BASIN ELECTRIC POWER COOPERATIVE

Belfield – Rhame 230kV Line Analysis

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1.0 Executive Summary

The existing Little Missouri Substation load limit is approximately 70MW. The existing limit also relies on an undervoltage load shedding (UVLS) scheme at the Little Missouri Substation. These results indicate the addition of the Belfield-Rhame 230kV line will allow the Integrated System to support approximately 140MW of Little Missouri Substation load and eliminate the need for the UVLS scheme. The project will add a 230kV terminal at the existing WAPA Belfield Substation. Rhame Substation will be a new facility on the existing Miles City-Hettinger 230kV line, located between Little Missouri Tap and Bowman Substation. The line will be approximately 70 miles long. The geographic location is provided in Figure #1.

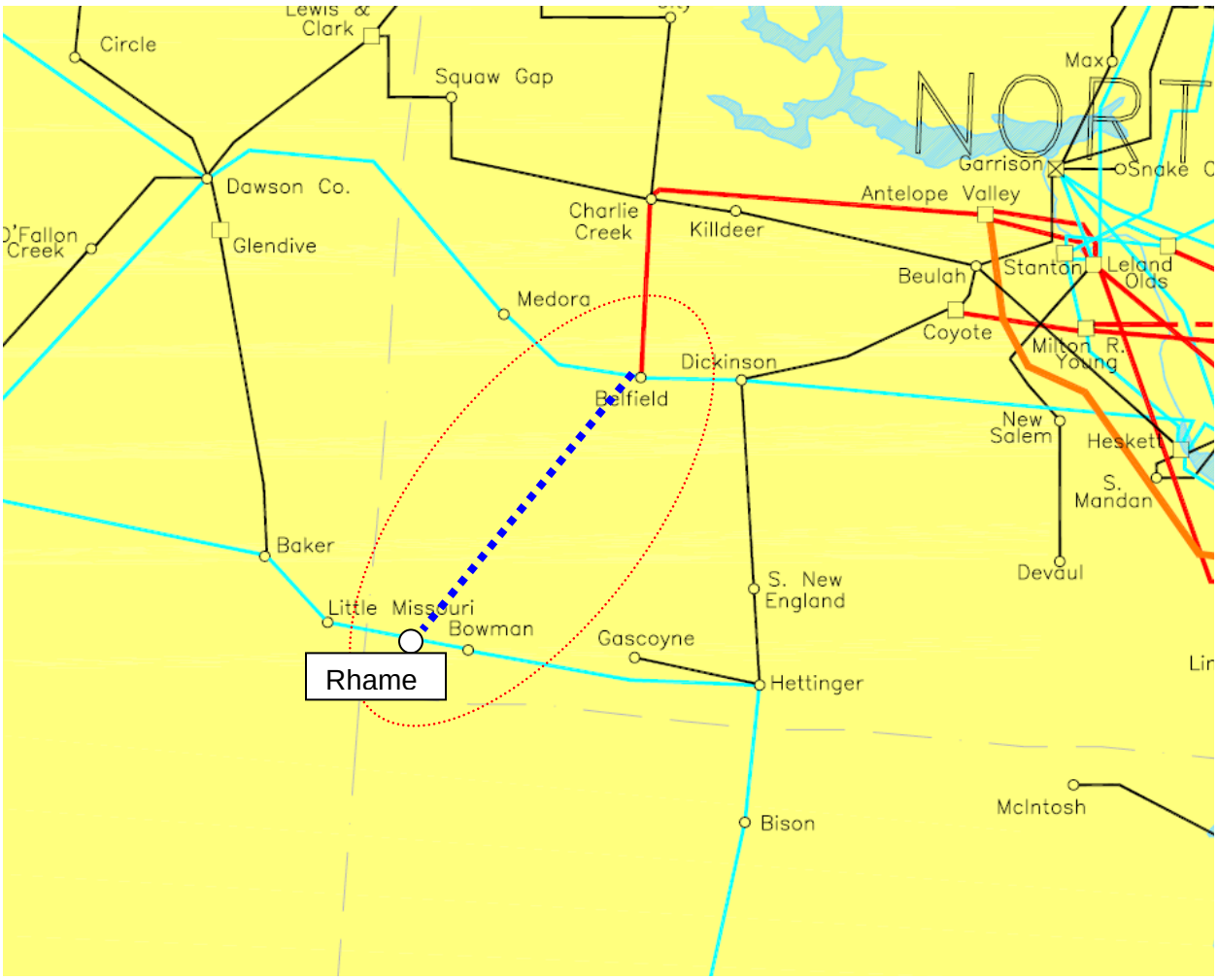

Figure #1 – Geographic Location

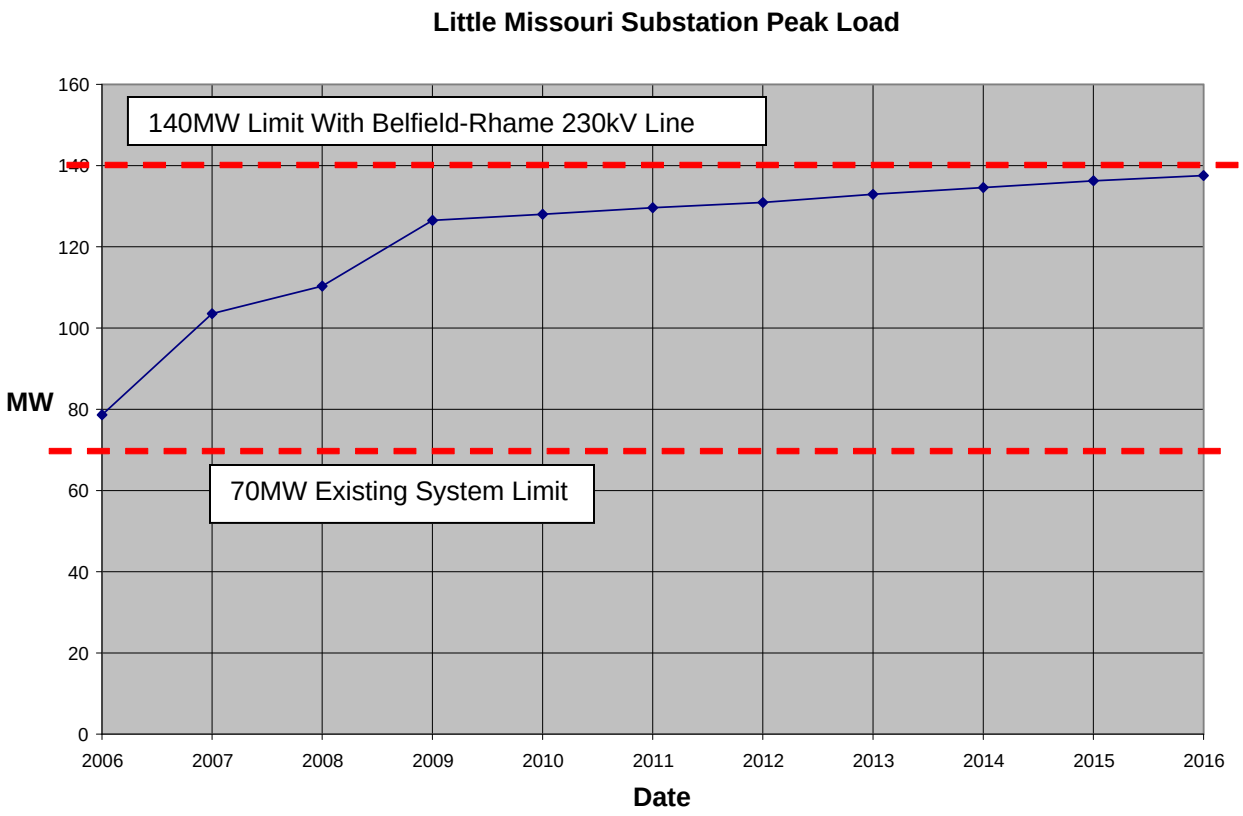

Table #1 – Little Missouri Load Forecast

2.0 Introduction

The purpose of this study is to analyze the impact of the latest load forecast for Little Missouri Substation.

The unconstrained base load forecast provided by Basin Marketing to Basin Transmission in January of 2007 show load levels in excess of the existing system capability. Actual July 2008 load at Little Missouri is projected to be 65MW.

This study is the first phase in a larger effort to analyze the impact of the recent load forecast. The next phase is an analysis of the northwest North Dakota area around Tioga. Finally the 2005 Midwest Electric Consumers Association load serving study will be updated with an analysis of the latest load forecasts.

3.0 Base Cases

3.1 Steady State

The steady state base cases are the 2008 heavy summer and 2008 heavy winter from the 2006 series. The latest updates from the MAPP website and other updates are added. The new capacitor banks are added at Dawson 115kV (2 x 20MVAR) and Little Missouri 115kV (2 x 20MVAR) buses.

The Miles City DC steady state powerflow model behavior complicates the steady state analysis. During solution iterations it blocks its power transfer during low voltage conditions. In block mode the steady state voltage usually recovers and the results appear to meet criteria. This only happens for east-west transfers. Therefore, in Miles City DC east-west transfer cases the Miles City DC model is replaced with a load with an equivalent MW and MVAR. For 200MW east-west operation the tie consumes 90MVAR, therefore a 200MW and 90MVAR load will be used. Shunt filter bank modeling is not changed. Miles City will also be tested operating in the west-east direction at 200MW.

RCDC Tie is scheduled 130MW east to west in all cases.

Saskatchewan schedules are tested 200MW north to south and 200MW south to north on the B10T path.

Area generation is set at the following levels;

Generation	2008 Heavy Summer MW	2008 Heavy Winter MW
Miles City CT	0	0
Ft Peck Hydro	60	60
Lewis & Clark	44	44
Glendive CT	0	0
Diamond Willow Wind	0	0

Table #2

Several cases are constructed to include the parameters listed in this section. The following table describes each case.

