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January 24, 2007

Reply to Fergus Falls office
Direct: 218-998-7108

Ms. Illona Jeffcoat-Sacco
Executive Secretary
North Dakota Public Service Commission
600 East Boulevard Avenue
Bismarck, ND 58505-0480

Re: Supplemental Application for Trade Secret Protection
Advanced Determination of Prudence
Case No. PU-06-481

Dear Ms. Jeffcoat-Sacco:

Enclosed for filing are the original and seven copies of the Supplemental Application of Otter Tail Corporation, d/b/a Otter Tail Power Company, in support of its Application for Trade Secret Protection filed in this proceeding on December 1, 2006. The Supplemental Application provides further information in support of the Application. In addition, Otter Tail hereby withdraws its request for trade secret protection for the preliminary Big Stone II Stability Analysis included as Exhibit TR-4 to the prefiled testimony of Timothy J. Rogelstad. At the time Otter Tail filed its Application, the Stability Analysis had not been posted on Midwest Independent Transmission System Operator, Inc.'s (MISO) Open Access Same-Time Information System (OASIS) and, therefore, was not publicly available. The Stability Analysis has since been posted on the MISO OASIS and, therefore, is publicly available. Enclosed are eight copies of the Stability Analysis for inclusion with the prefiled testimony of Timothy J. Rogelstad.

Please acknowledge receipt of this Supplemental Application by stamping or initialing the duplicate copy of this letter attached hereto and returning the same in the enclosed, self-addressed envelope.

Sincerely,

Bruce Gerhardson
Associate General Counsel
BG/dm

Enclosures

39 PU-06-481 Filed 01/24/2007 Pages: 17
Supplemental Application for Trade Secret
Otter Tail Corporation

cc: William W. Binek

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF NORTH DAKOTA

In the Matter of the Application of OTTER TAIL CORPORATION, d/b/a Otter Tail Power Company, for an Advance Determination of Prudence for the Big Stone II Generating Plant	))))))	Case No. PU-06-481

* * * *

SUPPLEMENTAL APPLICATION FOR TRADE SECRET PROTECTION

The Applicant, Otter Tail Corporation, d/b/a Otter Tail Power Company ("Otter Tail"), submits the following supplemental information in support of its Application for Trade Secret Protection filed on December 1, 2006, in this proceeding.

1. A general description of the nature of the information sought to be protected.

A. Big Stone II Power Project Cost Report included as Exhibit KET-2 to the prefiled testimony of Kermit E. Trout.

B. Preliminary Big Stone II Stability Analysis included as Exhibit TR-4 to the prefiled testimony of Timothy J. Rogelstad. (Otter Tail withdraws its request for trade secret protection of this transmission related document.)

C. Big Stone II Transmission Projected Costs included as Exhibit TR-5 to the prefiled testimony of Timothy J. Rogelstad.

2. Explanation of why the information derives independent economic value, actual or potential, from not being generally known to other persons.

A. The Big Stone II Cost Report was prepared by Black & Veatch Corporation, as the owners' engineer and construction manager for the Big Stone II project, based upon internally generated information from other Black & Veatch projects and trade publications as well as preliminary Big Stone II bid information from vendors of major equipment components. The information has economic value to competitors of Black & Veatch in providing services for other clients or potential clients and to potential vendors for the Big Stone II project by having access to preliminary bid amounts included in the project budget for various equipment components.

B. At the time of Otter Tail's Application, the preliminary Big Stone II Stability Analysis had not been posted on the MISO Open Access Same-Time Information System (OASIS) and, therefore, was confidential. The document has since been publicly posted on the MISO OASIS and is no longer confidential.

C. The Big Stone II Transmission Projected Costs were prepared by Otter Tail on behalf of the Big Stone II project based upon internal information from other Otter Tail projects, as well as from trade publications. The information has economic value to potential vendors and contractors who may bid to supply materials and labor for the Big Stone II transmission project or components thereof by having access to projected cost expectations of the project owners.

3. An explanation of why the information is not readily ascertainable by proper means by other persons.

A. The Big Stone II Cost Report was prepared by Black & Veatch for the Big Stone II project owners. The confidentiality of the information has been maintained by Black & Veatch and the project owners. The information is not disclosed to the public or to persons other than employees or authorized agents of Black & Veatch who need to know the information to fulfill their responsibilities in connection with the project or to third persons pursuant to agreement to maintain the confidentiality of the information.

B. Not applicable.

C. The Big Stone II Transmission Projected Costs were prepared by Otter Tail for the Big Stone II project owners. The confidentiality of the information has been maintained by Otter Tail and the project owners. The information is not disclosed to the public or to persons other than employees or authorized agents of the project owners who need to know the information to fulfill their responsibilities in connection with the project or to third persons pursuant to agreement to maintain the confidentiality of the information.

4. A general description of the persons or entities that would obtain economic value from disclosure or use of the information.

A. Competitors of Black & Veatch engaged in the engineering and construction management of electric generation stations would obtain economic value from disclosure of the project costs. Potential equipment vendors for the Big Stone II station would also obtain economic value from disclosure of the costs.

B. Not applicable.

C. Potential equipment and material vendors and contractors for the Big Stone II transmission project would obtain economic value from disclosure of the costs.

5. A specific description of known competitors and competitors' goods and services that is pertinent to the tariff or rate filing.

