



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

April 18, 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: NUCLEAR REGULATORY COMMISSION REPORT FOR THE AUDIT OF
NORTHERN STATES POWER COMPANY'S FLOOD HAZARD
REEVALUATION REPORT SUBMITTAL RELATING TO THE NEAR-TERM
TASK FORCE RECOMMENDATION 2.1-FLOODING FOR PRAIRIE ISLAND
NUCLEAR GENERATING PLANT, UNITS 1 AND 2 (CAC NOS. MF7710 AND
MF7711))**

Dear Mr. Northard:

The purpose of this letter is to provide you with the final audit report which summarizes and documents the U.S. Nuclear Regulatory Commission's (NRC's) regulatory audit of the Flood Hazard Reevaluation Report (FHRR) submitted by Northern States Power Company, a Minnesota corporation (NSPM, the licensee), doing business as Xcel Energy, related to Prairie Island Nuclear Generating Plant (Prairie Island). The FHRR was submitted as part of implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear plant. Specifically, the FHRR documents the results of the flood hazard reevaluation being completed as part of NRC Near-Term Task Force Recommendation 2.1.

By letter dated June 7, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16152A126), the NRC informed you of the staff's plan to conduct a regulatory audit of NSPM's FHRR submittal for Prairie Island. The audit was intended to support the NRC staff's review of the licensee's FHRR and the subsequent issuance of a staff assessment documenting the staff's review. The audit was conducted remotely during the months of June 2016 – March 2017, with a teleconference on August 18, 2016. The audit was performed consistent with NRC Office of Nuclear Reactor Regulation Office Instruction LIC-111, "Regulatory Audits," dated December 29, 2008 (ADAMS Accession No. ML082900195). The details of the audit were discussed with Ms. Lynne Gunderson of your staff.

S. Northard

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

Sincerely,

A handwritten signature in black ink, appearing to read "Lauren K. Gibson" with a stylized flourish at the end.

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

Docket Nos. 50-282 and 50-306

Enclosure:
Audit Report

cc w/encl: Distribution via Listserv



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

AUDIT REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOR THE AUDIT OF NORTHERN STATES POWER COMPANY'S

FLOOD HAZARD REEVALUATION REPORT

SUBMITTAL RELATING TO THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1-

FLOODING FOR PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

DOCKET NO. 50-282 AND 50-306

BACKGROUND AND AUDIT BASIS

By letter dated March 12, 2012, 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 report. Recommendation 2.1 in that document recommended that the NRC staff issue orders to all licensees to reevaluate seismic and flooding hazards for their sites using current NRC requirements and guidance. Subsequent staff requirements memoranda associated with SECY-11-0124 and SECY-11-0137 instructed the NRC staff address this recommendation through the issuance of requests for information to licensees pursuant to 10 CFR 50.54(f).

By letter dated May 9, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16133A041), 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 Nuclear Generating Plant, Units 1 and 2 (Prairie Island). The NRC is in the process of reviewing the aforementioned submittals and has completed a regulatory audit of NSPM to inform the licensee of its review of the submittals, identify any similarities/differences with past work completed, and ultimately aid in its review of licensees' FHRR. This audit summary is being completed in accordance with the guidance set forth in NRC Office of Nuclear Reactor Regulation Office Instruction LIC-111, "Regulatory Audits," dated December 29, 2008 (ADAMS Accession No. ML082900195).

AUDIT LOCATION AND DATES

The audit was completed by document review via electronic reading room (ERR) and a teleconference held on August 18, 2016. A closeout phone call was held on April 5, 2017.

AUDIT TEAM

Title	Team Member	Organization
Team Leader, NRR/JLD	Anthony Minarik	NRC
Project Manager, NRR/JLD	Lauren Gibson	NRC
Branch Chief, NRO/DSEA	Aida Rivera	NRC
Branch Chief, NRO/DSEA	Christopher Cook	NRC
Technical Manager	Richard Rivera-Lugo	NRC
Lead Hydrologist	Mike Lee	NRC
Contractor	Vinod Mahat	ANL
Contractor	Nicholoas Haas	ANL
Contractor	John Quinn	ANL
Contractor	Eugene Yan	ANL

DOCUMENTS AUDITED

Attachment 1 of this report contains a list that details all the documents reviewed by the NRC staff, in part or in whole, as part of this audit. The documents were located in an ERR during the NRC staff review.

