including groundwater ingress.

By letter dated November 27, 2012 (ADAMS Accession No. ML12333A319), NPPD submitted a flooding walkdown report for CNS in response to NTTF Recommendation 2.3. During the integrated inspection held the week of February 14, 2013, NRC inspectors had the opportunity to follow up on activities resulting from the flooding walkdown, as documented in Inspection Report 05000298/2012005 (ADAMS Accession No. ML13045A297). By letter dated

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June 24, 2014 (ADAMS Accession No. ML14149A146), the NRC staff issued a staff assessment documenting its evaluation of the walkdown report. In its assessment, the NRC staff concluded that NPPD responded appropriately to the requested information, and that no immediate safety concerns were identified. The results of the flooding walkdown activities at CNS are considered in this staff assessment.

3.0 TECHNICAL EVALUATION

Cooper has a General Electric boiling-water reactor (BWR) Model 4 with a Mark I containment. The site is located south-southeast from Omaha, NE, and north-northwest from Kansas City, KS. It is on the west bank of the Missouri River between the villages of Brownville and Nemaha, NE. Upstream from CNS, there are dams, levees, and river channels operated and maintained by the U.S. Army Corps of Engineers (USACE). These also form part of the Bank Stabilization and Navigation Project (BSNP). The licensee noted in the IA that the vertical datum used for this section was the CNS Plant Datum. The National Geodetic Vertical Datum of 1929 (NGVD29) elevation is equal to the CNS Plant Datum elevation plus 0.11 feet (ft). The North American Vertical Datum of 1988 (NAVD88) elevation is equal to NGVD29 elevation plus 0.26 ft. The NAVD88 elevation is equal to the CNS Plant Datum elevation plus 0.37 ft.

As stated in the IA, the general site grade elevation is 903.00 ft CNS Plant Datum (903.37 ft NAVD88) and the floor elevation for the CNS main building facilities is 903.50 ft (903.87 ft NAVD88). The IA, however, explains that flood protection is provided for these buildings (reactor building, emergency diesel generator building, radwaste building, augmented radwaste building, control building, controlled corridor, turbine building, turbine building exhaust room, boiler room, water treatment plant, tool crib, machine shop, and multi-purpose facility building) up to 906.00 ft CNS Plant Datum (906.37 ft NAVD88). Other elevations of interest are associated with the intake structure, which grade elevation varies from 902.0 ft (902.37 ft NAVD88) to 903.5 ft (903.87 ft NAVD88), and its floor elevation is also 903.5 ft CNS Plant Datum (903.87 ft NAVD88). The intake structure houses the service water pumps, which are located 4.5 ft above floor level and are protected by a 24-in-thick concrete wall up to 919.0 ft CNS Plant Datum (919.37 ft NAVD88). Also, west from the CNS site, there is a levee that provides flooding protection up to 902.0 ft CNS Plant Datum (902.37 ft NAVD88).

The CNS flooding CLB was exceeded for four mechanisms. Guidance document NEI 16-05, Revision 1, as endorsed, describes the different flood impact assessment paths. For LIP and ice-induced flooding, the licensee provided information to demonstrate that effective flood protection following NEI 16-05 Path 2. For failure of dams and onsite water control/storage structures flooding mechanisms, the licensee is pursuing Path 4, demonstrate effective mitigation. River channel migration or diversion is being treated as a consequence of dam failure.

3.1 Confirmation of the Flood Hazard Elevations

In the Closure Plan for Reevaluation of Flooding Hazards for Operating Nuclear Power Plants (ADAMS Accession No. ML15153A104), the staff clarified that, "...if a flooding hazard associated with a frequency of 10^{-4} per year cannot be defined in a timely and/or a technically defensible manner for a site...a surrogate (e.g., 10^{-3} plus a factor) consistent with the current state of practice may be developed to provide quantitative risk insights to augment the available qualitative risk insights." In its response, the Commission directed staff to, "...continue to look for additional opportunities to address any conservatism in the flood hazard evaluations and streamline the process..." (ADAMS Accession No. ML15209A682). Guidance in NEI 16-05

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states that a qualitative discussion utilizing appropriately justified generic studies and information should be provided if obtaining or collecting site-specific quantitative frequency information is not feasible.

