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Midcontinent Independent System Operator (MISO)

Affected System Impact Study
SPP DISIS-2016-001

Draft Report

REP-0147
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Submitted By:
Mitsubishi Electric Power Products, Inc. (MEPPI)
Power Systems Engineering Division
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Title: **Affected System Impact Study SPP DISIS-2016-001: Draft Report REP-0147**
Date: January 2018
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EXECUTIVE SUMMARY

The Midcontinent Independent System Operator ("MISO") requested an Affected System Impact Study ("SIS") for the Southwest Power Pool ("SPP") Definitive Interconnection System Impact Study ("DISIS"). This report documents the impacts of thirteen (13) projects in the SPP generator queue on the MISO transmission system. At the time of this study, the DPP February 2016 West Phase II study was being completed by MISO which consists of higher queued generation. This report contains preliminary results which will be revised and finalized after the completion of the DPP Phase III for the February 2016 West group in MISO. The SPP study projects are listed in Table ES-1.

Table ES-1
Interconnection Projects Evaluated

Queue #	Capacity	Service	Fuel Type	Area	Proposed Point of Interconnection
GEN-2015-089	200	ER	Wind	WAPA	Utica 230 kV Substation
GEN-2016-004	201.6	ER/NR	Wind	WAPA	Leland Olds 230 kV
GEN-2016-007	100.05	ER	Wind	WAPA	Valley City 115 kV
GEN-2016-017	250.7	ER	Wind	WAPA	Tap Fort Thompson - Leland Olds 345 kV
GEN-2016-021	300	ER	Wind	NPPD	Hoskins 345 kV
GEN-2016-023	150.53	ER	Wind	WAPA	Tap Laramie River - Sidney 345 kV
GEN-2016-029	150.53	ER	Wind	WAPA	Tap Laramie River - Sidney 345 kV
GEN-2016-043	230	ER	Wind	NPPD	Hoskins 345 kV
GEN-2016-050	250.7	ER	Wind	NPPD	Tap Axtell - Post Rock 345 kV
GEN-2016-052	3.3 (increase)	ER	Wind	WAPA	Hilken 230 kV
GEN-2016-053	3.3 (increase)	ER	Wind	WAPA	Hilken 230 kV
GEN-2016-054	3.4 (increase)	ER	Wind	WAPA	Wessington Springs 230 kV
GEN-2016-075	50	ER	Wind	WAPA	Grand Prairie 345 kV

Since the DPP February 2016 West Phase II study was not completed at the time of this study, the identified upgrades for higher queued generation were not implemented. Table ES-2 lists the thermal overloads identified in this study and notes if the constraint was identified in the DPP

February 2016 West Phase II study. Table ES-3 lists the voltage violations identified in this study and notes if the constraint was identified in the DPP February 2016 West Phase II study. Although the majority of the voltage violations identified in this study were not observed in the DPP February 2016 West Phase II study, the upgrades identified for thermal line loadings may improve the low voltages observed and therefore, reduce the required mitigation for voltage violations. Additional mitigation will be recommended pending the completion of the DPP February 2016 West Phase II study.

Table ES-2
Thermal Overloads Identified

MISO Area Transmission Elements				
Monitored Facility	**From Bus Owner**	**To Bus Owner**	**Rate (MVA)**	**Notes**
620327 HANKSON4 230 620329 WAHPETN4 230 1	OTP	OTP	368.2	Identified in DPP-FEB-2016-West Study Mitigation to follow
635200 RAUN 3 345 645451 S3451 3 345 1	MEC	OPPD	956*	MEC end of line is rated for 1152 MVA. Thermal overload observed on OPPD end. Identified in DPP-FEB-2016-West Study Mitigation to follow
635680 BONDRNT3 345 635730 MNTZUMA3 345 1	MEC	MEC	926	Identified in DPP-FEB-2016-West Study Mitigation to follow

Table ES-3
Voltage Violations Identified

Voltage Violations Outside of Threshold				
Bus Number	**Bus Name**	**Base kV**	**Bus Owner**	**Notes**
344923	5LATHROP	161	AMMO	Identified in DPP-FEB-2016-West Study Mitigation to follow
629074	ARNOLD1G	22	ALTW (ITC)	Not identified in DPP-FEB-2016-West Study Transformer tap adjustment
638032	GT SUB 8	69	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
638036	STRTR P8	69	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
635017	ATCHSN 3	345	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
635000	CBLUFFS3	345	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
635056	ADAMS 5	161	MEC	Not identified in DPP-FEB-2016-West Study

				Mitigation recommended for this study
638001	AMES 8	69	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
638002	DAYTON8	69	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
635645	MCKSBRG 5	161	MEC	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
50322	J442 POI	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
615637	GRE-SILVRLK4	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
616000	GRE-MARSHLK7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
616001	GRE-WALDEN 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
616002	GRE-JOHNJCT7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
616003	GRE-GRACEV 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
616006	GRE-HANCOCK7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
618206	GRE-FERGUS 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620170	EFERGUS7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620173	DAWS TP7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620174	DAWSON 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620205	BRUCE 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620206	LOUSBRG7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620208	BRUCE TP	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620209	HETLAND7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620210	TORONTO7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620211	CANBY 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620212	BURR 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620213	MARIETT7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620214	BIGSTON7	115	OTP	Not identified in DPP-FEB-2016-West Study

				Mitigation recommended for this study
620215	HIWY12 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620216	ORTONVL7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620218	MOROTP 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620223	HOOT LK7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620224	DUMONT 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620225	WHEATNS7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620227	FAIRMNT7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620228	TYLER 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620229	WAHPETN7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620232	EDGETWN7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620233	EDGETAP7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620287	ORTQUAR7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620288	ODESSA 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620289	CORRELL7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620294	TRAVWHE7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620295	TRAVPIP7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620296	TYLERRS7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620314	BIGSTON4	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620322	BSSOUTH4	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620325	BROWNSV4	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620327	HANKSON4	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620329	WAHPETN4	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
620363	FORMAN 4	230	OTP	Not identified in DPP-FEB-2016-West Study

				Mitigation recommended for this study
620417	BSSOUTH3	345	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
652555	MORRIS 7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
658102	GRANTCO7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
658104	ELBOWLK7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
658110	FERGSFL7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
658114	APPLETN7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
659698	WAHPET2Y	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
659699	WAHPET1Y	230	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
657709	LANGDON7	115	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study
657749	CENTER1G	22	OTP	Not identified in DPP-FEB-2016-West Study Mitigation recommended for this study

Table ES-4 lists the proposed mitigation and cost allocations for the upgrades identified in Table ES-2 and Table ES-3 that have been confirmed by the respective Transmission Owner.

Table ES-4
Cost Allocations for Confirmed Upgrades

Constraint	Mitigation Required	Cost Estimate	Cost Allocation
Bondurant - Montezuma 345 kV line	Structure replacements assumed to achieve rating above 1023 MVA.	N/A	*Will be mitigated by higher queued generation
Hankinson – Wahpeton 230 kV line	Line clearance mitigations and terminal equipment upgrades	N/A	*Will be mitigated by higher queued generation

Low Voltage at Lathrop 161 kV Bus	Install 161 kV bus with a breaker position and add 1*25 MVAR cap bank at Lathrop 161 kV	N/A	*Possibly mitigated by higher queued generation
Low voltages at CBEC 345 kV facility	Install 150 Mvar capacitor bank at Overland Trail 345 kV	$5,000,000	GEN-2015-089: $268,408 GEN-2016-004: $649,332 GEN-2016-007: $415,664 GEN-2016-017: $267,794 GEN-2016-021: $806,303 GEN-2016-023: $422,793 GEN-2016-029: $422,793 GEN-2016-043: $618,219 GEN-2016-050: $987,718 GEN-2016-052: $11,565 GEN-2016-053: $11,565 GEN-2016-054: $5,606 GEN-2016-075: $114,169
Low voltages at Streeter Switch and GT Sub	Install 20 Mvar capacitor bank at Viking Road 69 kV	$1,100,000	GEN-2015-089: $155,868 GEN-2016-004: $98,237 GEN-2016-007: $44,783 GEN-2016-017: $143,651 GEN-2016-021: $231,421 GEN-2016-023: $65,467 GEN-2016-029: $65,467 GEN-2016-043: $177,423 GEN-2016-050: $86,350 GEN-2016-052: $1,540 GEN-2016-053: $1,540 GEN-2016-054: $2,223 GEN-2016-075: $26,031
Low voltages at various OTP buses	Install 70 Mvar capacitor bank at Big Stone 230 kV	$1,800,000	GEN-2015-089: $75,634 GEN-2016-004: $537,305 GEN-2016-007: $768,683 GEN-2016-017: $209,840 GEN-2016-021: $29,389 GEN-2016-023: $42,505

			GEN-2016-029: $42,505 GEN-2016-043: $22,532 GEN-2016-050: $21,129 GEN-2016-052: $12,962 GEN-2016-053: $12,962 GEN-2016-054: $2,621 GEN-2016-075: $21,934
Low voltages at various OTP buses	Install 50 Mvar capacitor bank at Hankinson 230 kV	$1,700,000	GEN-2015-089: $109,125 GEN-2016-004: $258,422 GEN-2016-007: $880,167 GEN-2016-017: $188,566 GEN-2016-021: $66,739 GEN-2016-023: $40,448 GEN-2016-029: $40,448 GEN-2016-043: $51,166 GEN-2016-050: $29,753 GEN-2016-052: $4,968 GEN-2016-053: $4,968 GEN-2016-054: $2,961 GEN-2016-075: $22,272
Low voltages at various OTP buses	Install 5 Mvar capacitor bank at Toronto 115 kV	$550,000	GEN-2015-089: $ 27,390 GEN-2016-004: $208,561 GEN-2016-007: $191,086 GEN-2016-017: $42,685 GEN-2016-023: $25,630 GEN-2016-029: $25,630 GEN-2016-050: $7,423 GEN-2016-052: $3,872 GEN-2016-053: $3,872 GEN-2016-054: $1,359 GEN-2016-075: $12,492

No transient stability constraints were identified for the addition of the thirteen SPP projects in the 2021 Summer Shoulder scenarios. The post-project case showed similar performance as the respective pre-project case and did not affect the transient stability of the system.

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SECTION 1: BACKGROUND AND OBJECTIVE

The objective of this report is to provide MISO with the deliverables for the "Affected System Impact Study SPP DISIS-2016-001." MISO requested an Affected System Impact Study for thirteen (13) generation interconnections for 2021 Summer Shoulder conditions and 2021 Summer Peak conditions, which requires a steady-state analysis and stability analysis.

The Siemens Power Technologies International PSS/E power system simulation program Version 33.10.0 and PowerGEM's TARA 1701 was used for this study. MISO provided the steady-state and stability database cases for 2021 Summer Shoulder and 2021 Summer Peak conditions. This impact study required a steady-state analysis to determine if any SPP study projects contribute to thermally overloaded lines or bus voltages that exceed normal or emergency operating conditions. The stability analysis was performed to determine if any SPP study projects contribute to adverse impacts on the MISO transmission system including generator tripping, rotor angle oscillation instability, voltage recovery issues, and voltage instability. Table 1-1 is a list of SPP study projects that were examined for this study.

