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***MISO Affected System Impact  
Restudy on SPP DISIS-18-002 / 19-001  
West Phase 3 Cluster***

Prepared for

**MISO**

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# Contents

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|                                                                         |            |
|-------------------------------------------------------------------------|------------|
| <b>Legal Notice.....</b>                                                | <b>v</b>   |
| <b>Executive Summary .....</b>                                          | <b>vii</b> |
| 1.1 Study Project List.....                                             | vii        |
| 1.2 MISO AFSIS Restudy Summary .....                                    | vii        |
| 1.3 Total MISO AFSIS Network Upgrades.....                              | viii       |
| 1.4 Per Project Summary .....                                           | ix         |
| <b>Model Development and Study Criteria .....</b>                       | <b>1</b>   |
| 1.1 Model Development.....                                              | 1          |
| 1.1.1 MISO AFSIS Benchmark Models.....                                  | 1          |
| 1.1.2 Contingency Criteria .....                                        | 2          |
| 1.1.3 Monitored Elements.....                                           | 2          |
| 1.2 MISO Steady State Performance Criteria .....                        | 4          |
| <b>Section 2 – MISO Steady-State Thermal and Voltage Analysis .....</b> | <b>2-1</b> |
| 2.1 MISO Contingency Analysis for Summer Peak Condition .....           | 2-1        |
| 2.1.1 Summer Peak System Intact Conditions.....                         | 2-1        |
| 2.1.2 Summer Peak Post Contingency Conditions .....                     | 2-1        |
| 2.1.3 Summary of Summer Peak Results .....                              | 2-1        |
| 2.2 MISO Contingency Analysis for Summer Shoulder Condition .....       | 2-1        |
| 2.2.1 Summer Shoulder System Intact Conditions .....                    | 2-2        |
| 2.2.2 Summer Shoulder Post Contingency Conditions.....                  | 2-2        |
| 2.2.3 Summer Shoulder Worst Constraints.....                            | 2-2        |
| 2.2.4 Summary of Summer Shoulder Results.....                           | 2-4        |
| 2.2.5 Summary of MISO AFSIS Steady State Analysis.....                  | 2-4        |
| <b>Section 3 – MISO AFSIS Stability Analysis.....</b>                   | <b>3-1</b> |
| 3.1 Procedure .....                                                     | 3-1        |
| 3.1.1 Computer Programs .....                                           | 3-1        |
| 3.1.2 Methodology .....                                                 | 3-1        |
| 3.2 Model Development.....                                              | 3-1        |
| 3.3 Disturbance Criteria .....                                          | 3-1        |
| 3.4 Performance Criteria.....                                           | 3-2        |

|                                                                                     |                                                                                             |            |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------|
| 3.5                                                                                 | Summer Peak Stability Results .....                                                         | 3-2        |
| 3.5.2                                                                               | Transient Low Voltage Recovery .....                                                        | 3-3        |
| 3.5.3                                                                               | Stability Network Upgrades Identified in Summer Peak.....                                   | 3-3        |
| 3.6                                                                                 | Summer Shoulder Stability Results .....                                                     | 3-3        |
| 3.6.1                                                                               | Transient Low Voltage Recovery .....                                                        | 3-3        |
| 3.6.2                                                                               | GEN-2018-067 Active Power Reduction and Low Terminal Voltage.....                           | 3-3        |
| 3.6.3                                                                               | Stability Constraints Identified in Summer Shoulder .....                                   | 3-4        |
| 3.7                                                                                 | Summary of MISO AFSIS Transient Stability Analysis .....                                    | 3-4        |
| <b>Section 4 – Contingent Facilities.....</b>                                       |                                                                                             | <b>4-1</b> |
| <b>Section 5 – Network Upgrades and Cost Allocation .....</b>                       |                                                                                             | <b>5-1</b> |
| 5.1                                                                                 | Cost Assumptions for Network Upgrades .....                                                 | 5-1        |
| 5.2                                                                                 | Cost Allocation Methodology .....                                                           | 5-1        |
| 5.3                                                                                 | AFSIS Network Upgrades Required for the DISIS 2018-002 / 2019-001 West Study Projects ..... | 5-1        |
| <b>Appendix A – Model Development for Steady-State and Stability Analysis .....</b> |                                                                                             | <b>A-1</b> |
| A.1                                                                                 | Recently Withdrawn Prior Queued Projects.....                                               | A-1        |
| A.2                                                                                 | SPP Prior Queued Generation Projects.....                                                   | A-6        |
| A.3                                                                                 | MPC Prior Queued Generation Projects .....                                                  | A-8        |
| A.4                                                                                 | AECI Prior Queued Generation Projects.....                                                  | A-9        |
| A.5                                                                                 | Withdrawn Network Upgrades to Be Removed .....                                              | A-10       |
| A.6                                                                                 | Network Upgrades Required for Prior Queued Projects .....                                   | A-11       |
| A.7                                                                                 | Model Reviewing Comments.....                                                               | A-12       |
| A.8                                                                                 | MISO North for Power Balance .....                                                          | A-13       |
| A.9                                                                                 | SPP Market for Power Balance.....                                                           | A-14       |
| A.10                                                                                | AECI for Power Balance.....                                                                 | A-15       |
| A.11                                                                                | Contingency Files used in MISO AFSIS Analysis .....                                         | A-16       |
| <b>Appendix B – MISO AFSIS Thermal and Voltage Analysis Results .....</b>           |                                                                                             | <b>B-1</b> |
| B.1                                                                                 | Summer Peak (SPK) MISO AFSIS Constraints.....                                               | B-1        |
| B.2                                                                                 | Summer Shoulder (SH) MISO AFSIS Constraints.....                                            | B-3        |
| <b>Appendix C – MISO AFSIS Stability Analysis Results .....</b>                     |                                                                                             | <b>C-1</b> |
| C.1                                                                                 | Summer Peak (SPK) MISO AFSIS Stability Results .....                                        | C-1        |

|     |                                                    |     |
|-----|----------------------------------------------------|-----|
| C.2 | Summer Shoulder MISO AFSIS Stability Results ..... | C-4 |
|-----|----------------------------------------------------|-----|

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# Executive Summary

This report presents restudy results of an Affected System Impact Study (AFSIS) on MISO transmission system performed for generator interconnection requests in the Southwest Power Pool (SPP) queue 2018-002 / 2019-001 Phase 3 cluster west region (Study Projects). The AFSIS restudy results are summarized below.

