

Final Report

Midcontinent ISO (MISO)  
Affected System Studies for  
Southwest Power Pool (SPP)  
DISIS-2017-001 Projects  
Phase III



September 2021





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# MISO Affected System Studies for SPP Projects Phase III

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## EXECUTIVE SUMMARY

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Midcontinent Independent System Operator (“MISO”) has contracted with Leidos Engineering, LLC (“Leidos”) to perform Affected System Studies (“AFS”) for the interconnection requests in the Southwest Power Pool (“SPP”) queue (the “Project”). SPP is commencing the Definitive Interconnection System Impact Studies (DISIS) for their DISIS-2017-001 cycle Projects. The MISO AFS is intended to identify the impacts of these Projects on the MISO system.

The study was be done in three phases. Phase I has already been completed by SPP and is not part of this study scope. The report here includes the methodology, assumptions, and results for Phase III analysis utilizing the data acquired in Phase II. 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. This AFS includes only the steady state analysis for scenarios that reported issues (required upgrades) in Phase II studies.

The findings of this study may be subject to revision if the study assumptions change (study assumption change(s) include, but not limited to, withdrawal of higher queued projects or withdrawal of study projects).

The steady state analysis did not identify any thermal violations in the MISO-West and MISO-South regions due to SPP Projects. The study did not identify any voltage criteria violations in MISO-South region due to SPP Projects. However, there were several low voltage violations identified in the MISO-West region, as part of Phase III analysis, that are impacted by the SPP Projects. Based on the feedback from MISO and affected Transmission Owners, the study identified Network Upgrades to address the voltage criteria violations. These Network Upgrades along with their planning-level cost estimates are summarized below:

- 100 MVAR Capacitor Bank at Montezuma 345 kV (\$6M)
- 100 MVAR SVC/Statcom at Blackhawk 345 kV (\$30M)

Leidos allocated the cost of Network Upgrades among the Projects based on their pro rata impacts on the violations in accordance of the MISO business practices. Table ES-1 shows the responsibility of each Project.

**Table ES-1**  
**Cost Allocation Summary for the Network Upgrades**

Project	Total Network Upgrade Cost
GEN-2017-004	\$3,810,132
GEN-2017-010	\$5,254,306
GEN-2017-013	\$4,339,993
GEN-2017-014	\$7,862,422
GEN-2017-032	\$3,878,159
GEN-2017-048	\$7,951,046
GEN-2017-094	\$2,903,942
<b>Total</b>	<b>\$36,000,000</b>

Dynamic stability analysis was not required to be performed as part of Phase III study.

MISO reevaluated Higher Queued upgrades owing to projects being withdrawn. The list of DISIS-2017-001 study projects and DISIS-2016-002 higher queued projects withdrawn is given in Tables ES-2 and ES-3, respectively.

**Table ES-2**  
**Study Projects Withdrawn**

Project	Status for Phase III
GEN-2016-103	Removed from Phase III
GEN-2016-109	Withdrawn prior to Phase III
GEN-2016-127	Withdrawn prior to Phase III
GEN-2016-159	Removed from Phase III
GEN-2017-001	Withdrawn prior to Phase III
GEN-2017-006	Withdrawn prior to Phase III
GEN-2017-008	Not modeled in study case
GEN-2017-024	Not modeled in study case
GEN-2017-030	Removed from Phase III
GEN-2017-031	Removed from Phase III
GEN-2017-038	Withdrawn prior to Phase III
GEN-2017-041	Withdrawn prior to Phase III
GEN-2017-055	Not modeled in study case
GEN-2017-064	Not modeled in study case
GEN-2017-067	Withdrawn prior to Phase III
GEN-2017-095	Withdrawn prior to Phase III



**Table ES-3  
Higher Queued Projects Withdrawn**

<b>Project</b>	<b>Status for Phase III</b>
GEN-2016-164	Removed from Phase III
GEN-2016-096	Withdrawn prior to Phase III
GEN-2016-165	Removed from Phase III
GEN-2016-166	Not modeled in study case
GEN-2016-088	Removed from Phase III
GEN-2016-092	Removed from Phase III
GEN-2016-106	Removed from Phase III
GEN-2016-110	Removed from Phase III



## 1.1 Background

Midcontinent Independent System Operator (“MISO”) has contracted with Leidos Engineering, LLC (“Leidos”) 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-2017-001 cycle Projects. The MISO AFS is intended to identify the impacts of these Projects on the MISO system.