Table 1-1
Interconnection Projects Evaluated

Queue #	Capacity	Service	Fuel Type	Area	Proposed Point of Interconnection
GEN-2015-089	200	ER	Wind	WAPA	Utica 230 kV Substation
GEN-2016-004	201.6	ER/NR	Wind	WAPA	Leland Olds 230 kV
GEN-2016-007	100.05	ER	Wind	WAPA	Valley City 115 kV
GEN-2016-017	250.7	ER	Wind	WAPA	Tap Fort Thompson - Leland Olds 345 kV
GEN-2016-021	300	ER	Wind	NPPD	Hoskins 345 kV
GEN-2016-023	150.53	ER	Wind	WAPA	Tap Laramie River - Sidney 345 kV
GEN-2016-029	150.53	ER	Wind	WAPA	Tap Laramie River - Sidney 345 kV
GEN-2016-043	230	ER	Wind	NPPD	Hoskins 345 kV
GEN-2016-050	250.7	ER	Wind	NPPD	Tap Axtell - Post Rock 345 kV
GEN-2016-052	3.3	ER	Wind	WAPA	Hilken 230 kV
GEN-2016-053	3.3	ER	Wind	WAPA	Hilken 230 kV
GEN-2016-054	3.4	ER	Wind	WAPA	Wessington Springs 230 kV
GEN-2016-075	50	ER	Wind	WAPA	Grand Prairie 345 kV

SECTION 2: STEADY-STATE ANALYSIS

The steady-state analysis was performed to evaluate the thermal flow and voltage impact of the SPP study generators on the MISO transmission system.

2.1 Model Development

The following DPP February 2016 West Phase II study case load profiles were used for the study (include MISO queue projects up to DPP-2016-FEB):

- 2021 Summer Shoulder
  - StudyCase-MISO17_2022_SH90__TA_Pass3-DPP 2016-FEB_West_170921.sav
- 2021 Summer Peak
  - StudyCase-MISO17_2022_SUM__TA_Pass3-DPP 2016-FEB_West_170921.sav

The "pre-project" case was developed based on the above power flow cases by making the following changes:

- Remove the withdrawn Project J298, a 300 MW interconnection that connects to the Dysart 161 kV substation.
  - Note the withdrawal of Project J298 required a restudy for the MISO DPP-August-2015-West group which was not completed at the time of this study. Any changes to the results of that study may impact this study and may require a restudy of the Affected System Impact Study for SPP DISIS-2016-001.
- Re-dispatch generation in the MISO Classic region.

The SPP study cases were built by adding the SPP queue projects to the MISO "pre-project" cases. The details of each SPP interconnection request study projects are listed in Table 1-1. The SPP study projects and SPP higher queued projects were dispatched per MISO criteria to the entire SPP footprint, where generators were scaled in proportion to the available reserve.

2.2 Study Assumptions

This affected system impact study was conducted with all the participating generators and higher queued SPP generators. This study group includes higher queued SPP generators and requested study SPP generators in South Dakota (east, west, and south central), North Dakota (west and east), and Nebraska. In the summer shoulder scenario wind plants are dispatched at 100% nameplate rating in the study group and in the summer peak scenario wind plants are dispatched at 15.6% nameplate rating. Higher queued SPP projects were modeled as outlined in Appendix A of the report. The results obtained in this analysis may change if any of the data or assumptions made during the development of the study models is revised.

2.3 Study Criteria

All interconnection requirements are based on the applicable MISO Interconnection Planning Criteria and in accordance with the NERC Reliability Standards. Steady state violations of applicable planning criteria were attributed to the SPP group generation requests by the usage of MISO injection criteria, and applicable local planning criteria. The simulation software that was utilized for this analysis was Siemen's PTI PSS/E Version 33.10.0 and PowerGEM's TARA 1701.

2.3.1 MISO 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 Cumulative MW Impact from study generators is greater than or equal to 20% of the applicable (normal or Emergency) facility rating, where study generators whose Individual MW Impact is greater than 5% of the facility rating and its DF on the overloaded facility is greater than or equal to 5% will be responsible to mitigate the Cumulative MW Impact Constraint, or
4) The overloaded facility or the overload-causing contingency is at generator's outlet.

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 generation projects in the study group must mitigate thermal injection constraints in order to obtain unconditional Interconnection Service.

2.3.2 TOS' Local Planning Criteria

A constraint is identified as an injection constraint if it violates applicable Transmission Owner FERC filed Local Planning Criteria.

2.4 Contingency Criteria

A comprehensive list of contingencies was considered for steady-state analysis:

- NERC Category P0 with system intact (no contingencies)
- NERC category P1, P2, P4, P5, P7 contingencies
  - Single element outages, at buses with a nominal voltage of 69 kV and above in the following areas: CWLD (area 333), AMMO (area 356), AMIL (area 357), CWLP (area 360), SIPC (area 361), WEC (area 295), MIUP (area 296), MH (area 667), ALTE (area 694), WPS (area 696), MGE (area 697), UPPC (area 698), XCEL (area 600), MP (area 608), SMMPA (area 613), GRE (area 615), OTP (area 620), ITCM (area 627), MPW (area 633), MEC (area 635), MDU (area 661), DPC (area 680), CE(area 222), NPPD (area 640), OPPD (area 645), LES (area 650), WAPA (area 652), AECI (area 330), MIPU(area 540), KCPL (area 541), KACY (area 542), BEPC-SPP (area 659), and INDN (area 545).
  - Multiple-element outages initiated by a fault with normal clearing such as multi-terminal lines, in the Dakotas, Illinois, Iowa, Manitoba, Minnesota, Missouri, and Wisconsin.
- NERC Category P3
  - Selected NERC Category P3 events provided by ad-hoc study group in the study region.

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

2.5 Monitored Elements

Table 2-1 is a list of elements that were monitored in the MISO area.

Table 2-1
Monitored MISO Areas

Area #	Voltage	Area ID	Area Name
295	69kV and above	WEC	Wisconsin Electric Power Company (ATC)
296	69kV and above	MIUP	Michigan Upper Peninsula (ATC)
333	69kV and above	CWLD	Columbia, MO Water and Light
356	69kV and above	AMMO	Ameren Missouri
357	69kV and above	AMIL	Ameren Illinois
360	69kV and above	CWLP	City Water Light & Power (Springfield)

361	69kV and above	SIPC	Southern Illinois Power Co.
600	69kV and above	XEL	Xcel Energy North
608	69kV and above	MP	Minnesota Power & Light
613	69kV and above	SMMPA	Southern Minnesota Municipal Power Association
615	69kV and above	GRE	Great River Energy
620	69kV and above	OTP	Otter Tail Power Company
627	69kV and above	ITCM	ITC Midwest
633	69kV and above	MPW	Muscatine Power & Water
635	69kV and above	MEC	MidAmerican Energy
661	69kV and above	MDU	Montana-Dakota Utilities Co.
680	69kV and above	DPC	Dairyland Power Cooperative
694	69kV and above	ALTE	Alliant Energy East (ATC)
696	69kV and above	WPS	Wisconsin Public Service Corporation (ATC)
697	69kV and above	MGE	Madison Gas and Electric Company (ATC)
698	69kV and above	UPPC	Upper Peninsula Power Company (ATC)

2.6 Steady-State Analysis Results

This section lists the results from the steady-state analysis.

2.6.1 Summer Peak (2021) Steady-State Analysis

No constraints were identified in the 2021 Summer Peak Scenario.

2.6.2 Summer Shoulder (2021) Steady-State Analysis

Thermal and voltage constraints were identified for the 2021 Summer Shoulder Scenario. Refer to Table 2-2 for a summary of the thermal constraints identified.

Table 2-2
Summary of Thermal Constraints for 2021 Summer Shoulder

Constraint	Contflow (MVA)	Rating (MVA)	Loading (%)	Contingency	G089	G007	G021	G043
620327 HANKSON4 230 620329 WAHPETN4 230 1	378.47	368.2	102.79	System Intact	1.2%	7.3%	0.6%	0.6%
620327 HANKSON4 230 620329 WAHPETN4	378.47	368.2	102.79	System Intact	1.2%	26.7%	0.6%	0.6%

230 1								
635200 RAUN 3 345 645451 S3451 3 345 1	1063.93	956	111.29	P1	16.9%	13.0	22.8%	22.8%
635200 RAUN 3 345 645451 S3451 3 345 1 note 2	1010.87	956	105.74	P1	16.3%	12.5%	17.8%	17.8%
635680 BONDRNT3 345 635730 MNTZUMA3 345 1	1022.95	926	110.47	System Intact	5.4%	1.8%	6.9%	6.9%

The thermal overloads identified in Table 2-2 were also identified in the DPP February 2016 West study that was recently completed. It is expected that upgrades from that study will mitigate the thermal overloads identified here.

Table 2-3
Summary of Voltage Constraints for 2021 Summer Shoulder

Bus Number	Bus Name	Base kV	Area Owner	Pre-Proejct V (p.u.)	Post-Proejct V (p.u.)	Voltage Degradation	Criteria
344923	5LATHROP	161	AMMO	0.96	0.92	3%	0.95 to 1.05 p.u.
629074	ARNOLD1G	22	ALTW	1.04	1.06	2%	0.95 to 1.05 p.u.
638032	GT SUB 8	69	MEC	1.00	0.97	3%	1.00 to 1.05 p.u.
638036	STRTR P8	69	MEC	1.00	0.97	3%	1.00 to 1.05 p.u.
635017	ATCHSN 3	345	MEC	1.02	0.97	6%	1.00 to 1.05 p.u.
635000	CBLUFFS3	345	MEC	1.01	0.97	3%	1.00 to 1.05 p.u.
635056	ADAMS 5	161	MEC	1.00	0.97	3%	1.00 to 1.05 p.u.
638001	AMES 8	69	MEC	1.005	0.984	2.1%	1.00 to 1.05 p.u.
638002	DAYTON8	69	MEC	1.003	0.982	2.1%	1.00 to 1.05 p.u.
50322	J442 POI	230	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.

615637	GRE-SILVRLK4	230	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
616000	GRE-MARSHLK7	115	OTP	0.94	0.90	4%	0.92 to 1.10 p.u.
616001	GRE-WALDEN 7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
616002	GRE-JOHNJCT7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
616003	GRE-GRACEV 7	115	OTP	0.94	0.90	3%	0.92 to 1.10 p.u.
616006	GRE-HANCOCK7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
618206	GRE-FERGUS 7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620170	EFERGUS7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620173	DAWS TP7	115	OTP	0.93	0.90	4%	0.92 to 1.10 p.u.
620174	DAWSON 7	115	OTP	0.93	0.90	4%	0.92 to 1.10 p.u.
620205	BRUCE 7	115	OTP	0.91	0.87	4%	0.92 to 1.10 p.u.
620206	LOUSBRG7	115	OTP	0.93	0.90	4%	0.92 to 1.10 p.u.
620208	BRUCE TP	115	OTP	0.91	0.87	4%	0.92 to 1.10 p.u.

620209	HETLAND7	115	OTP	0.91	0.87	4%	0.92 to 1.10 p.u.
620210	TORONTO7	115	OTP	0.92	0.88	4%	0.92 to 1.10 p.u.
620211	CANBY 7	115	OTP	0.93	0.90	4%	0.92 to 1.10 p.u.
620212	BURR 7	115	OTP	0.92	0.89	4%	0.92 to 1.10 p.u.
620213	MARIETT7	115	OTP	0.92	0.89	4%	0.92 to 1.10 p.u.
620214	BIGSTON7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
620215	HIWY12 7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
620216	ORTONVL7	115	OTP	0.95	0.91	3%	0.92 to 1.10 p.u.
620218	MOROTP 7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
620223	HOOT LK7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620224	DUMONT 7	115	OTP	0.94	0.90	3%	0.92 to 1.10 p.u.
620225	WHEATNS7	115	OTP	0.94	0.90	4%	0.92 to 1.10 p.u.
620227	FAIRMNT7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.

