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

October 2, 2015

LICENSEE: Northern States Power Company - Minnesota

FACILITY: Monticello Nuclear Generating Plant
Prairie Island Nuclear Generating Plant, Units 1 and 2

SUBJECT: SUMMARY OF JULY 9, 2015, CLOSED MEETING BETWEEN REPRESENTATIVES OF THE U.S. ARMY CORPS OF ENGINEERS, U.S. NUCLEAR REGULATORY COMMISSION, AND NORTHERN STATES POWER COMPANY – MINNESOTA, TO DISCUSS FLOOD ANALYSIS ASSOCIATED WITH MONTICELLO NUCLEAR GENERATING PLANT AND PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2 (TAC NOS. MF3696, MF3697 AND MF3698)

On July 9, 2015, the U.S. Nuclear Regulatory Commission (NRC) staff held a closed meeting with the U.S. Army Corps of Engineers (USACE), and Northern States Power Company – Minnesota (the licensee), doing business as Xcel Energy (Xcel), to discuss the flooding hazard analysis being performed by the USACE under contract to the NRC for the Monticello Nuclear Generating Plant (MNGP) and Prairie Island Nuclear Generating Plant (PINGP), Units 1 and 2. The meeting was held at USACE's offices in Saint Paul, Minnesota. The closed meeting notice dated July 1, 2015, can be found in the Agencywide Documents Access and Management System (ADAMS) at Accession No. ML15181A020. This meeting was closed to the public because NRC, USACE, and the licensee discussed security-related information. The list of attendees can be found in Enclosure 1 of this summary. Xcel provided a list of questions associated with the USACE analysis for the MNGP and PINGP sites. These questions were discussed during the meeting. The questions and answers can be found in Enclosure 2 of this summary.

By letters dated March 5, 2014, Xcel requested NRC assistance in having the USACE perform a dam failure analysis for the Mississippi watershed for MNGP and PINGP, Units 1 and 2 (ADAMS Accession Nos. ML14065A112 and ML14064A291, respectively). Xcel requested the NRC's assistance to support Xcel's development of a MNGP and PINGP, Units 1 and 2 Flood Hazard Reevaluation Report in response to the March 12, 2012, request for information issued pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) (ADAMS Accession No. ML12073A348).

The USACE and NRC provided Xcel with preliminary results of the USACE dam failure analysis. The NRC stated that the next action to be completed in the process is the transmittal of the final results to Xcel. The NRC also stated that Xcel could request another meeting with the NRC after receiving the results.

The USACE was provided an opportunity to comment on this summary prior to its issuance and its comments were addressed in the final version of this summary.

If you have any questions, please contact me at (301) 415-2915 or e-mail at Victor.Hall@nrc.gov.

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Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-263, 50-282,
and 50-306

Enclosures:
1. List of Attendees
2. Xcel Questions and Answers

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US Army Corps of Engineers®	# NRC/USACE Initial Technical Review (ITR) Meeting Monticello and Prairie Island Nuclear Power Plants July 9, 2015
U.S.NRC United States Nuclear Regulatory Commission *Protecting People and the Environment*	USACE St. Paul District Office Executive Conference Room, 7th Floor 180 5th St E St Paul, MN 55101

LIST OF ATTENDEES:

NRC: Andy Campbell, Peter Chaput, Christopher Cook, Tekia Govan, Victor Hall, Brad Harvey

USACE Omaha: Roger Kay, Teresa Reinig, Chris Fassero

USACE St. Paul: Ann Banitt, Michael Bart, Theresa Grant-Gaines, Bonnie Greenleaf, Chanel Mueller, Jim Naren, Alex Nelson,

Xcel Energy: John Fields, Jeremiah Hill, Greg Lauinger, Joseph Mathew, William Partridge, Richard Rohrer, Sharida Ullah, Brian Zelenak

Black and Veatch: Pablo Gonzalez-Quesada, Frank Means

Xcel Questions Associated With U.S. Army Corps of Engineers (USACE) Flooding Hazard Reevaluation

Hydrologic Calibration and Simulation

1. **What hydrologic methods did you use for calculating precipitation losses and calculating hydrographs?**

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The Probable Maximum Flood (PMF) Hydrograph for Lock and Dam No. 3 was determined by the St. Paul District Corps of Engineers in 1985. The 1985 analysis at Lock and Dam 3 was adopted to evaluate the PMF event at Prairie Island Nuclear Generating Plant and is consistent with results obtained through subsequent PMF analyses generated for Locks and Dams 2 and 10. The PMF analysis at Prairie Island is consistent with the PMF values adopted at the other sites within its vicinity and is representative of the USACE's currently accepted analysis for the Mississippi River Locks and Dams.