The study was done in three phases. Phase I has already been completed by SPP and is not part of this study scope. The report here includes the methodology, assumptions, and results for Phase III analysis, utilizing the data acquired in Phase II. This Affected System Study includes steady state analysis for only the scenario that reported issues in Phase II.

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. Table 1-1 shows the specifics of each study group.

**Table 1-1  
MISO Study Groups for the AFS**

Group	Total Requests	Total Capacity (MW)	Geographical Region of the Requests
MISO West Region	17	3,701.5	ND, SD, NE, KS, OK, MO
MISO South Region	14	2,194.8	OK, KS, TX, LA, MO

## 1.2 Project Description

SPP Projects to be studied as part of Phase III analysis for MISO West region are listed in Table 1-2.

**Table 1-2  
SPP Projects List for MISO West Region**

Generator	Fuel	Shoulder Pgen (MW)	Point of Interconnection (POI)	State
GEN-2017-004	Wind	201.6	Elm Creek - Summit 345 kV	KS
GEN-2017-010	Wind	200.1	Rhame 230 kV Sub	ND
GEN-2017-013	Wind	200	Mingo 345kV	KS
GEN-2017-014	Wind	300	Underwood - Philip Tap 230 kV	SD
GEN-2017-032	Wind	200	Finney - Lamar 345 kV	CO

## Section 1

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Generator	Fuel	Shoulder Pgen (MW)	Point of Interconnection (POI)	State
GEN-2017-048	Wind	300	Neset 230 kV Substation	ND
GEN-2017-075	Solar	0	Hugo-Sunnyside 345 kV	OK
GEN-2017-090	Solar	0	Adrian 161 kV sub	MO
GEN-2017-094	Wind	200	Fort Thompson-Huron 230 kV	SD
GEN-2017-097	Solar	0	Underwood 115 kV Sub	SD

# Section 2

## METHODOLOGY AND ASSUMPTIONS

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### 2.1 Study Models

MISO provided DPP 2017-February Phase 3 Study cases for this AFS. The MISO cases were based on the MISO Transmission Expansion Planning (“MTEP”) cases from 2018, built for 2023. MISO provided following cases for the study:

- West Region:
  - Shoulder, MISO18\_2023\_SH90\_2017FebDPP-Ph3\_StudyCase\_190822.sav
  - Summer Peak, MISO18\_2023\_SUM\_2017FebDPP-Ph3\_StudyCase\_190822.sav
- South Region:
  - Summer Peak, DPP\_FEB\_17\_2022\_SPK\_South\_Phase3\_STUDY\_02162018.sav

Summer peak cases had load at 100% of summer peak condition and shoulder case had load scaled down to 70% and 85% of summer peak load. System topology included 2018 MTEP Appendix A Projects as well as other Appendix A Projects approved since the previous cycle.

### 2.2 Model Development

The scenario considered for Phase III study was only the West Shoulder Case since it reported issues in Phase II. Various updates were implemented to the model based on MISO input. This section lists the updates in various categories.

#### 2.2.1 Higher Queued Projects

Eight (8) higher queued projects were withdrawn. Six (6) out of these were present in the study cases and hence were removed as part of Phase III model development. These higher queued projects are listed in Table 2-1.

**Table 2-1  
Higher Queued Projects Withdrawn from Study Cases for West Shoulder Case**

Generator	Fuel	Shoulder Pgen (MW) – Post-Project Case	Shoulder Pgen (MW) - Pre-Project Case	Point of Interconnection (POI)	State
GEN-2016-164	Wind	7.3	7.8	Groton 115kV	KS
GEN-2016-165	Wind	191.6	194.2	Tap Fort Thompson - Grand Island 345kV	ND
GEN-2016-088	Wind	141.0	147.6	Ketchem (Gen-2015-005 Tap) 345kV	KS

## Section 2

Generator	Fuel	Shoulder Pgen (MW) – Post-Project Case	Shoulder Pgen (MW) - Pre-Project Case	Point of Interconnection (POI)	State
GEN-2016-092	Wind	169.5	169.5	Tap Leland Olds -Ft Thompson 345kV	SD
GEN-2016-106	Wind	376.3	386.7	Gentleman Substation 345kV	CO
GEN-2016-110	Wind	144.2	146.1	Tap Laramie - Stegall 345kV	ND

### 2.2.2 DISIS-2016-002 Upgrades

MISO provided a list of DISIS-2016-002 upgrades to be applied to the study models for Phase III model development. These are listed below.