620228	TYLER 7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
620229	WAHPETN7	115	OTP	0.93	0.91	3%	0.92 to 1.10 p.u.
620232	EDGETWN7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620233	EDGETAP7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620287	ORTQUAR7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620288	ODESSA 7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
620289	CORRELL7	115	OTP	0.94	0.90	4%	0.92 to 1.10 p.u.
620294	TRAVWHE7	115	OTP	0.94	0.90	4%	0.92 to 1.10 p.u.
620295	TRAVPIP7	115	OTP	0.94	0.90	4%	0.92 to 1.10 p.u.
620296	TYLERRS7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
620314	BIGSTON4	230	OTP	0.92	0.89	3%	0.92 to 1.10 p.u.
620322	BSSOUTH4	230	OTP	0.92	0.89	3%	0.92 to 1.10 p.u.
620325	BROWNSV4	230	OTP	0.90	0.87	3%	0.92 to 1.10 p.u.

620327	HANKSON4	230	OTP	0.91	0.88	3%	0.92 to 1.10 p.u.
620329	WAHPETN4	230	OTP	0.91	0.89	3%	0.92 to 1.10 p.u.
620363	FORMAN 4	230	OTP	0.93	0.91	2%	0.92 to 1.10 p.u.
620417	BSSOUTH3	345	OTP	0.92	0.90	2%	0.92 to 1.10 p.u.
652555	MORRIS 7	115	OTP	0.93	0.89	3%	0.92 to 1.10 p.u.
658102	GRANTCO7	115	OTP	0.92	0.89	3%	0.92 to 1.10 p.u.
658104	ELBOWLK7	115	OTP	0.93	0.90	3%	0.92 to 1.10 p.u.
658110	FERGSFL7	115	OTP	0.94	0.91	3%	0.92 to 1.10 p.u.
658114	APPLETN7	115	OTP	0.94	0.90	4%	0.92 to 1.10 p.u.
659698	WAHPET2Y	230	OTP	0.91	0.88	3%	0.92 to 1.10 p.u.
659699	WAHPET1Y	230	OTP	0.91	0.88	3%	0.92 to 1.10 p.u.
657709	LANGDON7	115	OTP	0.90	0.89	2%	0.92 to 1.10 p.u.
657749	CENTER1G	22	OTP	0.97	0.89	8%	0.973 to 1.015 p.u.

The Lathrop 161 kV bus voltage violation was identified in the DPP February 2016 West Phase II study. All other bus voltage violations were only identified for this study. The upgrades identified in the DPP February 2016 West study may impact the low voltages observed here. Mitigation for the low voltages will be identified pending the completion of the DPP February 2016 West Phase II study.

2.7 Steady-State Analysis Conclusions

The Affected System Study identified Steady State thermal violations associated with the interconnection of the thirteen SPP projects. The study identified injection constraints as well as voltage violations in the shoulder scenario for 2021 analysis. Network upgrades will be recommended pending the completion of the DPP February 2016 West Phase II study.

SECTION 3: TRANSIENT STABILITY ANALYSIS

The transient stability analysis was performed to evaluate the transient stability impact of the SPP study generators on the MISO transmission system for regional faults in the WAPA and NPPD area. The transient stability analysis was performed with PSS/E Version 33.10.0.

3.1 Model Development

The following MTEP17 DPP-2016-Feb-West Phase II study case stability files were used for the study:

- 2021 Summer Shoulder
  - StudyCase-2022_SH90_DS_171020.sav

The "pre-project" case was developed based on the above power flow case by making the following changes:

- Remove the withdrawn Project J298, a 300 MW interconnection that connects to the Dysart 161 kV substation.
  - Note the withdrawal of Project J298 required a restudy for the MISO DPP-August-2015-West group which was not completed at the time of this study. Any changes to the results of that study may impact this study and may require a restudy of the Affected System Impact Study for SPP DISIS-2016-001.
- Re-dispatch generation in the MISO Classic region.

The SPP study cases were built by adding the SPP queue projects to the MISO "pre-project" cases. The details of each SPP interconnection request study projects are listed in Table 1-1. The SPP study projects and SPP higher queued projects were dispatched per MISO criteria to the entire SPP footprint, where generators were scaled in proportion to the available reserve.

3.2 Study Criteria

All interconnections must be compliant with MISO criteria and will be required to provide mitigation to obtain Interconnection Service for the following:

- System instability
- Transient voltage constraints
- Damping violation

3.2.1 MISO Criteria

The faults selected for this analysis were evaluated based on the following MISO criteria:

- All on-line generating units are stable.
- No unexpected generator tripping.
- Post-fault transient voltage limits: 1.2 p.u. maximum, 0.7 p.u. minimum.
- All machine rotor angle oscillations must be positively damped with a minimum damping ratio of 0.81633% for disturbances with a fault or 1.6766% for line trips without a fault.
- Per local TO's planning criteria, specific transient voltage limits are applied to specific buses, areas, or companies that have different requirements.

A bus is considered a transient voltage constraint if both of the following conditions are met (all transient voltage constraints must be resolved before a project can receive Interconnection Service):

- The bus transient voltage is outside of specified transient voltage limits during the transient period, and
- The bus voltage is at least 0.01 p.u. worse than the pre-project case voltage for the same contingency.

3.3 List of Contingencies

The contingencies listed in Table 3-1 were simulated using the 2021 Summer Shoulder stability package. Simulations were performed using both the pre-project case and study case. The contingencies were performed by simulating a one second state-state run followed by the disturbance and element lost as described in Table 3-1.

Table 3-1
List and Description of Stability Contingencies

1	FLT01	3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
2	FLT02	3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
3	FLT03	3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus.

		b. Clear fault after 5 cycles by tripping the faulted line.
4	FLT04	3 phase fault on the Hoskins 345/230/13.8kV (640226/640227/643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
5	FLT05	3 phase fault on the Hoskins 345/115/13.8kV (640226/640228/640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
6	FLT06	3 phase fault on the Raun (635200) to Sioux City (652564) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
7	FLT07	3 phase fault on the Raun (635200) to J506_POI (65400) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
8	FLT08	3 phase fault on the Raun (635200) to S3451 (645451) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
9	FLT09	3 phase fault on the Raun (635200) to J412_POI (55201) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
10	FLT10	3 phase fault on the Raun 345/161kV (635200/635201) transformer, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
11	FLT11	3 phase fault on the Shell Creek (640342) to Columbus (640125) 345kV line circuit 1, near Shell Creek. a. Apply fault at the Shell Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
12	FLT12	3 phase fault on the Shell Creek 345/230/13.8kV (640342/640343/643136) transformer, near Shell Creek. a. Apply fault at the Shell Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
13	FLT13	3 phase fault on the Antelope 345/115/13.8kV (640520/640521/640524) transformer, near Antelope. a. Apply fault at the Antelope 345kV bus.

		b. Clear fault after 5 cycles by tripping the faulted line.
14	FLT14	3 phase fault on the Hoskins 230/115/13.8kV (640227/640228/643083) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
15	FLT15	3 phase fault on the Hoskins (640227) to Dixon County (560347) 230kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
16	FLT16	3 phase fault on the Hoskins (640228) to Norfolk (640298) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
17	FLT17	3 phase fault on the Hoskins (640228) to Belden (640080) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
18	FLT18	3 phase fault on the Hoskins (640228) to Norfolk North (640296) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
19	FLT19	3 phase fault on the Hoskins (640228) to Stanton West (640363) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
20	FLT20	**Hoskins 345 kV Stuck Breaker Scenario 1** a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) – Shell Creek (640342) 345kV d. Hoskins (640226) – Raun (635200) 345kV
21	FLT21	**Hoskins 345 kV Stuck Breaker Scenario 2** a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) – Shell Creek (640342) 345kV d. Hoskins (640226) – Antelope (640520) 345kV
22	FLT22	**Hoskins 345 kV Stuck Breaker Scenario 3** a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins 345/230/13.8kV (640226/640227/643082) transformer

		d. Hoskins 345/115/13.8kV (640226/640228/640231) transformer
23	FLT23	**Prior Outage of Hoskins 345 kV (640226) to Raun 345 kV (635200) CKT 1;** 3 phase fault on Hoskins 345kV (640226) to Antelope 345kV (640520), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
24	FLT24	**Prior Outage of Hoskins 345 kV (640226) to Raun 345 kV (635200) CKT 1;** 3 phase fault on Hoskins 345kV (640226) to Shell Creek 345kV (640342), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
25	FLT25	**Prior Outage of Hoskins 345 kV (640226) to Raun 345 kV (635200) CKT 1;** 3 phase fault on Hoskins 345/115/13.8kV (640226/640228/640298) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
26	FLT26	**Prior Outage of Hoskins 345 kV (640226) to Antelope 345 kV (640520) CKT 1;** 3 phase fault on Hoskins 345kV (640226) to Raun 345kV (635200), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
27	FLT27	**Prior Outage of Hoskins 345 kV (640226) to Antelope 345 kV (640520) CKT 1;** 3 phase fault on Hoskins 345kV (640226) to Shell Creek 345kV (640342), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
28	FLT28	**Prior Outage of Hoskins 345 kV (640226) to Antelope 345 kV (640520) CKT 1;** 3 phase fault on Hoskins 345/115/13.8kV (640226/640228/640298) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
29	FLT29	**Prior Outage of Hoskins 345/230/13.8 kV (640226/640227/643082) Transformer;** 3 phase fault on Hoskins 345kV (640226) to Antelope 345kV (640520), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
30	FLT30	**Prior Outage of Hoskins 345/230/13.8 kV (640226/640227/643082) Transformer;** 3 phase fault on Hoskins 345kV (640226) to Shell Creek 345kV (640342), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
31	FLT31	**Prior Outage of Hoskins 345/230/13.8 kV (640226/640227/643082) Transformer;** 3 phase fault on Hoskins 345kV (640226) to Raun 345kV (635200), near Hoskins.

		a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
32	FLT32	3 phase fault on the G16-023-Tap (560075) to Sidney2-LNX (659426) to Sidney (659133) 345kV line circuit 1, near G16-023-Tap. a. Apply fault at the G16-023-Tap 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
33	FLT33	3 phase fault on the G16-023-Tap (560075) to Laramie (659131) 345kV line circuit 1, near G16-023-Tap. a. Apply fault at the G16-023-Tap 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
34	FLT34	3 phase fault on the Laramie (659131) to Stegall (659135) 345kV line circuit 1, near Laramie. a. Apply fault at the Laramie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
35	FLT35	3 phase fault on the Sidney (659133) to Sidney1-LNX (659425) to Keystone (640252) 345kV line circuit 1, near Sidney. a. Apply fault at the Sidney 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
36	FLT36	3 phase fault on the Sidney 345/230/13.8kV (659133/659210/659168) Transformer, near Sidney. a. Apply fault at the Sidney 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
37	FLT37	3 phase fault on the Ogalala 230/115/13.8kV (640302/640304/643115) Transformer circuit 1, near Ogalala 230 kV. a. Apply fault at the Ogalala 230 kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
38	FLT38	3 phase fault on the Ogalala (640302) to Gentleman (640184) 230 kV line circuit 1, near Ogalala. a. Apply fault at the Ogalala 230kV bus. b. Clear fault after 5 cycles and trip the faulted line and remove fault.
39	FLT39	3 phase fault on the Sidney (659134) to Sidney West (652584) 230kV line circuit 1, near Sidney. a. Apply fault at the Sidney 230 kV bus. b. Clear fault after 5 cycles, trip the faulted line, and remove the fault. c. Block the DC tie at SIDNEY 4.
40	FLT40	**Sidney 230 kV Stuck Breaker Scenario 1** a. Apply single phase fault at the Sidney (659134) 230kV bus. b. Wait 16 cycles and remove fault.

