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JUN 17 2010

L-PI-10-061
10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Prairie Island Nuclear Generating Plant Units 1 and 2
Dockets 50-282 and 50-306
License Nos. DPR-42 and DPR-60

Supplement to License Amendment Request for Measurement Uncertainty Recapture – Power Uprate – Additional Information Regarding Main Steam System Stress Analyses and Electrical Output (TAC Nos. ME3015 and ME3016)

References:

1. Letter from Northern States Power Company, a Minnesota corporation, to the Nuclear Regulatory Commission, "License Amendment Request for Measurement Uncertainty Recapture – Power Uprate," L-PI-09-133, dated December 28, 2009, ADAMS Accession Number ML093650045.

2. Letter from Northern States Power Company, a Minnesota corporation, to the Nuclear Regulatory Commission, "Supplement to License Amendment Request for Measurement Uncertainty Recapture – Power Uprate – Response to Requests for Additional Information (TAC Nos. ME3015 and ME3016)," L-PI-10-036, dated April 19, 2010, ADAMS Accession Number ML101090498.

3. Letter from T. Beltz (NRC) to M. Schimmel (NSPM), "Prairie Island Nuclear Generating Plant, Units 1 and 2 – Requests for Additional Information (RAI) Associated with License Amendment Request Re: Measurement Uncertainty Recapture Power Uprate (TAC Nos. ME3015 and ME3016)," dated March 17, 2010, ADAMS Accession Number ML100740039.

This letter provides additional information in support of a License Amendment Request (LAR) submitted by the Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, in Reference 1. Reference 1 requested an amendment to the Operating License for the Prairie Island Nuclear Generating Plant (PINGP), Units 1 and 2, to increase the licensed thermal power as a result of a measurement uncertainty recapture (MUR) power uprate. In Reference 2, NSPM responded to Requests for Additional Information (RAIs) provided by the Nuclear Regulatory Commission (NRC) Staff in Reference 3.

During subsequent discussions with the NRC Staff, questions were raised regarding the impact of the MUR power uprate on the structural integrity of the PINGP Main Steam (MS) system, and also on the electrical output of the PINGP generators and the impacts of increased generation on grid stability. Enclosure 1 addresses questions regarding the Main Steam stress analysis and impacts of the MUR power uprate. Enclosure 2 discusses the electrical output of the PINGP generators and the grid stability studies performed in support of the MUR power uprate. Enclosure 3 provides a Generator Interconnection Study performed by the Midwest Independent System Operator (MISO), dated May 2006, in support of the MUR power uprate. NSPM submits this supplement in accordance with the provisions of 10 CFR 50.90.

The supplemental information provided in this letter does not impact the conclusions of the Determination of No Significant Hazards Consideration and Environmental Assessment presented in the Reference 1 submittal.

In accordance with 10 CFR 50.91, NSPM is notifying the State of Minnesota of this LAR supplement by transmitting a copy of this letter to the designated State Official.

If there are any questions or if additional information is needed, please contact Sam Chesnutt at 651-267-7546.

<u>Summary of Commitments</u>

The information in Enclosure 1 satisfies the commitment made in Reference 2 to submit justification for the Main Steam system stress analysis, including piping, supports, and components by August 27, 2010. The Reference 2 commitment is therefore complete.

This letter contains no new commitments and no revisions to existing commitments.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on JUN 17 2010

Mark A. Schimmel

Mark A. Schimmel
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (3)

cc: Administrator, Region III, USNRC
Project Manager, PINGP, USNRC
Resident Inspector, PINGP, USNRC
State of Minnesota

ENCLOSURE 1

<u>Additional Information Regarding Main Steam System Stress Analysis Issues Related to a License Amendment Request for a Measurement Uncertainty Recapture Power Uprate Project at the Prairie Island Nuclear Generating Plant</u>

This enclosure provides additional information from the Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, in support of NSPM's License Amendment Request (LAR) for a measurement uncertainty recapture (MUR) power uprate submitted in Reference 1. The information in this enclosure addresses the Main Steam (MS) System stress analyses at the Prairie Island Nuclear Generating Plant (PINGP) that were discussed in NSPM's response (Reference 2) to a Request for Additional Information (RAI) provided by the Nuclear Regulatory Commission (NRC) in Reference 3.

During telephone conferences held with members of the NRC Staff on April 26, May 21 and May 24, 2010, the NRC requested additional information supporting that the MUR power uprate would not adversely affect the structural integrity of the MS system.

1. Background

In support of the MUR power uprate, NSPM reviewed the analysis of record (AOR) for various plant systems to determine the impact of the uprate on system stress analyses. This review determined that Main Steam (MS) system design conditions for the MUR power uprate are bounded by the current licensing basis (CLB), but this review also identified certain discrepancies in the MS system piping stress AOR, as stated in Reference 1 (Enclosure 2, Section IV.1.A.v, page 48). It is important to note that the discrepant conditions discovered in the MS pipe stress analysis are applicable to current operating conditions and were not created by or uniquely associated with the MUR power uprate.

NSPM's evaluation of the MS pipe stress analysis discrepancies led to the initiation of a revision to the MS pipe stress analysis, as identified in Reference 1 (Enclosure 2, Section IV.1.B.i, page 51). The revised analysis is not yet complete, as described in Reference 2. The following discussion addresses the discrepancies that have been identified in the analysis, the effects of the MUR power uprate, and NSPM's conclusion that structural integrity of the MS system is maintained both for current operations and for MUR uprate conditions.

2. Discrepant Conditions

The discrepancies found in the MS system piping analysis involve errors in the modeling and seismic portions of the stress analysis which are not related to the MUR power uprate. Preliminary calculations have identified several pipe overstress conditions primarily due to inadequate treatment of torsional seismic acceleration and inaccurate modeling of snubbers in the MS safety valve (MSSV) thrust load stress runs.

Resolution of some of these overstress conditions will require physical modifications such as snubber replacement and removal of welded piping attachments, which will require plant shutdown conditions. The re-analysis is still in progress and additional non-conforming conditions may be identified.

Each overstress location identified to date has been identified as a non-conforming condition and entered into the PINGP Corrective Action Program (CAP). Structures, systems, and components (SSCs) such as the MS system piping and supports are evaluated to determine the impact of the overstress condition on the SSC's operability status (e.g., Operable, Inoperable, Operable but Degraded, Operable but Non-Conforming). Future non-conforming conditions will be processed in the same manner in accordance with PINGP CAP procedures.

MS system calculated stresses have been evaluated using the Piping Operability Stress Criteria in the PINGP Engineering Manual, and the overstress conditions have been determined Operable but Non-Conforming (OBN). The Piping Operability Stress Criteria requires that total stresses (e.g., due to pressure, dead weight, seismic, and thrust forces) must not exceed 2.0 times the material yield stress at operating temperatures. The stress analyses used to support the OBN evaluations were performed for Hot Zero Power (HZP) system conditions that are bounding for both current operations and for the MUR power uprate conditions at Hot Full Power (HFP), as shown below.