Monticello Nuclear Generating Plant. The initial and constant loss rate method was used to model precipitation losses in [Hydrologic Engineering Center- Hydrologic Modeling System] HEC-HMS. The initial and constant loss method is dependent on three parameters: the percent impervious, an initial loss and a constant loss rate. Loss parameters adopted to simulate the PMF event in HEC-HMS were selected based upon model calibration and the results of other hydrologic studies in the region. The model was calibrated to three large, historic events (1957 event, 2012 event and the 1965 event) to replicate the conditions that would persist during the PMF event at Monticello, MN. The values derived via calibration are consistent with the initial and constant loss rates adopted to model the PMF for the *Fargo Moorhead Flood Control Project* in the neighboring Red River Basin, the PMF analysis carried out for the *St. Paul Flood Control Project* and the analyses generated for the locks and dams.

2. **What meteorological data did you use for calibration of the hydrologic model?**

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. Documentation describing how the HEC-1 model was calibrated in order to model the PMF Hydrographs for Locks and Dams No. 2 and No.10 is not readily available. It can be assumed that when the analyses were carried out at Locks and Dams 2 and 10 the methodology was reviewed in accordance to USACE protocol. Likewise, the decision to utilize the analysis at Locks and Dams 2 and 10 to generate PMF magnitudes at Lock and Dam 3 was vetted by USACE personnel and is consistent with how the PMF was assessed at other sites throughout the St. Paul District.

Monticello Nuclear Generating Plant. The best meteorological data available within the Upper Mississippi River Basin is next generation RADAR (NEXRAD) data. NEXRAD data used for this study was obtained from the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) North Central River Forecast

Center (NCRFC). Gridded precipitation data from the NCRFC is available in three formats which vary in quality. The Multi-Sensor Precipitation Estimator (MPE) dataset is the best product available for precipitation estimates because it uses data from multiple radar sensors instead of only one; however, the MPE data only became available in 2002. To model gridded rainfall data in conjunction with a gridded snowmelt event, gridded snow water equivalent (SWE) records must be available; however, gridded SWE data only became available from the NOAA National Snow Analysis (NSA) National Operational Hydrologic Remote Sensing Center (NOHRSC) in 2003.

A watershed model used to model the PMF should be calibrated to the largest historic events that produce a basin wide response. Because high quality NEXRAD and gridded SWE datasets are only available after 2003, point precipitation data was also adopted for this study to increase the number of events available for calibration. Point precipitation data and data inputs used for snowmelt modeling were downloaded from the NOAA National Climatic Data Center.

3. Did you validate the hydrologic model? If yes, what storm event was used for the validation?

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. Documentation describing how the HEC-1 model was calibrated in order to model the PMF Hydrograph for Locks and Dams 2 and 10 is not readily available. It can be assumed that when the analyses were carried out at Locks and Dams 2 and 10 the methodology was reviewed in accordance to USACE protocol. Likewise, the decision to utilize the analysis at Locks and Dams 2 and 10 to generate PMF magnitudes at Lock and Dam 3 was vetted by USACE personnel and is consistent with how the PMF was assessed at other sites throughout the St. Paul District.

Monticello Nuclear Generating Plant. The model was initially calibrated to three significant, historic events: 1957, 1965, and 2012. The Clark's unit hydrograph parameters T_c and R and Muskingum hydrologic routing parameters (k and X) were initially determined independently for each calibration event.

After initial model calibration, a single set of representative T_c and R parameters and k and X parameters were adopted. To validate these parameters, the models were re-run for all three calibration events with the adopted T_c and R and k and X parameters to ensure that the results produced still replicated observed streamflow data reasonably well along the mainstem of the Mississippi River.