		c. Trip Sidney (659134) to Sidney Xfmr (659210) 230kV line circuit 1. d. Trip Sidney (659134) to Ogalala (640302) 230kV line circuit 1.
41	FLT41	**Sidney 230 kV Stuck Breaker Scenario** a. Apply single phase fault at the Sidney (659134) 230 kV bus. b. Wait 16 cycles and remove fault. c. Trip Sidney (659134) to Sidney Xfmr (659210) 230 kV line circuit 1. d. Trip Sidney (659134) 230 kV / (652573) 115 kV / (659803) 13.8 kV transformer circuit 1.
42	FLT42	**Sidney 345 kV Stuck Breaker Scenario 1** a. Apply single phase fault at the Sidney2-LNX (659426) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sidney2-LNX (659426) to G16-023-Tap (560075) 345kV line circuit 1. d. Trip Sidney2-LNX3 (659426) to Sidney (659133) 345kV line circuit 1
43	FLT43	**Stegall 345 kV Stuck Breaker Scenario 1** a. Apply single phase fault at the Stegall (659135) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Stegall (659135) to Laramie (659131) 345kV line circuit 1. d. Trip Stegall (659135) to Sidney (659133) 345kV line circuit 1
44	FLT44	**Keystone 345 kV Stuck Breaker 3310** a. Apply single phase fault at the Keystone (640252) 345kV bus on the Keystone to Sidney (659133) ckt1 345kV line. b. Run 16 cycles, remove fault. c. Trip line from Keystone (640252) to Sidney (659133) 345kV. d. Trip line from Keystone (640252) to Gentleman (640183) 345kV.
45	FLT45	**Keystone 345 kV Stuck Breaker 3304** a. Apply single phase fault at the Keystone (640252) 345kV bus on the Keystone to Gentleman (640183) ckt1 345kV line. b. Run 16 cycles, remove fault. c. Trip line from Keystone (640252) to Gentleman (640183) 345kV. d. Disconnect three winding transformer at bus 640252/640253/640254.
46	FLT46	**Prior outage on the Sidney (659134) – Sidney Xfmr (659210) 230 kV line circuit 1** 3 phase fault on the Sidney (659133) to Stegall (659135) 345kV line circuit 1, near Sydney. a. Apply fault at the Sidney 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 16 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

47	FLT47	**Prior outage on the Sidney (659134) – Sidney Xfmr (659210) 230 kV line circuit 1** 3 phase fault on the Sidney (659133) to Sidney2-LNX (659426) 345kV line circuit 1, near Sydney. a. Apply fault at the Sidney 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 16 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
48	FLT48	3 phase fault on the G16-050-Tap (560082) to Axtell (640065) 345kV line circuit 1, near G16-050-Tap. a. Apply fault at the G16-050-Tap 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
49	FLT49	3 phase fault on the G16-050-Tap (560082) to Post Rock (530583) 345kV line circuit 1, near G16-050-Tap. a. Apply fault at the G16-050-Tap 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
50	FLT50	3 phase fault on the Axtell (640065) to Sweetwater (640374) 345kV line circuit 1, near Axtell. a. Apply fault at the Axtell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
51	FLT51	3 phase fault on the Axtell (640065) to Pauline (640312) 345kV line circuit 1, near Axtell. a. Apply fault at the Axtell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
52	FLT52	3 phase fault on the Axtell 345/115/13.8kV (640065/640066/640067) Transformer, near Axtell. a. Apply fault at the Axtell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
53	FLT53	3 phase fault on the Post Rock (530583) to Spearville (531469) 345kV line circuit 1, near Post Rock. a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
54	FLT54	3 phase fault on the Post Rock 345/230/13.8kV (530583/530584/530673) Transformer, near Post Rock. a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
55	FLT55	**Axtell 345 kV Stuck Breaker Scenario 1** a. Apply fault at the Axtell 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Axtell (640065) – G16-050-Tap (560082) 345kV

		d. Axtell (640065) – Pauline (640312) 345kV
56	FLT56	**Axtell 345 kV Stuck Breaker Scenario 2** a. Apply fault at the Axtell 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Axtell (640065) – G16-050-Tap (560082) 345kV d. Axtell (640065) – Sweetwater (640374) 345kV
57	FLT57	**Axtell 345 kV Stuck Breaker Scenario 3** a. Apply fault at the Axtell 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Axtell (640065) – Pauline (640312) 345kV d. Axtell (640065) – Sweetwater (640374) 345kV
58	FLT58	**Post Rock 345 kV Stuck Breaker Scenario 1** a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Post Rock (530583) – G16-050-Tap (560082) 345kV d. Post Rock (530583) – Spearville (531469) 345kV
59	FLT59	**Post Rock 345 kV Stuck Breaker Scenario 2** a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Post Rock (530583) – G16-050-Tap (560082) 345kV d. Post Rock 345/230/13.8kV (530583/530584/530673) Transformer
60	FLT60	**Post Rock 345 kV Stuck Breaker Scenario 3** a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Post Rock (530583) – Spearville (531469) 345kV d. Post Rock 345/230/13.8kV (530583/530584/530673) Transformer
61	FLT61	**Prior Outage of G16-050-Tap 345 kV (560082) to Axtell 345 kV (640065) CKT 1;** 3 phase fault on Post Rock 345kV (530583) to Spearville (531469), near Post Rock. a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
62	FLT62	**Prior Outage of G16-050-Tap 345 kV (560082) to Axtell 345 kV (640065) CKT 1;** 3 phase fault on Post Rock 345/230/13.8kV (530583/530584/530673) Transformer, near Post Rock. a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
63	FLT63	**Prior Outage of G16-050-Tap 345 kV (560082) to Post Rock 345 kV (530583) CKT 1;** 3 phase fault on Axtell 345kV (640065) to Sweetwater 345kV (640374), near Axtell.

		a. Apply fault at the Axtell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
64	FLT64	**Prior Outage of G16-050-Tap 345 kV (560082) to Post Rock 345 kV (530583) CKT 1;** 3 phase fault on Axtell 345kV (640065) to Pauline 345kV (640312), near Axtell. a. Apply fault at the Axtell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
65	FLT65	**Prior Outage of G16-050-Tap 345 kV (560082) to Post Rock 345 kV (530583) CKT 1;** 3 phase fault on Axtell 345/115/13.8kV (640065/640066/640067) Transformer, near Axtell. a. Apply fault at the Axtell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
66	FLT66	3 phase fault on the Grand Prairie (652532) to GRPRAR1-LNX3 (652832) to Holt County (640510) 345kV line circuit 1, near Grand Prairie. a. Apply fault at the Grand Prairie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
67	FLT67	3 phase fault on the Grand Prairie (652532) to GRPRAR2-LNX3 (652833) to Ft Thompson (652506) 345kV line circuit 1, near Grand Prairie. a. Apply fault at the Grand Prairie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
68	FLT68	3 phase fault on the Holt County (640510) to Grand Island (653571) 345kV line circuit 1, near Holt County. a. Apply fault at the Holt County 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
69	FLT69	3 phase fault on the Holt County (640510) to Thedford (640500) 345kV line circuit 1, near Holt County. a. Apply fault at the Holt County 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
70	FLT70	3 phase fault on the Ft Thompson (652506) to FTTHOM1-LNX3 (652806) to G16-017-Tap (560074) 345kV line circuit 1, near Ft Thompson. a. Apply fault at the Ft Thompson 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
71	FLT71	3 phase fault on the Ft Thompson 345/230/14.8kV (652506/652507/652273) transformer, near Ft Thompson. a. Apply fault at the Ft Thompson 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
72	FLT72	**Grand Prairie 345 kV Stuck Breaker Scenario 1** a. Apply fault at the GRPRAR1-LNX3 345kV bus.

		b. Clear fault after 16 cycles and trip the following elements c. GRPRAR1-LNX3 (652832) – Grand Prairie (652532) 345kV d. GRPRAR1-LNX3 (652832) – Holt County (640510) 345kV
73	FLT73	**Grand Prairie 345 kV Stuck Breaker Scenario 2** a. Apply fault at the GRPRAR2-LNX3 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. GRPRAR2-LNX3 (652833) – Grand Prairie (652532) 345kV d. GRPRAR2-LNX3 (652833) – FTTHOM2-LNX3 (652807) 345kV
74	FLT74	**Prior Outage of Grand Prairie 345 kV (652532) to GRPRAR1-LNX3 345 kV (652832) CKT 1;** 3 phase fault on the Ft Thompson (652506) to FTTHOM1-LNX3 (652806) 345kV line circuit 1, near Ft Thompson. a. Apply fault at the Ft Thompson 345kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
75	FLT75	**Prior Outage of Grand Prairie 345 kV (652532) to GRPRAR1-LNX3 345 kV (652832) CKT 1;** 3 phase fault on the Ft Thompson 345/230/14.8kV (652506/652507/652273) transformer, near Ft Thompson. a. Apply fault at the Ft Thompson 345kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
76	FLT76	**Prior Outage of Grand Prairie 345 kV (652532) to GRPRAR2-LNX3 345 kV (652833) CKT 1;** 3 phase fault on the Holt County (640510) to Grand Island (652871) 345kV line circuit 1, near Holt County. a. Apply fault at the Holt County 345kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
77	FLT77	**Prior Outage of Grand Prairie 345 kV (652532) to GRPRAR2-LNX3 345 kV (652833) CKT 1;** 3 phase fault on the Holt County (640510) to Thedford (640500) 345kV line circuit 1, near Holt County. a. Apply fault at the Holt County 345kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
78	FLT78	3 phase fault on the Leland Olds (659106) to Garrison (652441) 230kV line circuit 1, near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
79	FLT79	3 phase fault on the Leland Olds (659106) to Washburn (652456) 230kV line circuit 1, near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
80	FLT80	3 phase fault on the Leland Olds (659106) to Logan (659108) 230kV line circuit 1, near Leland Olds.

		a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
81	FLT81	3 phase fault on the Leland Olds (659106) to Stanton (615901) 230kV line circuit 1, near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
82	FLT82	3 phase fault on the Leland Olds 345/230/13.8kV (659105/659106/659201) transformer circuit 1, near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
83	FLT83	3 phase fault on the Garrison (652441) to Hilken (652466) 230kV line circuit 1, near Garrison. a. Apply fault at the Garrison 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
84	FLT84	3 phase fault on the Garrison (652441) to Jamestown (652444) 230kV line circuit 1, near Garrison. a. Apply fault at the Garrison 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
85	FLT85	3 phase fault on the Washburn (652456) to Bismark (652426) 230kV line circuit 1, near Washburn. a. Apply fault at the Washburn 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
86	FLT86	3 phase fault on the Logan (659108) to Blaisdell (659143) 230kV line circuit 1, near Logan. a. Apply fault at the Logan 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
87	FLT87	3 phase fault on the Stanton (615901) to Coal Creek Tap (615900) 230kV line circuit 1, near Stanton. a. Apply fault at the Stanton 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
88	FLT88	3 phase fault on the Leland Olds (659105) to Antelope (659101) 345kV line circuit 1, near Leland Olds. a. Apply fault at the Leland Olds 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
89	FLT89	**Leland Olds 230 kV Stuck Breaker Scenario 1** a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Leland Olds (659106) – Washburn (652456) 230kV d. Leland Olds (659106) – Garrison (652441) 230kV

