

Ellendale Load Addition Expedited Project Request Study Report

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MONTANA-DAKOTA UTILITIES CO.
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- 66 PU-22-370 Filed 12/19/2022 Pages: 24
Exhibit MDU19 - MISO Ellendale load addition expedited project request study report dated 9-13-22
Montana-Dakota Utilities Co.
- 68 PU-22-366 Filed 12/19/2022 Pages: 24
Exhibit MDU19 - MISO Ellendale load addition expedited project request study report dated 9-13-22
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1 Executive Summary

The Ellendale load addition is an expedited project (EPR) request to add 180 MW of crypto mining load off the Ellendale 345/230/34.5 kV transformer tertiary in the Ellendale 345 Substation. The MISO MTEP22 models for the next ten years as well as MTEP22 contingencies were used to determine the impact of the load on the surrounding area. It was determined that the addition did not negatively affect existing violations or result in any new violations of note. It is recommended that the Ellendale Load Addition expedited project request be accepted.

2 Introduction

The load was connected to bus 661907 off the tertiary of the Ellendale transformer. The load is 180 MW modeled at 0.98 p.f. or 36.55 MVar. It is expected to be in service early 2023.

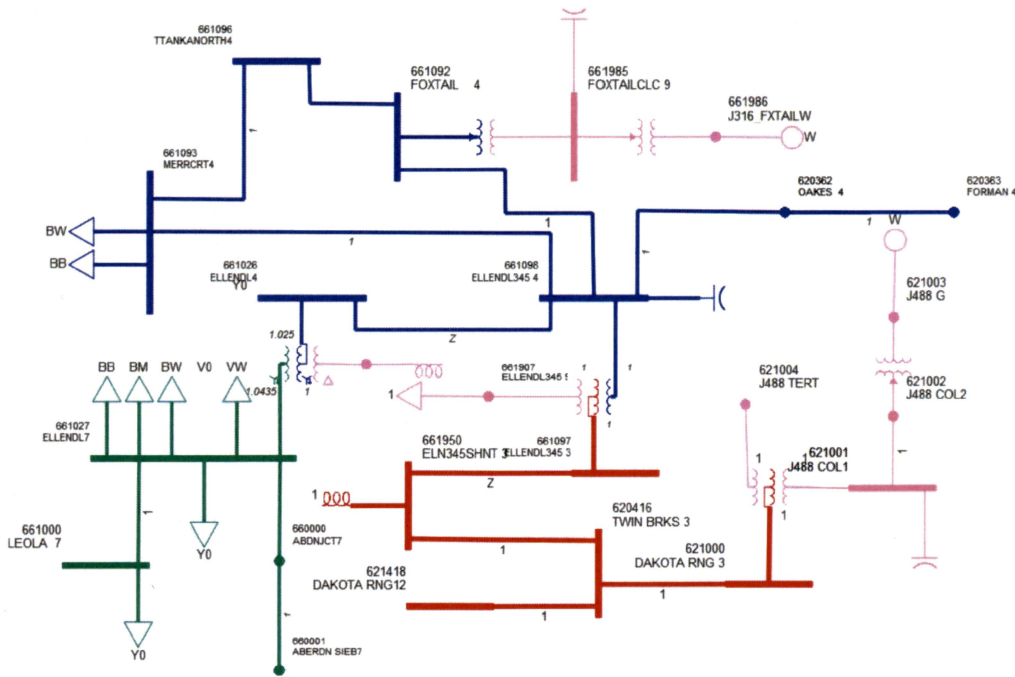


Figure 1: PSSE model with the load addition in the study area.

3 Methodology

Contingencies were applied to two cases, one with the load addition and one without, and the violations were compared against one another at monitored facilities in the study area.

3.1 Cases Used

The cases used for this study are as follows:

- MIS022_2022_WIN___TA
- MIS022_2023_SLL40_TA
- MIS022_2023_SUM___TA
- MIS022_2024_SLL0__TA
- MIS022_2024_SUM___TA
- MIS022_2027_SHAW__TA
- MIS022_2027_SHHW__TA
- MIS022_2027_SLL70_TA
- MIS022_2027_WINSF_TA
- MIS022_2032_SUM___TA

As the load is expected to be in service early 2023, the 2022 winter case was chosen as the starting case. As MDU and MISO are summer peaking, the summer cases were prioritized over the winter cases. As that area has lots of wind turbines, the light-load, no-wind cases were of particular interest.

3.2 Contingencies

The contingencies are the same used in MTEP22 and are listed in Table 1. Most of the contingencies are MDU contingencies. However, since the study area is on the edge of MDU's service area, contingencies from Otter Tail Power were used as well. Any contingencies that outaged the study bus were not used as they would not provide any insight.

4 Results

As the purpose of this study was to make sure the load addition did not result in any new violations or worsen existing violations, the existence of violations is not necessarily cause for concern. Rather, the violation with the load addition is compared to the violation without the load addition.

