Report Number: R077-23

MISO Affected System Study on SPP DISIS 2018-002 / 2019-001 Phase 2 Projects

Prepared for

MISO

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09/08/2023

Siemens PTI Project Number: 62OT-002355-B-2

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Revision History

Date	Rev.	Description
08/21/2023	A	Initial draft
09/08/2023	B	Final report

Contents

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Executive Summary

This report presents the results of an Affected System Impact Study (AFSIS) on MISO transmission system performed for Phase 2 generator interconnection requests in the Southwest Power Pool (SPP) queue 2018-002 cycle and 2019-001 cycle (Study Projects). The AFSIS results are summarized below.

1.1 Project List

Because of a wide geographical region of the SPP Phase 2 Study Projects, the MISO AFSIS was divided into two groups to identify the impacts on the MISO West and MISO South regions.

1.1.1 Phase 2 Study Projects in MISO South

The SPP Phase 2 Study Projects in MISO South region (Study Projects in MISO South) have 19 generation projects with combined energy of 2790 MW, which are listed in Table ES-1.

Table ES-1: Phase 2 Study Projects in MISO South

Project #	Town / County	State	Point of Interconnection	Generation Type	Pmax	SH (MW)	SPK (MW)
GEN-2018-064	Benton	AR	Tonnece 69 kV	Solar	80	0	80
GEN-2018-071	Kay	OK	Ranch Road 345 kV	Battery	151	151	151
GEN-2018-072	Kay	OK	Ranch Road 345 kV	Battery	151	151	151
GEN-2018-073	Floyd	TX	Crawfish 345 kV	Solar	250	0	250
GEN-2018-079	Craig / Novata	OK	Farmland-Delaware 138 kV	Solar	148	0	148
GEN-2018-082	Pittsburg	OK	Pittsburg 345 kV	Wind	215	215	33.54
GEN-2018-087	Bowie	TX	Lydia 345 kV	Battery	75	75	75
GEN-2018-088	Bowie	TX	Lydia 345 kV	Solar	130	0	130
GEN-2018-092	Foard / Wilbarger	TX	Oklaunion-Tuco 345 kV	Solar	400	0	400
GEN-2018-106	Caddo	LA	Longwood 345 kV	Solar	165	0	165
GEN-2018-115	Lawton	OK	Lawton East 345/138 kV	Hybrid (Solar / Storage)	250	50	250
GEN-2018-117	Roger Mills	OK	Sweetwater 230 kV	Solar	150	0	150
GEN-2019-002	Mayes	OK	Maid 161 kV	Battery	100	100	100
GEN-2019-013	Roger Mills	OK	Dempsey / Sweetwater 230 kV	Battery	50	50	50
GEN-2019-035	Barry	MO	Reeds Spring-Aurora 161 kV	Solar	80	0	80
GEN-2019-052	Canadian	OK	Cimarron 345 kV	Solar	135	0	135

Project #	Town / County	State	Point of Interconnection	Generation Type	Pmax	SH (MW)	SPK (MW)
GEN-2019-065	Smith	TX	Overton-Northwest Henderson 138 kV	Battery	180	180	180
GEN-2019-066	Beckham	OK	Sweetwater 230 kV	Battery	50	50	50
GEN-2019-067	Canadian	OK	Cimarron 345 kV	Battery	30	30	30

1.1.2 Phase 2 Study Projects in MISO West

The SPP Phase 2 Study Projects in MISO West region (Study Projects in MISO West) have 26 generation projects with combined energy of 3648 MW, which are listed in Table ES-2.

Table ES-2: Phase 2 Study Projects in MISO West

Project #	Town / County	State	Point of Interconnection	Generation Type	Pmax	SH (MW)	SPK (MW)
GEN-2018-063	Greene	MO	Sedalia Marshfield Springfield Nichols Street 69 kV	Solar	57	0	57.0
GEN-2018-065	Madison	NE	Antelope 345 kV	Wind	19.8	19.8	3.1
GEN-2018-067	Williams	ND	Strandahl 115 kV	Wind	255	255	39.8
GEN-2018-068	Madison	NE	Antelope 345 kV	Wind	302.4	302.4	47.2
GEN-2018-069	Wibaux	MT	WAPA-UGP Mingusville 230 kV	Wind	125	125	19.5
GEN-2018-070	Yankton	SD	Utica Junction 230 kV	Wind	18.31	18.31	2.9
GEN-2018-074	Crawford / Carrol	IA	Denison 230 kV	Wind	78	78	12.2
GEN-2018-083	Madison	NE	Shell Creek-Hoskins 345 kV	Wind	250	250	39.0
GEN-2018-090	Washington	NE	Raun-Fort Calhoun 345 kV	Battery	125	125	125.0
GEN-2018-121	Cass	MO	KC South-N. Raymore 161 kV	Battery	50	50	50.0
GEN-2018-125	Lincoln	NE	Gentleman-Sweetwater 345 kV	Wind	231	231	36.0
GEN-2018-131	Pierce	NE	Antelope 345 kV	Solar	221.4	0	221.4
GEN-2018-132	Pierce	NE	Antelope 345 kV	Solar	201.6	0	201.6
GEN-2019-009	Nemaha	NE	S1263 Brock 161 kV	Solar	100	0	100.0
GEN-2019-016	Polk / Dade	MO	Dadeville 161 kV	Solar	200	0	200.0
GEN-2019-019	Sioux	IA	Siouxland 69 kV	CT	15.15	0	15.2
GEN-2019-023	Wibaux	MT	WAPA-UGP Mingusville 230 kV	Hybrid (Wind / Storage)	110	75.625, 34.375	17.16, 50
GEN-2019-029	Keith / Deuel	NE	Sidney Keystone 345 kV	Wind	404	404	63.0

Project #	Town / County	State	Point of Interconnection	Generation Type	Pmax	SH (MW)	SPK (MW)
GEN-2019-033	Knox	NE	Sidney Keystone 345 kV	Solar	182	0	182.0
GEN-2019-037	Mercer	ND	Leland Olds 345 kV	Solar	150	0	150.0
GEN-2019-039	Butler	NE	Columbus Southeast-Rising City 115 kV	Solar	174.5	0	174.5
GEN-2019-041	Lancaster	NE	Monolith 115 kV	Solar	78	0	78.0
GEN-2019-048	Jackson	MO	Duncan 69 kV	Battery	50	50	50.0
GEN-2019-069	Madison	NE	Shell Creek-Hoskins 345 kV	Solar	100	0	100.0
GEN-2019-070	Madison	NE	Shell Creek-Hoskins 345 kV	Solar	50	0	50.0
GEN-2019-073	Madison	NE	Shell Creek-Hoskins 345 kV	Solar	100	0	100.0

1.2 MISO AFSIS Study Summary

1.2.1 Study Summary for Study Projects in MISO South

Steady state models and stability packages used for MISO AFSIS on SPP Study Projects in MISO South were developed from the models used in MISO DPP 2020 South Phase 3 System Impact Study (SIS).

Steady state thermal and voltage analysis was performed to identify any thermal and voltage violations in the MISO South region. No thermal or voltage constraints were identified in the 2025 summer peak (SPK) and summer shoulder (SH) scenarios. No thermal or voltage MISO AFSIS Network Upgrades (NUs) were identified in the steady state analysis.

Transient stability analysis was performed to identify any transient stability violations caused by the SPP Study Projects in MISO South. No transient stability constraints were identified in the 2025 summer peak and summer shoulder scenarios. No MISO AFSIS stability NUs were identified in the transient stability analysis.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the SPP Study Projects in MISO South. Based on the screening results, MISO Transmission Owners do not plan to conduct additional studies.

No contingent MTEP facilities were identified for the SPP Study Projects in MISO South.

In conclusion, SPP Study Projects in MISO South are not responsible for any MISO AFSIS NUs.

1.2.2 Study Summary for Study Projects in MISO West

Steady state models and stability packages used for MISO AFSIS on SPP Study Projects in MISO West were developed from the models used in MISO DPP 2020 West Phase 3 System Impact Study.

Steady state thermal and voltage analysis was performed to identify any thermal and voltage violations in MISO West region. Thermal and voltage AFSIS Network Upgrades identified in the summer shoulder scenario for steady state analysis are listed in Table ES-3 and Table ES-4. No MISO AFSIS Network Upgrades (NUs) were identified in the summer peak scenario.

Table ES-3: AFSIS Thermal Network Upgrades Identified in the Summer Shoulder Scenario for SPP Study Projects in MISO West

Constraint	Owner	Mitigation	Cost ($)
Raun - G18-043 Tap 345 kV	MEC OPPD	MEC: No mitigation required. Existing MEC Only rating is 1195/1333 MVA. $0 OPPD: Mitigation, if required, will be identified in SPP system impact study.	$0
Raun - G17-105 Tap 161 kV	MEC OPPD	MEC: Rebuild transmission line to increase line rating. New MEC rating projected to be 335 MVA. $2.25M OPPD: Mitigation, if required, will be identified in SPP system impact study.	$2,250,000
Grimes - Beaver Creek 345 kV	MEC	Replace transmission line structures to increase line rating. New rating projected to be 1286 MVA.	$500,000
Merricourt - Wishek 230 kV	MDU	As part of J1040 GI in DPP 2018, they are required to upgrade this line to 478[511] SN[SE] and 478[526] WN[WE].	$0

Table ES-4: AFSIS Voltage Network Upgrades Identified in Summer Shoulder Scenario for SPP Study Projects in MISO West

Constraint	Network Upgrades	Owner	Cost ($)
Low voltages under single contingency "MPC04300-Prairie 345 kV"	Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000
Low voltages under contingency "P23:345:XEL:8N64 LYC"	MTEP Appendix A project. Brookings-Lyon Co second circuit (2025 ISD)	Xcel	$0

Transient stability analysis was performed to identify any transient stability violations caused by the SPP Study Projects in MISO West. Voltage collapses were identified in the summer shoulder study case. No other transient stability violations are related to MISO Affected System. MISO West AFSIS stability NUs (Table ES-5) are required for the SPP Study Projects in MISO West to mitigate the voltage collapses only identified in the study case.

Table ES-5: MISO Transient Stability Voltage NUs and Cost

Constraint	Network Upgrades	Owner	Cost ($)
Voltage collapses under several stability faults	1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the SPP Study Projects in MISO West. Based on the screening results, MISO Transmission Owners do not plan to conduct additional studies.

Contingent facilities were identified. The study projects will be included in MISO's Annual studies to determine available injection until assumptions reach their expected In-Service Date. Details are in Section 4.2.

1.3 Total MISO AFSIS Network Upgrades

1.3.1 Total MISO AFSIS Network Upgrades for Study Projects in MISO South

The total cost of MISO AFSIS Network Upgrades required for the Study Projects in MISO South is listed in Table ES-6. No MISO AFSIS Network Upgrades were identified for the SPP Study Projects in MISO South.

Table ES-6: Total Cost of MISO AFSIS Network Upgrades for SPP Study Projects in MISO South

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2018-064	$0	$0	$0	$0
GEN-2018-071	$0	$0	$0	$0
GEN-2018-072	$0	$0	$0	$0
GEN-2018-073	$0	$0	$0	$0
GEN-2018-079	$0	$0	$0	$0
GEN-2018-082	$0	$0	$0	$0
GEN-2018-087	$0	$0	$0	$0
GEN-2018-088	$0	$0	$0	$0
GEN-2018-092	$0	$0	$0	$0
GEN-2018-106	$0	$0	$0	$0
GEN-2018-115	$0	$0	$0	$0
GEN-2018-117	$0	$0	$0	$0
GEN-2019-002	$0	$0	$0	$0
GEN-2019-013	$0	$0	$0	$0

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2019-035	$0	$0	$0	$0
GEN-2019-052	$0	$0	$0	$0
GEN-2019-065	$0	$0	$0	$0
GEN-2019-066	$0	$0	$0	$0
GEN-2019-067	$0	$0	$0	$0
Total ($)	**$0**	**$0**	**$0**	**$0**

1.3.2 Total MISO AFSIS Network Upgrades for Study Projects in MISO West

The total cost of MISO AFSIS Network Upgrades required for the Study Projects in MISO West is listed in Table ES-7. The costs for Network Upgrades are planning level estimates and subject to be revised in the facility studies.

Table ES-7: Total Cost of MISO AFSIS Network Upgrades for SPP Study Projects in MISO West

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2018-063	$0	$0	$0	$0
GEN-2018-065	$21,416	$300,752	$0	$322,168
GEN-2018-067	$1,058,566	$9,864,662	$0	$10,923,228
GEN-2018-068	$302,885	$4,390,977	$0	$4,693,862
GEN-2018-069	$590,472	$5,714,286	$0	$6,304,758
GEN-2018-070	$21,416	$360,902	$0	$382,318
GEN-2018-074	$52,010	$842,105	$0	$894,116
GEN-2018-083	$214,161	$3,368,421	$0	$3,582,582
GEN-2018-090	$2,829,545	$1,263,158	$0	$4,092,703
GEN-2018-121	$18,357	$240,602	$0	$258,958
GEN-2018-125	$208,042	$3,127,820	$0	$3,335,862
GEN-2018-131	$0	$0	$0	$0
GEN-2018-132	$0	$0	$0	$0
GEN-2019-009	$0	$0	$0	$0
GEN-2019-016	$0	$0	$0	$0
GEN-2019-019	$0	$0	$0	$0

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2019-023	$529,283	$5,172,932	$0	$5,702,216
GEN-2019-029	$385,490	$5,112,782	$0	$5,498,271
GEN-2019-033	$0	$0	$0	$0
GEN-2019-037	$0	$0	$0	$0
GEN-2019-039	$0	$0	$0	$0
GEN-2019-041	$0	$0	$0	$0
GEN-2019-048	$18,357	$240,602	$0	$258,958
GEN-2019-069	$0	$0	$0	$0
GEN-2019-070	$0	$0	$0	$0
GEN-2019-073	$0	$0	$0	$0
Total ($)	**$6,250,000**	**$40,000,000**	**$0**	**$46,250,000**

1.4 Per Project Summary

This section provides estimated cost of MISO AFSIS Network Upgrades on a per project basis for the Study Projects in SPP 2018-002 cycle and 2019-001 cycle.