- Remove 150 MVar SVC or STATCOM at Blackhawk 345 (MEC)
- Remove 150 MVar Capacitor at Montezuma 345 (MEC)
- Remove 100 MVar Capacitor at Grimes 345 (MEC)
- Remove 25 MVar Capacitor at Monona161 (MEC)
- Remove 2 x 20 MVar Capacitors at Wahpeton 115 (OTP)
- Keep 2 x 7.5 MVar Capacitors at Big Sand 69 kV (DPC)
- Add 15 MVar Capacitor at Northwoods 115 kV

### 2.2.3 Study Project Modeling

Only the scenario (West Region Shoulder Case) that reported issues in Phase II was analyzed for Phase III. The higher queued projects listed in Table 2.1 were withdrawn. DISIS-2016-002 network upgrades listed in Section 2.2.2 were applied to the model. MISO also provided a list of DISIS-2017-001 study projects to be withdrawn from the study model, which are listed in Table 2-2.

**Table 2-2  
Study Projects Withdrawn from West Shoulder Post-Project Case**

Generator	Fuel	Shoulder Pgen (MW)	Point of Interconnection (POI)	State
GEN-2016-103	Wind	250.7	Fort Thompson-Leland Olds 345kV	SD
GEN-2016-159	Wind	427.8	Turtle Creek 345kV	NE
GEN-2017-008	Solar	0	Moore (GEN-2016-096 Tap)-Pauline 345kV	NE
GEN-2017-030	Wind	200	Easttown - Iatan 345kV	KS
GEN-2017-031	Wind	100	Wildhorse - Covalt 115 kV	NE
GEN-2017-055	Solar	0	Wagener 115 kV Sub	NE
GEN-2017-064	Solar	0	Underwood - Wayside 230 kV	SD

To create the Post-Project case, Leidos removed these Projects and dispatched generation according to Load Ratio Share (LRS) of various SPP control areas per the SPP practices. Those Projects that were retained were dispatched based on the fuel type in accordance with the MISO business practices as listed in Table 2-2 below

**Table 2-2  
Project Dispatch Based on the Fuel Type**

Fuel Type	West – Shoulder Case
Wind	100%
Solar	offline

## 2.3 Methodology

Leidos performed this study to determine the impact of SPP’s Projects on the MISO transmission system, after applying the network upgrades and withdrawing appropriate study projects and higher projects identified by MISO. 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. Leidos used Siemens PSS/E v33 and PowerGEM TARA v2001 software tools to perform the analysis.

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

Since there were over 85,000 contingencies in MISO’s CON file, Leidos initially performed a DC run in TARA to limit the number of contingencies. A 75% loading cut-off was used for this DC run to select credible contingencies. All MISO facilities listed in the MON file were monitored. Leidos 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-2017-1 cycle Projects on the system performance.

## Section 2

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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
    - 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)

### MISO Outlet Facilities

For the purpose of applying the outlet criteria, MISO defines outlet facility as facilities within three-bus circle from each Project POI. For this AFS, two of the study Projects in West Region have MISO outlet facilities. Table 2-3 lists the MISO buses that fall under this three-bus radius used to define MISO facilities.

