INTERCONNECTION FACILITIES STUDY REPORT

GEN-2020-002

Published November 2021

By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
10/14/2021	SPP	Initial draft report issued.
11/2/2021	SPP	Updated report posted as final.

CONTENTS

SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2020-002 is for a 81 MW generating facility located in Yutan, Nebraska. The Interconnection Request was studied in the 2016 Group 9 Interim and Limited Operation Impact Study for ERIS interim service. The Interconnection Customer's requested in-service date is December 1st, 2022.

The interconnecting Transmission Owner, Omaha Public Power District (OPPD), performed a detailed IFS at the request of SPP. The full report is included in Appendix A. SPP has determined that 81 MW of ERIS interim service will be available after the assigned Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrades are complete.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades needed to grant the requested Interconnection Service.

PHASE(S) OF INTERCONNECTION SERVICE

It is not expected that Interconnection Service will occur in phases. However, full Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

FERC Order ER20-1687-000 eliminated the use of Attachment Z2 revenue crediting as an option for compensation. The Incremental Long Term Congestion Right (ILTCR) process will be the sole process to compensate upgrade sponsors as of July 1st, 2020.

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of twenty-seven (27) TMEIC-PVU-L0840GR solar inverters for a total generating nameplate capacity of 81 MW.

The Interconnection Customer's Interconnection Facilities to be designed, procured, constructed, installed, maintained, and owned by the Interconnection Customer at its sole expense include:

- 34.5 kV underground cable collection circuits;
- 34.5 kV to 69 kV transformation substation with associated 34.5 kV and 69 kV switchgear;
- One (1) 69/34.5 kV 52/69/87 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- An approximately .5 mile overhead 69 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 69 kV bus at existing Transmission Owner substation ("6846 Substation 69 kV") that is owned and maintained by Transmission Owner;
- All transmission facilities required to connect the Interconnection Customer's substation to the POI;
- Equipment at the Interconnection Customer's substation necessary to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 95% lagging and 95% leading in accordance with Federal Energy Regulatory Commission (FERC) Order 827. The Interconnection Customer may use inverter manufacturing options for providing reactive power under no/reduced generation conditions. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met; and,
- All necessary relay, protection, control and communication systems required to protect Interconnection Customer's Interconnection Facilities and Generating Facilities and coordinate with Transmission Owner's relay, protection, control and communication systems.

TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADE(S)

To facilitate interconnection, the interconnecting Transmission Owner will perform work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities.

Table 1 and **Table 2** lists the Interconnection Customer's estimated cost responsibility for Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) and provides an estimated lead time for completion of construction. The estimated lead time begins when the Generator Interconnection Agreement has been fully executed.

Table 1: Transmission Owner Interconnection Facilities (TOIF)

Transmission Owner Interconnection Facilities (TOIF)	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
6846 Substation 69kV GEN-2020-002 Interconnection (TOIF) (OPPD) (143682): None	$0	N/A	$0	N/A
Total	**$0**		**$0**	

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
6846 Substation GEN-2020-002 Interconnection (NU) (OPPD) (143683): Expand the existing S6846 69kV substation to a ring bus to accommodate the new generation facility.	Ineligible	$2,345,838	100%	$2,345,838	14 Months
Total		**$2,345,838**		**$2,345,838**	

*All interconnection costs from the OPPD facility study are summarized in Table 2 above.

SHARED NETWORK UPGRADE(S)

The Interconnection Customer's share of costs for Shared Network Upgrades is estimated in **Table 3** below.

Table 3: Interconnection Customer Shared Network Upgrade(s)

Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
None	N/A	$0	N/A	$0	N/A
Total		**$0**		**$0**	

All studies have been conducted assuming that higher-queued Interconnection Request(s) and the associated Network Upgrade(s) will be placed into service. If higher-queued Interconnection Request(s) withdraw from the queue, suspend or terminate service, the Interconnection Customer's share of costs may be revised. Restudies, conducted at the customer's expense, will determine the Interconnection Customer's revised allocation of Shared Network Upgrades.

CONTINGENT NETWORK UPGRADE(S)

Certain Contingent Network Upgrades are **currently not the cost responsibility** of the Interconnection Customer but will be required for full Interconnection Service.

Table 4: Interconnection Customer Contingent Network Upgrade(s)

Contingent Network Upgrade(s) Description	Current Cost Assignment	Estimated In-Service Date
None	$0	N/A

Depending upon the status of higher- or equally-queued customers, the Interconnection Request's in-service date is at risk of being delayed or Interconnection Service is at risk of being reduced until the in-service date of these Contingent Network Upgrades.

AFFECTED SYSTEM UPGRADE(S)

To facilitate interconnection, the Affected System Transmission Owner will be required to perform the facilities study work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities. **Table 5** displays the current impact study costs provided by MISO as part of the Affected System Impact review. The Affected System facilities study could provide revised costs and will provide each Interconnection Customer's allocation responsibilities for the upgrades.

Table 5: Interconnection Customer Affected System Upgrade(s)

Affected System Upgrades Description	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
None	$0	N/A	$0
Total	$0		$0

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 81 MW of ERIS service can be granted. The Interconnection Customer's estimated cost responsibility that is required for full interconnection service is summarized in the table below.

Table 6: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilitie Upgrade(s)	$0
Non-Shared Network Upgrade(s)	$2,345,838
Shared Network Upgrade(s)	$0
Affected System Upgrade(s)	$0
Total	**$2,345,838**

Use the following link for Quarterly Updates on upgrades from this report: https://spp.org/spp-documents-filings/?id=18641

A draft Generator Interconnection Agreement will be provided to the Interconnection Customer consistent with the final results of this IFS report. The Transmission Owner and Interconnection Customer will have 60 days to negotiate the terms of the GIA consistent with the SPP Open Access Transmission Tariff (OATT).

APPENDICES

A: TRANSMISSION OWNER'S INTERCONNECTION FACILITIES STUDY REPORT AND NETWORK UPGRADES REPORT(S)

See next page for the Transmission Owner's Interconnection Facilities Study Report and Network Upgrades Report(s).

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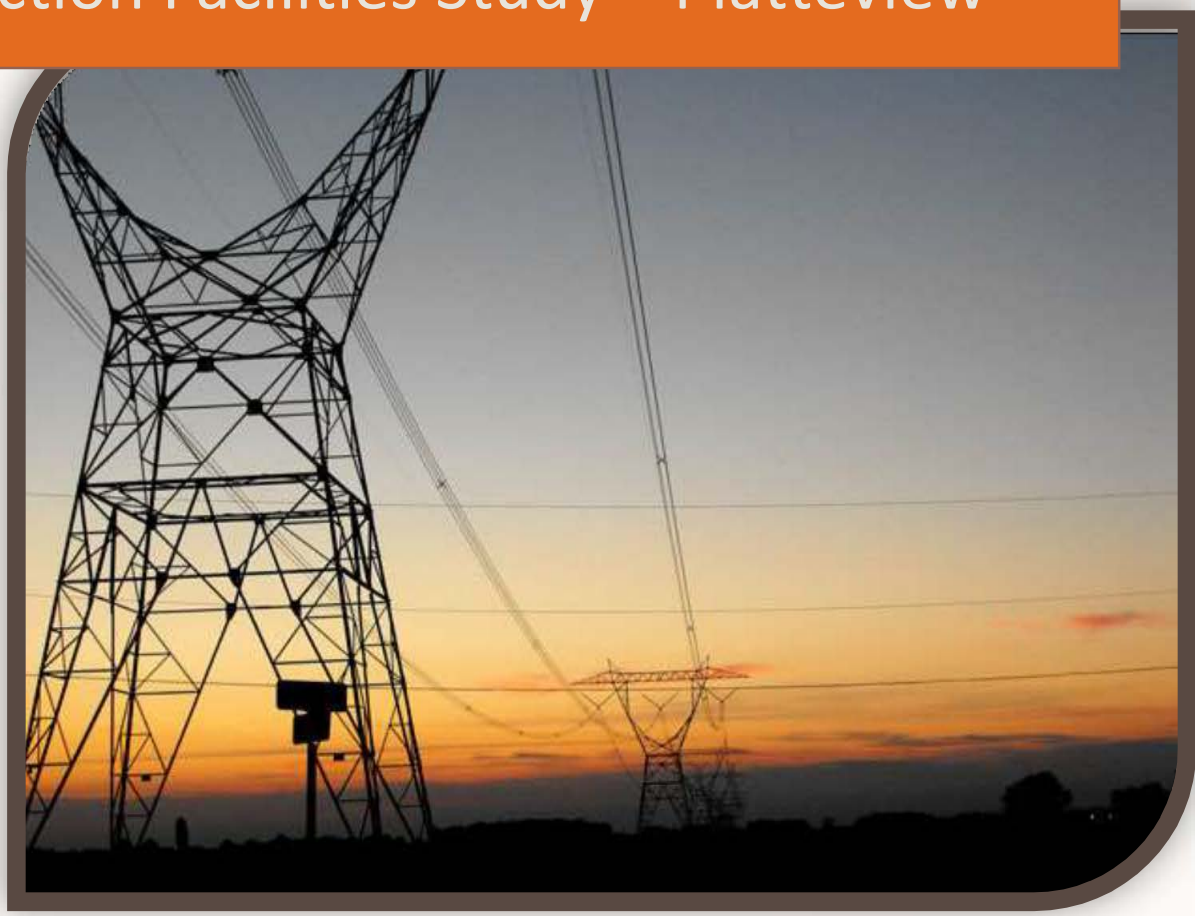
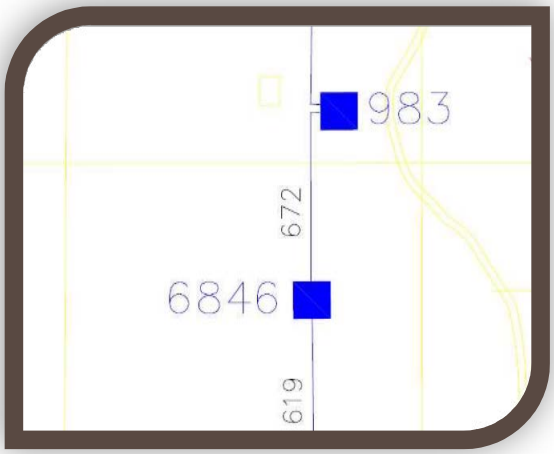
Interconnection Facilities Study – Platteview



Omaha Public Power District

Rev 0 – October 7, 2021

Executive Summary



An 81MW solar facility will be interconnected to the existing OPPD substation S6846. This facility will begin power production no earlier than the 4th quarter of 2022.