The following projects do not have MISO AFSIS Network Upgrade cost allocated to the projects:

- SPP Study Projects in MISO South:
  - GEN-2018-064, GEN-2018-071, GEN-2018-072, GEN-2018-073, GEN-2018-079, GEN-2018-082, GEN-2018-087, GEN-2018-088, GEN-2018-092, GEN-2018-106, GEN-2018-115, GEN-2018-117, GEN-2019-002, GEN-2019-013, GEN-2019-035, GEN-2019-052, GEN-2019-065, GEN-2019-066, GEN-2019-067.
- SPP Study Projects in MISO West:
  - GEN-2018-063, GEN-2018-131, GEN-2018-132, GEN-2019-009, GEN-2019-016, GEN-2019-019, GEN-2019-033, GEN-2019-037, GEN-2019-039, GEN-2019-041, GEN-2019-069, GEN-2019-070, GEN-2019-073.

MISO AFSIS Network Upgrade costs are allocated to the below projects:

1.4.1 GEN-2018-065 Summary

Network Upgrade	Owner	Cost	GEN-2018-065	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$21,416	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$300,752	SH Stability
Total Cost Per Project			**$322,168**	

1.4.2 GEN-2018-067 Summary

Network Upgrade	Owner	Cost	GEN-2018-067	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$1,058,566	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$9,864,662	SH Stability
Total Cost Per Project			**$10,923,228**	

1.4.3 GEN-2018-068 Summary

Network Upgrade	Owner	Cost	GEN-2018-068	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$302,885	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$4,390,977	SH Stability
Total Cost Per Project			**$4,693,862**	

1.4.4 GEN-2018-069 Summary

Network Upgrade	Owner	Cost	GEN-2018-069	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$590,472	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$5,714,286	SH Stability
Total Cost Per Project			**$6,304,758**	

1.4.5 GEN-2018-070 Summary

Network Upgrade	Owner	Cost	GEN-2018-070	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$21,416	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$360,902	SH Stability
Total Cost Per Project			**$382,318**	

1.4.6 GEN-2018-074 Summary

Network Upgrade	Owner	Cost	GEN-2018-074	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$52,010	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$842,105	SH Stability
Total Cost Per Project			**$894,116**	

1.4.7 GEN-2018-083 Summary

Network Upgrade	Owner	Cost	GEN-2018-083	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$214,161	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$3,368,421	SH Stability
Total Cost Per Project			**$3,582,582**	

1.4.8 GEN-2018-090 Summary

Network Upgrade	Owner	Cost	GEN-2018-090	NUs Type
Raun - G17-105 Tap 161 kV	MEC OPPD	$2,250,000	$2,250,000	SH
Grimes - Beaver Creek 345 kV	MEC	$500,000	$500,000	SH
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$79,545	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$1,263,158	SH Stability
Total Cost Per Project			**$4,092,703**	

1.4.9 GEN-2018-121 Summary

Network Upgrade	Owner	Cost	GEN-2018-121	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$18,357	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$240,602	SH Stability
Total Cost Per Project			**$258,958**	

1.4.10 GEN-2018-125 Summary

Network Upgrade	Owner	Cost	GEN-2018-125	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$208,042	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$3,127,820	SH Stability
Total Cost Per Project			**$3,335,862**	

1.4.11 GEN-2019-023 Summary

Network Upgrade	Owner	Cost	GEN-2019-023	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$529,283	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$5,172,932	SH Stability
Total Cost Per Project			**$5,702,216**	

1.4.12 GEN-2019-029 Summary

Network Upgrade	Owner	Cost	GEN-2019-029	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$385,490	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$5,112,782	SH Stability
Total Cost Per Project			**$5,498,271**	

1.4.13 GEN-2019-048 Summary

Network Upgrade	Owner	Cost	GEN-2019-048	NUs Type
Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$18,357	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$240,602	SH Stability
Total Cost Per Project			**$258,958**	

It should be noted that a restudy may be required should significant changes to the study assumptions occur, including but not limited to, interconnection request withdrawals and/or changes to higher-queued Network Upgrades included in the Base Case.

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Section

1

Model Development and Study Criteria

1.1 MISO South Model Development and Study Criteria

1.1.1 MISO South Region AFSIS Model Development

Models used in Affected System Impact Study (AFSIS) on SPP Study Projects in MISO South were developed from MISO DPP 2020 South Area Phase 3 final models. The MISO DPP 2020 South Area Phase 3 final models are listed below:

- 2025 summer peak model: DPP20-2025SUM-PhaseIII-Study_Final_2.sav
- 2025 summer shoulder model: DPP20-2025SH90-PhaseIII-Study_Final_2.sav

1.1.1.1 MISO South AFSIS Benchmark Cases

The benchmark cases for the MISO South AFSIS study were created as follows:

- Removed recently withdrawn MISO South prior queued generation projects (Table A-1). Power mismatch was balanced by scaling generation in the MISO South (Table A-9).
- Removed recently withdrawn MISO Central prior queued generation projects (Table A-2). Power mismatch was balanced by scaling generation in the MISO North (Table A-8).
- Removed recently withdrawn SPP prior queued generation projects (Table A-3). Power mismatch was balanced by scaling generation in SPP market (Table A-10) based on the load-ratio share of the Transmission Owner (TO) power flow modeling areas.
- Turned off MISO generation projects in DPP 2020 Central area. Power mismatch was balanced by scaling generation in the MISO North (Table A-8).
- Added and dispatched SPP prior queued generation projects (Table A-5) close to MISO South. Power mismatch was balanced by scaling generation in SPP market (Table A-10) based on the load-ratio share of the TO power flow modeling areas.
- Added and dispatched AECI prior queued generation projects (Table A-6). Removed withdrawn AECI project GI-084 (Table A-4). Power mismatch was balanced by scaling generation in AECI (Table A-11).
- Corrected J1488, J1490, and AECI GI-083 HVDC modeling.
- Added Network Upgrades (NUs) required for J1488, J1490, and AECI GI-083 HVDC (Table A-7).
- Added the SPP Study Projects with offline status in DISIS 2018-002 / 2019-001 cycles close to MISO South. The SPP Study Projects in MISO South are listed in Table ES-1.

1.1.1.2 MISO South AFSIS Study Cases

Summer peak (SPK) study case was created by dispatching the Study Projects in MISO South at the specified summer peak level from the benchmark case.

Summer shoulder (SH) study case was created by dispatching the Study Projects in MISO South at the specified summer shoulder level from the benchmark case.

Generation in the SPP market was used for power balance, where SPP generation was scaled based on the load-ratio share of the TO power flow modeling areas.

Both study and benchmark power flow cases were solved with transformer tap adjustment enabled, area interchange disabled, phase shifter adjustment enabled and switched shunt adjustment enabled.

1.1.2 MISO South Region AFSIS Contingency Criteria

The following contingencies were considered in the MISO South AFSIS analysis:

- NERC Category P0 (system intact - no contingencies)
- NERC Category P1 contingencies
  - Single element outages, at buses with a nominal voltage of 60 kV and above.
  - Multiple-element NERC Category P1 contingencies.
  - NERC Category P2, P4, P5, P7 contingencies.

The detailed list of contingency files is in Appendix A.9

For all contingency and post-disturbance analyses, cases were solved with transformer tap adjustment enabled, area interchange adjustment disabled, phase shifter adjustment disabled (fixed) and switched shunt adjustment enabled.

1.1.3 MISO South Region AFSIS Monitored Elements

The MISO South AFSIS study area is defined in Table 1-1. Facilities in the study area were monitored for system intact and contingency conditions. Under NERC category P0 conditions (system intact), branches were monitored for loading above the normal (PSS®E rate A) rating. Under NERC category P1-P7 conditions, branches were monitored for loading as shown in the column labeled "Post-Disturbance Thermal Limits".

Table 1-1: MISO South AFSIS Monitored Elements

Owner / Area	Thermal Limits [1]		Voltage Limits [2]	
	Pre-Disturbance	Post-Disturbance	Pre-Disturbance	Post-Disturbance
EES	100% of Rate A	100% of Rate B	1.05/0.975/0.95	1.05/0.95/0.92/0.90
CLECO	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
SMEPA	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.90
LAFA	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.90
LAGN	100% of Rate A	100% of Rate B	1.05/0.975/0.95	1.05/0.95/0.92
LEPA	100% of Rate A	100% of Rate B	1.05/0.975/0.95	1.05/0.95/0.92

Owner / Area	Thermal Limits [1]		Voltage Limits [2]	
	Pre-Disturbance	Post-Disturbance	Pre-Disturbance	Post-Disturbance
CWLD	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
AMMO	100% of Rate A	100% of Rate B	1.05/0.95	1.075/0.90
AMIL	100% of Rate A	100% of Rate B	1.05/0.95	1.075/0.90
GLH	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.90

Notes

1: PSS®E Rate A, Rate B or Rate C

2: Limits dependent on nominal bus voltage

1.2 MISO West Model Development and Study Criteria

1.2.1 MISO West Region AFSIS Model Development

Models used in AFSIS on SPP Study Projects in MISO West were developed from MISO DPP 2020 West Area Phase 3 final models. The MISO DPP 2020 West Area Phase 3 final models are listed below:

- 2025 summer peak model: DPP20-2025SUM-PhaseIII-Study_Discharging_FINAL_230309.sav
- 2025 summer shoulder model: DPP20-2025SH90-PhaseIII-Study_Discharging_FINAL_230309.sav

1.2.1.1 MISO West AFSIS Benchmark Cases

The benchmark cases for the MISO West AFSIS study were created as follows:

- Removed recently withdrawn MISO West and Central prior queued generation projects (Table B-1). Power mismatch was balanced by scaling generation in the MISO North (Table A-8).
- Removed recently withdrawn SPP prior queued generation projects (Table B-2). Power mismatch was balanced by scaling generation in SPP market (Table A-10) based on the load-ratio share of the TO) power flow modeling areas.
- Turned off MISO generation projects in DPP 2020 Central area. Power mismatch was balanced by scaling generation in the MISO North (Table A-8).
- Added and dispatched SPP prior queued generation projects (Table B-3) close to MISO West. Power mismatch was balanced by scaling generation in SPP market (Table A-10) based on the load-ratio share of the TO power flow modeling areas.
- Added and dispatched AECI prior queued generation projects (Table A-6). Removed withdrawn AECI project GI-084 (Table A-4). Power mismatch was balanced by scaling generation in AECI (Table A-11).
- Added and dispatched MPC prior queued generation projects (Table B-4). Removed duplicated MPC 04000 project. Power mismatch was balanced by scaling generation in the MISO North (Table A-8) except generation in Dakotas.

- Added NUs required for DPP 2019 West Phase 3 study (Table B-5); Added NUs required for SPP West prior queued projects (Table B-6); Added NUs required for MPC Group 2021 projects (Table B-7); Added steady state NUs required for MPC 04300 project (Table B-8).
- Added the SPP Study Projects with offline status in DISIS 2018-002 / 2019-001 cycles close to MISO West. The SPP Study Projects in MISO West are listed in Table ES-2.
- Corrected modeling errors based on reviewing comments (Table B-9).

1.2.1.2 MISO West AFSIS Study Cases

Summer peak (SPK) study case was created by dispatching the Study Projects in MISO West at the specified summer peak level from the benchmark case.

Summer shoulder (SH) study case was created by dispatching the Study Projects in MISO West at the specified summer shoulder level from the benchmark case.

Generation in the SPP market was used for power balance, where SPP generation was scaled based on the load-ratio share of the TO power flow modeling areas.

Both study and benchmark power flow cases were solved with transformer tap adjustment enabled, area interchange disabled, phase shifter adjustment enabled and switched shunt adjustment enabled.

1.2.2 MISO West Region AFSIS Contingency Criteria

The following contingencies were considered in the MISO West AFSIS analysis:

- NERC Category P0 (system intact - no contingencies)
- NERC Category P1 contingencies
  - Single element outages, at buses with a nominal voltage of 60 kV and above.
  - Multiple-element NERC Category P1 contingencies.
  - NERC Category P2, P4, P5, P7 contingencies.

The detailed list of contingency files is in Appendix B.6.

For all contingency and post-disturbance analyses, cases were solved with transformer tap adjustment enabled, area interchange adjustment disabled, phase shifter adjustment disabled (fixed) and switched shunt adjustment enabled.

1.2.3 MISO West Region AFSIS Monitored Elements

The MISO West AFSIS study area is defined in Table 1-2. Facilities in the study area were monitored for system intact and contingency conditions. Under NERC category P0 conditions (system intact), branches were monitored for loading above the normal (PSS®E rate A) rating. Under NERC category P1-P7 conditions, branches were monitored for loading as shown in the column labeled "Post-Disturbance Thermal Limits".

Table 1-2: MISO West AFSIS Monitored Elements

Owner / Area	Thermal Limits [1]		Voltage Limits [2]	
	Pre-Disturbance	Post-Disturbance	Pre-Disturbance	Post-Disturbance
AMIL	100% of Rate A	100% of Rate B	1.05/0.95	1.075/0.90
AMMO	100% of Rate A	100% of Rate B	1.05/0.95	1.075/0.90
ATCLLC	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
BEPC-MISO	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
CMMPA	100% of Rate A	100% of Rate B	1.05/0.95	1.07/0.90
CWLD	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
CWLP	100% of Rate A	100% of Rate B	1.05/0.95	1.075/0.90
DPC	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
EES	100% of Rate A	100% of Rate B	1.05/0.975/0.95	1.05/0.95/0.92/0.90
GLH	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.90
GRE	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.92/0.90
ITCM	100% of Rate A	100% of Rate B	1.07/1.05/0.95	1.10/0.93
MDU	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
MEC	100% of Rate A	100% of Rate B	1.05/0.96/0.95	1.05/0.96/0.95/0.94 /0.93[3]
MMPA	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
MP	100% of Rate A	100% of Rate B	1.05/1.00	1.10/0.95
MPW	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.95
MRES	100% of Rate A	100% of Rate B	1.05/0.97	1.05/0.92
OTP	100% of Rate A	100% of Rate B	1.07/1.05/0.97	1.10/0.92
PPI	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.95
RPU	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.92
SIPC	100% of Rate A	100% of Rate B	1.07/0.95	1.09/0.91
SMMPA	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
WPPI	100% of Rate A	100% of Rate B	1.05/0.95	1.10/0.90
XEL	100% of Rate A	100% of Rate B	1.05/0.95	1.05/0.92

Notes

1: PSS®E Rate A, Rate B or Rate C

2: Limits dependent on nominal bus voltage

3: For facilities in Cedar Falls Utilities or Ames Municipal Utilities, post-contingency voltage limits are 1.05/0.94 for >200 kV, and 1.05/0.93 for others.