The Nash-Sutcliffe coefficient (R_{NS}) is a widely accepted means of gaging effective computer model calibration in hydrologic and hydraulic engineering. The Nash-Sutcliffe coefficient can range from negative infinity to one. The closer the Nash-Sutcliffe efficiency coefficient is to 1, the better the match between the modeled and observed discharge data. Overall, the values of the Nash-Sutcliffe coefficient using the final, adopted parameters appear to fit the hydrographs at key locations well with only a few tributary locations where the Nash-Sutcliffe coefficient decreased below the target of R_{NS} = 0.70. The Monticello Nuclear Generating Plant is located on the mainstem of the Mississippi River, and the R_{NS} for sites on the mainstem of the Mississippi River remain above 0.70.

4. How did modeled results compare to observed (peak discharge, volume, and timing)?

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. Documentation describing how the HEC-1 model was calibrated in order to model the PMF Hydrograph for Locks and Dams 2 and 10 is not readily available. It can be assumed that when the analyses were carried out at Locks and Dams 2 and 10 the methodology was reviewed in accordance to USACE protocol. Likewise, the decision to utilize the analysis at Locks and Dams 2 and 10 to generate PMF magnitudes at Lock and Dam 3 was vetted by USACE personnel and is consistent with how the PMF was assessed at other sites throughout the St. Paul District.

Monticello Nuclear Generating Plant. The calibration goals for this study were to produce Nash-Sutcliffe Coefficient greater than 0.7, to generate hydrograph volumes and peaks within 10% of observed streamflow data, and to match the timing of the observed hydrograph peak within one day (+ or -) at all gage sites throughout the study area. The Nash-Sutcliffe coefficient is a widely accepted means of gaging effective computer model calibration in hydrologic and hydraulic engineering.

At all calibration locations the flood peaks generated by the adopted parameters during model validation are within 18% of the observed flood peaks. At mainstem locations the flood peaks generated by the adopted parameters are within 10% of the observed flood peaks. Flood volumes generated by adopted parameters for the 1957 and 2012 event are all within 10% of the observed flood volumes with the exception of the 1957 flood volume generated on the Crow River. For the Crow River, the 1957 flood volume modeled with adopted parameters is within 20% of the observed flood volume. The 1965 event flood volumes modeled using adopted parameters are within 23% of the observed flood volumes. The 1965 event adopted parameters used during model validation overestimate flood volumes being modeled at calibration sites.

5. How did you determine the Probable Maximum Precipitation values? Did you use HMR-51, and if so how did you overcome the 20,000 sq. mi. limitation?

USACE/NRC Response: The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St.

Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. For both the PMF analyses carried out at Locks and Dams 2 and 10, as well as for the PMF analysis generated for Monticello Nuclear Generating Plant, HMR 51 and HMR 52 were used to generate the All-Seasons probable maximum precipitation hyetograph.

HMR 51 was used to determine the precipitation depth-duration-area relationships. HMR-52 was used to optimize the probable maximum precipitation (PMP) storm orientation and size and the principles in HMR-52 were applied to determine the PMP rainfall hyetograph.

To generate the spring PMP event for Monticello Nuclear Generating Plant and for Locks and Dams 2 and 10, HMR 53 was used to generate the depth duration area relationships for a 10 square mile drainage area. The tables in *"Probable Maximum Precipitation Estimates and Snowmelt Criteria for the Upper Mississippi River in Minnesota and the Fox-Wolf Rivers in Wisconsin"* were used to translate this relationship to a wider range of drainage areas.

For the Locks and Dams 2 and 10 analyses, the USACE Hydrologic Engineering Center's computer program HMR-52 was used to determine the storm area and orientation that maximized the average precipitation depth for a given storm center. For the Monticello analysis, the required rainfall depth duration area relationships data was input into the USACE Modeling, Mapping and Consequence (MMC) Center's PMP Precipitation tool. This tool is [Geographical Information System] GIS based and applies the principles in HMR-52 to optimize storm orientation and size and to determine the rainfall hyetograph.

For both Locks and Dams 2 and 10 and Monticello Nuclear Generating Plant analysis, the energy budget equations in USACE EM 1110-2-1406 were used to generate the snowmelt rates applied to model a 10-day melt prior to a spring, rainfall event. The guidance in *"Probable Maximum Precipitation Estimates and Snowmelt Criteria for the Upper Mississippi River in Minnesota and the Fox-Wolf Rivers in Wisconsin"* was used to define the inputs to these equations and was used to define the 100-year Snow Water Equivalent (representative of the snowpack) prior to the melt.