This study was performed consistent with NERC reliability standards FAC-002-3 and TPL-001-4 to determine the impact of the new generating facility on the Transmission System. The study includes steady state power flow, transient stability and short circuit fault current analysis. This study is performed in addition to the SPP interim generator interconnection study. The results of two studies combine to demonstrate FAC-001 compliance of the proposed interconnection.

The results of the study indicate that no transmission system upgrades are required to support the reliable interconnection of the new facility.

Contents

SECTION 1: POWER FLOW

Models

The models used for this study were the 2021 SPP Integrated Transmission Planning (ITP) Base Reliability power flow models for years 2022, 2023, 2026 and 2031.

MODEL	ADDITION		CONTINGENCIES
2022 Fall	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2022 Winter Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2023 Light Load	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2023 Summer Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2023 Winter Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2026 Light Load	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2026 Summer Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2026 Winter Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2031 Light Load	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2031 Summer Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5
2031 Winter Peak	81.0 MW	26.6 MVAR	P1, P2, P3, P4, P5

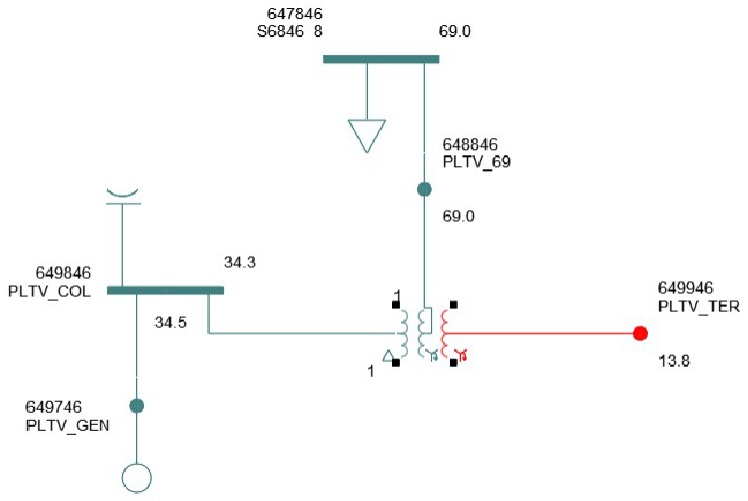
Model Studied and Generation Added at the new interconnection point.

Simulation

These models were studied with and without the addition listed above for each model. Full solar output was modeled in the winter models as a conservative first screening. Collector and transformer impedance values were taken from the vendor provide document:

- NE - Platteview - One Line Diagram - Solar Only (4-2-21).pdf

In addition, the new generation was studied with voltage schedules of both 1.00 and 1.05 per unit to ensure no invalid voltage violations were created by over or under injection of VARs from the new generation.



Power System Simulation for Engineering (PSS/E) was used to run contingency analysis for the TPL-001-4 Planning category events listed in the table above. All transmission facilities and tie lines 69 kV and above in OPPD's area were monitored. Contingencies considered for steady-state analysis include all transmission facilities 69 kV and above in OPPD's control area (area 645) and select neighboring transmission facilities in KCPL, GMO, WERE, NPPD, MEC, and LES that are not allowed to consider Non-Consequential Load Loss and curtailment of Firm Transmission Service per TPL-001-4.

N-1 & Multiple Element Contingency Results

The N-1 and multiple element (P1, P2, P4, & P5) thermal contingencies were monitored to 90% of the normal/emergency thermal rating, with mitigation required at or greater than 100% loading.

Voltage was monitored below 0.95 pu or above 1.05 pu, with mitigation required for:

- 161kV and 345kV – less than 0.95 pu or greater than 1.05pu
- 69kV - less than 0.90 pu or greater than 1.05pu

Distribution factors are shown below for information only.

There were no voltage issues caused by the addition of the new generation facility, and only one thermal overload presented as follows:

MODEL YEAR	OVERLOADED FACILITY FROM BUS	OVERLOADED FACILITY TO BUS	WORST N-1 CONTINGENCY	% OVERLOAD	% DF
26L	S902 (647902)	S983 (647983)	P12:069:OPPD:S914A-S6846:::HV	103.5	58.8%

N-1 Thermal Results

N-1-1 P3 Contingency Results

The P3 thermal contingencies were monitored to 90% of the normal/emergency thermal rating, with mitigation required at or greater than 100% loading.

Voltage was monitored below 0.95 pu or above 1.05 pu, with mitigation required for:

- 161kV and 345kV – less than 0.95 pu or greater than 1.05pu
- 69kV - less than 0.90 pu or greater than 1.05pu

Distribution factors are shown below for information only.

There were no voltage issues caused by the addition of the new generation facility, and only one thermal overload presented as follows:

MODEL YEAR	OVERLOADED FACILITY FROM BUS	OVERLOADED FACILITY TO BUS	WORST N-1 CONTINGENCY	% OVERLOAD	% DF
22W	S902 (647902)	S984 (647984)	P11:069:OPPD:FREM 8G:::HV & P12:161:OPPD:S1291-S1226:::HV	106.2	11.5%

N-1-1 P3 Thermal Results

SECTION 2: Stability

The models used for this portion of the study are the 2019 SPP Model Development Working Group (MDWG) series. The 2022 Light Load and the 2022 Summer Peak were chosen as the bounding scenarios. Where the summer peak model provides the maximum load on the system, and the light load model provides the least amount of running generation.

Contingency Selection

The fault disturbances OPPD selected are based on engineering judgment for those disturbances involving facilities in OPPD's system that are expected to produce the most severe system impacts. Previous stability study results are used to aid in the selection of disturbances. Many of the selected disturbances are in close proximity to significant generation plants or generation outlets where such a disturbance could result in loss of synchronism, loss of generation and potentially lead to grid instability. Other reasons why disturbances were selected are the following:

- The disturbance involves the outage of one or more strong transmission sources to the location of a fault.
- The disturbance involves high-speed automatic reclosing or automatic reclosing after a relatively short time delay.
- It is believed that the voltage swings that will result from the disturbance will be larger than those resulting from other disturbances.
- The disturbance involves a fault at a bus having a load to which a dynamic load model is applied in a manner specific to that load.
- Selection of the disturbance would increase the variety of locations at which disturbances are studied.

A category P0, system intact, analysis was performed to establish a base case for the MDWG and sensitivity models. This analysis consisted of a 20-second run in which no disturbance was applied.

Stability Criteria

Rotor angle dynamic simulation plots were generated for all monitored generators. Because of the number of buses monitored for voltage violations, dynamic simulation plots were developed for those buses flagged for not meeting disturbance performance criteria as listed below. Simulation plots are available on request and are not included in this report. The following items are monitored and recorded and represent OPPD's criteria for identifying instability conditions as per TPL-001-4 R6:

Rotor angle stability and oscillation damping – Rotor angles were monitored for all OPPD area generators (Area 645) and all generators in the following areas:

- 635 MEC
- 640 NPPD
- 650 LES

Those units that exhibited signs of instability were marked for further analysis. Rotor angle deviations were calculated relative to the system swing machine, Brown's Ferry. The curves of rotor angle deviation versus time for machines with rotor angle deviation greater than or equal to 16 degrees (measured as absolute maximum peak to absolute minimum peak) were judged against the SPPR1 and SPPR5 criteria as described in the SPP Disturbance Performance Requirements. Machines with rotor angle deviations less than 16 degrees that did not exhibit convergence were evaluated on an individual basis. Machines with rotor angle deviations greater than 180 degrees were also flagged. The SPPR1 and SPPR5 criteria is restated below:

- Well damped angular oscillations shall meet one of the following two requirements when calculated directly from the rotor angle:
    - Successive Positive Peak Ratio (SPPR1) must be less than or equal to 0.95 or have a Damping Factor % greater than or equal to 5%, where SPPR1 and its associated Damping Factor are calculated as follows:

$$SPPR1 = \frac{\text{Peak Rotor Angle of 2nd Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of 1st Positive Peak minus Minimum Value}} \leq 0.95$$

$$\text{Damping Factor \%} = (1 - SPPR1) \times 100\% \geq 5\%$$

    - Successive Positive Peak Ratio Five (SPPR5) must be less than or equal to 0.774 or have a Damping Factor % greater than or equal to 22.6%, where SPPR5 and its associated Damping Factor are calculated as follows:

$$SPPR5 = \frac{\text{Peak Rotor Angle of 6th Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of 1st Positive Peak minus Minimum Value}} \leq 0.774$$

$$\text{Damping Factor \%} = (1 - SPPR5) \times 100\% \geq 22.6\%$$

Transient voltage stability - Voltage was monitored at all OPPD generator buses, all OPPD buses 69 kV and above, generator buses in the areas monitored for rotor angle as listed above. The voltage responses were judged against the $0.70 < V_{transient} \leq 1.20$ p.u. criteria, as described in the SPP Disturbance Performance Requirements and restated below. Those units that violate the transient voltage criteria were marked for further analysis. (TPL-001-4 requirement R5)

- After a disturbance is cleared, bus voltages on the Bulk Electric System shall recover above 0.70 per unit, 2.5 seconds after the fault is cleared. Bus voltages shall not swing above 1.20 per unit after the fault is cleared, unless affected transmission system elements are designed to handle the rise above 1.2 per unit.