1.3 MISO Steady State Performance Criteria

A branch is considered as a thermal injection constraint if the branch is loaded above its applicable normal or emergency rating for the post-change case, and any of the following conditions are met:

1) the generator (NR/ER) has a larger than 20% DF on the overloaded facility under post contingent condition or 5% DF under system intact condition, or
2) the megawatt impact due to the generator is greater than or equal to 20% of the applicable rating (normal or emergency) of the overloaded facility, or
3) the overloaded facility or the overload-causing contingency is at generator's outlet, or
4) for any other constrained facility, where none of the study generators meet one of the above criteria in 1), 2), or 3), however, the cumulative megawatt impact of the group of study generators (NR/ER) is greater than 20% of the applicable rating, then only those study generators whose individual MW impact is greater than 5% of the applicable rating and has DF greater than 5% (OTDF or PTDF) will be responsible for mitigating the cumulative MW impact constraint.

A bus is considered a voltage constraint if both of the following conditions are met. All voltage constraints must be resolved before a project can receive interconnection service.

1) the bus voltage is outside of applicable normal or emergency limits for the post-change case, and
2) the change in bus voltage is greater than 0.01 per unit.

All Study Projects must mitigate thermal injection constraints and voltage constraints in order to obtain unconditional Interconnection Service.

Section

2

MISO South Affected System Study

Steady state thermal and voltage analysis and transient stability analysis were performed in the MISO South AFSIS study.

2.1 MISO South AFSIS Thermal and Voltage Analysis

Nonlinear (AC) contingency analysis was performed on the benchmark and study cases, and the incremental impact of the SPP Study Projects in MISO South were evaluated by comparing the steady-state performance of the transmission system in the benchmark and study cases. Network upgrades were identified to mitigate any steady state thermal and voltage constraints.

Steady-state analysis was performed in summer peak and summer shoulder discharging scenarios. PSS®E version 34.9.3 and PSS®MUST version 12.4.1 were used in the study.

2.1.1 MISO Contingency Analysis for 2025 Summer Peak Condition

Steady state AC contingency analysis was performed on the MISO South AFSIS summer peak (SPK) study and benchmark cases developed in Section 1.1.1. The 2025 summer peak MISO thermal and voltage results are in Appendix C.1.

2.1.1.1 Summer Peak System Intact Conditions

For NERC category P0 (system intact) conditions, no thermal constraints (Table C-1) or voltage constraints (Table C-2) were identified.

2.1.1.2 Summer Peak Post Contingency Conditions

The results in this Section are for analysis of conditions following NERC category P1-P7 contingencies.

For P1 contingencies, no thermal constraints (Table C-3) or voltage constraints (Table C-4) were identified.

For P2-P7 contingencies, no thermal constraints (Table C-5) or voltage constraints (Table C-6) were identified.

2.1.1.3 Summary of Summer Peak Results

In summer peak scenario, no thermal or voltage constraints were identified in the MISO South steady state analysis for the SPP Study Projects.

2.1.2 MISO Contingency Analysis for 2025 Summer Shoulder Condition

Steady state AC contingency analysis was performed on the MISO South AFSIS summer shoulder (SH) study and benchmark cases developed in Section 1.1.1. The 2025 summer shoulder MISO thermal and voltage results are in Appendix C.2.

2.1.2.1 Summer Shoulder System Intact Conditions

For NERC category P0 (system intact) conditions, no thermal constraints (Table C-7) or voltage constraints (Table C-8) were identified.

2.1.2.2 Summer Shoulder Post Contingency Conditions

The results in this Section are for analysis of conditions following NERC category P1-P7 contingencies.

For P1 contingencies, no thermal constraints (Table C-9) or voltage constraints (Table C-10) were identified.

For P2-P7 contingencies, no thermal constraints (Table C-11) or voltage constraints (Table C-12) were identified.

2.1.2.3 Summary of Summer Shoulder Results

In summer shoulder scenario, no thermal or voltage constraints were identified in the MISO South steady state analysis for the SPP Study Projects.

2.1.3 Summary of MISO South AFSIS Steady State Analysis

Based on the MISO South AFSIS steady state analysis, no thermal constraints or voltage constraints were identified in MISO system for the SPP Study Projects in MISO South; No MISO AFSIS thermal or voltage Network Upgrades (NUs) are required for the SPP Study Projects in MISO South.

2.2 MISO South AFSIS Transient Stability Analysis

Stability analysis was performed to evaluate transient stability and impact on the MISO South region of the SPP Study Projects in MISO South.

2.2.1 Procedure

2.2.1.1 Computer Programs

Stability analysis was performed using TSAT revision 22.0.

2.2.1.2 Methodology

Stability package representing 2025 summer peak (SPK) and summer shoulder (SH) scenarios with SPP Study Projects in MISO South was created from MISO DPP 2020 South Area Phase 3 final stability package. Power flow models are the same as steady state power flow models, which were developed in Section 1.1.1. Disturbances were simulated to evaluate the transient stability and impact on the region of the SPP Study Projects in MISO South. MISO transient stability criteria and local TOs' planning criteria specified in MTEP20 were adopted for checking stability violations.

2.2.2 Model Development

Summer peak and summer shoulder stability power flow models are the same as the correspondent steady state models, which were developed as specified in Section 1.1.1.

Transient stability study was performed for the following Study Projects listed in Table 2-1. Based on the generator / inverter / turbine types, corresponding dynamic models were used for representing the dynamic behaviors of these Study Projects. The dynamic models are listed in Table 2-1.

Table 2-1: Dynamic Models for SPP Study Projects in MISO South

SPP Project #	Fuel Type	Generator / Inverter / Turbine Type
GEN-2018-064	Solar	REGCAU1
GEN-2018-071	Battery	REGCA1 (SUNGROW_SG3600UD)
GEN-2018-072	Battery	REGCA1 (SUNGROW_SG3600UD)
GEN-2018-073	Solar	REGCAU1
GEN-2018-079	Solar	REGCA1 (PE)
GEN-2018-082	Wind	REGCA1
GEN-2018-087	Battery	REGCAU1 (PEGEN_HM1007a)
GEN-2018-088	Solar	REGCA1 (PE)
GEN-2018-092	Solar	REGCA1 (PE)
GEN-2018-106	Solar	REGCA1 (PE)
GEN-2018-115	Hybrid (Solar / Storage)	REGCAU1 (SMA)
GEN-2018-117	Solar	REGCA1 (Ingeteam, Sungrow)
GEN-2019-002	Battery	REGCA1 (SMA)
GEN-2019-013	Battery	REGCAU1
GEN-2019-035	Solar	REGCAU1
GEN-2019-052	Solar	REGCA1 (Ingeteam, Sungrow)
GEN-2019-065	Battery	REGCAU
GEN-2019-066	Battery	REGCA1 (Ingeteam)
GEN-2019-067	Battery	REGCA1 (Ingeteam)

2.2.3 Disturbance Criteria

The stability simulations performed as part of this study considered all the regional and local contingencies listed in Table 2-2. Regional contingencies with pre-defined switching sequences were selected from the MISO MTEP20 study; switching sequences for local contingencies were developed based on the generic clearing times shown in Table 2-3. The admittance for local single line-to-ground (SLG) faults were estimated by assuming that the Thevenin impedance of the positive, negative and zero sequence networks at the fault point are equal.

Table 2-2: MISO South AFSIS Regional and Local Disturbance Descriptions

CEII Redacted

Table 2-3: Generic Clearing Time Assumption

Voltage Level (kV)	Primary Clearing Time (cycle)	Backup Clearing Time (cycle)
345 kV	4	11
230 kV	5	13
161/138 kV	6	18
115 kV	6	20
69 kV	8	24

2.2.4 Performance Criteria

MISO transient stability criteria and local TOs' planning criteria specified in MTEP20 were adopted. The Study Projects must mitigate the stability constraints to obtain any type of Interconnection Service.

2.2.5 Summer Peak Stability Results

The contingencies listed in Table 2-2 were simulated using the summer peak stability model.

Appendix D.1.2 contains plots of generator rotor angles, generator power output, and bus voltages for each simulation. Simulations were performed with a 0.5 seconds steady-state run followed by the appropriate disturbance. Simulations were run for a 10-second duration.

MISO South AFSIS summer peak stability study results summary is in Appendix D.1.1, Table D-1.

The following stability related issues were identified in the summer peak stability study.

2.2.5.1 Generation Tripping Due to Instability

Under two NERC Category P6 contingencies (Table 2-4), several local generators were tripped due to instability. These local generators have more than 1200 MW power flowing through one or two transformers after the fault. The same local generators were also tripped due to instability under the same contingencies in the benchmark model. Therefore, the SPP Study Projects in MISO South are not responsible for the local generation tripping.

Table 2-4: Local Generation Tripping Due to Instability

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2.2.6 Stability Network Upgrades Identified in Summer Peak

There are no stability Network Upgrades identified in summer peak stability study.

2.2.7 Summer Shoulder Stability Results

The contingencies listed in Table 2-2 were simulated using the summer shoulder stability model.

Appendix D.2.2 contains plots of generator rotor angles, generator power output, and bus voltages for each simulation. Simulations were performed with a 0.5 seconds steady-state run followed by the appropriate disturbance. Simulations were run for a 10-second duration.

MISO South AFSIS summer shoulder stability study results summary is in Appendix D.2.1, Table D-2.

The following stability related issues were identified in the summer shoulder stability study.

2.2.7.1 Generation Tripping Due to Low Voltages / Instability

Under four NERC Category P6 contingencies (Table 2-5), several local generators were tripped due to instability and/or low voltages. These local generators have more than 1200 MW power flowing through one or two transformers after the fault. The same local generators were also tripped due to instability and/or low voltages under the same contingencies in the benchmark model. Therefore, the SPP Study Projects in MISO South are not responsible for the local generation tripping.

Table 2-5: Local Generation Tripping Due to Instability / Low Voltages

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2.2.8 Stability Network Upgrades Identified in Summer Shoulder

There are no stability Network Upgrades identified in summer shoulder stability study.

2.2.9 Summary of MISO South AFSIS Transient Stability Analysis

Based on the MISO South 2025 summer peak and summer shoulder transient stability analysis, no MISO South AFSIS stability NUs are required for the SPP Study Projects in MISO South.

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Section

3

MISO West Affected System Study

Steady state thermal and voltage analysis and transient stability analysis were performed in the MISO West AFSIS study.

3.1 MISO West AFSIS Thermal and Voltage Analysis

Nonlinear (AC) contingency analysis was performed on the benchmark and study cases, and the incremental impact of the SPP Study Projects in MISO West were evaluated by comparing the steady-state performance of the transmission system in the benchmark and study cases. Network upgrades were identified to mitigate any steady state thermal and voltage constraints.

Steady-state analysis was performed in summer peak and summer shoulder discharging scenarios. PSS®E version 34.9.3 and PSS®MUST version 12.4.1 were used in the study.

3.1.1 MISO Contingency Analysis for 2025 Summer Peak Condition

Steady state AC contingency analysis was performed on the MISO West AFSIS summer peak (SPK) study and benchmark cases developed in Section 1.2.1. The 2025 summer peak MISO thermal and voltage results are in Appendix E.1.

3.1.1.1 Summer Peak System Intact Conditions

For NERC category P0 (system intact) conditions, no thermal constraints (Table E-1) or voltage constraints (Table E-2) were identified.

3.1.1.2 Summer Peak Post Contingency Conditions

The results in this Section are for analysis of conditions following NERC category P1-P7 contingencies. All NERC Category P1 contingencies were converged.

For P1 contingencies, no thermal constraints (Table E-3) or voltage constraints (Table E-4) were identified.

One category P2-P7 contingency (Table E-7) was not converged in both the benchmark and study cases. No mitigation plan is required for the SPP Study Projects for this non-converged contingency.

For the non-converged contingencies in Table E-7, DC contingency analysis was performed to get the dc thermal results. The dc thermal results for non-converged contingencies are listed in Table E-8.

For P2-P7 contingencies, no thermal constraints (Table E-5) or voltage constraints (Table E-6) were identified.

3.1.1.3 Summary of Summer Peak Results

In summer peak scenario, no thermal or voltage constraints were identified in the MISO West steady state analysis for the SPP Study Projects.

3.1.2 MISO Contingency Analysis for 2025 Summer Shoulder Condition

Steady state AC contingency analysis was performed on the MISO West AFSIS summer shoulder (SH) study and benchmark cases developed in Section 1.2.1. The 2025 summer shoulder MISO thermal and voltage results are in Appendix E.2.

3.1.2.1 Summer Shoulder System Intact Conditions

For NERC category P0 (system intact) conditions, no thermal constraints (Table E-9) or voltage constraints (Table E-10) were identified.

3.1.2.2 Summer Shoulder Post Contingency Conditions

The results in this Section are for analysis of conditions following NERC category P1-P7 contingencies. All NERC Category P1 contingencies were converged.

For P1 contingencies, thermal constraints are listed in Table E-11, and voltage constraints are listed in Table E-12.

Two category P2-P7 contingencies (Table E-15) were not converged in both the benchmark and study cases. No mitigation plan is required for the SPP Study Projects for this non-converged contingency.

For the non-converged contingencies in Table E-15, DC contingency analysis was performed to get the dc thermal results. The dc thermal results for non-converged contingencies are listed in Table E-16.

For P2-P7 contingencies, thermal constraints are listed in Table E-13, and voltage constraints are listed in Table E-14.

3.1.2.3 Summer Shoulder Worst Constraints

In the 2025 summer shoulder scenario, MISO West AFSIS worst thermal constraints are listed in Table 3-1, and MISO West AFSIS worst voltage constraints are listed in Table 3-2.

