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

April 13, 2017

Mr. Scott D. Northard
Vice President
Northern States Power Company - Minnesota
Prairie Island Nuclear Generating Plant
1717 Wakonade Drive East
Welch, MN 55089-9642

SUBJECT: PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7964 AND MF7965)

Dear Mr. Northard:

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

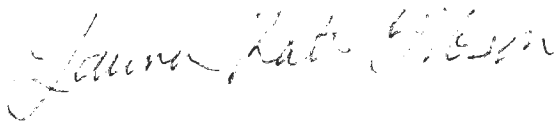
Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the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

By letter dated December 13, 2016 (ADAMS Accession No. ML16351A212), Northern States Power Company, a Minnesota Corporation (NSPM, the licensee), doing business as Xcel Energy, submitted the Prairie Island mitigating strategies assessment (MSA) for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Prairie Island MSA.

The NRC staff has concluded that the Prairie Island MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, and that the licensee has demonstrated that the mitigation strategies are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC Nos. MF7964 and MF7965.

If you have any questions, please contact me at 301-415-1056 or at Lauren.Gibson@nrc.gov.

Sincerely,



Lauren K. Gibson, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the Mitigating Strategies for Prairie Island

Docket Nos. 50-282 and 50-306

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO MITIGATION STRATEGIES FOR

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM

TASK FORCE RECOMMENDATION 2.1- FLOODING CAC NOS. MF7964 ABD MF7965

1.0 INTRODUCTION

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

Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit to the NRC for review a final integrated plan that describes how compliance with the requirements of Attachment 2 of the order was achieved. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis (CLB) flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of flood hazards. The NRC staff described this issue and provided recommendations to the Commission on integrating these related activities in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flood Hazards," dated November 21, 2014 (ADAMS Accession No. ML14309A256). The Commission issued a staff requirements memorandum on March 30, 2015 (ADAMS Accession No. ML15089A236), affirming that the Commission expects licensees for operating nuclear power plants to address the reevaluated flood hazards, which are considered beyond-design-basis external events, within their mitigating strategies. Nuclear Energy Institute (NEI) 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625), has been endorsed by

the NRC as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated flood hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 2, and Appendix G in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. The NRC's endorsement of NEI 12-06, including exceptions, clarifications, and additions, is described in NRC Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163). Therefore, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Prairie Island Nuclear Generating Plant, Units 1 and 2 (Prairie Island) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated May 9, 2016 (ADAMS Accession No. ML16133A030), as supplemented by letter dated September 29, 2016 (ADAMS Accession No. ML16273A556), Northern States Power Company, a Minnesota Corporation (NSPM, the licensee), doing business as Xcel Energy, submitted its flood hazard reevaluation report (FHRR) for Prairie Island. By letter dated October 17, 2016 (ADAMS Accession No. ML16248A005), the NRC issued an interim staff response (ISR) letter for Prairie Island. The ISR provided the reevaluated flood hazard mechanisms that exceed the current design basis (CDB) for Prairie Island and flood parameters that are suitable input for the mitigating strategies assessment (MSA). For Prairie Island, the only mechanism listed as not bounded by the CDB in the ISR is local intense precipitation (LIP). By letter dated December 13, 2016 (ADAMS Accession No. ML16351A212), NSPM submitted the Prairie Island MSA for review by the NRC staff.

3.0 TECHNICAL EVALUATION

3.1 Prairie Island's FLEX Strategies

Prairie Island's FLEX strategy is described in the document, "Final Integrated Plan (FIP) Beyond Design Basis FLEX Mitigation Strategies," Prairie Island Nuclear Generating Plant, Units 1 and 2, which was submitted by letter dated December 13, 2016 (ADAMS Accession No ML16351A208). The NRC staff is evaluating the strategies in the plan and will document the review in a safety evaluation. The purpose of the safety evaluation is to ensure the licensee has developed guidance and proposed designs that, if implemented appropriately, will adequately address the requirements of Order EA-12-049. An inspection will confirm compliance with the order.