Although, the licensee's IA submittal does not provide a flooding risk evaluation at CNS, the licensee refers to a number of evaluations completed by USACE (Non-Public). One of those evaluations provides a qualitative analysis of the frequency of floods associated with failure of the Missouri River dams upstream the CNS site. The NRC staff has reviewed this letter and found that the flood information discussed in the letter, when combined with the licensee's submittal, is suitable for use in the licensee's IA. Based upon the NRC staff review of the licensee's IA and the information provided by USACE, the staff finds that the licensee's submittal to be appropriate for use in this evaluation.

In its review of all flooding mechanisms, the NRC staff confirmed that the licensee's flood analysis in the IA submittal is identical to those submitted in the September 29, 2016, FHRR. The FHRR was reviewed and approved by the NRC staff in its assessment dated June 1, 2018. Based on staff's previous review and approval of the licensee's September 29, 2016, FHRR, the staff find that the flooding information provided in the IA submittal is acceptable for this evaluation.

3.2 Evaluation of Site Response, Available Physical Margin and Reliability of Flood Protection Features

Current Licensing Basis Flooding Response

The CNS Updated Safety Analysis Report describes the CLB floods, and the associated flood protection features for safety-related structures, systems, and components (SSCs). Based on that information, the licensee developed response procedures with actions for plant personnel to follow in the event of a flood. Plant features and response procedures were evaluated as part of the flooding walkdown activities and found to be appropriately maintained and capable of performing their intended function. Relevant information regarding plant response and protection features is summarized below:

- Passive flood protection by plant structures with floor elevation of 903.5 ft CNS Plant Datum (903.87 ft NAVD88).
- Added features like enhanced doors, seals, and temporary flood barriers to prevent water intrusion up to elevation 906.00 ft CNS Plant Datum (906.37 ft NAVD88).
- Completion of corrective actions associated with deficiencies identified during the flooding walkdown activities in response to NTTF Recommendation 2.3.
- Plant procedures (such as CNS Operations Manual, Emergency Procedure 5.1, "Flood," (or CNS Procedure 5.1, Non-Public) and CNS Maintenance Procedure 7.0.11, "Flood Control Barriers," Non-Public) with entry conditions for safe shutdown and to install temporary barriers if a flood were to occur at CNS.

The evaluation of these features and procedures is provided in the section "Reliability of Flood Protection Features."

Reevaluated Hazard Flooding Response

The CNS overall flood response plan for the reevaluated hazard includes activities from both the CLB response plan and the THMS. The THMS was previously evaluated as part of the NRC staff evaluation of the flooding MSA. The overall response plan provides instructions to monitor river levels and to respond accordingly to increasing water elevations with specific actions. Appendix C for NEI 16-05 provides guidelines for evaluating manual actions in external flood response strategies. Specifically, Section C.5 provides the following key elements to evaluate the adequacy of a flood response strategy:

- Establishing unambiguous procedural triggers
- Proceduralized and clear organizational response to a flood
- Developing a detailed flood response timeline
- Accounting for the expected environmental conditions
- Determining time and time margin availability

The NRC staff used these criteria to evaluate the adequacy of the CNS overall response strategy. As explained in the IA submittal, CNS Procedure 5.1 outlines the overall flood response strategy.

In evaluating the establishment of unambiguous procedural triggers, the NRC staff reviewed the entry conditions for implementing CNS Procedure 5.1. The licensee reported (in its IA) to have modified these entry conditions in May 2019 and provided the revisions in its submittal. The NRC staff reviewed the new entry conditions to conclude that the updated procedural triggers (or entry conditions) remain unambiguous.

