MISO Affected System Studies for SPP DISIS-2017-002 Phase III

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Executive Summary

Midcontinent Independent System Operator ("MISO") has contracted with CF Power Ltd. ("CFP") to perform Affected System Studies ("AFS") for the interconnection requests in the Southwest Power Pool ("SPP") queue (the "Projects"). SPP is commencing the Definitive Interconnection System Impact Studies ("DISIS") for their DISIS-2017-002 cycle Projects. The MISO AFS is intended to identify the impacts of these Projects on the MISO system.

The study will be done in two phases. Phase II study was completed in August 2022. The report here includes the methodology, assumptions, and results for Phase III analysis. No stability issue was identified in Phase II. Several projects were withdrawn in Phase III. Therefore, dynamic stability is not required in Phase III. This Affected System Study includes only steady state analyses.

Because of a wide geographical region of the SPP Projects, the MISO AFS was divided in two groups to identify the impacts on the MISO West and MISO South regions.

The steady state analysis identified several thermal violations in the MISO-West regions due to SPP Projects. Based on the feedback from MISO and Transmission Owners, the study identified Network Upgrades to address the thermal criteria violations. These Network Upgrades along with their planning level cost estimated are summarized below. Mitigations for non-MISO facilities are not required for this study.

Table ES- 1: Network Upgrades Required to Address Thermal Violations

Item#	Description	Planning Level Cost Estimate ($M)	Area	Area Name
1	Build new 2.5 mile Xcel 115kV line from Magic City to Mallard subs	5	600	XEL

The costs of Network Upgrades are allocated among the Projects based on their pro rata impacts on the violations in accordance of the MISO business practices.

Table ES- 2 shows the responsibility of each Project.

Table ES- 2: Cost Allocation Summary for the Network Upgrades

Project	Total
GEN-2017-214	1,250,000.00
GEN-2017-215	1,250,000.00
GEN-2017-216	1,250,000.00
GEN-2017-235	625,000.00
GEN-2017-236	625,000.00
Total	$5,000,000

No contingent MTEP facilities were identified for the studied projects.

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Section 1: Introduction

1.1 Background

Midcontinent Independent System Operator ("MISO") has contracted with CF Power Ltd. ("CFP") to perform Affected System Studies ("AFS") for the interconnection requests in the Southwest Power Pool ("SPP") queue (the "Projects"). SPP is commencing the Definitive Interconnection System Impact Studies ("DISIS") for their DISIS-2017-002 cycle Projects. The MISO AFS is intended to identify the impacts of these Projects on the MISO system.

The study will be done in two phases. Phase II study was completed in August 2022. The report here includes the methodology, assumptions, and results for Phase III analysis. No stability issue was identified in Phase II. Several projects were withdrawn in Phase III. Therefore, dynamic stability is not required in Phase III. This Affected System Study includes only steady state analyses. Because of a wide geographical region of the SPP Projects, the MISO AFS was divided in two groups to identify the impacts on the MISO west and MISO South regions

1.2 Project Description

SPP Projects, to be studied for MISO West region, are listed in Table 1- and MISO South region in Table 1- .

Table 1- 1: SPP Projects List for MISO West Region

Project	Capacity	Fuel Type	Area Name	County	State
ASGI-2017-014	40	Solar	KCPL	#N/A	KS
GEN-2017-105	75	Wind	OPPD	Burt County	NE
GEN-2017-108	400	Solar	KCPL	Henry County	MO
GEN-2017-111	152	Solar	KCPL	Bates	MO
GEN-2017-115	244	Wind	KCPL	Atchinson/Nodaway	MO
GEN-2017-119	180	Wind	SUNC	Cloud/Mitchell	KS
GEN-2017-120	260	Wind	WERE	Dickinson/Marion	KS
GEN-2017-125	252	Wind	WERE	Osage	KS
GEN-2017-128	202	Wind	WERE	Jackson	KS
GEN-2017-144	200	Wind	WAPA	Holt, Antelope, Wheeler	NE
GEN-2017-148	202	Wind	EMDE	Newton	MO
GEN-2017-175	300	Wind	WAPA	Turner	SD
GEN-2017-181	300	Wind	NPPD	Lancaster	NE
GEN-2017-182	128	Wind	NPPD	Lancaster	NE
GEN-2017-183	400	Wind	KCPL	Hodgeman/Ford	KS
GEN-2017-184	400	Solar	KCPL	Hodgeman/Ford	KS
GEN-2017-188	130	Solar	EMDE	Barry	MO
GEN-2017-191	201.6	Solar	WERE	Osage	KS
GEN-2017-195	500.4	Solar	KCPL	Johnson	KS