The licensee specified a particular strategy, which includes prestaging FLEX equipment, for the probable maximum flood (PMF). The licensee also addressed the reevaluated flood hazard for LIP and determined that the amount of internal flooding would be bounded by the internal flooding analysis for the affected area. However, although PMF elevations exceed the LIP elevations as stated in the FHRR, further analysis in the MSA was necessary due to the absence of warning time and therefore the inability to take certain measures as discussed in the strategy for the PMF. This will be discussed in Section 3.2. The license stated in its MSA that its existing, non-PMF FLEX strategy can be successfully implemented and deployed as designed for LIP.

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

- For Phase 1, reactor core cooling occurs by removing the decay heat by releasing steam through the steam generator power-operated relief valves (PORVs) or main steam safety valve (MSSV) on the steam generators while providing makeup to the steam generators from the turbine drive auxiliary feedwater pump. The normal source of makeup water is the Condensate Storage Tank (CST), of which the site has three cross-connected tanks. The backup makeup source is from the Mississippi River through the cooling water system. Meanwhile, the RCS will be cooled and depressurized. Makeup water for the RCS will be provided from refueling water storage tank (RWST), although it is not needed in order to prevent reflux cooling until 32 hours after the event.

  Essential instrumentation is powered from the inverters, which are powered by the safeguard batteries. The load shedding is accomplished within 90 minutes of event initiation to extend the battery capacity. After load shedding, the installed batteries can maintain the necessary voltage for 11.5 hours.

- For Phase 2, Prairie Island relies on components that include FLEX 480- volt alternating current (VAC) portable diesel generators. The equipment is stored in a FLEX storage building.

  The licensee will continue to cool the reactor by releasing steam through the PORVS or MSSVs. Should the CSTs be lost, the TDAFWPs would trip on low suction, and an operator would need to take manual action to realign the suction to the cooling water system diesel driven cooling pumps (DDCLP). The two DDCLPs each have their own fuel oil day tank, which would need to be replenished. A portable FLEX generator would power the fuel oil transfer pump which would then transfer oil from the fuel oil storage tank. A portable FLEX steam generator/spent fuel pool pump may be used as a backup to a TDAFWP.

  Reactor coolant system (RCS) makeup and boron addition will begin within 32 hours of the event. The RCS makeup will be from the refueling water storage tank.

  The power to the essential instrumentation will be maintained by connecting a 480 VAC portable diesel generator to a battery charger. This can be accomplished within the battery life of 11.5 hours.

- For Phase 3, the equipment from the National SAFER [Strategic Alliance of FLEX Emergency Response] Response Center (NSRC) will be transported the site. In particular, the SAFER 4 kV turbine generators will be used to repower a safeguard bus on each unit.

3.2 Evaluation of Flood Protection Features

The LIP was the only flooding mechanism in the FHRR that was not bounded by the CDB. The licensee does not have a current design basis for LIP. The maximum elevation for LIP is below the maximum elevation for the design-basis PMF. However, LIP can occur without a warning time, while a PMF may develop over days. Therefore, the strategies to address them are different.

Further evaluation of the local intense precipitation follows below.

LIP Flood

In the MSA, Section 4 describes the maximum elevation from LIP as 695.4 ft National Geodetic Vertical Datum of 1929 (NGVD29). As stated in the FIP, the maximum predicted flood water level for rivers and streams is 703.6 ft stillwater elevation and 706.7 ft. NGVD29 with wave runup. Finished site grade elevation is 695 ft. LIP therefore exceeds the site grade, and some flooding is expected, but the elevation is less than the licensee is required to handle by their CDB PMF. However, the timing is different. The licensee would not be able to prestage the necessary FLEX equipment, nor, in the case of the Phase 3 equipment, even acquire it before there is flooding on site. The licensee would also not have the opportunity to install bulkheads or seal flood doors. Instead of using the PMF FLEX strategy, the licensee would use the general FLEX strategy as described in the FIP and in Table 3.3-1 of the MSA, with slight variations. The licensee examined the effect of the LIP on internal flooding near structures, systems, and components (SSCs) necessary for FLEX, the potential for flooding of the Fuel Oil Tank vaults, the impact on the FLEX Storage Building, and how the general FLEX timeline would be affected.

