

Pine Falls Generation Station
Facility Up-grade
Interconnection Evaluation Study

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Executive Summary

The objective of this study was to identify any possible system deficiencies and impacts attributed to a facility upgrade at Pine Falls Generation Station. For this study, a proposed generation increase of 14 MW total was used (Pmax output from 92 MW to 106 MW). The estimated output increase of units 1 & 2 was 5 MW total and units 3 & 4 was 9 MW total. The latest proposed in service date for the units 1 & 2 is spring 2010. This study also investigated the impact of varied export levels and generation output from Selkirk with the proposed Pine Falls facility upgrades on the system. Impacts due to a potential 440 MW transfer to Ontario was not investigated. Should this additional project proceed, a sensitivity analysis may be required.

Single Contingency Analysis, Stability Analysis and Short Circuit Analysis were investigated. Both stability analysis and short circuit analysis investigations demonstrated no impact due to the Pine Falls Facility upgrade. Single contingency analysis identified 'major transmission line' deficiencies. Predominately, these deficiencies were isolated to the Winnipeg River Transmission system during export levels above current firm contract with Ontario. Also, certain deficiencies only occurred when Selkirk GS was in service. Those facilities are not the responsibility of the Pine Falls upgrade. Minimum network facility upgrades incurred from the proposed Pine Falls upgrades are highlighted in yellow. These minimum requirements are based on firm exports to Ontario (200 MW). Preliminary costs for these upgrades are around \$100 k. A list of the affected equipment is as follows:

<u>Line</u>	<u>Distance</u>	<u>Upgrade</u>
SG12 – 115 kV	43.12 km	336.4 MCM ACSR
SM26 – 110 kV	4.94 km	336.4 MCM ACSR
SW1 – 115 kV	2.36 km	795 MCM ACSR
SW2 – 115 kV	2.75 km	795 MCM ACSR
SW4 – 115 kV	2.75 km	795 MCM ACSR

<u>Station Work</u>	<u>Upgrade</u>
Parkdale – SC25	Riser
Mercy – SM26	Riser
Transcona – WT34	Riser*
Whiteshell – SW1, SW2, SW4	Risers
Seven Sisters GS – SW1, SW2, SW4	Risers

*Minimum requirements for Pine Falls upgrade

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1.0 Introduction

The purpose of this study was to evaluate the impacts of the proposed generation upgrades at Pine Falls Generation Station. Proposed generators upgrades to units 1-4 were combined for 14 MW. The estimated output increase of units 1 & 2 was 5 MW total and units 3 & 4 was 9 MW total. The latest proposed in service date for the units 1 & 2 is spring 2010 and 2012 for units 3 & 4.

1.1 Objectives

In order to evaluate the proposed facility upgrades at Pine Falls a number of different studies were required. Load Flow analysis included single contingencies and multi-element contingencies. Stability analysis simulated a number of disturbances on the system. Also, a short circuit analysis was performed to indicate any equipment violations due to increase fault contributions. Brief descriptions of each are as follows;

1.1.1 ACCC analysis

AC single contingency analysis was performed to identify any transmission limitations and voltage violation possibilities within the base case load flows following a single contingency outage. Multi-element (two separate circuits sharing the same tower) contingency outages were also included. Screening parameters for ACCC analysis was set to 0.01 p.u. voltage change and 2% rating change.

1.1.2 Stability Analysis

This study utilized the existing NMORWG UIP package and models. Five disturbances would be monitored for this project. Of particular interest were ‘Steady State Flow’, Transient Voltages and local area damping. A number of disturbances were monitored. They were as follows;

3 –phase, 5-cycle, 110 kV fault at Pine Falls end of Pine Falls – Great Falls Line GP1
3 –phase, 5-cycle, 110 kV fault at Pine Falls end of Pine Falls – Parkdale Line PC3 & PC4
3 –phase, 5-cycle, 110 kV fault at Pine Falls end of Pine Falls – McArther Falls Line PR2
3 –phase, 5-cycle, 110 kV fault at Pine Falls end of Pine Falls – Pine Falls Paper Co. Line PA1 & PA2
SLG, 5-cycle, 110 kV fault at Pine Falls end of Pine Falls – Great Falls Line GP1
SLG, 5 + 15-cycle, 110 kV fault at Pine Falls end of Pine Falls - Parkdale Line PC4,
simulates a stuck breaker disturbance

1.1.3 Fault Analysis

Short Circuit Analysis was required to indicate any impact of increased short circuit levels on local breakers with the increased output of Pine Fall. Three phase and single-line-to-ground fault levels were calculated with PSS/E.

2.0 Base Case Study Models

This study utilized the NMORWG PSS/E models for 2004. The summer off peak base model was derived from 2005 summer peak operation model. Manitoba Hydro loads were scaled to 70% of summer peak. Each study case contains two files, a base case file and a steady state file with Pine Falls upgrades. All working cases were modified to reflect known system changes. Listed below are the major changes;

- Set accredited generation (refer to Appendix J)
- Set Winnipeg River maximum generation (590 MW)
- Re-configuration of VH2-XS49 to VS1 and XS09.
- Remove Raven Lake Bank 3 from service
- Increase D72V rating.
- St. Leon Wind Generation in service
- System changes for Ontario Clean Air Transfer (440 MW) **not** included.
- System changes for new Transcona Station **not** included.

In conjunction with the load flow and contingency analysis, a number of export scenarios were evaluated. For each case (summer off peak, summer peak and winter peak) Ontario export levels were varied from 0 MW - 150 MW - 275 MW. A summer peak Ontario export level of 200 MW was also created for comparisons for a few contingency issues. As well, Selkirk G.S. output was switched from 145 MW to 0 MW. Maximum power export to the US was 2176 MW for summer and up to 1394 MW in winter. A comprehensive listing of file names and export levels can be found in Appendix A (LF/ACCC File Names).

2.1 ACCC Analysis – Single Contingency

AC single contingency analysis was performed to identify any transmission limitations and voltage violations between base case and Pine Falls generation enhancements. One transmission line violation occurred on line SG12 when SR3 was out of service. These violations occurred during the summer peak, Pine Falls facility upgrades, maximum export to Ontario, with and without Selkirk GS in-service. A recommended solution for this overload situation would be to upgrade SG12 to 336.4 MCM ACSR. However, this scenario exceeds MH firm export to Ontario and therefore is **not** required for the Pine Falls Upgrade. An overview of the ACCC Screening Summary can be found on Table 1. Complete ACCC Screening Summary results can be located in Appendix B.

ACCC Screening Summary Single Contingency								
Facility	Conductor Size (MCM)	Limit MVA	Contingency	pf2-sp06b02 MH/ON - 276 MW Overload (% Rate C)	pf2-sp06aa02 MH/ON - 275 MW Overload (% Rate C)	pf2-sp06b05 MH/ON - 274 MW Overload (% Rate C)	pf2-sp06aa05 MH/ON - 274 MW Overload (% Rate C)	Comment
SG12	266.8	93.2	SR3	106	111	-	105	N/A Exceeds firm MH/ON - 200MW

Table 1. ACCC Screening Summary, Single Contingency

2.2 ACCC Analysis – Single Contingency (Multiple Elements)

AC single contingency (multiple elements - common tower) analysis was performed to identify any transmission limitations and violations between base case and Pine Falls generation enhancements. The summer off peak cases produced two violations. Lines SC25 and WT34 exceeded their limitations. Line SC25 overload was rectified with station equipment upgrades at Parkdale. A recommended action to rectify WT34 overload would be to upgrade Transcona Riser and portion of the bus to 750 A minimum summer rating.. An overview of the ACCC Screening Summary Summer Off-Peak can be found on Table 2. Complete ACCC Screening Summary Summer Off-peak results can be located in Appendix C.

ACCC Screening Summary Single Contingency (Multiple Elements) Summer Off-Peak									
Facility	Conductor Size (MCM)	Limit MVA	Contingency	pf1-s006b01 MH/ON - 0 MW Overload (% Rate C)	pf1-s006aa01 MH/ON - 0 MW Overload (% Rate C)	pf1-s006b03 MH/ON - 0 MW Overload (% Rate C)	p1-s006aa04 MH/ON - 0 MW Overload (% Rate C)	Comment	
SC25	266.8	69.9	PC3	103	106			Completed 2005 - stn ok!	
	Revised 2005	93.2	PF Bnk 8 PC4		80				
WT34	336.4	120.6	ST5 ST6	115	118	108	111	Upgrade Transc. Riser / portion of bus	

Table 2. ACCC Screening Summary, Single Contingency (Multiple Elements) - Summer Off – Peak

The Summer Peak ACCC screening summary produced five line overload violations. Lines SM26, WT34, SW2, SW1, SW4, and SG12 were in violation. Line SM26 should be upgraded to 336.4 MCM ACSR and the Mercy Station riser should be 540 A minimum summer. However, SM26 and Mercy Station riser are only an issue with Selkirk GS in service. Due to the fact that Selkirk GS is operated as an energy supply, the SM26 and Mercy Station enhancements are **not** required by the Pine Falls up-grade. Lines SW2, SW1 and SW4 could be upgraded to 795 MCM ACSR and upgrade risers at Seven Sisters and Whiteshell station to 750 A minimum summer rating. Line SG12 could be upgraded to 336.4 MCM ACSR from Great Falls to Lac Du Bonnet tap, 578 A minimum summer rating. However, these scenarios for SW1, SW2, SW4 and SG12 exceeded MH firm export to Ontario. Therefore these enhancements are **not** required for the Pine Falls Upgrade. A recommended action to rectify WT34 overload would be to upgrade Transcona Riser and portion of the bus to 750 A minimum summer rating. An overview of the ACCC Screening Summary Summer Peak can be found on Table 3. Complete ACCC Screening Summary Summer peak results can be located in Appendix C.