To assess the remaining key elements, the NRC staff requested CNS Procedure 5.1 to be made available in an electronic reading room (or ePortal) for audit in accordance with the generic audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452). The licensee made available in its ePortal the version of the procedure effective on May 17, 2019. After reviewing the procedure, the NRC staff concluded that it meets the key elements for having a proceduralized and clear organizational response, having a detailed flood response timeline, accounting for the expected environmental conditions, and considering time available for implementation. A similar evaluation of CNS Procedure 5.1 was completed during the flooding walkdown activities, as documented in staff assessment dated June 24, 2014 (ADAMS Accession No. ML14149A146).

For the reevaluated dam failure event, the licensee proposed the THMS described in the licensee's flooding MSA submittal. The THMS was approved in the flooding MSA staff evaluation. Some of the key elements, such as time margins, operability, and validation of the THMS were evaluated and found acceptable in the flooding MSA staff evaluation dated June 27, 2018 (ADAMS Accession No. ML18045A052). The THMS implementation plan is documented in FLEX Support Guideline 5.10FLEX.32, Revision 2, "Dam Accident Mitigation System," dated May 17, 2019 (Non-Public). The staff requested Procedure 5.10FLEX.32 to be made available in the ePortal for audit. The NRC staff assessed the feasibility of the THMS given recent revisions of the response plans. A similar assessment was completed for CNS Procedure 7.0.11. Based on the information provided by the licensee, the NRC staff confirmed

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that the key elements for response adequacy remain satisfied for both CNS Procedures 5.1, 7.0.11, and 5.10FLEX.32.

The NRC staff also referred to the key elements in NEI 16-05 to evaluate a Path 4 approach. These elements include a detailed description of the strategy and equipment and/or actions required, a timeline of manual actions, an evaluation of equipment reliability per NEI 16-05 Appendix B, an evaluation of manual actions per NEI 16-05 Appendix C, and a discussion of the likelihood of flood severity associated with reaching and exceeding the consequential flooding conditions described in NEI 16-05 Section 6.3.2. After considering all the information provided by the licensee during the flooding walkdown activities, the review of the flooding MSA submittal, the information provided by the USACE, and the revisions made to the overall flooding response plan procedures; the NRC staff concludes that the Path 4 key elements are met and that the licensee's overall response plan (which includes the THMS) is feasible.

Available Physical Margin

The licensee provided, in its IA submittal, a comparison of the maximum water elevations estimated for each of the reevaluated flooding mechanisms against different protection features at CNS. This comparison was used by the NRC staff to determine if these protection features could be credited to maintain the key safety functions (core cooling, containment, and SFP makeup) during the LIP and ice-induced reevaluated flooding scenarios. A way to demonstrate adequate protection is to determine available physical margin (APM). Appendix B for NEI 16-05 provides guidance to determine the adequacy of APM. The guidance explains that APM adequacy is demonstrated differently for two types of features:

- Features engineered in the design basis or licensing basis as having a flood protection function.
- Features engineered for a purpose other than flood protection in the design basis or licensing basis but are now being credited in the flooding impact assessment process with this function when subject to the reevaluated flood hazard. Examples may include exterior doors or walls with protecting against a new LIP flood, security or vehicle barriers credited with dissipating wind-generated waves, etc.

The APM for a flood feature is the difference between the flood parameters expected to result in failure and the corresponding reevaluated flood parameters. The NRC staff used the guidance in NEI 16-05 Appendix B to evaluate the reliability for flood protection features that are credited as part of the CNS flood response strategy. As stated in the guidance: "For existing flood barriers that are being credited for higher flood levels, the purpose of this evaluation is to identify the specific flood parameters that exceed the current design and verify that the barrier will provide flooding protection."

Local Intense Precipitation

In its IA submittal, the licensee stated that it completed a simulation to quantify the effects of LIP over the CNS site. This flooding mechanism was not considered during the design of CNS. The licensee used the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) computer program to estimate the maximum water elevation and velocity associated with

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the LIP flooding mechanism. The maximum estimated water level was reported to be 903.5 ft CNS Plant Datum (903.87 ft NAVD88) and a maximum water velocity of 4.49 feet per second (fps). The licensee explained that this would be during the peak of the event, and that the simulation had conservative assumptions like having all site drainage clogged. It was also explained in the licensee's IA that there is potential for minor flooding at some building entrances during the peak of the LIP event but that inundation above the finished floor is not expected. This information was evaluated as part of the FHRR staff assessment.