AUDIT ACTIVITIES

In general, the audit activities consisted of the following actions:

- Review background information on site topography and geographical characteristics of the watershed.
- Review site physical features and plant layout.
- Understand the selection of important assumptions and parameters that would be the basis for evaluating the individual flood-causing mechanisms described in the 50.54(f) letter.
- Review model input/output computer files, such as Hydrologic Engineering Center (HEC)-River Analysis System (RAS), FLO-2D, and HEC- Hydrologic Modeling System (HMS), to gain an understanding of how modeling assumptions were programmed and executed.

Attachment 2 of this report provides more detail and summarizes specific technical topics (and resolution) of important items that were discussed and clarified during the audit. The items discussed in Attachment 2 may be referenced/mentioned in the staff assessment in more detail.

CLOSEOUT TELECONFERENCE MEETING

Following the August 18, 2016, teleconference, the NRC staff identified certain information that needed to be provided on the docket in order to resolve some of the items discussed during the audit. The information updated or supplemented the FHRR based on the audit discussions. This information included the following:

- 1) Certain plant diagrams showing the locations of key doors

The requested information was received by e-mail dated September 29, 2016 (ADAMS Accession No. ML16279A479, non-public), with three attachments (ADAMS Accession Nos. ML16280A035, ML16280A037, and ML16280A042, all non-public).

On April 5, 2017, the NRC informed the licensee that no further information was needed for the audit and that the virtual audit was henceforth considered closed.

Attachments:

1. Audit Documents
2. Prairie Island Information Needs – Audit/Post-Audit Summary

ATTACHMENT 1

Prairie Island Nuclear Generating Plant, Units 1 and 2 Audit Document List

1. Black & Veatch, 2014, "Local Intense PMP Hydrology and Hydraulics," Calculation No. 180461.51.1005, Revision 0. September 2014.
2. Black & Veatch, 2016, "Local Intense PMP Hydrology and Hydraulics," Calculation No. 180461.51.1005, Revision 1. September 2016.
3. NSPM (Northern States Power – Minnesota), 2016a, "FHRR (Flood Hazard Reevaluation Report) Audit Presentation 8-18-16 – Webinar Slides", in response to Prairie Island Nuclear Generating Plant (PINGP) Information Needs – Local Intense Precipitation, August 18, 2016.
4. NSPM, 2016b, "Subject: Prairie Island Nuclear Generating Plant Flood Hazard Reevaluation Report – Responses to Requested Information (CAC Nos. MF7710 and MF7711)," email from Lynne Gunderson, Prairie Island Projects Licensing to Lauren Gibson, Project Manager, U.S. Nuclear Regulatory Commission, September 29, 2016, 4:05 PM, ADAMS Accession No. ML16279A476.
5. USDA (U.S. Department of Agriculture), 1986, "Urban Hydrology for Small Watersheds", Technical Release 55, Natural Resources Conservation Service, USDA, June 1986.
6. Xcel Energy, 2016a, "Calculation 180461.51.1005 Rev 0 – Local Intense Precipitation, HEC-HMS and HEC-RAS Input & Output files", in a CD of "Prairie Island Nuclear Generating Plant" prepared on June 15, 2016 and sent to Victor Hall, Project Manager, U.S. Nuclear Regulatory Commission, June 2016.
7. Xcel Energy, 2017, "Calculation 180461.51.1005 Rev 1 – Local Intense Precipitation, HEC-HMS and HEC-RAS Input & Output files", in a CD prepared for U.S. Nuclear Regulatory Commission, received in February 2017.