Parameter	Current Operations	Post-MUR Power Uprate
Design Pressure (HZP) psig	1085	1085
Design Temperature (HZP) °F	600	600
Operating Pressure (HZP, saturated conditions at 547 °F) psig	1005	1005
Operating Temperature (HZP of 547 plus analytical margin) °F	560	560
Operating Pressure (HFP) psia	772 (U1) 719 (U2)	765 (U1) 712 (U2)
Operating Temperature (HFP) °F	514.1 (U1) 506.2 (U2)	513.2 (U1) 505.0 (U2)

The OBN process provides relaxed stress acceptance criteria for an interim period and is consistent with NRC Inspection Manual Section 9900, "Operability Determinations and Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety."

Based on PINGP's CAP evaluation and Operability Determination process, OBN MS piping conditions are acceptable for continued plant operation on an interim basis. Analyzed system conditions are bounding for both current operations and MUR uprate conditions. The PINGP CAP program requires that corrective actions for non-conforming conditions be completed at the first available opportunity.

3. Effects of MUR Power Uprate

Stress in the MS piping results from deadweight, pressure, thermal, seismic, pipe rupture, and safety relief valve thrust forces in combinations defined by USAR Table 12.2-11, "Load Combinations for Components." The effects of the MUR power uprate on these forces and the applicable AORs include the following:

- Thermal and pressure stresses depend on the operating temperature and pressure, respectively, of the piping system. The AOR thermal and pressure stress analysis of the MS system is based on the limiting HZP temperature and pressure, both of which do not change for the MUR power uprate as shown in the table above. For the HFP normal operating conditions as shown above, MS system temperature decreases approximately 1 °F and MS system pressure decreases approximately 7 psia. (Reference 1, Enclosure 2, Table IV.1.B.4, page 55). Therefore, thermal and pressure stresses in the AORs bound MUR power uprate conditions.
- Deadweight and seismic loads are unrelated to temperature, pressure, or power levels and are not affected by the MUR power uprate. The AOR for deadweight and seismic forces remains bounding.
- Pipe rupture loads from steam systems depend upon system pressure and break area. The AOR for the MS system calculates pipe rupture loads based upon the more limiting HZP pressure, which does not change for the MUR power uprate. Therefore, the MUR power uprate does not affect pipe rupture loads on MS piping and its supports.
- MS system flow rates increase approximately 2%, and moisture carryover (MCO) levels increase to approximately 1.4% (Reference 1, Enclosure 2, IV.1.B.i, page 51). The associated increases in steam flow and density result in higher thrust forces during lifting of the MSSVs. However, the associated CAP operability determination concluded that MS piping stress levels, including MSSV thrust forces at MUR uprate conditions, remain less than the interim Piping Operability Stress Criteria described above, and the associated piping is therefore OBN.

As described previously, the MS piping overstress conditions identified to date have not been created by the MUR uprated power level. Also, since overstress conditions have already been evaluated for conditions that bound MUR uprate conditions, the MUR uprate will not result in any increases in analyzed stress levels. Additional overstress or other non-conforming conditions that may be identified in the future will be processed though the PINGP CAP program and evaluated against the OBN criteria in the same manner as described above.

4. Conclusion

The MS piping system at PINGP has several overstress locations that have been determined Operable but Non-Conforming (OBN) and are acceptable for continued operation on an interim basis. The stress analyses that support the OBN operability determinations have been performed for system HZP conditions that are bounding for both current operations and MUR uprate conditions. The MUR power uprate will not increase analyzed stress levels and the Operability criteria will still be met.

Based on the above, the MUR power uprate is not considered to adversely affect the structural integrity of the system. The current AOR for the MS system piping, along with OBN overstress conditions that are processed through the PINGP CAP program, is bounding for MUR power uprate conditions.

5. Commitments and Actions Previously Described

In Reference 2, NSPM committed to submit justification for the Main Steam system stress analysis, including piping, supports, and components by August 27, 2010. Also, in Reference 1, although this was not identified as a commitment, NSPM indicated that a revision to the MS stress analysis to ensure that MSSV thrust forces would be acceptable at MUR conditions would be complete prior to uprate (Enclosure 2, page 51).

The information provided above provides justification for the MS stress analysis at MUR uprate conditions based on the current AOR and ongoing efforts to identify, process, and resolve OBN overstress conditions through the PINGP CAP program. Although the analysis efforts for MS piping, supports, components, and MSSV thrust forces are not yet finalized, the analyses described above and the PINGP process for ensuring that non-conforming conditions satisfy the operability criteria for MUR conditions, demonstrate the structural integrity of the MS system for MUR uprate conditions. NSPM therefore considers the commitment identified in Reference 2 and actions described in Reference 1 to be complete.

References

1. Letter from Northern States Power Company, a Minnesota corporation, to the Nuclear Regulatory Commission, "License Amendment Request for Measurement Uncertainty Recapture – Power Uprate," L-PI-09-133, dated December 28, 2009, ADAMS Accession Number ML093650045.

2. Letter from Northern States Power Company, a Minnesota corporation, to the Nuclear Regulatory Commission, "Supplement to License Amendment Request for Measurement Uncertainty Recapture – Power Uprate – Response to Requests for Additional Information (TAC Nos. ME3015 and ME3016)," L-PI-10-036, dated April 19, 2010, ADAMS Accession Number ML101090498.

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ENCLOSURE 2

Additional Information Regarding Electrical Output and Grid Stability Issues Related to a License Amendment Request for a Measurement Uncertainty Recapture Power Uprate Project at the Prairie Island Nuclear Generating Plant

This enclosure provides additional information from the Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, in support of NSPM's License Amendment Request (LAR) for a measurement uncertainty recapture (MUR) power uprate submitted in Reference 1. The information in this enclosure addresses the effects of the MUR power uprate on electrical output and grid stability of the Prairie Island Nuclear Generating Plant (PINGP). These effects were addressed in NSPM's response (Reference 2) to a Request for Additional Information (RAI) provided by the Nuclear Regulatory Commission (NRC) in Reference 3.

During telephone conferences held with members of the NRC Staff on May 21 and June 1, 2010, the NRC requested clarification of the net and gross generation values for PINGP units, both before and after the MUR power uprate, and of grid stability studies performed to support the uprate. In addition, clarification was requested of the grid analyses that demonstrate sufficient post-trip voltage at PINGP buses after an assumed trip of both units.

1. Effects of MUR power uprate on Electrical Generation

The proposed MUR power uprate will increase the licensed thermal power level of each of the two units at the Prairie Island Nuclear Generating Plant (PINGP) from 1650 MWt to 1677 MWt. This represents an increase in electrical generation of approximately 9 MWe per unit.