## 1.1 Study Project List

The generation projects (Study Projects) in SPP DISIS-2018-002 / 2019-001 Phase 3 cluster west region have 10 generation projects with combined energy of 1598.65 MW, which are listed in Table ES-1.

**Table ES-1: SPP DISIS-2018-002 / 2019-001 West Phase 3 Study Projects**

| Project #    | Town / County     | State | Point of Interconnection              | Generation Type | Pmax  | SH (MW) | SPK (MW) |
|--------------|-------------------|-------|---------------------------------------|-----------------|-------|---------|----------|
| GEN-2018-067 | Williams          | ND    | Strandahl 115 kV                      | Wind            | 255   | 255     | 39.8     |
| GEN-2018-074 | Crawford / Carrol | IA    | Denison 230 kV                        | Wind            | 72    | 72      | 11.2     |
| 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-2019-016 | Polk / Dade       | MO    | Dadeville 161 kV                      | Solar           | 200   | 0       | 200.0    |
| GEN-2019-019 | Sioux             | IA    | Siouxland 69 kV                       | CT              | 15.15 | 0       | 15.15    |
| 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     |

## 1.2 MISO AFSIS Restudy Summary

MISO AFSIS restudy steady state models and stability packages were developed from the final models and stability package used in MISO AFSIS study for DISIS-2018-002 / 2019-001 West Phase 3 cycle.

Steady state thermal and voltage analysis was performed to identify any thermal and voltage violations in MISO region. Thermal AFSIS Network Upgrades identified in the steady state analysis are listed in Table ES-2. No MISO AFSIS voltage Network Upgrades (NUs) were identified.

**Table ES-2: MISO AFSIS Thermal Network Upgrades Identified for SPP Study Projects**

| Constraint               | Owner | Mitigation                                                                                                                                                  | Cost (\$) |
|--------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Merricourt-Wishek 230 kV | MDU   | MTEP ID: 25503, Facility ID:28741. Reconductor and pole replacement.<br>Post upgrade rating:730 MVA/803 MVA SUM, and 767 MVA/844 MVA WIN (Normal/Emergency) | \$0       |

Transient stability analysis was performed to identify any transient stability violations caused by the DISIS-2018-002 / 2019-001 West Study Projects. No transient stability constraints were identified in the summer peak and summer shoulder scenarios. No MISO AFSIS stability Network Upgrades are required for the Study Projects in DISIS 2018-002 / 2019-001 West Cluster. The GEN-2018-067 issue of active power output reduction and low terminal voltage is unrelated to MISO Affected System.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the DISIS-2018-002 / 2019-001 West Study Projects. Based on the screening results, MISO Transmission Owners do not plan to conduct additional studies.

Contingent facilities were identified. Details are in Section 4.

It should be noted that a restudy may be required if 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.

For the study projects that are required to mitigate thermal violations, the projects should not be allowed to come into service before the required Network Upgrades are in service, unless a MISO restudy removes the mitigation requirement from the project, or an interim limit is provided to the project through MISO Annual ERIS process. For projects that are required to mitigate voltage violations, no injection is allowed until the allocated upgrades and contingent facilities are in service.

### 1.3 Total MISO AFSIS Network Upgrades

The total cost of MISO AFSIS Network Upgrades required for the Study Projects in DISIS-2018-002 / 2019-001 West Phase 3 cycle is listed in Table ES-3. The costs for Network Upgrades are planning level estimates and subject to be revised in the facility studies.

**Table ES-3: Total Cost of MISO AFSIS Network Upgrades for  
DISIS-2018-002 / 2019-001 West Study Projects**

| Project Num       | Network Upgrades (\$)  |                     |               | Total Network Upgrade Cost (\$) |
|-------------------|------------------------|---------------------|---------------|---------------------------------|
|                   | MISO Thermal & Voltage | Transient Stability | Short Circuit |                                 |
| GEN-2018-067      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-074      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-125      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-131      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-132      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2019-016      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2019-019      | \$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                             |
| <b>Total (\$)</b> | <b>\$0</b>             | <b>\$0</b>          | <b>\$0</b>    | <b>\$0</b>                      |

## 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 DISIS-2018-002 / 2019-001 West cluster.

All the Study Projects in SPP DISIS-2018-002 / 2019-001 West cluster do not have MISO AFSIS Network Upgrade cost allocated to the projects

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## Model Development and Study Criteria

### 1.1 Model Development

Models used in this AFSIS restudy were developed from the final models used in MISO AFSIS study for DISIS-2018-002 / 2019-001 West Phase 3 cycle, which were originally developed from MISO DPP 2020 West Area Phase 3 final models. The MISO AFSIS final benchmark models for DISIS-2018-002 / 2019-001 West Phase 3 cycle are listed below:

- 2025 summer peak model: SPP DISIS-West\_AFSIS-Ph3-2025SUM-Benchmark\_231118.sav
- 2025 summer shoulder model: SPP DISIS-West\_AFSIS-Ph3-2025SH90-Benchmark\_231118.sav

#### 1.1.1 MISO AFSIS Benchmark Models

The summer peak and summer shoulder benchmark cases for the AFSIS restudy were created as follows:

- Removed recently withdrawn MISO Classic prior queued generation projects (Table A-1). Power mismatch was balanced by scaling generation in the MISO North (Table A-10).
- Removed recently withdrawn SPP prior and current queued generation projects (Table A-2). Power mismatch was balanced by scaling generation in SPP market (Table A-11) 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-10).
- Added and dispatched SPP prior queued generation projects (Table A-4) close to MISO West. Power mismatch was balanced by scaling generation in SPP market (Table A-11) 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-3). Power mismatch was balanced by scaling generation in AECI (Table A-12).
- Added and dispatched MPC prior queued generation projects (Table A-5). Removed duplicated MPC 04000 project and withdrawn project MPC04300. Power mismatch was balanced by scaling generation in the MISO North (Table A-10) except generation in Dakotas.
- Removed Scott County – Hazel Creek 345 kV Network Upgrade which was originally required for DPP 2020 West projects. Removed fictitious shunt capacitors at Jamestown 345 kV bus (bus #: 620369) and Wahpeton 230 kV bus (bus #: 620329) which were originally modeled in DPP 2020 West summer shoulder models.
- Removed Gentleman – Keystone – Red Willow – Post Rock 345 kV line which is no longer required by prior queued SPP projects. Removed Antelope Valley – Grand Prairie 345 kV line which is no longer required by prior queued SPP projects.