ACCC Screening Summary													
Single Contingency (Multiple Elements)													
Summer Peak													
Facility	Conductor Size (MCM)	Limit MVA	Contingency	pf2-sp06b01	pf2-sp06aa01	pf2-sp06b02	pf2-sp06aa02	pf2-sp06b04	pf2-sp06aa04	pf2-sp06b05	pf2-sp06aa05	Comment	
				MH/ON - 0 MW Overload (% Rate C)	MH/ON - 0 MW Overload (% Rate C)	MH/ON - 276 MW Overload (% Rate C)	MH/ON - 275 MW Overload (% Rate C)	MH/ON - 0 MW Overload (% Rate C)	MH/ON - 0 MW Overload (% Rate C)	MH/ON - 274 MW Overload (% Rate C)	MH/ON - 274 MW Overload (% Rate C)		
SM26	266.8	69.9	PC3 PF Bnk8	107	110							Upgrade Line to 336.4 MCM/Mercy riser	
WT34	336.4	120.6	PC4 ST5	112	116			105	109			Upgrade Transc. Riser / portion of bus	
SW2	336.4	110.1	ST6 SW1							124	127	Exceeds firm MH/ON - 200MW	
SW1	336.4	110.1	SK1 SW3							116	118	Exceeds firm MH/ON - 200MW	
SW4	336.4	110.1	SW2 SW3							118	121	Exceeds firm MH/ON - 200MW	
SG12	266.8	93.2	SW2 SW3			108	111				100	Exceeds firm MH/ON - 200MW	

Table 3. ACCC Screening Summary, Single Contingency (Multiple Elements) - Summer Peak

The Winter Peak ACCC screening summary produced no overload violations. However, there was a low bus voltage violation at MacGregor Station. The station bus voltage dipped to 0.9 pu. The minimum allowable bus voltage in a post-contingency situation for a 66 kV station is 0.94 pu. There are no remedial solutions for this condition at this time. However, it is recommended that a solution be investigated within the IFS. An overview of the ACCC Screening Summary Winter Peak can be found on Table 4. Complete ACCC Screening Summary Summer peak results can be located in Appendix D.

ACCC Screening Summary						
Single Contingency (Multiple Elements)						
Winter Peak						
Facility	Pre-C. min	Post-C. min	Contingency	pf3-wp06b	pf3-wp06aa	Comment
	Limit (pu)	Limit (pu)		MH/ON - 0 MW Voltage Limit (pu)	MH/ON - 0 MW Voltage Limit (pu)	
MacGregor	0.99	0.94	CP17 RP16		0.9	N/A

Table 4. ACCC Screening Summary, Single Contingency (Multiple Elements) - Winter Peak

2.3 ACCC Analysis – Conclusions

Single Contingency multiple elements – summer peak had the most impact on the system with 5 separate lines affected. The majority of the system deficiencies were within the Winnipeg River Transmission Line system. Combinations of Selkirk GS and certain high Ontario transfer studies suggest multiple elements to be upgraded. However, WT34 riser at Transcona Station is the only facility requiring upgrades for this project. A budgetary estimate of \$0.1M (+/- 50%) is required for this work. An estimate breakdown of upgrade costs can be located in Appendix E.

3.0 Stability Analysis

Existing stability models from the NMORWG UIP package were utilized. Summer and winter models were modified to attain summer off-peak, summer peak and winter peak models. For each of the above files, base case models without Pine Falls upgrades and system intact models with Pine Falls upgrades were created. From these models, five different disturbances were monitored. There were 4 single contingency 3-phase, 5 cycle, 110 kV faults at Pine Falls end of transmission lines GP1, PC3, PR2 and PA1. A Single Line to Ground, 5 cycle, 110 kV fault at Pine Falls end of GP1 was performed. Additionally, a Single Line to Ground, 5 + 15 cycle, 110 kV fault at Pine Falls on PC4, this extended SLG fault was performed to imitate a stuck breaker scenario. In order to accommodate file changes required for this fault analysis, two cases were created. Case p7s utilized Pine Falls with an output of 91 MW (before) and case p8s evaluated Pine Falls with an output of 105 MW (after). Interconnections and local area impacts of disturbances were investigated. Listed within Table 5 are the particulars of the cases used for the different disturbances monitored.

PINE FALLS IES - 2005							
STABILITY FILE NAMES							
<u>Case</u>	<u>File Name</u>	<u>Type</u>	<u>Dorsey</u>	<u>Selkirk Output</u>	<u>Pine Falls</u>	<u>MH/US</u>	<u>MH / ON</u>
s-off peak	pfb-so06aa.uzvV4V4	stab	3227	0	91	2175	200
	pf1-so06aa.uzvV4V4	stab	3208	0	105	2177	198
summer peak	pfb-sp06aa.iznV4V4	stab	3297	120	91	2177	200
	pf2-sp06aa.iznV4V4	stab	3278	120	105	2177	198
winter peak	pfb-wp06aa.cji0454	stab	3280	120	91	1272	0
	pf3-wp06aa.cji0454	stab	3268	120	105	1272	0

<u>Faults</u>	
p1z	3P, 5 cycle, 110 kV fault at Pine Falls on line GP1
p2z	3P, 5 cycle, 110 kV fault at Pine Falls on line PC3
p3z	3P, 5 cycle, 110 kV fault at Pine Falls on line PR2
p4z	3P, 5 cycle, 110 kV fault at Pine Falls on line PA1
p6s	SLG, 5 cycle, 110 kV fault at Pine Falls on GP1
p7s	SLG, 5 + 15 cycle, 110 kV fault at Pine Falls on PC4 (PF @ 91 MW)
p8s	SLG, 5 + 15 cycle, 110 kV fault at Pine Falls on PC4 (PF @ 105 MW)

Table 5. Stability File Names and Fault Descriptions

3.1 Stability Disturbance Analysis Results

Complete summaries of Summer Off-Peak, Summer Peak and Winter Peak can be found in Appendices F, G & H respectfully.

3.1.1 Fault p1z observations

Interconnection power flow and stability was studied for summer off peak, summer peak and winter peak. Steady state flows produced no impact due to the increased output of Pine Falls. Transient voltages and out of step relay margins portion of the stability study produced marginal changes. Transient voltages only varied 0-2% from base case and are well within acceptable limits. The out of step relay margins varied 0-6% from base case. The largest reduction in relay margins occurred for F3M during winter peak, decreased from 304% to 298%. All relay margins were within acceptable limits.

Local area impact was observed to be very damped during recovery of the contingency. Results are acceptable for stability analysis. Figure 1 demonstrates an example of the post contingency results for fault p1z.

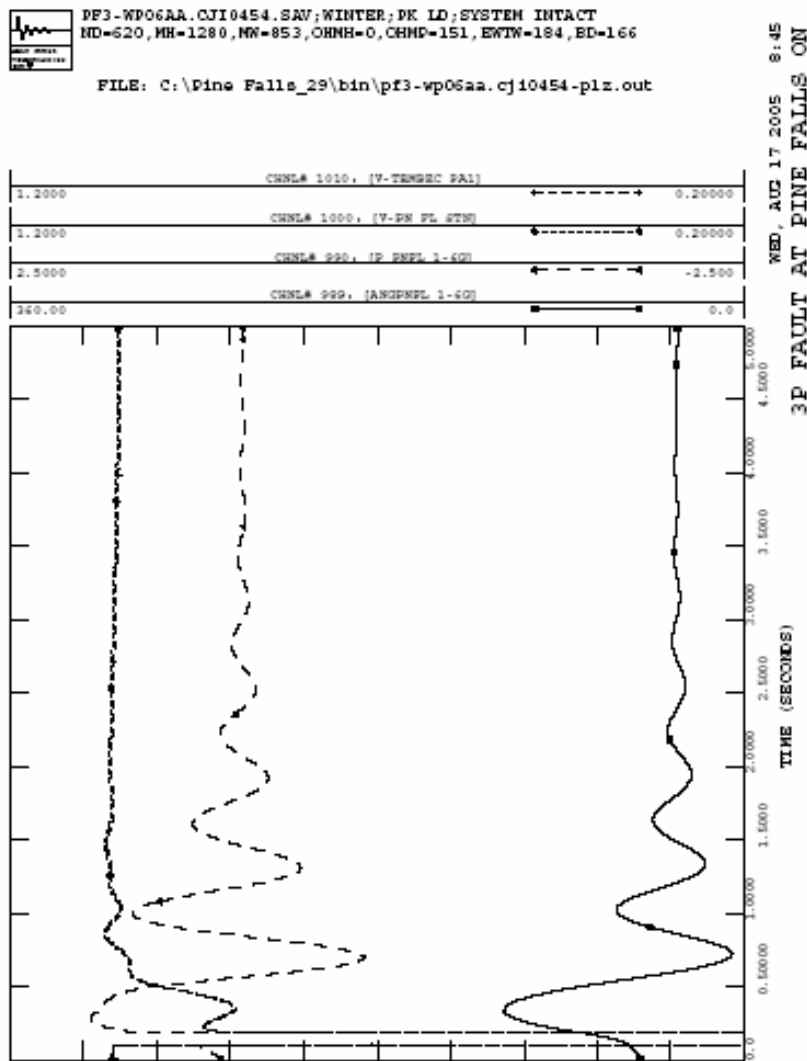


Figure 1. 3 Phase Fault at Pine Falls on GP1 (p1z Fault)

3.1.2 Fault p2z observations

Interconnection power flow and stability was studied for summer off peak, summer peak and winter peak. Steady state flows produced no impact due to the increased output of Pine Falls. Transient voltages and out of step relay margins portion of the stability study produced marginal changes. Transient voltages are well within acceptable limits. The out of step relay margins varied 0-4% from base case. The largest reduction in relay margins occurred for Dorsey during summer off peak, increased from 404% to 408%. All relay margins were within acceptable limits.