Case Naming Convention				
Case Name	Year/Season	B10T	MCDC	Belfield-Rhame 230
1	2008 Summer	165MW south-north	200MW east-west	
2	2008 Summer	80MW north-south	200MW east-west	
3	2008 Summer	165MW south-north	150MW west-east	
4	2008 Summer	80MW north-south	150MW west-east	
5	2008 Summer	165MW south-north	200MW east-west	In Service
6	2008 Summer	80MW north-south	200MW east-west	In Service
7	2008 Summer	165MW south-north	150MW west-east	In Service
8	2008 Summer	80MW north-south	150MW west-east	In Service
9	2008 Winter	165MW south-north	200MW east-west	
10	2008 Winter	80MW north-south	200MW east-west	
11	2008 Winter	165MW south-north	150MW west-east	
12	2008 Winter	80MW north-south	150MW west-east	
13	2008 Winter	165MW south-north	200MW east-west	In Service
14	2008 Winter	80MW north-south	200MW east-west	In Service
15	2008 Winter	165MW south-north	150MW west-east	In Service
16	2008 Winter	80MW north-south	150MW west-east	In Service

Table #3

The B10T path (Saskatchewan transfer) is currently limited to 80MW north to south due to overload of the Tioga 230/115kV transformer.

The Miles City DC tie limit is 200MW east-west and 150MW west-east.

3.2 Stability Case

The stability case is based on the 2006 NMORWG package 2008 summer off peak URGE case. NDEX is set to 2080MW. Additions required to support the 2080MW limit are added including the 60MVAR capacitors at Groton and the 75MVAR capacitors are Watertown. The “setexport” routine is run to establish the benchmark case with NDEX at 2080 and MHEX at 2180MW.

The Belfield-Rhame 230kV line and 70MW of load at Rhame 115kV are added to the benchmark case to create the study case. The Setexport routine is run to re-establish NDEX at 2080MW.

4.0 Alternatives

The Belfield-Rhame 230kV option is considered because other options are not feasible.

Little Missouri Substation is not suitable as the south terminal. The existing 230kV yard is a tap configuration. The terminals of the proposed 230kV line require a fully developed breaker substation and therefore the Little Missouri Substation offers no expansion options. Also, a

significant 115kV distribution system is being developed and a site remote from Little Missouri will offer 230kV connection redundancy.

Bowman Substation is a 230kV breakered ring bus. However the 230kV yard is physically congested due to its location in between the county road and the low voltage yard. A new 230kV terminal can not be added without a major reconstruction. Therefore Bowman Substation is not considered.

Since the adjacent existing substations are not expandable a new substation is proposed. The Rhame area is selected as it on the eastern edge of the proposed 115kV distribution system and near the area of future load growth. A one line diagram of the Rhame area 230kV and 115kV system is provided in Figure #2.

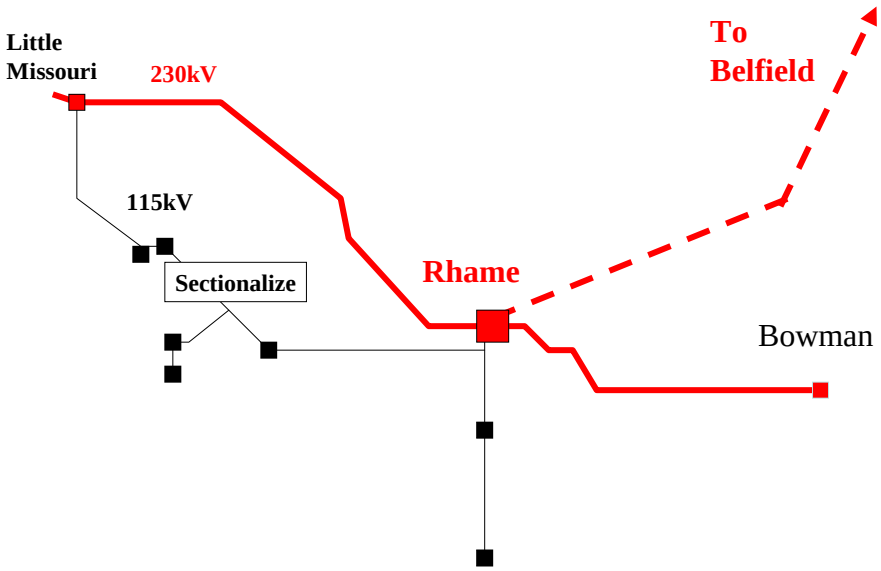

Figure #2 – Rhame Area

The 115kV system is planned to be sectionalized between Little Missouri and Rhame and is not anticipated to ever be operated in parallel. Rhame has a higher load serving capacity and area load should be encouraged to connect to it instead of Little Missouri.

The Belfield Substation 230kV yard is a main and transfer bus arrangement. A vacant 230kV bay position exists. Therefore a 230kV bay addition is practical.

The line mileage between Belfield and Rhame is approximately 70 miles. The assumed conductor is 1272 bittern with a thermal rating of 460MVA and a H frame arrangement. The electrical characteristics are as follows; R= 0.01011, X= 0.10435, B= 0.20235.

The Rhame Substation switching diagram is provided in Figure #3. 230kV bus arrangement will consist of a hybrid breaker and a half / ring bus arrangement. Due to the number of terminals the initial configuration is a ring with future expansion to a breaker and a half.

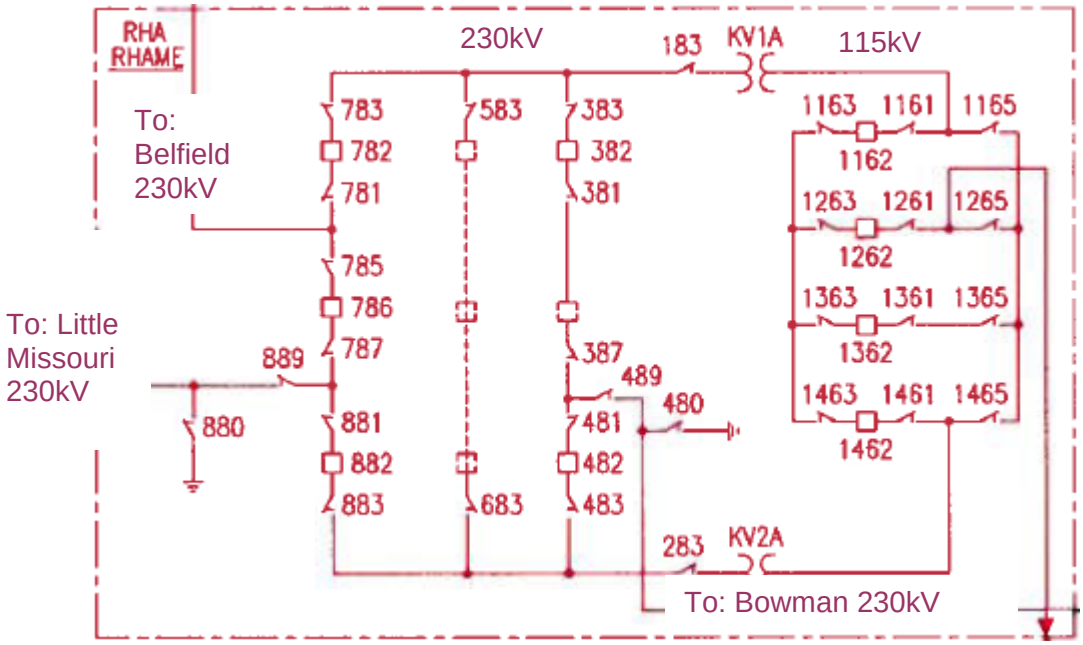

Figure #3 – Rhame Substation Preliminary Switching Diagram

5.0 Criteria

<u>Voltage Criteria:</u>

Normal Voltage Levels: The normal voltage range is a minimum of 0.95 PU and a maximum of 1.05 PU.

Emergency Voltage Limits: For periods less than 30 minutes, the emergency voltage range is a minimum of 0.90 PU and a maximum of 1.10 PU.

<u>Loading Criteria:</u>

Normal Loading Levels: The limit is 100% of normal ratings for transformers, conductors and line/substation related equipment.

Emergency Loading Limits: Not all facilities have an emergency limit. Continuous ratings (Rate A) will be monitored in the analysis. Facilities that are flagged as overloads will be checked for the presence of an emergency limit. If such a limit exists it will be noted in the results.

6.0 Methodology

The forced outage list includes all of the 230kV and 345kV branches in western North Dakota plus the Tioga 230/115kV Transformer Trip with loss of the Tioga-Logan 230kV line and also the Leland Olds 345/230kV double outage. For the MCDC-Dawson 230kV outage the MCDC tie is auto-ramped to 60MW east-west and for the Dawson-Medora-Belfield 230kV outage the MCDC tie is auto-ramped to 100MW east-west. All of the buses and branches in the WAPA control area and adjacent control areas in central North Dakota are monitored.

For each case in Table #3 the load at the Little Missouri 115kV bus will initially be set at 70MW at 0.95pf. The outage list will be run against each case and the results will be tabulated. If there are no violations, the Little Missouri load will be incrementally increased 10MW and the process will be repeated. This procedure will determine a load serving limit for each case or to a maximum of 200MW at Little Missouri/Rhame Substations.

Voltage stability at Little Missouri will also be tested. The most critical voltage stability scenario is with MCDC east-west and B10T south-north. Referring to Table #3, cases #1, #5, #9, and #13 represent the critical scenario. PV curves will be created for each of these cases. For cases without the Belfield-Rhame 230kV line, Little Missouri 115kV load will be incrementally increased to create the PV curve. For cases with the Belfield-Rhame 230kV line, equal load will be added at the Little Missouri and Rhame 115kV buses and incrementally increased. The outage list consists of the Hettinger-Bowman 230kV line, MCDC-Baker 230kV line, Baker-Little Missouri 230kV line, AVS-Belfield 345kV, Belfield-Medora 230kV, AVS-Belfield 345kV, and AVS-Charlie Creek 345kV line.

Fault duty at Little Missouri, Bowman, Belfield 230kV, and Belfield 345kV buses will be calculated before and after the addition of the Belfield-Rhame 230kV line.

A check on stability performance will be performed. A summer off peak, high transfer case (NDEX=2080), URGE case from the 2006 package will be used as a benchmark.

7.0 Steady State Contingency Results

Detailed Results are provided in Appendix A. The following is a summary of the results. The limiting condition for each case is listed.

Case 1- 2008 Summer, Saskatchewan 165MW south-north, MCDC = 200MW east-west

Load Limit = 75MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Watford7 115-Char.Ck7 115 101.1 % Of 120.0 Mva Rating
Bison 4 230 -Maurine4 230	Dksn-Nd7 115-N Engln7 115 102.3 % Of 112.5 Mva Rating

Case 2- 2008 Summer, Saskatchewan 80MW north-south, MCDC = 200MW east-west

Load Limit = 90MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Watford7 115-Char.Ck7 115 102.4 % Of 120.0 Mva Rating

Case 3 - 2008 Summer, Saskatchewan 165MW south-north, MCDC = 150MW west-east

Load Limit = 140MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Voltage Collapse If Load > 140MW

Case 4- 2008 Summer, Saskatchewan 80MW north-south, MCDC = 150MW west-east

Load Limit = 140MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Voltage Collapse If Load > 140MW

Case 5- 2008 Summer, Saskatchewan 165MW south-north, MCDC = 200MW east-west Belfield-Rhame 230kV Line In Service

This case has the lowest Belfield-Rhame 230kV load serving capacity.