In all but one case, both Rate A and Rate B thermal violations were lessened or mitigated with the addition of the load as seen in Tables 2 – 6 and Tables 7 – 9. Table 3 shows the new thermal violation. Upon manual inspection, the case did not initially solve which lead to this violation. Solving the case an additional time resolves the violation. It is recommended that this violation be ignored.

In all but four cases, both high and low voltage violations were lessened or mitigated with the addition of the load as seen in Tables 10 – 14 and Tables 15 – 20. The first case is seen in Table 11. Given that it is negligibly higher than the base case, it is recommended that this violation be ignored. The second and third cases are new contingencies. Since these were so close to the cut

off, they were manually checked and confirmed to be negligibly higher than the base case. It is recommended that these new violations be ignored. There is a new low voltage violation as seen in Table 16. As with the new Rate A thermal violation, this was because the case did not initially solve and is resolved by solving the case again. It is recommended that this violation be ignored.

It should be noted that the program MDU uses to monitor and run contingencies only reports the ten worst violations. This is not usually a problem, but some cases have more than ten violations. Tables 11, 17, and 20 show that some violations have been replaced. That particular contingency may not have been mitigated, but it is no longer among the ten worst violations. Tables 12, 18, and 21 show the replacement contingencies with the load addition. The addition of load lessens or mitigates contingencies in the Mandan area and exacerbates contingencies in the Ellendale area. There are no new buses that experienced violations, only different ranking of violations. In all cases, the violations in the base case are the worst case.

5 Conclusion

After a thorough study of the affects of the Ellendale load addition on the surrouding areas and various contingencies, the only new violations are a result of the model not initially solving or are negligibly higher than the base case, and existing contingencies are lessened, mitigated, or negligibly higher than the base case. It is recommended that the Ellendale Load Addition EPR be approved.

6 Appendix

6.1 List of Contingencies

Table 1: Contingencies used in the study.

P11:230:MDU:EMMONS LOGAN::W	P11:230:MDU:MERRICOURT::W
P11:230:MDU:FOXTAIL::W	P11:230:MDU:TATANKA ND::W1
P11:230:MDU:TATANKA SD::W2	P12:230:MDU:MANDAN:NAPOLEON SW:1
P12:115:MDU:EAST BISMARCK:WISHEK:1	P12:230:MDU:NAPOLEON SW:WISHEK:1
P12:230:MDU:NAPOLEON SW:EMMONS LOGAN:1	P12:230:MDU:MERRICOURT:WISHEK:1
P12:230:MDU:MERRICOURT:G359 MERRICOURT:Z	P12:230:MDU:MERRICOURT:TATANKA NORTH:1
P12:230:MDU:MERRICOURT:ELLENDALE345:1	P12:230:MDU:TATANKA NORTH:FOXTAIL:1
P12:230:MDU:TATANKA NORTH:TATANKA SOUTH:1	P12:230:MDU:ELLENDALE:ELLENDALE345:Z
P12:230:MDU:ELLENDALE345:FOXTAIL:1	P12:230:MDU:ELLENDALE345:OAKES:1
P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	NB12:115:MDU:ELLENDALE:LEOLA:1
P12:115:MDU:ELLENDALE:ABERDEEN:1	P13:230:MDU:EMMONS LOGAN::1
P13:014-115-230:MDU:WISHEK::1	P13:230:MDU:MERRICOURT::1
P13:230:MDU:TATANKA::1	P13:230:MDU:TATANKA::1
P13:230:MDU:FOXTAIL::1	P13:014-115-230:MDU:ELLENDALE::1
P13:034-230-345:MDU:ELLENDALE345::1	P14:014:MDU:WISHEK::SWREACT
P14:014:MDU:ELLENDALE::SWREACT	P14:230:MDU:ELLENDALE345::SWCAP
P14:345:MDU:ELLENDALE345::SWREACT	P21:115:MDU:LINTON:WISHEK:1
P21:345:MDU:ELLENDALE345:ELLENDALE REACTOR:Z	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1
P22:115:MDU:WISHEK::B1	P22:230:MDU:TATANKA SOUTH::B1
P23:230:MDU:MANDAN::7203	P23:230:MDU:MANDAN::7207
P23:230:MDU:MANDAN::7213	P23:230:MDU:MANDAN::7233
P23:230:MDU:MANDAN::7237	P23:230:MDU:MANDAN::7243
P23:230:MDU:MANDAN::7248	P23:230:MDU:MANDAN::7252
P23:230:MDU:MANDAN::7258	P23:230:MDU:NAPOLEON SW::3046-3052-3062
P23:230:MDU:WISHEK::6578-6582-6586	P23:230:MDU:MERRICOURT::2703
P23:230:MDU:MERRICOURT::2707	P23:230:MDU:MERRICOURT::2713
P23:230:MDU:MERRICOURT::2722	P23:230:MDU:MERRICOURT::F1
P23:230:MDU:TATANKA NORTH::5177-5181-5185	P23:230:MDU:FOXTAIL::2902-2906-2914
P23:230:MDU:ELLENDALE::5127	P23:115:MDU:ELLENDALE::5003-5255
P23:115:MDU:ELLENDALE::5145	P23:230:MDU:ELLENDALE345::4903
P23:230:MDU:ELLENDALE345::4907	P23:230:MDU:ELLENDALE345::4913
P23:230:MDU:ELLENDALE345::4923	P23:230:MDU:ELLENDALE345::4927
P23:230:MDU:ELLENDALE345::4933	P23:230:MDU:ELLENDALE345::4953-4957
P23:345:MDU:ELLENDALE345::4803-4813	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248
P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	P42:115:MDU:EAST BISMARCK:WISHEK:1:7129
P42:230:MDU:NAPOLEON SW:MANDAN:1:3046-3062	P42:115:MDU:WISHEK:EAST BISMARCK:1:6557
P42:230:MDU:WISHEK:MERRICOURT:1:6578-6582	P42:230:MDU:MERRICOURT:TATANKA NORTH:1:2703
P42:230:MDU:MERRICOURT:WISHEK:1:2707	P42:230:MDU:MERRICOURT:ELLENDALE345:1:2713
P42:230:MDU:MERRICOURT:ELLENDALE345:1:F1	P42:230:MDU:MERRICOURT:TATANKA NORTH:1:2722
P42:230:MDU:TATANKA NORTH:MERRICOURT:1:5177-5185	P42:230:MDU:TATANKA SOUTH:TATANKA NORTH:1:5193-5196
P42:230:MDU:FOXTAIL:ELLENDALE345:1:2906-2914	P42:115:MDU:ELLENDALE:ABERDEEN:1:5145
P42:115:MDU:ELLENDALE:LEOLA:1:5255	P42:230:MDU:ELLENDALE:ELLENDALE345:Z:5127
P42:230:MDU:ELLENDALE345:MERRICOURT:1:4903	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907