A. See response to 4A.

B. Not applicable.

C. See response to 4C.

6. A description of the efforts used to maintain the secrecy of the information.

A. See response to 3A.

B. Not applicable.

C. See response to 3C.

Respectfully submitted this 24th day of January, 2007.

OTTER TAIL CORPORATION, d/b/a
Otter Tail Power Company

By ______________________________
Bruce Gerhardson
Associate General Counsel

Preliminary Big Stone II Stability Analysis

Sensitivity to North Dakota Benefits from Big Stone II and Associated Transmission

Introduction

A brief study has been performed to determine the incremental export capability that the existing transmission system may gain when the Big Stone II project, along with its anticipated transmission additions, go into service. Specifically, this study has focused on the potential for increased export capability over the North Dakota interface with the addition of Big Stone II and its associated transmission. In order to quantify the direct benefits that the existing transmission system will have with the addition of the Big Stone II transmission additions, five separate scenarios have been studied. These scenarios include:

A. Existing Transmission System
  Scenario A1: All existing generators at their maximum (URGE) rating

B. Transmission System with Big Stone II Transmission Added
  Scenario B1: All existing generators at their maximum rating
  Scenario B2: Additional generation added in North Dakota Coal Fields (NDCF)
  Scenario B3: Big Stone II generation added
  Scenario B4: Big Stone II generation added with additional generation in the NDCF

The scenarios that included additional generation in the NDCF had a new generator installed at the existing Leland Olds station. This new generation was then scheduled to load in Minnesota thus forcing power flow across of the North Dakota interface.

Background

North Dakota has an abundance of generation near the coalmines northwest of Bismarck. The amount of generation within North Dakota exceeds the amount of load present within the North Dakota interface therefore making North Dakota a net exporter of power during most times of the year. The power exports out of North Dakota reach a maximum level during light load conditions, which typically occur during the summer off-peak season (spring and fall). During winter peak conditions loads within the North Dakota interface reach high enough levels to sometimes force North Dakota to import power from other areas both inside and outside of the Mid-Continent Area Power Pool (MAPP) Region.

Much of the generation in the northern MAPP Region is geographically remote from the large load centers of the Minneapolis / St. Paul metropolitan area. This geographic diversity requires the need for long transmission lines to transmit power from the generation sources to the load centers. A system with long transmission lines, such as the one found within the northern MAPP Region has been proven to be prone to transient voltage dips during major system disturbances. Through past analysis, it has been proven that the northern MAPP region is capable of transmitting a fixed amount of power across critical interfaces due to the potential for low transient voltages that occur on the edge of the North Dakota interface.

There are currently three key interfaces in the northern MAPP region. These interfaces are the Manitoba Hydro Export interface (MHEX), the North Dakota Export interface (NDEX), and the Minnesota-Wisconsin Stability Interface (MWSI). A listing of the transmission lines that compose each of these interfaces is shown below in Figure 1.

Figure 1 – Lines that Compose the Three Critical Interfaces in the Northern MAPP Region

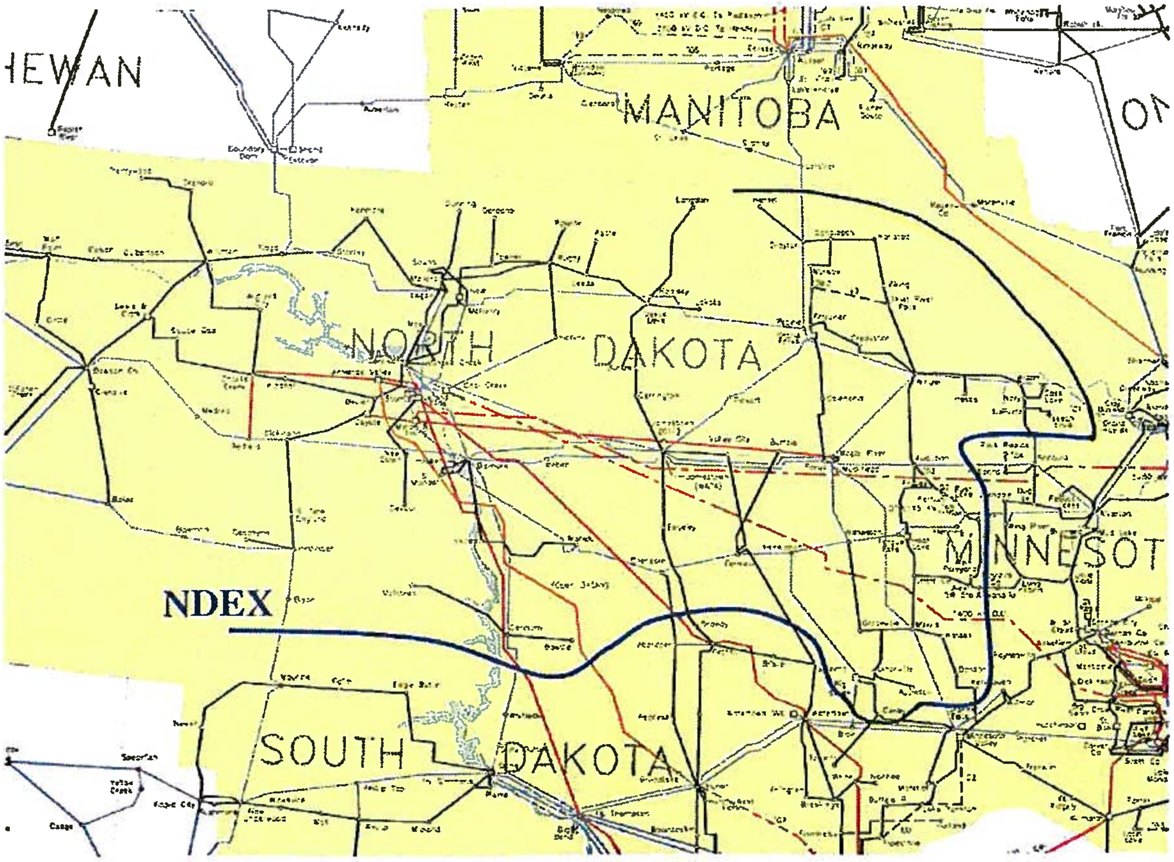
Lines that Compose the NDEX Interface
67105 Leland Olds - 66506 Fort Thompson 345 kV Line
67105 Leland Olds - 67160 Groton 345 kV Line
67101 Antelope Valley - 67120 Huron 345 kV Line
66521 Sully Butte - 66519 Oahe 230 kV Line
66470 Bison - 66497 Maurine 230 kV Line
63314 Big Stone - 66503 Blair 230 kV Line
66554 Morris - 66550 Granite Falls 230 kV Line
63336 Audubon - 63053 Hubbard 230 kV Line
63052 Inman - 61611 Wing River 230 kV Line
67327 Ellendale - 67401 Aberdeen 115 kV Line
66432 Edgeley - 66534 Ordway 115 kV Line
66438 Forman - 66522 Summit 115 kV Line
63211 Canby - 66551 Granite Falls 115 kV Line
63222 Alexandria - 60144 Douglas County 115 kV Line
66716 Laporte - 61640 Badoura 115 kV Line
62006 Kerkhoven - 62005 Kerkhoven Tap 115 kV Line
66752 Drayton - 67557 Letellier 230 kV Line
63379 Rugby - 67523 Glenboro 230 kV Line