Load Limit = 140MW, UVLS Not Required

Outage	Violation
AVS-Charlie Creek 345kv	Haliday7 115-Beulah 7 115 100.7 % Of 120.0 Mva Rating

Case 6- 2008 Summer, Saskatchewan 80MW north-south, MCDC = 200MW east-west Belfield-Rhame 230kV Line In Service

Load Limit = 150MW, UVLS Not Required

Outage	Violation
Rhame-Belfield 230kV	Voltage Collapse

Case 7- 2008 Summer, Saskatchewan 165MW south-north, MCDC = 150MW west-east Belfield-Rhame 230kV Line In Service

Load Serving Limit > 200MW, UVLS Not Required, No Limiting Criteria Violations

Case 8- 2008 Summer, Saskatchewan 80MW north-south, MCDC = 150MW west-east Belfield-Rhame 230kV Line In Service

Load Serving Limit > 200MW, UVLS Not Required, No Limiting Criteria Violations

Case 9- 2008 Winter,Saskatchewan 165MW south-north, MCDC = 200MW east-west

This case has the lowest load serving capacity.

Load Limit = 70MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Watford7 115-Char.Ck7 115 100.4 % Of 120.0 Mva Rating

Case 10 - 2008 Winter, Saskatchewan 80MW north-south, MCDC = 200MW east-west

Load Limit = 150MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Dawsonc7 115-Lewis7 115 102.8 % Of 101.67 Mva Rating

Case 11 - 2008 Winter, Saskatchewan 165MW south-north, MCDC = 150MW west-east

Load Limit = 120MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Bison 69kV Voltage at 0.90 p.u.

Case 12 - 2008 Winter, Saskatchewan 80MW north-south, MCDC = 150MW west-east

Load Limit = 120MW, UVLS Required

Outage	Violation
Belfield-Medora230, Mcdc@100	Bison 69kV Voltage at 0.897 p.u.

Case 13 - 2008 Winter, Saskatchewan 165MW south-north , MCDC = 200MW east-west Belfield-Rhame 230kV Line In Service

Load Limit = 180MW, UVLS Not Required

Outage	Violation
AVS-Charlie Creek 345kv	Haliday7 115-Beulah 7 115 100.8 % Of 120.0 Mva Rating

Case 14 - 2008 Winter, Saskatchewan 80MW north-south, MCDC = 200MW east-west Belfield-Rhame 230kV Line In Service

Load Limit = 190MW, UVLS Not Required

Outage	Violation
Rhame-Belfield 230kV	Voltage Collapse

Case 15 - 2008 Winter, Saskatchewan 165MW south-north, MCDC = 150MW west-east Belfield-Rhame 230kV Line In Service

Load Serving Limit > 200MW, UVLS Not Required, No Limiting Criteria Violations

Case 16 - 2008 Winter, Saskatchewan 80MW north-south, MCDC = 150MW west-east Belfield-Rhame 230kV Line In Service

Load Serving Limit > 200MW, UVLS Not Required, No Limiting Criteria Violations

Summary:

The lowest existing system limit is 70MW in Case #9. This case represents 2008 winter peak, Saskatchewan transfer 165MW south-north and MCDC = 200MW east-west. The limit is caused by the overload of the Charlie Creek-Watford City 115kV line during the Belfield-Medora 230kV outage with MCDC runback. Several outages cause an activation of the Little Missouri Substation UVLS.

The lowest load serving limit after the addition of the Belfield-Rhame 230kV line is 140MW in Case #5. This case represents 2008 summer peak, Saskatchewan transfer 165MW south-north, and MCDC = 200MW east-west.

8.0 Voltage Stability Results

PV curves are provided in Appendix B.

2008 Summer Peak:

The 2008 summer peak case system intact case has a voltage stability capacity of approximately 135MW. The system intact curve has several spikes indicating area capacitors are switching. The most limiting outage is loss of the Bowman-Hettinger 230kV line. The load serving capacity is only 30MW. The curve is extremely unstable with an almost vertical slope and the collapse occurs at a voltage above 1.0 p.u. The established UVLS will protect against the actual collapse should this line be tripped.

The addition of the Belfield-Rhame 230kV line significantly increases the voltage stability limits. The system intact limit is 280MW. The worst case outage is the loss of the AVS-Charlie Creek 345kV line. The outage limit is approximately 162MW. The curves are relatively gradual. The collapse occurs at a voltage above 0.90 p.u. which may be a result of the large numbers of capacitors in the area.

2008 Winter Peak:

The 2008 winter peak case system intact case has a voltage stability capacity of approximately 150MW. The most limiting outage is loss of the Bowman-Hettinger 230kV line. The load serving capacity is only 55MW. The established UVLS will protect against the actual collapse should this line be tripped.

The addition of the Belfield-Rhame 230kV line significantly increases the voltage stability limits. The system intact limit is 290MW. The worst case outage is the loss of the AVS-Charlie Creek 345kV line. The outage limit is approximately 190MW.

Summary

The lowest existing voltage stability limit is 30MW in the summer peak case. The established UVLS mitigates this impact. Addition of the Belfield-Rhame 230kV line increases the voltage stability limit to 160MW in the summer peak case. This limit is above the forecasted long term load growth for the area, therefore the UVLS can be abandoned after the addition of the Belfield-Rhame 230kV line.

9.0 Stability Results

The following Table #4 shows that the addition of the Belfield-Rhame 230kV line does not change any of the transient voltages for the regional faults. Three critical buses that have been noted with low voltages in the past are compared.

	Groton 345 kV (PU) Transient Voltage Minimum			Wahpeton 115 kV (PU) Transient Voltage Minimum			Watertown 345 kV (PU) Transient Voltage Minimum		
	Disturbance			**Disturbance**			**Disturbance**		
	ag1	**ei2**	**nmz**	**ag1**	**ei2**	**nmz**	**ag1**	**ei2**	**nmz**
Base Case	0.85	0.83	0.85	0.95	0.86	0.88	0.93	0.88	0.90
Befield-Rhame 230kV Added	0.86	0.84	0.86	0.96	0.87	0.89	0.94	0.89	0.90
Delta Impact	+0.01	+0.01	+0.01	+0.01	+0.01	+0.01	+0.01	+0.01	0.00

Table #4 - Transient Voltages at Critical Buses in MAPP Region

The results indicate a slightly positive impact. The transient low voltage increased by 0.01 p.u. or remained the same for each disturbance.

10.0 Fault Duty

The addition of the Belfield-Rhame 230kV line will increase fault current in the area. The following table provides the three phase fault duty's at Little Missouri, Bowman, Belfield 230kV, and Belfield 345kV.

Three Phase Fault Duty - MVA		
Bus	Pre – Belfield-Rhame 230	Belfield-Rhame 230 In Service
Bowman 230kV	724	1065
Little Missouri 230kV	744	1067
Belfield 230kV	1974	2142
Belfield 345kV	2159	2254
Rhame 230kV	-	1213

Table #5

11.0 – Conclusion

The Belfield-Rhame 230kV line provides enough support to enable the Little Missouri/Rhame area 140MW load forecast to be served without the need for single contingency under voltage load shedding. Based on January 2007 load forecast this capacity will be sufficient through 2016.

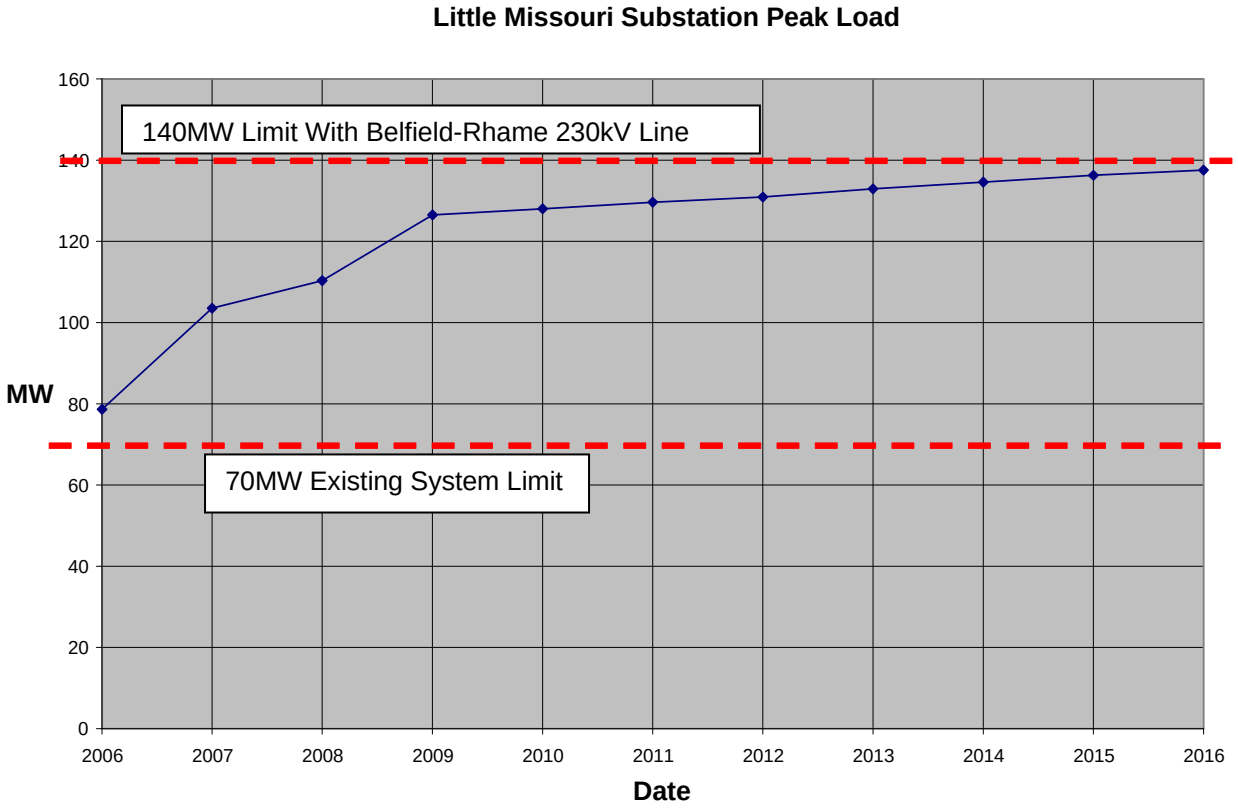

Table #6 – Load serving Capacity With Belfield-Rhame 230kV Line

The next phase of this effort is an analysis of the northwest North Dakota area around Tioga. The Belfield-Rhame 230kV impact will be reexamined in coordination with the upgrades identified with the northwest North Dakota study to ensure any cumulative effects are studied. Finally the 2005 Midwest Electric Consumers Association load serving study will be updated with an analysis of the latest load forecasts.