The drainage area above Monticello Nuclear Generating Plant is less than 20,000 square miles (~14, 000 square miles), so there is no limitation on using HMR-51 for Monticello Nuclear Generating Plant. The drainage area at Lock and Dam 3 is less than 50, 000 square miles (~ 45,000 square miles). It appears that no adjustment was made to the output from HMR-51, 53 and 52 when applied to determine the probable maximum precipitation events at Locks and Dams 2 and 10. Although both HMR-51 and HMR-52 specify that they should be applied to drainage areas between 10 and 20,000 square miles, HMR-51 indicates that less detailed maps and analysis were prepared for drainage areas up to 50,000 square miles to incorporate the influence of possible extreme values for areas greater than 20,000 square miles.

6. How did you develop the Probable Maximum Storm? Did you use HMR-52, and if so how did you overcome the 20,000 sq. mi. limitation?

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. For the PMF analyses carried out at Locks and Dams 2 and 10, the USACE's Hydrologic Engineering Center's computer program [Hydrometeorological Reports] HMR-52 was used to determine the storm area and orientation that maximized the average precipitation depth for a given storm center.

The drainage area at Lock and Dam 3 is less than 50,000 square miles (~ 45,000 square miles). It appears that no adjustment was made to the output from HMR-51, 53 and 52 when applied to determine the probable maximum precipitation events at Locks and Dams 2 and 10. Although both HMR-51 and HMR-52 specify that they should be applied to drainage areas between 10 and 20,000 square miles, HMR-51 indicates that less detailed maps and analysis were prepared for drainage areas up to 50,000 square miles to incorporate the influence of possible extreme values for this area sizes on areas greater than 20,000 square miles.

Monticello Nuclear Generating Plant. The drainage area above Monticello Nuclear Generating Plant is less than 20,000 square miles (~14, 000 square miles), so there was no limitation on using HMR-52. For Monticello Nuclear Generating Plant the GIS based, USACE Modeling, Mapping and Consequence (MMC) Center's PMP Precipitation tool was used. The MMC's Precipitation tool applies the principles in HMR-52 to calculate the optimal storm size and orientation for the probable maximum precipitation event over the study area and outputs a rainfall time series for each subbasin based on the standard HMR-52 isohyets.

The PMP sequence was applied for the standard PMP seasons: March 31, April 15, April 31 and All Season. The storm centering used to determine the PMP was varied and applied in the hydrologic model, HEC-HMS, until an estimate of the maximum peak flow was determined.

7. **What storm size and orientation was determined to result in maximum average depth over the watershed?**

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10.

For Lock and Dam 2, the maximum average precipitation depths could be generated by centering a 1,500 square mile storm over the Minnesota River Basin. The orientation was selected as 245 degrees using the USACE's HEC HMR-52 computer program.

For Lock and Dam 10, the maximum average precipitation depths could be generated by centering a 10,000 square mile storm over a drainage area that extends from Prescott, Wisconsin to Lock and Dam 10. The orientation was selected as 255 degrees using the USACE's HEC HMR-52 computer program.

Monticello Nuclear Generating Plant. For Monticello Nuclear Generating Plant the maximum average precipitation depth could be generated by using basin centroidal storm centering and applying a 15,000 square mile Probable Maximum Precipitation event at a 210 degree storm orientation.

8. How many storm centers and temporal distributions were considered in the evaluation and where were they located?

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. Six different probable maximum storm scenarios were considered for Lock and Dam 2. Four potential probable maximum storm scenarios were considered for Lock and Dam 10.

Monticello Nuclear Generating Plant. Four storms that varied by season were considered for Monticello Nuclear Generating Plant: an all season (15 July- rainfall only) storm and three spring snowmelt/rainfall storms (Mar 15, Mar 31 and Apr 15). After the March 31st storm was determined as having the greatest average depth of the four storms, seven different storm centering locations were examined to see which would generate the highest peak flow at Monticello Nuclear Generating Plant.