- Removed withdrawn Network Upgrades (Table A-7).
- Added MISO LRTP-1 project “Jamestown – Ellendale” and MISO LRTP-2 project “Big Stone South - Alexandria - Cassie's Crossing” (Table A-8).
- Network Upgrades for prior queued projects and MTEP Appendix A projects were added into the models (Table A-8).
- Added the SPP Study Projects with offline status in DISIS 2018-002 / 2019-001 West Cluster. The SPP Study Projects in MISO West are listed in Table ES-1.
- Updated bus voltage limits based on MTEP25
- Corrected modeling errors based on reviewing comments (Table A-9).

#### 1.1.1.1 MISO AFSIS Study Models

Summer peak (SPK) study case was created by dispatching the DISIS-2018-002 / 2019-001 West Study Projects at the specified summer peak level from the benchmark case.

Summer shoulder (SH) study case was created by dispatching the DISIS-2018-002 / 2019-001 West Study Projects 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 Contingency Criteria

The following contingencies were considered in the AFSIS steady-state 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.11.

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 Monitored Elements

The MISO 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<sup>®</sup>E rate A) rating, and bus voltages were monitored based on normal voltage limits associated with each bus in power flow case. Under NERC category P1-P7 conditions, branches were monitored for loading as shown in the column labeled "Post-Disturbance Thermal Limits", and bus voltages were monitored based on emergency voltage limits associated with each bus in power flow case.

**Table 1-1: MISO AFSIS Monitored Elements**

| Owner / Area | Thermal Limits <sup>1</sup> |                  |
|--------------|-----------------------------|------------------|
|              | Pre-Disturbance             | Post-Disturbance |
| AMIL         | 100% of Rate A              | 100% of Rate B   |
| AMMO         | 100% of Rate A              | 100% of Rate B   |
| ATCLLC       | 100% of Rate A              | 100% of Rate B   |
| BEPC-MISO    | 100% of Rate A              | 100% of Rate B   |
| CMPA         | 100% of Rate A              | 100% of Rate B   |
| CWLD         | 100% of Rate A              | 100% of Rate B   |
| CWLP         | 100% of Rate A              | 100% of Rate B   |
| DPC          | 100% of Rate A              | 100% of Rate B   |
| EES          | 100% of Rate A              | 100% of Rate B   |
| GLH          | 100% of Rate A              | 100% of Rate B   |
| GRE          | 100% of Rate A              | 100% of Rate B   |
| ITCM         | 100% of Rate A              | 100% of Rate B   |
| MDU          | 100% of Rate A              | 100% of Rate B   |
| MEC          | 100% of Rate A              | 100% of Rate B   |
| MMPA         | 100% of Rate A              | 100% of Rate B   |
| MP           | 100% of Rate A              | 100% of Rate B   |
| MPW          | 100% of Rate A              | 100% of Rate B   |
| MRES         | 100% of Rate A              | 100% of Rate B   |
| OTP          | 100% of Rate A              | 100% of Rate B   |
| PPI          | 100% of Rate A              | 100% of Rate B   |
| RPU          | 100% of Rate A              | 100% of Rate B   |
| SIPC         | 100% of Rate A              | 100% of Rate B   |
| SMMPA        | 100% of Rate A              | 100% of Rate B   |
| WPPI         | 100% of Rate A              | 100% of Rate B   |
| XEL          | 100% of Rate A              | 100% of Rate B   |

Notes

1: PSS®E Rate A, Rate B or Rate C

## 1.2 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.

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## MISO Steady-State Thermal and Voltage Analysis

Nonlinear (AC) contingency analysis was performed on the benchmark and study cases, and the incremental impact of the DISIS-2018-002 / 2019-001 West Study Projects was 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 TARA were used in the study.

### 2.1 MISO Contingency Analysis for Summer Peak Condition

Steady state AC contingency analysis was performed on the MISO AFSIS summer peak (SPK) study and benchmark cases developed in Section 1.1. The summer peak MISO AFSIS thermal and voltage results are in Appendix B.1.

#### 2.1.1 Summer Peak System Intact Conditions

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

#### 2.1.2 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 B-3) or voltage constraints (Table B-4) were identified.

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

#### 2.1.3 Summary of Summer Peak Results

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

### 2.2 MISO Contingency Analysis for Summer Shoulder Condition

Steady state AC contingency analysis was performed on the MISO AFSIS summer shoulder (SH) study and benchmark cases developed in Section 1.1. The summer shoulder MISO AFSIS thermal and voltage results are in Appendix B.2.

### **2.2.1 Summer Shoulder System Intact Conditions**

For NERC category P0 (system intact) conditions, thermal constraints are listed in Table B-7, no voltage constraints were identified (Table B-8).

### **2.2.2 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 B-9, no voltage constraints were identified (Table B-10).

One category P2-P7 contingencies (Table B-13) 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 B-13, DC contingency analysis was performed to get the dc thermal results. The dc thermal results for non-converged contingencies are listed in Table B-14.

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

### **2.2.3 Summer Shoulder Worst Constraints**

In the summer shoulder scenario, MISO AFSIS worst thermal constraints are listed in Table 2-1. No MISO AFSIS voltage constraints were identified.

**Table 2-1: Summer Shoulder MISO AFSIS Thermal Constraints, Maximum Screened Loading**

| Generator    | Constraint               | Rating | Owner | Worst Loading |       | Contingency   | Cont Type |
|--------------|--------------------------|--------|-------|---------------|-------|---------------|-----------|
|              |                          |        |       | (MVA)         | (%)   |               |           |
| GEN-2018-067 | Merricourt-Wishek 230 kV | 343.0  | MDU   | 388.7         | 113.3 | CEII Redacted | P0        |
| GEN-2018-067 | Merricourt-Wishek 230 kV | 343.0  | MDU   | 386.4         | 112.6 | CEII Redacted | P1        |

## 2.2.4 Summary of Summer Shoulder Results

In the summer shoulder scenario, Table 2-2 lists MISO AFSIS thermal constraints and Network Upgrades. No MISO AFSIS voltage Network Upgrades are required.