12.0 – Listing of Appendices

Appendix A – Powerflow Results
Appendix B – PV Results
Appendix C – Stability Results Table

Appendix A

CASE #1
2008 Summer Peak
Saskatchewan 165MW South-North, MCDC 200MW East-West

```
CELL NAME = 4A1D2,B10T=-161,LM=75 LM=75, NC, DC-EW, B10T=165SN, JUL08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====
 OUTAGES:

 20_4A1D2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     124.0 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     124.0 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 40_4A1D2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MI CTYE4 230    ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 42_4A1D2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MEDORA 4 230    ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 45_4A1D2*NOT SOLVED* OUTAGE: MEDORA 4 230 -BELFELD4 230    ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 46_4A1D2OUTAGE:BELFIELD-MEDORA230, MCDC@100     WATFORD7 115-CHAR.CK7 115     101.1 % OF  120.0 MVA RATING

 60_4A1D2 OUTAGE: BISON  4 230 -MAURINE4 230     DKSN-ND7 115-N ENGLN7 115     102.3 % OF  112.5 MVA RATING

 67_4A1D2 OUTAGE: TIOGA4 4 230 -LOGAN  4 230     LOGAN  7 115-BTHOLD 7 115     103.8 % OF  100.0 MVA RATING
                                                 BTHOLD 7 115-KENMARE7 115     102.9 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

 70_4A1D2 OUTAGE: LELANDO4 230 -LOGAN  4 230     GARRISN7 115-MAX    7 115     104.8 % OF  120.0 MVA RATING
                                                 Local Limit caused by b10t flow, minimum thermal rating = 199MVA

 72_4A1D2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BOWMAN 4 230    ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri

 74_4A1D2*NOT SOLVED* OUTAGE: BOWMAN 4 230 -HETINGR4 230    ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri
```

CASE #2
2008 Summer Peak
Saskatchewan 80MW North-South, MCDC 200MW East-West

```
CELL NAME = 6A1C2,B10T=83,LM=90 LM=90, NC, DC-EW, B10T=80NS, JUL08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 SYSTEM INTACT                                   TIOGA4 4 230-TIOGA4 7 115     105.0 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

 OUTAGES:

 20_6A1C2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     107.7 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     107.7 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 40_6A1C2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MI CTYE4 230    ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 42_6A1C2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MEDORA 4 230    ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 45_6A1C2*NOT SOLVED* OUTAGE: MEDORA 4 230 -BELFELD4 230    ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 46_6A1C2OUTAGE:BELFIELD-MEDORA230, MCDC@100     DAWSONC7 115-LEWIS  7 115     102.4 % OF  101.67 MVA RATING

 60_6A1C2*NOT SOLVED* OUTAGE: BISON  4 230 -MAURINE4 230    ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri
                                                UVLS trips occur with Little Missouri load at > 60 MW

 61_6A1C2*NOT SOLVED* OUTAGE: BISON  4 230 -HETINGR4 230    ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri
                                                UVLS trips occur with Little Missouri load at > 60 MW

 66_6A1C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     WILISTN7 115-TIOGA7 7 115     113.6 % OF  101.67 MVA RATING
                                                 TIOGA4 7 115-TIOGA7 7 115     124.4 % OF  101.4 MVA RATING
```

Local Limit caused by b10t flow

72_6A1C2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BOWMAN 4 230 ****DID NOT SOLVE*****
Outage initiates UVLS Trip at Little Missouri
UVLS trips occur with Little Missouri load at > 60 MW

74_6A1C2*NOT SOLVED* OUTAGE: BOWMAN 4 230 -HETINGR4 230 ****DID NOT SOLVE*****
Outage initiates UVLS Trip at Little Missouri
UVLS trips occur with Little Missouri load at > 60 MW

88_6A1C2 OUTAGE: DICKSWH7 115 -COYOTE 7 115 DICKNSN4 230-DKSN-ND7 115 100.0 % OF 100.0 MVA RATING
Rate C = 125%

CASE #3
2008 Summer Peak
Saskatchewan 165MW South-North, MCDC 150MW West-East

```
CELL NAME = 12A2D2,B10T=-162,LM=150 LM=150, NC, DC-WE, B10T=165SN, JUL08

 STATUS                                          VIOLATED ELEMENT             PU
========                                        ==================           ====

 OUTAGES:

 20_12A2D2 OUTAGE: LELANDO4 230 -LELND2TY 345    LELANDO3 345-LELND1TY 345     134.1 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     134.1 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 43_12A2D2*NOT SOLVED*OUTAGE:DAWSON-MEDORA230, MCDC@100     ****DID NOT SOLVE*****
                                                 Outage will solve within criteria with load at 140MW

 44_12A2D2 OUTAGE: MI CTYE4 230 -BAKER  4 230    LTLMISS7 115                  0.850 VOLTAGE LOWER THAN  0.9
                                                 LTLMISS4 230                  0.866 VOLTAGE LOWER THAN  0.9
                                                 BAKER  4 230                  0.869 VOLTAGE LOWER THAN  0.9
                                                 BAKER  7 115                  0.886 VOLTAGE LOWER THAN  0.9
                                                 BOWMAN 4 230                  0.894 VOLTAGE LOWER THAN  0.9
                                                Outage initiates UVLS Trip at Little Missouri

 46_12A2D2*NOT SOLVED*OUTAGE:BELFIELD-MEDORA230, MCDC@100   ****DID NOT SOLVE*****
                                                 Outage will solve within criteria with load at 140MW

 70_12A2D2 OUTAGE: LELANDO4 230 -LOGAN  4 230    GARRISN7 115-MAX    7 115     101.1 % OF  120.0 MVA RATING
                                                 Local Limit caused by b10t flow, minimum thermal rating = 199MVA

 71_12A2D2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BAKER  4 230   ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri
```

CASE #4
2008 Summer Peak
Saskatchewan 80MW North-South, MCDC 150MW West-East

```
 CELL NAME = 12A2C2,B10T=84,LM=150 LM=150, NC, DC-WE, B10T=80NS, JUL08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 OUTAGES:

 20_12A2C2 OUTAGE: LELANDO4 230 -LELND2TY 345    LELANDO3 345-LELND1TY 345     118.9 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     118.9 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 43_12A2C2OUTAGE:DAWSON-MEDORA230, MCDC@100      TIOGA4 4 230-TIOGA4 7 115     132.4 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow
                                                 DAWSONC7 115-LEWIS  7 115     100.4 % OF  101.67 MVA RATING
                                                 Local Limit caused by b10t flow
                                                 LTLMISS4 230-BOWMAN 4 230     106.4 % OF  216.1 MVA RATING
                                                 Thermal rating – 319MVA
                                                 BOWMAN 4 230-HETINGR4 230     120.8 % OF  216.1 MVA RATING
                                                 Thermal rating – 319MVA

 44_12A2C2 OUTAGE: MI CTYE4 230 -BAKER  4 230    LTLMISS7 115                  0.851 VOLTAGE LOWER THAN  0.9
                                                 LTLMISS4 230                  0.867 VOLTAGE LOWER THAN  0.9
                                                 BAKER  4 230                  0.869 VOLTAGE LOWER THAN  0.9
                                                 BAKER  7 115                  0.880 VOLTAGE LOWER THAN  0.9
                                                 BOWMAN 4 230                  0.896 VOLTAGE LOWER THAN  0.9
                                                 DAWSONC7 115-GLENDCT7 115     103.3 % OF  112.5 MVA RATING
                                                Outage initiates UVLS Trip at Little Missouri

 46_12A2C2*NOT SOLVED*OUTAGE:BELFIELD-MEDORA230, MCDC@100   ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri
                                                OK with LM load at 140MW

 66_12A2C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345    TIOGA4 4 230-TIOGA4 7 115     103.6 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

 71_12A2C2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BAKER  4 230   ****DID NOT SOLVE*****
                                                Outage initiates UVLS Trip at Little Missouri
```

CASE #5
Belfield-Rhame 230kV In Service
2008 Summer Peak
Saskatchewan 165MW South-North, MCDC 200MW East-West