ATTACHMENT 2

Prairie Island Nuclear Generating Plant Information Needs – Audit/Post-Audit Summary

Information Need No.	Information Need Description	Response
<p align="center">1</p>	<p><u>Local Intense Precipitation – Drainage basin #205 outflow routing in HEC-RAS Model</u></p> <p><u>Background:</u> In the LIP flood hazard calculation package (Black & Veatch, 2014), Figure 5.3.2-2 is entitled “HEC-RAS Model Schematic in the Vicinity of Structures of Concern.” Each subbasin depicted within the figure has associated with it an inflow and outflow. However, the outflow from subbasin #205 is not routed to any of the potential reaches identified within the LIP model (i.e., river reach #203, river reach #204, or river reach #234 marked by the black arrows), nor is the outflow routed over any potential lateral structures (none of which are shown as being available to subbasin #205).</p> <p><u>Request:</u> It is requested that the licensee describe how the HEC-RAS modeling structures cited above were developed, and clarify how flow routing from subbasin #205 to the appropriate river reach was treated.</p>	<p>The licensee provided figures that showed topographic contours of the ground surface within the reactor site; those contours illustrated a relatively steep slope for subbasin #205 in comparison to the balance of the site’s topography. Moreover, the orientation of the topographic contours within subbasin #205 indicates that the ground surface slopes away from areas and structures of concern within the powerblock. The licensee also performed a simple hydraulic analysis to estimate the Froude number for the three reaches that pass through subbasin 205 based on the estimated flow rate, slope, and flow depth for each of the reaches within subbasin #205. The resultant Froude numbers were all found to be greater than 1. The licensee stated that the upstream water depth is not impacted by downstream flow depths based on the hydraulic condition of a Froude number greater than 1 (NSPM, 2016a).</p> <p>The NRC staff checked the assumptions described by the licensee during the audit, as outlined in the response to this information need request, and concluded that the information provided by the licensee was sufficient to address the information need request.</p>
<p align="center">2</p>	<p><u>Local Intense Precipitation – Source of inflow to river reach #210 in HEC-RAS Model</u></p> <p><u>Background:</u> In the LIP flood hazard calculation package (Black & Veatch, 2014), Figure 5.3.2-2 is entitled “HEC-RAS Model Schematic in the Vicinity</p>	<p>In response to the information need request, the licensee indicated that the inflow hydrograph used for stream reach #210 in the HEC-RAS model was incorrectly taken from the outflow hydrograph of subbasin #210 based on a previous run of the HEC-HMS model with a higher lag time which resulted in lower flow. The licensee noted that it</p>

Information Need No.	Information Need Description	Response
	<p>of Structures of Concern.” Each subbasin depicted within the figure has associated with it an inflow and outflow. Upon review, it was found that the inflow to river reach #210 could not be matched to output from any of the HEC-HMS subbasins to which it might be physically correlated in the licensee’s LIP model – specifically subbasins #210, #214, #217, #294, or #299.</p> <p><u>Request:</u> It is requested that the licensee describe the source of the inflow hydrograph for river reach #210, and describe how it was treated for the purpose of maintaining mass balance within the LIP model.</p>	<p>subsequently updated the inflow hydrograph for reach #210 with the correct HEC-HMS outflow hydrograph for that particular subbasin. A preliminary run of the HEC-RAS model with updated inflow hydrograph was performed, and the model results indicated that changes in the estimated maximum water surface elevations (WSEs) at all the critical door locations were insignificant (<0.01 ft). The licensee also stated that it intended to initiate a corrective action process with its technical assistance contractor to verify and update the LIP calculation packages and models. Nevertheless, the licensee stated that it anticipates no changes to the WSEs reported in the FHRR based on the preliminary results from its corrected HEC-RAS model.</p> <p>The NRC staff performed a sensitivity of the computer model and with its results and the licensee’s responses concluded that the information presented by the licensee was sufficient to address the information need request.</p>
<p>3</p>	<p><u>Local Intense Precipitation – General request related to HEC-RAS modeling</u></p> <p><u>Background:</u> Figure 5.3.2-2 in the LIP calculation package is a schematic diagram that shows a general overview of the HEC-RAS modeling structure. However, detailed information about which river reaches in the HEC-RAS model receive their water (hydrograph) from the corresponding drainage basin(s) in the HEC-HMS model is not explicitly specified. Review of the LIP model shows that there is a total of 32 subbasins, 10 river reaches, and 18 storage areas. Upon review of the calculation package, the staff determined that information about river reach boundary conditions</p>	<p>In response to the information need request, the licensee provided two tables that illustrated: (a) the linkage/correlation among the respective HEC-HMS subbasins, the corresponding river reaches in the HEC-RAS model, and the cross sections that receive flows from the various subbasins; and (b) the correspondence between the subbasins in the HEC-HMS model and the respective storage areas in the HEC-RAS model (NSPM 2016a).</p> <p>The licensee also presented additional new information on three critical door opening locations (Doors 420, 423, and 437) at the building designated “D5/D6”. In response to this new information, the staff requested that the licensee provide figure(s) to illustrate all critical door opening locations (including the three additional doors) at this new building</p>