Lines that Compose the MHEX Interface
67523 Glenboro - 63379 Rugby 230 kV Line
67557 Letellier - 66752 Drayton 230 kV Line
67564 Dorsey - 60173 Roseau 500 kV Line
67576 Richer - 60175 Roseau 230 kV Line

Lines that Compose the MWSI Interface
60304 Eau Claire - 92494 Arpin 345 kV Line
60105 Prairie Island - 61950 Byron 345 kV Line

As mentioned previously, the focus of this study is to determine the potential for incremental export capability across the NDEX interface with Big Stone II in-service. The following figure includes a thicker blue line that intersects each of the existing transmission lines that compose the NDEX interface. The sum of the real power flows on each of the transmission lines intersected by the thicker blue line represents the NDEX quantity. As can be seen in the figure, the NDEX interface extends into west central Minnesota and includes a portion of northern South Dakota.

Figure 2 – North Dakota Interface within the Northern MAPP Region



Transmission Alternatives for Big Stone II

The Big Stone II project is currently evaluating the necessary transmission additions to accommodate a new 600 MW generation plant at the existing Big Stone site. The transmission being studied with this plant includes two separate alternatives.

1. New 230 kV line from Big Stone to Ortonville with uprate of Ortonville to Johnson Junction to Morris 115 kV line to 230 kV with new 230 kV line from Big Stone to Canby with uprate of the Canby to Granite Falls 115 kV line to 230 kV.
2. New 230 kV line from Big Stone to Willmar with new 230 kV line from Big Stone to Canby with uprate of the Canby to Granite Falls 115 kV line to 230 kV.

These alternatives are explained in further detail in the following sections.

Alternative #1 – New 230 kV line from Big Stone – Ortonville and from Big Stone to Canby with a 115 kV to 230 kV uprate of Ortonville – Johnson Jct. – Morris line and Canby – Granite Falls line

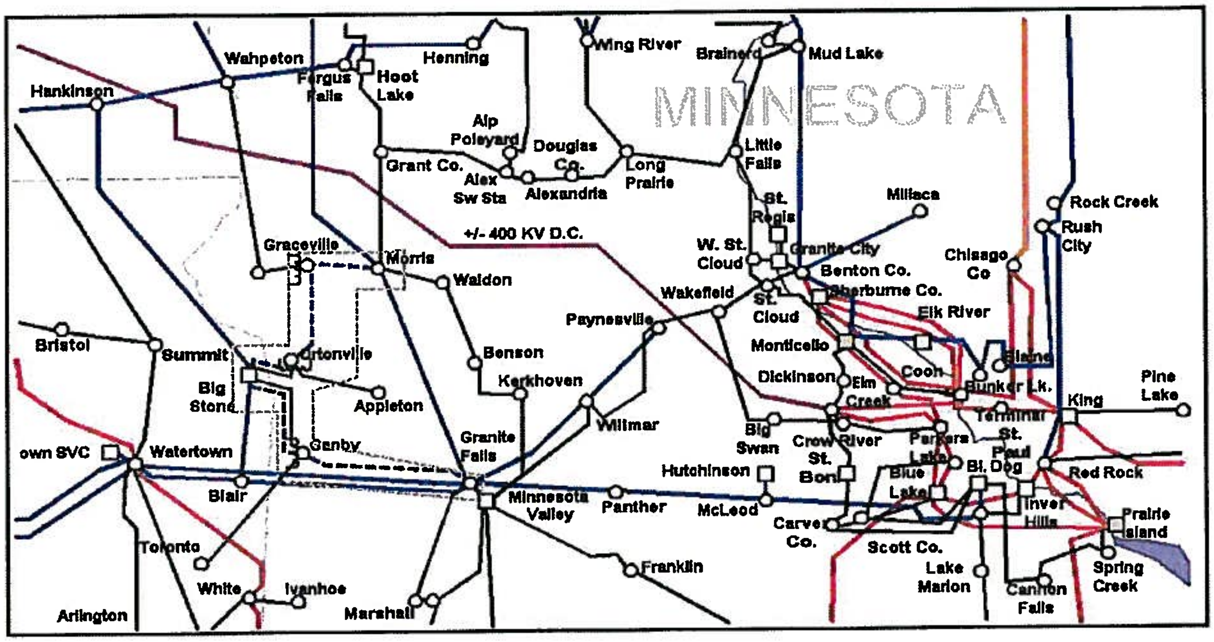
The first alternative under consideration for the Big Stone II project involves utilizing existing 115 kV line routes from the Big Stone plant.