CELL NAME = 1I1D2,B10T=-161,LM=140 NC, BL-RH140, DC-EW, B10T=165SN, JUL08

STATUS	VIOLATED ELEMENT	PU	
OUTAGES:			
3_1I1D2 OUTAGE: BELFELDT 345 -BELFELD4 230	DKSN-ND7 115-DICKSWH7 115	102.9 % OF	101.41 MVA RATING
	COYOTE 7 115-DICKSWH7 115	109.0 % OF	101.41 MVA RATING
	Coyote overload initiates unit runback		
20_1I1D2 OUTAGE: LELANDO4 230 -LELND2TY 345	LELANDO3 345-LELND1TY 345	121.7 % OF	250.0 MVA RATING
	LELANDO4 230-LELND1TY 345	121.7 % OF	250.0 MVA RATING
	Overload of L.Olds transformers initiates tripping scheme		
23_1I1D2 OUTAGE: CHAR.CK7 115 -CHARCKTY 345	BELFELDT 345-BELFELD3 345	108.1 % OF	319.0 MVA RATING
	BELFELDT 345-BELFELD4 230	108.1 % OF	319.0 MVA RATING
	Emergency Rating – 390MVA		
45_1I1D2 OUTAGE: MEDORA 4 230 -BELFELD4 230	LTLMISS4 230-BAKER 4 230	104.6 % OF	216.1 MVA RATING
	Thermal rating – 319MVA		
47_1I1D2 OUTAGE: DICKNSN4 230 -BELFELD4 230	BELFELDT 345-BELFELD3 345	107.3 % OF	319.0 MVA RATING
	BELFELDT 345-BELFELD4 230	107.3 % OF	319.0 MVA RATING
	Emergency Rating – 390MVA		
48_1I1D2 OUTAGE: DICKNSN4 230 -HESKETT4 230	BELFELDT 345-BELFELD3 345	109.0 % OF	319.0 MVA RATING
	BELFELDT 345-BELFELD4 230	109.0 % OF	319.0 MVA RATING
	Emergency Rating – 390MVA		
49_1I1D2 OUTAGE: BELFELD3 345 -CHAR.CK3 345	DKSN-ND7 115-DICKSWH7 115	103.0 % OF	101.41 MVA RATING
	COYOTE 7 115-DICKSWH7 115	109.1 % OF	101.41 MVA RATING
	Coyote overload initiates unit runback		

```
66_1I1D2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     DICKNSN4 230-BELFELD4 230     102.2 % OF  319.0 MVA RATING
                                                Minimum  Thermal Rating = 398MVA
                                                DKSN-ND7 115-DICKSWH7 115     103.3 % OF  101.41 MVA RATING
                                                Coyote overload initiates unit runback
                                                HALIDAY7 115-BEULAH 7 115     100.7 % OF  120.0 MVA RATING
                                                COYOTE 7 115-DICKSWH7 115     109.4 % OF  101.41 MVA RATING
                                                Coyote overload initiates unit runback

67_1I1D2 OUTAGE: TIOGA4 4 230 -LOGAN  4 230     LOGAN  7 115-BTHOLD 7 115     103.2 % OF  100.0 MVA RATING
                                                BTHOLD 7 115-KENMARE7 115     102.3 % OF  100.0 MVA RATING
                                                Local Limit caused by b10t flow

70_1I1D2 OUTAGE: LELANDO4 230 -LOGAN  4 230     GARRISN7 115-MAX    7 115     103.6 % OF  120.0 MVA RATING
                                                Local Limit caused by b10t flow
```

CASE #6
Belfield-Rhame 230kV In Service
2008 Summer Peak
Saskatchewan 80MW North-South, MCDC 200MW East-West

```
 CELL NAME = 1K1C2,B10T=83,LM=160 NC, BL-RH160, DC-EW, B10T=80NS, JUL08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 SYSTEM INTACT                                   TIOGA4 4 230-TIOGA4 7 115     104.1 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

 OUTAGES:

 3_1K1C2 OUTAGE: BELFELDT 345 -BELFELD4 230      DKSN-ND7 115-DICKSWH7 115     104.5 % OF  101.41 MVA RATING
                                                 COYOTE 7 115-DICKSWH7 115     110.5 % OF  101.41 MVA RATING
                                                 Coyote overload initiates unit runback

 20_1K1C2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     105.2 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     105.2 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 23_1K1C2 OUTAGE: CHAR.CK7 115 -CHARCKTY 345     BELFELDT 345-BELFELD3 345     106.9 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     106.9 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 40_1K1C2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MI CTYE4 230    ****DID NOT SOLVE*****
                                                 Outage initiates MCDC ramp which enables solution

 47_1K1C2 OUTAGE: DICKNSN4 230 -BELFELD4 230     BELFELDT 345-BELFELD3 345     108.7 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     108.7 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 48_1K1C2 OUTAGE: DICKNSN4 230 -HESKETT4 230     BELFELDT 345-BELFELD3 345     111.1 % OF  319.0 MVA RATING
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```
                                                BELFELDT 345-BELFELD4 230     111.1 % OF  319.0 MVA RATING
                                                Rate C = 390MW

49_1K1C2 OUTAGE: BELFELD3 345 -CHAR.CK3 345     DKSN-ND7 115-DICKSWH7 115     104.6 % OF  101.41 MVA RATING
                                                COYOTE 7 115-DICKSWH7 115     110.7 % OF  101.41 MVA RATING
                                                Coyote overload initiates unit runback

66_1K1C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     DKSN-ND7 115-DICKSWH7 115     101.3 % OF  101.41 MVA RATING
                                                Coyote overload initiates unit runback
                                                WILISTN7 115-TIOGA7 7 115     123.8 % OF  101.67 MVA RATING
                                                Local Limit caused by b10t flow
                                                COYOTE 7 115-DICKSWH7 115     107.5 % OF  101.41 MVA RATING
                                                Coyote overload initiates unit runback
                                                TIOGA4 7 115-TIOGA7 7 115     134.8 % OF  101.4 MVA RATING
                                                Local Limit caused by b10t flow

98_1K1C2*NOT SOLVED* OUTAGE: RHAME    230 -BELFELD4 230    ****DID NOT SOLVE*****
                                                Solves OK with Little Missouri/Rhame Load at 150MW
```

CASE #7
Belfield-Rhame 230kV In Service
2008 Summer Peak
Saskatchewan 165MW South-North, MCDC 150MW West-East

```
CELL NAME = 1O2D2,B10T=-161,LM=200 NC, BL-RH200, DC-WE, B10T=165SN, JUL08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====


 OUTAGES:


 20_1O2D2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     132.9 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     132.9 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 70_1O2D2 OUTAGE: LELANDO4 230 -LOGAN  4 230     GARRISN7 115-MAX    7 115     100.5 % OF  120.0 MVA RATING
                                                 Local Limit caused by b10t flow, minimum thermal rating = 199MVA


Load limit > 200MW
```

CASE #8
Belfield-Rhame 230kV In Service
2008 Summer Peak
Saskatchewan 80MW North-South, MCDC 150MW West-East

```
CELL NAME = 1O2C2,B10T=84,LM=200 NC, BL-RH200, DC-WE, B10T=80NS, JUL08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====


 OUTAGES:

 20_1O2C2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     117.3 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     117.3 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 43_1O2C2OUTAGE:DAWSON-MEDORA230, MCDC@100       TIOGA4 4 230-TIOGA4 7 115     112.0 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

 46_1O2C2OUTAGE:BELFIELD-MEDORA230, MCDC@100     TIOGA4 4 230-TIOGA4 7 115     113.5 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

 66_1O2C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     TIOGA4 4 230-TIOGA4 7 115     107.6 % OF  100.0 MVA RATING
                                                 Local Limit caused by b10t flow

Load limit > 200MW
```

CASE #9
2008 Winter Peak
Saskatchewan 165MW South-North, MCDC 200MW East-West

```
 CELL NAME = 3A1A2,B10T=-162,LM=70 LM=70, NC, DC-EW, B10T=165SN, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

OUTAGES:

 19_3A1A2 OUTAGE: LELANDO4 230 -LELND1TY 345     LELANDO3 345-LELND2TY 345     100.7 % OF  500.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 20_3A1A2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     176.3 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     176.3 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 30_3A1A2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MI CTYE4 230    ****DID NOT SOLVE*****
                                                 Outage initiates MCDC ramp which enables solution

 32_3A1A2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MEDORA 4 230    ****DID NOT SOLVE*****
                                                 Outage initiates MCDC ramp which enables solution

 35_3A1A2*NOT SOLVED* OUTAGE: MEDORA 4 230 -BELFELD4 230    ****DID NOT SOLVE*****
                                                 Outage initiates MCDC ramp which enables solution

 36_3A1A2OUTAGE:BELFIELD-MEDORA230, MCDC@100     WATFORD7 115-CHAR.CK7 115     100.4 % OF  120.0 MVA RATING

 56_3A1A2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     LELANDO3 345-LELND1TY 345     108.9 % OF  250.0 MVA RATING
                                                 LELANDO3 345-LELND2TY 345     106.1 % OF  500.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     108.9 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND2TY 345     103.4 % OF  500.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 57_3A1A2 OUTAGE: TIOGA4 4 230 -LOGAN  4 230     LOGAN  7 115-BTHOLD 7 115     100.2 % OF  100.0 MVA RATING

 60_3A1A2 OUTAGE: LELANDO4 230 -LOGAN  4 230     MALLARD7 115-MAX    7 115     115.4 % OF  120.0 MVA RATING
                                                 GARRISN7 115-MAX    7 115     122.7 % OF  120.0 MVA RATING
                                                 Boundary Dam Phase shifter would lock due to delta P, these
                                                 violations are caused by phase shifter readjusting to 165MW s-n
```

64_3A1A2*NOT SOLVED* OUTAGE: BOWMAN 4 230 -HETINGR4 230 ****DID NOT SOLVE*****
Outage initiates UVLS at Little Missouri Sub

73_3A1A2 OUTAGE: TIOGA4 7 115 -STANLEY7 115 STANLEY7 115 0.877 VOLTAGE LOWER THAN 0.9
Portion of Stanley load to be transferred to Tioga 115 by 12/08

CASE #10
2008 Winter Peak
Saskatchewan 80MW North-South, MCDC 200MW East-West

```
CELL NAME = 12A1C2,B10T=83,LM=150 LM=150, NC, DC-EW, B10T=80NS, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 OUTAGES:

 20_12A1C2 OUTAGE: LELANDO4 230 -LELND2TY 345    LELANDO3 345-LELND1TY 345     160.6 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     160.6 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme


 30_12A1C2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MI CTYE4 230   ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 32_12A1C2*NOT SOLVED* OUTAGE: DAWSONC4 230 -MEDORA 4 230   ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 34_12A1C2 OUTAGE: MI CTYE4 230 -BAKER  4 230    LTLMISS7 115                  0.852 VOLTAGE LOWER THAN  0.9
                                                 LTLMISS4 230                  0.867 VOLTAGE LOWER THAN  0.9
                                                 BAKER  4 230                  0.875 VOLTAGE LOWER THAN  0.9
                                                 BOWMAN 4 230                  0.882 VOLTAGE LOWER THAN  0.9
                                                 Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW

 35_12A1C2*NOT SOLVED* OUTAGE: MEDORA 4 230 -BELFELD4 230   ****DID NOT SOLVE*****
                                                Outage initiates MCDC ramp which enables solution

 36_12A1C2OUTAGE:BELFIELD-MEDORA230, MCDC@100    DAWSONC7 115-LEWIS  7 115     102.8 % OF  101.67 MVA RATING
                                                 BOWMAN 4 230-HETINGR4 230     102.2 % OF  239.0 MVA RATING

 50_12A1C2*NOT SOLVED* OUTAGE: BISON  4 230 -MAURINE4 230   ****DID NOT SOLVE*****
                                                 Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW

 51_12A1C2*NOT SOLVED* OUTAGE: BISON  4 230 -HETINGR4 230   ****DID NOT SOLVE*****
                                                 Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW

 56_12A1C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345    LELANDO3 345-LELND1TY 345     103.6 % OF  250.0 MVA RATING
```

```
                                                LELANDO3 345-LELND2TY 345     100.9 % OF  500.0 MVA RATING
                                                LELANDO4 230-LELND1TY 345     103.6 % OF  250.0 MVA RATING
                                                Overload of L.Olds transformers initiates tripping scheme
                                                WILISTN7 115-TIOGA7 7 115     108.5 % OF  101.67 MVA RATING
                                                TIOGA4 7 115-TIOGA7 7 115     113.2 % OF  108.9 MVA RATING
                                                Local Limit caused by b10t flow

61_12A1C2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BAKER  4 230   ****DID NOT SOLVE*****
                                                Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW

62_12A1C2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BOWMAN 4 230   ****DID NOT SOLVE*****
                                                Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW

64_12A1C2*NOT SOLVED* OUTAGE: BOWMAN 4 230 -HETINGR4 230   ****DID NOT SOLVE*****
                                                Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW
```