Table 3-1: 2025 Summer Shoulder MISO West AFSIS Thermal Constraints, Maximum Screened Loading

Generator	Constraint	Rating	Owner	Worst Loading		Contingency	Cont Type
				(MVA)	(%)		
GEN-2018-083	Raun - G18-043 Tap 345 kV	956.0	MEC OPPD	1049.4	109.8	CEII Redacted	P1
GEN-2018-090	Raun - G17-105 Tap 161 kV	217.0	MEC OPPD	250.5	115.5	CEII Redacted	P1
GEN-2018-090	Grimes - Beaver Creek 345 kV	1222.0	MEC	1257.2	102.9	CEII Redacted	P1
GEN-2018-067	Merricourt - Wishek 230 kV	343.0	MDU	472.6	137.8	CEII Redacted	P2-P7

Table 3-2: 2025 Summer Shoulder MISO West AFSIS Voltage Constraints, Worst Voltage Violations

Bus			Owner	Vlow	Vhi	Benchmark	StudyCase	Delta (> 0.01 p.u.)	Contingency Details	Cont Type
						VCONT	VCONT			
601053	HAZEL CK4	230	XEL	0.92	1.05	0.9098	0.8664	-0.0434	CEII Redacted	P2-P7
602008	MINVALT4	230	XEL	0.92	1.05	0.9070	0.8628	-0.0442	CEII Redacted	P2-P7
602009	MNVLTAP4	230	XEL	0.92	1.05	0.9069	0.8628	-0.0441	CEII Redacted	P2-P7

Bus			Owner	Vlow	Vhi	Benchmark VCONT	StudyCase VCONT	Delta (> 0.01 p.u.)	Contingency Details	Cont Type
602036	PAYNES 4	230	XEL	0.92	1.05	0.9280	0.8899	-0.0381	CEII Redacted	P2-P7
603030	MINVALY7	115	XEL	0.92	1.05	0.9253	0.8810	-0.0443	CEII Redacted	P2-P7
603177	MAYNARD7	115	XEL	0.92	1.05	0.9338	0.8823	-0.0515	CEII Redacted	P2-P7
603257	MINVALY CAP7	115	XEL	0.92	1.05	0.9255	0.8812	-0.0443	CEII Redacted	P2-P7
603267	KERKHOVENTP7	115	XEL	0.92	1.05	0.9324	0.8800	-0.0524	CEII Redacted	P2-P7
615365	GRE-BENSON 7	115	GRE	0.92	1.10	0.9327	0.8869	-0.0458	CEII Redacted	P2-P7
615529	GRE-PANTHER4	230	GRE	0.90	1.10	0.9057	0.8673	-0.0384	CEII Redacted	P2-P7
616001	GRE-WALDEN 7	115	GRE	0.90	1.10	0.9331	0.8900	-0.0431	CEII Redacted	P2-P7

Bus			Owner	Vlow	Vhi	Benchmark	StudyCase	Delta (> 0.01 p.u.)	Contingency Details	Cont Type
						VCONT	VCONT			
616005	GRE-KERKHO 7	115	GRE	0.90	1.10	0.9326	0.8822	-0.0504	CEII Redacted	P2-P7
616006	GRE-HANCOCK7	115	GRE	0.92	1.10	0.9321	0.8882	-0.0439	CEII Redacted	P2-P7
616007	GRE-SWNDATP7	115	GRE	0.90	1.10	0.9328	0.8853	-0.0475	CEII Redacted	P2-P7
616008	GRE-SWENODA7	115	GRE	0.92	1.10	0.9328	0.8853	-0.0475	CEII Redacted	P2-P7
616009	GRE-DUBLIN 7	115	GRE	0.90	1.10	0.9327	0.8834	-0.0493	CEII Redacted	P2-P7
620175	JAMESTN W7	115	OTP	0.92	1.10	0.9616	0.9087	-0.0529	CEII Redacted	P1
620218	MORRIS T 7	115	OTP	0.92	1.10	0.9358	0.8941	-0.0417	CEII Redacted	P2-P7
620269	JAMSTWN7	115	OTP	0.92	1.10	0.9711	0.9182	-0.0529	CEII Redacted	P1
620270	SPIRITWD 7	115	OTP	0.92	1.10	0.9643	0.9114	-0.0529	CEII Redacted	P1
620271	AVIKO 7	115	OTP	0.92	1.10	0.9619	0.9091	-0.0528	CEII Redacted	P1

Bus			Owner	Vlow	Vhi	Benchmark	StudyCase	Delta (> 0.01 p.u.)	Contingency Details	Cont Type
						VCONT	VCONT			
620272	JAMESPK7	115	OTP	0.92	1.10	0.9619	0.9091	-0.0528	CEII Redacted	P1
620273	JAMETAP7	115	OTP	0.92	1.10	0.9624	0.9096	-0.0528	CEII Redacted	P1
620274	JAMSDTN7	115	OTP	0.92	1.10	0.9621	0.9093	-0.0528	CEII Redacted	P1
620275	NJAMES 7	115	OTP	0.92	1.10	0.9636	0.9107	-0.0529	CEII Redacted	P1
620369	JAMESTN3	345	OTP	0.92	1.10	0.9564	0.8962	-0.0602	CEII Redacted	P1
657748	CENTER2G	20	MPC	0.97	1.02	0.9975	0.9728	-0.0247	CEII Redacted	P1
658258	WMU-PRIAM 7	115	MRES	0.92	1.05	0.9310	0.8764	-0.0546	CEII Redacted	P2-P7
658259	WMU-WILLMAR4	230	MRES	0.92	1.05	0.9136	0.8729	-0.0407	CEII Redacted	P2-P7

3.1.2.4 Summary of Summer Shoulder Results

In the summer shoulder scenario, Table 3-3 lists MISO West AFSIS thermal constraints and Network Upgrades, and Table 3-4 lists MISO West AFSIS voltage constraints and Network Upgrades.

Table 3-3: MISO West AFSIS Thermal Constraints and Network Upgrades in Summer Shoulder Scenario

Constraint	Owner	Mitigation	Cost ($)
Raun - G18-043 Tap 345 kV	MEC OPPD	MEC: No mitigation required. Existing MEC Only rating is 1195/1333 MVA. $0 OPPD: Mitigation, if required, will be identified in SPP system impact study.	$0
Raun - G17-105 Tap 161 kV	MEC OPPD	MEC: Rebuild transmission line to increase line rating. New MEC rating projected to be 335 MVA. $2.25M OPPD: Mitigation, if required, will be identified in SPP system impact study.	$2,250,000
Grimes - Beaver Creek 345 kV	MEC	Replace transmission line structures to increase line rating. New rating projected to be 1286 MVA.	$500,000
Merricourt - Wishek 230 kV	MDU	As part of J1040 GI in DPP 2018, they are required to upgrade this line to 478[511] SN[SE] and 478[526] WN[WE].	$0

Table 3-4: MISO West AFSIS Voltage Constraints and Network Upgrades in Summer Shoulder Scenario

Constraint	Network Upgrades	Owner	Cost ($)
Low voltages under single contingency "MPC04300-Prairie 345 kV"	Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000
Low voltages under contingency "P23:345:XEL:8N64 LYC"	MTEP Appendix A project. Brookings-Lyon Co second circuit (2025 ISD)	Xcel	$0

3.1.3 Summary of MISO West AFSIS Steady State Analysis

MISO West steady state analyses were performed on the MISO 2025 summer peak and summer shoulder scenarios. The steady state thermal constraints and required Network Upgrades are listed in Table 3-5, and voltage constraints and required Network Upgrades are listed in Table 3-6.

Table 3-5: Combined Thermal Constraints and Network Upgrades

Constraint	Owner	Mitigation	Cost ($)
Raun - G18-043 Tap 345 kV	MEC OPPD	MEC: No mitigation required. Existing MEC Only rating is 1195/1333 MVA. $0 OPPD: Mitigation, if required, will be identified in SPP system impact study.	$0
Raun - G17-105 Tap 161 kV	MEC OPPD	MEC: Rebuild transmission line to increase line rating. New MEC rating projected to be 335 MVA. $2.25M OPPD: Mitigation, if required, will be identified in SPP system impact study.	$2,250,000
Grimes - Beaver Creek 345 kV	MEC	Replace transmission line structures to increase line rating. New rating projected to be 1286 MVA.	$500,000
Merricourt - Wishek 230 kV	MDU	As part of J1040 GI in DPP 2018, they are required to upgrade this line to 478[511] SN[SE] and 478[526] WN[WE].	$0

Table 3-6: Combined Voltage Constraints and Network Upgrades

Constraint	Network Upgrades	Owner	Cost ($)
Low voltages under single contingency "MPC04300-Prairie 345 kV"	Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000
Low voltages under contingency "P23:345:XEL:8N64 LYC"	MTEP Appendix A project. Brookings-Lyon Co second circuit (2025 ISD)	Xcel	$0

3.2 MISO West AFSIS Transient Stability Analysis

Stability analysis was performed to evaluate transient stability and impact on the MISO West region of the SPP Study Projects in MISO West.

3.2.1 Procedure

3.2.1.1 Computer Programs

Stability analysis was performed using TSAT revision 22.0.

3.2.1.2 Methodology

Stability package representing 2025 summer peak (SPK) and summer shoulder (SH) scenarios with SPP Study Projects in MISO West was created from MISO DPP 2020 West Area Phase 3 final stability package. Power flow models are the same as steady state power flow models, which were developed in Section 1.2.1. Disturbances were simulated to evaluate the transient stability and impact on the region of the SPP Study Projects in MISO West. MISO transient stability criteria and local TOs' planning criteria specified in MTEP20 were adopted for checking stability violations.

3.2.2 Model Development

Summer peak and summer shoulder stability power flow models are the same as the correspondent steady state models, which were developed as specified in Section 1.2.1.

Transient stability study was performed for the following Study Projects listed in Table 3-7. Based on the generator / inverter / turbine types, corresponding dynamic models were used for representing the dynamic behaviors of these Study Projects. The dynamic models are listed in Table 3-7.

Table 3-7: Dynamic Models for SPP Study Projects in MISO West

SPP Project #	Fuel Type	Generator / Inverter / Turbine Type
GEN-2018-063	Solar	REGCAU1 (SMA SC138)
GEN-2018-065	Wind	REGCA1
GEN-2018-067	Wind	REGCA1
GEN-2018-068	Wind	GEWTGCU1 (GE 2.52-127)
GEN-2018-069	Wind	REGCA1 (GE2.82-127)
GEN-2018-070	Wind	REGCAU1 (3.83 MW GE WTG)
GEN-2018-074	Wind	REGCA1 (GE 2.3 MW)
GEN-2018-083	Wind	REGCA1
GEN-2018-090	Battery	REGCAU1 (PE BESS)
GEN-2018-121	Battery	REGCAU1 (PE BESS)
GEN-2018-125	Wind	REGCA1
GEN-2018-131	Solar	REGCAU1 (TMEIC PVU-L0840GR 3.6MW)
GEN-2018-132	Solar	REGCAU1 (TMEIC PVU-L0840GR 3.6MW)
GEN-2019-009	Solar	REGCAU1 (PE HEMK)
GEN-2019-016	Solar	REGCAU1 (SMASC172)
GEN-2019-019	Thermal (CT)	GENROU
GEN-2019-023	Hybrid (Wind / Storage)	GEWTGCU1 (GE 2.5-127), REGCAU1 (PE FP3510M)
GEN-2019-029	Wind	GEWTGCU1
GEN-2019-033	Solar	REGCAU1 (TMEIC PVU-L0840GR 3.71MW)
GEN-2019-037	Solar	REGCAU1 (SMA SC)
GEN-2019-039	Solar	REGCAU1 (PE 3.714MW)

SPP Project #	Fuel Type	Generator / Inverter / Turbine Type
GEN-2019-041	Solar	REGCAU1 (PE 3.714MW)
GEN-2019-048	Battery	REGCAU1 (PEGEN_HM1007a)
GEN-2019-069	Solar	REGCA1 (PE)
GEN-2019-070	Solar	REGCA1 (PE)
GEN-2019-073	Solar	REGCA1 (PE)

3.2.3 Disturbance Criteria

The stability simulations performed as part of this study considered all the regional and local contingencies listed in Table 3-8. Regional contingencies with pre-defined switching sequences were selected from the MISO MTEP20 study; switching sequences for local contingencies were developed based on the generic clearing times shown in Table 2-3. The admittance for local single line-to-ground (SLG) faults were estimated by assuming that the Thevenin impedance of the positive, negative and zero sequence networks at the fault point are equal.

Table 3-8: MISO West AFSIS Regional and Local Disturbance Descriptions

CEII Redacted

3.2.4 Performance Criteria

MISO transient stability criteria and local TOs' planning criteria specified in MTEP20 were adopted. The Study Projects must mitigate the stability constraints to obtain any type of Interconnection Service.

3.2.5 Summer Peak Stability Results

The contingencies listed in Table 3-8 were simulated using the summer peak stability model.

Appendix F.1.2 contains plots of generator rotor angles, generator power output, and bus voltages for each simulation. Simulations were performed with a 0.5 seconds steady-state run followed by the appropriate disturbance. Simulations were run for a 10-second duration.

MISO West AFSIS summer peak stability study results summary is in Appendix F.1.1, Table F-1.

The following stability related issues were identified in the summer peak stability study.

3.2.5.1 Post-Fault Small Oscillation of Generation Output

Under several contingencies listed in Table 3-9, small oscillations were observed on active and reactive power output of several conventional generators (Antelope Valley, Coal Creek unit 2, Young 1) after faults were cleared. The same power output oscillations were also observed in the benchmark case. The oscillation issues were not caused by the SPP Study Projects in MISO West.

Table 3-9: Post-Fault Small Oscillation of Generation Output

CEII Redacted

3.2.5.2 Transient Low Voltage Recovery

Under two contingencies listed in Table 3-10, voltages at Firth 115 kV (640171) and Sterling 115 kV (640362) were around 0.82 p.u. after the faults were cleared. The two 115 kV buses were back fed by 69 kV system via a 3-winding transformer. Same low voltage recovery issues were also observed in the benchmark case. The low voltage recovery issues were not caused by the SPP Study Projects in MISO West.

Table 3-10: Transient Low Voltage Recovery

CEII Redacted

3.2.5.3 Transient High Voltage Violation at Luverne 230 kV Bus in OTP

Under several contingencies, transient voltage at Luverne 230 kV bus (bus # 620217) is more than 1.2 p.u. for no more than 0.071 sec. This transient high voltage violation can be mitigated by updating scheduled voltage for Ash WTGs (657964, 657985, 657737, 615124) and substation transformer tap position. Network Upgrades are not required.

3.2.6 Stability Network Upgrades Identified in Summer Peak

There are no stability Network Upgrades identified in summer peak stability study.

3.2.7 Summer Shoulder Stability Analysis

The contingencies listed in Table 3-8 were simulated using the summer shoulder stability model. Since MPC 04300 generation project is prior queued project, and voltage collapse was observed in the MPC stability study when contingency of “MPC 04300 – Prairie 345 kV line” occurred, MISO proposed to build a 2nd MPC 04300 – Prairie 345 kV line to resolve the voltage collapse issue caused by the prior queued MPC 04300 project. Therefore, the 2nd MPC 04300 – Prairie 345 kV line was added to the summer shoulder stability model for this MISO West AFSIS stability study.

3.2.7.1 Voltage Collapse and Mitigations

With the 2nd MPC 04300 – Prairie 345 kV line added to the summer shoulder benchmark and study cases, voltage collapses were only observed in the study case under five disturbances listed in Table 3-11. The identified voltage collapses can be mitigated by adding three STATCOMs at Winger 230 kV, Wahpeton 230 kV, and Audubon 230 kV buses (Table 3-12).