Protection System Operation – The analysis simulated the removal of all elements that the Protection System and other automatic controls are expected to disconnect for each contingency without operator intervention. This was accomplished by defining all appropriate actions in PSAS files that were run for each event. The analysis considered the impacts of high speed reclosing, tripping of generators when bus voltages or high side of the GSU voltages are less than known or assumed generator low voltage ride through capability, and tripping of transmission lines or transformers where transient swings cause Protection System operation. PSS/E system-wide monitoring models were used as a way to quickly scan for transmission lines or generators that may be impacted by the transient swings caused by a disturbance. PSS/E activity RELSCN was used to place a generic distance relay model at each end of every circuit. The model uses relay characteristics that are based on percentages of line impedance. PSS/E activity OSSCAN was also used and places a generic out-of-step relay at the end of every circuit to monitor for instances where apparent impedance is less than line impedance. Results were reviewed for instances where either RELSCN or OSSCAN flagged transient conditions. These were reviewed to determine whether or not subsequent tripping was required. If it was determined that subsequent tripping was warranted, then this action was defined in the PSAS file for the event and the event was re-run.

Generator Low Voltage Ride Through – To simulate protection system responses to abnormal voltage conditions, OPPD reviewed generator voltage protective relay settings using PRC-024-2, Attachment 2 as a guideline and developed appropriate dynamic relay models for those units with generator voltage protective relaying. Additionally, OPPD post-processed disturbance results to look for any instances where generator bus voltages or GSU high side bus voltages lie in the allowable tripping region (either above or below the 'No Trip Zone' in Attachment 2 of PRC-024-2) per the high and low voltage ride through duration criteria listed in PRC-024-2, Attachment 2. These instances were flagged and examined further to determine if additional actions would occur based on in-service protection systems.

Cascading – Potential cascading due to a disturbance was evaluated for NERC Planning Events (category P1-P7) and Extreme Events to check for the uncontrolled successive loss of system elements. OPPD's evaluation of disturbances that have the potential to cause cascading is meant to identify those situations where unrestrained electric service interruption cannot be prevented from spreading. Simulation results were scanned for instances where units exhibit instability as evidenced by a loss of synchronism or violation of voltage criteria. Simulations are re-run with the unit(s) that exhibited a loss of stability being tripped at an appropriate simulation time. A steady state evaluation is also performed to simulate the outage of elements lost due to the original event and the subsequent tripping events to identify thermal issues that may arise as a result. The stability results are scanned again to look for instances of units that lose synchronism. If any are found, the previous steps are repeated to trip these additional

elements. This entire process is repeated until either all units display rotor angle stability, or one of the following cascading criteria are met:

- The disturbance causes more than three iterations of successive instability, tripping, and reviewing following the initial event.
- The accumulated amount of generation lost due to the initial event and subsequent events is greater than 2000 MW. This criterion represents approximately 150% of OPPD's largest generation site, which is consistent with SPP cascading criteria.

The event is considered to have the potential of causing cascading if one of the above criteria is met. Per requirement R4.5, if an extreme event causes cascading an evaluation of possible actions designed to reduce the likelihood or mitigate the consequences of the event(s) will be conducted.

Stability Modeling

Stability data was obtained from the vendor provided PSSE dynamic data file:

- TMEIC_NINJA_PVU_L0840GR_PSSE_GENERIC_MODEL_REV-F1_WITH_GEN_PPC.dyr

Stability Results

No stability issues were identified for the interconnection of the new generation. Transient curves can be provided upon request.

SECTION 3: Short Circuit

The intent of the short circuit study is to determine if the interconnection of the new generation causes an increase in available fault current above the ratings of the currently installed circuit breakers on the OPPD Transmission System.

The model used was the 2021 SPP Integrated Transmission Planning (ITP) Short Circuit Max Fault model for year 2023. All OPPD circuit breakers 69kV and greater were evaluated.

Short Circuit Simulation

Analysis was performed using the Power System Simulation for Engineering (PSS/E) short circuit function ANSI. These results are then compared to breaker rating to determine whether the circuit breakers have interrupting capability for the faults that they will be expected to interrupt.

Short circuit data was taken from the vendor provided document:

- Short Circuit Modeling of TMEIC NINJA series Inverter in Aspen OneLiner_Rev.A2.pdf

Short Circuit Results

No circuit breaker fault duty ratings are exceed with the interconnection of the generating facility. See Appendix 1 for the detailed results.

SECTION 4: MITIGATIONS

This section analyzes the impacts of different facility improvements needed to mitigate the issues on the Transmission System caused by adding the new generating facility.

Impact of Facility Improvements

The process of identifying improvements to the Transmission System began with a focus on upgrades to the existing facilities in lieu of constructing new facilities.

The following issues required mitigation:

OVERLOADED FACILITY FROM BUS	TO BUS	MITIGATION
S902	S983	This circuit was recently uprated from the 72.0 MVA rating in the 2021 ITP models that were used in this study. No further action required.
S902	S984	This violation is only present in the winter peak models and only present on a non-BES 69kV facility; which were conservatively run with the solar generation at maximum summer output. Reducing the solar output to 50% (40.5MW) eliminates this overload. The facility is not expected to generate >50% output during winter peak conditions, and the P3 contingency that generated this issue allows for curtailment as a system adjustment. In addition, there is no reliability concerns for the BES because the overload only affects non-BES 69kV. Therefore, no mitigation is recommended.

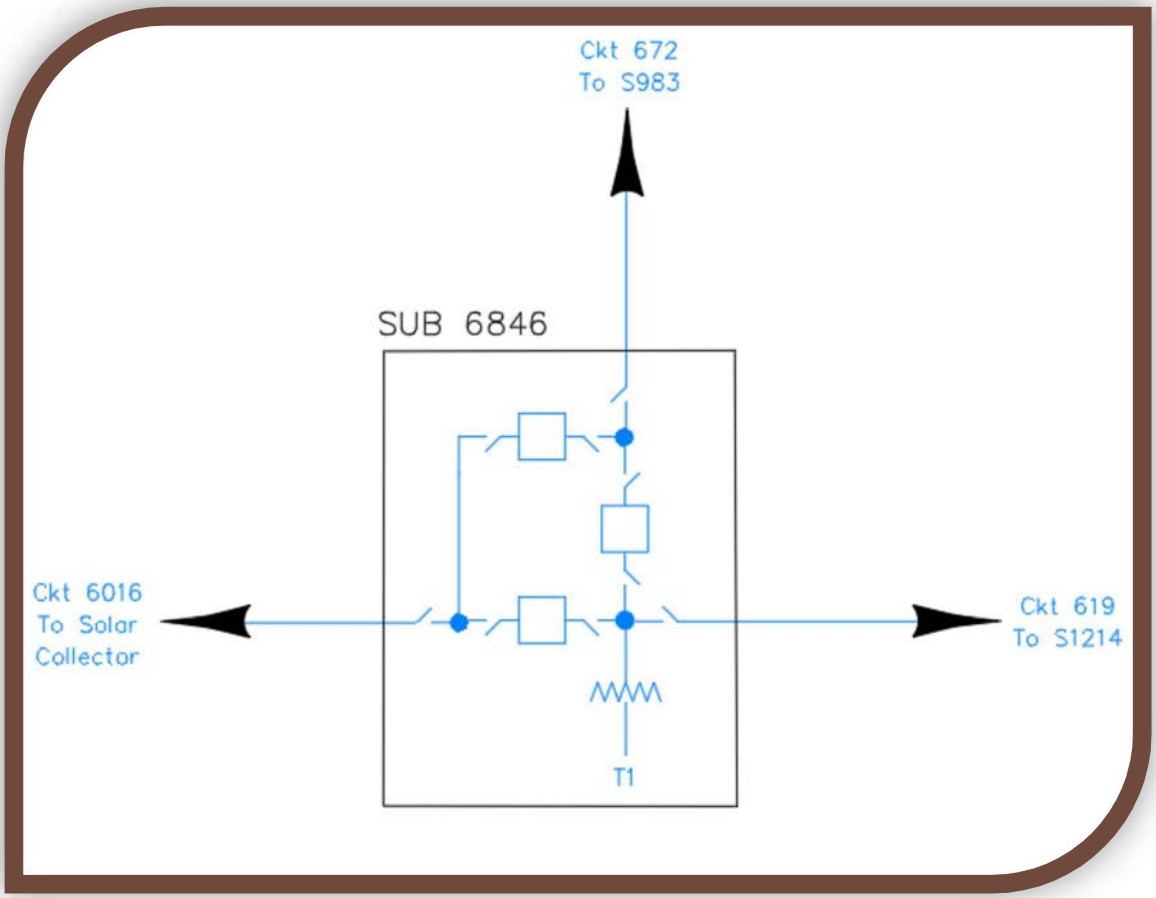
As a result, no network upgrades are required.