The guidance in NEI 16-05 Appendix B states that the threshold for what constitutes "Adequate APM" for specific flood mechanisms can be established using appropriate method such as government standards. Per NEI 16-05, the USACE HEC-RAS program is an acceptable method to justify what constitutes adequate APM, which the licensee used to quantify the effects of the LIP at CNS. The guidance also states, as an APM example for consideration, that negligible or zero APM can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established. This would be the case for CNS given that the quantification of the LIP flood elevation is the same as the floor elevation. A conservatism used by the licensee was the assumption of clogged drainage, which is unlikely given frequent cleaning and maintenance provided by the licensee. For the case of the Z-Sump, which contains equipment essential to the operation of the Standby Gas Treatment System (SGTS) and must remain functional whenever secondary containment is required, the floor elevation is 891 ft CNS Plant Datum (891.37 ft NAVD88). The licensee explained that the Z-Sump will not be affected by flooding because the sump penetrations are sealed, and the proper functioning of the sump is monitored when flood levels reach the ground elevation of 890.0 ft CNS Plant Datum (890.37 ft NAVD88). This was observed during the flooding walkdown activities, as documented in the staff assessment dated June 24, 2014 (ADAMS Accession No. ML14149A146).

Given these criteria being met and based on the information provided by the licensee, the NRC staff concludes that the licensee has acceptably represented the effects of LIP and to have adequately quantified the APM. The NRC staff also concludes that the key safety functions should be adequately protected against LIP.

Ice-Induced Flooding

The licensee stated to have assessed the effects of ice-induced flooding at CNS. In its IA submittal, the licensee stated to have looked at the historical records of ice jams and ice dams to determine the most severe event near the site and to have calculated the peak water elevation after failure of that ice jam historic event. A maximum water elevation of 896.49 ft CNS Plant Datum (896.86 ft NAVD88) was estimated from upstream ice jam or ice dam breach. This information was evaluated as part of the FHRR staff assessment dated June 1, 2018 (ADAMS Accession No. ML18054B428). Given that the floor elevation for most safety-related buildings is 903.50 ft CNS Plant Datum (903.87 ft NAVD88), it is reasonable to conclude that there should be adequate APM (approximately 7.00 ft) to address a flood that could be generated from an ice jam or ice dam breach like the highest historical event in record, and that the key safety functions should remain adequately protected from this flooding mechanism.

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Reliability of Flood Protection Features

As mentioned before, several flood protection features are being credited to provide protection and effective mitigation from reevaluated flood elevations at CNS. Section B.2 of NEI 16-05 provide attributes and considerations to evaluate the reliability for specific flood features (both passive and active) that are credited in the overall flood response strategy. As stated in Section B.5, active flood protection features should be reviewed against the requirements in NEI 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," ADAMS Accession No. ML16005A625) Section 11.5 for maintenance and testing consideration as appropriate for the specific feature. Also, passive flood protection features should be evaluated for the appropriate maintenance and inspection regime based on site and industry standards relevant for those features.

Passive Protection Features

The licensee explained in its IA submittal that passive protection features such as temporary flood barriers, building exterior walls, doors, hatches, and penetration seals are credited to protect equipment relied for maintaining the key safety functions at CNS. During the flooding walkdown activities, the NRC staff was able to assess these flood barriers, as documented in the flooding walkdown staff assessment dated June 24, 2014. The NRC staff also confirmed that these are part of maintenance programs and that are subject of periodic inspection, which provides assurance regarding their reliability and effectiveness.