Table 1: Contingencies used in the study.

P42:230:MDU:ELLENDAL345:OAKES:1:4913	P42:230:MDU:ELLENDAL345:FOXTAIL:1:4923
P42:230:MDU:ELLENDAL345:FOXTAIL:1:4927	P42:230:MDU:ELLENDAL345:ELLENDAL345:Z:4933
P42:345:MDU:ELLENDAL345:BIG STONE SOUTH:1:4803-4813	P43:034-230-345:MDU:ELLENDAL345::1:4953-4957
P12:345:OTP:BSSOUTH3:TWINBRKS3:1	P11:24:OTP:BIGSTN1G:1
P12:230:OTP::HANKSON4:WAHPETN4	

6.2 Thermal Violations

6.2.1 Rate A Violations

Table 2: Rate A overloads for 2022 WIN.

Branch	Contingency	Base Case (%)	Load Addition (%)
620263-620:FORMAN	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	100.7	Mitigated
	P12:230:OTP::HANKSON4:WAHPETN4	129.0	113.8
620363-620:FORMAN	P12:230:OTP::HANKSON4:WAHPETN4	108.6	Mitigated

Table 3: Rate A overloads for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
661907-661:ELLENDL	P21:345:MDU:ELLENDAL345:REACTOR:TWIN BROOKS:1	-	103.4

Table 4: Rate A overloads for 2027 SHHW.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214-620215	P12:230:OTP::HANKSON4:WAHPETN4	109.6	105.7
620263-620:FORMAN	P12:230:OTP::HANKSON4:WAHPETN4	112.5	Mitigated
620314-620325	P12:230:MDU:ELLENDAL345:OAKES:1	103.9	100.8
	P23:230:MDU:ELLENDAL345::4913	103.9	100.8

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Table 4: Rate A overloads for 2027 SHHW.

Branch	Contingency	Base Case (%)	Load Addition (%)
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	103.9	100.8
	P23:230:MDU:ELLENDALE345::4907	103.4	100.2
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	103.4	100.2

Table 5: Rate A overloads for 2027 SLL70.

Branch	Contingency	Base Case (%)	Load Addition (%)
620263-620:FORMAN	P12:230:OTP::HANKSON4:WAHPETN4	101.7	Mitigated

Table 6: Rate A overloads for 2027 WINSF.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214-620215	P12:230:OTP::HANKSON4:WAHPETN4	118.4	114.6
	P12:230:MDU:MANDAN:NAPOLEON SW:1	102.0	Mitigated
	P23:230:MDU:MANDAN::7248	102.0	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	102.0	Mitigated
	P23:230:MDU:MANDAN::7252	102.0	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	102.0	Mitigated
	P12:230:MDU:ELLENDALE345:OAKES:1	101.7	Mitigated
	P23:230:MDU:ELLENDALE345::4913	101.7	Mitigated
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	101.7	Mitigated
	P23:230:MDU:ELLENDALE345::4907	101.4	Mitigated
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	101.4	Mitigated
620215-620:BIG STONE	P12:230:OTP::HANKSON4:WAHPETN4	100.7	Mitigated

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Table 6: Rate A overloads for 2027 WINSF.