SECTION 5: Detailed Cost Estimates and Schedule

Detailed cost estimates have been prepared for the interconnection facilities and any identified network upgrades identified. The prepared cost estimates are Study level estimates (+20/-20%) and assume the implementation of standard OPPD construction and procurement practices. The cost estimates for the interconnection and network upgrades are below:

Interconnection Facilities:

- Expand existing S6846 69kV substation to a ring bus to accommodate the new generation facility.
  - Cost: $ 2,345,838
  - Estimated in-service date: 12/31/2022



Network Upgrades:

- This Interim generation interconnection study process did not identify any network upgrades. Network upgrades may be identified during the SPP DISIS study that this generation facility is included in.

Appendix 1 - Short Circuit Results

No circuit breaker fault duty ratings are exceed with the interconnection of the generating facility.

Sub	Breaker	Base kV	Duties
1250	CB-11	161	92%
1211	CB 13	161	91%
1211	CB 14	161	91%
1211	CB 16	161	91%
1211	CB 17	161	91%
1211	CB 19	161	91%
1211	CB 20	161	91%
1211	CB 22	161	91%
1211	CB 23	161	91%
1231	CB 1	161	90%
1231	CB 2	161	90%
1231	CB 4	161	90%
1231	CB 6	161	90%
1209	CB-21	161	90%
1209	CB-22	161	90%
1209	CB-23	161	90%
1209	CB-24	161	90%
1209	CB-25	161	90%
1209	CB-26	161	90%
1209	CB-30	161	90%
1209	CB-31	161	90%
1209	CB-32	161	90%
1206	CB-10	161	87%
1206	CB-11	161	87%
1206	CB-12	161	87%
1206	CB-13	161	87%
1206	CB-14	161	87%
1206	CB-15	161	87%
1206	CB-16	161	87%
1206	CB-17	161	87%
1206	CB-18	161	87%
1206	CB-19	161	87%
1206	CB-7	161	87%
1206	CB-8	161	87%
1206	CB-9	161	87%
1260	CB-1	161	86%
1221	1541	161	85%
923	CB-1	69	85%

1211	CB-15	161	83%
1211	CB-18	161	83%
1211	CB-21	161	83%
1211	CB-24	161	83%
1211	CB-31	161	83%
1211	CB-32	161	83%
1211	CB-33	161	83%
1211	CB-7	161	83%
1211	CB-8	161	83%
1211	CB-9	161	83%
1231	CB-7	161	83%
1231	CB-8	161	83%
1231	CB-9	161	83%
3455	CB 1 A Phase	345	77%
3455	CB 1 B Phase	345	77%
3455	CB 1 C Phase	345	77%
3455	CB 10 A Phase	345	77%
3455	CB 10 B Phase	345	77%
3455	CB 10 C Phase	345	77%
3455	CB 11 A Phase	345	77%
3455	CB 11 B Phase	345	77%
3455	CB 11 C Phase	345	77%
3455	CB 12 A Phase	345	77%
3455	CB 12 B Phase	345	77%
3455	CB 12 C Phase	345	77%
910	647	69	76%
910	613 B	69	76%
910	646 B	69	76%
901	Circuit 613 (CB-1)	69	75%
901	Circuit 605 (CB-2)	69	75%
901	Circuit 601 GT 2 (CB-3)	69	75%
901	Circuit 603 (CB-5)	69	75%
901	Circuit 615 GT 1 (CB-4)	69	75%
921	640	69	75%
921	653	69	75%
1255	CB-21	161	74%
1255	CB-22	161	74%
1255	CB-23	161	74%
1255	CB-25	161	74%
1255	CB-26	161	74%
1255	CB-27	161	74%
1255	CB-28	161	74%
1255	CB-29	161	74%

1255	CB-30	161	74%
1255	CB-32	161	74%
1250	CB 2	161	74%
1250	CB 3	161	74%
1250	CB 4	161	74%
1250	CB 5	161	74%
911	CB-661	69	73%
911	CB-662	69	73%
911	CB-665	69	73%
911	CB-668	69	73%
1298	CB-1	161	72%
1210	CB-676	161	72%
921	679	69	72%
921	680	69	72%
1209	CB-27	161	71%
1209	CB-28	161	71%
1222	CB 1	161	71%
938	CB 2	69	70%
909	CB-651	69	70%
1286	CB-1	161	70%
3456	CB 1 A Phase	345	69%
3456	CB 1 B Phase	345	69%
3456	CB 1 C Phase	345	69%
3456	CB 2 A Phase	345	69%
3456	CB 2 B Phase	345	69%
3456	CB 2 C Phase	345	69%
3456	CB 3 A Phase	345	69%
3456	CB 3 B Phase	345	69%
3456	CB 3 C Phase	345	69%
3456	CB 4 A Phase	345	69%
3456	CB 4 B Phase	345	69%
3456	CB 4 C Phase	345	69%
3456	CB 5 A Phase	345	69%
3456	CB 5 B Phase	345	69%
3456	CB 5 C Phase	345	69%
3456	CB 6 A Phase	345	69%
3456	CB 6 B Phase	345	69%
3456	CB 6 C Phase	345	69%
1281	CB 1	161	69%
1281	CB 2	161	69%
906	BT-61	69	69%
906	BT-62	69	69%
906	BT-63	69	69%

906	CB-621	69	69%
906	CB-623	69	69%
906	CB-624	69	69%
906	CB-625	69	69%
906	CB-626	69	69%
906	CB-628	69	69%
906	CB-629	69	69%
906	CB-631	69	69%
906	CB-632	69	69%
906	CB-633	69	69%
906	CB-634	69	69%
906	CB-635	69	69%
906	CB-636	69	69%
906	CB-637	69	69%
906	CB-658	69	69%
1251	CB-104	161	68%
1251	CB-105	161	68%
1251	CB-106	161	68%
1251	CB-107	161	68%
1251	CB-108	161	68%
1251	CB-109	161	68%
1251	CB-110	161	68%
1251	CB-111	161	68%
1251	CB-112	161	68%
1217	CB-11	161	67%
1217	CB-1579	161	67%
1217	CB-1580	161	67%
1217	CB-1619	161	67%
917	CB 1	69	67%
917	CB 3	69	67%
917	CB-2	69	67%
1201	CB-4	161	67%
1201	CB-7	161	67%
1201	CB-8	161	67%
1231	CB-3	161	66%
3458	CB 1 A Phase	345	66%
3458	CB 1 B Phase	345	66%
3458	CB 1 C Phase	345	66%
3458	CB 10 A Phase	345	66%
3458	CB 10 B Phase	345	66%
3458	CB 10 C Phase	345	66%
3458	CB 12 A Phase	345	66%
3458	CB 12 B Phase	345	66%

3458	CB 12 C Phase	345	66%
3458	CB 16 A Phase	345	66%
3458	CB 16 B Phase	345	66%
3458	CB 16 C Phase	345	66%
3458	CB 18 A Phase	345	66%
3458	CB 18 B Phase	345	66%
3458	CB 18 C Phase	345	66%
3458	CB 23 A Phase	345	66%
3458	CB 23 B Phase	345	66%
3458	CB 23 C Phase	345	66%
3458	CB 24 A Phase	345	66%
3458	CB 24 B Phase	345	66%
3458	CB 24 C Phase	345	66%
3458	CB 25 A Phase	345	66%
3458	CB 25 B Phase	345	66%
3458	CB 25 C Phase	345	66%
3458	CB-19 - A PHASE, POLE 1	345	66%
3458	CB-19 - B PHASE, POLE 2	345	66%
3458	CB-19 - C PHASE, POLE 3	345	66%
3458	CB-21 - A PHASE, POLE 1	345	66%
3458	CB-21 - B PHASE, POLE 2	345	66%
3458	CB-21 - C PHASE, POLE 3	345	66%
3458	CB-27 - A PHASE, POLE 1	345	66%
3458	CB-27 - B PHASE, POLE 2	345	66%
3458	CB-27 - C PHASE, POLE 3	345	66%
3458	CB-3 - A PHASE, POLE 1	345	66%
3458	CB-3 - B PHASE, POLE 2	345	66%
3458	CB-3 - C PHASE, POLE 3	345	66%
3458	CB-4 - A PHASE, POLE 1	345	66%
3458	CB-4 - B PHASE, POLE 2	345	66%
3458	CB-4 - C PHASE, POLE 3	345	66%
3458	CB-6 - A PHASE, POLE 1	345	66%
3458	CB-6 - B PHASE, POLE 2	345	66%
3458	CB-6 - C PHASE, POLE 3	345	66%
1229	CB 1	161	65%
3454	CB 1 A PHASE	345	65%
3454	CB 1 B PHASE	345	65%
3454	CB 1 C PHASE	345	65%
3454	CB 2 A PHASE	345	65%
3454	CB 2 B PHASE	345	65%
3454	CB 2 C PHASE	345	65%
3454	CB 3 A Phase	345	65%
3454	CB 3 B Phase	345	65%