Table 3-11: Identified Voltage Collapse and Required Mitigations

CEII Redacted

Table 3-12: Three STATCOMs to Mitigate Voltage Collapses in the Study Case

Network Upgrade	Cost ($)
Increase STATCOM size from 50 Mvar to 200 Mvat at Winger 230 kV (657758), $20M. Currently allocated to MPC-2021-1 group	$0
Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329)	$20,000,000
Add a 200 Mvar STATCOM at Audubon 230 kV (620336)	$20,000,000

3.2.7.2 Summer Shoulder Stability Results

The following stability analysis was performed on the updated summer shoulder stability model with additions of 2nd MPC 04300 – Prairie 345 kV line and three STATCOMs (Table 3-12).

Appendix F.2.2 contains plots of generator rotor angles, generator power output, and bus voltages for each simulation. Simulations were performed with a 0.5 seconds steady-state run followed by the appropriate disturbance. Simulations were run for a 10-second duration.

MISO West AFSIS summer shoulder stability study results summary is in Appendix F.2.1, Table F-2.

The following stability related issues were identified in the summer shoulder stability study.

1. MPC 04300 Tripping and Early Termination Due to Low Terminal Voltage

Under two contingencies (Table 3-13), MPC 04300 projects was either tripped by low voltage relays due to low terminal voltage, or the stability simulation was early terminated due to low voltages of MPC 04300. This issue was caused by MPC 04300 generation project, and SPP Study Projects in MISO West are not responsible for this issue.

Table 3-13: MPC 04300 Tripping and Early Termination

CEII Redacted

2. Post-Fault Small Oscillation of Generation Output

Under several contingencies listed in Table 3-14, small oscillations were observed on active and reactive power output of several conventional generators (Antelope Valley, Coal Creek unit 2, Young 1) after faults were cleared. The same power output oscillations were also observed in the benchmark case. The oscillation issues were not caused by the SPP Study Projects in MISO West.

Table 3-14: Post-Fault Small Oscillation of Generation Output

CEII Redacted

3. Transient Low Voltage Recovery

Under two contingencies listed in Table 3-15, voltages at Firth 115 kV (640171) and Sterling 115 kV (640362) were around 0.86 p.u. after the faults were cleared. The two 115 kV buses were back fed by 69 kV system via a 3-winding transformer. Same low voltage recovery issues were also observed in the benchmark case. The low voltage recovery issues were not caused by the SPP Study Projects in MISO West.

Table 3-15: Transient Low Voltage Recovery

CEII Redacted

4. GEN-2018-067 Active Power Reduction and Low Terminal Voltage

Under two local contingencies at GEN-2018-067 POI (Table 3-16), GEN-2018-067 active power output was reduced and its terminal voltage was around 0.81 p.u. after the fault was cleared. Nearby 115 kV buses also had post-fault low voltages. It is not clear why GEN-2018-067 wind farm had this dynamic performance. The GEN-2018-067 generation project is responsible for fixing this issue.

Table 3-16: GEN-2018-067 Active Power Reduction and Low Terminal Voltage

CEII Redacted

5. Transient High Voltage Violations in OTP, GRE, MRES

Under many contingencies, transient high voltage violations (>1.2 p.u. for more than 0.012 sec) were observed in OTP, GRE, and MRES buses. These transient high voltage violations should be mitigated once the added STACOMs at Winger, Wahpeton, and Audubon (Table 3-12) are designed in detail. Network Upgrade is not required for the SPP Study Projects in MISO West.

3.2.8 Stability Network Upgrades Identified in Summer Shoulder

In summary, three STATCOMs at Winger, Wahpeton, and Audubon (Table 3-12) are required to mitigate the voltage collapses only identified in the study case. The GEN-2018-067 issue of active power output reduction and low terminal voltage is unrelated to MISO Affected System.

3.2.9 Summary of MISO West AFSIS Transient Stability Analysis

Based on the MISO West 2025 summer peak and summer shoulder transient stability analysis, additional MISO AFSIS stability Network Upgrades are listed in Table 3-17.

Table 3-17: Additional MISO AFSIS Stability Network Upgrades

Network Upgrade	Cost ($)
Increase STATCOM size from 50 Mvar to 200 Mvat at Winger 230 kV (657758), $20M. Currently allocated to MPC-2021-1 group	$0
Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329)	$20,000,000
Add a 200 Mvar STATCOM at Audubon 230 kV (620336)	$20,000,000

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Section
4

Contingent Facilities

4.1 Contingent Facilities in MISO South

No contingent MTEP facilities were identified for the SPP Study Projects in MISO South.

4.2 Contingent Facilities in MISO West

Table 4-1 describes transmission assumptions modeled in the studies that were deemed necessary to allow for the Interconnection Service of study unit. If the transmission assumptions are not completed or significantly modified, the Interconnection Service of study unit may be restricted until a re-study is performed to determine the applicable service level that results. If any of the higher queued and/or same group study generators in MISO and/or SPP are to drop out, the Interconnection Customer may be subject to restudy. If there are no modifications to the table, the study projects will be included in MISO's Annual studies to determine available injection until assumptions reach their expected In-Service Date.

Table 4-1: Contingent Facility and Conditional Projects in MISO West

MTEP ID	MTEP Cycle	Project Name	Project Description	Expected ISD	Conditional Projects
23452	MTEP22	Brookings - Lyon, Hampton - Helena 2nd 345kV Circuits	Install second 345 kV circuit between the Brookings County and Lyon County substations. Install second 345 kV circuit between the Hampton Corner and Helena substations. Perform substation upgrades associated with installation of line.	9/1/2025	GEN-2018-065, GEN-2018-067, GEN-2018-068, GEN-2018-069, GEN-2018-070, GEN-2018-074, GEN-2018-083, GEN-2018-090, GEN-2018-121, GEN-2018-125, GEN-2019-023, GEN-2019-029, GEN-2019-048
TBD	TBD	200 MVAR STATCOM at Winger 230 Station	The Network Upgrade was currently assigned to MPC-2021-1 group, conditional to the listed SPP projects	TBD	GEN-2018-065, GEN-2018-067, GEN-2018-068, GEN-2018-069, GEN-2018-070, GEN-2018-074, GEN-2018-083, GEN-2018-090, GEN-2018-121, GEN-2018-125, GEN-2019-023, GEN-2019-029, GEN-2019-048

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Section 5

Network Upgrades and Cost Allocation

5.1 Cost Assumptions for Network Upgrades

The cost estimate for each network upgrade was provided by the corresponding transmission owning company.

5.2 Cost Allocation Methodology

Costs of AFSIS Network Upgrades are allocated based on MISO Network Upgrade cost allocation methodology, which is detailed in the MISO Generation Interconnection Business Practices Manual BPM-015.

5.3 AFSIS Network Upgrades Required for the SPP DISIS 2018-002 and 2019-001 Phase 2 Study Projects

5.3.1 AFSIS Network Upgrades Required for the SPP Study Projects in MISO South

5.3.1.1 MISO South AFSIS Network Upgrades

Based on the MISO South 2025 summer peak and summer shoulder steady state analysis, no thermal constraints or voltage constraints were identified in MISO system for the SPP Study Projects in MISO South; No MISO South AFSIS thermal or voltage NUs are required for the SPP Study Projects in MISO South.

Based on the MISO South 2025 summer peak and summer shoulder transient stability analysis, no transient stability constraints were identified for the SPP Study Projects in MISO South; No MISO South AFSIS stability NUs are required for the SPP Study Projects in MISO South.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the SPP Study Projects in MISO South. Based on the screening results, MISO Transmission Owners do not plan to conduct additional studies.

No contingent MTEP facilities were identified for the SPP Study Projects in MISO South.

In conclusion, SPP Study Projects in MISO South are not responsible for any MISO AFSIS NUs.

5.3.1.2 MISO South AFSIS NU Cost Allocation

A summary of the costs for total MISO AFSIS NUs allocated to the SPP Study Projects in MISO South is listed in Table 5-1.

Table 5-1: Summary of MISO South AFSIS NU Costs Allocated to the SPP South Study Projects

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2018-064	$0	$0	$0	$0
GEN-2018-071	$0	$0	$0	$0
GEN-2018-072	$0	$0	$0	$0
GEN-2018-073	$0	$0	$0	$0
GEN-2018-079	$0	$0	$0	$0
GEN-2018-082	$0	$0	$0	$0
GEN-2018-087	$0	$0	$0	$0
GEN-2018-088	$0	$0	$0	$0
GEN-2018-092	$0	$0	$0	$0
GEN-2018-106	$0	$0	$0	$0
GEN-2018-115	$0	$0	$0	$0
GEN-2018-117	$0	$0	$0	$0
GEN-2019-002	$0	$0	$0	$0
GEN-2019-013	$0	$0	$0	$0
GEN-2019-035	$0	$0	$0	$0
GEN-2019-052	$0	$0	$0	$0
GEN-2019-065	$0	$0	$0	$0
GEN-2019-066	$0	$0	$0	$0
GEN-2019-067	$0	$0	$0	$0
Total ($)	**$0**	**$0**	**$0**	**$0**

5.3.2 AFSIS Network Upgrades Required for the SPP Study Projects in MISO West

5.3.2.1 MISO West AFSIS Network Upgrades

Based on the MISO West 2025 summer peak and summer shoulder steady state analysis, thermal constraints and voltage constraints were identified in MISO system for the SPP Study Projects in MISO West; MISO West AFSIS thermal and voltage NUs are required for the SPP Study Projects in MISO West.

Based on the MISO West 2025 summer peak and summer shoulder transient stability analysis, voltage collapses were identified in the summer shoulder study case. No other transient stability violations are related to MISO Affected System. MISO West AFSIS stability

NUs are required for the SPP Study Projects in MISO West to mitigate the voltage collapses only identified in the study case.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the SPP Study Projects in MISO West. Based on the screening results, MISO Transmission Owners do not plan to conduct additional studies.

Contingent facilities were identified. The study projects will be included in MISO's Annual studies to determine available injection until assumptions reach their expected In-Service Date. Details are in Section 4.2.

The total costs of MISO West AFSIS Network Upgrades for SPP Study Projects in MISO West are summarized in Table 5-2.

Table 5-2: Summary of MISO West AFSIS Network Upgrades

Category of Network Upgrades	Cost ($)
Thermal Network Upgrades Identified in MISO Steady-State Analysis	$2,750,000
Voltage Network Upgrades Identified in MISO Steady-State Analysis	$3,500,000
Network Upgrades Identified in Stability Analysis	$40,000,000
Network Upgrades Identified in Short Circuit Analysis	$0
Total	**$46,250,000**

MISO West AFSIS Network Upgrades for SPP Study Projects in MISO West are listed below:

Table 5-3: MISO Thermal NUs and Cost

Constraint	Owner	Mitigation	Cost ($)
Raun - G18-043 Tap 345 kV	MEC OPPD	MEC: No mitigation required. Existing MEC Only rating is 1195/1333 MVA. $0 OPPD: Mitigation, if required, will be identified in SPP system impact study.	$0
Raun - G17-105 Tap 161 kV	MEC OPPD	MEC: Rebuild transmission line to increase line rating. New MEC rating projected to be 335 MVA. $2.25M OPPD: Mitigation, if required, will be identified in SPP system impact study.	$2,250,000
Grimes - Beaver Creek 345 kV	MEC	Replace transmission line structures to increase line rating. New rating projected to be 1286 MVA.	$500,000
Merricourt - Wishek 230 kV	MDU	As part of J1040 GI in DPP 2018, they are required to upgrade this line to 478[511] SN[SE] and 478[526] WN[WE].	$0

Table 5-4: MISO Steady-State Voltage NUs and Cost

Constraint	Network Upgrades	Owner	Cost ($)
Low voltages under single contingency "MPC04300-Prairie 345 kV"	Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000
Low voltages under contingency "P23:345:XEL:8N64 LYC"	MTEP Appendix A project. Brookings-Lyon Co second circuit (2025 ISD)	Xcel	$0

Table 5-5: MISO Transient Stability Voltage NUs and Cost

Constraint	Network Upgrades	Owner	Cost ($)
Voltage collapses under several stability faults	1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000

5.3.2.2 MISO West AFSIS NU Cost Allocation

The calculated Distribution Factor (DF) results, voltage impact, and MW contribution on each MISO West Affected System constraint are in Appendix G.1. The cost allocation for each NU is calculated based on the contribution of each generating facility, as detailed in Appendix G.2.

Assuming all generation projects in the SPP Study Projects in MISO West advance, a summary of the costs for total MISO West AFSIS NUs allocated to each generation project is listed in Table 5-6.