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Project	Capacity	Fuel Type	Area Name	County	State
GEN-2017-196	128	Battery	KCPL	Johnson	KS
GEN-2017-199	202	Battery	WAPA	Beadle	SD
GEN-2017-200	302	Wind	WAPA	Beadle	SD
GEN-2017-201	250	Wind	NPPD	Wayne County	NE
GEN-2017-202	200	Solar	SWPA	New Madrid	MO
GEN-2017-209	300	Solar	KCPL	McPherson	KS
GEN-2017-210	310	Solar	NPPD	Cedar	NE
GEN-2017-214	100	Wind	WAPA	Ward	ND
GEN-2017-215	100	Wind	WAPA	Ward	ND
GEN-2017-216	100	Wind	WAPA	Ward	ND
GEN-2017-222	180	Wind	WAPA	Denison	IA
GEN-2017-225	76	Storage	KCPL	Johnson County	KS
GEN-2017-229	76	Storage	KCPL	Johnson County	KS
GEN-2017-234	115	Wind	NPPD	Greeley	NE
GEN-2017-235	50	Wind	WAPA	Ward	ND
GEN-2017-236	50	Wind	WAPA	Ward	ND

Table 1- 2: SPP Projects List for MISO South Region

Project	Capacity	Fuel Type	Area Name	County	State
GEN-2017-132	400	Wind	OKGE	Oklahoma	OK
GEN-2017-133	200	Wind	OKGE	Oklahoma	OK
GEN-2017-134	250	Wind	OKGE	Oklahoma	OK
GEN-2017-137	295	Wind	OKGE	Oklahoma	OK
GEN-2017-140	160	Solar	AEPW	Wagoner	OK
GEN-2017-141	241.7	Solar	AEPW	Wagoner	OK
GEN-2017-149	258	Wind	OKGE	Johnston	OK
GEN-2017-150	250	Solar	OKGE	Grady	OK
GEN-2017-151	300	Wind	SPS	Crosby	TX
GEN-2017-152	252	Wind	OKGE	McClain	OK
GEN-2017-154	255	Wind	OKGE	Johnston	OK
GEN-2017-155	300	Wind	OKGE	Muskogee	OK
GEN-2017-164	250	Solar	OKGE	Garfield	OK
GEN-2017-166	250	Solar	OKGE	Carter	OK
GEN-2017-171	150	Solar	AEPW	Stephen	OK
GEN-2017-213	300	Solar	AEPW	Grant/Kay	OK
GEN-2017-231	72.5	Solar	OKGE	Franklin County	AR
GEN-2017-233	215	Wind	OKGE	Grady	OK
GEN-2017-240	202	Solar	OKGE	Okmulgee	OK

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Section 2: Assumptions and Methodology

2.1 Study Models

MISO provided DPP 2017-Aug Phase 2 Study cases for this AFS:

- West Region:
  - Shoulder, DPP_AUG17_West_2023SH90_Study_P3_FINAL_210212.raw
  - Summer Peak, DPP_AUG17_West_2023SUM_Study_P3_FINAL_210215.raw
- South Region:
  - ERIS, DPP3_2017_AUG_THERMAL_STUDY.raw

2.2 Model Development

Various updates were implemented to the models based on the MISO input. This section lists the updates in various categories.

2.2.1 Higher Queued Projects

The models for both west and south region also included upgrades from the higher-queued (HQ) Projects in the SPP generator interconnection queue. Thirty-one (31) higher-queued Projects were added. MISO provided the idevs for these higher queued Projects as listed in Table 2- 1.

Table 2- 1: Higher Queued Projects

HQ#	IDEV
GEN-2016-094	15.DIS-16-2_ADD_GEN-2016-094 - North Bend Wind.IDV
GEN-2016-115	15.DIS-16-2_ADD_GEN-2016-115 - White Cloud Wind.IDV
GEN-2016-130	15.DIS-16-2_ADD_GEN-2016-130 - Oliver IV.IDV
GEN-2016-147	15.DIS-16-2_ADD_GEN-2016-147 - Sidney Solar.idv
GEN-2016-151	15.DIS-16-2_ADD_GEN-2016-151 - Burke 1.IDV
GEN-2016-036	15.DIS-16-2_ADD_GEN-2016-036 - Palmer Creek Wind Farm.IDV
GEN-2016-074	15.DIS-16-2_ADD_GEN-2016-074 - Custer (AKA Broken Bow 3 Wind Farm 200MW in FCS-2016-003).IDV
GEN-2016-087	15.DIS-16-2_ADD_GEN-2016-087 - Campbell County Wind Farm.IDV
GEN-2017-057	18.0DIS-17-1_ADD_GEN-2017-057.IDV