Branch	Contingency	Base Case (%)	Load Addition (%)
620263-620:FORMAN	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	105.6	Mitigated
	P12:230:OTP::HANKSON4:WAHPETN4	136.1	126.6
620314-620:BIG STONE	P12:230:OTP::HANKSON4:WAHPETN4	100.7	Mitigated
620363-620:FORMAN	P12:230:OTP::HANKSON4:WAHPETN4	116.7	106.2

6.2.2 Rate B Violations

Table 7: Rate B overloads for 2022 WIN.

Branch	Contingency	Base Case (%)	Load Addition (%)
620263-620:FORMAN	P12:230:OTP::HANKSON4:WAHPETN4	103.2	Mitigated

Table 8: Rate B overloads for 2027 SHHW.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214-HIWY12	P12:230:OTP::HANKSON4:WAHPETN4	109.6	105.7

Table 9: Rate B overloads for 2027 WINSF.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214-HIWY12	P12:230:OTP::HANKSON4:WAHPETN4	107.7	104.2
620263-620:FORMAN	P12:230:OTP::HANKSON4:WAHPETN4	111.3	101.3

6.3 Voltage Violations

6.3.1 High Voltage Violations

Table 10: High voltage violations for 2023 SUM.

Branch	Contingency	Base Case (%)	Load Addition (%)
620416	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	106.39	105.83
	P21:345:MDU:ELLENDAL345:ELLENDAL345:REACTOR:Z	105.13	105.13
	P14:345:MDU:ELLENDAL345::SWREACT	105.04	Mitigated
621001	SYSTEM INTACT	105.25	105.07
621002	SYSTEM INTACT	105.28	105.09
621003	SYSTEM INTACT	105.28	105.09

Table 11: High voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
620129	SYSTEM INTACT	107.61	107.02
620229	SYSTEM INTACT	106.95	Mitigated
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	107.93	Mitigated
	P11:24:OTP:BIGSTN1G:1	107.69	Mitigated
	P14:345:MDU:ELLENDAL345::SWREACT	107.42	Mitigated
	P12:230:MDU:ELLENDAL345:ELLENDAL345:Z	107.26	Mitigated
	P23:230:MDU:ELLENDAL345::4933	107.26	Mitigated
	P42:230:MDU:ELLENDAL345:ELLENDAL345:Z:4933	107.26	Mitigated
	P13:014-115-230:MDU:ELLENDAL345::1	107.25	Mitigated
	P23:230:MDU:ELLENDAL345::5127	107.25	Mitigated
	P23:115:MDU:ELLENDAL345::5003-5255	107.25	Mitigated
	P42:115:MDU:ELLENDAL345:LEOLA:1:5255	107.25	Mitigated
620314	P11:24:OTP:BIGSTN1G:1	105.96	105.12
620322	P11:24:OTP:BIGSTN1G:1	105.98	105.14
620325	P11:24:OTP:BIGSTN1G:1	106.02	Mitigated
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	105.06	Mitigated

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Table 11: High voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
620327	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	106.06	Mitigated
	P11:24:OTP:BIGSTN1G:1	105.68	Mitigated
	P14:345:MDU:ELLENDAL345::SWREACT	105.31	Mitigated
	P12:230:MDU:ELLENDAL345:ELLENDAL345:Z	105.08	Mitigated
	P23:230:MDU:ELLENDAL345::4933	105.08	Mitigated
	P42:230:MDU:ELLENDAL345:ELLENDAL345:Z:4933	105.08	Mitigated
	P13:014-115-230:MDU:ELLENDAL345::1	105.07	Mitigated
	P23:230:MDU:ELLENDAL345::5127	105.07	Mitigated
	P23:115:MDU:ELLENDAL345::5003-5255	105.07	Mitigated
	P42:115:MDU:ELLENDAL345:LEOLA:1:5255	105.07	Mitigated
620328	P11:24:OTP:BIGSTN1G:1	105.91	Mitigated
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	105.6	Mitigated
	P14:345:MDU:ELLENDAL345::SWREACT	105.11	Mitigated
620329	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	105.53	Mitigated
	P11:24:OTP:BIGSTN1G:1	105.30	Mitigated
	P14:345:MDU:ELLENDAL345::SWREACT	105.04	Mitigated
620362	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	108.85	Mitigated
	P14:345:MDU:ELLENDAL345::SWREACT	106.34	Mitigated
	P12:230:MDU:ELLENDAL345:ELLENDAL345:Z	105.99	Mitigated
	P23:230:MDU:ELLENDAL345::4933	105.99	Mitigated
	P42:230:MDU:ELLENDAL345:ELLENDAL345:Z:4933	105.99	Mitigated
	P13:014-115-230:MDU:ELLENDAL345::1	105.98	Mitigated
	P23:230:MDU:ELLENDAL345::5127	105.98	Mitigated
	P23:115:MDU:ELLENDAL345::5003-5255	105.98	Mitigated
	P42:115:MDU:ELLENDAL345:LEOLA:1:5255	105.98	Mitigated
	P42:230:MDU:ELLENDAL345:ELLENDAL345:Z:5127	105.98	Mitigated
620363	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	107.44	Mitigated
	P14:345:MDU:ELLENDAL345::SWREACT	105.74	Mitigated