Table 5-6: Summary of MISO West AFSIS NU Costs Allocated to the SPP West Study Projects

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2018-063	$0	$0	$0	$0
GEN-2018-065	$21,416	$300,752	$0	$322,168
GEN-2018-067	$1,058,566	$9,864,662	$0	$10,923,228
GEN-2018-068	$302,885	$4,390,977	$0	$4,693,862
GEN-2018-069	$590,472	$5,714,286	$0	$6,304,758
GEN-2018-070	$21,416	$360,902	$0	$382,318
GEN-2018-074	$52,010	$842,105	$0	$894,116
GEN-2018-083	$214,161	$3,368,421	$0	$3,582,582
GEN-2018-090	$2,829,545	$1,263,158	$0	$4,092,703
GEN-2018-121	$18,357	$240,602	$0	$258,958
GEN-2018-125	$208,042	$3,127,820	$0	$3,335,862

Project Num	Network Upgrades ($)			Total Network Upgrade Cost ($)
	MISO Thermal & Voltage	Transient Stability	Short Circuit	
GEN-2018-131	$0	$0	$0	$0
GEN-2018-132	$0	$0	$0	$0
GEN-2019-009	$0	$0	$0	$0
GEN-2019-016	$0	$0	$0	$0
GEN-2019-019	$0	$0	$0	$0
GEN-2019-023	$529,283	$5,172,932	$0	$5,702,216
GEN-2019-029	$385,490	$5,112,782	$0	$5,498,271
GEN-2019-033	$0	$0	$0	$0
GEN-2019-037	$0	$0	$0	$0
GEN-2019-039	$0	$0	$0	$0
GEN-2019-041	$0	$0	$0	$0
GEN-2019-048	$18,357	$240,602	$0	$258,958
GEN-2019-069	$0	$0	$0	$0
GEN-2019-070	$0	$0	$0	$0
GEN-2019-073	$0	$0	$0	$0
Total ($)	**$6,250,000**	**$40,000,000**	**$0**	**$46,250,000**

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Appendix

A

MISO South AFSIS Model Development for Steady-State Analysis

A.1 Recently Withdrawn Prior Queued Projects

Table A-1: Recently Withdrawn MISO South Prior Queued Project

Prj #	Bus Number	Bus Name	Id	Status
J1441	44410	J1441 GEN 0.6300	1	Withdrawn
J1455	44550	J1455 GEN 0.6300	1	Withdrawn
J1723	47230	J1723 GEN 0.6900	1	Withdrawn
J1790	47900	J1790 GEN 0.6000	1	Withdrawn

Table A-2: Recently Withdrawn MISO Central Prior Queued Project

Prj #	Bus Number	Bus Name	Id	Status
J1152	41520	J1152 GEN 0.5500	1	Withdrawn
J1197	41970	J1197 GEN 0.6600	1	Withdrawn
J1222	42220	J1222 GEN 0.6300	1	Withdrawn
J1222	42221	J1222 GEN1 0.6300	1	Withdrawn
J1227	42270	J1227 GEN 0.6300	1	Withdrawn
J1242	42420	J1242 GEN 0.6450	1	Withdrawn
J1243	42430	J1243 GEN 0.6450	1	Withdrawn
J1254	42540	J1254 GEN 0.6300	1	Withdrawn
J1265	42650	J1265 GEN 0.6300	1	Withdrawn
J1271	42710	J1271 GEN 0.6450	1	Withdrawn
J1274	42740	J1274 GEN 0.6450	1	Withdrawn
J1276	42741	J1276 GEN1 0.6450	1	Withdrawn
J1275	42750	J1275 GEN 0.6300	1	Withdrawn
J1409	42751	J1409 GEN1 0.6300	1	Withdrawn

Prj #	Bus Number	Bus Name	Id	Status
J1288	42880	J1288 GEN 22.000	1	Withdrawn
J1296	42960	J1296 GEN 0.6000	1	Withdrawn
J1301	43010	J1301 GEN 0.6000	1	Withdrawn
J1318	43180	J1318 GEN 0.6000	1	Withdrawn
J1324	43240	J1324 GEN 0.6000	1	Withdrawn
J1330	43300	J1330 GEN 0.6000	1	Withdrawn
J1338	43380	J1338 GEN 0.7200	1	Withdrawn
J1363	43381	J1363 GEN1 0.6900	1	Withdrawn
J1342	43420	J1342 GEN 0.3850	1	Withdrawn
J1356	43560	J1356 GEN 0.3850	1	Withdrawn
J1376	43760	J1376 GEN 0.7200	1	Withdrawn
J1385	43850	J1385 GEN 0.6300	1	Withdrawn
J1233	43931	J1233 GEN1 0.6300	1	Withdrawn
J1398	43980	J1398 GEN 0.6000	1	Withdrawn
J1405	44050	J1405 GEN 0.6450	1	Withdrawn
J1412	44120	J1412 GEN 0.6300	1	Withdrawn
J1412	44121	J1412 GEN1 0.6300	1	Withdrawn
J1418	44180	J1418 GEN 0.6300	1	Withdrawn
J1419	44190	J1419 GEN 0.6450	1	Withdrawn
J1420	44200	J1420 GEN 0.6000	1	Withdrawn
J1448	44480	J1448 GEN 0.6300	1	Withdrawn
J1457	44570	J1457 GEN 0.6900	1	Withdrawn
J1457	44571	J1457 GEN1 0.6900	1	Withdrawn
J979	89790	J979 GEN 0.6900	1	Withdrawn
J979	89791	J979 GEN1 0.6900	1	Withdrawn

Table A-3: Recently Withdrawn SPP Prior Queued Project

Prj #	Status	Bus Number	Bus Name	Id
GEN-2016-088	TERMINATED	587733	G16-088-GEN10.6900	1
GEN-2016-092	WITHDRAWN	587753	G16-092-GEN10.6900	1
GEN-2016-103	WITHDRAWN	587833	G16-103-GEN10.6900	1
GEN-2016-106	WITHDRAWN	587853	G16-106-GEN10.6900	1
GEN-2016-110	WITHDRAWN	587873	G16-110-GEN10.6900	1

Prj #	Status	Bus Number	Bus Name	Id
GEN-2016-127	WITHDRAWN	588033	G16-127-GEN10.6900	1
GEN-2016-127	WITHDRAWN	588036	G16-127-GEN20.6900	1
GEN-2017-001	WITHDRAWN	588373	G17-001-GEN10.6900	1
GEN-2016-159	WITHDRAWN	588383	G16-159-GEN10.6900	1
GEN-2016-159	WITHDRAWN	588386	G16-159-GEN20.6900	1
GEN-2017-008	WITHDRAWN	588533	G17-008-GEN10.6900	1
GEN-2017-008	WITHDRAWN	588537	G17-008-GEN20.6900	1
GEN-2017-013	WITHDRAWN	588583	G17-013-GEN10.6900	1
GEN-2017-024	WITHDRAWN	588683	G17-024-GEN10.6000	1
GEN-2017-030	WITHDRAWN	588733	G17-030-GEN10.6900	1
GEN-2017-031	WITHDRAWN	588743	G17-031-GEN10.6900	1
GEN-2017-032	WITHDRAWN	588753	G17-032-GEN10.6900	1
GEN-2017-038	WITHDRAWN	588793	G17-038-GEN10.6900	1
GEN-2017-041	WITHDRAWN	588823	G17-041-GEN10.6900	1
GEN-2017-055	WITHDRAWN	588943	G17-055-GEN10.5500	1
GEN-2017-064	WITHDRAWN	589023	G17-064-GEN10.5500	1
GEN-2017-064	WITHDRAWN	589027	G17-064-GEN20.5500	1
GEN-2017-067	WITHDRAWN	589053	G17-067-GEN10.5500	1
GEN-2017-067	WITHDRAWN	589057	G17-067-GEN20.5500	1
GEN-2017-090	WITHDRAWN	589283	G17-090-GEN10.6900	1
GEN-2017-090	WITHDRAWN	589287	G17-090-GEN20.6900	1
GEN-2017-095	WITHDRAWN	589333	G17-095-GEN10.6900	1
GEN-2016-109	WITHDRAWN	589453	G16-109-GEN112.000	1

Table A-4: Recently Withdrawn AECI Prior Queued Project

Projects	MW	Generation Type	Substation or Line
GIA-84	196	Solar	New Madrid 345 kV

A.2 SPP Prior Queued Generation Projects

Table A-5: SPP Prior Queued Generation Projects

Projects	Cluster	MW	Generation Type	Town or County	State	Substation or Line	TO at POI
GEN-2016-037	DISIS-2017-001	300	Wind	Washita	OK	Chisholm-Gracemont 345kV	AEP
GEN-2017-023	DISIS-2017-001	85	Solar	Choctaw	OK	Hugo Power Plant 138 kV Sub	WFEC
GEN-2017-027	DISIS-2017-001	140	Wind	Carter	OK	Pooleville-Ratliff (Carter County) 138kV	OGE
GEN-2017-040	DISIS-2017-001	200.1	Solar	Ochiltree	TX	Canadian River-Muskogee and Muskogee-Seminole 345kV	OGE
GEN-2017-057	DISIS-2017-001	72.5	Solar	Caddo Parish	LA	Hosston 69kV	AEP
GEN-2017-061	DISIS-2017-001	101.5	Solar	Mayes	OK	GRDA1 to CLARMR 5 161kV line	GRDA
GEN-2017-071	DISIS-2017-001	124.7	Solar	Payne	OK	Greenwood 138kV sub	OGE
GEN-2017-075	DISIS-2017-001	200	Solar	Johnston	OK	Hugo-Sunnyside 345 kV	OGE
GEN-2017-077	DISIS-2017-001	124.7	Solar	Mayes	OK	Explorer Claremore Tap EXCLART4	AEP
GEN-2017-092	DISIS-2017-001	200	Solar	Muskogee	OK	Canadian River-Muskogee and Muskogee-Seminole 345kV	OGE
GEN-2017-132	DISIS-2017-002	400	Wind	Oklahoma	OK	Arcadia 345kV	OGE
GEN-2017-133	DISIS-2017-002	200	Wind	Oklahoma	OK	Arcadia 345kV	OGE
GEN-2017-134	DISIS-2017-002	250	Wind	Oklahoma	OK	Arcadia 345kV	OGE
GEN-2017-137	DISIS-2017-002	295	Wind	Oklahoma	OK	Arcadia 345kV	OGE
GEN-2017-140	DISIS-2017-002	160	Solar	Wagoner	OK	Clarksville 345kV Switching Station	AEP
GEN-2017-141	DISIS-2017-002	241.7	Solar	Wagoner	OK	Clarksville 345kV Switching Station	AEP
GEN-2017-149	DISIS-2017-002	258	Wind	Johnston	OK	Johnson County 345kV Substation	OGE
GEN-2017-150	DISIS-2017-002	250	Solar	Grady	OK	Minco 345kV	OGE
GEN-2017-151	DISIS-2017-002	300	Wind	Crosby	TX	TUCO-Oklaunion 345kV	SPS
GEN-2017-152	DISIS-2017-002	252	Wind	McClain	OK	McClain 138kV	OGE
GEN-2017-154	DISIS-2017-002	255	Wind	Johnston	OK	Johnson County 345kV Substation	OGE
GEN-2017-155	DISIS-2017-002	300	Wind	Muskogee	OK	Muskogee 345kV Substation	OGE
GEN-2017-164	DISIS-2017-002	250	Solar	Garfield	OK	Woodring 345kV Substation	OGE
GEN-2017-166	DISIS-2017-002	250	Solar	Carter	OK	Sunnyside 345kV	OGE
GEN-2017-171	DISIS-2017-002	150	Solar	Stephen	OK	Lawton Eastside - Terry Road 345kV	AEP
GEN-2017-213	DISIS-2017-002	300	solar / battery)	Grant / Kay	OK	Clarksville 345kV Substation	AEP

Projects	Cluster	MW	Generation Type	Town or County	State	Substation or Line	TO at POI
GEN-2017-231	DISIS-2017-002	72.5	Solar	Franklin	AR	Branch 161kV Substation	OGE
GEN-2017-233	DISIS-2017-002	215	Wind	Grady	OK	Minco 345kV	OGE
GEN-2017-240	DISIS-2017-002	202	Solar	Okmulgee	OK	Bristow 138kV Substation	OGE
GEN-2018-003	DISIS-2018-001	150	Solar	Bowie	TX	North Boston-Bann 138kV Line	AEP
GEN-2018-011	DISIS-2018-001	74.1	Battery	Kingfisher	OK	Dover 138 kV Switching Station	WFEC
GEN-2018-015	DISIS-2018-001	252	Solar	Paducah	TX	Tuco-Oklaunion 345kV Line	SPS
GEN-2018-021	DISIS-2018-001	74.1	Solar	Washita	OK	Chisholm-Gracemont 345kV Line	AEP
GEN-2018-024	DISIS-2018-001	100	Battery	Muskogee	OK	Canadian River-Muskogee and Muskogee-Seminole 345kV	OGE
GEN-2018-026	DISIS-2018-001	100	Battery	Canadian	OK	Mustang 138kV Substation	OGE
GEN-2018-027	DISIS-2018-001	100	Battery	Tulsa	OK	Tulsa Power Station 138kV Substation	AEP
GEN-2018-028	DISIS-2018-001	200	Battery	Tulsa	OK	Tulsa North 138kV Substation	AEP
GEN-2018-029	DISIS-2018-001	100	Battery	Oklahoma	OK	Horseshoe Lake 138kV Substation	OGE
GEN-2018-048	DISIS-2018-001	300	Solar	Caddo	OK	Pecan Creek 345kV Substation	OGE
GEN-2018-050	DISIS-2018-001	200	Solar	Caddo	LA	Longwood 345kV Substation	AEP
GEN-2018-051	DISIS-2018-001	35	Battery	Muskogee	OK	Pecan Creek 345kV	OGE
GEN-2018-055	DISIS-2018-001	252	Solar	Grady	OK	Terry Road 345kV station (shared with Rush Springs Windfarm on a common gentie)	AEP

A.3 AECI Prior Queued Generation Projects

Table A-6: AECI Prior Queued Generation Projects

Projects	MW	Generation Type	Substation or Line
GIA-90	100	Solar	Montgomery City 161 kV
GIA-91	96	Solar	Sedalia 69 kV
GIA-93	100	Solar	Palmyra 161 kV
GIA-95	247	Wind	Jasper-Morgan 345 kV
GIA-96	97.5	Wind	Stroud 138kV

A.4 Network Upgrades Required for J1488, J1490, AECI GI-083 HVDC Projects

Table A-7: NUs Required for J1488, J1490, AECI GI-083 HVDC Projects

Assigned Project	Network Upgrade
GI-083	2nd Overton 345-161kV 560 MVA Transformer
GI-083	Apache Tap-California 161kV Line Rebuild to 1600 A
GI-083	California-Overton 161kV Reconductor and California Terminal Upgrades
GI-083	J1145-McCredie 345kV Line Rebuild to 3000 A
GI-083	J1145-Montgomery-1 345kV Line Rebuild to 3000 A
GI-083	Loy Martin-Guthrie 161kV Reconductor and Loy Martin Terminal Upgrades
GI-083	Loy Martin-McBain Tap 161kV Reconductor and Loy Martin Terminal Upgrades
J1488/J1490	McCredie-Overton-5475 345kV Line, upgrade (2) 345kV Overton switches
J1488/J1490	Big Creek-Warrenton-3 161kV Line
J1488/J1490	Guthrie-Moreau section of Guthrie-Mariosa Delta-1 161kV Line
J1488/J1490	Montgomery-HVDC POI (J1145) 345kV Line (double ckt)
J1488/J1490	Montgomery-HVDC POI (J1145) 345kV Line (3rd ckt)

A.5 MISO North for Power Balance

Table A-8. MISO North for Power Balance

Area #	Area Name	Area #	Area Name
207	HE	608	MP
208	DEI	613	SMMPA
210	SIGE	615	GRE
216	IPL	620	OTP
217	NIPS	627	ALTW
218	METC	633	MPW
219	ITC	635	MEC
295	WEC	661	MDU
296	MIUP	663	BEPC-MISO
314	BREC	680	DPC
333	CWLD	694	ALTE
356	AMMO	696	WPS
357	AMIL	697	MGE
360	CWLP	698	UPPC
361	SIPC	701	Classic Prior
600	Xcel		

A.6 MISO South for Power Balance

Table A-9. MISO South for Power Balance

Area #	Area Name	Area #	Area Name
326	EES-EMI	502	CLEC
327	EES-EAI	503	LAFA
332	LAGN	504	LEPA
349	SMEPA	700	South Prior
351	EES		