Local area impact was observed to be very damped during recovery of the contingency. Results are acceptable for stability analysis. Figure 2 demonstrates an example of the post contingency results for fault p2z.

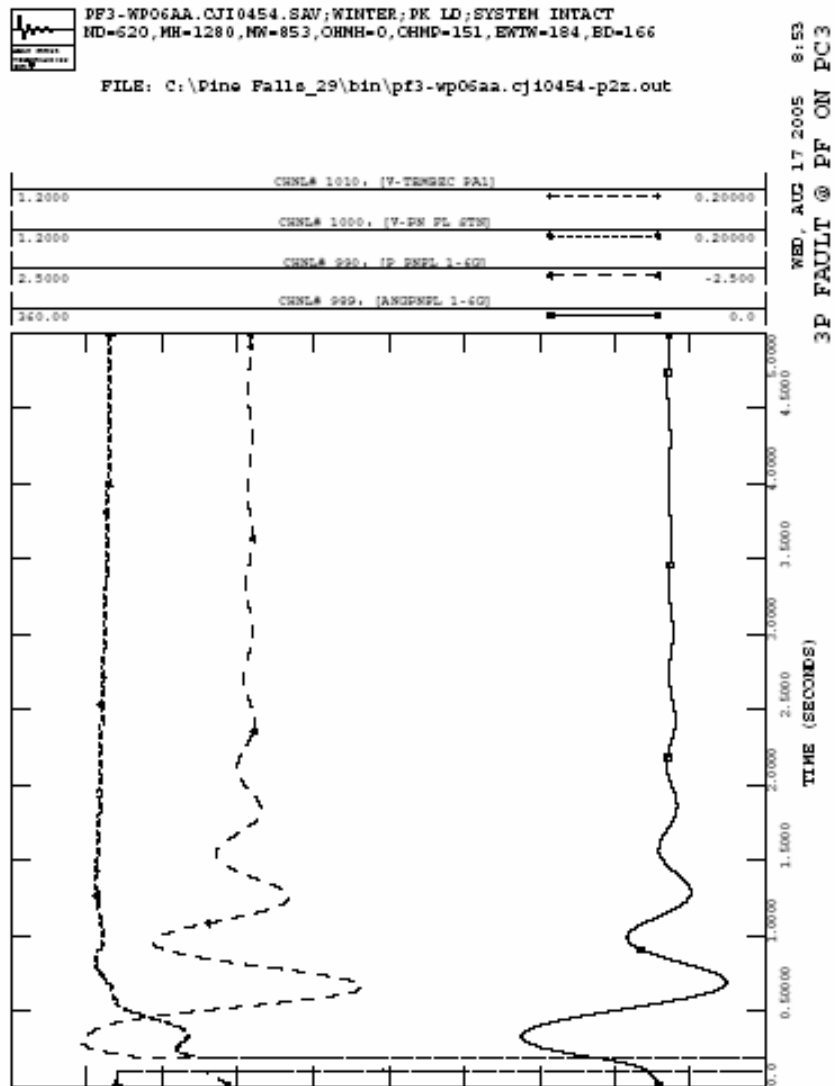


Figure 2. 3 Phase Fault at Pine Falls on PC3 (p2z Fault)

3.1.3 Fault p3z observations

Interconnection power flow and stability was studied for summer off peak, summer peak and winter peak. Steady state flows produced no impact due to the increased output of Pine Falls. Transient voltages and out of step relay margins portion of the stability study produced marginal changes. Transient voltages are well within acceptable limits. The out of step relay margins varied 0-24% from base case. The largest reduction in relay margins occurred for Dorsey during winter peak, decreased from 739% to 715%. All relay margins were within acceptable limits.

Local area impact was observed to be very damped during recovery of the contingency. Results are acceptable for stability analysis. Figure 3 demonstrates an example of the post contingency results for fault p1z.

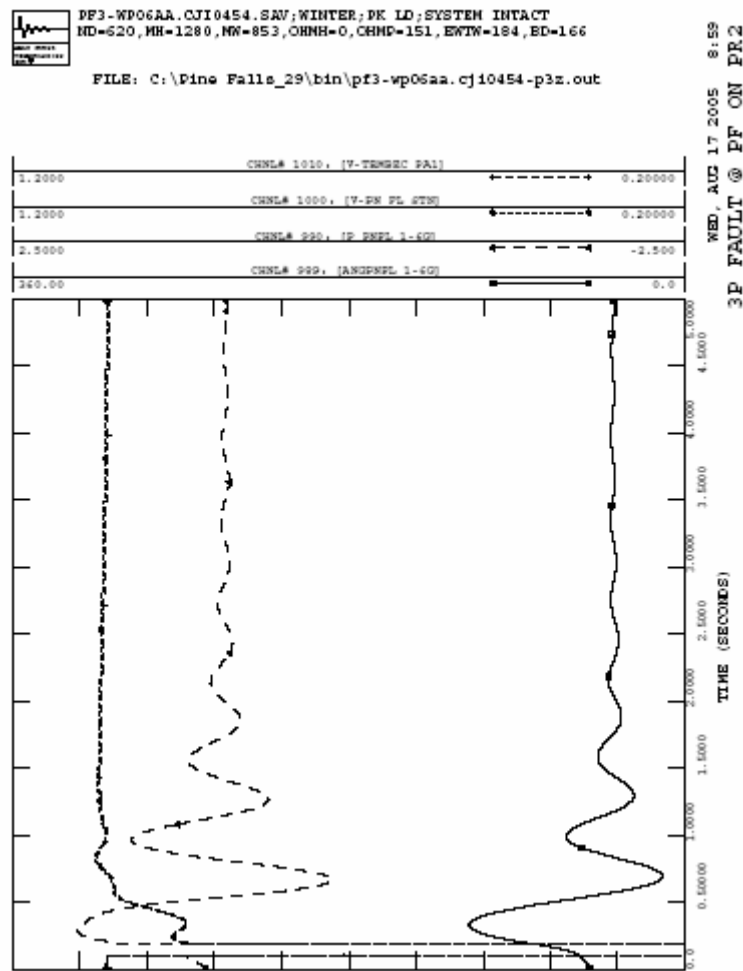


Figure 3. 3 Phase Fault at Pine Falls on PR2 (p3z Fault)

3.1.4 Fault p4z observations

Interconnection power flow and stability was studied for summer off peak, summer peak and winter peak. Steady state flows produced no impact due to the increased output of Pine Falls. Transient voltages and out of step relay margins portion of the stability study produced marginal changes. Transient voltages are well within acceptable limits. The out of step relay margins varied 0-13% from base case. The largest reduction in relay margins occurred for Dorsey during winter peak, decreased from 677% to 664%. All relay margins were within acceptable limits.

Local area impact was observed to be very damped during recovery of the contingency. Results are acceptable for stability analysis. Figure 4 demonstrates an example of the post contingency results for fault p4z.

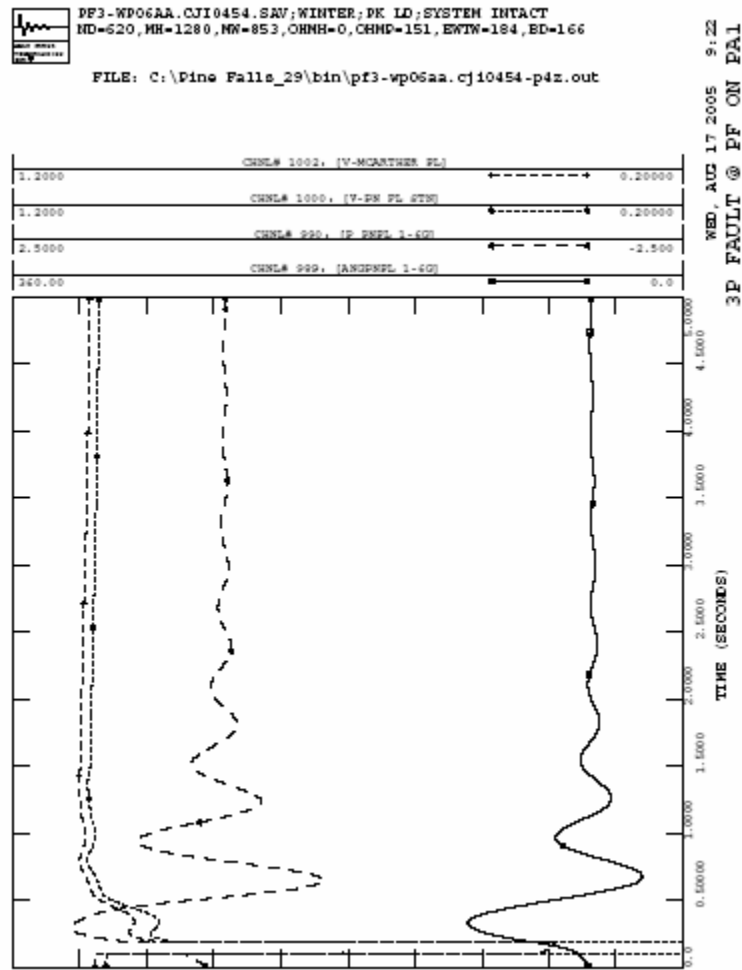


Figure 3. 3 Phase Fault at Pine Falls on PR2 (p3z Fault)

3.1.5 Fault p6s observations

Interconnection power flow and stability was studied for summer off peak, summer peak and winter peak. Steady state flows produced virtually no impact due to the increased output of Pine Falls. Transient voltages and out of step relay margins portion of the stability study produced no changes. Transient voltages are well within acceptable limits. The out of step relay margins varied 0-11% from base case. The largest reduction in relay margins occurred for Dorsey during winter peak, decreased from 744% to 733%. All relay margins were within acceptable limits.