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Table 11: High voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
620416	P12:230:MDU:ELLENDALE:ELLENDALE345:Z	105.46	Mitigated
	P23:230:MDU:ELLENDALE345::4933	105.46	Mitigated
	P42:230:MDU:ELLENDALE345:ELLENDALE:Z:4933	105.46	Mitigated
	P13:014-115-230:MDU:ELLENDALE::1	105.44	Mitigated
	P23:230:MDU:ELLENDALE::5127	105.44	Mitigated
	P23:115:MDU:ELLENDALE::5003-5255	105.44	Mitigated
	P42:115:MDU:ELLENDALE:LEOLA:1:5255	105.44	Mitigated
	P42:230:MDU:ELLENDALE:ELLENDALE345:Z:5127	105.44	Mitigated
	SYSTEM INTACT	106.13	105.45
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.61	111.26
	P11:24:OTP:BIGSTN1G:1	107.81	106.53
	P12:230:MDU:ELLENDALE:ELLENDALE345:Z	106.54	105.75
	P14:345:MDU:ELLENDALE345::SWREACT	107.08	106.12
	P21:345:MDU:ELLENDALE345:ELLENDALE REAC-TOR:Z	106.74	106.74
	P12:230:MDU:MANDAN:NAPOLEON SW:1	106.54	Replaced
	P23:230:MDU:MANDAN::7248	106.54	Replaced
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	106.54	Replaced
	P23:230:MDU:MANDAN::7252	106.54	Replaced
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	106.54	Replaced
	620417	P11:24:OTP:BIGSTN1G:1	106.81
P14:345:MDU:ELLENDALE345::SWREACT		106.54	105.01
P21:345:MDU:ELLENDALE345:ELLENDALE REAC-TOR:Z		105.26	105.26
P12:230:MDU:MANDAN:NAPOLEON SW:1		105.18	Mitigated
P23:230:MDU:MANDAN::7248		105.18	Mitigated
P42:230:MDU:MANDAN:NAPOLEON SW:1:7248		105.18	Mitigated
P23:230:MDU:MANDAN::7252		105.18	Mitigated
P42:230:MDU:MANDAN:NAPOLEON SW:1:7252		105.18	Mitigated

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Table 11: High voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)	
620480	P12:230:MDU:ELLENDALE:ELLENDALE345:Z	105.17	Mitigated	
	P23:230:MDU:ELLENDALE345::4933	105.17	Mitigated	
	SYSTEM INTACT	105.22	105.07	
	P11:24:OTP:BIGSTN1G:1	106.55	105.91	
	P14:345:MDU:ELLENDALE345::SWREACT	105.61	105.26	
	P21:345:MDU:ELLENDALE345:ELLENDALE TOR:Z	REAC- 105.41	105.43	
	P12:230:MDU:MANDAN:NAPOLEON SW:1	105.36	Replaced	
	P23:230:MDU:MANDAN::7248	105.36	Replaced	
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	105.36	Replaced	
	P23:230:MDU:MANDAN::7252	105.36	Replaced	
620482	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	105.36	Replaced	
	P12:230:MDU:ELLENDALE:ELLENDALE345:Z	105.34	105.15	
	P23:230:MDU:ELLENDALE345::4933	105.34	105.12	
	P11:24:OTP:BIGSTN1G:1	105.78	105.36	
	P14:345:MDU:ELLENDALE345::SWREACT	105.12	Mitigated	
	P21:345:MDU:ELLENDALE345:ELLENDALE TOR:Z	REAC- 104.98 ¹	105.01	
	620483	P11:24:OTP:BIGSTN1G:1	105.78	105.36
		P14:345:MDU:ELLENDALE345::SWREACT	105.12	Mitigated
		P21:345:MDU:ELLENDALE345:ELLENDALE TOR:Z	REAC- 104.98 ¹	105.01
	620829	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	105.53	Mitigated
P11:24:OTP:BIGSTN1G:1		105.30	Mitigated	
P14:345:MDU:ELLENDALE345::SWREACT		105.04	Mitigated	
621000	SYSTEM INTACT	106.14	105.49	
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.66	111.31	
621001	SYSTEM INTACT	106.75	106.07	

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¹These are below the high voltage threshold. It is only recorded as a reference for the load addition voltage.