A.7 SPP Market for Power Balance

Table A-10. SPP Market for Power Balance

Area #	Area Name
515	SWPA
520	AEPW
523	GRDA
524	OKGE
525	WFEC
526	SPS
527	OMPA
531	MIDW
534	SUNC
536	WERE
541	KCPL

Area #	Area Name
542	KACY
544	EMDE
545	INDN
546	SPRM
640	NPPD
641	HAST
642	KACY
645	OPPD
650	LES
652	WAPA
659	BEPC-SPP

A.8 AECI for Power Balance

Table A-11. AECI for Power Balance

Area #	Area Name
330	AECI

A.9 Contingency Files used in MISO South AFSIS Analysis

Table A-12: List of Contingencies used in the MISO South AFSIS Analysis

Contingency File Name	Description
Automatic single element contingencies	Single element outages at buses 60 kV and above in the study region
MISO20_2025_SUM__TA_P1_AMRN.con	Specified category P1 contingencies in Ameren
MISO20_2025_SUM__TA_P1_South.con	Specified category P1 contingencies in MISO South
MISO20_2025_SUM__TA_P1_P2_P4_P5_NoLoadLoss_South.con	Specified category P1, P2, P4, P5 no load loss contingencies in MISO
MISO20_2025_SUM__TA_P2_P4_P5_P6_P7_LoadLoss_South.con	Specified category P2, P4, P5, P6, P7 load loss contingencies in MISO
AECI-AMMO.CON	Specified category P1, P2 contingencies in AECI-AMMO
AECI-EES.con	Specified category P2, P3, P6 contingencies in AECI-EES
s21_P1_MISO.con	Specified category P1 contingencies in TVA
2021SUM_TA_TVA_s21_P1_MISO.con	Specified category P1 contingencies in TVA
s21_P2_MISO.con	Specified category P2 contingencies in TVA
s21_P4P5_MISO.con	Specified category P4, P5 contingencies in TVA
s21_P7_MISO.con	Specified category P7 contingencies in TVA

Appendix

B

MISO West AFSIS Model Development for Steady-State and Stability Analysis

B.1 Recently Withdrawn Prior Queued Projects

Table B-1: Recently Withdrawn MISO West and Central Prior Queued Project

Prj #	Bus Number	Bus Name	Id	Status
J803	88035	J803 0.6000	PV	Withdrawn

Table B-2: Recently Withdrawn SPP Prior Queued Project

Prj #	Status	Bus Number	Bus Name	Id
GEN-2016-088	TERMINATED	587733	G16-088-GEN10.6900	1
GEN-2016-092	WITHDRAWN	587753	G16-092-GEN10.6900	1
GEN-2016-103	WITHDRAWN	587833	G16-103-GEN10.6900	1
GEN-2016-106	WITHDRAWN	587853	G16-106-GEN10.6900	1
GEN-2016-110	WITHDRAWN	587873	G16-110-GEN10.6900	1
GEN-2016-127	WITHDRAWN	588033	G16-127-GEN10.6900	1
GEN-2016-127	WITHDRAWN	588036	G16-127-GEN20.6900	1
GEN-2017-001	WITHDRAWN	588373	G17-001-GEN10.6900	1
GEN-2016-159	WITHDRAWN	588383	G16-159-GEN10.6900	1
GEN-2016-159	WITHDRAWN	588386	G16-159-GEN20.6900	1
GEN-2017-013	WITHDRAWN	588583	G17-013-GEN10.6900	1
GEN-2017-030	WITHDRAWN	588733	G17-030-GEN10.6900	1
GEN-2017-031	WITHDRAWN	588743	G17-031-GEN10.6900	1
GEN-2017-032	WITHDRAWN	588753	G17-032-GEN10.6900	1
GEN-2017-038	WITHDRAWN	588793	G17-038-GEN10.6900	1
GEN-2017-041	WITHDRAWN	588823	G17-041-GEN10.6900	1
GEN-2017-095	WITHDRAWN	589333	G17-095-GEN10.6900	1
GEN-2016-109	WITHDRAWN	589453	G16-109-GEN112.000	1

B.2 SPP Prior Queued Generation Projects

Table B-3: SPP Prior Queued Generation Projects

Projects	Cluster	MW	Generation Type	Town or County	State	Substation or Line	TO at POI
ASGI-2017-013	NA	40	Wind	WAPA	ND	Wolsey 69 kV	WAPA
ASGI-2017-014	NA	40	Solar	NA	KS	Post Oak 34.5 kV	KCPL
ASGI-2018-003	NA	20	Solar	KCPL	KS	Appleton 69 kV	KCPL
ASGI-2018-006	NA	20	Solar	KCPL	KS	Metz 69 kV	KCPL
ASGI-2018-007	NA	20	Solar	KCPL	KS	Salisbury 161 kV	KCPL
ASGI-2018-010	NA	35	Solar	KCPL	KS	Pleasant Valley 161 kV	KCPL
ASGI-2018-011	NA	35	Solar	KCPL	KS	South Ottawa 161 kV	KCPL
GEN-2016-036	DISIS-2016-002-1	44.6	Wind	Chippewa	MN	Granite Falls 115 kV	WAPA
GEN-2016-074	DISIS-2016-002-1	200	Wind	Custer	NE	Sweetwater 345 kV	NPPD
GEN-2016-087	DISIS-2016-002-1	98.9	Wind	Campbell	SD	Bismark-Glenham 230 kV	WAPA
GEN-2016-094	DISIS-2016-002-1	200	Wind	Hyde	SD	Ft Thompson-Oahe 230 kV	WAPA
GEN-2016-115	DISIS-2016-002-1	300	Wind	Atchison	MO	Nebraska City-Mullen Creek 345 kV	GMO
GEN-2016-130	DISIS-2016-002-1	202	Wind	Mercer	ND	Leland Olds 345 kV	BEPC
GEN-2016-147	DISIS-2016-002-1	40	Solar	Cheyenne	NE	Sidney 115 kV	Tri-State
GEN-2016-151	DISIS-2016-002-1	202	Wind	Burke	ND	Tande 345 kV	BEPC
GEN-2017-004	DISIS-2017-001	201.6	Wind	Cloud	KS	Elm Creek-Summit 345 kV	ITCGP
GEN-2017-005	DISIS-2017-001	190	Wind	Bourbon / Crawford	OK	Marmaton-Litchfield 161 kV	WERE
GEN-2017-009	DISIS-2017-001	302	Wind	Neoshoe	KS	Neosho-Caney River 345 kV	WERE
GEN-2017-010	DISIS-2017-001	200.1	Wind	Bowman	ND	Rhame 230 kV	BEPC
GEN-2017-014	DISIS-2017-001	300	Wind	Haakon	SD	Philip Tap 230 kV	WAPA
GEN-2017-048	DISIS-2017-001	300	Wind	Williams	ND	Neset 230 kV	BEPC
GEN-2017-060	DISIS-2017-001	149.4	Wind	Barton	MO	LaRussell Energy Center 161 kV	EDE
GEN-2017-082	DISIS-2017-001	149.4	Wind	Barton / Jasper	MO	Asbury Plant 161 kV	EDE
GEN-2017-094	DISIS-2017-001	200	Wind	Wessington / Hand	SD	Fort Thompson-Huron 230 kV	WAPA
GEN-2017-097	DISIS-2017-001	128	Solar	Pennington	SD	Underwood 115 kV	WAPA
GEN-2017-105	DISIS-2017-002	75	Wind	Burt	NE	Tekamah-Raun 161 kV	OPPD

Projects	Cluster	MW	Generation Type	Town or County	State	Substation or Line	TO at POI
GEN-2017-108	DISIS-2017-002	400	Solar	Henry	MO	Stillwell-Clinton 161 kV	KCPL
GEN-2017-111	DISIS-2017-002	152	Solar	Bates	MO	Clinton-Stilwell 161 kV	KCPL
GEN-2017-115	DISIS-2017-002	244	Wind	Atchinson / Nodaway	MO	Holt County 345 kV	KCPL
GEN-2017-119	DISIS-2017-002	180	Wind	Cloud / Mitchell	KS	Elm Creek 345 kV	SUNC
GEN-2017-120	DISIS-2017-002	260	Wind	Dickinson / Marion	KS	Abilene Energy Center-Northview 115 kV	WERE
GEN-2017-125	DISIS-2017-002	252	Wind	Osage	KS	Swissvale 345 kV	WERE
GEN-2017-128	DISIS-2017-002	202	Wind	Jackson	KS	Swissvale 345 kV	WERE
GEN-2017-144	DISIS-2017-002	200	Wind	Holt, Antelope, Wheeler	NE	Holt County 345 kV	WAPA
GEN-2017-148	DISIS-2017-002	202	Wind	Newton	MO	Joplin 161 kV	EDE
GEN-2017-175	DISIS-2017-002	300	Wind	Turner	SD	Vfodnes-Utica Jct. 230 kV	WAPA
GEN-2017-181	DISIS-2017-002	300	Wind	Lancaster	NE	Tobias 345 kV	NPPD
GEN-2017-182	DISIS-2017-002	128	Wind	Lancaster	NE	Tobias 345 kV	NPPD
GEN-2017-183	DISIS-2017-002	400	Wind	Hodgeman / Ford	KS	Nashua-St. Joe 345 kV	KCPL
GEN-2017-184	DISIS-2017-002	400	Solar	Hodgeman / Ford	KS	Nashua-St. Joe 345 kV	KCPL
GEN-2017-188	DISIS-2017-002	130	Solar	Barry	MO	Asbury 161 kV	EDE
GEN-2017-191	DISIS-2017-002	201.6	Solar	Osage	KS	Swissvale 345 kV	WERE
GEN-2017-195	DISIS-2017-002	500.4	Solar	Johnson	KS	West Gardner 345 kV	KCPL
GEN-2017-196	DISIS-2017-002	128	Battery	Johnson	KS	West Gardner 345 kV	KCPL
GEN-2017-201	DISIS-2017-002	250	Wind	Wayne	NE	Hoskins 345 kV	NPPD
GEN-2017-202	DISIS-2017-002	200	Solar	New Madrid	MO	New Madrid-Sikeston 161 kV	SWPA
GEN-2017-209	DISIS-2017-002	300	Hybrid (Solar / Battery)	McPherson	KS	LaCygne-Neosho 345 kV	KCPL
GEN-2017-210	DISIS-2017-002	310	Hybrid (Solar / Battery)	Cedar	NE	McCool 345 kV	NPPD
GEN-2017-214	DISIS-2017-002	100	Wind	Ward	ND	Logan 230 kV	BEPC
GEN-2017-215	DISIS-2017-002	100	Wind	Ward	ND	Logan 230 kV	BEPC
GEN-2017-216	DISIS-2017-002	100	Wind	Ward	ND	Logan 230 kV	BEPC
GEN-2017-222	DISIS-2017-002	180	Wind	Denison	IA	Denison 230 kV	WAPA

Projects	Cluster	MW	Generation Type	Town or County	State	Substation or Line	TO at POI
GEN-2017-229	DISIS-2017-002	76	Battery	Johnson	KS	Stilwell 345 kV	KCPL
GEN-2017-234	DISIS-2017-002	115	Wind	Greeley	NE	Spalding-North Loup 115 kV	NPPD
GEN-2018-008	DISIS-2018-001	252	Wind	McIntosh	ND	Groton-Leland Olds 345 kV	BEPC
GEN-2018-010	DISIS-2018-001	74.1	Battery	Montrail	ND	Neset 230 kV	BEPC
GEN-2018-012	DISIS-2018-001	74.1	Wind	Wayne	NE	Antelope 345 kV	NPPD
GEN-2018-013	DISIS-2018-001	74.1	Wind	Dickinson	KS	Abilene Energy Center-Northview 115 kV	WERE
GEN-2018-022	DISIS-2018-001	300	Solar	Nodaway	MO	Mullen Creek 345 kV	GMO
GEN-2018-025	DISIS-2018-001	200	Battery	Washington	NE	Fort Calhoun 345 kV	OPPD
GEN-2018-030	DISIS-2018-001	200	Battery	Prowers	CO	Lamar-Finney 345 kV	SPS
GEN-2018-031	DISIS-2018-001	50	Battery	Jackson	MO	Blue Valley 161 kV	INDN
GEN-2018-032	DISIS-2018-001	310	Wind	McPhearson	KS	Neosho 345 kV	WERE
GEN-2018-033	DISIS-2018-001	200	Battery	Cass	NE	Cass County 345 kV	OPPD
GEN-2018-037	DISIS-2018-001	100	Battery	Douglas	NE	Looping in OPPD (S1211) (S1220) (S1211) (S1299) 161 kV	OPPD
GEN-2018-039	DISIS-2018-001	72	Solar	LaMoure	ND	Edgeley 115 kV	WAPA
GEN-2018-043	DISIS-2018-001	500	Solar	Burt	NE	Ft. Calhoun-Raun 345 kV	OPPD
GEN-2018-054	DISIS-2018-001	120	Solar	Linn	KS	KC South-N. Raymore 161 kV	GMO
GEN-2018-056	DISIS-2018-001	102.6	Solar	Knox / Holt	NE	Grand Prairie 345 kV	WAPA
GEN-2018-057	DISIS-2018-001	203.4	Solar	Sedgwick	KS	Gordon Evans 138 kV	WERE
GEN-2018-060	DISIS-2018-001	50	Wind	Webster	NE	Axtell-Post Rock 345 kV	NPPD
GEN-2018-062	DISIS-2018-001	75.6	Solar	Wyandotte	KS	Nearman 161 kV	KACY

B.3 MPC Prior Queued Generation Projects

Table B-4: MPC Prior Queued Generation Projects

Projects	Cluster	MW	Generation Type	Town or County	State	Substation or Line	TO at POI
MPC03600	MPC Group 2020	170	Solar	Richland	ND	Frontier-Wahpeton 230 kV	MPC
MPC03700	MPC Group 2020	130	Solar	Richland	ND	Frontier-Wahpeton 230 kV	MPC
MPC03800	MPC Group 2021	250	Wind	Eddy; Wells	ND	Center-Prairie 345 kV	MPC
MPC03900	MPC Group 2021	151.2	Wind	Eddy; Wells	ND	Center-Prairie 345 kV	MPC
MPC04000	MPC Group 2021	284	Wind	Oliver; Morton	ND	Square Butte 230 kV	MPC
MPC04300	NA	400	Wind	Steele	ND	Center-Prairie 345 kV	MPC

B.4 Network Upgrades Required for Prior Queued Projects

Table B-5: NUs Required for DPP 2019 West Phase 3 Study

Constraint	Owner	Mitigation
Thermal and voltage constraints in OTP	OTP	Build a 2nd Astoria-Brookings County 345 kV line