Internal Flooding

Water could potentially intrude into the turbine building, the auxiliary building, and the D5/D6 building. In the case of the turbine building, the water would collect in the condenser and sump pit, resulting in a flooding elevation that is less than the elevation of the "SSCs important to safety" (the licensee's term). The predicted interior flooding elevation for LIP in the auxillary building is also lower than the SSCs important to safety. The SSCs important to safety are also not affected in the D5/D6 building since the maximum allowable inleakage during an external flood is greater than that expected during LIP. The NRC agrees that, due to the available physical margin (the difference between the expected flood level in the building and the location of the SSCs important to safety as described by the licensee), the SSCs important to safety in the turbine, auxiliary, or D5/D6 buildings would not be affected.

Flooding of the Fuel Oil Tanks

During a LIP, the licensee would not have the opportunity to install blank flanges on the tank overflow lines. The fuel oil tank vaults are located below grade and are accessed through watertight covers. The blank flanges would be an additional protective measure. The licensee states that, "given the heavy duty watertight design of the vault covers, the relatively short time period of the LIP, and the relatively small head of water above the vault covers, it is reasonable to conclude that potential inleakage [to the vault] would be small and not enter the fuel oil tanks." The NRC also finds this reasonable.

FLEX Building and Deployment Path

As described in the FIP, the FLEX building is not designed to withstand the CDB PMF. Therefore, the licensee's strategy for the PMF depends on warning time and prestaging equipment. For a LIP, however, the expected elevation at the FLEX building is to be approximately 692.5 ft, which is below the finished floor elevation of the FLEX building. The deployment path in the vicinity of the building is also above (between 694 and 695 ft.) the maximum water surface elevation. The NRC agrees that although the FLEX building is not designed to withstand the CDB PMF, it would not be affected during LIP.

The deployment paths in the vicinity would also not be affected.

Variations on the FLEX Timeline

In its MSA, the licensee noted that the LIP reevaluated hazard was compared to the FLEX strategies as described in Table. 3.3-1 rather than to the PMF-specific strategies. Compared to Table 3.3-1, certain actions may be delayed due to the flooding conditions and other actions may not be needed.

The operator is expected to reduce the cooling water (CL) system flow rate in order to extend the available time that the DDCLP could draw fuel oil from the Day Tank. This is done by reducing the speed on the running DDCLP. The timeline in Table 3.3-1 states that the speed must be reduced within two hours. Due to the expected precipitation rate during a LIP, it may be difficult for the operator to travel from the turbine building to the screenhouse to perform this action during the first hour. However, the operator may wait an hour to begin the process and would still complete it within 2 hours. This delay would not have an impact on the same operator's subsequent actions, since it is expected it will not be necessary to clear downed powerlines during a LIP, which is the next action for that same operator.

Debris removal may also be delayed due to the rate of precipitation during the first hour. The licensee asserts that the debris expected from a LIP would be significantly less than that from other external hazards, such as a tornado. Furthermore, internal debris is not expected to be created during a LIP. Therefore, even with the delay, the debris removal is expected to be completed no later than 3 hours after the initial event.

Since all necessary actions will be completed during the time constraint identified in Table 3.3-1, the NRC staff finds that these delays do not constitute a modification to the FLEX strategy.

Conclusion

The NRC staff reviewed the licensee's assessment of the reevaluated LIP event as compared to the existing FLEX strategies in the Prairie Island FIP. The NRC staff finds the licensee has adequately assessed the MFSHI for the LIP flood event and that the applicable FLEX strategies can be implemented as described in the FIP.

. The NRC staff made its determination based upon:

- The available physical margin between the expected interior flood levels and the key SSCs or credited FLEX equipment;

- The fuel oil tanks are less likely to be flooded during a LIP that during a PMF (without licensee actions beforehand) due to the watertight covers and the short duration of the LIP; and

- Actions that may be delayed by the precipitation rate during the first hour would still be able to be completed within the time constraint.

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to deploy FLEX strategies, against a postulated beyond-design-basis event for the above flood events, as described in Appendix G of NEI 12-06, Revision 2 and ISG-2012-01, Revision 1.

3.3 Confirmation of the Flood Hazard Elevations in the MSA

The NRC staff reviewed the flood hazard elevations in the MSA, and confirmed the elevations match values in the site's ISR.

