MH-US TSR Sensitivity Analysis

Draft Report (Eastern Plan)

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Introduction

The purpose of this study was to perform sensitivity analysis on alternative transmission options for the MH-US south bound TSRs. The sensitivity included iterations of the MH-US transfer.

Executive Summary

Results from this study show that the impact of the proposed Riel-Shannon 230kV or Dorsey-Iron Range 500kV (750 or 1100MW) transmission options do not impact the existing transmission system in an adverse way. The facilities that are impacted have mitigations that are outlined in the report. The estimated costs associated with these mitigations are relatively small. The status of G519 (Excelsior 600MW) has been confirmed as withdrawn, and hence it is not modeled for this study. Mitigation costs are shown below.

Scenario	Mitigation Costs (millions)
Riel-Shannon 230kV (250MW transfer)	0
Dorsey-Iron Range 500kV (750MW transfer)	2.16
Dorsey-Iron Range 500kV (1100MW transfer)	0

Description of Request

The south bound requests reserve a total of 1100 MW of transmission service from Manitoba Hydro to several sinks in the northern Midwest United States (Table 1).

Table 1: MH-US South Bound Requests

\Oasis Ref No	Service Type	Start time	Stop Time	POR	POD	Requested Capacity	Queue Date	Study Number
76703536	Network	Nov-2014	Nov-2024	MHEB-MISO	GRE	200	12/7/2006	A388
76703671	Network	Jun-2017	Jun-2027	MHEB-MISO	WPS	500	6/12/2007	A380
76703672	Network	Jun-2017	Jun-2037	MHEB-MISO	MP	250	7/6/2007	A383
76703686	Network	Jun-2017	Jun-2027	MHEB-MISO	NSP	50	4/17/2008	A416
76703687	Network	Jun-2017	Jun-2027	MHEB-MISO	WEC	100	4/17/2008	A417

The proposed sensitivity options are described in Table 2.

Table 2 Sensitivity Options

Option	Description
230 kV	• MH-MP TSR only (250 MW) • Riel – Shannon 230 kV (294.15 miles) ○ Line data based on R50M
Y500 kV	• MH-MP TSR + MH-WPS TSR (750 MW) • Dorsey – Blackberry 500 kV (271.12 miles) ○ Line data based on Dorsey – Bison 500 kV option • Arrowhead PST = 0 • One 500/230 kV transformer at Blackberry (based on Forbes 500/230 kV)
Y500 kV + A/B	• All TSRs (1100 MW) • One Dorsey – Blackberry 500 kV circuit (271.12 miles) ○ Line data based on Dorsey – Bison 500 kV option • Two 345 kV circuits from Blackberry – Arrowhead (71.15 miles) • Arrowhead PST = 0 • Two 500/345 kV transformers at Blackberry (based on Maple River 500/345 kV) • One 500/230 kV transformer at Blackberry (based on Forbes 500/230 kV)

Criteria, Methodology, and Assumptions

Models

MTEP 2012 power flow model representing a 2022 Summer Peak condition was utilized. Modeling of TSRs and GIPs was based on "MHEB Group TSR System Impact Study Transmission Options W.1 and W.2" with revision date April 19, 2010. Flow on the MHEX is 1850 MW (south) in the summer peak benchmark case.

The three HVDC bipoles are set at 3670 MW in the benchmark case as follows:

- Bipole 1 = 958 MW
- Bipole 2 = 1032 MW
- Bipole 3 = 1680 MW

The bipole inverters were used to source the south bound requestsas shown in Table 3.

Table 3 MH-US TSR Sources

250 MW Injection	750 MW Injection	1100 MW Injection
• Bipole 1 = 1241.4 MW • Bipole 2 = 1339.3 MW • Bipole 3 = 1335.4 MW	• Bipole 1 = 1405.7 MW • Bipole 2 = 1516.5 MW • Bipole 3 = 1512.1 MW	• Bipole 1 = 1519.6 MW • Bipole 2 = 1639.5 MW • Bipole 3 = 1634.7 MW

Study TSRs were sunk to the generators in Table 4.