Table B-6: NUs Required for SPP West Prior Queued Projects

NUs	Study Cycle
Capacitor at Bagley 115: 1x20 Mvar	DISIS-2016-002
100 MVAR Capacitor Bank at Montezuma 345 kV (MEC)	DISIS-2017-001
100 MVAR STATCOM at Blackhawk 345 kV (MEC)	DISIS-2017-001
Capacitor at Maynard 115: 1x40 Mvar	DISIS-2018-001

Table B-7: NUs Required for MPC Group 2021 Projects

Bus #	Bus Name	MPC Group 2021
658047	ALEXMRES3 345.00	MSC: 2x75 MVAr
601067	BISON 3 345.00	MSC: 2x75 MVAr
615529	PANTHER4230.00	MSC: 1x50 MVAr
657758	WINGER 4 230.00	MSC: 1x30 MVAr STATCOM: ±50 MVAr

Table B-8: Steady State NUs Required for MPC 04300 Project

Constraint	Owner	Mitigation
J897 POI-Prairie 230 kV	GRE MPC	GRE: Rebuild the 30 mi 230 kV line. NU cost is assigned to J897 MPC: Subject to MPC SIS
Sheyenne-Lake Park 230 kV	XEL OTP	OTP: Structure replacements. $0.5M XEL: Default to OTP's solution. $0
Inman-Wing River 230 kV	GRE	Incorrect rating; rating is 343.7 MVA
Winger-Fertile 115 kV	OTP	Reconductor /rebuild
Wilton-Scribner 115 kV	OTP MPC	OTP: Structure replacements. $0.6M MPC: Subject to MPC SIS
Crookston-Fertile 115 kV	OTP	Reconductor /rebuild
Donaldson-J1575 POI 115 kV	OTP	J1575 prior queued upgrades
Solway-Wilton Tap 115 kV	OTP MPC	OTP: Structure replacements. $100k MPC: Subject to MPC SIS

Constraint	Owner	Mitigation
Wahpeton-Fergus Falls 230 kV	OTP MRES	OTP: Structure replacements. $3.5M MRES: MRES terminal rating adequate
Audubon-Lake Park 230 kV	OTP	OTP structure replacements.
Jamestown-Center 345 kV	OTP MPC	OTP: CT adjustments. $10K MPC: Subject to MPC SIS
Warsaw-J1575 POI 115 kV	OTP MPC	OTP: Incorrect rating. $0 MPC: Subject to MPC SIS
Drayton-Lake Ardoch 230 kV	OTP MPC	OTP: Structure replacements. $0.1M MPC: Subject to MPC SIS
Voltage constraints	XEL	Add 1×50 Mvar switched capacitor at Hazel Crk 230 kV (601053)
Voltage constraints	OTP	Add 1×40 Mvar switched capacitor at Audubon 230 kV (620336)

B.5 Model Reviewing Comments

Table B-9: Model Reviewing Comments

Company	Python/ Idev File Name	2025 SH	2025 SPK	Comments
MPC	DPP20-2025SH90-PhaseIII-MPC Ratings.idv	X	X	
MPC	LakeArdoch.idv	X	X	
MISO	RMV Duplicated GEN-2017-060_GEN-2017-082.py	X	X	Remove duplicated GEN-2017-060, GEN-2017-082
SPTI	psspy.purgmac(531451,r"""1""")	X	X	Remove fictitious SVC at Mingo 345 kV
SPTI	RMV Extra MPC04000.py	X	X	Remove duplicated MPC04000 model
SPTI	Update_MPC038_039_043_Pgen_Pmax_Mbase_SUM.py		X	
SPTI	SH_MPC_03800_03900_04300_Pmax_Mbase_to_Pgen.py	X		

B.6 Contingency Files used in MISO West AFSIS Analysis

Table B-10: List of Contingencies used in the MISO West AFSIS Analysis

Contingency File Name	Description
Automatic single element contingencies	Single element outages at buses 60 kV and above in the study region
MISO20_2025_SUM__TA_P1_AMRN.con	Specified category P1 contingencies in Ameren
MISO20_2025_SUM__TA_P1_ATC.con	Specified category P1 contingencies in ATC
MISO20_2025_SUM__TA_P1_IOWA.con	Specified category P1 contingencies in Iowa
MISO20_2025_SUM__TA_P1_IOWA_ITCM_MPW.con	Specified category P1 contingencies in ITCM and MPW
MISO20_2025_SUM__TA_P1_IOWA_MEC.con	Specified category P1 contingencies in MEC
MISO20_2025_SUM__TA_P1_MINN-DAKS.con	Specified category P1 contingencies in MN, ND and SD
HVDC_Red_2025PK.con	Specified contingencies related to HVDC reduction in SPK
HVDC_Red_2025SH.con	Specified contingencies related to HVDC reduction in SH
MISO20_2025_SUM__TA_P1_P2_P4_P5_NoLoadLoss.con	Specified category P1, P2, P4, P5 contingencies in MISO
MISO20_2025_SUM__TA_P2_P5_P7_ATC.con	Specified category P2, P5, P7 contingencies in ATC
MISO20_2025_SUM__TA_P2_P7_MEC.con	Specified category P2, P7 contingencies in MEC
MISO20_2025_SUM__TA_P2_P4_P5_P6_P7_LoadLoss.con	Specified category P2, P4, P5, P7 contingencies in MISO
AECI-AMMO.CON	Specified category P1, P2 contingencies in AECI-AMMO
AECI-EES.con	Specified category P2, P3, P6 contingencies in AECI-EES
160303-KACY_P1.con	Specified category P1 contingencies in KACY
160303-KACY_P2.con	Specified category P2 contingencies in KACY
KCPL_P1.con	Specified category P1 contingencies in KCPL
KCPL_P2.con	Specified category P2 contingencies in KCPL
KCPL_P4.con	Specified category P4 contingencies in KCPL
KCPL_P5.con	Specified category P5 contingencies in KCPL
KCPL_P7.con	Specified category P7 contingencies in KCPL

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Appendix C

MISO South AFSIS Thermal and Voltage Analysis Results

C.1 2025 Summer Peak (SPK) MISO South AFSIS Constraints

Table C-1. 2025 SPK System Intact MISO South Thermal Constraints

Table C-2. 2025 SPK System Intact MISO South Voltage Constraints

Table C-3. 2025 SPK Category P1 MISO South Thermal Constraints

Table C-4. 2025 SPK Category P1 MISO South Voltage Constraints

Table C-5. 2025 SPK Category P2-P7 MISO South Thermal Constraints

Table C-6. 2025 SPK Category P2-P7 MISO South Voltage Constraints

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C.2 2025 Summer Shoulder (SH) MISO South AFSIS Constraints

Table C-7. 2025 SH System Intact MISO South Thermal Constraints

Table C-8. 2025 SH System Intact MISO South Voltage Constraints

Table C-9. 2025 SH Category P1 MISO South Thermal Constraints

Table C-10. 2025 SH Category P1 MISO South Voltage Constraints

Table C-11. 2025 SH Category P2-P7 MISO South Thermal Constraints

Table C-12. 2025 SH Category P2-P7 MISO South Voltage Constraints

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Appendix

D

MISO South AFSIS Stability Analysis Results

D.1 2025 Summer Peak (SPK) MISO South AFSIS Stability Results

Stability simulation was performed in the 2025 summer peak (SPK) stability model.

D.1.1 2025 SPK MISO South AFSIS Stability Summary

MISO South AFSIS summer peak stability study results are summarized in Table D-1.

Table D-1: 2025 Summer Peak MISO South AFSIS Stability Analysis Results Summary

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D.1.2 2025 SPK MISO South AFSIS Stability Plots

Plots of stability simulations for 2025 summer peak study case are in separate files which are listed below:

AppendixD1-2_2025SPK_SPP South_Study_Plots.zip

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D.2 2025 Summer Shoulder MISO South AFSIS Stability Results

Stability simulation was performed in the 2025 summer shoulder (SH) stability model.

D.2.1 2025 SH MISO South AFSIS Stability Summary

MISO South AFSIS summer shoulder stability study results are summarized in Table D-2.

Table D-2: 2025 Summer Shoulder MISO South AFSIS Stability Analysis Results Summary

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D.2.2 2025 SH MISO South AFSIS Stability Plots

Plots of stability simulations for 2025 summer shoulder study case are in separate files which are listed below:

AppendixD2-2_2025SH_SPP South_Study_Plots.zip

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Appendix

E

MISO West AFSIS Thermal and Voltage Analysis Results

E.1 2025 Summer Peak (SPK) MISO West AFSIS Constraints

Table E-1. 2025 SPK System Intact MISO West Thermal Constraints

Table E-2. 2025 SPK System Intact MISO West Voltage Constraints

Table E-3. 2025 SPK Category P1 MISO West Thermal Constraints

Table E-4. 2025 SPK Category P1 MISO West Voltage Constraints

Table E-5. 2025 SPK Category P2-P7 MISO West Thermal Constraints

Table E-6. 2025 SPK Category P2-P7 MISO West Voltage Constraints

Table E-7. 2025 SPK MISO West Non-Converged Contingencies

Table E-8. 2025 SPK MISO West Non-Converged Contingencies DCCC Results

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E.2 2025 Summer Shoulder (SH) MISO West AFSIS Constraints

Table E-9. 2025 SH System Intact MISO West Thermal Constraints

Table E-10. 2025 SH System Intact MISO West Voltage Constraints

Table E-11. 2025 SH Category P1 MISO West Thermal Constraints

Table E-12. 2025 SH Category P1 MISO West Voltage Constraints

Table E-13. 2025 SH Category P2-P7 MISO West Thermal Constraints

Table E-14. 2025 SH Category P2-P7 MISO West Voltage Constraints

Table E-15. 2025 SH MISO West Non-Converged Contingencies

Table E-16. 2025 SH MISO West Non-Converged Contingencies DCCC Results

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Appendix

F

MISO West AFSIS Stability Analysis Results

F.1 2025 Summer Peak (SPK) MISO West AFSIS Stability Results

Stability simulation was performed in the 2025 summer peak (SPK) stability model.

F.1.1 2025 SPK MISO West AFSIS Stability Summary

MISO West AFSIS summer peak stability study results are summarized in Table F-1.

Table F-1: 2025 Summer Peak MISO West AFSIS Stability Analysis Results Summary

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F.1.2 2025 SPK MISO West AFSIS Stability Plots

Plots of stability simulations for 2025 summer peak study case are in separate files which are listed below:

AppendixF1-2_2025SPK_SPP West_Study_Plots.zip

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F.2 2025 Summer Shoulder MISO West AFSIS Stability Results

Stability simulation was performed in the 2025 summer shoulder (SH) stability model.

F.2.1 2025 SH MISO West AFSIS Stability Summary

MISO West AFSIS summer shoulder stability study results are summarized in Table F-2.

Table F-2: 2025 Summer Shoulder MISO West AFSIS Stability Analysis Results Summary

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F.2.2 2025 SH MISO West AFSIS Stability Plots

Plots of stability simulations for 2025 summer shoulder study case are in separate files which are listed below:

AppendixF2-2_2025SH_SPP West_Study_Plots.zip

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Appendix

G

2025 Cost Allocation Results

G.1 Distribution Factor (DF), Voltage Impact, and MW Contribution Results for Cost Allocation in 2025

Table G-1: Distribution Factor and MW Contribution on Constraints for MISO West Affected System Thermal NU Cost Allocation

Table G-2: Voltage Impact on MISO West Voltage NUs Cost Allocation

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G.2 Cost Allocation Details

Table G-3: MISO West Affected System Network Upgrades Cost Allocation

Table G-3: MISO West Affected System Network Upgrades Cost Allocation

Monitored Element	English Name	Owner	Cost	GEN-2018-063	GEN-2018-065	GEN-2018-067	GEN-2018-068	GEN-2018-069	GEN-2018-070	GEN-2018-074	GEN-2018-083	GEN-2018-090	GEN-2018-121	GEN-2018-125	GEN-2018-131	GEN-2018-132	GEN-2019-009	GEN-2019-016	GEN-2019-019	GEN-2019-023	GEN-2019-029	GEN-2019-033	GEN-2019-037	GEN-2019-039	GEN-2019-041	GEN-2019-048	GEN-2019-069	GEN-2019-070	GEN-2019-073	Upgrade for
635200 RAUN 3 345 762779 G18-043-TAP 345 1	Raun - G18-043 Tap 345 kV	MEC OPPD	$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	SH
635201 RAUN 5 161 762069 G17-105TAP 161 1	Raun - G17-105 Tap 161 kV	MEC OPPD	$2,250,000	$0	$0	$0	$0	$0	$0	$0	$0	$2,250,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	SH
635600 GRIMES 3 345 636003 BEAVER CRK 3 345 1	Grimes - Beaver Creek 345 kV	MEC	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	SH
661093 MERRCRT4 230 661094 WISHEK 4 230 1	Merricourt - Wishek 230 kV	MDU	$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	SH
Add 1×60 MVar switched cap at Jamestown 345 kV	Add 1×60 MVar switched cap at Jamestown 345 kV	OTP	$3,500,000	$0	$21,416	$1,058,566	$302,885	$590,472	$21,416	$52,010	$214,161	$79,545	$18,357	$208,042	$0	$0	$0	$0	$0	$529,283	$385,490	$0	$0	$0	$0	$18,357	$0	$0	$0	SH Volt
MTEP Appendix A project. Brookings-Lyon Co second circuit (2025 ISD)	MTEP Appendix A project. Brookings-Lyon Co second circuit (2025 ISD)	XEL	$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	SH Volt
1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	1) Add a 200 Mvar STATCOM at Wahpeton 230 kV (620329). $20M 2) Add a 200 Mvar STATCOM at Audubon 230 kV (620336). $20M	OTP	$40,000,000	$0	$300,752	$9,864,662	$4,390,977	$5,714,286	$360,902	$842,105	$3,368,421	$1,263,158	$240,602	$3,127,820	$0	$0	$0	$0	$0	$5,172,932	$5,112,782	$0	$0	$0	$0	$240,602	$0	$0	$0	SH Stability
Total Cost Per Project for each Project	**Total Cost Per Project**		**$46,250,000**	**$0**	**$322,168**	**$10,923,228**	**$4,693,862**	**$6,304,758**	**$382,318**	**$894,116**	**$3,582,582**	**$4,092,703**	**$258,958**	**$3,335,862**	**$0**	**$0**	**$0**	**$0**	**$0**	**$5,702,216**	**$5,498,271**	**$0**	**$0**	**$0**	**$0**	**$258,958**	**$0**	**$0**	**$0**	

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