CASE #11
2008 Winter Peak
Saskatchewan 165MW South-North, MCDC 150MW West-East

```
CELL NAME = 10A2A2,B10T=-161,LM=130 LM=130, NC, DC-WE, B10T=165SN, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====
 OUTAGES:

 19_10A2A2 OUTAGE: LELANDO4 230 -LELND1TY 345    LELANDO3 345-LELND2TY 345     106.6 % OF  500.0 MVA RATING
                                                 LELANDO4 230-LELND2TY 345     103.9 % OF  500.0 MVA RATING
                                                Overload of L.Olds transformers initiates tripping scheme

 20_10A2A2 OUTAGE: LELANDO4 230 -LELND2TY 345    LELANDO3 345-LELND1TY 345     186.9 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     186.9 % OF  250.0 MVA RATING
                                                Overload of L.Olds transformers initiates tripping scheme

 33_10A2A2OUTAGE:DAWSON-MEDORA230, MCDC@100      BOWMAN 4 230-HETINGR4 230     107.8 % OF  239.0 MVA RATING
                                                 Thermal rating – 319MVA

 36_10A2A2OUTAGE:BELFIELD-MEDORA230, MCDC@100    BISON  869.0                  0.899 VOLTAGE LOWER THAN  0.9
                                                 Voltage OK with load at 120MW
                                                 BOWMAN 4 230-HETINGR4 230     113.4 % OF  239.0 MVA RATING
                                                 Thermal rating – 319MVA

 60_10A2A2 OUTAGE: LELANDO4 230 -LOGAN  4 230    MALLARD7 115-MAX    7 115     111.9 % OF  120.0 MVA RATING
                                                 GARRISN7 115-MAX    7 115     119.1 % OF  120.0 MVA RATING
                                                 Local Limit caused by b10t flow

 61_10A2A2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BAKER  4 230   ****DID NOT SOLVE*****
                                                 Outage initiates UVLS at Little Missouri Sub, Ok with Load at 70MW

 73_10A2A2 OUTAGE: TIOGA4 7 115 -STANLEY7 115    STANLEY7 115                  0.882 VOLTAGE LOWER THAN  0.9
                                                 Portion of Stanley load to be transferred to Tioga 115 by 12/08
```

CASE #12
2008 Winter Peak
Saskatchewan 80MW North-South, MCDC 150MW West-East

```
CELL NAME = 12A2C2,B10T=83,LM=150 LM=150, NC, DC-WE, B10T=80NS, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 OUTAGES:

 20_12A2C2 OUTAGE: LELANDO4 230 -LELND2TY 345    LELANDO3 345-LELND1TY 345     172.7 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     172.7 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 21_12A2C2 OUTAGE: LOGAN  7 115 -LOGAN TY 230    TIOGA4 4 230-TIOGA4 7 115     104.2 % OF  100.0 MVA RATING
                                                 Rate C = 125%

 33_12A2C2OUTAGE:DAWSON-MEDORA230, MCDC@100      TIOGA4 4 230-TIOGA4 7 115     122.6 % OF  100.0 MVA RATING
                                                 Rate C = 125%
                                                 BOWMAN 4 230-HETINGR4 230     106.9 % OF  239.0 MVA RATING
                                                 Thermal rating – 319MVA

 36_12A2C2OUTAGE:BELFIELD-MEDORA230, MCDC@100    BISON  869.0                  0.897 VOLTAGE LOWER THAN  0.9
                                                 Voltage OK with load at 140MW
                                                 TIOGA4 4 230-TIOGA4 7 115     127.1 % OF  100.0 MVA RATING
                                                 Rate C = 125%
                                                 BOWMAN 4 230-HETINGR4 230     112.7 % OF  239.0 MVA RATING
                                                 Thermal rating – 319MVA

 61_12A2C2*NOT SOLVED* OUTAGE: LTLMISS4 230 -BAKER  4 230   ****DID NOT SOLVE*****
                                                 Outage initiates UVLS at Little Missouri Sub
```

CASE #13
Belfield-Rhame 230kV In Service
2008 Winter Peak
Saskatchewan 165MW South-North, MCDC 200MW East-West

```
 CELL NAME = 1M1A2,B10T=-163,LM=180 NC, BL-RH180, DC-EW, B10T=165SN, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

OUTAGES:

 20_1M1A2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     173.9 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     173.9 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 22_1M1A2 OUTAGE: CHAR.CK7 115 -CHARCKTY 345     BELFELDT 345-BELFELD3 345     106.7 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     106.7 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 37_1M1A2 OUTAGE: DICKNSN4 230 -BELFELD4 230     BELFELDT 345-BELFELD3 345     104.1 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     104.1 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 38_1M1A2 OUTAGE: DICKNSN4 230 -HESKETT4 230     BELFELDT 345-BELFELD3 345     104.7 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     104.7 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 50_1M1A2 OUTAGE: BISON  4 230 -MAURINE4 230     BELFELDT 345-BELFELD3 345     101.5 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     101.5 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 56_1M1A2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     LELANDO3 345-LELND1TY 345     114.7 % OF  250.0 MVA RATING
                                                 LELANDO3 345-LELND2TY 345     111.7 % OF  500.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     114.7 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND2TY 345     108.9 % OF  500.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme
                                                 DICKNSN4 230-BELFELD4 230     104.0 % OF  319.0 MVA RATING
                                                 Minimum  Thermal Rating = 398MVA
                                                 HALIDAY7 115-BEULAH 7 115     100.8 % OF  120.0 MVA RATING
```

```
57_1M1A2 OUTAGE: TIOGA4 4 230 -LOGAN  4 230     LOGAN  7 115-BTHOLD 7 115     101.4 % OF  100.0 MVA RATING
                                                BTHOLD 7 115-KENMARE7 115     100.1 % OF  100.0 MVA RATING
                                                Local Limit caused by b10t flow

60_1M1A2 OUTAGE: LELANDO4 230 -LOGAN  4 230     MALLARD7 115-MAX    7 115     114.8 % OF  120.0 MVA RATING
                                                GARRISN7 115-MAX    7 115     122.1 % OF  120.0 MVA RATING
                                                Boundary Dam Phase shifter would lock due to delta P, these
                                                violations are caused by phase shifter readjusting to 165MW s-n

73_1M1A2 OUTAGE: TIOGA4 7 115 -STANLEY7 115     STANLEY7 115                  0.877 VOLTAGE LOWER THAN  0.9
                                                Portion of Stanley load to be transferred to Tioga 115 by 12/08
```

CASE #14
Belfield-Rhame 230kV In Service
2008 Winter Peak
Saskatchewan 80MW North-South, MCDC 200MW East-West

```
 CELL NAME = 1O1C2,B10T=83,LM=200 NC, BL-RH200, DC-EW, B10T=80NS, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 OUTAGES:

 20_1O1C2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     158.6 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     158.6 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 22_1O1C2 OUTAGE: CHAR.CK7 115 -CHARCKTY 345     BELFELDT 345-BELFELD3 345     105.0 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     105.0 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 37_1O1C2 OUTAGE: DICKNSN4 230 -BELFELD4 230     BELFELDT 345-BELFELD3 345     104.7 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     104.7 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 38_1O1C2 OUTAGE: DICKNSN4 230 -HESKETT4 230     BELFELDT 345-BELFELD3 345     106.1 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     106.1 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 50_1O1C2 OUTAGE: BISON  4 230 -MAURINE4 230     BELFELDT 345-BELFELD3 345     103.5 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     103.5 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 51_1O1C2 OUTAGE: BISON  4 230 -HETINGR4 230     BELFELDT 345-BELFELD3 345     101.6 % OF  319.0 MVA RATING
                                                 BELFELDT 345-BELFELD4 230     101.6 % OF  319.0 MVA RATING
                                                 Rate C = 390MW

 56_1O1C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     LELANDO3 345-LELND1TY 345     106.6 % OF  250.0 MVA RATING
```

```
                                        LELANDO3 345-LELND2TY 345     103.8 % OF  500.0 MVA RATING
                                        LELANDO4 230-LELND1TY 345     106.6 % OF  250.0 MVA RATING
                                        LELANDO4 230-LELND2TY 345     101.2 % OF  500.0 MVA RATING
                                        Overload of L.Olds transformers initiates tripping scheme
                                        STANTON4 230-LELANDO4 230     101.1 % OF  478.0 MVA RATING
                                        WILISTN7 115-TIOGA7 7 115     114.5 % OF  101.67 MVA RATING
                                        TIOGA4 7 115-TIOGA7 7 115     119.0 % OF  108.9 MVA RATING
                                        Local Limit caused by b10t flow

88_1O1C2*NOT SOLVED* OUTAGE: RHAME    230 -BELFELD4 230    ****DID NOT SOLVE*****
                                        OK with Load at 190MW
```

CASE #15
Belfield-Rhame 230kV In Service
2008 Winter Peak
Saskatchewan 165MW South-North, MCDC 150MW West-East

```
CELL NAME = 1O2A2,B10T=-161,LM=200 NC, BL-RH200, DC-WE, B10T=165SN, JAN08

 STATUS                                          VIOLATED ELEMENT              PU
========                                        ==================            ====

 OUTAGES:

 19_1O2A2 OUTAGE: LELANDO4 230 -LELND1TY 345     LELANDO3 345-LELND2TY 345     105.9 % OF  500.0 MVA RATING
                                                 LELANDO4 230-LELND2TY 345     103.3 % OF  500.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 20_1O2A2 OUTAGE: LELANDO4 230 -LELND2TY 345     LELANDO3 345-LELND1TY 345     185.8 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     185.8 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 56_1O2A2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345     LELANDO3 345-LELND1TY 345     100.9 % OF  250.0 MVA RATING
                                                 LELANDO4 230-LELND1TY 345     100.9 % OF  250.0 MVA RATING
                                                 Overload of L.Olds transformers initiates tripping scheme

 60_1O2A2 OUTAGE: LELANDO4 230 -LOGAN  4 230     MALLARD7 115-MAX    7 115     111.7 % OF  120.0 MVA RATING
                                                 GARRISN7 115-MAX    7 115     118.9 % OF  120.0 MVA RATING
                                                 Local Limit caused by b10t flow
```