The corresponding gross and net electrical generation values before and after the MUR power uprate are as follows:

- Gross electrical generation:
  - Before uprate: 575 MWe (Unit 1 and Unit 2)
  - After uprate: 584 MWe (Unit 1 and Unit 2); this represents a 9 MWe increase per unit

- Net electrical generation, which is determined by subtracting station service loads from the gross generation values:
  - Before uprate: 551 MWe (Unit 1), 545 MWe (Unit 2); note that the differences in Unit 1 and Unit 2 net generation values reflect differences in the sharing of station service loads
  - After uprate: 560 MWe (Unit 1), 554 MWe (Unit 2); this represents a 9 MWe increase per unit and reflects the fact that station service loads are not changed by the MUR power uprate

These generation values represent winter conditions, which typically provide the highest seasonal generation values at PINGP. During winter months, PINGP typically uses cooling water from the Mississippi River. Colder cooling water temperatures produce greater condenser vacuum and more efficient thermal performance, therefore, the plant produces more electrical power for the same reactor thermal power levels. In addition, net generation levels are further increased in winter months because the cooling towers are not operated, resulting in lower station service loads.

2. <u>Grid Stability Studies – Generation Levels and Grid Conditions</u>

This section discusses the following three grid studies that support the MUR power uprate:

- Midwest Independent System Operator (MISO) Study, March 2006, provided in Reference 1, Enclosure 8. This study included steady state and grid stability analyses using a summer case grid model and summer generation values.
- MISO Study, May 2006, included as Enclosure 3 to this letter. This study included steady state and grid stability analyses using a summer case grid model and higher winter generation values.
- IEEE-765 Study, November 2009, provided in Reference 1, Enclosure 8. This study included a transient stability analysis and evaluated post-disturbance voltages after a dual-unit trip at PINGP, using summer generation values. This study was also re-evaluated to consider higher winter generation values.

<u>MISO Study – March 2006</u>
The Midwest Independent System Operator (MISO) evaluated the impact of an MUR power uprate on transmission system performance, in support of the PINGP Large Generator Interconnection Agreement (GIA). The resulting MISO Generation Interconnection Study, dated March 24, 2006, (hereafter referred to as the March 2006 MISO Study) evaluated the addition of 19 MWe to Unit 1 and 19 MWe to Unit 2, for a total of 38 MWe. The additional 19 MWe for each unit includes approximately 9 MWe for the MUR power uprate and approximately 10 MWe to account for unspecified efficiency improvements and equipment changes unrelated to the MUR power uprate. The March 2006 MISO Study was submitted as part of Enclosure 8 in Reference 1, and reflects MISO's designations of the uprate projects as G433 (Unit 1) and G434 (Unit 2).

The March 2006 MISO Study evaluated the impact of the MUR power uprate project on transmission system performance. System impact studies included steady state and stability analyses based on a grid system model that includes the PINGP generators and station service loads. Steady state analyses included thermal and voltage analyses, which evaluated the effects of a loss of transmission lines or other grid elements. The stability analysis evaluates system stability when subjected to various local and regional disturbances, which included faults and trips.

The following summer generation levels were included in the March 2006 MISO Study:

- Gross generation after the uprate:
  - 569 MWe (Unit 1), 565 MWe (Unit 2)

- Net generation to the grid after the uprate, determined by subtracting station service loads from the gross generation values:
  - 537 MWe (Unit 1), 532 MWE (Unit 2)

The March 2006 MISO Study evaluated the grid under various system conditions, which represent the most stressed conditions for the analysis being performed.

The March 2006 MISO Study steady state analyses determined that the impacts of the MUR power uprate on transmission facility loadings and bus voltages did not result in any new thermal or voltage violations.

The March 2006 MISO Study stability analysis evaluated the impact of the proposed MUR power uprate and other unspecified efficiency improvements and equipment changes on system stability. The stability analysis simulated summer off-peak conditions with maximum simultaneous transfer levels across the major interfaces. No stability criteria violations were observed for the simulated disturbances. Results indicate that the interconnection of the proposed MUR power uprate would not adversely impact transmission system stability.

<u>MISO Study – May 2006</u>
In May 2006, MISO performed an additional Generation Interconnection Study analysis based on winter PINGP generation levels, to more clearly bound the proposed MUR power uprate output levels. This study was performed as a Sensitivity Study for the Generation Interconnection Study for the MUR power uprate projects, G433 and G434. The May 2006 MISO Sensitivity Study - Generation Interconnection Study (hereafter referred to as the May 2006 MISO Study) is included as Enclosure 3 to this letter.

The enclosed May 2006 MISO Study used the same transmission system models used for the March 2006 MISO Study, and was also simulated under the most stressed conditions for the analysis being performed. This study included steady state and stability analyses and evaluated the following winter PINGP generation levels:

- Net generation to the grid after the uprate:
  - 568 MWe (Unit 1), 565 MWe (Unit 2)

- Note that these <u>net</u> generation values are comparable to the <u>gross</u> generation values evaluated in the March 2006 report, and these values bound the net generation values for the MUR power uprate.

The steady state analyses in the enclosed May 2006 MISO Study determined that the impacts of the MUR power uprate on transmission facility loadings and bus voltages did not result in any new thermal or voltage violations.

The stability analysis in the enclosed May 2006 MISO Study evaluated the impact of the proposed MUR power uprate and other unspecified efficiency improvements on system stability. The stability analysis simulated summer off-peak conditions with maximum simultaneous transfer levels across the major interfaces, and evaluated winter PINGP generation levels. No stability criteria violations were observed for the simulated disturbances. Results indicate that the interconnection of the proposed projects would not adversely impact transmission system stability.

Xcel Energy and MISO subsequently entered into the MISO G433/G434 Large GIA, in June 2006. This GIA granted interconnection services to PINGP Unit 1 for a total of 568 MWe net, and to Unit 2 for a total of 565 MWe net. This is the maximum net output generation allowed under this agreement.

<u>IEEE-765 Study – November 2009</u>
An additional study was performed in 2009 to confirm that the MUR power uprate meets transmission study requirements of IEEE-765, "IEEE Standard for Preferred Power Supply (PPS) for Nuclear Power Generating Stations (NPGS)." This study was a transient stability study that confirmed the strength of the transmission system following disturbances, although it was not required to support the MISO GIA. This study also evaluated post-disturbance voltage levels at the PINGP buses. As stated in Reference 1 (Enclosure 2, Section V.1.D, page 79), the IEEE-765 supplemental analysis demonstrated that following the PINGP MUR power uprate expansions, the voltages at the PINGP 161 kV and 345 kV buses were within the PINGP voltage criteria for all disturbances studied. The 2009 IEEE-765 Study was included in Enclosure 8 to Reference 1.

The IEEE-765 Study evaluated post-disturbance voltage levels at the PINGP 161 kV and 345 kV buses. The following conditions are evaluated, as specified in IEEE-765:

a. Loss of the nuclear power generating unit (Unit 1, Unit 2, and both units)
b. Loss of the largest or most significant generating unit
c. Loss of the largest or most significant transmission circuit or intertie
d. Loss of the largest or most significant load

This study evaluated the following PINGP summer generation levels:

- Net generation to the grid after the uprate:
    - 537 MWe (Unit 1), 532 MWe (Unit 2)

This study verified that there were no stability criteria violations or damping problems for the 38 MWe uprates. This study also included an evaluation of 19 system disturbances, including a trip of both units at PINGP, to determine whether post-event voltages on the PINGP buses after the system reaches steady state, would meet minimum criteria.