This alternative includes a new 6.5-mile, 230 kV line from Big Stone to Ortonville. At Ortonville, a new 230/115/13.8 kV transformer was added to connect into the existing 115 kV system feeding the radial line out to Appleton as well as looping back into the Highway 12 substation. From Ortonville, alternative 1 includes a rebuild of the existing Ortonville to Johnson Junction 115 kV line to 230 kV. At Johnson Junction, another 230/115 kV transformer is installed to connect to the existing 115 kV line to Graceville (and eventually to Wahpeton). From Johnson Junction, alternative 1 continues the 115 kV to 230 kV rebuild to the Morris 230 kV substation.

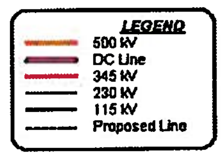
In addition to the "northern" 230 kV line, alternative 1 also has a new 50.5-mile, 230 kV line from Big Stone to Canby with a new 230/115 kV transformer at Canby. This new transformer will allow for a connection back to the existing 115 kV system feeding towards Toronto and Marietta. From Canby, alternative 1 includes a 115 kV to 230 kV rebuild of the existing line to Granite Falls, which then terminates into the existing 230 kV bus at Granite Falls.

The following figure illustrates a geographic representation of alternative 1 that is being considered as part of the Big Stone II project. Changes or additions to the existing transmission system are shown with dotted lines and circled in gray boxes.

Figure 3 – Geographic Map of Interconnection Alternative 1



Big Stone - Ortonville - Johnson Jct. - Morris 115 kV to 230 kV Uprate with
Big Stone - Canby - Granite Falls 115 kV to 230 kV Uprate



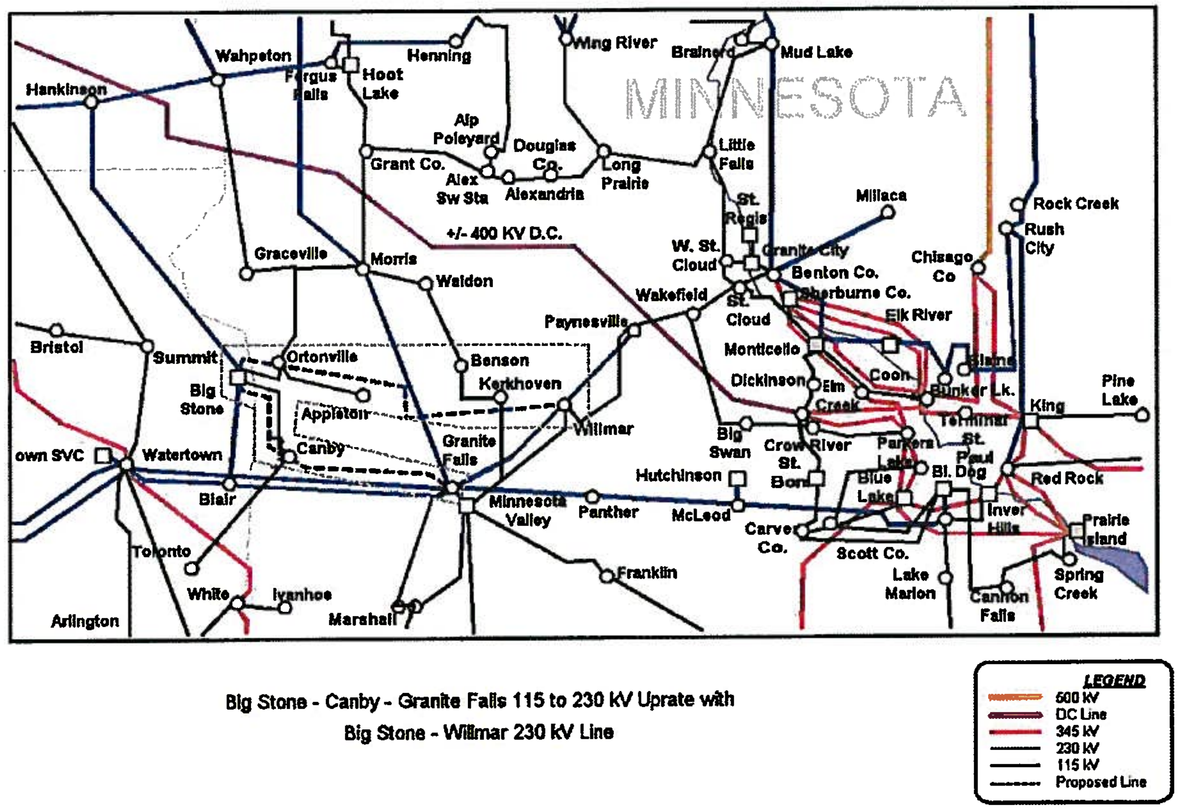
Alternative #2 – New 230 kV line from Big Stone to Willmar and from Big Stone to Canby with a 115 kV to 230 kV uprate of Canby – Granite Falls line