Local area impact was observed to be very damped during recovery of the contingency. Results are acceptable for stability analysis. Figure 4 demonstrates an example of the post contingency results for fault p6s.

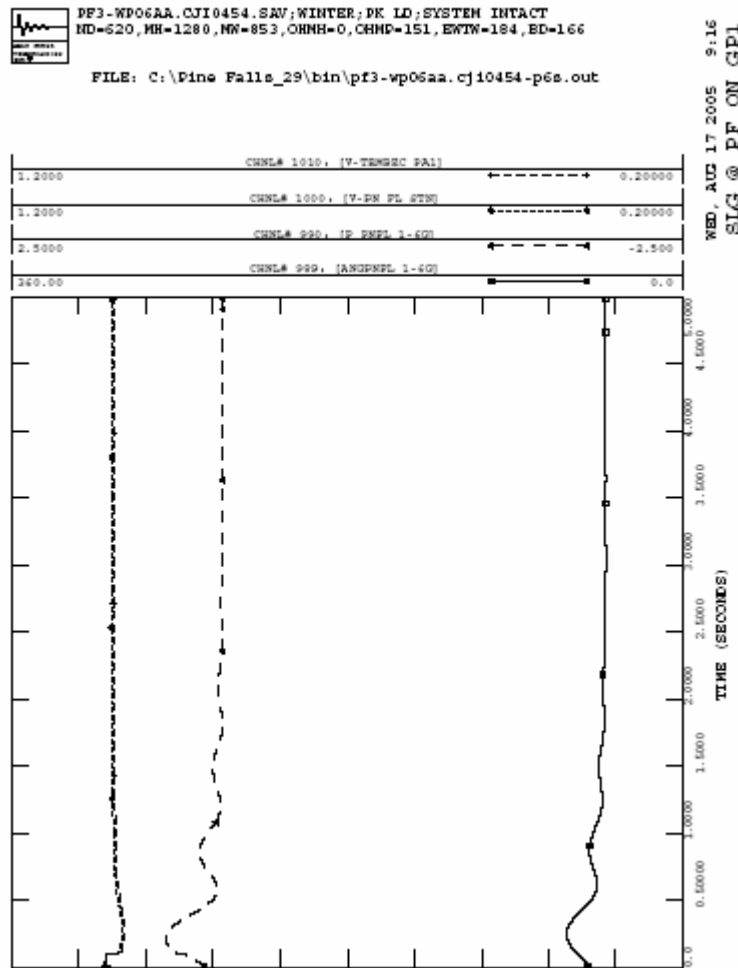


Figure 4. SLG Fault at Pine Falls on GP1 (p6s Fault)

3.1.6 Faults p7s and p8s observations

Interconnection power flow and stability was studied for summer off peak, summer peak and winter peak. Steady state flows produced virtually no impact due to the increased output of Pine Falls. Transient voltages and out of step relay margins portion of the stability study produced no changes. Transient voltages are well within acceptable limits. The out of step relay margins varied 0-13% from base case. The largest reduction in relay margins occurred for Dorsey during winter peak, decreased from 714% to 706%. All relay margins were within acceptable limits.

Local area impact was observed to be very damped during recovery of the contingency. Results are acceptable for stability analysis. Figure 5 demonstrates an example of the post contingency results for fault p8s.

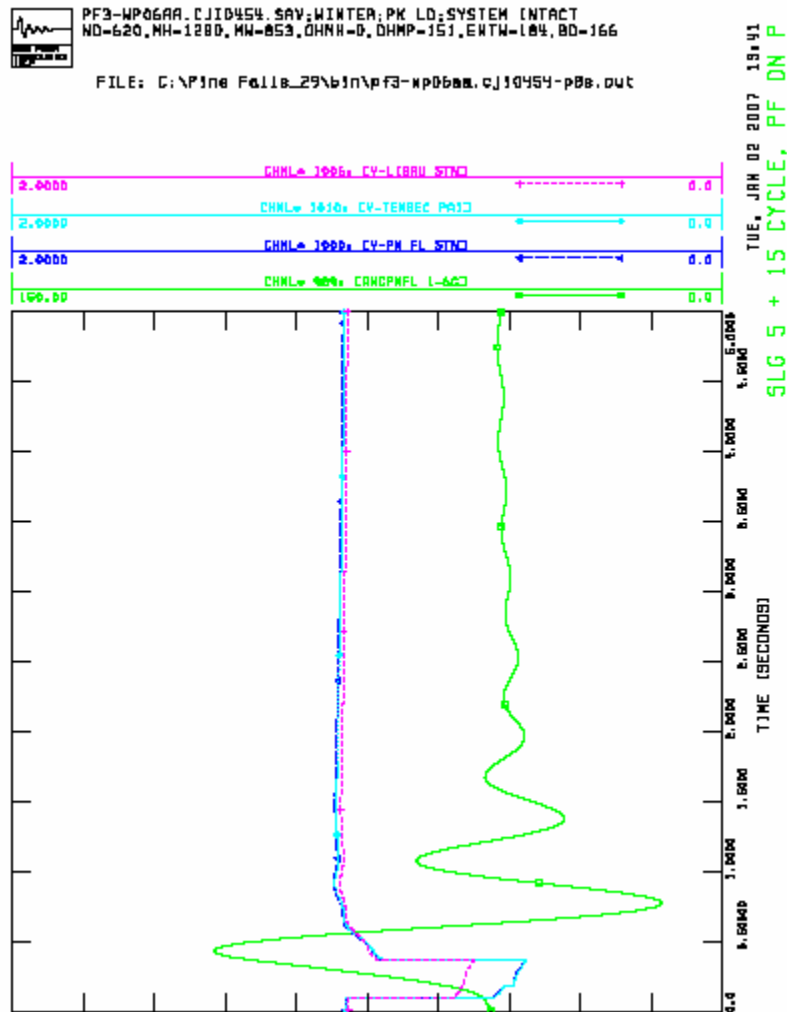


Figure 5. SLG Fault (5+15 cycles) at Pine Falls on PC4 (p8s Fault)

3.2 Stability Disturbance Analysis Conclusion

Proposed Pine Falls facility upgrades of 14 MW does not negatively affect system stability.

4.0 Short Circuit Analysis

A short circuit Analysis was performed to indicate, if any, impact of increased short circuit levels on local breakers with the proposed increased output of Pine Falls. Both three phase and single-line-to-ground fault levels were used. A report written by M. Wonsiak regarding short circuit levels concluded that the fault level rise due to the facility increase would not exceed the capabilities of the surrounding equipment. Furthermore, the maximum fault level on the 115 kV bus at Pine falls was under 82% of the breaker interrupting rating. Also, fault levels on the 66 kV portions of Pine falls were only 15% of the breaker interrupting rating. In conclusion, the Pine Falls facility increase does not adversely effect any equipment in the surrounding area. A copy of Mr. Wonsiak's report can be located in Appendix I.

5.0 Future IFS Study

There are a number of suggested scenarios that require further investigation within the future IFS study. They are as follows:

- a) Adjust study parameters to include the preceding projects identified by In Service Dates within the generation queue.
- b) 0 MW transfer to Ontario, WT34 Line and Termination
MacGregor low bus Voltage
- c) 200 MW transfer to Ontario, SW1, SW2, SW4, SR3, SG12
- d) 0-145 MW stepped Selkirk GS, "Non-Firm"
SC25, SM26
- e) Detailed generation increase (stepped) for Pine Falls.
Units 1 & 2
Units 3 & 4
- f) Investigate stuck breaker at Pine Falls, PC4 (trip at Parkdale)
- g) Investigate possible low voltage at Tembec with low Winnipeg River during winter peak (only 2 units running). Control specifications of the proposed generator upgrades may be required. Another option could be to have a unit or units run in synchronous condenser mode.