Table 4 MH-US TSR Sinks

Bus #	Generator Name	MW
WPS (A380)		
699993	Skygen Unit #1	172
699661	West Marinette Unit #3	75.0
699597	Pulliam Unit #31	74.0
698925	AP_PPRGT Unit	42.3
699591	Pulliam Unit #5	51.0
699679	Weston Unit #1	62.0
699595	Pulliam Unit #6	23.7
GRE (A388)		
615031	Pleasant Valley Unit #1	29.0
615041	Lakefield Unit #1	84.9
615045	LakefieldUnit #5	86.1
MP (A383)		
608667	Potlatch	24
608676	Hibbard Unit #3	20
608676	Hibbard Unit #4	15
608776	Boswell Unit #1	54
608777	Boswell Unit #2	54
608665	Thomson	36
608702	Laskin Unit #1	25
608702	Laskin Unit #2	22
Xcel Energy (A416)		
600073	River Falls	20
605308	Hatfield	6
600035	Wheaton Unit #4	24
WEC (A417)		
699322	Germantown Unit #5	83
699507	Valley Unit #2	17

Criteria

The following system conditions were considered for the steady-state analysis.

- NERC Category A with system intact (no contingencies)
- NERC Category B contingencies
- NERC Category C contingencies (only for the no harm test part.)
- Outage of single element 100 kV or higher (B.2 and B.3) associated with single contingency event in the following areas: ATCLLC (WEC, ALTE, WPS, MGE, UPPC), DPC, GRE, ITC Midwest, MH, MP, OTP, SMMPA, WAPA, XEL
- Outage of multiple-elements 100 kV or higher (B.2 and B.3) associated with single contingency events in the Dakotas, Manitoba, Minnesota, Wisconsin

The Manitoba HVDC power order reduction scheme was not simulated for this sensitivity. Overloads that would be properly mitigated by a Manitoba HVDC runback were not included in the results of this study report. Thermal limits were identified using AC solve methods. Voltage and stability considerations were not included in the sensitivities.

Methodology

Complete sensitivity analysis is comprised of two parts. First part of the analysis studied impact of the transfer only. Both pre and post cases prepared for this part have the transmission plan modeled in them, only difference being the amount of MH-US Transfer. This part of the analysis was performed for all scenarios listed in the Table 2 above.

Second part of the analysis is a no harm test which studied the impact of both transfer and the transmission plan put together. Pre case for this study didn't have transmission plan or the transfer modeled in it, whereas post case included both transfer and the transmission plan in it. This part of the analysis was performed only for the 'Y500 kV + A/B' option as listed in the Table 2 above.

Analysis Results

PSS®E version 32 and PSS®MUST version 10.2 were used to perform the sensitivities.
Post transfer cases were screened at 100%.

250 MW Transfer, 230 kV Transmission

Table 5: 250 MW Transfer, 230 kV Transmission

Monitored Element	Pre ContMW	Post ContMW	Base Flow	Rating	Cont. Ld%	Contingency Description	Impact	DF
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

750 MW Transfer, 500 kV Transmission

Table 6: 750 MW Transfer, 500 kV Transmission

Monitored Element	Pre ContMW	Post ContMW	Base Flow	Rating	Cont. Ld%	Contingency Description	Impact	DF
608625 BLCKBRY4 230 B$0490 BANK 3 1.00 3	572.4	816.5	816.5	800	102.1	** Base Case **	244.1	32.54667
Blackberry 500/230KV transformer loading not a concern as actual size can still be changed to fit need.								
B$0490 BANK 3 1.00 608635 BLCKBRY2 500 3	573.3	816.5	816.5	800	102.1	** Base Case **	243.2	32.42667
Blackberry 500/230KV transformer loading not a concern as actual size can still be changed to fit need.								
608737 NASHWAK7 115 608739 BLCKBRY7 115 2	126.7	164	106	158	103.8	20L	37.3	4.973333
Line can be upgraded to increase thermal rating above post-contingent levels. Estimated cost is $2.16 million.								
608737 NASHWAK7 115 608739 BLCKBRY7 115 2	126.7	163.9	106	158	103.7	608739 BLCKBRY7 115 608781 20L TAP7 115 1	37.2	4.96
Same line section as above, Line can be upgraded to increase thermal rating above post-contingent levels. Estimated cost is $2.16 million.								