The second alternative being considered for the Big Stone II project still uses the "southern" 230 kV line discussed as part of alternative 1, but includes a new 102-mile, 230 kV line from Big Stone to Willmar. From Willmar, existing 230 kV lines head northeast towards Paynesville and southwest towards Granite Falls. This new 230 kV line from Big Stone to Willmar does not require the need for any additional transformers.

As mentioned previously, in addition to the new line from Big Stone to Willmar, the same Big Stone to Granite Falls 230 kV line configuration, as discussed as part of alternative 1, is also included as part of alternative 2.

Figure 4 illustrates a geographic representation of alternative 2 that is under consideration as part of the Big Stone II project. Changes or additions to the existing transmission system are shown with dotted lines and circled in gray boxes.

Figure 4 – Geographic Map of Transmission Alternative 2



Big Stone - Canby - Granite Falls 115 to 230 kV Uprate with
Big Stone - Willmar 230 kV Line

The preliminary stability analysis performed as part of this study has only included alternative 1 for the addition of the Big Stone II project. Alternative 1 represents transmission routes utilizing existing transmission corridors that may have more success through the permitting stages of the Big Stone II project. All of the study results discussed in subsequent sections of this report that include Big Stone transmission are in reference to alternative 1.

Study Procedure

The March 11, 2004 approved version of the Northern MAPP Operating Review Working Group (NMORWG) stability package has been utilized to perform this study. The existing 2003 summer off-peak URGE case (referred to as the "ug4 case") from the stability package has been updated with the Big Stone II facilities and the proposed Big Stone II generator.

The Big Stone II project is currently in the feasibility study stage. The feasibility study is being sponsored by Otter Tail Power Company (OTP), Great River Energy (GRE), Missouri River Energy Services (MRES), Montana-Dakota Utilities (MDU), Heartland Consumers Power District (HCPD), Central Minnesota Municipal Power Agency (CMMPA), Southern Minnesota Municipal Power Agency (SMMPA), and Hutchinson Utilities Commission (HUC).

Due to the variety of parties taking part in the Big Stone II project, the output from the proposed plant was scheduled to entities both inside and outside of the North Dakota interface. Since the final ownership of the plant is not yet finalized, assumptions had to be made as to how to sink the generation from the new plant at Big Stone. Since many of the utilities involved in this project have load both inside and outside of the North Dakota interface, MDU and OTP loads were scaled up more than others involved in the project since these loads are entirely contained within the North Dakota interface. For this study, the 600 MW's modeled for the Big Stone II plant was scheduled to the following loads in the amounts specified below in Figure 5.

Figure 5 – Modeling Assumptions for Sinking the Output from the Big Stone II Generator

Sink	***Amount***
1. Montana-Dakota Utilities	125 MW to load inside North Dakota
2. Otter Tail Power Company	125 MW to load inside North Dakota
3. Great River Energy	150 MW to load outside North Dakota
4. Missouri River Energy Services	100 MW to load outside North Dakota
5. Xcel Energy	30 MW to load outside North Dakota
6. Southern Minnesota Municipal Power Agency	20 MW to load outside North Dakota
7. Western Area Power Administration	50 MW to load outside North Dakota

Since CMMPA is a transmission customer of Xcel Energy, the Xcel Energy load was scaled up to model CMMPA's share of the Big Stone II project. Likewise, HCPD is a transmission customer of WAPA therefore making a load scale on the WAPA load necessary in modeling HCPD's take of the plant. HUC is also a transmission customer of GRE making GRE's load scale larger than those other entities outside the North Dakota interface. For sinking generation to Xcel, GRE, WAPA, and MRES loads, only those loads outside of the North Dakota interface were increased to keep 250 MW's within the North Dakota interface while forcing 350 MW's from Big Stone II across the North Dakota interface.

The NMORWG stability package has pre-defined fault files that automate some parts of the stability analysis. Several study engineers have used these fault files extensively within the northern MAPP region. Based on past studies, it has been determined that the following three faults have traditionally been the most limiting for exports out of North Dakota. Many other faults on the northern MAPP region were included as part of this study, but this report will focus mainly on these three worst known faults.