Load limit > 200MW

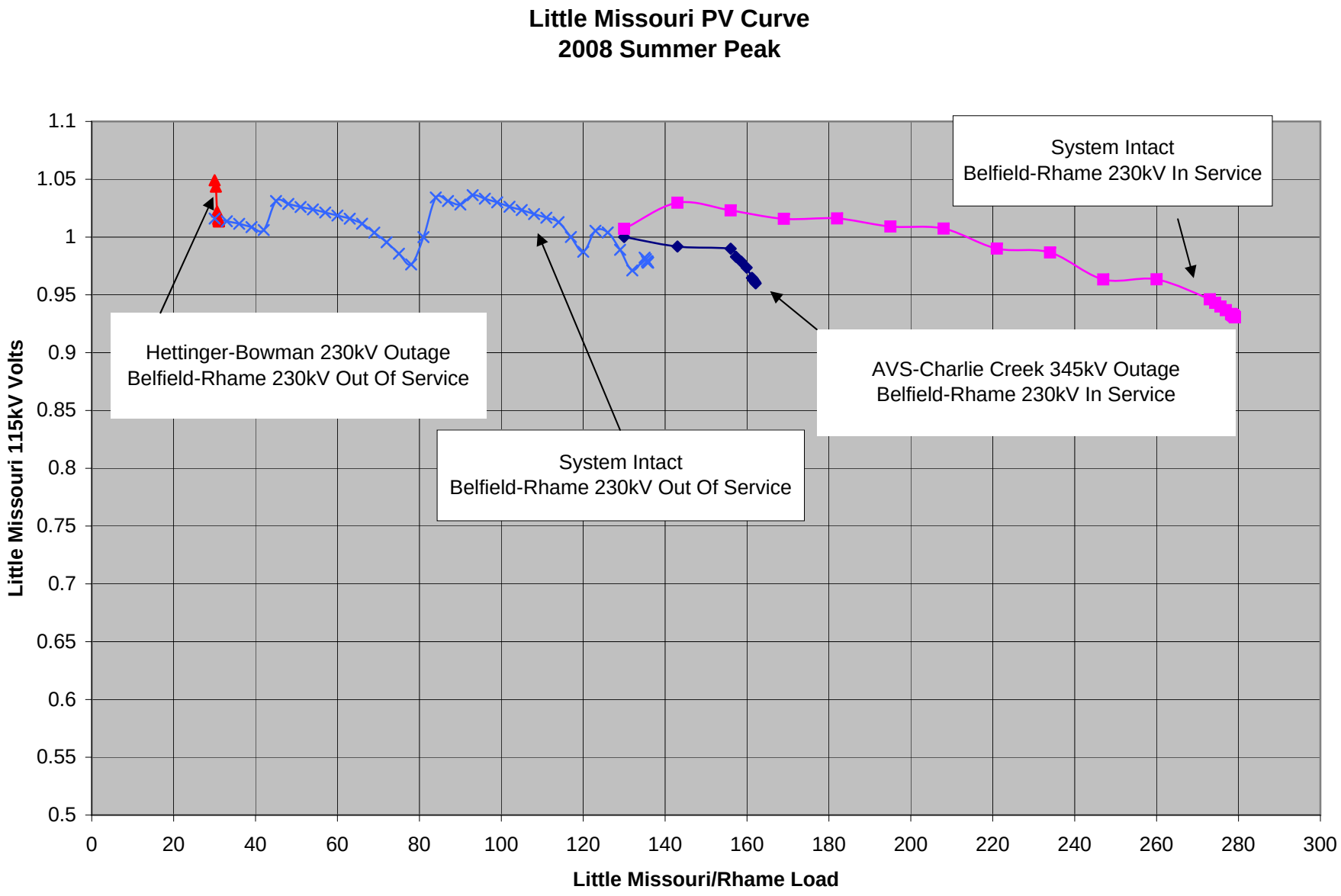
CASE #16
Belfield-Rhame 230kV In Service
2008 Winter Peak
Saskatchewan 80MW North-South, MCDC 150MW West-East

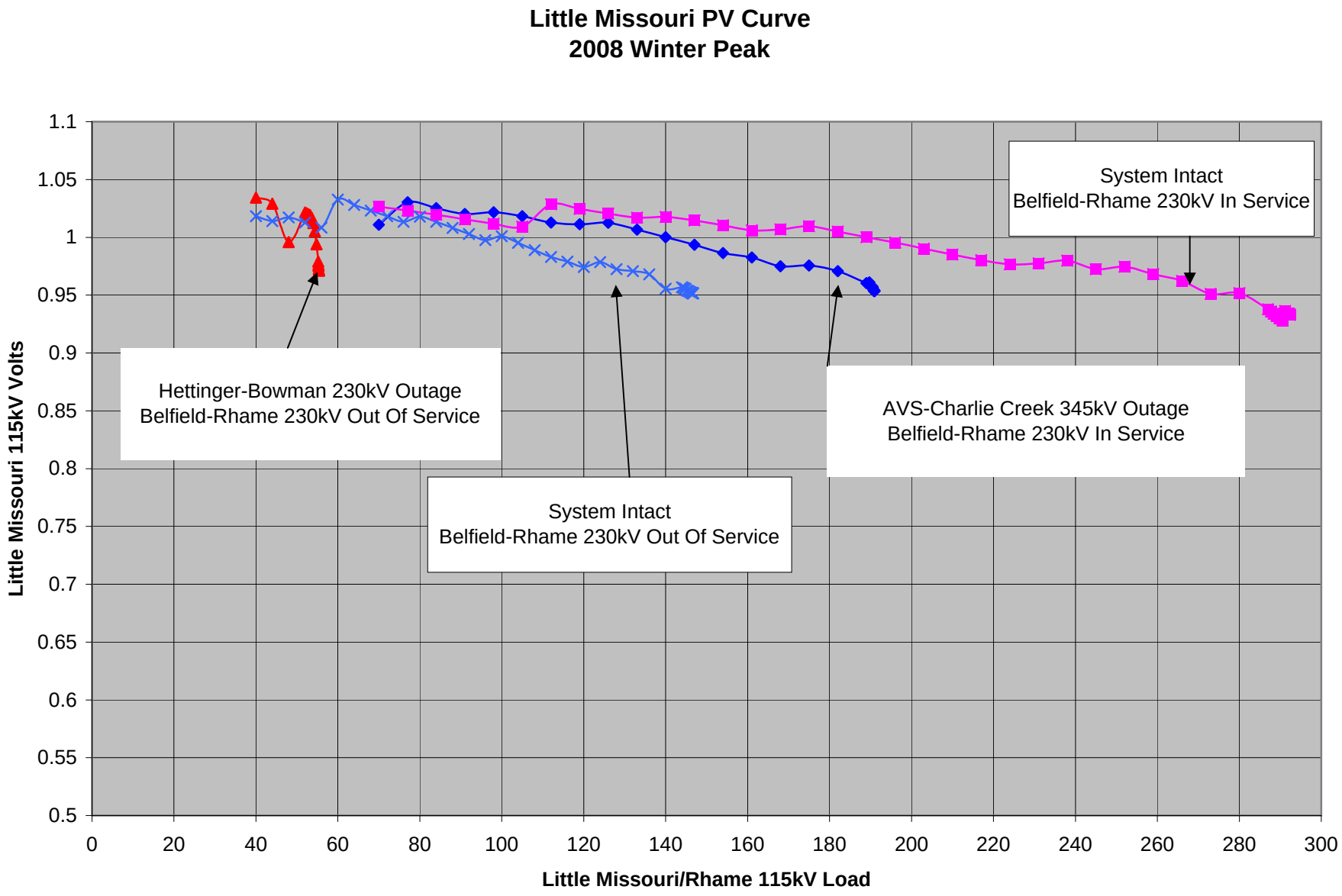
CELL NAME = 1O2C2,B10T=84,LM=200 NC, BL-RH200, DC-WE, B10T=80NS, JAN08

STATUS	VIOLATED ELEMENT	PU
OUTAGES:		
20_1O2C2 OUTAGE: LELANDO4 230 -LELND2TY 345	LELANDO3 345-LELND1TY 345	171.8 % OF 250.0 MVA RATING
	LELANDO4 230-LELND1TY 345	171.8 % OF 250.0 MVA RATING
	Overload of L.Olds transformers initiates tripping scheme	
21_1O2C2 OUTAGE: LOGAN 7 115 -LOGAN TY 230	TIOGA4 4 230-TIOGA4 7 115	105.0 % OF 100.0 MVA RATING
	Local Limit caused by b10t flow	
33_1O2C2OUTAGE:DAWSON-MEDORA230, MCDC@100	TIOGA4 4 230-TIOGA4 7 115	107.2 % OF 100.0 MVA RATING
	Local Limit caused by b10t flow	
36_1O2C2OUTAGE:BELFIELD-MEDORA230, MCDC@100	TIOGA4 4 230-TIOGA4 7 115	109.1 % OF 100.0 MVA RATING
	Local Limit caused by b10t flow	
56_1O2C2 OUTAGE: ANTELOP3 345 -CHAR.CK3 345	TIOGA4 4 230-TIOGA4 7 115	102.9 % OF 100.0 MVA RATING
	Local Limit caused by b10t flow	

Load limit > 200MW

Appendix B


Little Missouri PV Curve
2008 Summer Peak
Little Missouri 115kV Volts
Little Missouri/Rhame Load
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
System Intact
Belfield-Rhame 230kV In Service
Hettinger-Bowman 230kV Outage
Belfield-Rhame 230kV Out Of Service
AVS-Charlie Creek 345kV Outage
Belfield-Rhame 230kV In Service
System Intact
Belfield-Rhame 230kV Out Of Service