**Table 2-2: MISO AFSIS Thermal Constraints and Network Upgrades in Summer Shoulder Scenario**

| Generator    | Constraint               | Owner | Mitigation                                                                                                                                                  | Cost (\$) |
|--------------|--------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| GEN-2018-067 | Merricourt-Wishek 230 kV | MDU   | MTEP ID: 25503, Facility ID:28741. Reconductor and pole replacement.<br>Post upgrade rating:730 MVA/803 MVA SUM, and 767 MVA/844 MVA WIN (Normal/Emergency) | \$0       |

## 2.2.5 Summary of MISO AFSIS Steady State Analysis

MISO AFSIS steady state analyses were performed on the MISO summer peak and summer shoulder scenarios. The steady state thermal constraints and required Network Upgrades are listed in Table 2-3. No MISO AFSIS voltage Network Upgrades are required.

**Table 2-3: MISO AFSIS Thermal Constraints and Network Upgrades**

| Generator    | Constraint               | Owner | Mitigation                                                                                                                                                  | Cost (\$) |
|--------------|--------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| GEN-2018-067 | Merricourt-Wishek 230 kV | MDU   | MTEP ID: 25503, Facility ID:28741. Reconductor and pole replacement.<br>Post upgrade rating:730 MVA/803 MVA SUM, and 767 MVA/844 MVA WIN (Normal/Emergency) | \$0       |

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## MISO AFSIS Stability Analysis

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Stability analysis was performed to evaluate transient stability and impact on the MISO region of the Study Projects in SPP DISIS-2018-002 / 2019-001 West Cluster.

### 3.1 Procedure

#### 3.1.1 Computer Programs

Stability analysis was performed using TSAT.

#### 3.1.2 Methodology

Stability package representing summer peak (SPK) and summer shoulder (SH) scenarios with generating facilities in the SPP DISIS-2018-002 / 2019-001 West Cluster was created from MISO AFSIS stability package for DISIS-2018-002 / 2019-001 West Phase 3 cycle, which was originally developed 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 1.1. Disturbances were simulated to evaluate the transient stability and impact on the region of the DISIS-2018-002 / 2019-001 West Study Projects. MISO transient stability criteria and local TOs' planning criteria specified in MTEP20 were adopted for checking stability violations.

### 3.2 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.

### 3.3 Disturbance Criteria

The stability simulations performed as part of this study considered all the regional and local contingencies listed in Table 3-1. 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 3-2. 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 3-1: MISO AFSIS Regional and Local Disturbance Descriptions****CEII Redacted****Table 3-2: 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                           |

### 3.4 Performance Criteria

MISO transient stability criteria and local TOs' planning criteria specified in MTEP20 were adopted. All Study Generators in SPP DISIS-2018-002 / 2019-001 West Cluster must mitigate the stability constraints to obtain any type of Interconnection Service.

### 3.5 Summer Peak Stability Results

The contingencies listed in Table 3-1 were simulated using the summer peak stability model as developed in Section 1.1.

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

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

#### 3.5.1.1 Post-Fault Small Oscillation of Generation Output

Under two contingencies listed in Table 3-3, small oscillations were observed on active and reactive power output of several conventional generators (Coal Creek unit 1 or 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 DISIS-2018-002 / 2019-001 West Study Projects.

**Table 3-3: Post-Fault Small Oscillation of Generation Output****CEII Redacted**

### 3.5.2 Transient Low Voltage Recovery

Under two contingencies listed in Table 3-4, voltages at Firth 115 kV (640171) and Sterling 115 kV (640362) were around 0.83 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 DISIS-2018-002 / 2019-001 West Study Projects.

**Table 3-4: Transient Low Voltage Recovery**

**CEII Redacted**

### 3.5.3 Stability Network Upgrades Identified in Summer Peak

In summary, no MISO Affected System stability constraints were identified in the summer peak scenario. No MISO AFSIS stability Network Upgrades are required in summer peak stability study

## 3.6 Summer Shoulder Stability Results

The contingencies listed in Table 3-1 were simulated using the summer shoulder stability model as developed in Section 1.1.

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

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

### 3.6.1 Transient Low Voltage Recovery

Under two contingencies listed in Table 3-5, voltages at Firth 115 kV (640171) and Sterling 115 kV (640362) were below 0.9 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 DISIS-2018-002 / 2019-001 West Study Projects.

**Table 3-5: Transient Low Voltage Recovery**

**CEII Redacted**

### 3.6.2 GEN-2018-067 Active Power Reduction and Low Terminal Voltage

Under two local contingencies at GEN-2018-067 POI (Table 3-6), GEN-2018-067 active power output was reduced and its terminal voltage was around 0.82 p.u. after the fault was cleared. Nearby 115 kV buses also had post-fault low voltages. This is an indication of local voltage collapse. The GEN-2018-067 generation project is responsible for fixing this issue.

**Table 3-6: GEN-2018-067 Active Power Reduction and Low Terminal Voltage**

## **CEII Redacted**

### **3.6.3 Stability Constraints Identified in Summer Shoulder**

In summary, no MISO Affected System stability constraints were identified in the summer shoulder scenario. The GEN-2018-067 issue of active power output reduction and low terminal voltage is unrelated to MISO Affected System. No MISO AFSIS stability NUs are required.

### **3.7 Summary of MISO AFSIS Transient Stability Analysis**

Based on the MISO summer peak and summer shoulder transient stability analysis, no MISO AFSIS stability Network Upgrades are required for the Study Projects in DISIS 2018-002 / 2019-001 West Cluster. The GEN-2018-067 issue of active power output reduction and low terminal voltage is unrelated to MISO Affected System.

## Contingent Facilities

Table 4-1 describes transmission assumptions modeled in the studies that were deemed necessary to mitigate the voltage violations identified in the study. 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 shall not be allowed for injection until the identified contingent facilities are in service.