90	FLT90	**Leland Olds 230 kV Stuck Breaker Scenario 2** a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Leland Olds (659106) – Logan (659108) 230kV d. Leland Olds (659106) – Stanton (615901) 230kV
91	FLT91	**Leland Olds 230 kV Stuck Breaker Scenario 3** a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Leland Olds 345/230/13.8kV (659105/659106/659201) transformer, circuit 1 d. Leland Olds 345/230/13.8kV (659105/659106/659202) transformer, circuit 2
92	FLT92	**Prior Outage of Leland Olds 230 kV (659106) to Washburn 230 kV (652456) CKT 1;** 3 phase fault on Leland Olds 230kV (659106) to Logan 230kV (659108), near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
93	FLT93	**Prior Outage of Leland Olds 230 kV (659106) to Washburn 230 kV (652456) CKT 1;** 3 phase fault on Leland Olds 230kV (659106) to Garrison 230kV (652441), near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
94	FLT94	**Prior Outage of Leland Olds 230 kV (659106) to Washburn 230 kV (652456) CKT 1;** 3 phase fault on Leland Olds 345/230/13.8kV (659105/659106/659201) transformer, near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
95	FLT95	**Prior Outage of Leland Olds 230 kV (659106) to Logan 230 kV (659108) CKT 1;** 3 phase fault on Leland Olds 230kV (659106) to Washburn 230kV (652456), near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
96	FLT96	**Prior Outage of Leland Olds 230 kV (659106) to Logan 230 kV (659108) CKT 1;** 3 phase fault on Leland Olds 230kV (659106) to Garrison 230kV (652441), near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
97	FLT97	**Prior Outage of Leland Olds 230 kV (659106) to Logan 230 kV (659108) CKT 1;** 3 phase fault on Leland Olds 345/230/13.8kV (659105/659106/659201) transformer, near Leland Olds. a. Apply fault at the Leland Olds 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

98	FLT98	3 phase fault on the GROTON3 (659160) TO GROTON-LNX3 (659422) to LELAND1-LNX3 (659422) to LELANDO3 (659105) 345kV line circuit 1, near GROTON3. a. Apply fault at the GROTON3 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
99	FLT99	3 phase fault on the Leland Olds (659105) to LELAND2-LNX3 (659424) to G16-017-TAP (560074) 345kV line circuit 1, near Leland Olds. a. Apply fault at the Leland Olds 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
100	FLT100	3 phase fault on the Groton (659160) to G09_001IST (652175) 345kV line circuit 1, near Groton. a. Apply fault at the Groton 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
101	FLT101	3 phase fault on the Groton 345/115/13.8kV (659160/652568/659161) transformer, near Groton. a. Apply fault at the Groton 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
102	FLT102	3 phase fault on the G09_001IST (652175) to Watertown (652529) 345kV line circuit 1, near G09_001IST. a. Apply fault at the G09_001IST 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
103	FLT103	3 phase fault on the Hilken (652466) to Baldwin (659365) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
104	FLT104	3 phase fault on the Hilken (652466) to Garrison (652441) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
105	FLT105	3 phase fault on the Hilken (652466) to Bismark (652426) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
106	FLT106	3 phase fault on the Bismark (652426) to Jamestown (652444) 230kV line circuit 1, near Bismark. a. Apply fault at the Bismark 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
107	FLT107	3 phase fault on the Bismark (652426) to Weber (659128) 230kV line circuit 1, near Bismark. a. Apply fault at the Bismark 230kV bus.

		b. Clear fault after 6 cycles by tripping the faulted line.
108	FLT108	3 phase fault on the Bismark (652426) to Mound City (652499) 230kV line circuit 1, near Bismark. a. Apply fault at the Bismark 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
109	FLT109	3 phase fault on the Bismark (652426) to Ward (652296) 230kV line circuit 1, near Bismark. a. Apply fault at the Bismark 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
110	FLT110	3 phase fault on the Bismark 230/115/12.4kV (652426/652427/652392) transformer circuit 1, near Bismark. a. Apply fault at the Bismark 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
111	FLT111	3 phase fault on the Baldwin (659365) to Ecklund (659284) 230kV line circuit Z, near Baldwin. a. Apply fault at the Baldwin 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
112	FLT112	**Hilken 230 kV Stuck Breaker Scenario 1** a. Apply fault at the Hilken 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hilken (652466) – Baldwin (659365) 230kV d. Hilken (652466) – Bismark (652426) 230kV
113	FLT113	**Hilken 230 kV Stuck Breaker Scenario 2** a. Apply fault at the Hilken 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hilken (652466) – Baldwin (659365) 230kV d. Hilken (652466) – Garrison (652441) 230kV
114	FLT114	**Hilken 230 kV Stuck Breaker Scenario 3** a. Apply fault at the Hilken 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hilken (652466) – Garrison (652441) 230kV d. Hilken (652466) – Bismark (652426) 230kV
115	FLT115	**Garrison 230 kV Stuck Breaker Scenario 1** a. Apply fault at the Garrison 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Garrison (652441) – Leland Olds (659106) 230kV d. Garrison (652441) – Jamestown (652444) 230kV

116	FLT116	**Bismark 230 kV Stuck Breaker Scenario 1** a. Apply fault at the Bismark 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Bismark (652426) – Weber (659128) 230kV d. Bismark (652426) – Jamestown (652444) 230kV
117	FLT117	**Prior Outage of Hilken 230 kV (652466) to Baldwin 230 kV (659365) CKT 1;** 3 phase fault on the Hilken (652466) to Garrison (652441) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
118	FLT118	**Prior Outage of Hilken 230 kV (652466) to Baldwin 230 kV (659365) CKT 1;** 3 phase fault on the Hilken (652466) to Bismark (652426) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
119	FLT119	**Prior Outage of Hilken 230 kV (652466) to Baldwin 230 kV (659365) CKT 1;** 3 phase fault on the Garrison (652441) to Jamestown (652444) 230kV line circuit 1, near Garrison. a. Apply fault at the Garrison 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
120	FLT120	**Prior Outage of Hilken 230 kV (652466) to Garrison 230 kV (652441) CKT 1;** 3 phase fault on the Hilken (652466) to Bismark (652426) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
121	FLT121	**Prior Outage of Hilken 230 kV (652466) to Garrison 230 kV (652441) CKT 1;** 3 phase fault on the Hilken (652466) to Baldwin (659365) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
122	FLT122	**Prior Outage of Hilken 230 kV (652466) to Garrison 230 kV (652441) CKT 1;** 3 phase fault on the Baldwin (659365) to Ecklund (659284) 230kV line circuit Z, near Baldwin. a. Apply fault at the Baldwin 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
123	FLT123	**Prior Outage of Hilken 230 kV (652466) to Bismark 230 kV (652426) CKT 1;** 3 phase fault on the Hilken (652466) to Baldwin (659365) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

124	FLT124	**Prior Outage of Hilken 230 kV (652466) to Bismark 230 kV (652426) CKT 1;** 3 phase fault on the Hilken (652466) to Garrison (652441) 230kV line circuit 1, near Hilken. a. Apply fault at the Hilken 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
125	FLT125	**Prior Outage of Hilken 230 kV (652466) to Bismark 230 kV (652426) CKT 1;** 3 phase fault on the Baldwin (659365) to Ecklund (659284) 230kV line circuit Z, near Baldwin. a. Apply fault at the Baldwin 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
126	FLT126	**Prior Outage of Hilken 230 kV (652466) to Bismark 230 kV (652426) CKT 1;** 3 phase fault on the Garrison (652441) to Jamestown (652444) 230kV line circuit 1, near Garrison. a. Apply fault at the Garrison 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
127	FLT127	3 phase fault on the Heart River (659448) to Rhame (659266) 230kV line circuit 1, near Heart River. a. Apply fault at the Heart River 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
128	FLT128	3 phase fault on the Heart River (659448) to Belfield (652425) 230kV line circuit 1, near Heart River. a. Apply fault at the Heart River 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
129	FLT129	3 phase fault on the Belfield (652425) to Dickinson (659124) 230kV line circuit 1, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
130	FLT130	3 phase fault on the Belfield (652425) to Medora (652413) 230kV line circuit 1, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
131	FLT131	3 phase fault on the Belfield (652425) to South Heart River (659309) 230kV line circuit Z, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
132	FLT132	3 phase fault on the Belfield 345/230/13.8kV (652424/652425/652221) transformer circuit 1, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
133	FLT133	3 phase fault on the Rhame (659266) to Bowman (659339) 230kV line circuit 1, near

		Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
134	FLT134	3 phase fault on the Rhame (659266) to Little Missouri (659265) 230kV line circuit 1, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
135	FLT135	3 phase fault on the Rhame 230/115kV (659266/659267) transformer circuit 1, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
136	FLT136	**Belfield 230 kV Stuck Breaker Scenario 1** a. Apply fault at the Belfield 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Belfield (652425) – Heart River (659448) 230kV d. Belfield (652425) – Medora (652413) 230kV
137	FLT137	**Belfield 230 kV Stuck Breaker Scenario 2** a. Apply fault at the Belfield 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Belfield (652425) – Dickinson (659124) 230kV d. Belfield (652425) – Medora (652413) 230kV
138	FLT138	**Belfield 230 kV Stuck Breaker Scenario 3** a. Apply fault at the Belfield 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Belfield (652425) – South Heart River (659309) 230kV d. Belfield (652425) – Medora (652413) 230kV
139	FLT139	**Belfield 230 kV Stuck Breaker Scenario 4** a. Apply fault at the Belfield 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Belfield (652425) – Dickinson (659124) 230kV d. Belfield (652425) – South Heart River (659309) 230kV
140	FLT140	**Belfield 230 kV Stuck Breaker Scenario 5** a. Apply fault at the Belfield 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Belfield 345/230/13.8kV (652424/652425/652221) transformer, circuit 1 d. Belfield 345/230/13.8kV (652424/652425/652220) transformer, circuit 1
141	FLT141	**Rhame 230 kV Stuck Breaker Scenario 1**

		a. Apply fault at the Rhame 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rhame (659266) – Heart River (659448) 230kV d. Rhame (659266) – Little Missouri (659265) 230kV
142	FLT142	**Rhame 230 kV Stuck Breaker Scenario 2** a. Apply fault at the Rhame 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rhame (659266) – Bowman (659339) 230kV d. Rhame (659266) – Little Missouri (659265) 230kV
143	FLT143	**Rhame 230 kV Stuck Breaker Scenario 3** a. Apply fault at the Rhame 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rhame 230/115kV (659266/659267) transformer d. Rhame (659266) – Little Missouri (659265) 230kV
144	FLT144	**Rhame 230 kV Stuck Breaker Scenario 4** a. Apply fault at the Rhame 230kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rhame 230/115kV (659266/659267) transformer d. Rhame (659266) – Bowman (659339) 230kV
145	FLT145	**Prior Outage of Heart River 230 kV (659448) to Rhame 230 kV (659266) CKT 1;** 3 phase fault on the Belfield (652425) to Dickinson (659124) 230kV line circuit 1, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
146	FLT146	**Prior Outage of Heart River 230 kV (659448) to Rhame 230 kV (659266) CKT 1;** 3 phase fault on the Belfield (652425) to Medora (652413) 230kV line circuit 1, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
147	FLT147	**Prior Outage of Heart River 230 kV (659448) to Rhame 230 kV (659266) CKT 1;** 3 phase fault on the Belfield (652425) to South Heart River (659309) 230kV line circuit Z, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
148	FLT148	**Prior Outage of Heart River 230 kV (659448) to Rhame 230 kV (659266) CKT 1;** 3 phase fault on the Belfield 345/230/13.8kV (652424/652425/652221) transformer circuit 1, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