3454	CB 3 C Phase	345	65%
3454	CB 6 A PHASE	345	65%
3454	CB 6 B PHASE	345	65%
3454	CB 6 C PHASE	345	65%
1227	CB-1	161	65%
1234	CB-1	161	63%
924	CB-1	69	62%
1216	CB-1	161	62%
3455	CB 2 A Phase	345	61%
3455	CB 2 B Phase	345	61%
3455	CB 2 C Phase	345	61%
3455	CB 3 A Phase	345	61%
3455	CB 3 B Phase	345	61%
3455	CB 3 C Phase	345	61%
3455	CB 5	345	61%
3455	CB 6 A Phase	345	61%
3455	CB 6 B Phase	345	61%
3455	CB 6 C Phase	345	61%
1253	CB-22	161	61%
1235	CB-1	161	60%
1235	CB-2	161	60%
1235	CB-3	161	60%
1235	CB-4	161	60%
1254	CB-11	161	60%
1254	CB-12	161	60%
916	CB 636	69	60%
916	CB 680	69	60%
1220	CB-1	161	60%
1299	CB-1	161	59%
911	CB-664	69	59%
918	CB-651	69	58%
918	CB-661D	69	58%
918	CB-675B	69	58%
1250	CB-1	161	58%
1298	CB-2	161	58%
1298	CB-3	161	58%
1298	CB-4	161	58%
1210	CB-1	161	58%
1210	CB-2	161	58%
912	CB-1	69	58%
912	CB-2	69	58%
912	CB-3	69	58%
1249	CB 1	161	58%

1244	CB-1	161	57%
1361	CB-23	161	57%
1361	CB-24	161	57%
1361	CB-25	161	57%
1361	CB-27	161	57%
1361	CB-28	161	57%
1361	CB-30	161	57%
1361	CB-31	161	57%
1361	CB-32	161	57%
1361	CB-33	161	57%
1361	CB-34	161	57%
1361	CB-35	161	57%
1361	CB-36	161	57%
1361	CB-37	161	57%
1361	CB-38	161	57%
1361	CB-39	161	57%
1361	CB-40	161	57%
1361	CB-41	161	57%
1361	CB-42	161	57%
919	CB-1	69	57%
919	CB-2	69	57%
919	CB-3	69	57%
1259	CB-1	161	56%
1259	CB-2	161	56%
1259	CB-3	161	56%
1259	CB-4	161	56%
909	CB-648	69	56%
909	CB-649	69	56%
909	CB-652	69	56%
909	CB-653	69	56%
938	CB-1	69	55%
1233	CB-1	161	55%
930	CB 1	69	55%
930	CB 2	69	55%
1305	CB-1	161	55%
1305	CB-2	161	55%
1260	CB-10	161	55%
1260	CB-11	161	55%
1260	CB-12	161	55%
1260	CB-13	161	55%
1260	CB-2	161	55%
1260	CB-3	161	55%
1260	CB-4	161	55%

1260	CB-5	161	55%
1260	CB-6	161	55%
1260	CB-7	161	55%
1260	CB-8	161	55%
1260	CB-9	161	55%
908	CB-1	69	54%
908	CB-2	69	54%
1221	CB-1550	161	54%
1341	CB-1	161	53%
1232	CB-1	161	53%
3451	CB 1 A PHASE	345	53%
3451	CB 1 B PHASE	345	53%
3451	CB 1 C PHASE	345	53%
3451	CB 10 A PHASE	345	53%
3451	CB 10 B PHASE	345	53%
3451	CB 10 C PHASE	345	53%
3451	CB 11 A PHASE	345	53%
3451	CB 11 B PHASE	345	53%
3451	CB 11 C PHASE	345	53%
3451	CB 12 A PHASE	345	53%
3451	CB 12 B PHASE	345	53%
3451	CB 12 C PHASE	345	53%
3451	CB 2 A PHASE	345	53%
3451	CB 2 B PHASE	345	53%
3451	CB 2 C PHASE	345	53%
3451	CB 3 A PHASE	345	53%
3451	CB 3 B PHASE	345	53%
3451	CB 3 C PHASE	345	53%
3451	CB 4 A PHASE	345	53%
3451	CB 4 B PHASE	345	53%
3451	CB 4 C PHASE	345	53%
3451	CB 5 A PHASE	345	53%
3451	CB 5 B PHASE	345	53%
3451	CB 5 C PHASE	345	53%
3451	CB 6 A PHASE	345	53%
3451	CB 6 B PHASE	345	53%
3451	CB 6 C PHASE	345	53%
1278	CB-1	161	53%
1201	CB-1	161	53%
1201	CB-2	161	53%
1201	CB-3	161	53%
1201	CB-5	161	53%
1201	CB-6	161	53%

1201	CB-9	161	53%
940	680	69	53%
940	680-B	69	53%
6866	CB-11	69	53%
6866	CB-12	69	53%
939	CB-1	69	51%
939	CB-2	69	51%
1252	CB-1	161	51%
907	CB-1	69	50%
1234	CB-2	161	50%
3459	CB 1 A Phase	345	50%
3459	CB 1 B Phase	345	50%
3459	CB 1 C Phase	345	50%
3459	CB 2 A Phase	345	50%
3459	CB 2 B Phase	345	50%
3459	CB 2 C Phase	345	50%
3459	CB 3 A Phase	345	50%
3459	CB 3 B Phase	345	50%
3459	CB 3 C Phase	345	50%
3459	CB 4 A Phase	345	50%
3459	CB 4 B Phase	345	50%
3459	CB 4 C Phase	345	50%
3459	CB 5 A Phase	345	50%
3459	CB 5 B Phase	345	50%
3459	CB 5 C Phase	345	50%
3459	CB 6 A Phase	345	50%
3459	CB 6 B Phase	345	50%
3459	CB 6 C Phase	345	50%
1226	CB 1	161	49%
1226	CB 3	161	49%
1226	CB 4	161	49%
1226	CB 5	161	49%
1226	CB 6	161	49%
1226	CB 7	161	49%
1226	CB 8	161	49%
1226	CB 9	161	49%
1253	CB-21	161	49%
1253	CB-23	161	49%
3455	CB-7 A Phase	345	49%
3455	CB-7 B Phase	345	49%
3455	CB-7 C Phase	345	49%
3455	CB-9 A Phase	345	49%
3455	CB-9 B Phase	345	49%

3455	CB-9 C Phase	345	49%
923	CB 3	69	49%
923	CB-2	69	49%
1367	CB-1	161	47%
1244	CB-2	161	46%
1236	CB 1	161	46%
928	CB-1	69	44%
913	CB-1	69	44%
913	CB-2	69	44%
1366	CB-1	161	43%
1366	CB-2	161	43%
1256	CB-1	161	42%
902	CB 1	69	41%
902	CB 2	69	41%
902	CB 3	69	41%
942	CB-1	69	41%
942	CB-2	69	41%
1226	CB-2	161	39%
3740	CB 2 A Phase	345	39%
3740	CB 2 B Phase	345	39%
3740	CB 2 C Phase	345	39%
3740	CB 3 A Phase	345	39%
3740	CB 3 B Phase	345	39%
3740	CB 3 C Phase	345	39%
3740	CB 4 A Phase	345	39%
3740	CB 4 B Phase	345	39%
3740	CB 4 C Phase	345	39%
3740	CB 5 A Phase	345	39%
3740	CB 5 B Phase	345	39%
3740	CB 5 C Phase	345	39%
3740	CB 6 A Phase	345	39%
3740	CB 6 B Phase	345	39%
3740	CB 6 C Phase	345	39%
3740	CB 7 A Phase	345	39%
3740	CB 7 B Phase	345	39%
3740	CB 7 C Phase	345	39%
3740	CB 8 A Phase	345	39%
3740	CB 8 B Phase	345	39%
3740	CB 8 C Phase	345	39%
1253	CB-25	161	39%
975	CB-23	69	39%
1250	CB-6	69	37%
985	CB 2	69	37%

985	CB1	69	37%
900	CB 1	69	36%
900	CB 2	69	36%
900	CB 3	69	36%
900	CB 5	69	36%
900	CB 6	69	36%
1237	CB-1	161	36%
1237	CB-2	161	36%
1237	CB-3	161	36%
3761	CB-2 A Phase	345	35%
3761	CB-2 B Phase	345	35%
3761	CB-2 C Phase	345	35%
991	CB-1	69	32%
991	CB-2	69	32%
1345	CB-1	161	31%
1214	CB-13	69	31%
1214	CB-14	69	31%
1214	CB-2	69	31%
1214	CB-3	69	31%
6815	CB-1	69	31%
6815	CB-2	69	31%
1287	CB-1	161	30%
1214	CB-1	161	30%
1214	CB-11	161	30%
1214	CB-12	161	30%
6874	CB-1	69	30%
6874	CB-2	69	30%
963	683	69	28%
963	684	69	28%
963	689	69	28%
963	690	69	28%
976	CB-1	69	27%
1263	CB-1	161	25%
1263	CB-11	161	25%
1263	CB-12	161	25%
1263	CB-2	161	25%
1263	CB-3	161	25%
1280	CB-1	161	23%
1280	CB-2	161	23%
1280	CB-3	161	23%
904	CB-1	69	23%
975	CB-21	69	22%
975	CB-22	69	22%

975	CB-24	69	22%
960	CB-20	69	21%
984	CB-1	69	21%
6846	CB-1	69	21%
914	CB-1	69	20%
1258	CB-41	161	20%
1258	CB-42	161	20%
1258	CB-44	161	20%
1258	CB-45	161	20%
1258	CB-46	161	20%
1258	CB-48	161	20%
1258	CB-49	161	20%
983	CB-1	69	20%
962	682	69	19%
962	694	69	19%
962	697	69	19%
1291	CB-21	161	18%
NCU 903	683	69	17%
NCU 903	697	69	17%
1399	CB-1	161	14%
1399	CB-2	161	14%
1399	CB-3	161	14%
974	CB-602	69	14%
974	CB-604	69	14%
961	CB-1	69	13%
971	687	69	12%
971	693	69	12%
971	694	69	12%
968	CB-1	69	11%
968	CB-2	69	11%
970	CB-1	69	11%
982	CB-1	69	10%
972	CB-1	69	9%