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HQ#	IDEV
GEN-2017-060	18.0DIS-17-1_ADD_GEN-2017-060_MODIFIED.IDV
GEN-2017-061	18.0DIS-17-1_ADD_GEN-2017-061.IDV
GEN-2017-071	18.0DIS-17-1_ADD_GEN-2017-071.IDV
GEN-2017-075	18.0DIS-17-1_ADD_GEN-2017-075 (REQUIRES GEN-2016-063).IDV
GEN-2017-077	18.0DIS-17-1_ADD_GEN-2017-077.IDV
GEN-2017-082	18.0DIS-17-1_ADD_GEN-2017-082_MODIFIED.IDV
GEN-2017-092	18.0DIS-17-1_ADD_GEN-2017-092 (Requires GEN-2017-044).IDV
GEN-2017-094	18.0DIS-17-1_ADD_GEN-2017-094.IDV
GEN-2017-097	18.0DIS-17-1_ADD_GEN-2017-097.IDV
GEN-2016-037	16.0DIS-16-1_ADD_GEN-2016-037(NEW_TAP).IDV
GEN-2016-063	16.0DIS-16-1_ADD_GEN-2016-063(NEW_TAP).IDV
GEN-2017-004	18.0DIS-17-1_ADD_GEN-2017-004.IDV
GEN-2017-005	18.0DIS-17-1_ADD_GEN-2017-005.IDV
GEN-2017-009	18.0DIS-17-1_ADD_GEN-2017-009_MODIFIED.IDV
GEN-2017-010	18.0DIS-17-1_ADD_GEN-2017-010.IDV
GEN-2017-014	18.0DIS-17-1_ADD_GEN-2017-014_MODIFIED.IDV
GEN-2017-023	18.0DIS-17-1_ADD_GEN-2017-023.IDV
GEN-2017-027	18.0DIS-17-1_ADD_GEN-2017-027.IDV
GEN-2017-032	18.0DIS-17-1_ADD_GEN-2017-032.IDV
GEN-2017-040	18.0DIS-17-1_ADD_GEN-2017-040_MODIFIED.IDV
GEN-2017-048	18.0DIS-17-1_ADD_GEN-2017-048_MODIFIED.IDV

2.2.2 Higher Queued Network Upgrades

MISO provided a list of DISIS-2016-002 and DISIS-2017-001 network upgrades with associated idev files to model the upgrades. The following upgrades were added to the base case:

- 20 MVAr Capacitor Bank at Bagley 115kV (OTP)
- 2x75 MVAr Capacitors at Buffalo 345 kV (OTP)
- 100 MVAr Capacitor Bank at Montezuma 345 (MEC)
- 100 MVAr SVC at Blackhawk 345 kV (MEC)

2.2.3 Study Projects Modeling

MISO also provided the idevs for SPP Projects to be studied. To create Post-Project cases, CFP added these projects to the study cases and dispatched these Projects according to Load Ratio Share (LRS) of various SPP control areas per the SPP practices. Projects were dispatched based on the fuel type in accordance with the MISO business practices as listed in

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Table 2- 2 below.

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Table 2- 2: Projects Dispatch based on the Fuel Type

Fuel type	Summer Case	Shoulder Case	ERIS
Solar/CT/Diesel/Oil	100%	0%	100%
Wind	15.6%	100%	100%
Coal/Hydro/Nuclear/Waste Heat	100%	100%	100%
Combined Cycle	100%	50%	100%
Storage	100%	±100%	100%

2.3 Methodology

CFP performed this study to determine the impact of SPP's Projects on the MISO transmission system. MISO's transmission planning criteria were used to evaluate the results.

2.3.1 Power Flow Analysis

An AC contingency analysis was performed for the selected North American Electric Reliability Corporation (NERC) Reliability Standard TPL-001-4 Category P1 through P7 contingencies within the MISO and external region as previously defined by the MISO transmission owners and available in the MISO model package. MISO facilities of 69 kV and higher voltage levels and relevant third-party facilities were monitored in the study region. CFP used Siemens PSS/E v34 and PowerGEM TARA v2101 software tools to perform the analysis.