**Table 4-1: Contingent Facility and Conditional Projects**

| MTEP ID | MTEP Cycle | Project Name                                     | Project Description                                                                                                                                                                                  | Status                   | Expected ISD | Conditional Projects |
|---------|------------|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------|----------------------|
| 25503   | MTEP24     | MDU Network and Interconnection Upgrades - J1040 | Facility ID:28741, Facility Name: 28741-Wishek-Merricourt. Description: reconductor and pole replacement.<br><br>Post upgrade rating:730 MVA/803 MVA SUM, and 767 MVA/844 MVA WIN (Normal/Emergency) | M2 - Appendix A Approved | 07/24/2026   | GEN-2018-067         |

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## 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 DISIS 2018-002 / 2019-001 West Study Projects

Based on the MISO summer peak and summer shoulder steady state analysis, thermal constraints were identified in MISO system for the DISIS-2018-002 / 2019-001 West Study Projects. No MISO AFSIS voltage constraints were identified. MISO AFSIS thermal NUs are required for the DISIS-2018-002 / 2019-001 West Study Projects.

Based on the MISO summer peak and summer shoulder transient stability analysis, no additional MISO AFSIS stability Network Upgrades are required for the DISIS-2018-002 / 2019-001 West Study Projects.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the DISIS-2018-002 / 2019-001 West Study Projects. 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.

The total costs of MISO AFSIS Network Upgrades for DISIS-2018-002 / 2019-001 West Study Projects are summarized in Table 5-1.

**Table 5-1: Summary of MISO AFSIS Network Upgrades**

| Category of Network Upgrades                                      | Cost (\$)  |
|-------------------------------------------------------------------|------------|
| Thermal Network Upgrades Identified in MISO Steady-State Analysis | \$0        |
| Voltage Network Upgrades Identified in MISO Steady-State Analysis | \$0        |
| Network Upgrades Identified in Stability Analysis                 | \$0        |
| Network Upgrades Identified in Short Circuit Analysis             | \$0        |
| <b>Total</b>                                                      | <b>\$0</b> |

MISO AFSIS Network Upgrades for DISIS-2018-002 / 2019-001 West Study Projects are listed below:

**Table 5-2: MISO Thermal NUs and Cost**

| Constraint               | Owner | Mitigation                                                                                                                                                  | Cost (\$) |
|--------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Merricourt-Wishek 230 kV | MDU   | MTEP ID: 25503, Facility ID:28741. Reconductor and pole replacement.<br>Post upgrade rating:730 MVA/803 MVA SUM, and 767 MVA/844 MVA WIN (Normal/Emergency) | \$0       |

**Table 5-3: MISO Steady-State Voltage NUs and Cost**

| Network Upgrades | Owner | Cost (\$) |
|------------------|-------|-----------|
| No voltage NUs   |       | \$0       |

**Table 5-4: MISO Transient Stability Voltage NUs and Cost**

| Constraint               | Network Upgrades              | Owner | Cost (\$) |
|--------------------------|-------------------------------|-------|-----------|
| No stability constraints | No stability Network Upgrades |       | \$0       |

### 5.3.1.1 MISO AFSIS NU Cost Allocation

Assuming all generation projects in the DISIS-2018-002 / 2019-001 West Study Projects advance, a summary of the costs for total MISO AFSIS NUs allocated to each generation project is listed in Table 5-5.

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

| Project Num       | Network Upgrades (\$)  |                     |               | Total Network Upgrade Cost (\$) |
|-------------------|------------------------|---------------------|---------------|---------------------------------|
|                   | MISO Thermal & Voltage | Transient Stability | Short Circuit |                                 |
| GEN-2018-067      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-074      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-125      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-131      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2018-132      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2019-016      | \$0                    | \$0                 | \$0           | \$0                             |
| GEN-2019-019      | \$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                             |
| <b>Total (\$)</b> | <b>\$0</b>             | <b>\$0</b>          | <b>\$0</b>    | <b>\$0</b>                      |

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# Model Development for Steady-State and Stability Analysis

## A.1 Recently Withdrawn Prior Queued Projects

**Table A-1: Recently Withdrawn MISO Classic Prior Queued Project**

| Prj # | Bus Number | Bus Name          | Id | Status    |
|-------|------------|-------------------|----|-----------|
| J803  | 88035      | J803 0.6000       | PV | Withdrawn |
| J1042 | 40420      | J1042 GEN 0.6300  | PV | Withdrawn |
| J1043 | 40430      | J1043 GEN 0.6500  | 1  | Withdrawn |
| J1074 | 40740      | J1074 GEN 0.6000  | 1  | Withdrawn |
| J1225 | 42250      | J1225 GEN 0.6300  | 1  | Withdrawn |
| J1350 | 43500      | J1350 GEN 0.6000  | 1  | Withdrawn |
| J1353 | 43530      | J1353 GEN 0.3850  | 1  | Withdrawn |
| J1497 | 44970      | J1497 GEN 0.6300  | 1  | Withdrawn |
| J1510 | 45100      | J1510 GEN 0.6300  | 1  | Withdrawn |
| J1567 | 45670      | J1567 GEN 0.6300  | 1  | Withdrawn |
| J1708 | 47080      | J1708 GEN 0.6300  | 1  | Withdrawn |
| J1735 | 47350      | J1735 GEN 0.6300  | 1  | Withdrawn |
| J897  | 88977      | J897 G1 0.6900    | W  | Withdrawn |
| J897  | 88978      | J897 G2 0.6900    | W  | Withdrawn |
| J1101 | 41010      | J1101 GEN 0.6900  | BT | Withdrawn |
| J1191 | 41910      | J1191 GEN 0.6000  | 1  | Withdrawn |
| J1204 | 42040      | J1204 GEN 0.6000  | 1  | Withdrawn |
| J1231 | 42310      | J1231 GEN 0.6450  | 1  | Withdrawn |
| J1253 | 42530      | J1253 GEN 0.6450  | PV | Withdrawn |
| J1332 | 43320      | J1332 GEN 0.6000  | 1  | Withdrawn |
| J1408 | 44080      | J1408 GEN 0.7200  | 1  | Withdrawn |
| J1408 | 44081      | J1408 GEN1 0.4800 | 1  | Withdrawn |