1100 MW Transfer, 500 kV + 345 kV A/B Transmission

Table 7: 1100 MW Transfer, 500 kV + 345 kV A/B Transmission

Monitored Element	Pre ContMW	Post ContMW	Base Flow	Rating	Cont. Ld%	Contingency Description	Impact	DF
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

No Harm Test Results, 500 kV + 345 kV A/B Transmission

Table 8: No Harm test results, 500 kV + 345 kV A/B Transmission

Monitored Element	Max Post Case Loading	Max Pre Case Loading	Rating	Contingency Description
N/A	N/A	N/A	N/A	N/A

Summary

In this study AC contingency analysis is performed for following three transfer levels made from Manitoba Hydro to US: 250MW, 750 MW and 1100MW. Transfer level are simulated by adjusting MW flows at the DC bipoles in Manitoba Hydro and sinking them to generation in MP, WPS, WEC, Xcel Energy and GRE. Table 3 and Table 4 of this report gives information on adjusted MW flows on DC bipoles and the study sinks respectively.

Details on study assumptions are given in the Table 2 of this report. Result tables given in this report are made by comparing the AC analysis results of post and pre transfer scenarios. Since this was not a facility study cost of various upgrades suggested by the study remain as preliminary estimates. Result summaries of the individual transmission options are described below.

- **250MW transfer, Riel-Shannon 230kV**
  No valid constraints were found for 250 MW transfer.
- **750MW transfer, Dorsey-Blackberry 500kV**
  The 750MW transfer option showed violations on two MP facilities. These would both be mitigated by increasing the thermal line ratings. Blackberry 500/230 kV Transformer is not a concern as actual size can still be changed to fit the need. It is estimated to cost 2.16 million to upgrade Blackberry-Nashwauk 115kV.
- **1100MW transfer, Dorsey-Blackberry 500kV, 345kV Blackberry-Arrowhead 345kV double circuit**
  No valid constraints were found for 1100 MW transfer.
- **No Harm Test, Dorsey-Blackberry 500kV, 345kV Blackberry-Arrowhead 345kV double circuit**
  No valid constraints were found for 1100 MW transfer.

Definition of Terms

In order to make it easier for the reader to interpret the results, definitions of various columns used in the result tables are provided below:

Monitored Element: This is the limiting element. Description of the limiting element does not represent the actual name of the network elements. These are the names used in the PSSE models and include PSSE bus numbers.

Pre ContMW: This is the amount of MW flow on the limiting element in the model without the transfer modeled.

Post ContMW: This is the amount of MW flow on the limiting element in the model having study transfers modeled.

Base Flow: This is the MW flow on the limiting element in the base case having study transfers implemented.

Rating: This is the rating of the limiting element.

Cont. Ld%: This is the post-contingency percentage loading on the limiting element in the model having study transfers modeled.

Contingency Description: This is the contingent element. Description of the contingent element does not represent the actual name of the network element. These are the names used in the PSSE models and include PSSE bus numbers.

Impact: This value is calculated as difference between the **Pre ContMW** and **Post ContMW** values defined above.

DF: Distribution factor is the Impact calculated as percentage of the MW transfer level being studied. For this study all post –contingent overloads with greater than 100 Cont LD% and a DF of 3.0% were included.

DF = ((Impact/MW transfer Level)*100)