Analyzed PINGP bus voltages were within the acceptable range for all disturbances evaluated, including a two-unit PINGP trip, as shown in Table 4-2 of the IEEE-765

Study for Fault Codes 'nat' (Unit 1 trip), 'nbt' (Unit 2 trip), and 'nct' (dual unit trip). In addition, the IEEE-765 Study validated the stability results of the March 2006 MISO Study.

The November 2009 IEEE-765 Study was re-evaluated for the higher PINGP winter generation levels as follows:

- Net generation to the grid after the uprate:
  - 568 MWe (Unit 1), 565 MWe (Unit 2)

This re-evaluation considered the trips of PINGP Unit 1, Unit 2, and both units in the same manner previously evaluated in the November 2009 IEEE-765 Study, and confirmed the previous results. At the higher PINGP winter generation levels after the MUR power uprate, post-event voltages at PINGP 161 kV and 345 kV buses were found to satisfy minimum voltage requirements for expected bus alignments.

3. Grid Stability Studies – Response to Disturbances and a Two-Unit Trip

The requirement to maintain adequate voltage after a two-unit trip is included in the current licensing basis for PINGP, as discussed in USAR Section 8.2.2, "Offsite Grid Reliability."

The grid stability analyses included in the MISO Studies evaluate grid responses to disturbances local to PINGP and the most limiting disturbances in the North Dakota, South Dakota, and Twin Cities metro area. Typical MISO-analyzed fault scenarios or disturbances include various ground faults and protective breaker failures that represent generator trips and the loss of transmission lines. The resulting system voltages and oscillations were examined and the MUR power uprate projects were determined to not adversely impact transmission system stability or result in any stability criteria violations.

Voltages at the PINGP grid interface location are ensured both on a real-time basis by nearly continuous contingency analyses and on a planning basis by use of computer models. The minimum voltages for PINGP are based on the equipment required to safely shut down the plant after a two-unit trip. These voltages are contained in site calculations for different bus alignments and are included in a site abnormal operating procedure. The minimum voltages to ensure safe shutdown conditions at PINGP do not change as a result of the MUR power uprate.

Adequate voltage support for post-trip conditions is assured on a real-time basis, as mentioned above, by the Security Analysis computer software. This software continuously looks at the current grid configuration and runs contingency analyses for various grid events, including a dual unit trip at PINGP. The Security Analysis software evaluates grid conditions and calculates parameters such as voltages on the PINGP 161 kV and 345 kV buses approximately once every 4 to 8 minutes. As long as the resultant voltages are greater than the requirements of station procedures, the analysis assures that adequate voltage would be available to ensure operation of necessary shutdown and safety equipment following a two-unit trip under the current grid configuration. In the event that minimum required voltages would not be met, an alarm alerts transmission operations personnel to perform corrective actions. If low voltage conditions would still exist, then PINGP control room personnel are contacted and actions are taken to change either the grid configuration or local plant conditions to ensure that required post-trip voltages can be met.

The current Security Analysis also ensures that post-trip voltages will be adequate at PINGP buses after the MUR power uprate is implemented, because the MUR power uprate does not change the post-trip voltage requirements used in the Security Analysis. The Security Analysis is part of MISO standing operating guidance and NSPM plans to continue this analysis to ensure adequate post-contingent voltages at the PINGP 161 kV and 345 kV buses, following events that include the trip of both PINGP units.

In addition to real time studies, grid performance after the MUR power uprate was also evaluated in the November 2009 IEEE-765 study discussed above. As noted previously, the November 2009 IEEE-765 study evaluated a trip of PINGP Units 1 and 2 at post-MUR power uprate conditions, and confirmed that post-trip voltages exceed the minimum voltages established in site procedures, based on the summer generation values considered in that evaluation. These conclusions have also been confirmed for the higher winter generation values, post-MUR power uprate, as identified above.

4. <u>Conclusion</u>

In summary, the MISO Generation Interconnection Studies performed in March 2006 and in May 2006 both demonstrate that the PINGP MUR power uprate will not result in additional instabilities in the grid following worst case disturbances or other contingency events. In addition, the Security Analysis computer software real time contingency studies will continue to demonstrate adequate voltage at PINGP after the MUR power uprate. PINGP voltage requirements are not changed by the MUR power uprate and grid capabilities for supporting these requirements remain adequate. In addition, the IEEE-765 study performed in 2009 and re-evaluated in 2010 confirm the conclusions of the 2006 MISO Studies, and confirm adequate post-trip voltage support after a two-unit trip at PINGP.

Based on the above, the higher generation values associated with the MUR power uprate will not affect grid stability, and post-trip voltages after a trip of both units at PINGP will continue to exceed minimum voltages for normal bus alignments.

References

1. Letter from Northern States Power Company, a Minnesota corporation, to the Nuclear Regulatory Commission, “License Amendment Request for Measurement Uncertainty Recapture – Power Uprate,” L-PI-09-133, dated December 28, 2009, ADAMS Accession Number ML093650045.

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Enclosure 3

to

Letter from Mark A. Schimmel (NSPM)

to

Document Control Desk (NRC)

Midwest Independent System Operator (MISO)
"Sensitivity Study - Generation Interconnection Study – Projects #G433 and G434
38 MW Expansion of Prairie Island Units 1 and 2"
dated May 31, 2006

19 pages follow

ABB

Sensitivity Study

Generation Interconnection Study - Projects # G433 and G434
38 MW Expansion of Prairie Island Units 1 and 2

May 31, 2006

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ESC Report No. 2005-11125-2.R03

ABB Inc.			**Technical Report**
Midwest ISO	ESC Report No. 2005-11125-013-2.R03		
Title: Sensitivity Study - Generation Interconnection for Projects # G433 and G434	Dept	Date	Pages
	ESC	May 31, 2006	14

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Executive Summary

A generator interconnection evaluation study was recently completed to evaluate the collective impact of generation interconnection requests G433 and G434 on transmission system performance. See reference [1]. Together, these projects have requested a combined output of 38 MW (Gross). Project G433 is a 19 MW expansion to Prairie Island #1 and Project G434 is a 19 MW expansion to Prairie Island #2.

In the above study, the MW outputs of the Prairie Island units (pre- and post-expansion) were modeled based on their Summer maximum ratings. MISO recently indicated that the Prairie Island units would have higher ratings in Winter (a total of 64 MW higher than the Summer ratings) and requested that a sensitivity study be performed to assess the impact of the proposed interconnections based on the higher pre- and post-project MW outputs.

The scope of the sensitivity study included a limited amount of steady-state and stability analysis to assess the impact of the proposed interconnections on the transmission system. In this study, the pre- and post-expansion MW outputs of the Prairie Island units are modeled based on the Winter maximum ratings.

The following is a summary of study results.

<u>Steady-State Analysis</u>:
The interconnection of the proposed projects impacted several transmission facilities and resulted in steady-state criteria violations for system intact and contingency conditions. These violations are remote from the Prairie Island substation. The transmission outlets out of the Prairie Island substation are not overloaded. Based on the available information, these remote violations should not limit the ability of the proposed projects to interconnect as Energy Resource.