**Table 2-3**  
**MISO Buses within Three-Bus Circle from the Project POIs**

Projects	Bus no.	Bus Name	Base kV	Area	Area Name
GEN-2017-010	661004	BAKER 4	230	652	WAPA
GEN-2017-010	661005	BAKER 7	115	661	MDU
GEN-2017-010	661047	HETINGR4	230	652	WAPA
GEN-2017-010	661048	HETINGR7	115	661	MDU
GEN-2017-010	661901	BAKER 9	13.8	661	MDU
GEN-2017-010	661902	HETINGR9	13.8	661	MDU
GEN-2017-010	661988	THDRSPTCLC 9	34.5	661	MDU
GEN-2017-048	85931	J593	230	661	MDU



## METHODOLOGY AND ASSUMPTIONS

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Projects	Bus no.	Bus Name	Base kV	Area	Area Name
GEN-2017-048	85932	J593 COL1	34.5	661	MDU
GEN-2017-048	661080	STANLEY7	115	661	MDU
GEN-2017-048	661084	TIOGA4 4	230	652	WAPA
GEN-2017-048	661085	TIOGA4 7	115	661	MDU
GEN-2017-048	661086	TIOGA7 7	115	661	MDU
GEN-2017-048	661900	TIOGA4 9	13.8	661	MDU



## Section 3

# STEADY STATE ANALYSIS

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### 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 the shoulder case.

#### 3.1.2 Voltage Results

Shoulder case showed several violations impacted by the study Projects. Few low voltage violations were identified in the following areas – XEL (600), OTP (620), ALTW (627), and MEC (635). Several remote area violations were ignored based on the discussions with MISO as they appeared to be “noise” rather than legitimate impacts from the Projects. MISO shared the results with the affected 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.

#### 3.1.3 Network Upgrades

There are few Network Upgrades identified to address the voltage violations based on the feedback from the Transmission Owners. MISO also received planning-level cost estimates for these Network Upgrades. Table 3-1 shows the required upgrades and their planning-level cost estimates

**Table 3-1**  
**Network Upgrades Required to Address Voltage Violations**

Item#	Description	Planning Level Cost Estimate (\$M)	Area	Area Name
1	100 MVAR Capacitor Bank at Montezuma 345 kV	6.0	635	MEC
2	100 MVAR SVC/Statcom at Blackhawk 345 kV	30.0	635	MEC

#### Cost Allocation

Leidos performed cost allocation of Network Upgrades identified in Table 3-1 in accordance with the MISO business practices. Projects impacting the worst violation were turned off one at a time to identify the impact of each project on the voltage violation, and cost allocation was performed based on their pro rata impacts. Table 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.

**Table 3-2**  
**Network Upgrades Cost Allocation**

Project	NU1	NU2	Total
GEN-2017-004	\$782,609	\$3,027,523	\$3,810,132
GEN-2017-010	\$758,893	\$4,495,413	\$5,254,306
GEN-2017-013	\$853,755	\$3,486,239	\$4,339,993
GEN-2017-014	\$1,256,917	\$6,605,505	\$7,862,422
GEN-2017-032	\$758,893	\$3,119,266	\$3,878,159
GEN-2017-048	\$1,162,055	\$6,788,991	\$7,951,046
GEN-2017-094	\$426,877	\$2,477,064	\$2,903,942
<b>Total</b>	<b>\$6,000,000</b>	<b>\$30,000,000</b>	<b>\$36,000,000</b>

It should be noted that the Network Upgrades are required to address the voltage violations observed only in shoulder case where solar PV projects were offline per the MISO dispatch methodology. Therefore, none of the solar PV projects were part of this cost allocation.

# Appendix A

## Steady State Voltage Results – West Region

**Table A-1**  
**Steady State Voltage Violations – West Region**

Bus #	Bus Name	kV	Area	Vlow	Vhi	Benchmark Contingency Voltage	Study Case Contingency Voltage	Delta	Contingency Details
75730	J530 POI	345	635	1.00	1.05	1.01	0.99	-0.02	[Redacted]
75730	J530 POI	345	635	1.00	1.05	1.01	0.99	-0.02	[Redacted]
620180	CSLTNE T7	115	620	0.92	1.10	0.94	0.91	-0.03	[Redacted]
620260	ENDER LN7	115	620	0.92	1.10	0.94	0.91	-0.03	[Redacted]
636199	BLACKH AWK 3	345	635	0.96	1.05	0.98	0.95	-0.03	[Redacted]
636199	BLACKH AWK 3	345	635	0.96	1.05	0.98	0.95	-0.03	[Redacted]
636199	BLACKH AWK 3	345	635	0.96	1.05	0.99	0.95	-0.04	[Redacted]
636199	BLACKH AWK 3	345	635	0.96	1.05	0.99	0.95	-0.03	[Redacted]
636302	CH CITY S 8	69	635	1	1.05	1.01	0.99	-0.01	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]