Appendices

Appendix A

PINE FALLS IES - 2005

LF/ACCC FILE NAMES

Case	File Name	Type	Dorsey	Selkirk Output	Pine Falls	NDEX	MH / ON
1	pf1-so06base	LF /ACCC	3270	145	91	2175	150
	pf1-so06b01	LF /ACCC	2106	145	91	2176	-0.2
	pf1-so06b02	LF /ACCC	2376	145	91	2174	278
	pf1-so06b03	LF /ACCC	2248	0	91	2175	0.3
	pf1-so06b04	LF /ACCC	2390	0	91	2173	151
	pf1-so06b05	LF /ACCC	2520	0	91	2177	276
	pf1-so06aa	LF /ACCC	3270	145	105	2175	149.4
	pf1-so06aa01	LF /ACCC	2092	145	105	2174	-0.2
	pf1-so06aa02	LF /ACCC	2360	145	105	2176	274.4
	pf1-so06aa03	LF /ACCC	2378	0	105	2175	151
	pf1-so06aa04	LF /ACCC	2234	0	105	2175	-1.1
pf1-so06aa05	LF /ACCC	2504	0	105	2176	274.2	
2	pf2-sp06base	LF /ACCC	3280	145	91	2176	149
	pf2-sp06b01	LF /ACCC	3134	145	91	2173	0
	pf2-sp06b02	LF /ACCC	3350	145	91	2117	276
	pf2-sp06b02b	LF /ACCC	3330	145	91	2175	200
	pf2-sp06b03	LF /ACCC	3350	0	91	2099	152
	pf2-sp06b04	LF /ACCC	3280	0	91	2176	-0.2
	pf2-sp06b05	LF /ACCC	3350	0	91	1975	274
	pf2-sp06b05b	LF /ACCC	3350	0	91	2052	200
	pf2-sp06aa	LF /ACCC	3260	145	105	2176	149
	pf2-sp06aa01	LF /ACCC	3116	145	105	2175	0.1
	pf2-sp06aa02	LF /ACCC	3350	145	105	2139	275
	pf2-sp06aa02b	LF /ACCC	3310	145	105	2175	200
	pf2-sp06aa03	LF /ACCC	3350	0	105	2121	151
	pf2-sp06aa04	LF /ACCC	3260	0	105	2176	-0.2
	pf2-sp06aa05	LF /ACCC	3350	0	105	1996	274
	pf2-sp06aa05b	LF /ACCC	3350	0	105	2072	200
	3	pf3-wp06base	LF /ACCC	3350	145	91	1381
pf3-wp06b01		LF /ACCC	3350	145	91	1236	151
pf3-wp06b02		LF /ACCC	3350	145	91	1110	274
pf3-wp06b03		LF /ACCC	3350	0	91	1094	150
pf3-wp06b04		LF /ACCC	3350	0	91	1239	-0.1
pf3-wp06b05		LF /ACCC	3350	0	91	965	275
pf3-wp06aa		LF /ACCC	3350	145	105	1394	0.1
pf3-wp06aa01		LF /ACCC	3350	145	105	1250	150
pf3-wp06aa02		LF /ACCC	3350	145	105	1122	275
pf3-wp06aa03		LF /ACCC	3350	0	105	1106	151
pf3-wp06aa04		LF /ACCC	3350	0	105	1253	-0.1
pf3-wp06aa05		LF /ACCC	3350	0	105	978	275

APPENDIX B

Pine Falls IES - ACCC SCREENING SUMMARY 2005
Summer Off Peak 2006

Facility	mcm	Line Thermal Rating (deg C)	Limit (MVA)	Contingency	pf1-so06 base MH/ON -150 Overload (% Rate C)	pf1-so06 aa MH/ON - 149 Overload (% Rate C)	pf1-so06 b01 MH/ON - 0 Overload (% Rate C)	pf1-so06 aa01 MH/ON - 0 Overload (% Rate C)	pf1-so06 b02 MH/ON - 278 Overload (% Rate C)	pf1-so06 aa02 MH/ON - 274 Overload (% Rate C)	pf1-so06 b03 MH/ON - 0 Overload (% Rate C)	pf1-so06 aa04 MH/ON - 0 Overload (% Rate C)	pf1-so06 b04 MH/ON - 151 Overload (% Rate C)	pf1-so06 aa03 MH/ON - 151 Overload (% Rate C)	pf1-so06 b05 MH/ON - 276 Overload (% Rate C)	pf1-so06 aa05 MH/ON - 274 Overload (% Rate C)	Comment
Pine Falls Bk 1				base R50M BK41 MH-011	*	* 107	*	*	*	* 107.5	*	*			*	*	RATING ERROR DC REDUCTION
SC25	266.8	100	69.9	MH-031			102.8	105.8									Done 2005-ok!
WT34	336.4	75	120.6	MH-024			115.3	118.2			108	111					Upgrade Trans. Risers / portion of BUS
SR3	266.8 60 (100)		69.7 (336A)	SG12 MH-032 MH-031					112.8 101	116.3 (391 A) 104.3 102.4					103	108	Upgrade summer 2005 - OK!

APPENDIX C

Pine Falls IES - ACCC SCREENING SUMMARY 2005
Summer Peak 2006

Facility	MCM	Line Thermal Rating (deg.C)	Limit (MVA)	Contingency	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	pf2-sp06	Comment
					base MH/ON - 149 Overload (% Rate C)	aa MH/ON - 149 Overload (% Rate C)	b01 MH/ON - 0 Overload (% Rate C)	aa01 MH/ON - 0 Overload (% Rate C)	b02 MH/ON - 276 Overload (% Rate C)	aa02 MH/ON - 275 Overload (% Rate C)	b02b MH/ON - 200 Overload (% Rate C)	aa02b MH/ON - 200 Overload (% Rate C)	b03 MH/ON - 152 Overload (% Rate C)	aa03 MH/ON - 151 Overload (% Rate C)	b04 MH/ON - 0 Overload (% Rate C)	aa04 MH/ON - 0 Overload (% Rate C)	b05 MH/ON - 274 Overload (% Rate C)	aa05 MH/ON - 274 Overload (% Rate C)	b05b MH/ON - 200 Overload (% Rate C)	
				L20D MH-006 R49R R50M MH-032	*	*	*	*	*	*	*	*	*	*	*	*	*	*	NOT CONVERGED DC Reduction DC Reduction DC Reduction	
SM26	266.8	100	93	SC25		100.4													Within Tolerance	
SC25	266.8	100	69.9	SM26			107	110											Upgrade Line to 336.4 MCM/Mercy riser to 540 A Parkdale Risers 2005 OK!	
WT34	336	75	120.6	MH-024			112	116							105	109			Upgrade Trans. Risers / portion of BUS	
SW2	336	100	110.1	MH-034													124	127	N/A - Exceeds firm MH/ON - 200MW	
SW1	336	100	110.1	MH-035													116	118	N/A - Exceeds firm MH/ON - 200MW	
SW4-(SS-SK1)	336	100	110.1	MH-035													118	121	N/A - Exceeds firm MH/ON - 200MW	
SW4 (WHT-SK1)	336	100	110.1	MH-035													118	121	N/A - Exceeds firm MH/ON - 200MW	
L20D	954	100	419	G82R					100.5										Within Tolerance	
SR3	266.8	60	69.7	SG12					116	123							107	114	up-graded in 2005 (489 A @ 100c) OK	
				MH-032					105	109										
				MH-031						105										
				MH-034													117	120		
SG12	266.8	100	93.2	SR3					106	111								105	N/A - Exceeds firm MH/ON - 200MW	
				MH-035					106	110								100	N/A - Exceeds firm MH/ON - 200MW	

APPENDIX D

Pine Falls IES - ACCC SCREENING SUMMARY 2005
Winter Peak 2006

Line	Thermal	Rating	Limit	Contingency	pf3-wp06 base	pf3-wp06 aa	pf3-wp06 b01	pf3-wp06 aa01	pf3-wp06 b02	pf3-wp06 aa02	pf3-wp06 b03	pf3-wp06 aa03	pf3-wp06 b04	pf3-wp06 aa04	pf3-wp06 b05	pf3-wp06 aa05	Comment
		(deg C)	(MVA)		MH/ON - 0 Overload (% Rate C)	MH/ON - 0 Overload (% Rate C)	MH/ON - 151 Overload (% Rate C)	MH/ON - 150 Overload (% Rate C)	MH/ON - 274 Overload (% Rate C)	MH/ON - 275 Overload (% Rate C)	MH/ON - 150 Overload (% Rate C)	MH/ON - 151 Overload (% Rate C)	MH/ON - 0 Overload (% Rate C)	MH/ON - 0 Overload (% Rate C)	MH/ON - 275 Overload (% Rate C)	MH/ON - 275 Overload (% Rate C)	
Facility																	
WHTSHELL BK 7				BK7	*	*											NOT CONVERGED
WHTSHELL BK 8				BK8	*	*											Prg issue
R50M																	Prg issue
LOW VOLTAGE (PU)																	
MacGregor				MH-015			0.9										
HIGH VOLTAGE																	

APPENDIX E

Pine Falls IES - Facility Up-grades
Estimated Dollars

Estimate of September 7, 2005

Cost
(Thousands)

Re-conductor MH lines @ \$35k/km
(\$100k/km for short lines*)

km

SG12 115 kV	43.12	\$1,509.2	336.4 MCM ACSR @100°C
SM26 110 kV	4.94	\$494.0	336.4 MCM ACSR @100°C
SW1 115 kV	2.36	\$236.0	795 MCM ACSR @ 100°C
SW2 115 kV	2.75	\$275.0	795 MCM ACSR @ 100°C
SW3 115 kV (2.36)			795 MCM ACSR @ 100°C
SW4 115 kV	2.75	\$275.0	795 MCM ACSR @ 100°C

Station improvements to increase MH line ratings

Parkdale - SC25 Riser	\$0.0	Done 2005
Mercy St. - SM26 Riser	\$100.0	
* Transcona - WT34 Riser	\$100.0	
White Shell - SW1, SW2, SW4 - Risers	\$300.0	
Seven Sisters - SW1, SW2, SW4 - Risers	\$300.0	

Total (+/- 50%)	\$3,589.2
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* Minimum Required for Pine Falls Upgrades (+/- 50%)	\$100.0
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**APPENDIX F
POWER FLOW AND STABILITY SUMMARY**