The violations reported in this study could potentially limit the ability of the projects to deliver power into the transmission system. MISO has indicated that these overloads can not be classified as injection issues and therefore they need not to be mitigated for Energy Resource Interconnection Service.

Stability Analysis:

Stability analysis was performed to evaluate the impact of the proposed projects on the system stability. All faults simulated in reference [1] were tested. No transient or dynamic instability problems were observed.

Simulation plots for faults ag1, ei2, 4b3, 4p3 and pr3 showed poorly damped oscillations in the rotor angles for the following units, both with and without the proposed projects: Big Falls (4.8 MW unit at bus 60662) and Redwing (23.2 MW unit at bus 60823). These oscillations are most prominent for faults 4b3, 4p3 and pr3 and appear to be confined to the Big Falls and Redwing units i.e., the oscillations do not propagate to the bulk power system. Prony analysis was used to calculate the oscillation modes of the Big Falls and Redwing rotor angles and the corresponding damping ratios for fault "4b3". Results suggest that the damping ratios associated with the rotor angle oscillations at Big Falls and Redwing are in violation of the MAPP Transient Period Damping Criteria even prior to the addition of the proposed projects. The proposed projects, however, do not adversely impact damping performance and no oscillatory behavior was observed in the Prairie Island rotor angles.

In conclusion, the results of the stability analysis indicate that the interconnection of the proposed projects would not adversely impact transmission system stability.

The results of this study are based on available data and assumptions made at the time of conducting this study. In particular, it should be noted that the results depend on delivery assumptions of prior-queued generator interconnections. If the delivery assumptions of the prior-queued generators change and/or if the prior-queued units drop out of the generator interconnection queue, additional studies may be required to determine possible criteria violations that may limit the ability of the project to inject and/or deliver power into the transmission system. Any additional studies are considered outside of the scope of the system impact studies. The results provided in this report may not apply if any of the data and/or assumptions made in developing the study models change.

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Table of Contents

1. INTRODUCTION

A generator interconnection evaluation study was recently completed to evaluate the collective impact of generation interconnection requests G433 and G434 on transmission system performance. See reference [1]. Together, these projects have requested a combined output of 38 MW (Gross). Project G433 is a 19 MW expansion to Prairie Island #1 and Project G434 is a 19 MW expansion to Prairie Island #2.

In the above study, the MW outputs of the Prairie Island units (pre- and post-expansion) were modeled based on their Summer maximum ratings. MISO recently indicated that the Prairie Island units would have higher ratings in Winter (a total of 64 MW higher than the Summer ratings) and requested that a sensitivity study be performed to assess the impact of the proposed interconnections based on the higher pre- and post-project MW outputs. For the purposes of this study, the pre- and post-expansion MW outputs of the Prairie Island units were modeled based on the Winter maximum ratings. These values were provided by MISO.

<u>Prairie Island Unit 1</u>:
Net MW Output = 549 MW (pre-project) and 568 MW (post-project)

<u>Prairie Island Unit 2</u>:
Net MW Output = 546 MW (pre-project) and 565 MW (post-project)

The scope of work for the sensitivity study included a limited amount of steady-state and stability analysis to assess the impact of the proposed interconnections on the transmission system.

For steady-state analysis purposes, the same pre- and post-project peak 2007 summer peak load cases that were used in reference [1] were used. The Gross MW outputs of the Prairie Island units were increased by a total of approximately 64 MW in order to obtain the Net MW outputs shown above. System intact and contingency analyses were repeated on these cases using the same criteria described in reference [1]. For contingency analysis purposes, a limited number of single line outages in the vicinity of Prairie Island were tested. Also tested were a small number of multi-terminal contingencies. Section 2 of this report summarizes the results of the steady-state analysis.

For stability analysis purposes, the same pre- and post-project stability models that were used in reference [1] were used. Again, the Gross MW outputs of the Prairie Island units were adjusted so as to obtain the desired Net MW outputs shown above. All local and regional contingencies that were tested in reference [1] were repeated. Section 3 of this report summarizes the results of the stability analysis.

2. STEADY-STATE ANALYSIS

2.1 Base Case Development

For the purposes of this study, the same pre- and post-project 2007 summer peak load cases that were used in reference [1] were used. Gross generation levels at Prairie Island were adjusted to obtain the Net MW outputs listed in Section 1 of this report. As before, generators in the MISO footprint[1] were scaled down in order to account for the increase in generation.

Figures 2.1 and 2.2 show PSS/E power flow diagrams of the area in the vicinity of the Prairie Island substation for 2007 summer peak load conditions, both with and without the proposed projects.

System intact and contingency analyses were repeated on these cases using the same criteria described in reference [1]. For contingency analysis purposes, a limited number of single line outages in the vicinity of Prairie Island were tested. Also tested were a small number of multi-terminal contingencies. Appendix A lists the subsystem description, monitored element and the contingency description files used in the power flow analysis.

2.2 System Intact Analysis

Impact of Proposed Projects on Facility Loadings

Thermal overloads were observed on several transmission facilities, both with and without the proposed projects (see Appendix B). MAPP DRS Guidelines[2] were used to identify Significantly Affected Facilities (SAF). According to these guidelines, all overloaded facilities that have a TDF (Transfer Distribution Factor) greater than 2% of the generation addition and an increase in flow of at least 1 MW (without plant vs. with plant) are to be flagged as significantly affected facilities.

Results indicate that the impact of the proposed projects on facility loadings under system intact conditions is negligible. No significant impacts were noted and no new thermal violations were observed.

Impact of Proposed Projects on Bus Voltages

Voltage criteria violations were observed at several remote buses, both with and without the proposed projects (see Appendix B). In accordance with MAPP DRS Guidelines, those buses that have a voltage change of more than 0.01 p.u. (without plant vs. with

[1] MISO Footprint was defined as generation in the following areas: Area 356: Ameren, Area 359: Cilco, Area 208: Cinergy, Area 360: CWLP, and Area 211: LGEE, Area 650: Lincoln Electric System, Area 218: CONS, Area 361: SIPC, Area 202: FE, Area 217: NIPS.

[2] Steady-State Facility & Constrained Path Impact Determination Requirements & Screening Guidelines for Study Submissions, Prepared by MAPP Design Review Subcommittee (DRS). Oct 28, 2003.

plant) are included in the SAF list. The impact of the proposed projects on bus voltages under system intact conditions is negligible. No significant impacts were noted and no new voltage violations were observed.

2.3 Contingency Analysis

After establishing the system intact violations, transmission system steady-state performance was compared by performing N-1 contingency analyses on the summer peak cases, both with and without the proposed projects. Also tested were a small number of multi-terminal contingencies. See Appendix A. The analyses were conducted using activity ACCC of PSS/E.

AC contingency analysis results were post-processed to create SCREENACCC reports to compare the results obtained from the pre-project cases vs. those obtained from the post-project cases (see Appendix C).

The impact of the proposed projects on facility loadings and bus voltages is summarized below. As before, MAPP DRS Guidelines were used to identify significantly affected facilities.