| Prj # | Bus Number | Bus Name          | Id | Status    |
|-------|------------|-------------------|----|-----------|
| J1408 | 44082      | J1408 GEN2 0.6600 | 1  | Withdrawn |
| J1447 | 44470      | J1447 GEN 0.6300  | 1  | Withdrawn |
| J1516 | 45160      | J1516 GEN 0.6300  | 1  | Withdrawn |
| J1526 | 45260      | J1526 GEN 0.6300  | 1  | Withdrawn |
| J1527 | 45270      | J1527 GEN 0.6300  | 1  | Withdrawn |
| J1716 | 47160      | J1716 GEN 0.6450  | 1  | Withdrawn |
| J750  | 87500      | J750 GEN 0.7200   | 1  | Withdrawn |
| J801  | 88011      | J801 0.5500       | PV | Withdrawn |
| J974  | 89740      | J974 GEN 0.6900   | 1  | Withdrawn |
| J974  | 89741      | J974 GEN1 0.6900  | 1  | Withdrawn |
| J987  | 89870      | J987 GEN 0.6000   | 1  | Withdrawn |
| J991  | 89910      | J991 GEN 0.6000   | 1  | Withdrawn |
| J994  | 89940      | J994 GEN 0.6000   | 1  | Withdrawn |
| J815  | 348308     | J815G1 0.5500     | S1 | Withdrawn |
| J815  | 348309     | J815G2 0.6300     | S2 | Withdrawn |

**Table A-2: Recently Withdrawn SPP Prior & Current 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  |

| Prj #        | Status     | Bus Number | Bus Name           | Id |
|--------------|------------|------------|--------------------|----|
| 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  |
| GEN-2017-008 | WITHDRAWN  | 588533     | G17-008-GEN10.6900 | 1  |
| GEN-2017-008 | WITHDRAWN  | 588537     | G17-008-GEN20.6900 | 1  |
| GEN-2017-024 | WITHDRAWN  | 588683     | G17-024-GEN10.6000 | 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-2017-148 | WITHDRAWN  | 760896     | G17-148GEN1 0.6900 | 1  |
| GEN-2017-216 | WITHDRAWN  | 761043     | G17-216GEN1 0.6900 | 1  |
| GEN-2017-229 | WITHDRAWN  | 761757     | G17-229GEN1 0.6900 | 1  |
| GEN-2017-128 | WITHDRAWN  | 761925     | G17-128GEN1 0.6900 | 1  |
| GEN-2017-191 | WITHDRAWN  | 761946     | G17-191GEN1 0.6900 | 1  |
| GEN-2017-111 | WITHDRAWN  | 762009     | G17-111-GEN10.6300 | 1  |
| GEN-2018-054 | WITHDRAWN  | 762892     | G18-054-GEN10.6600 | 1  |
| GEN-2018-070 | WITHDRAWN  | 763057     | G18-070-GEN10.6900 | 1  |
| GEN-2018-090 | WITHDRAWN  | 763199     | G18-090-GEN10.6450 | 1  |
| GEN-2018-121 | WITHDRAWN  | 763364     | G18-121-GEN10.6450 | 1  |
| GEN-2019-029 | WITHDRAWN  | 763662     | G19-029-GEN10.5500 | 1  |
| GEN-2019-029 | WITHDRAWN  | 763665     | G19-029-GEN20.5500 | 1  |
| GEN-2019-033 | WITHDRAWN  | 763684     | G19-033-GEN10.6600 | 1  |
| GEN-2016-007 | TERMINATED | 587053     | G16-007-GEN10.6500 | 1  |
| GEN-2016-063 | TERMINATED | 587433     | G16-063-GEN10.6900 | 1  |
| GEN-2017-048 | TERMINATED | 588873     | G17-048-GEN10.6900 | 1  |
| GEN-2017-120 | WITHDRAWN  | 760003     | G17-120-GEN10.6900 | 1  |

| Prj #        | Status     | Bus Number | Bus Name           | Id |
|--------------|------------|------------|--------------------|----|
| GEN-2017-120 | WITHDRAWN  | 760006     | G17-120-GEN20.6900 | 1  |
| GEN-2017-119 | WITHDRAWN  | 760581     | G17-119-GEN10.6900 | 1  |
| GEN-2017-119 | WITHDRAWN  | 760584     | G17-119-GEN20.6900 | 1  |
| GEN-2017-115 | TERMINATED | 760749     | G17-115GEN1 0.6900 | 1  |
| GEN-2017-115 | TERMINATED | 760752     | G17-115GEN2 0.6900 | 1  |
| GEN-2017-209 | TERMINATED | 760917     | G17-209GEN1 0.6900 | 1  |
| GEN-2017-209 | TERMINATED | 760917     | G17-209GEN1 0.6900 | 2  |
| GEN-2017-209 | TERMINATED | 760920     | G17-209GEN2 0.6300 | 1  |
| GEN-2017-209 | TERMINATED | 760920     | G17-209GEN2 0.6300 | 2  |
| GEN-2017-210 | WITHDRAWN  | 761211     | G17-210-GEN10.6900 | 1  |
| GEN-2017-210 | WITHDRAWN  | 761211     | G17-210-GEN10.6900 | 2  |
| GEN-2017-210 | WITHDRAWN  | 761214     | G17-210-GEN20.6900 | 1  |
| GEN-2017-210 | WITHDRAWN  | 761214     | G17-210-GEN20.6900 | 2  |
| GEN-2017-202 | WITHDRAWN  | 761421     | G17-202GEN1 0.6900 | 1  |
| GEN-2017-125 | TERMINATED | 761904     | G17-125GEN1 0.6900 | 1  |
| GEN-2018-010 | TERMINATED | 762485     | G18-010-GEN10.6300 | 1  |
| GEN-2018-012 | WITHDRAWN  | 762507     | G18-012-GEN10.6900 | 1  |
| GEN-2018-013 | WITHDRAWN  | 762517     | G18-013-GEN10.7200 | 1  |
| GEN-2018-008 | WITHDRAWN  | 762540     | G18-008-GEN10.6900 | 1  |
| GEN-2018-008 | WITHDRAWN  | 762543     | G18-008-GEN20.6900 | 1  |
| GEN-2018-022 | WITHDRAWN  | 762584     | G18-022GEN1 0.6000 | 1  |
| GEN-2018-022 | WITHDRAWN  | 762587     | G18-022GEN2 0.6000 | 1  |
| GEN-2018-022 | WITHDRAWN  | 762588     | G18-022GEN3 0.6300 | 1  |
| GEN-2018-030 | WITHDRAWN  | 762661     | G18-030GEN1 0.6600 | 1  |
| GEN-2018-032 | TERMINATED | 762683     | G18-032GEN1 0.6500 | 1  |
| GEN-2018-032 | TERMINATED | 762686     | G18-032GEN2 0.6500 | 1  |
| GEN-2018-039 | WITHDRAWN  | 762738     | G18-039GEN1 0.6600 | 1  |
| GEN-2018-056 | WITHDRAWN  | 762914     | G18-056-GEN10.6600 | 1  |
| GEN-2018-060 | WITHDRAWN  | 762957     | G18-060-GEN10.6300 | 1  |
| GEN-2018-062 | WITHDRAWN  | 762979     | G18-062-GEN10.6900 | 1  |
| GEN-2018-063 | WITHDRAWN  | 762991     | G18-063-GEN10.6000 | 1  |
| GEN-2018-065 | WITHDRAWN  | 763013     | G18-065-GEN10.6900 | 1  |
| GEN-2018-068 | WITHDRAWN  | 763035     | G18-068-GEN10.6900 | 1  |