Information Need No.	Information Need Description	Response
	<p>(including the missing data for subbasin #205), storage area boundary conditions, and connections between these respective features was not specified or discussed in any of the documents available to the staff.</p> <p><u>Request:</u> It is requested that the licensee describe for each river reach, where the water comes from and is added at which cross section in the HEC-RAS model. A table might be useful to convey this information. Also, it is requested that the licensee briefly describe the correspondence between the reach in the HEC-RAS model and the respective drainage basins in the HEC-HMS model. Again, a table might be useful to convey this information.</p>	<p>location as well as HEC-RAS river reaches and cross sections associated with each of the critical door locations using appropriate annotations and legends. In response to this request, the figures were submitted to the NRC electronically on September 29, 2016 (NSPM 2016b).</p> <p>The licensee also updated calculation package “Local Intense PMP Hydrology and Hydraulics” (180461.51.1005 Rev. 1), to include an evaluation of LIP at the three new door locations (Black & Veatch, 2016).</p> <p>The NRC staff reviewed information provided during the audit, as well as the revised figures and revised calculation package (180461.51.1005 Rev. 1) subsequently provided by the licensee, and concluded that the information provided was sufficient to address the information need request.</p>
4	<p><u>Local Intense Precipitation – Unit hydrograph</u></p> <p><u>Background:</u> The licensee used the Soil Conservation Service (SCS) Unit Hydrograph method to transform precipitation into runoff. A derived unit hydrograph (including the SCS unit hydrograph) may not always represent hydrometeorological conditions that would prevail during the probable maximum flood (PMF), and thus non-linearity adjustments to the unit hydrograph should be made by increasing the peak of the unit hydrograph by 20% and reducing the time to peak by 33% as per recommendations presented in NUREG/CR-7046 (NRC, 2011). In connection with its review, the staff determined that this adjustment was not applied in estimation of the unit hydrograph.</p>	<p>In response to the information need request, the licensee explained that the lag time for the respective subbasins was chosen based on the minimum time of concentration used in the Technical Release 55 (TR-55) software (USDA 1986) due to the small size of the subbasins, and further reduction of lag time is not necessary. The licensee also indicated that the conservatively-chosen lag time would automatically result in an increase in the unit hydrograph peak discharge, and thus further adjustment in the peak discharge was not warranted.</p> <p>The staff subsequently conducted an independent sensitivity analysis and based on the results concluded that the information provided by the licensee is sufficient to address the information need request.</p>

Information Need No.	Information Need Description	Response
	<u>Request:</u> It is requested that the licensee explain why the unit hydrograph was not adjusted to account for the effects of a non-linear basin response to the peak flow.	

Sources:

Black & Veatch, 2014, "Local Intense PMP Hydrology and Hydraulics," Calculation No. 180461.51.1005, Revision 0. September 2014.

Black & Veatch, 2016, "Local Intense PMP Hydrology and Hydraulics," Calculation No. 180461.51.1005, Revision 1. September 2016.

NSPM, 2016a, "FHRR (Flood Hazard Reevaluation Report) Audit Presentation 8-18-16 – Webinar Slides", in response to Prairie Island Nuclear Generating Plant (PINGP) Information Needs – Local Intense Precipitation, August 18, 2016.

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NUCLEAR REGULATORY COMMISSION REPORT FOR THE AUDIT NORTHERN STATES POWER COMPANY'S FLOOD HAZARD REEVALUATION REPORT SUBMITTAL RELATING TO THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1-FLOODING FOR PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2 DATED APRIL 18, 2017

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*** via email**

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