149	FLT149	**Prior Outage of Heart River 230 kV (659448) to Belfield 230 kV (652425) CKT 1;** 3 phase fault on the Rhame (659266) to Bowman (659339) 230kV line circuit 1, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
150	FLT150	**Prior Outage of Heart River 230 kV (659448) to Belfield 230 kV (652425) CKT 1;** 3 phase fault on the Rhame (659266) to Little Missouri (6529265) 230kV line circuit 1, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
151	FLT151	**Prior Outage of Heart River 230 kV (659448) to Belfield 230 kV (652425) CKT 1;** 3 phase fault on the Rhame 230/115kV (659266/659267) transformer circuit 1, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
152	FLT152	3 phase fault on G16-017-TAP (560074) to Fort Thompson (652806) 345 kV Line, CKT 1, near G16-017-TAP Bus a. Apply fault at the G16-017-TAP (560074) 345 kV Bus b. Clear fault after 6 cycles and trip the faulted line and disconnect Fort-Thompson-LNX3 (652806) bus
153	FLT153	3 phase fault on G16-017-TAP (560074) to Leland Olds (659424) 345 kV Line, CKT 1, near G16-017-TAP Bus a. Apply fault at the G16-017-TAP (560074) 345 kV Bus b. Clear fault after 6 cycles and trip the faulted line and disconnect Leland-Olds-LNX3 (659424) bus
154	FLT154	**Prior Outage of G16-017-TAP (560074) to Leland Olds (659105) 345 kV Line;** **3 phase fault on Fort Thompson (652506) to Grand Prairie (652532) 345 kV Line, near Fort Thompson** a. Apply fault at the Fort Thompson (652506) 345 kV Bus b. Clear fault after 6 cycles and trip the faulted line and disconnect Fort-Thompson-LNX3 (652807) and GrandPrairie-LNX3 (652833) bus
155	FLT155	**Prior Outage of G16-017-TAP (560074) to Leland Olds (659105) 345 kV Line;** **3 phase fault on Fort Thompson 345 kV (652506) to Fort Thompson 230 kV (652507) to Fort Thompson 13.8 kV (652274) XFMR, CKT 1, near Fort Thompson 345 kV** a. Apply fault at the Fort Thompson (652506) 345 kV Bus b. Clear fault after 6 cycles and trip the faulted transformer
156	FLT156	**Prior Outage of G16-017-TAP (560074) to Fort Thompson (652506) 345 kV Line;**

		3 phase fault on Leland Olds 345 kV (659105) to Antelop Valley 345 kV (659101) CKT 1, near Leland Olds
		a. Apply fault at the Leland Olds (659105) 345 kV Bus
		b. Clear fault after 6 cycles and trip the faulted line
157	FLT157	**Prior Outage of G16-017-TAP (560074) to Fort Thompson (652506) 345 kV Line;** **3 phase fault on Leland Olds 345 kV (659105) to Leland Olds 230 kV (659106) to leland Olds 13.8 kV (659201) XFMR, CKT 1, near Leland Olds 345 kV**
		a. Apply fault at the Leland Olds (659105) 345 kV Bus
		b. Clear fault after 6 cycles and trip the faulted transformer
158	FLT158	3 phase fault on the Utica 230kV (652526) to Ft. Randall 230kV (652509) near Utica 230kV bus a. Apply fault at the Utica 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
159	FLT159	3 phase fault on the Utica 230kV (652526) to Rasmussen 230 kV (652536) near Utica bus a. Apply fault at the Utica 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
160	FLT160	3 phase fault on the Utica 230kV (652526) to Vfodnes 230 kV (652398) near Utica bus a. Apply fault at the Utica 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
161	FLT161	3 phase fault on the Rasmussen 230 kV (652536) to Sioux City 230 kV (652565) near Rasmussen bus a. Apply fault at the Rasmussen 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
162	FLT162	3 phase fault on the FT Randall 230kV (652509) to FT. Thompson 230kV (652507) near Ft Randall bus a. Apply fault at the FT Randall 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
163	FLT163	3 phase fault on the Vfodnes 230kV (652398) to Sioux Falls 230kV (652523) near Vfodnes bus a. Apply fault at the Vfodnes 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
164	FLT164	3 phase fault on the Sioux Falls 230kV (652523) to Hanlon 230kV (652513) near Sioux falls bus a. Apply fault at the Sioux Falls 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
165	FLT165	3 phase fault on the Sioux Falls 230kV (652523) to Letcher 230kV (652606) near Letcher bus

		a. Apply fault at the Letcher 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
166	FLT166	3 phase fault on the FT Randall 230kV (652509) to Meadow Grove 230kV (640540) near FT Randall bus a. Apply fault at the FT Randall 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
167	FLT167	3 phase fault on the Hanlon 230kV (652513) to Storla 230kV (659122) near Storla Bus a. Apply fault at the Storla 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
168	FLT168	3 phase fault on the Storla 230kV (659122) to Wessington 230kV (652607) near Wessington bus a. Apply fault at Wessington 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
169	FLT169	3 phase fault on the Wessington 230kV (652607) to FT. Thompson 230kV (652507) near Wessington Bus a. Apply fault at the Wessington 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
170	FLT170	3 phase fault on the FT. Thompson 230kV (652507) to Letcher 230kV (652606) near Letcher Bus a. Apply fault at the Letcher 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
171	FLT171	3 phase fault on the Ft Randall 230kV (652509) to Love Platte 230kV (652516) near Love Platte bus a. Apply fault at the Love Platte 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
172	FLT172	3 phase fault on the FT. Thompson 230kV (652507) to Love Platte 230kV (652516) near Love Platte bus a. Apply fault at the Love Platte 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
173	FLT173	3 phase fault on the FT. Randall 230kV (652509) to Sioux City 230kV (652565) near Sioux City Bus a. Apply fault at the Sioux City Bus 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
174	FLT174	3 phase fault on the Sioux City 230kV (652565) to Eagle 230kV (659900) near Eagle Bus a. Apply fault at the Eagle Bus 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
175	FLT175	3 phase fault on the Pohoja 230kV (652578) to Sioux Falls 230kV (652523) near

		Pohoja Bus a. Apply fault at the Pohoja 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
176	FLT176	3 phase fault on the Sioux City 230kV (652565) to Twin Church 230kV (640386) near Sioux City Bus a. Apply fault at the Sioux City 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
177	FLT177	3 phase fault on the Sioux City 230kV (652565) to Denison 230kV (652567) near Sioux City a. Apply fault at the Sioux City 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
178	FLT178	3 phase fault on the FT. Thompson 230kV (652507) to Huron 230kV (652514) near FT. Thompson Bus a. Apply fault at the FT. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
179	FLT179	3 phase fault on the FT. Thompson 230kV (652507) to OAHE 230kV (652519) circuit 1 near FT. Thompson Bus a. Apply fault at the FT. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
180	FLT180	3 phase fault on the Meadow Grove 230kV (640540) to Columbus 230kV (640133) near Meadow Grove Bus a. Apply fault at the Meadow Grove 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
181	FLT181	3 phase fault on the Utica 230kV (652526) to Utica 115kV (652626) to Utica 13.2kV (652627) XFMR CKT 1, near Utica 230kV. a. Apply fault at the Utica 230kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.
182	FLT182	3 phase fault on the Sioux City 230kV (652565) to Sioux City 345kV (652564) XFMR CKT 1, near Sioux City 230kV bus. a. Apply fault at the Sioux City 230kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.
183	FLT183	3 phase fault on the Split Rock 345kV (601006) to White 345kV (652537) line near Split Rock Bus a. Apply fault at the Split Rock 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
184	FLT184	3 phase fault on the Split Rock 345kV (601006) to Nobles 345kV (601034) line near Split Rock Bus a. Apply fault at the Split Rock 345kV bus.

		b. Clear fault after 6 cycles by tripping the faulted line.
185	FLT185	3 phase fault on the Split Rock 345kV (601006) to Sioux City 345kV (652864) line near Split Rock Bus a. Apply fault at the Split Rock 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
186	FLT186	3 phase fault on the Utica 115kV (652626) to Napa 115kV (660026) line near Napa Bus a. Apply fault at the Napa 115kV bus. b. Clear fault after 7 cycles by tripping the faulted line.
187	FLT187	3 phase fault on the Utica 115kV (652626) to MENNO 115kV (660007) line near KeyStone Bus a. Apply fault at the KeyStone 115kV bus. b. Clear fault after 7 cycles by tripping the faulted line.
188	FLT188	3 phase fault on the WH Swan 115kV (652463) to Ft. Randall (652510) line near WH Swan Bus a. Apply fault at the WH Swan 115kV bus. b. Clear fault after 7 cycles by tripping the faulted line.
189	FLT189	**Prior Outage of Ft. Thompson to Huron 230kV circuit 1**. 3 phase fault on the 345/230/13.8kV FT. Thompson Transformer. a. Prior outage Ft. Thompson (652507) 230kV to Huron (652514) 230kV (solve network for steady state solution) circuit 1. b. 3 phase fault on the 345/230/13.8kV Ft. Thompson (652507) transformer #3 (652506) 13.8kV (652274) near 230kV Ft. Thompson bus. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
190	FLT190	**Prior Outage of Utica to Vfodnes 230kV**. 3 phase fault on the Utica - Ft. Randall 230kV line. a. Prior outage Utica (652526) to Vfodnes (652398) 230kV line (solve network for steady state solution). b. 3 phase fault on the Utica (652526) to Ft. Randall (652509) 230kV, near Utica 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
191	FLT191	**Prior Outage of Utica to Rasmussen 230kV**. 3 phase fault on the Utica - Vfodnes 230kV line. a. Prior outage Utica (652526) to Rasmussen (652536) 230kV line (solve network for steady state solution). b. 3 phase fault on the Utica (652526) to Vfodnes (652398) 230kV line, near Utica 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
192	FLT192	**Prior Outage of Utica to Rasmussen 230kV**. 3 phase fault on the Utica - Ft. Randall 230kV line.

		a. Prior outage Utica (652526) to Rasmussen (652536) 230kV line (solve network for steady state solution). b. 3 phase fault on the Utica (652526) to Ft. Randall 230kV (652509) 230kV line, near Utica 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
193	FLT193	**Prior Outage of Utica to Ft. Randall 230kV**. 3 phase fault on the Utica - Vfodnes 230kV line. a. Prior outage Utica (652526) to Ft. Randall 230kV (652509) 230kV line (solve network for steady state solution). b. 3 phase fault on the Utica (652526) to Vfodnes (652398) 230kV line, near Utica 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
194	FLT194	**Prior Outage of Utica to Ft. Randall 230kV**. 3 phase fault on the Utica - Rasmussen 230kV line. a. Prior outage Utica (652526) to Ft. Randall (652509) 230kV line (solve network for steady state solution). b. 3 phase fault on the Utica (652526) to Rasmussen (652536) 230kV line, near Utica 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
195	FLT195	**Prior Outage of Wessington to Ft. Thompson 230kV**. 3 phase fault on the Sioux Falls - Letcher 230kV line. a. Prior outage Wessington (652607) to Ft. Thompson (652507) 230kV line (solve network for steady state solution). b. 3 phase fault on the Sioux Falls (652523) to Letcher (652606) 230kV, near Sioux Falls 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
196	FLT196	**Prior Outage of Wessington to Ft. Thompson 230kV**. 3 phase fault on the Sioux Falls - Pohoja 230kV line. a. Prior outage Wessington (652607) to Ft. Thompson (652507) 230kV line (solve network for steady state solution). b. 3 phase fault on the Sioux Falls (652523) to Pohoja (652578) 230kV line, near Sioux Falls 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
197	FLT197	**Prior Outage of Wessington to Storla 230kV**. 3 phase fault on the Ft. Thompson - Huron 230kV line. a. Prior outage Wessington (652607) to Storla 230kV (659122) 230kV line (solve network for steady state solution). b. 3 phase fault on the Ft. Thompson (652607) to Huron (652514) 230kV line, near Ft. Thompson 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).