Figure 6 – Most Limiting Faults in Northern MAPP Region

1. ei2 – Bipole fault on Coal Creek DC line with trip of both Coal Creek generating units
2. nbz – 3.5 cycle three-phase fault at Chisago on Forbes – Chisago 500 kV line with trip of the Forbes SVS
3. nmz – 3.5 cycle three-phase fault at Chisago on Forbes – Chisago 500 kV line without trip of the Forbes SVS

The nbz fault has been analyzed extensively in the past and will no longer be valid in the future since a project is planned to make sure that the Forbes SVS stays on-line during a trip of the Chisago to Forbes 500 kV line. Although this fault was included in this study, the nmz fault will be discussed within this report since the necessary system modifications will likely be completed on the Forbes SVS by the 2011 timeframe when the Big Stone II plant is projected to go into service.

Study Models

The final models that were developed for this study are listed below in Figure 8 and illustrate the following export levels (in MW's) over the known interfaces in the northern MAPP region:

- NDEX: North Dakota Export Interface
- MHEX: Manitoba Hydro Export Interface (Manitoba to US)
- MWSI: Minnesota Wisconsin Stability Interface
- MHOH: Manitoba Hydro/Ontario Hydro Interface
- OHMP: Ontario Hydro/Minnesota Power Interface
- EWTW: Ontario East-West Transfer (East to West)
- BD: Boundary Dam/Tioga 230 kV Line

The base case summer off-peak models obtained from the NMORWG stability package included maximum simultaneous export levels over MHEX, NDEX, and MWSI. In the process of sinking generation from Big Stone II and the North Dakota Coal Fields, the maximum export level across the MWSI interface was unintentionally altered. Therefore, in order to restore the maximum transfer level across the MWSI interface, the setexports iplan within the stability package was utilized to restore the flow back to the maximum export level.

The addition of the Big Stone II plant and its associated transmission and assumed sinks does increase the NDEX quantity since the transmission alternative included in this study (alternative 1) alters an existing 115 kV line on the North Dakota interface (Canby – Granite Falls). The stability package has been modified to replace the existing Canby to Granite Falls 115 kV flow with the new flow present on the Canby to Granite Falls 230 kV line. The summer off-peak models derived for this study are listed below and include the new export levels with Big Stone II and the associated transmission added to the models.

Figure 8 - 2007 Summer Off-peak Steady State Analysis Models

Case Name	Description	Big Stone II	NDEX	MHEX	MWSI	OHMH	OHMP	EWTW	BD
ug4-so03aa.uzvV4V4.sav	Existing Transmission System All Existing Generation at Maximum	0	1947	2176	1482	-196	151	-200	162
bxm-so03aa.uzvV4V4.sav	Big Stone II Transmission Added All Existing Generation at Maximum	0	1954	2175	1480	-195	151	-200	163
stf-so03aa.wyvV4V4.sav	Big Stone II Transmission Added New Generation in North Dakota	0	2044	2171	1478	-198	149	-204	165
bgf-so03aa.ByvV4V4.sav	Big Stone II Transmission Added Big Stone II Plant Included	600	2294	2174	1478	-196	152	-200	164
ct2-so03aa.EyvV4V4.sav	Big Stone II Transmission Added Big Stone II and New ND Gen Added	600	2449	2171	1481	-197	150	-203	166

As shown in Figure 8, the ug4 base case that was used to derive all of the study models included the maximum simultaneous approved transfer limits of 1950 MW, 2175 MW, and 1480 MW across the NDEX, MHEX, and MWSI interfaces, respectively.

Study Criteria

The MAPP region as a whole has a transient voltage criteria of 0.70 p.u. to 1.20 p.u. for all buses on the transmission system. Some utilities have more stringent criteria for certain buses on the system as noted in the *MAPP Members Reliability Criteria and Study Procedures Manual.* These specific buses and their corresponding low and high transient voltage criteria are shown below in Figure 7.

Figure 7 – Specific Transient Voltage Criteria at Selected Buses

	Transient Voltage Criteria	
Critical Bus	Low (p.u.)	High (p.u.)
Arrowhead 230 kV Bus	0.82	1.15
Boise 115 kV Bus	0.82	1.15
Dorsey 230 kV Bus	0.70	1.25
Forbes 230 kV Bus	0.82	1.15
Riverton 230 kV Bus	0.82	1.15
Coal Creek 230 kV Bus	0.70	1.18
Dickinson 345 kV Bus	0.70	1.17
Drayton 230 kV Bus	0.80	1.15
Groton 345 kV Bus	0.70	1.20
Tioga 230 kV Bus	0.80	1.15
Wahpeton 115 kV Bus	0.80	1.18
Watertown 345 kV Bus	0.75	1.18
Hubbard 230 kV Bus	0.82	1.20

Past studies have indicated that either the 0.70 p.u. low transient voltage criteria at Groton or the 0.80 p.u. low transient voltage criteria at Wahpeton are most often violated first.

Study Results

Comparison of Existing System to System with Big Stone II Transmission Added

To determine the direct benefit of transmission alternative 1, which may be built as a result of the Big Stone II project, performance of the existing transmission system was compared directly to the performance of the system with the new Big Stone II transmission included. Based on the transient voltages in Figure 9, it appears that the new transmission alone improves transient voltage levels up to approximately 0.02 p.u. at the Wahpeton 115 kV and Groton 345 kV buses.