<u>Impact of Proposed Projects on Facility Loadings</u>

Table 2.1 lists the significantly affected facilities. A comparison of limiting facility loadings in percentage with and without the proposed projects is presented. These tables list only the most limiting contingency (one that causes highest overload) for each overloaded facility. The limiting elements listed in these tables are segregated based on transmission ownership information as available from PSS/E power flow model and information provided by various transmission owners.

The results of Table 2.1 indicate that the significantly affected facilities are remote from the point of interconnection. A detailed analysis of the impacts is considered beyond the scope of this study.

<u>Impact of Proposed Projects on Bus Voltages</u>

Voltage violations were observed at several remote buses both with and without the proposed project. No new voltage violations were observed, and the impact of the proposed projects on pre-project voltage violations is insignificant.

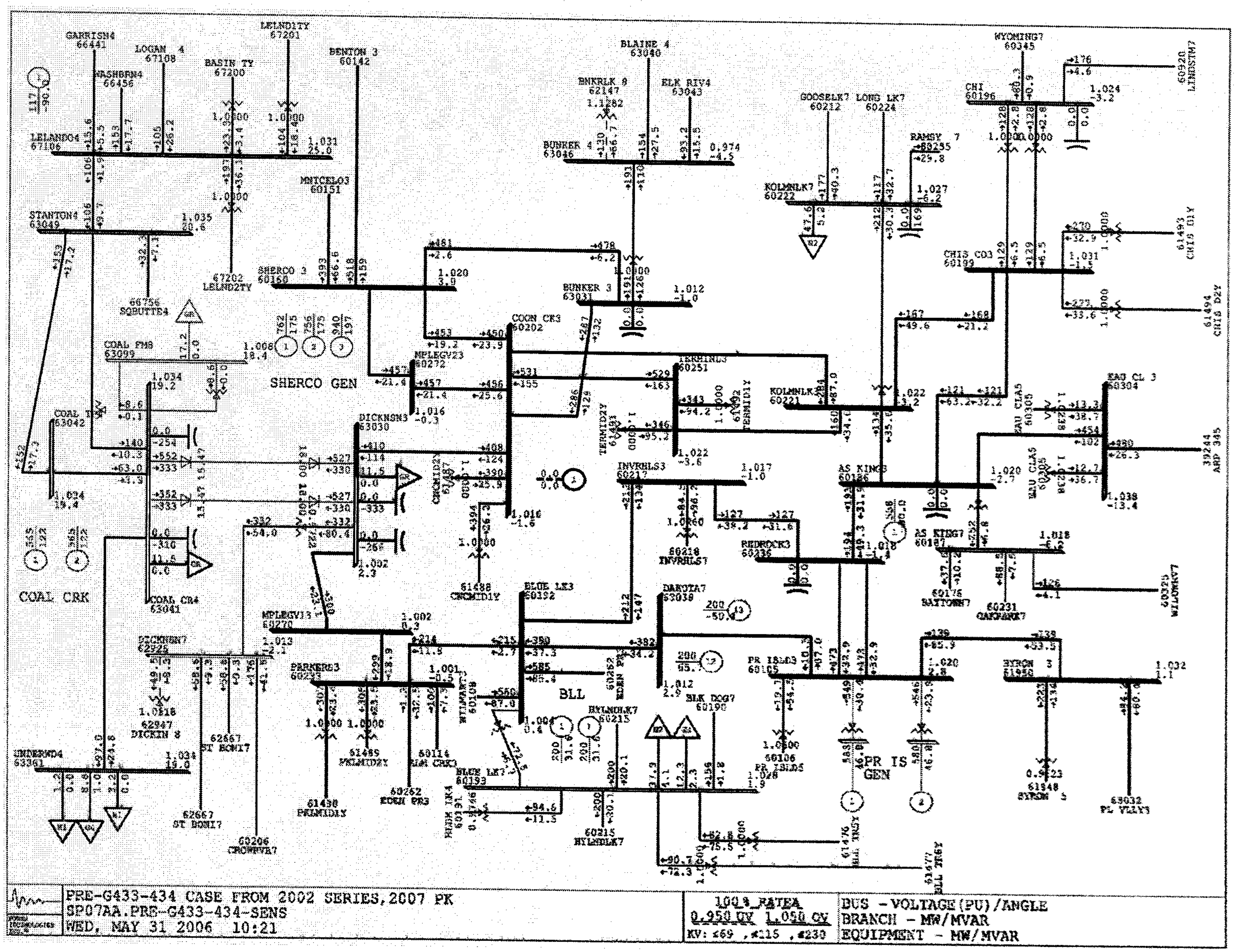

Figure 3.1: Power Flow Diagram for 2007 Summer Peak Load Conditions (Without G433 & G434)