In its IA, the licensee stated that temporary flood barriers are designed for a flood water elevation of 906.00 ft CNS Plant Datum (906.37 ft NAVD88). To confirm this, the NRC staff requested CNS Procedure 7.0.11 for audit. In its procedure, the licensee explained the geometrical configuration of the barriers, including attachments to structural walls and floors. Based on that information, the NRC staff confirmed that the flood barriers should be able to provide adequate protection against floods up to 906 ft CNS Plant Datum (906.37 ft NAVD88).

The licensee stated, in its IA submittal, to have assessed the effects of channel migration and diversion at CNS. Portions of the Missouri River path, upstream from the CNS site, have been enhanced as part of the BSNP, which began over a 100 years ago. Since then, the Missouri River has been subject of monitoring and modifications for flood control and to preserve the BSNP. These modifications include the construction, operation, and maintenance of channels, levees, and dams. In its IA submittal, the licensee stated that the channels, levees, and dams are maintained by the USACE and that changes to the current maintenance procedures are unknown. The NRC staff believes that the maintenance provided by the USACE, and the oversight provided by the BSNP, provide assurance that these passive protection features are reliable and that these should prevent migration and diversion of the Missouri River. If failure of these channels, levees, or dams were to occur, the licensee should be able to implement its overall flood response procedure, which includes the THMS. The NRC staff evaluated the THMS in its MSA staff evaluation dated June 27, 2018 (ADAMS Accession No. ML18045A052). Additional information of the NRC staff evaluation of the THMS is provided in the following section "*Active Protection Features.*"

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Active Protection Features

The licensee has a THMS to address the possibility of a mayor flood associated with upstream dam failure. 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.

The DAMS consist of two redundant trains, each consisting of a submersible pump, booster pump, filter, necessary hosing and valves, diesel generator, and electrical distribution. The licensee explained that this equipment, except for the submersible pumps, will be positioned on building rooftops and floor elevations above the maximum predicted flood heights following dam failure. The purpose of the DAMS is to maintain water levels within the reactor cavity and SFP for an extended period. The DAMS was previously evaluated by the NRC staff, as documented in the MSA staff evaluation dated June 27, 2018 (ADAMS Accession No. ML18045A052). However, in Attachment 2 of the IA submittal, the licensee provided additional information regarding revised trigger points to pre-stage and deploy DAMS, revised preventive maintenance plans for the chopper and booster pumps, and a statement regarding changes made to CNS Procedure 5.1 and to the DAMS implementation procedure (CNS Procedure 5.10FLEX.32, Non-Public).

As stated above in the section for "Reevaluated Hazard Flood Response," the NRC staff assessed the adequacy of the procedural triggers in CNS Procedure 5.1 and found them to be adequate. Also in the above section, the NRC staff documented its evaluation of the changes made to CNS Procedure 5.1 to incorporate provisions associated with the DAMS. Regarding maintenance, the NRC staff referred to the guidance in Section 11.5 of NEI 12-06 to assess the maintenance proposed to the equipment needed for the DAMS. In its IA submittal, the licensee stated to have revised Engineering Change (EC) 18-002, Revision 3, "Dam Accident Mitigation System" (Non-Public), to include preventive maintenance plans for the chopper and booster pumps to include a 12-month frequency functional test and 36-month frequency performance test. The licensee attached EC 18-002 to its IA submittal for NRC staff review. After reviewing EC 18-002, the NRC staff confirmed these revisions and that there are clear indications for the maintenance of this equipment. Also, the NRC staff confirmed that the DAMS equipment is included in the Cooper Preventative Maintenance Program (like other FLEX equipment) to provide maintenance and testing, and to assure reliability of this equipment. These elements were also reviewed as part of the staff evaluation of the flooding MSA submittal. Storage of the DAMS equipment was also reviewed as part of the MSA staff evaluation and was found to be adequate. The MSA staff evaluation also states that the licensee should be able of installing DAMS before the flood waters reach the site, and that sufficient diesel fuel will be available to

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maintain or restore the reactor cavity and SFP levels during and after the dam failure flood event.