Case No.	1	2	3	4	5	6	7	8	9	10	11	12
Case Name	pfb-so06aa.uzvV4V4-p1z	pf1-so06aa.uzvV4V4-p1z	pfb-so06aa.uzvV4V4-p2z	pf1-so06aa.uzvV4V4-p2z	pfb-so06aa.uzvV4V4-p3z	pf1-so06aa.uzvV4V4-p3z	pfb-so06aa.uzvV4V4-p4z	pf1-so06aa.uzvV4V4-p4z	pfb-so06aa.uzvV4V4-p6s	pf1-so06aa.uzvV4V4-p6s	pfb-so06aa.uzvV4V4-p7s	pf1-so06aa.uzvV4V4-p8s
Disturbance	p1z	p1z	p2z	p2z	p3z	p3z	p4z	p4z	p6s	p6s	p7s	p8s
Prior Outage	None	None	None	None	None	None	None	None	None	None	None	None
Date/Time	MAY 25 2005 9:02	MAY 25 2005 7:36	MAY 25 2005 9:07	MAY 25 2005 9:41	MAY 25 2005 9:10	MAY 25 2005 10:15	MAY 25 2005 9:19	MAY 25 2005 10:19	NOV 22 2006 7:31	NOV 22 2006 7:37	NOV 22 2006 7:34	NOV 22 2006 7:40
Comments	3P, 5 cycle-F @ Pine Falls end of GP1	3P, 5 cycle-F @ Pine Falls end of GP1	3P, 5 cycle-F @ Pine Falls end of PC3 & PC4	3P, 5 cycle-F @ Pine Falls end of PC3 & PC4	3P, 5 cycle-F @ Pine Falls end of PR2	3P, 5 cycle-F @ Pine Falls end of PR2	3P, 5 cycle-F @ Pine Falls end of PA1 & PA2	3P, 5 cycle-F @ Pine Falls end of PA1 & PA2	SLG, 5 cycle-F @ Pine Falls end of GP1	SLG, 5 cycle-F @ Pine Falls end of GP1	SLG 110kV- on PC4 (5 + 15 CYCLES)	SLG 110kV- on PC4 (5 + 15 CYCLES)
Dorsey	3227	3208	3227	3208	3227	3208	3227	3208	3208	3208	3227	3208
Selkirk Output	0	0	0	0	0	0	0	0	0	0	0	0
Pine Falls	91	105	91	105	91	105	91	105	91	105	91	105
MH/US Export	2175	2177	2175	2177	2175	2177	2175	2177	2177	2177	2175	2177
MH/on Export	200	198	200	198	200	198	200	198	200	198	200	198
Steady State Flows												
NDEX / EAST BIAS	1954 / 230	1950 / 230	1954 / 230	1950 / 230	1954 / 230	1950 / 230	1954 / 230	1950 / 230	1954 / 230	1950 / 230	1954 / 230	1950 / 230
MHEX / L20D	2176 / 280	2176 / 281	2176 / 280	2176 / 281	2176 / 280	2176 / 281	2176 / 280	2176 / 281	2176 / 280	2176 / 281	2176 / 280	2176 / 281
ECL-ARP / PRI-BYN	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806	674 / 806
MWSI / MNEX	1481 / 2547	1480 / 2546	1481 / 2547	1480 / 2546	1481 / 2547	1480 / 2546	1481 / 2547	1480 / 2546	1481 / 2547	1480 / 2546	1481 / 2547	1480 / 2546
D602F / F601C	1730 / 1793	1730 / 1792	1730 / 1793	1730 / 1792	1730 / 1793	1730 / 1792	1730 / 1793	1730 / 1792	1730 / 1793	1730 / 1792	1730 / 1793	1730 / 1792
B10T / MH>SPC	169 / 77	164 / 73	169 / 77	164 / 73	169 / 77	164 / 73	169 / 77	164 / 73	169 / 77	164 / 73	169 / 77	164 / 73
OH E-W / OH>MH	-202 / -196	-200 / -195	-202 / -196	-200 / -195	-202 / -196	-200 / -195	-202 / -196	-200 / -195	-202 / -196	-200 / -195	-202 / -196	-200 / -195
R50M / OH>MP	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150	133 / 150
G82R	30	31	30	31	30	31	30	31	30	31	30	31
Dorsey BP1 / BP2	1513 / 1713	1504 / 1704	1513 / 1713	1504 / 1704	1513 / 1713	1504 / 1704	1513 / 1713	1504 / 1704	1513 / 1713	1504 / 1704	1513 / 1713	1504 / 1704
Dorsey Reserve / Wtrtn SVC	321 / 66	336 / 65	321 / 66	336 / 65	321 / 66	336 / 65	321 / 66	336 / 65	321 / 66	336 / 65	321 / 66	336 / 65
Forbes SVC / MSC	40 / 600	39 / 600	40 / 600	39 / 600	40 / 600	39 / 600	40 / 600	39 / 600	40 / 600	39 / 600	40 / 600	39 / 600
Steady State Vltgs												
Dorsey 500/Dorsey 230	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045	1.036 / 1.045
Roseau 500/Forbes 500	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023	1.064 / 1.023
Chisago 500/EauClaire 345	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006	1.016 / 1.006
Int Falls 115/Badoura 115	1.015 / 1.032	1.015 / 1.033	1.015 / 1.032	1.015 / 1.033	1.015 / 1.032	1.015 / 1.033	1.015 / 1.032	1.015 / 1.033	1.015 / 1.032	1.015 / 1.033	1.015 / 1.032	1.015 / 1.033
Drayton 230/Groton 345	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993	1.035 / 0.993
SS OS Relay Margins												
D602F at Forbes/Dorsey	260% / 411%	261% / 412%	260% / 411%	261% / 412%	260% / 411%	261% / 412%	260% / 411%	261% / 412%	260% / 411%	261% / 412%	260% / 411%	261% / 412%
32R at Rugby/L20D at Drayton	999% / 708%	999% / 707%	999% / 708%	999% / 707%	999% / 708%	999% / 707%	999% / 708%	999% / 707%	999% / 708%	999% / 707%	999% / 708%	999% / 707%
R50M/F3M	999% / 321%	999% / 322%	999% / 321%	999% / 322%	999% / 321%	999% / 322%	999% / 321%	999% / 322%	999% / 321%	999% / 322%	999% / 321%	999% / 322%
B10T	329%	344%	329%	344%	329%	344%	329%	344%	329%	344%	329%	344%
Min/MaxTransientVltg												
Arrowhd 230	1.03 1.05	1.03 1.05	1.03 1.05	1.03 1.05	1.03 1.05	1.03 1.05	1.03 1.05	1.03 1.05	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Boise 115	0.94 1.03	0.94 1.04	0.94 1.01	0.94 1.02	0.94 1.03	0.94 1.03	0.94 1.02	0.94 1.03	0.98 1.02	0.98 1.02	0.98 1.03	0.98 1.04
Dorsey 230	0.92 1.06	0.92 1.06	0.92 1.05	0.92 1.05	0.92 1.06	0.92 1.06	0.92 1.06	0.92 1.06	0.99 1.07	0.99 1.07	0.99 1.07	0.99 1.07
Forbes 230	1.00 1.04	1.00 1.04	1.00 1.04	1.00 1.04	1.00 1.04	1.00 1.04	1.00 1.04	1.00 1.04	1.01 1.03	1.01 1.03	1.01 1.04	1.01 1.04
Riverton 230	1.01 1.02	1.01 1.03	1.01 1.03	1.01 1.03	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.03	1.03 1.03	1.03 1.04	1.03 1.04
Dickinson 345	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.03	1.01 1.02	1.01 1.02	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.02	1.01 1.02
Drayton 230	0.96 1.04	0.96 1.04	0.96 1.05	0.96 1.05	0.96 1.04	0.96 1.04	0.96 1.04	0.96 1.04	1.00 1.04	1.00 1.04	1.00 1.05	1.00 1.04
Groton 345	0.99 1.00	0.99 1.00	0.99 1.00	0.99 1.01	0.99 1.00	0.99 1.00	0.99 0.99	0.99 0.99	0.99 0.99	0.99 0.99	0.99 0.99	0.99 1.00
Tioga 230	1.03 1.04	1.03 1.04	1.03 1.05	1.03 1.05	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Wahpeton 115	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Watertown 345	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.02	1.02 1.02	1.02 1.02	1.02 1.02	1.02 1.02	1.02 1.02	1.02 1.02	1.02 1.02
Dynamic Voltage Warnings	none	none	none	none	none	none	none	none	none	none	none	none
Worst Case Angle Damping												
Dorsey SUIVP / UdHold	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.183	/ 0.183		
Forbes DC Red (DCAR)	483%	473%	504%	502%	485%	474%	471%	471%	496%	493%	468%	462%
K22W (max +dP @ t, d-ang)	97.0@(0.17499,-3.7)	96.9@(0.16666,-3.6)	127.8@(2.31657,-20.9)	130.9@(2.31657,-21.7)	97.0@(0.17499,-3.7)	96.9@(0.16666,-3.6)	97.0@(0.17499,-3.7)	96.9@(0.16666,-3.6)	42.5@(0.14166,-1.2)	41.7@(0.14166,-1.1)	38.3@(0.14166,-1.1)	37.8@(0.14166,-1.0)
K22W (max -dP @ t, d-ang)	1.9@(0.96663,-7.2)	7.0@(1.08329,-7.2)	0.0@(0.10000,0.0)	1.1@(0.10000,0.1)	7.4@(0.99163,-4.2)	12.4@(1.07496,-4.0)	29.3@(1.01663,2.8)	38.9@(1.06663,3.1)	10.9@(0.27499,0.9)	12.3@(0.28332,1.2)	33.9@(1.10829,-0.9)	38.6@(1.13329,-0.8)
K22W (max d-ang @ t, dP)	-8.5@(2.42490,18.2)	-9.4@(2.59156,25.6)	-22.1@(2.73322,121.1)	-22.8@(2.73322,121.5)	-4.7@(0.83330,2.7)	-5.3@(2.61656,16.1)	5.9@(2.24157,-16.0)	5.3@(2.24157,-13.5)	-1.3@(0.10833,40.6)	1.3@(0.36665,-7.5)	3.3@(0.49998,-15.7)	3.9@(0.53331,-13.9)
OS Rel Trip / Marg												
MH - OH												
D602F at Forbes/Dorsey	260% / 411%	258% / 406%	258% / 404%	260% / 408%	256% / 403%	249% / 392%	240% / 377%	234% / 367%	255% / 404%	254% / 402%	249% / 391%	248% / 391%
32R at Rugby/L20D at Drayton	999% / 708%	999% / 707%	999% / 708%	999% / 707%	999% / 707%	999% / 682%	999% / 653%	999% / 632%	999% / 693%	999% / 688%	999% / 678%	999% / 667%
R50M / F3M	999% / 313%	999% / 310%	988% / 278%	996% / 280%	999% / 312%	982% / 312%	962% / 290%	932% / 282%	995% / 311%	989% / 309%	961% / 289%	958% / 285%
B10T	328%	339%	323%	338%	322%	332%	302%	318%	323%	337%	315%	328%
FSCAPS (SS/Unav/Final)												
Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
Eau Cl 345 / Park Lk 115	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)	(4 4 4)/(0 0 0)
Prairie 115 / Ramsey 230	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)
Roseau 230 / Running 230	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)
Shey 115 / Split Rock 115	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)