ABB

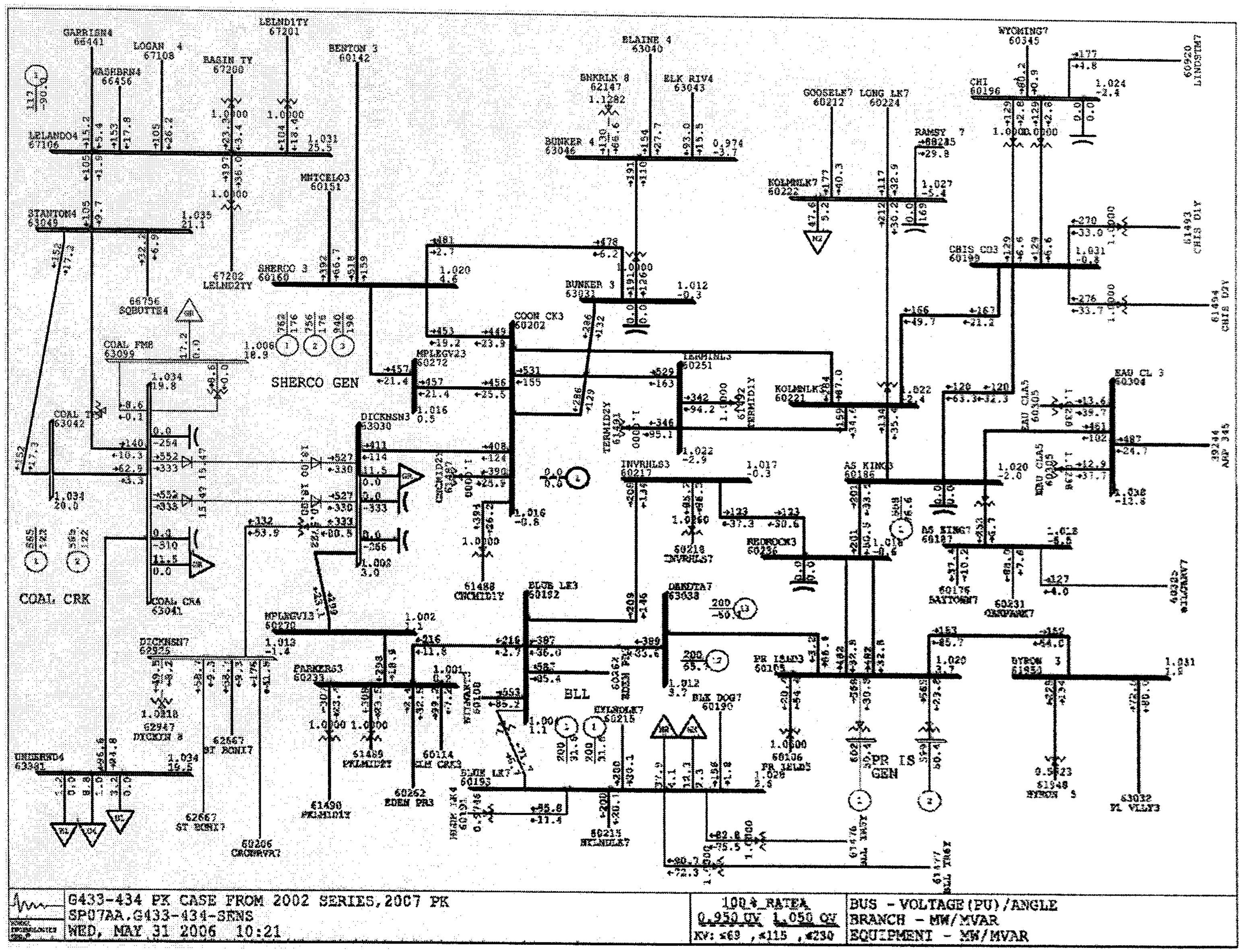

Figure 3.2: Power Flow Diagram for 2007 Summer Peak Load Conditions (With G433 & G434)

Table 2.1: Significantly Affected Facilities for Contingency Conditions (2007 Summer Peak)

LIMITING ELEMENT	RATING (MVA)			CONTINGENCY	% LOADING (ON RATE C)		CHANGE (%)	TDF
	RATEA	RATEB	RATEC		WITHOUT G433/434	WITH G433/434		
ALTW								
34020 HAZL S 5 161 - 34135 DUNDEE 5 161 1	167.0	167.0	167.0	34018 HAZLTON3 345 - 34093 ARNOLD 3 345 ckt 1	125.4	127.1	1.7	0.06842
MEC								
34016 EMERY 5 161 - 64252 FLOYD 5 161 1	238.0	238.0	238.0	34018 HAZLTON3 345 - 60102 ADAMS 3 345 ckt 1	105.5	106.1	0.6	0.03947
64239 FRANKLN5 161 - 64285 BUTLER 5 161 1	181.0	181.0	181.0	34018 HAZLTON3 345 - 60102 ADAMS 3 345 ckt 1	125.5	126.0	0.5	0.02105
XEL								
60305 EAU CLA5 161 - 60317 WHEATON5 161 1	272.0	272.0	300.0	60186 AS KING3 345 - 60304 EAU CL 3 345 ckt 1	121.0	121.5	0.5	0.04474

2.4 Summary of Results

The interconnection of the proposed projects impacted several transmission facilities and resulted in steady-state criteria violations for system intact and contingency conditions. These violations are remote from the Prairie Island substation. The transmission outlets out of the Prairie Island substation are not overloaded. Based on the available information, these remote violations should not limit the ability of the proposed projects to interconnect as Energy Resource.

The violations reported in this study could potentially limit the ability of the projects to deliver power into the transmission system. MISO has indicated that these overloads can not be classified as injection issues and therefore they need not to be mitigated for Energy Resource Interconnection Service.

3. STABILITY ANALYSIS

3.1 Model Development

For stability analysis purposes, the same pre- and post-project stability models that were used in reference [1] were used. Again, the Gross MW outputs of the Prairie Island units were adjusted so as to obtain the desired Net MW outputs listed in Section 1 of this report. As before, generators in the MISO footprint were scaled down in order to account for the increase in generation. The setexports program was used to adjust the maximum simultaneous interface levels to the following values: NDEX (1950 MW), MHEX (2175 MW), and MWSI (1480 MW). The case titles for the study cases with and without the proposed interconnections are presented below:

Pre-project Case (Without G433 & G434):

```
N44-SO07AA.UYVV4V4.SAV;SUMMER;OP LD;SYSTEM INTACT
ND=1947,MH=2172,MW=1479,OHMH=-197,OHMP=150,EWTW=-202,BD=167
```

Post-Project Case (With G433 & G434):

```
S44-SO07AA.UYVV4V4.SAV;SUMMER;OP LD;SYSTEM INTACT
ND=1947,MH=2172,MW=1479,OHMH=-197,OHMP=150,EWTW=-202,BD=167
```

As before, the studies were conducted utilizing the April 2004 MS Windows Version of the NMORWG Stability Package.

3.2 Results of Stability Analysis

The fault scenarios considered for stability assessment are the same as those simulated in reference [1]. See Table 3.1. With the exception of faults 4b3, 4p3 and pr3, all other faults listed in this table are standard faults from the NMORWG study package. All faults were run for 5 seconds, except for faults pcs, pct, pys, and pyt, which were run to 20 seconds, thus allowing for Prony analyses of any oscillations that might occur.

Table 3.1: List of Disturbances Simulated for Stability Assessment

Fault	Fault Description
ag1	4 cy slgf @ l.old 345 on ftthomp line, lo brkr 2692 stk clr @ 11 cy by tripping fltd line
ei2	permanent bipole fault on the cu dc line both coal creek units tripped at 0.28 sec
mss	SLGBF fault at Sherco on Coon Creek #1 line Trip Sherco to Coon Creek 345 kV and Coon Creek 345/115 kV
mts	SLGBF fault at Monticello with 8N6 stuck Trip Monticello to Elm Creek
nbz	4 cycle, three phase fault at chisago county trip f601c cross trip d602f, use new 100% reduction init from chisago
nmz	4 cycle, three phase fault at chisago trip f601c, xtrip d602f use new 100% reduction init from chisago, leave svs on mp sys
pcs	SLG fault at King-Eau Claire line with a breaker failure at king trips King-ECL,ECL-ARP,and ASK-CHI line
pct	trip of ask-ecl-arp without a fault trips ask-ecl-arp 345 kv line
pys	14 cycle slg at at prairie island trip pri-byn line
pyt	trip of pri-byn without a fault trips pri-byn 345 kv line
4b3	5 cycle 3 phase fault at DCG. Trip DCG-Blue Lake 345 kV line
4p3	5 cycle 3 phase fault at Prairie Island. Trip DCG-Prairie Island 345 kV line.
pr3	5 cycle 3 phase fault on Prairie Island end of Prairie Island-Red Rock. Trip Prairie Island-Red Rock 345 kV line Ckt 2

Table 3.2 summarizes the results. Simulation summary tables and plots for selected fault scenarios for the pre- and post-project cases are presented in Appendices D and E respectively.

No stability criteria violations were observed for the simulated faults after addition of proposed projects.

Simulation summary tables for fault "ag1" showed a transient voltage violation at bus 67233 "DCGX4 T230". This is the midpoint of a three-winding 345/230/13.8 kV transformer at the Antelope Valley substation. Since the pre- and post-project transient voltages are 0.67 pu, it is concluded that the proposed projects do not adversely impact the voltage at this bus.