| Prj #        | Status    | Bus Number | Bus Name           | Id |
|--------------|-----------|------------|--------------------|----|
| GEN-2018-068 | WITHDRAWN | 763038     | G18-068-GEN20.6900 | 1  |
| GEN-2018-069 | WITHDRAWN | 763046     | G18-069-GEN10.6900 | 1  |
| GEN-2018-083 | WITHDRAWN | 763145     | G18-083-GEN10.6900 | 1  |
| GEN-2018-083 | WITHDRAWN | 763148     | G18-083-GEN20.6900 | 1  |
| GEN-2019-009 | WITHDRAWN | 763508     | G19-009-GEN10.6900 | 1  |
| GEN-2019-023 | WITHDRAWN | 763629     | G19-023-GEN10.6300 | 1  |
| GEN-2019-023 | WITHDRAWN | 763632     | G19-023-GEN20.6300 | 1  |
| GEN-2019-048 | WITHDRAWN | 763805     | G19-048-GEN10.6500 | 1  |
| GEN-2019-069 | WITHDRAWN | 763981     | G19-069-GEN10.6600 | 1  |
| GEN-2019-070 | WITHDRAWN | 763991     | G19-070-GEN10.6600 | 1  |
| GEN-2019-073 | WITHDRAWN | 764002     | G19-073-GEN10.6600 | 1  |

**Table A-3: 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-4: 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            | Neosho                  | 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-2017-060  | 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      |
| GEN-2017-108  | DISIS-2017-002   | 400   | Solar           | Henry                   | MO    | Stillwell-Clinton 161 kV          | KCPL      |
| GEN-2017-144  | DISIS-2017-002   | 200   | Wind            | Holt, Antelope, Wheeler | NE    | Holt County 345 kV                | WAPA      |

| Projects     | Cluster        | MW    | Generation Type | Town or County  | State | Substation or Line                                     | TO at POI |
|--------------|----------------|-------|-----------------|-----------------|-------|--------------------------------------------------------|-----------|
| 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-2017-195 | 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-2017-214 | 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-2017-222 | DISIS-2017-002 | 180   | Wind            | Denison         | IA    | Denison 230 kV                                         | WAPA      |
| GEN-2017-234 | DISIS-2017-002 | 115   | Wind            | Greeley         | NE    | Spalding-North Loup 115 kV                             | NPPD      |
| GEN-2018-025 | DISIS-2018-001 | 200   | Battery         | Washington      | NE    | Fort Calhoun 345 kV                                    | OPPD      |
| GEN-2018-031 | DISIS-2018-001 | 50    | Battery         | Jackson         | MO    | Blue Valley 161 kV                                     | INDN      |
| 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-2018-043 | DISIS-2018-001 | 500   | Solar           | Burt            | NE    | Ft. Calhoun-Raun 345 kV                                | OPPD      |
| GEN-2018-057 | DISIS-2018-001 | 203.4 | Solar           | Sedgwick        | KS    | Gordon Evans 138 kV                                    | WERE      |

### A.3 MPC Prior Queued Generation Projects

**Table A-5: MPC Prior Queued Generation Projects**

| Projects | Cluster        | MW    | Generation Type | Town or County    | State | Substation or Line       | TO at POI |
|----------|----------------|-------|-----------------|-------------------|-------|--------------------------|-----------|
| MPC03600 | MPC Group 2020 | 167.2 | Solar           | Richland          | ND    | Frontier-Wahpeton 230 kV | MPC       |
| MPC03700 | MPC Group 2020 | 127.9 | Solar           | Richland          | ND    | Frontier-Wahpeton 230 kV | MPC       |
| MPC03800 | MPC Group 2021 | 230   | Wind            | Eddy;<br>Wells    | ND    | Center-Prairie 345 kV    | MPC       |
| MPC03900 | MPC Group 2021 | 140   | Wind            | Eddy;<br>Wells    | ND    | Center-Prairie 345 kV    | MPC       |
| MPC04000 | MPC Group 2021 | 284   | Wind            | Oliver;<br>Morton | ND    | Square Butte 230 kV      | MPC       |