Figure 9 – Comparison of Existing System Performance to System Performance with Big Stone II Transmission

Critical Bus	Existing System ei2	BS2 Xmsn Added ei2	Voltage Change (in p.u.)	Existing System nmz	BS2 Xmsn Added nmz	Voltage Change (in p.u.)
Arrowhead 230 kV Bus	0.92	0.93	0.01	0.88	0.88	0.00
Boise 115 kV Bus	0.96	0.96	0.00	0.96	0.96	0.00
Dorsey 230 kV Bus	1.01	1.01	0.00	1.04	1.04	0.00
Forbes 230 kV Bus	0.92	0.93	0.01	0.98	0.98	0.00
Riverton 230 kV Bus	0.85	0.87	0.02	0.80	0.81	0.01
Coal Creek 230 kV Bus	0.98	0.99	0.01	0.93	0.93	0.00
Dickinson 345 kV Bus	0.98	0.98	0.00	0.94	0.94	0.00
Drayton 230 kV Bus	0.93	0.94	0.01	0.97	0.97	0.00
Groton 345 kV Bus	0.75	0.77	0.02	0.76	0.79	0.03
Tioga 230 kV Bus	0.99	0.99	0.00	0.99	0.99	0.00
Wahpeton 115 kV Bus	0.81	0.83	0.02	0.81	0.83	0.02
Watertown 345 kV Bus	0.80	0.83	0.03	0.80	0.83	0.03

Comparison of Existing System to System with Big Stone II Transmission Added with increase in North Dakota Export (Big Stone II Off-Line)

Since the addition of Big Stone II transmission alternative 1 results in an increase in transient voltage levels at some of the critical buses on the system, additional analysis has been completed to determine how much more power could be exported across the North Dakota interface before transient voltage levels are degraded to the point of meeting the minimum criteria. The following figure shows the resultant transient voltage levels during the ei2 and nmz disturbances with the addition of approximately 100 MW's of power being exported across the North Dakota interface. The additional 100 MW's of power transferred across the North Dakota interface was sourced from a new generator at Leland Olds in the NDCF and scheduled to GRE load outside of the North Dakota interface. As can be seen below, the Wahpeton 115 kV transient voltage reached 0.80 p.u. during the ei2 disturbance, which indicates that the Big Stone II transmission, by itself, will be able to accommodate approximately 100 MW of additional export out of North Dakota when the Big Stone II plant is off-line.

Figure 10 – Comparison of Existing System Performance to System Performance with Big Stone II Transmission and New NDCF Generation

Critical Bus	Existing System ei2	BS2 Xmsn with NDCF Gen ei2	Voltage Change (in p.u.)	Existing System nmz	BS2 Xmsn with NDCF Gen nmz	Voltage Change (in p.u.)
Arrowhead 230 kV Bus	0.92	0.92	0.00	0.88	0.88	0.00
Boise 115 kV Bus	0.96	0.96	0.00	0.96	0.96	0.00
Dorsey 230 kV Bus	1.01	1.01	0.00	1.04	1.04	0.00
Forbes 230 kV Bus	0.92	0.92	0.00	0.98	0.97	-0.01
Riverton 230 kV Bus	0.85	0.85	0.00	0.80	0.80	0.00
Coal Creek 230 kV Bus	0.98	0.98	0.00	0.93	0.93	0.00
Dickinson 345 kV Bus	0.98	0.98	0.00	0.94	0.94	0.00
Drayton 230 kV Bus	0.93	0.93	0.00	0.97	0.97	0.00
Groton 345 kV Bus	0.75	0.73	-0.02	0.76	0.75	-0.01
Tioga 230 kV Bus	0.99	0.99	0.00	0.99	0.99	0.00
Wahpeton 115 kV Bus	0.81	0.80	-0.01	0.81	0.81	0.00
Watertown 345 kV Bus	0.80	0.79	-0.01	0.80	0.79	-0.01

Comparison of Existing System to System with Big Stone II Transmission Added with Big Stone II On-Line

To determine the benefits of adding the Big Stone II transmission with the proposed Big Stone II generation, the previously mentioned dispatch was modeled, which resulted in a net increase in the North Dakota export by approximately 350 MW. Comparing the transient voltages of the Big Stone II case to that of the existing system indicates that transient voltage levels were increased at several of the critical buses on the transmission system. Figure 11 illustrates the transient voltage levels with the addition of the Big Stone II plant and its associated transmission compared to the performance of the existing system.

Figure 11 – Comparison of Existing System Performance to System Performance with Big Stone II Transmission and Generation In-Service

Critical Bus	Existing System ei2	BS2 Xmsn with BS2 Gen ei2	Voltage Change (in p.u.)	Existing System nmz	BS2 Xmsn with BS2 Gen nmz	Voltage Change (in p.u.)
Arrowhead 230 kV Bus	0.92	0.92	0.00	0.88	0.87	-0.01
Boise 115 kV Bus	0.96	0.96	0.00	0.96	0.96	0.00
Dorsey 230 kV Bus	1.01	1.01	0.00	1.04	1.04	0.00
Forbes 230 kV Bus	0.92	0.92	0.00	0.98	0.97	-0.01
Riverton 230 kV Bus	0.85	0.85	0.00	0.80	0.80	0.00
Coal Creek 230 kV Bus	0.98	0.99	0.01	0.93	0.93	0.00
Dickinson 345 kV Bus	0.98	0.98	0.00	0.94	0.94	0.00
Drayton 230 kV Bus	0.93	0.95	0.02	0.97	0.98	0.01
Groton 345 kV Bus	0.75	0.80	0.05	0.76	0.80	0.04
Tioga 230 kV Bus	0.99	1.00	0.01	0.99	0.99	0.00
Wahpeton 115 kV Bus	0.81	0.85	0.04	0.81	0.84	0.03
Watertown 345 kV Bus	0.80	0.83	0.03	0.80	0.82	0.02

The increase of the transient voltage levels at Groton and Wahpeton are likely a direct benefit of the Big Stone II generator and its ability to deliver reactive power during transient stability events.