Little Missouri PV Curve
2008 Winter Peak
Little Missouri 115kV Volts
Little Missouri/Rhame 115kV Load
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
System Intact
Belfield-Rhame 230kV In Service
Hettinger-Bowman 230kV Outage
Belfield-Rhame 230kV Out Of Service
AVS-Charlie Creek 345kV Outage
Belfield-Rhame 230kV In Service
System Intact
Belfield-Rhame 230kV Out Of Service

Appendix C
Transient Stability Results Table

1	**Case No.**	benchmark	belfield-rhame 230	benchmark	belfield-rhame 230	benchmark	belfield-rhame 230
2	**Case Name**	g00-so08aa-ag1	br0-so08aa-ag1	g00-so08aa-ei2	br0-so08aa-ei2	g00-so08aa-nmz	br0-so08aa-nmz
3	**Disturbance**	ag1	ag1	ei2	ei2	nmz	nmz
4	**Prior Outage**	None	None	None	None	None	None
5	**Date/Time**	AUG 05 2008 9:27	AUG 05 2008 9:45	AUG 05 2008 9:29	AUG 05 2008 9:50	AUG 05 2008 9:41	AUG 05 2008 10:00
6	**Comments**						
7							
8	**Steady State Flows**						
9	NDEX / EAST BIAS	2080 / 331	2080 / 333	2080 / 331	2080 / 333	2080 / 331	2080 / 333
10	MHEX / L20D	2173 / 249	2174 / 248	2173 / 249	2174 / 248	2173 / 249	2174 / 248
11	ECL-ARP / PRI-BYN	558 / 704	558 / 704	558 / 704	558 / 704	558 / 704	558 / 704
12	MWEX / AHD-SLK	1524 / 654	1524 / 654	1524 / 654	1524 / 654	1524 / 654	1524 / 654
13	D602F / F601C	1769 / 1507	1769 / 1508	1769 / 1507	1769 / 1508	1769 / 1507	1769 / 1508
14	B10T / MH>SPC	166 / 62	166 / 62	166 / 62	166 / 62	166 / 62	166 / 62
15	OH E-W / OH>MH	190 / -196	189 / -196	190 / -196	189 / -196	190 / -196	189 / -196
16	R50M / OH>MP	153 / 151	153 / 151	153 / 151	153 / 151	153 / 151	153 / 151
17	G82R	1	3	1	3	1	3
18	Dorsey bipole / CU bipole	3246 / 1104	3246 / 1104	3246 / 1104	3246 / 1104	3246 / 1104	3246 / 1104
19	Dorsey Reserve / Wtrtn SVC	263 / 22	267 / 15	263 / 22	267 / 15	263 / 22	267 / 15
20	Forbes SVC / MSC	25 / 600	25 / 600	25 / 600	25 / 600	25 / 600	25 / 600
21	RCDC	0	0	0	0	0	0
22	**Steady State Vltgs**						
23	Dorsey 500/Dorsey 230	1.002 / 1.045	1.002 / 1.045	1.002 / 1.045	1.002 / 1.045	1.002 / 1.045	1.002 / 1.045
24	Roseau 500/Forbes 500	1.027 / 1.004	1.029 / 1.004	1.027 / 1.004	1.029 / 1.004	1.027 / 1.004	1.029 / 1.004
25	Chisago 500/EauClaire 345	1.008 / 1.026	1.008 / 1.026	1.008 / 1.026	1.008 / 1.026	1.008 / 1.026	1.008 / 1.026
26	Int Falls 115/Badoura 115	1.015 / 1.027	1.015 / 1.029	1.015 / 1.027	1.015 / 1.029	1.015 / 1.027	1.015 / 1.029
27	Drayton 230/Groton 345	1.034 / 1.008	1.037 / 1.010	1.034 / 1.008	1.037 / 1.010	1.034 / 1.008	1.037 / 1.010
28	**SS OS Relay Margins**						
29	D602F at Forbes/Dorsey	222% / 345%	222% / 346%	222% / 345%	222% / 346%	222% / 345%	222% / 346%
30	G82R at Rugby/L20D at Drayton	999% / 836%	999% / 844%	999% / 836%	999% / 844%	999% / 836%	999% / 844%
31	R50M/F3M	826% / 317%	827% / 317%	826% / 317%	827% / 317%	826% / 317%	827% / 317%
32	B10T	335%	334%	335%	334%	335%	334%
33	**Min/MaxTransientVltg**						
34	Arrowhd 230	0.98 | 1.03	0.98 | 1.03	0.96 | 1.05	0.96 | 1.05	0.96 | 1.06	0.96 | 1.06
35	Boise 115	0.99 | 1.03	0.99 | 1.03	0.96 | 1.04	0.97 | 1.03	0.92 | 1.04	0.92 | 1.04
36	Dorsey 230	1.02 | 1.06	1.02 | 1.06	1.02 | 1.06	1.02 | 1.06	1.04 | 1.17	1.04 | 1.17
37	Forbes 230	0.99 | 1.03	0.99 | 1.03	0.95 | 1.02	0.95 | 1.03	0.99 | 1.04	0.99 | 1.04
38	Riverton 230	0.97 | 1.05	0.98 | 1.05	0.89 | 1.06	0.90 | 1.06	0.90 | 1.05	0.91 | 1.05
39	Coal Creek 230	0.95 | 1.13	0.95 | 1.13	1.00 | 1.14	1.01 | 1.14	0.95 | 1.10	0.95 | 1.10
40	Jamestown 345	0.87 | 1.06	0.88 | 1.06	0.80 | 1.06	0.81 | 1.06	0.82 | 1.05	0.83 | 1.04
41	Drayton 230	0.99 | 1.10	0.99 | 1.10	0.94 | 1.11	0.95 | 1.11	0.98 | 1.09	0.99 | 1.10
42	Groton 345	0.85 | 1.05	0.86 | 1.04	0.83 | 1.09	0.84 | 1.10	0.85 | 1.06	0.86 | 1.06
43	Minong 161	1.00 | 1.05	1.01 | 1.05	1.01 | 1.08	1.01 | 1.08	1.00 | 1.08	1.00 | 1.08
44	Wahpeton 115	0.95 | 1.11	0.96 | 1.10	0.86 | 1.11	0.87 | 1.12	0.88 | 1.10	0.89 | 1.09
45	Watertown 345	0.93 | 1.04	0.94 | 1.04	0.88 | 1.09	0.89 | 1.09	0.90 | 1.06	0.90 | 1.06
46	**Dynamic Voltage Warnings**						
47		none	none	none	none	none	none
48							
49							
50							
51							
52							
53							
54	Worst Case Angle Damping						
55	Dorsey SUVP / UdHold					/ 0.133	/ 0.133
56	Forbes DC Red (DCAR)	392%	396%	507%	507%	507%	507%
57	K22W (max +dP @ t, d-ang)	9.1@(2.54165,2.9)	8.0@(2.52499,3.1)	60.8@(1.92500,-27.9)	62.0@(1.91666,-27.4)	118.5@(2.31666,-53.9)	117.9@(2.32499,-53.6)
58	K22W (max -dP @ t, d-ang)	23.2@(0.79166,5.7)	22.1@(0.80000,5.6)	10.4@(0.58333,1.5)	10.1@(0.58333,1.5)	87.0@(0.23333,6.9)	87.0@(0.23333,6.9)
59	K22W (max d-ang @ t, dP)	8.5@(1.08333,-10.8)	8.1@(1.07500,-10.1)	-31.4@(2.20833,56.3)	-30.8@(2.26666,58.4)	-54.0@(2.31666,117.4)	-53.7@(2.32499,116.8)
60	**OS Rel Trip / Marg**						
61	MH - OH						
62	D602F at Forbes/Dorsey	164% / 250%	166% / 253%	118% / 176%	119% / 178%	0.18333 sec / 0.18333 sec	0.18333 sec / 0.18333 sec
63	G82R at Rugby/L20D at Drayton	999% / 613%	999% / 631%	999% / 501%	999% / 507%	999% / 576%	999% / 582%
64	R50M / F3M	659% / 261%	663% / 263%	574% / 212%	576% / 213%	370% / 143%	369% / 142%
65	B10T	169%	178%	79%	81%	118%	121%
66	**FSCAPS (SS/Unav/Final)**						
67	Balta 230	(0 | 1 | 0)	(0 | 0 | 0)	(0 | 0 | 0)	(0 | 0 | 0)	(0 | 0 | 0)	(0 | 0 | 0)
68	Eau Cl 345 / Park Lk 115	(4 | 4 | 4) / (0 | 0 | 0)	(4 | 4 | 4) / (0 | 0 | 0)	(4 | 4 | 3) / (0 | 0 | 0)	(4 | 4 | 3) / (0 | 0 | 0)	(4 | 4 | 2) / (0 | 0 | 0)	(4 | 4 | 2) / (0 | 0 | 0)
69	Prairie 115 / Ramsey 230	(1 | 5 | 1) / (0 | 1 | 0)	(1 | 3 | 1) / (0 | 1 | 0)	(1 | 5 | 1) / (0 | 1 | 0)	(1 | 5 | 1) / (0 | 1 | 0)	(1 | 4 | 1) / (0 | 1 | 0)	(1 | 3 | 1) / (0 | 1 | 0)
70	Roseau 230 / Running 230	(0 | 0 | 0) / (1 | 1 | 1)	(0 | 0 | 0) / (1 | 1 | 1)	(0 | 1 | 0) / (1 | 3 | 2)	(0 | 1 | 1) / (1 | 2 | 2)	(0 | 1 | 0) / (1 | 4 | 1)	(0 | 1 | 0) / (1 | 4 | 1)
71	Shey 115 / Split Rock 115	(1 | 5 | 2) / (1 | 1 | 1)	(1 | 5 | 2) / (1 | 1 | 1)	(1 | 5 | 0) / (1 | 2 | 2)	(1 | 5 | 0) / (1 | 2 | 2)	(1 | 5 | 2) / (1 | 2 | 2)	(1 | 5 | 1) / (1 | 2 | 2)
72	**Damping Performance**	N/A	N/A	N/A	N/A	N/A	N/A

Case	g00-so08aa-ag1	br0-so08aa-ag1	g00-so08aa-ei2	br0-so08aa-ei2	g00-so08aa-nmz	br0-so08aa-nmz
Disturbance	ag1	ag1	ei2	ei2	nmz	nmz
System Response	OK	OK	OK	OK	OK	OK
70% or 120% Violations						
ORWG Criteria Violations						
Line Tripping					(5T)(6T)	(5T)(6T)