Table 11: High voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
621002	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	118.30	111.91
	SYSTEM INTACT	106.78	106.09
621003	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	118.32	111.94
	SYSTEM INTACT	106.78	106.09
621010	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	118.32	111.94
	SYSTEM INTACT	106.37	106.22
621011	SYSTEM INTACT	106.47	106.32
621012	SYSTEM INTACT	106.47	106.32
621013	SYSTEM INTACT	105.97	105.82
621014	SYSTEM INTACT	106.01	105.86
621015	SYSTEM INTACT	106.01	105.86
621096	SYSTEM INTACT	107.61	105.37
621097	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.52	111.17
	SYSTEM INTACT	106.04	105.36
621098	SYSTEM INTACT	106.05	105.37
621099	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.52	111.18
	SYSTEM INTACT	106.04	105.36
621102	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.51	111.17
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.51	111.17
	SYSTEM INTACT	105.99	105.31
621418	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.45	111.11
	SYSTEM INTACT	106.13	105.45
621480	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.61	111.26
	SYSTEM INTACT	105.22	105.07
621995	SYSTEM INTACT	105.98	105.31
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	117.45	111.26
655694	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	106.31	Mitigated
	P11:24:OTP:BIGSTN1G:1	105.95	Mitigated

Continued on next page

Table 11: High voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
	P14:345:MDU:ELLENDAL345::SWREACT	105.55	Mitigated
	P12:230:MDU:ELLENDAL345:ELLENDAL345:Z	105.32	Mitigated
	P23:230:MDU:ELLENDAL345::4933	105.32	Mitigated
	P42:230:MDU:ELLENDAL345:ELLENDAL345:Z:4933	105.32	Mitigated
	P13:014-115-230:MDU:ELLENDAL345::1	105.30	Mitigated
	P23:230:MDU:ELLENDAL345::5127	105.30	Mitigated
	P23:115:MDU:ELLENDAL345::5003-5255	105.30	Mitigated
	P42:115:MDU:ELLENDAL345:LEOLA:1:5255	105.30	Mitigated
661026	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	110.26	Mitigated
661092	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	110.08	Mitigated
661096	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	110.02	Mitigated
661097	SYSTEM INTACT	105.25	Mitigated
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	112.06	Mitigated
661098	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	110.26	Mitigated
661907	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	110.07	Mitigated
661950	SYSTEM INTACT	105.25	Mitigated
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	112.06	Mitigated
661996	SYSTEM INTACT	105.10	Mitigated
	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	110.08	Mitigated

Table 12: High voltage violations for 2024 SLL0 that replaced violations in Table 11.

Branch	Contingency	Base Case (%)	Load Addition (%)
620416	P13:014-115-230:MDU:ELLENDAL345::1	-	105.74
	P23:115:MDU:ELLENDAL345::5003-5255	-	105.74
	P23:230:MDU:ELLENDAL345::5127	-	105.74
	P23:230:MDU:ELLENDAL345::4933	-	105.75

Continued on next page

Table 12: High voltage violations for 2024 SLL0 that replaced violations in Table 11.

Branch	Contingency	Base Case (%)	Load Addition (%)
620480	P42:230:MDU:ELLENDALE345:ELLENDALE:Z:4933	-	105.75
	P13:014-115-230:MDU:ELLENDALE::1	-	105.15
	P23:115:MDU:ELLENDALE::5003-5255	-	105.15
	P23:230:MDU:ELLENDALE::5127	-	105.15
	P42:115:MDU:ELLENDALE:LEOLA:1:5255	-	105.15
	P42:230:MDU:ELLENDALE345:ELLENDALE:Z:4933	-	105.15

Table 13: High voltage violations for 2024 SUM.

Branch	Contingency	Base Case (%)	Load Addition (%)
620416	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	106.41	105.84
	P21:345:MDU:ELLENDALE345:ELLENDALE REACTOR:Z	105.13	105.13
	P14:345:MDU:ELLENDALE345::SWREACT	105.04	Mitigated
621001	SYSTEM INTACT	105.25	105.07
621002	SYSTEM INTACT	105.28	105.09
621003	SYSTEM INTACT	105.28	105.09

Table 14: High voltage violations for 2032 SUM.

Branch	Contingency	Base Case (%)	Load Addition (%)
620416	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	106.75	105.88
	P14:345:MDU:ELLENDALE345::SWREACT	105.15	Mitigated
	P21:345:MDU:ELLENDALE345:ELLENDALE REACTOR:Z	105.12	105.12
621001	SYSTEM INTACT	105.32	105.05

Continued on next page

Table 14: High voltage violations for 2032 SUM.

Branch	Contingency	Base Case (%)	Load Addition (%)
621002	SYSTEM INTACT	105.34	105.08
621003	SYSTEM INTACT	105.34	105.08

6.3.2 Low Voltage Violations

The nominal low voltage for buses 620214 and 620215 is 97.

Table 15: Low voltage violations for 2022 WIN.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214	P11:24:OTP:BIGSTN1G:1	96.27	96.61
	P12:230:MDU:ELLENDALE345:OAKES:1	96.20	96.74
	P12:230:OTP::HANKSON4:WAHPETN4	95.55	95.94
	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	96.45	96.62
	P23:230:MDU:ELLENDALE345::4907	96.21	96.74
	P23:230:MDU:ELLENDALE345::4913	96.20	96.74
	P23:230:MDU:MANDAN::7252	96.46	Mitigated
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	96.21	96.74
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	96.20	96.74
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.46	Mitigated
620214	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	-	96.62
620215	P11:24:OTP:BIGSTN1G:1	96.64	96.99
	P12:230:MDU:ELLENDALE345:OAKES:1	96.50	Mitigated
	P12:230:OTP::HANKSON4:WAHPETN4	95.74	96.16
	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	96.76	96.93
	P23:230:MDU:ELLENDALE345::4907	96.52	Mitigated
	P23:230:MDU:ELLENDALE345::4913	96.50	Mitigated

Continued on next page

Table 15: Low voltage violations for 2022 WIN.