198	FLT198	**Prior Outage of Wessington to Storla 230kV**. 3 phase fault on the Ft. Thompson - FT Randall 230kV line. a. Prior outage Wessington (652607) to Storla 230kV (659122) 230kV line (solve network for steady state solution). b. 3 phase fault on the Ft. Thompson (652507) to FT Randall 230kV (652509) 230kV line, near Ft. Thompson 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
199	FLT199	**Prior Outage of Wessington to Storla 230kV**. 3 phase fault on the Ft. Thompson - Letcher 230kV line. a. Prior outage Wessington (652607) to Storla 230kV (659122) 230kV line (solve network for steady state solution). b. 3 phase fault on the Ft. Thompson (652507) to Letcher 230kV (652606) 230kV line, near Ft. Thompson 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
200	FLT200	**Prior Outage of Wessington to Storla 230kV**. 3 phase fault on the Ft. Thompson - Love Platte 230kV line. a. Prior outage Wessington (652607) to Storla 230kV (659122) 230kV line (solve network for steady state solution). b. 3 phase fault on the Ft. Thompson (652507) to Love Platte (652516) 230kV line, near Ft. Thompson 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
201	FLT201	**Utica 230kV Stuck Breaker** a. Apply single phase fault at the Utica (652526) 230kV line to Ft. Randall (652509) 230kV line near Utica (652526) bus. b. Wait 16 cycles, and then trip Utica (652526) to FT. Randall (652509) 230kV. c. Trip Utica (652526) to VFodnes (652398) 230kV line and remove the fault.
202	FLT202	**Utica 230kV Stuck Breaker** a. Apply single phase fault at the Utica (652526) 230kV line to Rasmussen (652536) 230kV line near Utica (652526) bus. b. Wait 16 cycles, and then trip Utica (652526) to Rasmussen (652536) Line. c. Trip Utica (652526) 230kV to Utica (652626) 115kV to Utica (652627) 13.2kV transformer and remove the fault.
203	FLT203	**Utica 115kV Stuck Breaker** a. Apply single phase fault at the Utica (652626) 115kV bus on the Utica – Napa Jn (660026) 115kV line. b. Wait 16 cycles, and then trip Utica (652626) to Napa Jn (660026) Line. c. Trip Utica (652626) 115kV to MENNO (660007) 115kV line and remove the fault.
204	FLT204	**Wessington 230kV Stuck Breaker**

		a. Apply single phase fault at the Wessington (652607) 230kV line to Ft. Thompson (652507) 230kV line near Wessington bus. b. Wait 16 cycles, and then trip Wessington (652607) to FT. Thompson (652507) 230kV line.
205	FLT205	**Wessington 230kV Stuck Breaker** a. Apply single phase fault on the Wessington (652607) – Storla (659122) 230kV line near Wessington 230kV bus. b. Wait 16 cycles, and then trip Storla (659122) to Wessington (652607) line.
206	FLT206	**Prior Outage of Utica to Vfodnes 230kV**. 3 phase fault on the Utica - Rasmussen 230kV line. a. Prior outage Utica (652526) 230kV to Vfodnes (652398) 230kV line (solve network for steady state solution). b. 3 phase fault on the Utica (652526) 230kV to Rasmussen (652536) 230kV, near Utica 230kV. c. Leave fault on for 6 cycles, then trip the faulted line in (b).
207	FLT207	3 phase fault on the VALLEY CITY 115KV (652454) to ENDERLIN 115KV (652638) CKT 1, near VALLEY CITY. a. Apply fault at the VALLEY CITY 115KV bus. a. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
208	FLT208	3 phase fault on the VALLEY CITY 115KV (652454) to JAMESTOWN 115KV (652445) CKT 1, near VALLEY CITY. a. Apply fault at the VALLEY CITY 115KV bus. a. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
209	FLT209	3 phase fault on the ENDERLIN 115KV (652638) to ELLIOTT 115KV (652462) CKT 1, near ENDERLIN. a. Apply fault at the ENDERLIN 115KV bus. a. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
210	FLT210	3 phase fault on the ELLIOTT 115KV (652462) to FORMAN 115KV (652438) CKT 1, near ELLIOTT. a. Apply fault at the ELLIOTT 115KV bus. a. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
211	FLT211	1) 3 phase fault on the JAMESTOWN 115KV (652445) to JAMESTOWN 230kV (652444) to JAMESTOWN 13.2kV (652208) XMFR CKT 1, near JAMESTOWN 115kV. 2) a. Apply fault at the JAMESTOWN 115kV bus. a. b. Clear fault after 7 cycles by tripping the faulted transformer.
212	FLT212	3 phase fault on the JAMESTOWN 115KV (652445) to CARINGTON 115KV (652428) CKT 1, near JAMESTOWN. a. Apply fault at the JAMESTOWN 115KV bus.

		a. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
213	FLT213	3 phase fault on the JAMESTOWN 115KV (652445) to EDGELEY 115KV (652432) CKT 1, near JAMESTOWN. a. Apply fault at the JAMESTOWN 115KV bus. a. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
214	FLT214	3 phase fault on the EDGELEY 115KV (652432) to ORDWAY115KV (652534) CKT 1, near EDGELEY. a. Apply fault at the EDGELEY 115KV bus. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
215	FLT215	3 phase fault on the CARINGTON 115KV (652428) to BARLOW 115KV (655610) CKT 1, near CARINGTON. a. Apply fault at the CARINGTON 115KV bus. b. Clear fault after 7 cycles by tripping the faulted line (CKT 1).
216	FLT216	3 phase fault on the JAMESTOWN 230KV (652444) to FARGO 230KV (652435) CKT 1, near JAMESTOWN. a. Apply fault at the JAMESTOWN 230KV bus. b. Clear fault after 6 cycles by tripping the faulted line (CKT 1).
217	FLT217	3 phase fault on the JAMESTOWN 345KV (620369) to CENTRE 345KV (657791) CKT 1, near JAMESTOWN. a. Apply fault at the JAMESTOWN 345KV bus. b. Clear fault after 6 cycles by tripping the faulted line (CKT 1).
218	FLT218	3 phase fault on the JAMESTOWN 345KV (620369) to BUFFALO 345KV (620358) CKT 1, near JAMESTOWN. a. Apply fault at the JAMESTOWN 345KV bus. b. Clear fault after 6 cycles by tripping the faulted line (CKT 1).
219	FLT219	3 phase fault on the BUFFALO 345KV (620358) to BISON 345KV (601067) CKT 1, near BUFFALO a. Apply fault at the BUFFALO 345KV bus. b. Clear fault after 6 cycles by tripping the faulted line (CKT 1).
220	FLT220	3 phase fault on the ANTELOPE VALLEY 345KV (659420) to BROADLAND 345KV (659421) CKT 1, near ANTELOPE VALLEY a. Apply fault at the ANTELOPE VALLEY 345KV bus. b. Clear fault after 6 cycles by tripping the faulted line (CKT 1).
221	FLT221	**Prior Outage of VALLEY CITY (652454) to JAMESTOWN (652445) 115kV.** 3 phase fault on the FORMAN (652438) –LUDDEN (659172) 115kV line.

		a. Prior outage VALLEY CITY (652454) to JAMESTOWN (652445) 115kV (solve network for steady state solution). b. 3 phase fault on the FORMAN (652438) –LUDDEN (659172) 115kV line near FORMAN 115kV. c. Leave fault on for 7 cycles, then trip the faulted line in (b).
222	FLT222	**Prior Outage of VALLEY CITY (652454) to JAMESTOWN (652445) 115kV.** 3 phase fault on the FORMAN (652438) –ROBERTS CO. (655455) 115kV line. a. Prior outage VALLEY CITY (652454) to JAMESTOWN (652445) 115kV (solve network for steady state solution). b. 3 phase fault on the FORMAN (652438) –ROBERTS CO. (655455) 115kV line near FORMAN 115kV. c. Leave fault on for 7 cycles, then trip the faulted line in (b).
223	FLT223	**Prior Outage of VALLEY CITY (652454) to ENDERLIN (652638) 115kV.** 3 phase fault on the JAMESTOWN (652445) – CARRINGTON (652428) 115kV line. a. Prior outage VALLEY CITY (652454) to ENDERLIN (652638) 115kV (solve network for steady state solution). b. 3 phase fault on the JAMESTOWN (652445) – CARRINGTON (652428) 115kV line near JAMESTOWN 115kV. c. Leave fault on for 7 cycles, then trip the faulted line in (b).
224	FLT224	**Prior Outage of VALLEY CITY (652454) to ENDERLIN (652638) 115kV.** 3 phase fault on the JAMESTOWN (652445) – CARRINGTON (652428) 115kV line. a. Prior outage VALLEY CITY (652454) to ENDERLIN (652638) 115kV (solve network for steady state solution). b. 3 phase fault on the JAMESTOWN (652445) – EDGELEY (652432) 115kV line near JAMESTOWN 115kV. c. Leave fault on for 7 cycles, then trip the faulted line in (b).
225	FLT225	VALLEY CITY 115kV Stuck Breaker a. Apply single phase fault on the VALLEY CITY 115KV (652454) to ENDERLIN 115KV (652638) CKT 1, near VALLEY CITY. b. Wait 16 cycles, and then trip VALLEY CITY 115KV (652454) to ENDERLIN 115KV (652638) CKT 1 115kV line and remove fault.
226	FLT226	VALLEY CITY 115kV Stuck Breaker a. Apply single phase fault on the VALLEY CITY 115KV (652454) to JAMESTOWN 115KV (652445) CKT 1, near VALLEY CITY. b. Wait 16 cycles, and then trip VALLEY CITY 115KV (652454) to JAMESTOWN 115KV (652445) CKT 1 115kV line and remove fault.
227	FLT227	ENDERLIN 115kV Stuck Breaker