9. How did you subdivide the watershed? How many sub-basins are in each watershed?

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. The Upper Mississippi River Basin Flood Routing Model was utilized to calculate runoff hydrographs for both Locks and Dams 2 and 10. This HEC-1 model divides the Upper Mississippi River basin above Lock and Dam 10 into 27 subareas. To simplify the snowmelt and precipitation computations in support of modeling the PMF these subareas were combined into nine subbasins.

Monticello Nuclear Generating Plant. ArcGIS (Version 10.1) and HEC-GeoHMS (Version 10.1) were used to generate the hydrologic model layout, with the Upper Mississippi River Basin between the headwaters of the Mississippi River and

Anoka/Brooklyn Park divided into nineteen subbasins. Model complexity is consistent with the level of detail applied to produce the 1990 PMF analysis at St. Paul, Minnesota.

Subbasin delineation was based on the availability of calibration data, the location of major water management structures, and tributary pour points into the Mississippi River. Given the relatively consistent land use and soil characteristics in the subbasins used to model the Upper Mississippi River Basin above Monticello and the spatial scale of the probable maximum precipitation event used to generate the probable maximum flood event, this approach to watershed modeling is appropriate for generating a probable maximum flood analysis for such a large drainage area.

10. How did you account for snowmelt in the simulation?

USACE/NRC Response: For both Monticello Nuclear Generating Plant and the analysis generated for Locks and Dams 2 and 10 the guidance in "*Probable Maximum Precipitation Estimates and Snowmelt Criteria for the Upper Mississippi River in Minnesota and the Fox-Wolf Rivers in Wisconsin*" was used to estimate the available snow water equivalent prior to the PMP. The daily snowmelt rate for the 10 days prior to the PMP was calculated according to the rain-free snowmelt rate equations found in USACE EM 1110-2-1406. Many of the parameters used as inputs to the snowmelt equations were determined from "*Probable Maximum Precipitation Estimates and Snowmelt Criteria for the Upper Mississippi River in Minnesota and the Fox-Wolf Rivers in Wisconsin.*"

11. Assuming that USACE EM 1110-2-1406 was used for snowmelt, how was k value determined? Were snowmelt parameters calibrated/how was snow-water equivalent determined?

USACE/NRC Response: The parameter "k" is the basin convection –condensation melt factor. This factor is dependent on the relative exposure of the watershed to wind and was determined based on information in paragraph "c", on page 5-7 of EM 1110-2-1406.

Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. For Locks and Dams 2 and 10, k was assumed to be 0.9. Please see the response to the following questions regarding how snow water equivalent was determined for the study area.

Monticello Nuclear Generating Plant. The equations selected to determine the probable maximum snowmelt rate in the Upper Mississippi River Basin depend on the specific meteorological conditions in the region and the percent of the basin that is forested. For Monticello Nuclear Generating Plant, the basin convection-condensation melt factor was assumed to be 0.8 for partly forested areas and 1.0 for open areas.

In accordance to the guidance presented in USACE engineering manual *Runoff from Snowmelt* (EM 1110-2-1406), energy budget equations can be used to compute the

Probable Maximum Snowmelt associated with the probable maximum flood event at Monticello, Minnesota - they were not calibrated. The watershed model was calibrated to a snowmelt event (the 1965 event). Please see the response to the following questions regarding how snow water equivalent was determined for the study area.

12. How was the 100-year snowpack determined?

USACE/NRC Response:
Prairie Island Nuclear Generating Plant. The PMF event at Prairie Island Nuclear Generating Plant was developed using a drainage area-discharge relationship developed to support evaluating extreme storm events like the PMF at Lock and Dam sites throughout the St. Paul District. This drainage area-discharge relationship was verified using the PMF analysis carried out for Locks and Dams 2 and 10. For Locks and Dams 2 and 10, the average 100-year values of the 15 March snow water equivalent for the Upper Mississippi River Basin for the four zones presented in Table 13 of the *Upper Mississippi River/Fox-Wolf River* study were increased by 12 percent to obtain the probable maximum snowpack. Values for the 31 March and 15 April probable maximum snowpack were obtained by reducing the 15 March values by 25 and 50 percent, respectively. The probable maximum water equivalent by subbasin was determined by proportioning the snowpack by zone within the subbasin and reducing this 100-square mile value by the appropriate drainage area ratio.