Appendix 2 – Stability Events

	Faulted Bus				Fault Admittance			Outage or System Adjustment								
Category	Fault Type	Bus Name	Voltage (kV)	Bus Number	R	X	Units	Run For Cycles/ Set Scale (MW, Max, Min)	Action	Element	From Bus	To Bus	Tertiary Bus	Circuit ID	Clear Fault	Description
P1_2	3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	3-PH fault at S3458 on S3458-Cooper. Normal clearing.
P1_2	3PH	S3740 3	345.00	645740				5	Open	Transmission Circuit	645455	645740		1	Yes	3-PH fault at S3740 on S3455-S3740. Normal clearing with unsuccessful reclosing.
								600								
	SLG	S3455 3	345.00	645455	932	-10192	MVA	7.5							Yes	
P1_2	3PH	S1206 5	161.00	646206				9	Open	Transmission Circuit	646206	646232		1	Yes	3-PH fault at S1206 on S1206-S1232. Normal clearing with unsuccessful reclosing.
								0	Open	Load	646232			O0		
								600								
	SLG	S1232 5	161.00	646232	1434	-9156	MVA	11.5							Yes	
P1_2	3PH	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646220		1	Yes	3-PH fault at S1211 on S1211-S1220. Normal clearing with unsuccessful reclosing.
								0	Open	Load	646220			O0		
								600								
	SLG	S1220 5	161.00	646220	1162	-7458	MVA	8.5							Yes	
P1_2	3PH	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646299		1	Yes	3-PH fault at S1211 on S1211-S1299. Normal clearing with unsuccessful reclosing.
								0	Open	Load	646299			O0		
								600								
	SLG	S1299 5	161.00	646299	2872	-18493	MVA	8.5							Yes	

P1_2	3PH	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646250		2	Yes	3-PH fault at S1211 on S1211-S1250 Cir 1520. Normal clearing with unsuccessful reclosing.
								0	Open	Load	646211			O0		
								600								
	SLG	S1250 5	161.00	646250	1454	-9334	MVA	8.5							Yes	
P1_3	3PH	S3451 3	345.00	645451				7.5	Open	Three Winding	645451	646251	648251	1	Yes	3-PH fault at S3451 on S3451 T3 transformer. Normal clearing.
P2_2	SCMU L-G	S1217 5	161.00	646217				8.5	Open	Trip Bus	646217				Yes	SLG Fault at S1217 on 161-kV bus. Normal clearing.
P3_2									Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3458 on S3458-S3456. Normal clearing with unsuccessful reclosing.
	3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	645456		1	Yes	
								600								
	SLG	S3456 3	345.00	645456	411	-4361	MVA	7.5							Yes	
P3_2									Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3456 on S3458-S3456. Normal clearing with unsuccessful reclosing.
	3PH	S3456 3	345.00	645456				5	Open	Transmission Circuit	645458	645456		1	Yes	
								600								
	3PH	S3456 3	345.00	645456				4.5							Yes	
P3_2									Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3451 on S3451-S3459. Normal clearing with unsuccessful reclosing.

	3PH	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	
								20	Close	Transmission Circuit	645451	645459		1		
	3PH	S3451 3	345.00	645451				4.5	Open	Transmission Circuit	645451	645459		1	Yes	
	SLG	S3459 3	345.00	645459	994	-11394	MVA	3							Yes	
P3_2									Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3451 on S3451-S3459. Normal clearing with successful reclosing.
	3PH	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	
								20	Close	Transmission Circuit	645451	645459		1		
P3_2									Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3459 on S3451-S3459. Normal clearing with unsuccessful reclosing.
	3PH	S3459 3	345.00	645459				5	Open	Transmission Circuit	645451	645459		1	Yes	
								20	Close	Transmission Circuit	645451	645459		1		
	3PH	S3459 3	345.00	645459				4.5	Open	Transmission Circuit	645451	645459		1	Yes	
	SLG	S3451 3	345.00	645451	994	-11394	MVA	3							Yes	
P3_2									Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3459 on S3451-S3459. Normal clearing with successful reclosing.
	3PH	S3459 3	345.00	645459				5	Open	Transmission Circuit	645451	645459		1	Yes	
								20	Close	Transmission Circuit	645451	645459		1		
P4_2	SCMU L-G	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	635200		1	Yes	SLG Fault at S3451 on S3451-Raun followed by a stuck breaker opening S3451 T4. Delayed clearing.
	SCMU L-G	S3451 3	345.00	645451				9.5	Open	Three Winding	645451	646251	648351	1	Yes	
P4_2	SCMU L-G	S3454 3	345.00	645454				5	Open	Transmission Circuit	645454	650185		1	Yes	SLG Fault at S3454 on S3454-Wagener followed by a stuck breaker opening

																S3454-S3455. Delayed clearing.
	SCMU L-G	S3454 3	345.00	645454				9	Open	Transmission Circuit	645454	645455		1	Yes	
P4_2	SCMU L-G	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	SLG Fault at S3458 on S3458-Cooper followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU L-G	S3458 3	345.00	645458				8.5							Yes	
P4_2	SCMU L-G	S3740 3	345.00	645740				5	Open	Transmission Circuit	645455	645740		1	Yes	SLG Fault at S3740 on S3455-S3740 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU L-G	S3740 3	345.00	645740				8.5							Yes	
P4_2	SCMU L-G	S1206 5	161.00	646206				9	Open	Transmission Circuit	646206	646232		1	Yes	SLG Fault at S1206 on S1206-S1232 followed by a stuck breaker opening S1201-S1206. Delayed clearing.
								0	Open	Load	646232			O0		
	SCMU L-G	S1206 5	161.00	646206				10.5	Open	Transmission Circuit	646206	646201		1	Yes	
								0	Open	Load	646206			O0		
P5_5	SCMU L-G	S1244 5	161.00	646244				25.5	Open	Transmission Circuit	646244	646206		1	Yes	SLG Fault at S1244 on bus followed by failure of a non-redundant relay resulting in remote-end opening of transmission circuits. Delayed clearing.
								0	Open	Transmission Circuit	646244	646366		1		
P5_5	SCMU L-G	S1305 5	161.00	646305				25.5	Open	Transmission Circuit	646305	646298		1	Yes	SLG Fault at S1305 on bus followed by failure of a non-redundant relay resulting in remote-end opening of transmission circuits. Delayed clearing.

								0	Open	Transmission Circuit	646305	646341		1		
P6_1_1									Prior Outage	Transmission Circuit	645455	645740		1		Prior outage of S3455-S3740. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
	3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	
P6_1_1									Prior Outage	Transmission Circuit	645458	650189		1		Prior outage of S3458-103rd&RFirst OKeby. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
	3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	
P6_1_1									Prior Outage	Transmission Circuit	645458	640139		1		Prior outage of S3458-Cooper. 3-PH fault at S3740 on S3455-S3740. Normal clearing with unsuccessful reclosing.
	3PH	S3740 3	345.00	645740				5	Open	Transmission Circuit	645455	645740		1	Yes	
								600								
	SLG	S3455 3	345.00	645455	932	-10192	MVA	7.5							Yes	
P6_1_1									Prior Outage	Transmission Circuit	646211	646220		1		Prior outage of S1211-S1220. 3-PH fault at S1211 on S1211-S1299. Normal clearing with unsuccessful reclosing.
	3PH	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646299		1	Yes	
								0	Open	Load	646299			O0		
								600								
	SLG	S1299 5	161.00	646299	2872	-18493	MVA	8.5							Yes	
P6_1_1									Prior Outage	Transmission Circuit	645454	645451		1		Prior outage of S3454-S3451. 3-PH fault at S3454 on S3454-S3455. Normal clearing with unsuccessful reclosing.
	3PH	S3454 3	345.00	645454				5	Open	Transmission Circuit	645454	645455		1	Yes	

								20	Close	Transmission Circuit	645454	645455		1		
	3PH	S3454 3	345.00	645454				4.5	Open	Transmission Circuit	645454	645455		1	Yes	
	SLG	S3455 3	345.00	645455	2782	-31399	MVA	3							Yes	
P6_1_1									Prior Outage	Transmission Circuit	645454	645451		1		Prior outage of S3454-S3451. 3-PH fault at S3454 on S3454-S3455. Normal clearing with successful reclosing.
	3PH	S3454 3	345.00	645454				5	Open	Transmission Circuit	645454	645455		1	Yes	
								20	Close	Transmission Circuit	645454	645455		1		
P6_1_1									Prior Outage	Transmission Circuit	645454	645455		1		Prior outage of S3454-S3455. 3-PH fault at S3455 on S3455-S3456. Normal clearing with unsuccessful reclosing.
	3PH	S3455 3	345.00	645455				5	Open	Transmission Circuit	645455	645456		1	Yes	
								20	Close	Transmission Circuit	645455	645456		1		
	3PH	S3455 3	345.00	645455				4.5	Open	Transmission Circuit	645455	645456		1	Yes	
	SLG	S3456 3	345.00	645456	2687	-32674	MVA	3							Yes	
P6_1_1									Prior Outage	Transmission Circuit	645454	645455		1		Prior outage of S3454-S3455. 3-PH fault at S3455 on S3455-S3456. Normal clearing with successful reclosing.
	3PH	S3455 3	345.00	645455				5	Open	Transmission Circuit	645455	645456		1	Yes	
								20	Close	Transmission Circuit	645455	645456		1		
P6_1_1									Prior Outage	Transmission Circuit	640139	300039		1		Prior outage of Cooper-Fairport. 3-PH fault at Cooper on Cooper-St. Joe. Normal clearing.
	3PH	COOPER 3	345.00	640139				4.5	Open	Transmission Circuit	640139	541199		1	Yes	
P6_1_1									Prior Outage	Transmission Circuit	645458	650189		1		Prior outage of S3458-103rd&Rokeby. 3-PH fault at S3458 on S3458-S3456. Normal clearing with