		a. Apply single phase fault at the ENDERLIN (652638) 115kV bus on the ENDERLIN (652638) – ELLIOTT (652462) 115kV line. b. Wait 16 cycles, and then trip ENDERLIN (652638) – ELLIOTT (652462) 115kV line. c. Trip ENDERLIN (652638) to VALLEY CITY (652454) 115kV line and remove the fault.
228	FLT228	JAMESTOWN 115kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652445) 115kV bus on the JAMESTOWN (652445) – CARINGTON (652428) 115kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652445) – CARINGTON (652428) 115kV line. c. Trip JAMESTOWN (652445) to VALLEY CITY 115KV (652454) line and remove the fault.
229	FLT229	JAMESTOWN 115kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652445) 115kV bus on the JAMESTOWN (652445) – CARINGTON (652428) 115kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652445) – CARINGTON (652428) 115kV line. c. Trip JAMESTOWN (652445) to EDGELEY (652432) 115kV line and remove the fault.
230	FLT230	JAMESTOWN 230kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652444) 230kV bus on the JAMESTOWN (652444) – PICKERT (657759) 230kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652444) – PICKERT (657759) 230kV line. c. Trip JAMESTOWN (652444) to BISMARK (652426) 230kV line and remove the fault.
231	FLT231	JAMESTOWN 230kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652444) 230kV bus on the JAMESTOWN (652444) – WEBER (661028) 230kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652444) – WEBER (659128) 230kV line. c. Trip JAMESTOWN (652444) to BISMARK (652426) 230kV line and remove the fault.
232	FLT232	JAMESTOWN 230kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652444) 230kV bus on the JAMESTOWN (652444) – PICKERT (657759) 230kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652444) – PICKERT (657759) 230kV line. c. Trip JAMESTOWN (652444) 230kV to JAMESTOWN (652445) 115kV to JAMESTOWN (652208) 13.8kV transformer and remove the fault.
233	FLT233	JAMESTOWN 230kV Stuck Breaker

		a. Apply single phase fault at the JAMESTOWN (652444) 230kV bus on the JAMESTOWN (652444) – WEBER (661028) 230kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652444) – WEBER (659128) 230kV line. c. Trip JAMESTOWN (652444) 230kV to JAMESTOWN (652445) 115kV to JAMESTOWN (652208) 13.8kV transformer and remove the fault.
234	FLT234	JAMESTOWN 230kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652444) 230kV bus on the JAMESTOWN (652444) – GARRISON (652441) 230kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652444) – GARRISON (652441) 230kV line. c. Trip JAMESTOWN (652444) to BISMARK (652426) 230kV line and remove the fault.
235	FLT235	JAMESTOWN 230kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (652444) 230kV bus on the JAMESTOWN (652444) – GARRISON (652441) 230kV line. b. Wait 16 cycles, and then trip JAMESTOWN (652444) – GARRISON (652441) 230kV line. c. Trip JAMESTOWN (652444) 230kV to JAMESTOWN (652445) 115kV to JAMESTOWN (652208) 13.8kV transformer and remove the fault.
236	FLT236	JAMESTOWN 345kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (620369) 345kV bus on the JAMESTOWN (620369) – CENTRE (657791) 345kV line. b. Wait 16 cycles, and then trip JAMESTOWN (620369) – CENTRE (657791) 345kV line. c. Trip JAMESTOWN (620369) 345kV to JAMESTOWN (620269) 115kV to JAMESTOWN (620169) 41.6kV transformer and remove the fault.
237	FLT237	JAMESTOWN 345kV Stuck Breaker a. Apply single phase fault at the JAMESTOWN (620369) 345kV bus on the JAMESTOWN (620369) – BUFFALO (620358) 345kV line. b. Wait 16 cycles, and then trip JAMESTOWN (620369) – BUFFALO (620358) 345kV line. c. Trip JAMESTOWN (620369) 345kV to JAMESTOWN (620269) 115kV to JAMESTOWN (620169) 41.6kV transformer and remove the fault.

Fault scenarios were first simulated using the post-project cases. After the contingencies were completed, the results were reviewed and evaluated against the criteria in section 3.3. If any contingency exhibited voltage instability, angular instability, or voltage deviation outside of stated criteria, the pre-project case was simulated for the respective contingency to compare the

results. Any new stability or angular issues attributed to the study project were flagged and reported.

3.4 Transient Stability Analysis Results

This section lists the results from the transient stability analysis.

3.4.1 Summer Shoulder (2021) Transient Stability Analysis

Stability results for the 2021 summer shoulder case showed no stability constraints for the disturbances simulated for this study (refer to Table 3-1 for a list and description of contingencies).

3.5 Transient Stability Analysis Conclusions

No transient stability constraints were identified for the addition of the thirteen SPP projects in the 2021 Summer Shoulder scenario. The post-project case showed similar performance as the respective pre-project case and did not affect the transient stability of the system.

SECTION 4: CONCLUSIONS

The report presents the results of the system impacts SPP's DISIS-2016-001 has on the MISO transmission system for 2021 Summer Peak and 2021 Summer Shoulder scenarios.

Thermal violations and voltage violations associated with the interconnection of the thirteen SPP projects were identified. Network upgrades were identified and cost allocation was performed. A summary of cost estimates identified for each scenario is provided in Table ES-2, detailed information regarding network upgrades is provided in section 2 of this report.

No transient stability constraints were identified for the addition of the thirteen SPP projects in the 2021 Summer Shoulder scenario. The post-project case showed similar performance as the respective pre-project case and did not affect the transient stability of the system.

The generators which have impacts on the MISO system will need to mitigate for the identified constraints prior to being granted full injection on the SPP system. If the generator would elect to proceed on a limited operation basis, then the impacting generator(s) will be subject to injection limits identified from MISO's Annual and Quarterly studies.

APPENDIX A: STEADY-STATE STUDY CONTINGENCIES

Table A-1
Steady-State Study Contingencies

Con File	Con Type	Number of Contingencies
DPP-2016Feb-West_Ph2_Outlet_Contingency.con	P1	66
DPP_2016Feb-West_Ph2_Master-P1-West-1.con	P1	10349
DPP_2016Feb-West_Ph2_Master-P1-Other-1.con	P1	5432
DPP_2016Feb-West_Ph2_Master-P1-Other-2.con	P1	4560
P1_AMRN_MTEP17-2022TA.con	P1	714
P1_CWLD_MTEP17-2022TA.con	P1	19
P1_CWLP_MTEP17-2022TA.con	P1	60
P1_PPI_MTEP17-2022TA.con	P1	5
P1_SIPC_MTEP17-2022TA.con	P1	22
ComEd_RTEP_Cat_P1.con	P1	467
P1_AECI_MTEP17-2022TA.con	P1	24
P1_CE_MTEP17-2022TA.con	P1	27
P1_WAPA_MTEP17-2022TA.con	P1	53
P1-4_AMRN_MTEP17-2022TA.con	P1	25
P1-4_CWLP_MTEP17-2022TA.con	P1	7
P1-4_SIPC_MTEP17-2022TA.con	P1	2
P1-4_WAPA_MTEP17-2022TA.con	P1	2
20170808_CHC-NLL_Eden2.con	P1	19
MEC-DPP2016FEB West Ph2 2022 Cat P1 09.15.2017.con	P1	148
P1_AMES_MTEP17-2022TA.con	P1	9
P1_ATC_MTEP17-2022TA.con	P1	1359
P1_BEPC_MTEP17-2022TA.con	P1	3
P1_CBPC_MTEP17-2022TA.con	P1	2
P1_CFU_MTEP17-2022TA.con	P1	10
P1_CIPCO_MTEP17-2022TA.con	P1	10
P1_DPC_MTEP17-2022TA.con	P1	119
P1_ITCM_MTEP17-2022TA.con	P1	421
P1_MDU_MTEP17-2022TA.con	P1	119
P1_MP_MTEP17-2022TA.con	P1	510
P1_MPC_MTEP17-2022TA.con	P1	34
P1_MPW_MTEP17-2022TA.con	P1	31
P1_XEL_MTEP17-2022TA.con	P1	1270
P1-4_ATC_MTEP17-2022TA.con	P1	166

P1-4_DPC_MTEP17-2022TA.con	P1	3
P1-4_GRE_MTEP17-2022TA.con	P1	31
P1-4_ITCM_MTEP17-2022TA.con	P1	23
P1-4_MDU_MTEP17-2022TA.con	P1	14
P1-4_MP_MTEP17-2022TA.con	P1	45
P1-4_MPC_MTEP17-2022TA.con	P1	7
P1-4_OTP_MTEP17-2022TA.con	P1	25
P1-4_SMMPA_MTEP17-2022TA.con	P1	2
P1-4_XEL_MTEP17-2022TA.con	P1	64
P2-P7_AMRN_MTEP17-2022TA1.con	P2-P7	1064
P2-P7_CWLD_MTEP17-2022TA.con	P2-P7	18
P2-P7_CWLP_MTEP17-2022TA.con	P2-P7	60
P2-P7_PPI_MTEP17-2022TA.con	P2-P7	5
P2-P7_SIPC_MTEP17-2022TA.con	P2-P7	2
ComEd_RTEP_Cat_P2-P7.con	P2-P7	1164
P2-P7_AECI_MTEP17-2022TA.con	P2-P7	15
P2-P7_CE_MTEP17-2022TA.con	P2-P7	79
P2-P7_WAPA_MTEP17-2022TA.con	P2-P7	17
MEC-DPP2016FEB West Ph2 2022 Cat P2 09.15.2017.con	P2	704
MEC-DPP2016FEB West Ph2 2022 Cat P5 09.15.2017.con	P5	98
MEC-DPP2016FEB West Ph2 2022 Cat P7 09.15.2017.con	P7	44
P2-P7_AMES_MTEP17-2022TA.con	P2-P7	10
P2-P7_ATC_MTEP17-2022TA.con	P2-P7	2166
P2-P7_BEPC_MTEP17-2022TA.con	P2-P7	4
P2-P7_CBPC_MTEP17-2022TA.con	P2-P7	11
P2-P7_CFU_MTEP17-2022TA.con	P2-P7	17
P2-P7_CIPCO_MTEP17-2022TA.con	P2-P7	52
P2-P7_DPC_MTEP17-2022TA.con	P2-P7	68
P2-P7_GRE_MTEP17-2022TA.con	P2-P7	239
P2-P7_ITCM_MTEP17-2022TA.con	P2-P7	480
P2-P7_MDU_MTEP17-2022TA.con	P2-P7	150
P2-P7_MP_MTEP17-2022TA.CON	P2-P7	365
P2-P7_MPC_MTEP17-2022TA.con	P2-P7	115
P2-P7_MPW_MTEP17-2022TA.CON	P2-P7	210
P2-P7_MRES_MTEP17-2022TA.CON	P2-P7	40
P2-P7_OTP_MTEP17-2022TA.con	P2-P7	222
P2-P7_RPU_MTEP17-2022TA.con	P2-P7	30
P2-P7_SMMPA_MTEP17-2022TA.con	P2-P7	39

P2-P7_XEL_MTEP17-2022TA.con	P2-P7	1319

APPENDIX B: STUDY PROJECT ONE-LINE DIAGRAMS

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APPENDIX C: STUDY PROJECT DYNAMIC DATA

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APPENDIX D: TRANSIENT STABILITY ANALYSIS PLOTS

Refer to separate document for plots of the contingencies performed for 2021 Summer Shoulder scenarios.