<u>Comparison of Existing System to System with Big Stone II Transmission Added with increase in North Dakota Export (Big Stone II On-Line)</u>

Since the addition of the Big Stone II plant results in an increase in transient voltages at many critical locations on the system, additional stability analysis has been performed to determine the amount of additional export that could be achieved across the North Dakota interface once the Big Stone II plant and its associated transmission is in-service. Additional analysis has determined that it is possible to increase exports out of North Dakota by up to 150 MW's when Big Stone II is on-line. An increase of 150 MW's across the North Dakota interface is the level at which transient voltage violations start appearing in west central and southwest Minnesota. Figure 12 illustrates the transient voltage levels at the critical buses on the system for the ei2 and nmz disturbances compared to that of the existing system.

Figure 12 – Comparison of Existing System Performance to System Performance with Big Stone II Transmission and Generation and New NDCF Generation

	Existing System	BS2 Xmsn with BS2 and NDCF Gen	Voltage Change	Existing System	BS2 Xmsn with BS2 and NDCF Gen	Voltage Change
Critical Bus	ei2	ei2	(in p.u.)	nmz	nmz	(in p.u.)
Arrowhead 230 kV Bus	0.92	0.90	-0.02	0.88	0.86	-0.02
Boise 115 kV Bus	0.96	0.96	0.00	0.96	0.96	0.00
Dorsey 230 kV Bus	1.01	1.01	0.00	1.04	1.04	0.00
Forbes 230 kV Bus	0.92	0.91	-0.01	0.98	0.96	-0.02
Riverton 230 kV Bus	0.85	0.83	-0.02	0.80	0.77	-0.03
Coal Creek 230 kV Bus	0.98	1.00	0.02	0.93	0.93	0.00
Dickinson 345 kV Bus	0.98	0.97	-0.01	0.94	0.93	-0.01
Drayton 230 kV Bus	0.93	0.94	0.01	0.97	0.98	0.01
Groton 345 kV Bus	0.75	0.75	0.00	0.76	0.75	-0.01
Tioga 230 kV Bus	0.99	0.99	0.00	0.99	0.98	-0.01
Wahpeton 115 kV Bus	0.81	0.82	0.01	0.81	0.80	-0.01
Watertown 345 kV Bus	0.80	0.78	-0.02	0.80	0.75	-0.05

Although the transient voltage levels at the critical buses meet criteria, stability simulations have shown that transient voltage violations are evident in Minnesota from Willmar down to Panther and over to the Redwood Falls area. Transient voltage levels down to about 0.65 p.u. are evident at Willmar with many of the other low transient voltage violations being around 0.68 p.u. It is anticipated that the system enhancements planned in southwest Minnesota as part of the Buffalo Ridge wind generation will alleviate system performance concerns will alleviate these transient voltage violations. In particular, a SVC is being planned for the Lake Yankton substation, which will likely eliminate the transient voltage concerns in southwest Minnesota. Furthermore, the transient voltage concerns that are evident in the Willmar area could be relieved with the addition of the new synchronous generator being installed on the 115 kV system near Benson (FibroMinn).

Conclusion

Power exports out of North Dakota reach a maximum during light load conditions, which typically occur during the summer off-peak season (spring and fall). However, these power exports outside of North Dakota have traditionally been dynamically limited by low transient voltage swings during major disturbances on the transmission system. This transient voltage stability issue currently defines the maximum export level capable across the North Dakota interface. This study has attempted to quantify the direct benefits that the Big Stone II project will have on the existing transmission system in North Dakota.

From a transient stability standpoint, this study has proven that the addition of the facilities associated with Big Stone II transmission alternative 1 will increase transient voltage levels at key locations on the transmission system alone, without the Big Stone II generator in-service. Transient voltage levels are increased so much that an additional 100 MW's of power can be transmitted across the North Dakota interface. It has also been shown that the proposed Big Stone II generator will improve transient voltage levels even more than transmission alternative 1 due to the dynamic nature of the reactive capability inherent with the Big Stone II generator. Furthermore, the combination of the Big Stone II generator with transmission alternative 1 will allow for another 150 MW of export out of the North Dakota interface without any transient voltage violations, assuming that the planned upgrades in southwest Minnesota go forward to accommodate the wind generation and that FibroMinn is constructed. Figure 13 quantifies the results of this study in the form of a table.

Figure 13 – Approximate NDEX Capability Existing and Expected with Big Stone II

System Description	NDEX Interface Capability	Increase over Existing System
Existing System with Big Stone #1 off-line	1800	---
Existing System with Big Stone #1 on-line	1950	---
Big Stone II Transmission with Big Stone #2 off-line	2050	100
Big Stone II Transmission with Big Stone #2 on-line	2300	350
Big Stone II Transmission with Big Stone #2 and additional ND Generation	2450	500

Based on the results of this study, the addition of the Big Stone II generator with its associated transmission will have transient stability benefits to the transmission system in North Dakota, and more importantly, the entire Northern MAPP Region.