Monticello Nuclear Generating Plant. The water equivalent values presented in Table 13 of the *Upper Mississippi River/Fox-Wolf River* study are for an area of 100 square miles and must be adjusted for the total basin area. Values for the basin size above Monticello were obtained by using the appropriate factor given in the *Upper Mississippi River-Fox Wolf River* study. Adjustments were made based on daily SWE observations made at Duluth, St. Cloud and Minneapolis, MN. Using GIS tools, the snow water equivalent amounts (SWE) at the start of the melt for the 15th of March, 31st of March, and 15th of April snowmelt driven probable maximum precipitation events were calculated for each subbasin in the Upper Mississippi River Watershed Model above Monticello, Minnesota.

Dam Breach Analysis

13. Can you provide the screening process used for the dam breach analysis, including how inconsequential dams were identified (i.e., was process defined in [Japan Lessons-Learned Directorate(JLD) Interim Staff Guidance (ISG) JLD-ISG-2013-01 Rev 0 used)?

USACE/NRC Response: All the dams upstream of the Monticello and Prairie Island Nuclear Generating Plants (NGP) were screened out with regard to dam failures that could potentially impact the NGPs. The Dam Screen process was conducted in accordance to the current version of the JLD-ISG guidance. The dam screening analysis was completed in August 2014. The screening process screened out all dams based on cumulative volume and cumulative peak flow that would result from simultaneous failures of the all dams in the basin utilizing the JLD-ISG guidance.

14. Did you apply any of the simplified modeling approaches provided in the ISG (Section 3.2) to differentiate non-critical and potentially critical dams? If yes, how were the cumulative effects of non-critical dams carried forward and analyzed?

USACE/NRC Response:

Explanation of Screening Analysis: The simplified methods described in section 3.2 of JLD-ISG-2013-01 were applied to differentiate non-critical dams from potentially critical dams. After screening for inconsequential dams, the Methods 1 and 2 outlined in Section 3.2 of JLD-ISG-2013-01 were utilized to screen for non-critical and potentially critical dams. All dams above Monticello and Prairie Island Nuclear Generating Plants were screened out and thus are considered non-critical. The analysis at both sites was performed using several conservative assumptions; therefore a high degree of confidence in this result exists.

Treatment of Dams in PMF Analysis: Small, non-critical dams were not explicitly analyzed as part of this analysis. The impact that smaller impoundments have on storage throughout the study area is reflected in the calibrated Clark's parameters adopted for each of the subbasins in the watershed model.

A decision was made to model the larger flood control reservoirs in the Upper Mississippi River basin explicitly or using a baseflow release based upon the intervening drainage area between the reservoir sites and Monticello Nuclear Generating Plant and the spatial extents of the Probable Maximum Precipitation event.

Due to their close proximity to the probable maximum precipitation event centroid, Pine River Dam (Cross Lake Reservoir Project) and the Gull Lake Dam (Gull Lake Reservoir Project) were modeled explicitly. The other reservoirs in the Upper Mississippi River basin are further from the PMP centroid and would see rainfall depths less than a 1% precipitation event would generate. When modeling the PMF event, the flow contribution from the three upstream most reservoirs is represented as a constant, specified release of 5,000 cfs at Grand Rapids, Minnesota, which is equivalent to the 1% annual instantaneous peak flow magnitude at Grand Rapids (*Source: USACE Upper Mississippi River Hydrology Study*). To represent the flow contribution from Sandy Lake reservoir a constant specified release of 3,200 cfs was adopted, which is equivalent to the 1% annual instantaneous peak outflow from Sandy Lake *(Source: USACE Upper Mississippi River Hydrology Study)*.

Gull Lake Dam may overtop during the Monticello PMF event, but it is assumed that the dam does not fail. All dams upstream of Monticello and Prairie Island Nuclear Generating Plants were screened out as being non-critical, consequently a dam breech analysis was deemed outside the scope of this analysis.

The location of Prairie Island Nuclear Generating Plant site is far removed from any large, flood control projects. Consequently none of the dams upstream of Prairie Island Nuclear Generating Plant were modeled explicitly when generating the PMF analysis at Prairie Island.