## Appendix A

Bus #	Bus Name	kV	Area	Vlow	Vhi	Benchmark Contingency Voltage	Study Case Contingency Voltage	Delta	Contingency Details
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.97	-0.02	[Redacted]
681539	ELK MND5	161	680	0.95	1.05	0.94	0.93	-0.01	[Redacted]
75730	J530 POI	345	635	1.00	1.05	1.02	0.99	-0.03	[Redacted]
75730	J530 POI	345	635	1.00	1.05	1.02	0.99	-0.03	[Redacted]
75730	J530 POI	345	635	1.00	1.05	1.02	0.99	-0.03	[Redacted]
75730	J530 POI	345	635	1.00	1.05	1.02	0.99	-0.03	[Redacted]
606108	BRIGGS RD 9	69	600	0.92	1.05	1.04	1.06	0.02	[Redacted]
620358	BUFFAL O3	345	620	0.92	1.10	0.93	0.91	-0.02	[Redacted]
620358	BUFFAL O3	345	620	0.95	1.10	0.93	0.91	-0.02	[Redacted]
620358	BUFFAL O3	345	620	0.92	1.10	0.93	0.91	-0.02	[Redacted]
620369	JAMEST N3	345	620	0.92	1.10	0.93	0.91	-0.02	[Redacted]
620369	JAMEST N3	345	620	0.95	1.10	0.93	0.91	-0.02	[Redacted]

## Steady State Voltage Results – West Region

Bus #	Bus Name	kV	Area	Vlow	Vhi	Benchmark Contingency Voltage	Study Case Contingency Voltage	Delta	Contingency Details
620369	JAMEST N3	345	620	0.92	1.10	0.93	0.91	-0.02	[Redacted]
635730	MNTZU MA3	345	635	1.00	1.05	1.02	0.99	-0.02	[Redacted]
635730	MNTZU MA3	345	635	1.00	1.05	1.03	0.99	-0.04	[Redacted]
635730	MNTZU MA3	345	635	1.00	1.05	1.03	0.99	-0.04	[Redacted]
635730	MNTZU MA3	345	635	1.00	1.05	1.03	0.99	-0.04	[Redacted]
635730	MNTZU MA3	345	635	1.00	1.05	1.03	0.99	-0.03	[Redacted]
636003	BVR CRK 3	345	635	1.00	1.05	1.01	0.99	-0.01	[Redacted]
636199	BLACKH AWK 3	345	635	0.96	1.05	0.98	0.95	-0.03	[Redacted]
636199	BLACKH AWK 3	345	635	0.96	1.05	0.99	0.95	-0.03	[Redacted]
638000	AMES 5	161	635	0.95	1.05	0.94	0.93	-0.01	[Redacted]
638010	STANG E 5	161	635	0.95	1.05	0.94	0.93	-0.01	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	0.99	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.01	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.00	0.98	-0.01	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	0.99	0.98	-0.02	[Redacted]

## Appendix A

Bus #	Bus Name	kV	Area	Vlow	Vhi	Benchmark Contingency Voltage	Study Case Contingency Voltage	Delta	Contingency Details
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638033	UNI GEN8	69	635	1.00	1.05	1.00	0.98	-0.01	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	0.99	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.00	0.98	-0.02	[Redacted]
638032	GT SUB 8	69	635	1.00	1.05	1.01	0.99	-0.02	[Redacted]



**Steady State Voltage Results – West Region**

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Bus #	Bus Name	kV	Area	Vlow	Vhi	Benchmark Contingency Voltage	Study Case Contingency Voltage	Delta	Contingency Details
638033	UNI GEN8	69	635	1.00	1.05	1.01	0.99	-0.02	[Redacted]
638036	STRTR P8	69	635	1.00	1.05	1.01	0.99	-0.02	[Redacted]