The power flow analysis was performed for the Pre and Post Project cases. CFP used subsystem (SUB), monitored elements (MON) and contingencies (CON) files provided by MISO and updated them for the study as appropriate.

A 70% loading cut-off was used for Pre Project AC run and 90% is used for Post Project AC run. All MISO facilities listed in the MON file were monitored. CFP also generated distribution factors (DFs) for the study Projects to identify their impacts on the constraints.

Pre- and Post-Project power flow analyses were conducted and results were compared to identify the impacts of the SPP DISIS-2017-002 cycle Projects on the system performance.

Results were screened based on the following MISO criteria:

- Thermal Loading Criteria
  - Branch loading is >100% applicable normal or emergency rating and generator has:
    - P0 (No Contingency) : 5% DF Cutoff, or

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    - P1 & P2 (Single Contingency) : 20% DF Cutoff, or
    - P4 (Fault plus stuck breaker) : 20% DF Cutoff, or
    - P7 (Common Structure): 20% DF Cutoff, or
  - MW Impact from study generator greater than or equal to 20% of the applicable line rating (normal or emergency), or
  - Overloaded facility or overload-causing contingency at generator's outlet
  - Cumulative MW Impact from study generators greater than or equal to 20% of the applicable line rating (normal or emergency), where study generators whose individual MW Impact is greater than 5% of the rating and has DFAX of greater than 5% will be responsible to mitigate the cumulative MW Impact Constraint
  - Any Transmission Owner (TO) planning criteria
- Voltage Criteria
  - Bus voltage is outside of applicable normal or emergency limits, and
  - Voltage degradation is greater than 1%
  - Any TO planning criteria (Not applicable for this AFS)

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Section 3: Steady State Analysis

3.1 West Region

3.1.1 Thermal Results

As per the planning criteria listed in Section 2 of this report, no thermal violations were identified as impacted by the SPP Projects in summer case. However, shoulder case showed several violations impacted by the study Projects. Few thermal violations were identified in following MISO areas – Xcel (600), Minnesota Power & Light (608), Otter Tail Power Company (620), MidAmerican Energy (635). MISO shared the results with the Transmission Owners and received their inputs on potential mitigations and validity of results. A detailed list of violations that require mitigations is provided in Appendix A.

3.1.2 Voltage Results

As per the planning criteria listed in Section 2 of this report, the SPP Projects are not required to mitigate voltage violations identified in the study.

3.1.3 Network Upgrades

A Network Upgrade was identified to address the thermal violations based on the feedback from the Transmission Owners. MISO also received a planning level cost estimate for this Network Upgrade. Table 3- 1 shows the required upgrade and the planning level cost estimate. Mitigations for non-MISO facilities are not required for this study.

Table 3- 1: Network Upgrades Required to Address Thermal Violations

Item#	Description	Planning Level Cost Estimate ($M)	Area	Area Name
1	Build new 2.5 mile Xcel 115kV line from Magic City to Mallard subs	5	600	XEL

Cost Allocation

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CFP performed cost allocation of network upgrades identified in Table 3- 1 in accordance with the MISO business practicesTable 3- 2 presents the share of each Project on each network upgrade. The numbering for the upgrades in the Table heading corresponds to the item numbers in Table 3- 1. Mitigations for non-MISO facilities are not required for this study.

Table 3- 2: Network Upgrades Cost Allocation

Project	NU1
GEN-2017-214	1,250,000.00
GEN-2017-215	1,250,000.00
GEN-2017-216	1,250,000.00
GEN-2017-235	625,000.00
GEN-2017-236	625,000.00
Total	$5,000,000

3.1.4 Contingent Facilities

No contingent MTEP projects were identified for the studied SPP projects.

3.2 South Region

3.2.1 Thermal Results

As per the planning criteria listed in Section 2 of this report, no thermal violations were identified as impacted by the SPP Projects in South Region.

3.2.2 Voltage Results

As per the planning criteria listed in Section 2 of this report, no voltage violations were identified as impacted by the SPP Projects in South Region.

3.2.3 Network Upgrades

The study did not identify any constraints that would require Network Upgrades in south region as per MISO's planning criteria.

3.2.4 Contingent Facilities

No contingent MTEP projects were identified for the studied SPP projects.

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Appendix A: Steady State Thermal Results

Table A- 1: Thermal Violation for West Region, Shoulder Case[1]

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[1] Overloads meeting Thermal Loading Criteria included in Section 2 are shown.