15. **How did you assess/analyze potential seismic failures and/or sunny-day failures? If seismic failures were screened out, was seismic study used to support this determination?**

USACE/NRC Response: All dams were screened out in terms of flood risk to the NGP regardless of failure mode. Therefore, a seismic analysis was unnecessary.

16. **How did you determine if there were or were not dam failures for the PMF condition?**

USACE/NRC Response: As a result of its limited outlet capacity and the minimal amount of flood storage space available, Gull Lake Dam overtops when the Monticello probable maximum precipitation event is applied to the watershed. For the purposes of this analysis, it was assumed that Gull Lake Dam overtops, but does not breach. Because all the dams upstream of the Monticello Nuclear Generating Plant were screened out as non-critical, carrying out a dam breach analysis at Gull Lake Dam coincident to the PMF event at Monticello Nuclear Generating Plant is beyond the scope of this study.

17. **Are you routing the dam breach hydrographs using hydrologic methods or did you set up a hydraulic model from the individual dams to the NGP?**

USACE/NRC Response: As a result of the dam screening analysis, all dams were screened out as being non-critical. Consequently, no dams were assumed to fail in conjunction with the PMF at Monticello Nuclear Generating Plant or Prairie Island Nuclear Generating Plant. Therefore, more detailed hydrologic/hydraulic modeling of dam failures was unnecessary.

18. **Please describe the USACE's approach to how failure will be triggered in the hydrologic model for the hydrologic dam failure mechanism.**

USACE/NRC Response: As a result of the dam screening analysis, all dams were screened out as being non-critical. Consequently, no dams were assumed to fail in conjunction with the PMF at Monticello Nuclear Generating Plant or Prairie Island Nuclear Generating Plant. Therefore, more detailed hydrologic/hydraulic modeling of dam failures was unnecessary.

Hydraulic Modeling

19. Was a steady or unsteady-flow model used to determine water surface elevations at MNGP and PINGP?

USACE/NRC Response: Unsteady modeling using the Corps of Engineers HEC-RAS (Hydrologic Engineering Center – River Analysis System) was implemented for developing the PMF stage hydrographs at both NGP locations.

20. How were downstream boundary conditions determined?

USACE/NRC Response: The downstream boundary for each model was set a substantial distance downstream from each NGP site such that the selection of the downstream boundary type does not have a major impact on stages at the site.

At the PINGP, the downstream boundary location was downstream of Lock and Dam No. 4 and was set to a Normal Depth calculation based on the slope of the river downstream of Lock and Dam No. 4. The upstream boundary of the PINGP HEC-RAS model is just downstream of the St. Croix River's confluence with the Mississippi River.

At the MNGP, the downstream boundary type was set to a stage-discharge rating curve at the [United States Geological Survey] USGS gage (USGS gage 05288500) location Mississippi River at Highway 610 in Brooklyn Park, Minnesota (previously known as the "near Anoka, Minnesota" gage). The rating curve was extended to capture PMF magnitude events. The MNGP model extends upstream to a point immediately downstream of St. Cloud Dam, in St. Cloud, MN. The rating curve generated by HEC-RAS for St. Cloud Dam was checked to ensure that it could reproduce published values after model determination.

Coon Rapids Dam was explicitly modeled within the HEC-RAS model using existing model geometry provided by the Minnesota Department of Natural Resources (MnDNR).

21. Was the hydraulic model calibrated to gage data? Or how were Manning's "n" values determined?

USACE/NRC Response: For Prairie Island Nuclear Generating Plant the calibration process involved looking at available historic stage and flow data and at previously determined synthetic stage data and published rating curve data. Manning's n-values were one of the primary parameters that were adjusted to achieve a better fit to the calibration data. Other parameters that influenced calibration were ineffective flow limits, local inflows, and L&D gate and weir coefficients.

For Monticello Nuclear Generating Plant the primary method of calibration was the modification of Manning's n-values which were consistent with the results of both the Anoka and Sherburne County FIS studies. A sensitivity analysis was carried out to determine what impact increasing or decreasing the Manning's n values by 20% had on the PMF water surface profile at Monticello Nuclear Generating Plant.