**APPENDIX H
POWERFLOW AND STABILITY SUMMARY**

Case No.	1	2	3	4	5	6	7	8	9	10	11	12
Case Name	pf3-wp06aa.cji0454-p1z	pf3-wp06aa.cji0454-p1z	pf3-wp06aa.cji0454-p2z	pf3-wp06aa.cji0454-p2z	pf3-wp06aa.cji0454-p3z	pf3-wp06aa.cji0454-p3z	pf3-wp06aa.cji0454-p4z	pf3-wp06aa.cji0454-p4z	pf3-wp06aa.cji0454-p6s	pf3-wp06aa.cji0454-p6s	pf3-wp06aa.cji0454-p7s	pf3-wp06aa.cji0454-p8s
Disturbance	p1z	p1z	p2z	p2z	p3z	p3z	p4z	p4z	p6s	p6s	p7s	p8s
Prior Outage	None	None	None	None	None	None	None	None	None	None	None	None
Date/Time	MAY 25 2005 12:49	MAY 25 2005 14:00	MAY 25 2005 13:18	MAY 25 2005 14:04	MAY 25 2005 13:26	MAY 25 2005 14:10	MAY 25 2005 13:31	MAY 25 2005 14:15	NOV 22 2006 8:06	NOV 22 2006 8:14	NOV 22 2006 8:11	NOV 22 2006 8:17
Comments	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	3P, 5 cycle-F @ Pine Falls	LG, 5 cycle-F @ Pine Falls	LG, 5 cycle-F @ Pine Falls	SLG 110kV- on PC4	SLG 110kV- on PC4
Dorsey	3297	3278	3297	3278	3297	3278	3297	3278	3297	3278	3297	3278
Selkirk Output	120	120	120	120	120	120	120	120	120	120	120	120
Pine Falls	91	105	91	105	91	105	91	105	91	105	91	105
MH/US Export	2177	2177	2177	2177	2177	2177	2177	2177	2177	2177	2177	2177
MH/on Export	200	198	200	198	200	198	200	198	200	198	200	198
Steady State Flows												
NDEX / EAST BIAS	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29	620 / 29
MHEX / L20D	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308	1271 / 308
ECL-ARP / PRI-BYN	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519	330 / 519
MWSI / MNEX	849 / 1713	850 / 1713	849 / 1713	850 / 1713	849 / 1713	850 / 1713	849 / 1713	850 / 1713	849 / 1713	850 / 1713	849 / 1713	850 / 1713
D602F / F601C	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836	892 / 836
B10T / MH>SPC	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74	165 / 74
OH E-W / OH>MH	185 / 1	185 / 0	185 / 1	185 / 0	185 / 1	185 / 0	185 / 1	185 / 0	185 / 1	185 / 0	185 / 1	185 / 0
R50M / OH>MP	80 / 150	80 / 151	80 / 150	80 / 151	80 / 150	80 / 151	80 / 150	80 / 151	80 / 150	80 / 151	80 / 150	80 / 151
G82R	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
Dorsey BP1 / BP2	1538 / 1742	1532 / 1735	1538 / 1742	1532 / 1735	1538 / 1742	1532 / 1735	1538 / 1742	1532 / 1735	1538 / 1742	1532 / 1735	1538 / 1742	1532 / 1735
Dorsey Reserve / Wtrtn SVC	572 / 38	583 / 38	572 / 38	583 / 38	572 / 38	583 / 38	572 / 38	583 / 38	572 / 38	583 / 38	572 / 38	583 / 38
Forbes SVC / MSC	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300	-12 / 300
Steady State Vltgs												
Dorsey 500/Dorsey 230	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045	1.041 / 1.045
Roseau 500/Forbes 500	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044	1.073 / 1.044
Chisago 500/EauClaire 345	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037	1.040 / 1.037
Int Falls 115/Badoura 115	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010	1.019 / 1.010
Drayton 230/Groton 345	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005	1.012 / 1.005
SS OS Relay Margins												
D602F at Forbes/Dorsey	745% / 999%	744% / 999%	745% / 999%	744% / 999%	745% / 999%	744% / 999%	745% / 999%	744% / 999%	745% / 999%	744% / 999%	745% / 999%	744% / 999%
32R at Rugby/L20D at Drayton	999% / 587%	999% / 586%	999% / 587%	999% / 586%	999% / 587%	999% / 586%	999% / 587%	999% / 586%	999% / 587%	999% / 586%	999% / 587%	999% / 586%
R50M/F3M	999% / 324%	999% / 322%	999% / 324%	999% / 322%	999% / 324%	999% / 322%	999% / 324%	999% / 322%	999% / 324%	999% / 322%	999% / 324%	999% / 322%
B10T	331%	331%	331%	331%	331%	331%	331%	331%	331%	331%	331%	331%
Min/MaxTransientVltg												
Arrowhd 230	1.01 1.04	1.01 1.04	1.01 1.03	1.01 1.03	1.01 1.04	1.01 1.04	1.01 1.04	1.01 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03
Boise 115	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.99 1.02	0.99 1.02	0.99 1.03	0.99 1.03
Dorsey 230	0.94 1.07	0.94 1.07	0.94 1.05	0.94 1.05	0.94 1.07	0.94 1.07	0.94 1.07	0.94 1.07	1.00 1.07	1.00 1.07	1.00 1.07	1.00 1.07
Forbes 230	1.01 1.05	1.01 1.05	1.01 1.04	1.01 1.04	1.01 1.05	1.01 1.05	1.01 1.05	1.01 1.04	1.02 1.04	1.02 1.04	1.02 1.04	1.02 1.04
Riverton 230	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01
Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.04	1.03 1.04
Dickinson 345	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Drayton 230	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.95 1.02	0.98 1.02	0.98 1.02	0.98 1.02	0.98 1.02
Groton 345	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01
Tioga 230	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03
Wahpeton 115	1.01 1.03	1.01 1.03	1.01 1.02	1.01 1.02	1.01 1.03	1.01 1.03	1.01 1.03	1.01 1.03	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03
Watertown 345	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03
Dynamic Voltage Warnings												
	none	none	none	none	none	none	none	none	none	none	none	none
Worst Case Angle Damping												
Dorsey SUVV / UdHold	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133	/ 0.133
Forbes DC Red (DCAR)	490%	487%	499%	499%	492%	489%	481%	481%	492%	493%	489%	487%
K22W (max +dP @ t, d-ang)	34.8@(0.10000,-1.0)	35.7@(0.70831,-3.5)	84.5@(3.14987,-13.0)	87.1@(3.14987,-13.7)	34.8@(0.10000,-1.0)	35.6@(0.10000,-1.0)	34.8@(0.10000,-1.0)	35.6@(0.10000,-1.0)	14.3@(0.10000,-0.3)	14.0@(0.10000,-0.3)	29.2@(0.75830,0.0)	33.4@(0.77497,0.1)
K22W (max -dP @ t, d-ang)	1.2@(0.97496,-5.2)	5.9@(1.06663,-5.2)	0.0@(0.10000,0.0)	1.6@(0.10000,0.1)	7.7@(1.00829,-3.0)	12.1@(1.07496,-2.9)	32.1@(1.04163,3.3)	39.9@(1.07496,3.4)	7.9@(0.26666,1.2)	10.1@(0.27499,1.4)	29.7@(1.11662,-1.0)	34.4@(1.14162,-0.9)
K22W (max d-ang @ t, dP)	-7.2@(5.00815,18.8)	-7.8@(5.00815,20.6)	-14.8@(4.99148,73.4)	-15.9@(4.93315,83.3)	-3.6@(2.37490,6.3)	-4.3@(2.46656,7.6)	6.0@(5.00815,-16.7)	5.4@(2.06658,-11.0)	1.2@(0.27499,-7.9)	1.4@(0.29999,-9.9)	3.9@(0.46665,-22.8)	4.4@(0.49165,-24.3)
OS Rel Trip / Marg												
MH - OH												
D602F at Forbes/Dorsey	745% / 999%	743% / 999%	745% / 999%	744% / 999%	739% / 999%	715% / 999%	677% / 999%	664% / 999%	734% / 999%	730% / 999%	714% / 999%	706% / 999%
32R at Rugby/L20D at Drayton	999% / 587%	999% / 586%	999% / 587%	999% / 586%	999% / 583%	999% / 568%	999% / 542%	999% / 531%	999% / 578%	999% / 575%	999% / 564%	999% / 558%
R50M / F3M	999% / 304%	999% / 298%	999% / 245%	999% / 245%	999% / 306%	999% / 301%	999% / 296%	999% / 288%	999% / 314%	999% / 311%	999% / 286%	999% / 283%
B10T	331%	331%	331%	331%	329%	328%	285%	298%	328%	327%	320%	319%
FSCAPS (SS/Unav/Final)												
Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
Eau Cl 345 / Park Lk 115	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)	(2 2 2)/(0 0 0)
Prairie 115 / Ramsey 230	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)	(3 3 3)/(2 2 2)
Roseau 230 / Running 230	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)
Shey 115 / Split Rock 115	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)	(0 0 0)/(1 1 1)