3.4 Evaluation of Flood Event Duration

The staff reviewed information provided by the licensee in its FHRR and MSA regarding the flood event duration (FED) parameters needed to perform the MSA for flood hazards not bounded by the CDB at the Prairie Island. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 3.4.

The licensee states in its MSA that warning time is not credited (not applicable) in the flood protection strategy for LIP flood-causing mechanism since only permanent/passive flood protection measures are relied on, and therefore, was not considered as part of the MSA. The staff notes that this approach is consistent with guidance provided by Appendix G of NEI 12-06, Revision 2. The staff notes the licensee also has the option to use NEI 15-05, "Warning Time for Local Intense Precipitation Events," Revision 6 (ADAMS Accession No. ML15104A158) to estimate warning time (as needed) for further analyses.

The maximum water surface elevations (WSEs) generated during the LIP event were reported at multiple locations within the Prairie Island powerblock; those locations and their corresponding WSEs are described in Table 6.1-2 of the ISR. In its MSA, the licensee reported that the period of inundation is about 1.1 hrs. The time necessary for LIP-related flood waters to recede from the Prairie Island site is 5.4 hrs. The NRC staff confirmed these FED parameters by reviewing the licensee-provided LIP model input and output files. Based on this review, the staff determined that the licensee's FED parameters for LIP are reasonable and acceptable for use in the MSA.

3.5 Evaluation of Flood Associated Effects

The staff reviewed the information provided by the licensee in its FHRR and MSA regarding associated effects (AE) parameters for flood hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by staff, and were transmitted to the licensee via the ISR. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.5.

For the LIP flood-causing mechanism, the licensee stated in its FHRR and MSA that the associated effects, including hydrodynamic and debris loads, erosion and sedimentation, groundwater, concurrent site conditions, and other effects, are not applicable or minimal due to the relative low flow velocities and depths for this flood event and limited sources of debris and sediment exist within the power block area. The staff confirmed this statement by reviewing the licensee-provided LIP model input and output files. The staff found that the estimated inundation depths and flow velocities presented in the FHRR are reasonable and acceptable for use in the MSA. The staff reviewed the potential for debris load at the Prairie Island site and concluded that, under the LIP conditions, significant debris is not expected to be generated. The staff agrees with the licensee's conclusion that the AE parameters for LIP are either minimal or will have no impact on the safety-related plant facilities.

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

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Prairie Island MSA related to the FLEX strategies, as evaluated against the reevaluated hazard described in Section 2 of this staff assessment, and found that:

- The FLEX strategies are not affected by the impacts of the ISR flood levels (including impacts due to the environmental conditions created by the ISR flood levels);

- The deployment of the FLEX strategies, as described in the FIP (which is under review by the NRC staff) and subject to subsequent inspection, is not affected by the impacts of the ISR flood levels; and

- Associated effects and FED are reasonable and acceptable for use in the Prairie Island MSA, and have been appropriately considered in the MSA.

Therefore, the NRC staff concludes that the licensee has followed the guidance in Appendix G of NEI 12-06, Revision 2, and demonstrated the capability to deploy the original FLEX strategies, as designed, against a postulated beyond-design-basis event for LIP, including associated effects and flood event duration.

Table 3.4 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 (or use NEI 15-05 (NEI, 2015) as needed)	≈ 1.1 hrs (1)	≈ 5.4 hrs (1)
(1) MSA			

TABLE 3.5. ASSOCIATED EFFECTS PARAMETERS NOT DIRECTLY ASSOCIATED WITH TOTAL WATER HEIGHT FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB

	FLOODING MECHANISM
Associated Effects Parameter	**LOCAL INTENSE PRECIPITATION**
Hydrodynamic loading at plant grade	Minimal
Debris loading at plant grade	Minimal
Sediment loading at plant grade	Minimal
Sediment deposition and erosion	Minimal
Concurrent conditions, including adverse weather	Minimal
Groundwater ingress	Minimal
Other pertinent factors (e.g., waterborne projectiles)	Minimal

Source: MSA

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED APRIL 13, 2017

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NAME	LKGibson	SLent	PBamford	CCook
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