In EC 18-002, the licensee included an assessment of the structural capacity of the building roof structures where the DAMS will be staged and the loading effects of the crane that will be used for staging and concluded that the roofs will not fail under those loads. In its assessment, the NRC staff confirmed that the licensee considered adequate geometric and material properties for these structures. In addition, the building structures housing the reactor cavity and SFP should have enough margin to maintain its structural integrity under the anticipated flood levels associated with failure of upstream dams because water will enter the structures, which will reduce and balance hydrostatic pressures over the building walls. With the structural integrity maintained, the staff concludes that the THMS provide a reasonable approach to address the postulated flooding conditions associated with dam failure. Based on the above arguments and the information provided by the licensee, the NRC staff concludes that the THMS should be feasible and that the equipment used for it should be reliable.

3.3 Discussion of Likelihood of Flooding Events

The guidance in NEI 16-05 Section 8.1 states that, for a Path 4 evaluation, one of the key elements to include is a discussion of the likelihood of the flood severity associated with reaching and exceeding the consequential flooding conditions identified in NEI 16-05 Section 6.3.2. The guidance continues to explain that this discussion could include the development of a specific frequency for a flood greater than 10^{-4} per year or just demonstrating that the frequency of those flood conditions is estimated to be less than 10^{-4} per year. If obtaining or collecting site-specific quantitative frequency information is not feasible due to issues such as a lack of access to data (e.g., dam failures or combination of events) and/or lack of accepted methods, a qualitative discussion utilizing appropriately justified generic studies and information should be provided instead.

For the purposes of this evaluation and given the lack of a detailed quantitative analysis, the NRC staff is assuming as a "lower" frequency event any flood scenario with a frequency less than 10^{-4} per year. Consequently, a "higher" frequency flood scenario would be any event with a frequency above 10^{-4} per year. In addition, based on the information provided in the licensee's IA and other information gathered during the FHRR staff evaluation, the NRC staff is assuming that LIP, ice-induced flood, and streams and rivers (without dam breach) could have a frequency above 10^{-4} per year. Because channel diversion or migration is treated as a consequence of dam failures, its frequency is assumed to be equal or less than the estimated frequency for dam failure.

Because the Missouri River dams of interest are maintained by the USACE, the licensee referred to a qualitative evaluation completed by the USACE (Non-Public) regarding the frequency of dam failures upstream the CNS site. The USACE evaluation was made available for staff review, and a summary of the USACE evaluation was provided to the licensee by the NRC in a letter dated June 9, 2017 (ADAMS Accession No. ML17150A260). [REDACTED]

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[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

As described above, the staff concludes that the THMS provides a feasible flood protection strategy for the less frequent flood (i.e., flood frequencies lower than 1E-4 annual exceedance probability). Because the rivers and streams flooding (non-dam breach) flood mechanism and

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[REDACTED],] the staff concludes that the licensee has effective flood protection since the reevaluated flood associated with rivers and streams is below Cooper's CLB flood elevations.

Therefore, the staff concludes that the licensee meets the NEI 16-05, Revision 1 guidance, as endorsed, for having a feasible flood protection strategy for less frequent unbounded flood mechanisms and an effective mitigation strategy for the less frequent dam failure flood mechanism. For unbounded flood mechanisms other than the dam failure flood mechanism, the staff concludes that the licensee has effective flood protection. Therefore, the staff concludes that further regulatory action in response to the flood hazard reevaluation is not warranted.

3.4 Staff Determination for the 50.54(f) Phase 2 Regulatory Decisionmaking Process

The NRC staff reviewed the licensee's IA submittal, and other available information, to determine if further regulatory actions should be taken, such as backfitting additional safety enhancements, as described in the internal memorandum dated September 21, 2016. After its evaluation of the information provided by the licensee to address the flooding mechanisms associated with failure of upstream dams and channel migration or diversion, the NRC staff has concluded that:

1. The licensee has demonstrated to have a feasible THMS. This strategy relies on anticipatory actions taken well in advance of flood waters reaching the site, such as performing shutdown and cooldown procedures, opening of doors to equalize water pressures, installing the DAMS to provide reactor core and SFP makeup, and the availability of additional offsite equipment, as needed.
2. The staff has inspected, audited, and reviewed, as appropriate, pertinent provisions of the licensee's strategy and found it acceptable.
3. The information provided by the USACE indicates that the failure probability of dams upstream the CNS site is sufficiently low, and the staff's conclusion is that the low failure probability will not meet the threshold for pursuing additional analysis or regulatory actions.
4. The maintenance and surveillance provided by the USACE and the BNSP to dams, channels, and levees upstream CNS provide assurance regarding their reliability and capacity to perform their function.

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Based on these statements, the NRC staff recommends that no additional regulatory actions are warranted for addressing the reevaluated dam failure flood hazard and recommends Cooper to be classified as a **Group 1** plant.

4.0 SENIOR MANAGEMENT REVIEW PANEL

In accordance with the September 21, 2016, memo described above, the technical team met with the SMRP and presented the results of the review including the recommendation that CNS be treated as a Group 1 plant. The staff noted, and the SMRP agreed, that the LIP and ice-induced flood hazards were outside the scope of the SMRP decision because in accordance with NEI 16-05, Revision 1, as endorsed, only Path 4 and 5 hazards are subject to an SMRP review. Because the LIP and ice-induced flooding mechanisms were evaluated using the Path 2 process, an SMRP decision for the treatment of those hazards was not necessary. The SMRP members asked questions and provided input to the technical team related to the Path 4 flood hazards (dam failure and channel migration or diversion). The SMRP approved the staff's recommendation that CNS should be classified as a **Group 1** plant, meaning that no further response or regulatory action is required.

5.0 AUDIT REPORT

The NRC staff previously issued a generic audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452), that described the NRC staff's intention to conduct audits related to IAs and issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's IA. The NRC staff activities have been limited to performing the reviews described above. Because this staff assessment appropriately summarizes the results of those reviews, the NRC staff concludes that a separate audit report is not necessary, and that this document serves as the final audit report described in the July 18, 2017, letter.

6.0 REGULATORY COMMITMENT

In a letter dated October 17, 2018 (ADAMS Accession No. ML19295F432), the licensee stated that the THMS will be maintained as regulatory commitment No. NLS2019042-01. With regards to regulatory commitments, the NRC staff notes that NEI 99-04 "Guidelines for Managing NRC Commitments" (ADAMS Accession No. ML003680088), as endorsed by the NRC in SECY-00-0045 "Acceptance of NEI 99-04, "Guidelines for Managing NRC Commitments"" (ADAMS Accession No. ML003679799), provides an acceptable method to manage commitments. If the licensee were to change this regulatory commitment, the staff would expect to be informed in accordance with the process outlined in NEI 99-04, as endorsed by the NRC. If the commitment were to be changed, the staff may revisit its conclusion that no additional regulatory action is warranted.

7.0 CONCLUSION

The NRC staff concludes that the CNS IA was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), with the clarifications provided in the NRC's endorsement document, JLD-ISG-2016-01, "Guidance for Activities Related to

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Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation” (ADAMS Accession No. ML16162A301).

For LIP and ice-induced flooding, the NRC staff has concluded that the licensee has demonstrated that effective flood protection exists and that the site is reasonably protected against these flood hazards. For failure of dams and channel migration or diversion, the licensee has effective flood protection for the higher frequency event and a feasible flood protection strategy for the lower frequency event, if appropriately implemented.

In addition, the NRC staff concludes that the probability of dam failure is sufficiently low and that it does not meet the criteria for pursuing additional response or actions from the CNS licensee. As such, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, no additional regulatory actions or responses associated with the reevaluated flood hazard are warranted. The staff further concludes that the licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

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HAZARD INTEGRATED ASSESSMENT DATE: NOVEMBER 8, 2019

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**ADAMS Accession Nos. Pkg ML19262G752, Letter ML19262G863 (non-public);
Letter ML19262G904 (Public)**

*concurring via email

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