APPENDIX I

MANITOBA HYDRO
INTEROFFICE MEMORANDUM

FROM M. R. Wonsiak
Transmission Planning Technical Officer
System Planning Department
12-1146 Waverly St.

TO Glenn Evans
Transmission Planning Technical Officer
System Planning Department
12-1146 Waverly St.

DATE 2005 07 11

FILE 5-9

SUBJECT **THE IMPACT OF INCREASED SHORT CIRCUIT FAULT LEVELS ON LOCAL CIRCUIT BREAKERS AFTER THE COMPLETION OF THE PINE FALLS GENERATOR UPGRADE PROJECT**

Summary

By modifying Pine Falls generation and unit transformers to accommodate the 14 MW (16 MVA) increase detailed in your request, it was found that the additional capacity will not raise fault levels in the surrounding area beyond the capabilities of any local area circuit breakers.

Study Model Description

The study model was based on the SPD 2005 Short Circuit Series, but includes the required generation and transformation necessary to accommodate the 14 MW (16 MVA) increase.

In addition the following system conditions/modifications were included:

1. Winnipeg River Generation at maximum.
2. Selkirk G.S. in full operation.
3. St. Leon 99 MW wind farm completed.
4. The proposed Rosser – Silver 230 kV line in-service.
5. The proposed VH2 – XS49 115 kV line modification was assumed complete.

Criteria Used In the Evaluation

Three phase and single-line-ground fault levels were calculated at Pine Falls as well as at 2 stations in close electrical proximity. The results were developed and evaluated under the following criteria:

1. “Flat Classical” analysis was used in all fault calculations. The base kV was then escalated and the fault levels adjusted to better reflect actual system voltages.
2. Station fault levels were directly compared to the lowest rated breaker(s) at a

particular location, i.e. an individual breaker is required to interrupt the entire fault kA produced by a “close in” fault. No consideration was given for breaker duty or individual equipment contribution. Appendix 1 contains a summary of circuit breaker data used in the study.

3. All busses in the major transmission system were analyzed in their “normal”¹ operating condition.
4. All busses in the sub-transmission system were analyzed in a “minimal networked”² operating condition.

Study Results

Base Case (No added Generation)

The evaluation of circuit breaker capabilities requires the development of a base set of fault levels that *do not* contain any added generation. This reference case was used to calculate the percent increase in fault levels associated with the generation increase.

14 MW (16MVA) Increase at Pine Falls

The additional 14 MW of Pine Falls generation, produces a maximum fault level increase of 2.2% at the Pine Falls 115 kV bus. The levels are however under 82% of the breaker interrupting rating. The increase at the 66 kV bus at Pine Falls is negligible with fault levels at only 15% of the interrupting rating.

A minimal fault level increase was observed at both Tembec Industries (formerly Pine Falls Paper) and the Great Falls Generating Station, and below the breaker interrupting rating. Table No. 1 is a summary of the resulting data.

Table No. 1
Fault Levels and Percent Breaker Capability
After the 14 MW (16 MVA) Pine Falls Upgrade

Station	Base kV	SLG Fault (kA)	Increase (%)	3Phase Fault (kA)	Increase (%)	Lowest Breaker MSIR*	Breaker Capability (%)
Pine Falls 115 kV	118.0	10.6	2.1	9.9	2.2	13	81.5
Pine Falls 66 kV	68.0	1.4	Nil	2.9	Nil	19	15.3

¹ This is the “normal operating” model of the 2005 Manitoba Hydro system; all N/O points in use during non-emergency operation are represented.

² “Minimal Networked” fault levels allow for a maximum of two switch closures thus linking as many as three supply stations. This differs from normal switching procedures in which only one closure linking a maximum of two supply stations is permitted. All other N/O points are consistent with normal operation

Station	Base kV	SLG Fault (kA)	Increase (%)	3Phase Fault (kA)	Increase (%)	Lowest Breaker MSIR*	Breaker Capability (%)
Great Falls 115 kV	119.5	11.5	0.4	10.9	0.6	13	88.5
Tembec Industries	118.0	7.2	1.5	8.4	1.9	13	64.6

* MSIR – Maximum Symmetrical Interrupting Rating in kA.

If you require additional information feel free to contact Mike Wonsiak at 474-4455.

Original Signed by:

M. Wonsiak

MRW/mrw/PineFallsUpgrade_fault_breakers.doc

Appendix No.1
Circuit Breaker Data Used in the Study

Station	Location	Voltage	Manufacturer	Model	Serial#	Amps	MSIR*	
Pine Falls G.S.	R1	115	Westinghouse	BQOB	1084253	800	13 kA	
	R2	115	Westinghouse	BQOB	1084254	800	13 kA	
	R3	115	Westinghouse	BQOB	1084255	800	13 kA	
	R4	115	Westinghouse	BQOB	1084256	800	13 kA	
	R5	115	Westinghouse	BQOB	1084257	800	13 kA	
	R6	115	Westinghouse	BQOB	1084258	800	13 kA	
	R7	115	Westinghouse	BQOB	1084259	800	13 kA	
	R12	115	Westinghouse	BQOB	1084260	800	13 kA	
	R13	115	Westinghouse	BQOB	1084261	800	13 kA	
	R14	115	Westinghouse	BQOB	1084262	800	13 kA	
	R15	115	Westinghouse	BQOB	1084263	800	13 kA	
	R16	115	Westinghouse	BQOB	1084264	800	13 kA	
	R17	115	Westinghouse	BQOB	1084265	800	13 kA	
	R18	115	Westinghouse	BQOB	1084266	800	13 kA	
		B9	66	CGE	FKP72.5	64710	1200	19 kA
		B10	66	CGE	FKP72.5	64711	1200	19 kA
		T910	66	ASEA	HPL72.5	7346281	2500	40 kA
	Tembec Ind.	52LM	115	ABB	LTB145		3150	31.5 kA
52PQ		115	ABB	LTB145		3150	31.5 kA	
52ST		115	ABB	LTB145		3150	31.5 kA	
52L1		115	Westinghouse	BQOB		800	13 kA	
52L2		115	Westinghouse	BQOB		800	13 kA	
Great Falls G.S.	Bus Tie	115	BRBO	DCVF	354343	600	13 kA	
	Gen1	115	BRBO	DCVF	354349	600	13 kA	
	Gen2	115	BRBO	DCVF	354344	600	13 kA	
	Gen3	115	BRBO	DCVF	354350	600	13 kA	
	Gen4	115	BRBO	DCVF	354351	600	13 kA	
	Gen5	115	BRBO	DCVF	354348	600	13 kA	
	Gen6	115	BRBO	DCVF	354345	600	13 kA	
	GP1	115	BRBO	DCVF	354346	600	13 kA	
	GS21	115	BRBO	DCVF	354342	600	13 kA	
	GS22	115	BRBO	DCVF	354347	600	13 kA	
	GT1	115	BRBO	DCVF	354341	600	13 kA	
	Mines	115	BRBO	DCVF	384099	600	13 kA	

* MSIR – Maximum Symmetrical Interrupting Rating in kA.

APPENDIX J

Manitoba Hydro Generation Output Pine Falls IES

<u>Station</u>	<u>Base File</u>	<u>2004 Accredited</u>	<u>Wpg River max gen.</u>
Limestone		1348.7	
Long Spruce 1-12		1030.6	
Kettle 1-12		1233.1	
Selkrik 1 Gen		145	
Jenpeg 1-6		138.4	
Kelsey 1-7		237.6	
Grand Rpds 1 st gen		120	
Grand Rpds 2 st gen		120	
Grand Rpds 1 Amp		120	
Grand Rpds 2 Amp		120	
Brandon 5 gen		105.9	
Brandon Unit 6		140.3	
Brandon Unit 7		140.3	
Pine Falls 1-6	91	91	106
Great Falls 1-6	98	131.6	146.8
McArther 1-8	61.2	61.2	68
Seven Sisters 1-6	172.72	172	232.8
Pointe Du Bois 1-4	20.43	20.43	20.55
Pointe Du Bois 5-16	58.4	58.4	70.75
Slave Falls 1-8	72	72	80