																unsuccessful reclosing.
	3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	645456		1	Yes	
								600								
	SLG	S3456 3	345.00	645456	411	-4361	MVA	7.5							Yes	
P6_1_2									Prior Outage	Transmission Circuit	645451	635200		1		Prior outage of S3451-Raun. 3-PH fault at S3451 on T3 transformer. Normal clearing.
	3PH	S3451 3	345.00	645451				7.5	Open	Three Winding	645451	646251	648251	1	Yes	
P6_2_1									Prior Outage	Three Winding	645456	646206	648256	1		Prior outage of S3456 T4. 3-PH fault at S1206 on S1201-S1206. Normal clearing with unsuccessful reclosing.
	3PH	S1206 5	161.00	646206				9	Open	Transmission Circuit	646206	646201		1	Yes	
								0	Open	Load	646206			O0		
								600								
	SLG	S1201 5	161.00	646201	589	-4038	MVA	11.5							Yes	
P7_1	SCMU L-L-G	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	DLG Fault at S3451 on S3451-S3459 and S3451-S3454. Normal clearing with unsuccessful reclosing.
								0	Open	Transmission Circuit	645451	645454		1		
								20	Close	Transmission Circuit	645451	645459		1		
								0	Close	Transmission Circuit	645451	645454		1		
	SCMU L-L-G	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	
								0	Open	Transmission Circuit	645451	645454		1		
P7_1	SCMU L-L-G	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	DLG Fault at S3451 on S3451-S3459 and S3451-S3454. Normal clearing with successful reclosing.
								0	Open	Transmission Circuit	645451	645454		1		
								20	Close	Transmission Circuit	645451	645459		1		
								0	Close	Transmission Circuit	645451	645454		1		

P7_1	SCMU L-L-G	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646220		1	Yes	DLG Fault at S1211 on S1211-S1220 and S1211-S1299. Normal clearing with unsuccessful reclosing.
								0	Open	Transmission Circuit	646211	646299		1		
								0	Open	Load	646220			O0		
								0	Open	Load	646299			O0		
								600								
	SLG	S1220 5	161.00	646220	1162	-7458	MVA	0							No	
	SLG	S1299 5	161.00	646299	2872	-18493	MVA	8.5							Yes	
								0							Yes	
P7_1	SCMU L-L-G	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646250		1	Yes	DLG Fault at S1211 on S1211-S1250 Cir 1511 and S1211-S1250 Cir 1520. Normal clearing with unsuccessful reclosing.
								0	Open	Transmission Circuit	646211	646250		2		
								0	Open	Load	646211			O0		
								0	Open	Load	646250			O0		
								600								
	SCMU L-L-G	S1250 5	161.00	646250				8.5							Yes	
Extreme_2_b	3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	3-PH fault at S3458 on S3458-Cooper followed by a stuck breaker opening the west bus. Delayed clearing.
	3PH	S3458 3	345.00	645458				8.5							Yes	
Extreme_2_c	3PH	S3451 3	345.00	645451				7.5	Open	Three Winding	645451	646251	648251	1	Yes	3-PH fault at S3451 on S3451 T3 transformer followed by a stuck breaker opening S3451-S3459. Delayed clearing.
	3PH	S3451 3	345.00	645451				9.5	Open	Transmission Circuit	645451	645459		1	Yes	

Extreme_2_f									Prior Outage	Transmission Circuit	645451	635200		1		Prior outage of S3451-Raun. SLG fault at S3451 on 3451 T3 transformer followed by a stuck breaker opening S3451-S3459. Delayed clearing.
	SCMU L-G	S3451 3	345.00	645451				7.5	Open	Three Winding	645451	646251	648251	1	Yes	
	SCMU L-G	S3451 3	345.00	645451				9.5	Open	Transmission Circuit	645451	645459		1	Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	645455	645740		1		Prior outage of S3455-S3740. SLG Fault at S3458 on S3458-Cooper followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU L-G	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	
	SCMU L-G	S3458 3	345.00	645458				8.5							Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	645458	640139		1		Prior outage of S3458-Cooper. SLG Fault at S3740 on S3455-S3740 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU L-G	S3740 3	345.00	645740				5	Open	Transmission Circuit	645455	645740		1	Yes	
	SCMU L-G	S3740 3	345.00	645740				8.5							Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	646201	646206		1		Prior outage of S1201-S1206. SLG Fault at S1206 on S1206-S1232 followed by a stuck breaker opening S1206T1. Delayed clearing.
	SCMU L-G	S1206 5	161.00	646206				9	Open	Transmission Circuit	646206	646232		1	Yes	
								0	Open	Load	646232			O0		
	SCMU L-G	S1206 5	161.00	646206				8	Open	Three Winding	646206	647906	648206	1	Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	645454	645455		1		Prior outage of S3454-S3455.

																SLG Fault at S3455 on S3455-S3456 followed by a stuck breaker opening S3455 T1. Delayed clearing.
	SCMU L-G	S3455 3	345.00	645455				5	Open	Transmission Circuit	645455	645456		1	Yes	
	SCMU L-G	S3455 3	345.00	645455				9.5	Open	Three Winding	645455	646255	648255	1	Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	645458	640139		1		Prior outage of S3458-Cooper. SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU L-G	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	645456		1	Yes	
	SCMU L-G	S3458 3	345.00	645458				8.5							Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	645458	640139		1		Prior outage of S3458-Cooper. SLG Fault at S3458 on S3458-103rd&Rokeby followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU L-G	S3458 3	345.00	645458				4.5	Open	Transmission Circuit	645458	650189		1	Yes	
	SCMU L-G	S3458 3	345.00	645458				9							Yes	
Extreme_2_f									Prior Outage	Transmission Circuit	640139	300039		1		Prior outage of Cooper-Fairport. SLG Fault at Cooper on Cooper-St. Joe followed by a stuck breaker opening Cooper-Atchison. Delayed clearing.
	SCMU L-G	COOPER 3	345.00	640139				4.5	Open	Transmission Circuit	640139	541199		1	Yes	
	SCMU L-G	COOPER 3	345.00	640139				9	Open	Transmission Circuit	640139	635017		1	Yes	
P1_2	3PH	S3456 3	345.00	645456				5	Open	Transmission Circuit	645456	635000		1	Yes	3-PH fault at S3456 on S3456-C. Bluffs. Normal clearing with

																	unsuccessful reclosing.
								600									
	3PH	S3456 3	345.00	645456				4.5								Yes	
P4_2	SCMU L-G	S3456 3	345.00	645456				5	Open	Transmission Circuit	645456	635000		1	Yes	SLG Fault at S3456 on S3456-C. Bluffs followed by a stuck breaker opening S3456-S3455. Delayed clearing.
	SCMU L-G	S3456 3	345.00	645456				9	Open	Transmission Circuit	645456	645455		1	Yes	
P4_2	SCMU L-G	S3456 3	345.00	645456				5	Open	Transmission Circuit	645456	645455		1	Yes	SLG Fault at S3456 on S3456-S3455 followed by a stuck breaker opening S3456-C. Bluffs. Delayed clearing.
	SCMU L-G	S3456 3	345.00	645456				9	Open	Transmission Circuit	645456	635000		1	Yes	
P6_1_1									Prior Outage	Transmission Circuit	645456	645455		1		Prior outage of S3456-S3455. 3-PH fault at S3456 on S3456-C. Bluffs. Normal clearing with unsuccessful reclosing.
	3PH	S3456 3	345.00	645456				5	Open	Transmission Circuit	645456	635000		1	Yes	
								600									
	3PH	S3456 3	345.00	645456				4.5							Yes	
P1_3	3PH	S1206 5	161.00	646206				7.5	Open	Three Winding	645456	646206	648256	1	Yes	3-PH fault at S1206 on S3456 T4. Normal clearing.
P4_2	SCMU L-G	S1206 5	161.00	646206				9	Open	Transmission Circuit	646206	646216		1	Yes	SLG Fault at S1206 on S1206-S1216 followed by a stuck breaker opening S3456 T4. Delayed clearing.
								0	Open	Load	646216			O0		
	SCMU L-G	S1206 5	161.00	646206				10	Open	Three Winding	645456	646206	648256	1	Yes	
P4_3	SCMU L-G	S1206 5	161.00	646206				7.5	Open	Three Winding	645456	646206	648256	1	Yes	SLG Fault at S1206 on S3456 T4 followed by a stuck breaker opening