Simulation plots for faults ag1, ei2, 4b3, 4p3 and pr3 showed poorly damped oscillations in the rotor angles for the following units, both in the pre- and post-project cases: Big Falls (4.8 MW unit at bus 60662) and Redwing (23.2 MW unit at bus 60823). The oscillations are present even when the faults are run out to 20 seconds and appear to be most prominent for faults 4b3, 4p3 and pr3. Also, the oscillations appear to be confined to the Big Falls and Redwing units and do not propagate to the bulk power system. The proposed G433 and G434 projects appear to have no significant impact on these oscillations. Prony analysis was used to calculate the oscillation modes of the Big Falls and Redwing rotor angles and the corresponding damping ratios for fault "4b3". The results are summarized in Table 3.3. The damping ratios were compared against the MAPP Damping Period Transient Criteria[3]. Per the MAPP criteria, the minimum damping ratio for disturbances with faults is 0.0081633. The Table 3.3 results suggest that the rotor angle oscillations at Big Falls and Redwing are in violation of the MAPP criteria. The proposed projects, however, do not adversely impact damping performance and no oscillatory behavior was observed in the Prairie Island rotor angles.

In conclusion, the results of the stability analysis indicate that the addition of proposed projects would not adversely impact system transmission system stability.

[3] *MAPP Members Reliability Criteria and Study Procedures Manual,* Prepared by MAPP Planning Standards Development Working Group, November 19, 2004 Revision

Table 3.2: Results of Stability Analysis

Fault	Fault Description	Without G433/434	With G433/434
ag1	4 cy slgf @ l.old 345 on ftthomp line, lo brkr 2692 stk clr @ 11 cy by tripping fltd line	Stable	Stable
ei2	permanent bipole fault on the cu dc line both coal creek units tripped at 0.28 sec	Stable	Stable
mss	SLGBF fault at Sherco on Coon Creek #1 line Trip Sherco to Coon Creek 345 kV and Coon Creek 345/115 kV	Stable	Stable
mts	SLGBF fault at Monticello with 8N6 stuck Trip Monticello to Elm Creek	Stable	Stable
nbz	4 cycle, three phase fault at chisago county trip f601c cross trip d602f, use new 100% reduction init from chisago	Stable	Stable
nmz	4 cycle, three phase fault at chisago trip f601c, xtrip d602f use new 100% reduction init from chisago, leave svs on mp sys	Stable	Stable
pcs	SLG fault at King-Eau Claire line with a breaker failure at king trips King-ECL,ECL-ARP,and ASK-CHI line	Stable	Stable
pct	trip of ask-ecl-arp without a fault trips ask-ecl-arp 345 kv line	Stable	Stable
pys	14 cycle slg at at prairie island trip pri-byn line	Stable	Stable
pyt	trip of pri-byn without a fault trips pri-byn 345 kv line	Stable	Stable
4b3	5 cycle 3 phase fault at DCG. Trip DCG-Blue Lake 345 kV line	Stable	Stable
4p3	5 cycle 3 phase fault at Prairie Island. Trip DCG-Prairie Island 345 kV line.	Stable	Stable
pr3	5 cycle 3 phase fault on Prairie Island end of Prairie Island-Red Rock. Trip Prairie Island-Red Rock 345 kV line Ckt 2	Stable	Stable

Table 3.3: Comparison of Damping Ratios at Big Falls and Redwing Without and With the Proposed G433 & G434 Projects for Fault "4b3"

Generator	Without G433 & G434		With G433 & G434	
	Dominant Mode (Hz)	Damping Ratio	Dominant Mode (Hz)	Damping Ratio
Big Falls	1.67	0.006018	1.67	0.012623
Redwing	1.79	0.005198	1.79	0.005358

ABB

4. CONCLUSIONS

A generator interconnection evaluation study was recently completed to evaluate the collective impact of generation interconnection requests G433 and G434 on transmission system performance. See reference [1]. Together, these projects have requested a combined output of 38 MW (Gross). Project G433 is a 19 MW expansion to Prairie Island #1 and Project G434 is a 19 MW expansion to Prairie Island #2.

In the above study, the MW outputs of the Prairie Island units (pre- and post-expansion) were modeled based on their Summer maximum ratings. MISO recently indicated that the Prairie Island units would have higher ratings in Winter (a total of 64 MW higher than the Summer ratings) and requested that a sensitivity study be performed to assess the impact of the proposed interconnections based on the higher pre- and post-project MW outputs.

The scope of the sensitivity study included a limited amount of steady-state and stability analysis to assess the impact of the proposed interconnections on the transmission system. In this study, the pre- and post-expansion MW outputs of the Prairie Island units were modeled based on the Winter maximum ratings.

Based on the technical evaluation, the following conclusions can be drawn:

<u>Steady-State Analysis</u>:
The interconnection of the proposed projects impacted several transmission facilities and resulted in steady-state criteria violations for system intact and contingency conditions. These violations are remote from the Prairie Island substation. The transmission outlets out of the Prairie Island substation are not overloaded. Based on the available information, these remote violations should not limit the ability of the proposed projects to interconnect as Energy Resource.

The violations reported in this study could potentially limit the ability of the projects to deliver power into the transmission system. MISO has indicated that these overloads can not be classified as injection issues and therefore they need not to be mitigated for Energy Resource Interconnection Service.

<u>Stability Analysis</u>:
Stability analysis was performed to evaluate the impact of the proposed projects on the system stability. All faults simulated in reference [1] were tested. No transient or dynamic instability problems were observed.

Simulation plots for faults ag1, ei2, 4b3, 4p3 and pr3 showed poorly damped oscillations in the rotor angles for the following units, both with and without the proposed projects: Big Falls (4.8 MW unit at bus 60662) and Redwing (23.2 MW unit at bus 60823). These oscillations are most prominent for faults 4b3, 4p3 and pr3 and appear to be confined to the Big Falls and Redwing units i.e., the oscillations do not propagate to the bulk power system. Prony analysis was used to calculate the oscillation modes of the Big Falls and

Redwing rotor angles and the corresponding damping ratios for fault "4b3". Results suggest that the damping ratios associated with the rotor angle oscillations at Big Falls and Redwing are in violation of the MAPP Transient Period Damping Criteria even prior to the addition of the proposed projects. The proposed projects, however, do not adversely impact damping performance and no oscillatory behavior was observed in the Prairie Island rotor angles.

In conclusion, the results of the stability analysis indicate that the interconnection of the proposed projects would not adversely impact transmission system stability.

The results of this study are based on available data and assumptions made at the time of conducting this study. In particular, it should be noted that the results depend on delivery assumptions of prior-queued generator interconnections. If the delivery assumptions of the prior-queued generators change and/or if the prior-queued units drop out of the generator interconnection queue, additional studies may be required to determine possible criteria violations that may limit the ability of the project to inject and/or deliver power into the transmission system. Any additional studies are considered outside of the scope of the system impact studies. The results provided in this report may not apply if any of the data and/or assumptions made in developing the study models change.

5. REFERENCES

1. Generation Interconnection Study - Projects # G433 and G434. 38 MW Expansion of Prairie Island Units 1 and 2 (Final Report), Prepared by ABB Inc., March 24, 2006.