Branch	Contingency	Base Case (%)	Load Addition (%)
	P23:230:MDU:MANDAN::7252	96.76	Mitigated
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	96.52	Mitigated
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	96.50	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.76	Mitigated
620215	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	-	96.63

Table 16: Low voltage violations for 2024 SLL0.

Branch	Contingency	Base Case (%)	Load Addition (%)
620362	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	-	96.53

The nominal low voltage for buses 620213, 620214, 620215, 620327, 620329, AND 620829 is 97.

Table 17: Low voltage violations for 2027 SHHW.

Branch	Contingency	Base Case (%)	Load Addition (%)
620213	SYSTEM INTACT	96.44	94.48
	P23:230:MDU:MANDAN::7252	95.59	96.54
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	95.59	96.54
	P12:230:MDU:MANDAN:NAPOLEON SW:1	95.59	96.54
	P23:230:MDU:MANDAN::7248	95.59	96.54
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	95.59	Replaced
	P12:230:MDU:ELLENDALE345:OAKES:1	95.61	96.49
	P23:230:MDU:ELLENDALE345::4913	95.61	96.49
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	95.61	96.49

Continued on next page

Table 17: Low voltage violations for 2027 SHHW.

Branch	Contingency	Base Case (%)	Load Addition (%)	
620214	P23:230:MDU:ELLENDALE345::4907	95.66	96.51	
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	95.66	96.51	
	SYSTEM INTACT	98.04	94.48	
	P12:230:OTP::HANKSON4:WAHPETN4	91.71	92.54	
	P12:230:MDU:ELLENDALE345:OAKES:1	92.87	93.78	
	P23:230:MDU:ELLENDALE345::4913	92.87	93.78	
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	92.87	93.78	
	P23:230:MDU:ELLENDALE345::4907	92.91	93.79	
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	92.91	93.79	
	P23:230:MDU:MANDAN::7252	92.92	93.88	
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	92.92	93.88	
	P12:230:MDU:MANDAN:NAPOLEON SW:1	92.92	Replaced	
	P23:230:MDU:MANDAN::7248	92.92	Replaced	
	620215	SYSTEM INTACT	94.35	95.02
P12:230:OTP::HANKSON4:WAHPETN4		92.06	92.94	
P12:230:MDU:ELLENDALE345:OAKES:1		93.39	94.32	
P23:230:MDU:ELLENDALE345::4913		93.39	94.32	
P42:230:MDU:ELLENDALE345:OAKES:1:4913		93.39	94.32	
P23:230:MDU:MANDAN::7252		93.42	94.41	
P42:230:MDU:MANDAN:NAPOLEON SW:1:7252		93.42	94.41	
P12:230:MDU:MANDAN:NAPOLEON SW:1		93.42	Replaced	
P23:230:MDU:MANDAN::7248		93.42	Replaced	
P42:230:MDU:MANDAN:NAPOLEON SW:1:7248		93.42	Replaced	
P23:230:MDU:ELLENDALE345::4907		93.44	94.34	
620229		P12:345:OTP:BSSOUTH3:TWINBRKS3:1	96.93	Mitigated
620327		P12:345:OTP:BSSOUTH3:TWINBRKS3:1	94.53	96.54
		P23:230:MDU:MANDAN::7252	96.52	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.52	Mitigated	

Continued on next page

Table 17: Low voltage violations for 2027 SHHW.

Branch	Contingency	Base Case (%)	Load Addition (%)
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.52	Mitigated
	P23:230:MDU:MANDAN::7248	96.52	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.52	Mitigated
620328	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	95.98	Mitigated
620329	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	94.96	96.88
	P23:230:MDU:MANDAN::7252	96.58	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.58	Mitigated
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.58	Mitigated
	P23:230:MDU:MANDAN::7248	96.58	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.58	Mitigated
620362	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	95.97	Mitigated
620363	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	94.08	96.82
620829	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	94.96	96.88
	P23:230:MDU:MANDAN::7252	96.58	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.58	Mitigated
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.58	Mitigated
	P23:230:MDU:MANDAN::7248	96.58	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.58	Mitigated
655694	P12:345:OTP:BSSOUTH3:TWINBRKS3:1	94.60	Mitigated

Table 18: Low voltage violations for 2027 SHHW that replaced violations in Table 17.

Branch	Contingency	Base Case (%)	Load Addition (%)
620213	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	-	96.51
620214	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	-	93.85
	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	-	93.85
620215	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	-	94.39
	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	-	94.39
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	-	94.34

Table 19: Low voltage violations for 2027 SLL70.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.98	Mitigated
	P23:230:MDU:MANDAN::7248	96.98	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.98	Mitigated
	P23:230:MDU:MANDAN::7252	96.98	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.98	Mitigated

Table 20: Low voltage violations for 2027 WINSF.