																	S1206-S1216. Delayed clearing.
	SCMU L-G	S1206 5	161.00	646206				12	Open	Transmission Circuit	646206	646216		1	Yes	
								0	Open	Load	646216			O0		
P6_1_2									Prior Outage	Transmission Circuit	646206	646216		1		Prior outage of S1206-S1216. 3-PH fault at S1206 on S3456 T4. Normal clearing.
	3PH	S1206 5	161.00	646206				7.5	Open	Three Winding	645456	646206	648256	1	Yes	
P6_1_1									Prior Outage	Transmission Circuit	646211	646250		1		Prior outage of S1211-S1250 Cir 1511. 3-PH fault at S1211 on S1211-S1250 Cir 1520. Normal clearing with unsuccessful reclosing.
	3PH	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	646250		2	Yes	
								0	Open	Load	646211			O0		
								600								
	SLG	S1250 5	161.00	646250	1454	-9334	MVA	8.5							Yes	
P1_2	3PH	S3459 3	345.00	645459				5	Open	Transmission Circuit	645459	645456		1	Yes	3-PH fault at S3459 on S3459-S3456. Normal clearing with unsuccessful reclosing.
								20	Close	Transmission Circuit	645459	645456		1		
	3PH	S3459 3	345.00	645459				4.5	Open	Transmission Circuit	645459	645456		1	Yes	
	SLG	S3456 3	345.00	645456	1690	-19307	MVA	3							Yes	
P1_2	3PH	S3459 3	345.00	645459				5	Open	Transmission Circuit	645459	645456		1	Yes	3-PH fault at S3459 on S3459-S3456. Normal clearing with successful reclosing.
								20	Close	Transmission Circuit	645459	645456		1		
P1_2	3PH	S1258 5	161.00	646258				6	Open	Transmission Circuit	646258	646263		1	Yes	3-PH fault at S1258 on S1258-S1263. Normal clearing with unsuccessful reclosing.
								20								
	SLG	S1263 5	161.00	646263	261	-1983	MVA	8.5							Yes	

P1_2	3PH	S1258 5	161.00	646258				6	Open	Transmission Circuit	646258	646263		1	Yes	3-PH fault at S1258 on S1258-S1263. Normal clearing with successful reclosing.
								200	Close	Transmission Circuit	646258	646263		1		
P6_2_1									Prior Outage	Three Winding	645456	646206	648256	1		Prior outage of S3456 T4. 3-PH fault at S1258 on S1258-S1263. Normal clearing with unsuccessful reclosing.
	3PH	S1258 5	161.00	646258				6	Open	Transmission Circuit	646258	646263		1	Yes	
								20								
	SLG	S1263 5	161.00	646263	261	-1983	MVA	8.5							Yes	
P6_2_1									Prior Outage	Three Winding	645456	646206	648256	1		Prior outage of S3456 T4. 3-PH fault at S1258 on S1258-S1263. Normal clearing with successful reclosing.
	3PH	S1258 5	161.00	646258				6	Open	Transmission Circuit	646258	646263		1	Yes	
								200	Close	Transmission Circuit	646258	646263		1		
P1_2	3PH	S1298 5	161.00	646298				6	Open	Transmission Circuit	646298	646251		1	Yes	3-PH fault at S1298 on S1298-S1251. Normal clearing with unsuccessful reclosing.
								20								
	3PH	S1298 5	161.00	646298				6							Yes	
P1_2	3PH	S1298 5	161.00	646298				6	Open	Transmission Circuit	646298	646251		1	Yes	3-PH fault at S1298 on S1298-S1251. Normal clearing with successful reclosing.
								200	Close	Transmission Circuit	646298	646251		1		
P4_2	SCMU L-G	S1298 5	161.00	646298				6	Open	Transmission Circuit	646298	646251		1	Yes	SLG Fault at S1298 on S1298-S1251 followed by a stuck breaker opening S1298-S1305. Delayed clearing.
	SCMU L-G	S1298 5	161.00	646298				13.5	Open	Transmission Circuit	646298	646305		1	Yes	

P4_2	SCMU L-G	S1298 5	161.00	646298				9	Open	Transmission Circuit	646298	646305		1	Yes	SLG Fault at S1298 on S1298-S1305 followed by a stuck breaker opening S1298-S1251. Delayed clearing.
	SCMU L-G	S1298 5	161.00	646298				10.5	Open	Transmission Circuit	646298	646251		1	Yes	
P6_1_1									Prior Outage	Transmission Circuit	646298	646305		1		Prior outage of S1298-S1305. 3-PH fault at S1298 on S1298-S1251. Normal clearing with unsuccessful reclosing.
	3PH	S1298 5	161.00	646298				6	Open	Transmission Circuit	646298	646251		1	Yes	
								20								
	3PH	S1298 5	161.00	646298				6							Yes	
P6_1_1									Prior Outage	Transmission Circuit	646298	646305		1		Prior outage of S1298-S1305. 3-PH fault at S1298 on S1298-S1251. Normal clearing with successful reclosing.
	3PH	S1298 5	161.00	646298				6	Open	Transmission Circuit	646298	646251		1	Yes	
								200	Close	Transmission Circuit	646298	646251		1		
P5_5	SCMU L-G	S1210 5	161.00	646210				25.5	Open	Transmission Circuit	646210	646222		1	Yes	SLG Fault at S1210 on bus followed by failure of a non-redundant relay resulting in remote-end opening of transmission circuits and opening of transformer by overcurrent protection. Delayed clearing.
	SCMU L-G	S1210 5	161.00	646210				4.0	Open	Transmission Circuit	646210	646217		1	Yes	
	SCMU L-G	S1210 5	161.00	646210				103.0	Open	Three Winding	646210	647910	648210	1	Yes	
P0		System Intact														System Intact.
P4_2	SCMU L-G	S1260 5	161.00	646260				6	Open	Trip Bus	646281				Yes	SLG Fault at S1260 on S1260-S1281

																followed by a stuck breaker opening S1260-S1361. Delayed clearing.
	SCMU L-G	S1260 5	161.00	646260				10.5	Open	Transmission Circuit	646260	646361		1	Yes	
								0	Open	Load	646260			O0		
P4_2	SCMU L-G	S3455 3	345.00	645455				4.5	Open	Transmission Circuit	645455	645761		1	Yes	SLG Fault at S3455 on S3455-S3761 followed by a stuck breaker opening S3455 T3. Delayed clearing.
	SCMU L-G	S3455 3	345.00	645455				9.5	Open	Three Winding	645455	646255	648355	1	Yes	
P4_2	SCMU L-G	S1361 5	161.00	646361				6	Open	Transmission Circuit	646255	646361		1	Yes	SLG Fault at S1361 on S1361-S1255 followed by a stuck breaker opening the east bus. Delayed clearing.
	SCMU L-G	S1361 5	161.00	646361				9							Yes	
P1_2	3PH	S1361 5	161.00	646361				6	Open	Transmission Circuit	646255	646361		1	Yes	3-PH fault at S1361 on S1361-S1255. Normal clearing with unsuccessful reclosing.
								20	Close	Transmission Circuit	646255	646361		1		
	3PH	S1361 5	161.00	646361				6	Open	Transmission Circuit	646255	646361		1	Yes	
P1_2	3PH	S1361 5	161.00	646361				6	Open	Transmission Circuit	646255	646361		1	Yes	3-PH fault at S1361 on S1361-S1255. Normal clearing with successful reclosing.
								20	Close	Transmission Circuit	646255	646361		1		
Extreme_2_f									Prior Outage	Three Winding	645456	646206	648256	1		Prior outage of S3456 T4. SLG Fault at S3455 on S3455-S3761 followed by a stuck breaker opening S3455 T3. Delayed clearing.
	SCMU L-G	S3455 3	345.00	645455				4.5	Open	Transmission Circuit	645455	645761		1	Yes	
	SCMU L-G	S3455 3	345.00	645455				9.5	Open	Three Winding	645455	646255	648355	1	Yes	

Extreme_2_f	3PH	S3761 3	345.00	645761											No	3-PH fault at S3761 on S3455-S3761 and 3-PH fault at S1361 on S1255-S1361. Normal clearing with unsuccessful reclosing.
	3PH	S1361 5	161.00	646361				4.5	Open	Transmission Circuit	645455	645761		1	Yes	
								1.5	Open	Transmission Circuit	646255	646361		1	Yes	
								20	Close	Transmission Circuit	646255	646361		1		
	3PH	S1361 5	161.00	646361				6	Open	Transmission Circuit	646255	646361		1	Yes	
								572.5								
	SLG	S3455 3	345.00	645455	2615	-47487	MVA	4.5							Yes	
Extreme_2_f	3PH	S3761 3	345.00	645761											No	3-PH fault at S3761 on S3455-S3761 and 3-PH fault at S1361 on S1255-S1361. Normal clearing with successful reclosing.
	3PH	S1361 5	161.00	646361				4.5	Open	Transmission Circuit	645455	645761		1	Yes	
								1.5	Open	Transmission Circuit	646255	646361		1	Yes	
								20	Close	Transmission Circuit	646255	646361		1		
								596.5	Close	Transmission Circuit	645455	645761		1		
Extreme_2_f	3PH	S3455 3	345.00	645455											No	3-PH fault at S3455 on S3455-S3761 and 3-PH fault at S1255 on S1255-S1361. Normal clearing with unsuccessful reclosing.
	3PH	S1255 5	161.00	646255				4.5	Open	Transmission Circuit	645455	645761		1	Yes	
								1.5	Open	Transmission Circuit	646255	646361		1	Yes	
								20	Close	Transmission Circuit	646255	646361		1		
	3PH	S1255 5	161.00	646255				6	Open	Transmission Circuit	646255	646361		1	Yes	
								572.5								
	3PH	S3455 3	345.00	645455				4.5							Yes	
Extreme_2_f	3PH	S3455 3	345.00	645455											No	3-PH fault at S3455 on S3455-S3761 and 3-PH fault at S1255 on S1255-S1361. Normal clearing with successful reclosing.

	3PH	S1255 5	161.00	646255				4.5	Open	Transmission Circuit	645455	645761		1	Yes	
								1.5	Open	Transmission Circuit	646255	646361		1	Yes	
								20	Close	Transmission Circuit	646255	646361		1		
								596.5	Close	Transmission Circuit	645455	645761		1		