## A.4 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.5 Withdrawn Network Upgrades to Be Removed

**Table A-7: Withdrawn Network Upgrades to Be Removed**

| Network Upgrades                                                                                    | Study Cycle     |
|-----------------------------------------------------------------------------------------------------|-----------------|
| Astoria-Brookings 345 kV 2nd line                                                                   | J1456 withdrawn |
| 100 MVAR Capacitor Bank at Montezuma 345 kV (635730)                                                | DISIS-2017-001  |
| Replace 100 MVAR SVC at Blackhawk 345 kV (636197) with 100 MVAR MSC                                 |                 |
| 40 MVar switched cap at Wahpeton 230 kV (620329)                                                    | DISIS-2017-001  |
| 60 MVar switched cap at Buffalo 345 kV (620358)                                                     | DISIS-2017-001  |
| Capacitor at Maynard 115: 1x40 Mvar (603177)                                                        | DISIS-2018-001  |
| 1x75 MVar MSC at Alexandria 345 (658047)                                                            | MPC Group 2021  |
| Reduced from 3x75 MVar MSC at Bison 345 (601067) to 1x75 MVar (assigned to DPP 2018 West)           | MPC Group 2021  |
| 1x30 Mvar MSC and $\pm 50$ Mvar STATCOM at Winger 230 kV (657758)                                   | MPC Group 2021  |
| Capacitor at Prairie 115 kV: 3x40 Mvar (603007)                                                     | MTEP            |
| New 345 kV outlet line from MPC04300 to a new substation tapping the Buffalo-Jamestown 345 kV line. | MPC 04300       |
| Maple River 230 (657754) 2x40 MVar MSC                                                              | MPC 04300       |

## A.6 Network Upgrades Required for Prior Queued Projects

**Table A-8: Modeled Prior Queued Network Upgrades**

| Network Upgrades                                                                    | Study Cycle              |
|-------------------------------------------------------------------------------------|--------------------------|
| LRTP-1 project: Jamestown – Ellendale 345 kV                                        | MTEP Appendix A          |
| LRTP-2 project: Big Stone South - Alexandria - Cassie's Crossing                    | MTEP Appendix A          |
| Build Brookings Co-Lyon Co 2nd 345 kV line; Build Helena-Hampton Corner 345 kV line | MTEP Appendix A          |
| Reactor at Prairie 115 (657712): 1x50 Mvar                                          | MTEP Appendix A          |
| Capacitor at Bagley 115: 1x20 Mvar                                                  | DISIS-2016-002           |
| 100 MVAR switched cap at Blackhawk 345 kV (MEC)                                     | DISIS-2017-001           |
| 40 MVar switched cap at Wahpeton 230 kV (620329)                                    | DISIS-2017-001           |
| 60 MVar switched cap at Buffalo 345 kV (620358)                                     | DISIS-2017-001           |
| Add breaker to the Bison shunt reactor                                              | MISO AFS on MPC Grp 2021 |
| Jamestown Load.idv                                                                  | MTEP                     |
| MDU-50037-EPR-EllendaleDataCenter2.idv                                              | MTEP                     |
| MDU-50152-EPR-EllendaleDataCenter3.idv                                              | MTEP                     |
| OTP_EXPEDITED_50603_Big_Stone_South_Load_Addtion-155MW.idv                          | MTEP                     |

## A.7 Model Reviewing Comments

**Table A-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       |          |                                              |
| SPTI    | Correct Bus Name.py                            | X       | X        |                                              |

## A.8 MISO North for Power Balance

**Table A-10. 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.9 SPP Market for Power Balance

**Table A-11. SPP Market for Power Balance**

| Area # | Area Name | Area # | Area Name |
|--------|-----------|--------|-----------|
| 515    | SWPA      | 542    | KACY      |
| 520    | AEPW      | 544    | EMDE      |
| 523    | GRDA      | 545    | INDN      |
| 524    | OKGE      | 546    | SPRM      |
| 525    | WFEC      | 640    | NPPD      |
| 526    | SPS       | 641    | HAST      |
| 527    | OMPA      | 642    | KACY      |
| 531    | MIDW      | 645    | OPPD      |
| 534    | SUNC      | 650    | LES       |
| 536    | WERE      | 652    | WAPA      |
| 541    | KCPL      | 659    | BEPC-SPP  |

## A.10 AECI for Power Balance

**Table A-12. AECI for Power Balance**

| Area # | Area Name |
|--------|-----------|
| 330    | AECI      |

## A.11 Contingency Files used in MISO AFSIS Analysis

**Table A-13: List of Contingencies used in the MISO AFSIS Steady-State 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                |
| 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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## MISO AFSIS Thermal and Voltage Analysis Results

### B.1 Summer Peak (SPK) MISO AFSIS Constraints

Table B-1. SPK System Intact MISO Thermal Constraints

Table B-2. SPK System Intact MISO Voltage Constraints

Table B-3. SPK Category P1 MISO Thermal Constraints

Table B-4. SPK Category P1 MISO Voltage Constraints

Table B-5. SPK Category P2-P7 MISO Thermal Constraints

Table B-6. SPK Category P2-P7 MISO Voltage Constraints

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## **B.2 Summer Shoulder (SH) MISO AFSIS Constraints**

**Table B-7. SH System Intact MISO Thermal Constraints**

**Table B-8. SH System Intact MISO Voltage Constraints**

**Table B-9. SH Category P1 MISO Thermal Constraints**

**Table B-10. SH Category P1 MISO Voltage Constraints**

**Table B-11. SH Category P2-P7 MISO Thermal Constraints**

**Table B-12. SH Category P2-P7 MISO Voltage Constraints**

**Table B-13. SH MISO Non-Converged Contingencies**

**Table B-14. SH MISO Non-Converged Contingencies DCCC Results**

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## MISO AFSIS Stability Analysis Results

### C.1 Summer Peak (SPK) MISO AFSIS Stability Results

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

#### C.1.1 SPK MISO AFSIS Stability Summary

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

**Table C-1: Summer Peak MISO AFSIS Stability Analysis Results Summary**

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### **C.1.2 SPK MISO AFSIS Stability Plots**

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

AppendixC1-2\_SPK\_DISIS-18-2\_19-1\_Restudy\_Plots.zip

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## **C.2 Summer Shoulder MISO AFSIS Stability Results**

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

### **C.2.1 SH MISO AFSIS Stability Summary**

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

**Table C-2: Summer Shoulder MISO AFSIS Stability Analysis Results Summary**

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### **C.2.2 SH MISO AFSIS Stability Plots**

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

AppendixC2-2\_SH\_DISIS-18-2\_19-1\_Restudy\_Plots.zip

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