Branch	Contingency	Base Case (%)	Load Addition (%)
620213	SYSTEM INTACT	96.79	Mitigated
	P12:230:MDU:ELLENDALE345:OAKES:1	96.00	96.63
	P23:230:MDU:ELLENDALE345::4913	96.00	96.63
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	96.00	96.63
	P12:230:OTP::HANKSON4:WAHPETN4	94.78	95.37

Continued on next page

Table 20: Low voltage violations for 2027 WINSF.

Branch	Contingency	Base Case (%)	Load Addition (%)
620214	P23:230:MDU:ELLENDALE345::4907	96.02	96.65
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	96.02	96.65
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.26	96.93
	P23:230:MDU:MANDAN::7248	96.26	Replaced
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.26	Replaced
	P23:230:MDU:MANDAN::7252	96.26	Replaced
	SYSTEM INTACT	94.38	94.82
	P12:230:MDU:ELLENDALE345:OAKES:1	94.07	93.38
	P12:230:MDU:MANDAN:NAPOLEON SW:1	94.47	93.78
	P12:230:OTP::HANKSON4:WAHPETN4	92.60	93.15
	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	93.78	93.96
	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	93.75	93.92
	P23:230:MDU:ELLENDALE345::4907	94.07	93.41
	P23:230:MDU:ELLENDALE345::4913	93.38	94.07
	P23:230:MDU:MANDAN::7248	93.78	Replaced
	620215	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	93.38
P42:230:MDU:ELLENDALE345:OAKES:1:4913		93.38	94.07
SYSTEM INTACT		94.85	95.32
P12:230:MDU:ELLENDALE345:OAKES:1		93.86	94.56
P12:230:MDU:MANDAN:NAPOLEON SW:1		94.24	94.96
P12:230:OTP::HANKSON4:WAHPETN4		92.87	94.45
P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1		94.22	94.41
P23:230:MDU:ELLENDALE345::4907		93.88	94.57
P23:230:MDU:ELLENDALE345::4913		93.86	94.56
P23:230:MDU:MANDAN::7248		94.24	Replaced
P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907		93.88	94.57
P42:230:MDU:ELLENDALE345:OAKES:1:4913		93.86	94.56

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Table 20: Low voltage violations for 2027 WINSF.

Branch	Contingency	Base Case (%)	Load Addition (%)
620327	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	94.24	Replaced
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.77	Mitigated
	P23:230:MDU:MANDAN::7248	96.77	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.77	Mitigated
	P23:230:MDU:MANDAN::7252	96.77	Mitigated
620328	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.77	Mitigated
	P12:230:MDU:ELLENDALE345:OAKES:1	96.83	Mitigated
	P23:230:MDU:ELLENDALE345::4913	96.83	Mitigated
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	96.83	Mitigated
	P23:230:MDU:ELLENDALE345::4907	96.85	Mitigated
620329	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	96.85	Mitigated
	P23:230:MDU:MANDAN::7252	96.51	Mitigated
	P12:230:MDU:ELLENDALE345:OAKES:1	94.38	94.07
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.26	96.93
	P12:230:OTP::HANKSON4:WAHPETN4	94.78	95.37
620829	P23:230:MDU:ELLENDALE345::4907	94.41	94.07
	P23:230:MDU:ELLENDALE345::4913	94.38	94.07
	P23:230:MDU:MANDAN::7248	96.26	Replaced
	P23:230:MDU:MANDAN::7252	96.26	Replaced
	P42:230:MDU:ELLENDALE345:MERRICOURT:1:4907	94.41	94.07
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.26	Replaced
	P42:230:MDU:ELLENDALE345:OAKES:1:4913	94.38	94.07
	P23:230:MDU:MANDAN::7252	96.51	Mitigated
	P42:230:MDU:MANDAN:NAPOLEON SW:1:7252	96.51	Mitigated
	P12:230:MDU:MANDAN:NAPOLEON SW:1	96.51	Mitigated
	P23:230:MDU:MANDAN::7248	96.51	Mitigated
P42:230:MDU:MANDAN:NAPOLEON SW:1:7248	96.51	Mitigated	

Table 21: Low voltage violations for 2027 WINSF that replaced violations in Table 20.

Branch	Contingency	Base Case (%)	Load Addition (%)
620213	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	-	96.52
	P21:345:MDU:ELLENDALE REACTOR:TWIN BROOKS:1	-	96.48
	P21:345:MDU:ELLENDALE345:ELLENDALE REACTOR:Z	-	96.85
620214	P21:345:MDU:ELLENDALE345:ELLENDALE REACTOR:Z	-	94.41
620215	P12:345:MDU:ELLENDALE345:TWIN BROOKS:1	-	94.45
	P21:345:MDU:ELLENDALE345:ELLENDALE REACTOR:Z	-	94.88

6.4 Errors

The only error was not being able to disconnect a load in four contingencies. The load was not modeled in earlier cases. These contingencies were manually checked and verified to be within tolerances.