22. What flood events were used for calibration and validation of the hydraulic model?

USACE/NRC Response: At the PINGP, the model was calibrated to the 1965, 2001, and 2014 events using observed stage and flow hydrographs at the L&D locations and high-water-mark data for calibration to peak stages throughout the river reach.

At the MNGP, the model was calibrated to the Anoka County and Sherburne County Flood Insurance Study (FIS) steady flow profiles for the 10-yr, 50-yr, 100-yr and 500-yr events as well as published USGS rating curves at two locations. The calibration effort primarily focused on calibrating to the 100 year flood profile. The inflows for the calibration runs were taken from the Anoka and Sherburne County FIS study HEC-2 models. The model cross sections were calibrated to water surface elevations within 0.5 feet of the 100 year FIS study water surface elevations and within 1.0 foot of the 500 year flood water surface elevations, while ensuring the 10 year and 50 year calibrated within a reasonable range.

23. Please provide the source for the 1965 snow water equivalent data used for the calibration of the HEC HMS model for Monticello? Please discuss what gages were used to determine snow depths and how was snow water equivalent content determined?

USACE/NRC Response: Daily point precipitation data, daily maximum and minimum temperature data, and daily snow depth measurements were downloaded from NOAA's NCDC database to model the April 1965 snowmelt event. Thirty-eight meteorological data collection sites were used to calibrate the watershed model to the 1965 snowmelt event. The snowmelt rate was computed by determining the daily decrease in the snowpack depth and then converting this change in depth to a liquid equivalent. Liquid equivalents were approximated using observed trends in snow water equivalent. Throughout the entire Upper Mississippi River Basin it was found that on average SWE is equivalent to about 20% of the total snow depth in mid-March and 30% of total snow depth after March 25. These densities were applied to approximate the melt rate for the 1965 event.

24. **It was indicated during the meeting that the calibration of the HEC HMS model for Monticello compared simulated data to observed stream gage data. Please identify how many and which stream gages were used for this purpose?**

USACE/NRC Response: The following table contains the stream gages used for this purpose.

Name	Gage ID	Data Source
Grand Rapids	05211000	USGS
Below Sandy River near Libby	05220500	USGS
Aitkin	05227500	USGS
Brainerd	05242300	USGS
Fort Ripley	05261000	USGS
Royalton	05267000	USGS
St. Cloud	05270700	USGS
Elk River	05275500	USGS
HWY 610 in Brooklyn Park	05288500	USGS
Sandy River: Big Sandy Lake Dam near McGregor	SDYM5/6	USACE
Pine River Dam on Cross Lake at Crosslake	CRLM5/6	USACE
Gull River: Gull Lake Dam and Reservoir near Brainerd	GLLM5/6	USACE
Crow Wing River near Pillager	05247500	USGS
Platte River at Royalton	05268000	USGS
Sauk River near St. Cloud	05270500	USGS
Rum River near St. Francis	05286000	USGS
Crow River at Rockford	05280000	USGS

25. **NUREG/CR-7046 recommends adjusting the peak discharge by 5-to-20 percent and reducing the lag time by 33 percent. Our notes indicated that the USACE used a 25 percent increase to the peak discharge and a 50 percent increase adjustment to the flow. Can you please confirm the percent peak discharge and flow increases and address these relative to the NUREG?**

USACE/NRC Response: The NUREG/CR-7046's recommendation to adjust the peak discharge is analogous to the hydrograph peaking technique applied in the St. Paul District's analysis of the Monticello PMF. The USACE technique is described in the USACE's guidance document ER 1110-8-2(FR), *Inflow Design Floods for Dams and Reservoirs*, which states that unit hydrograph parameters should be peaked by 25-50 percent to account for the fact that the watershed model used to generate the PMF hydrograph was calibrated to smaller floods than the PMF. Since the event of record is about half the magnitude of the PMF event hydrograph at Monticello, and the event of record was used for calibration, the calibrated model parameters were peaked 25%. A sensitivity analysis of the hydrograph peaking factors of 0% and 50% found peak discharge values to vary no more than 8% at the Monticello Nuclear Generating Plant.

If you have any questions, please contact me at (301) 415-2915 or e-mail at Victor.Hall@nrc.gov.

/RA/

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Docket Nos. 50-263, 50-282, and 50-306

Enclosures:
1. List of Attendees
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