INTERCONNECTION FACILITIES STUDY REPORT

GEN-2021-039

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By SPP Generator Interconnections Dept.

REVISION HISTORY

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SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2021-039 is for a 100 MW generating facility located in Douglas County, NE. The Interconnection Request was studied in the DISIS-2021-001 Impact Study for ERIS. The Interconnection Customer's requested in-service date is 5/31/2030.

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 full Interconnection Service will be available after the assigned Transmission Owner Interconnection Facilities (TOIF), Non-Shared Network Upgrades, Shared Network Upgrades, Contingent Network Upgrades, and Affected System Upgrades that are required for full interconnection service are completed.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, Network Upgrades, other direct assigned upgrades, cost estimates, and associated upgrade lead times 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 sixty-eight (68) 2.987863 MW Power Electronics FP3510m inverters for a total generating nameplate capacity of 100 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 161 kV transformation substation with associated 34.5 kV and 161 kV switchgear;
- Two 161 kV/34.5 kV 81/107/135 MVA (ONAN/ONAF/ONAF) step-up transformers to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- An Approximately 0.28 mile overhead 161 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 161 kV bus at existing Transmission Owner substation ("New 161kV substation looping in OPPD 161kV lines S1211 to S1220 and S1211 to S1299") 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** list 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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
Transmission Owner's New 161kV sub looping 161kV lines S1211-S1220 & S1211-S1299 GEN-2021-039 Interconnection (TOIF) (UID 157088): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2021-039 (100/Battery/Storage), into the Point of Interconnection (POI) at New 161kV substation looping in OPPD 161kV lines S1211 to S1220 and S1211 to S1299. Estimated Lead Time: 0 Months	$0	100.00%	$0
Total	**$0**		**$0**

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
Transmission Owner's New 161kV sub looping 161kV lines S1211-S1220 & S1211-S1299 GEN-2021-039 Interconnection (Non-shared NU) (UID 157089): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2021-039 (100/Battery/Storage), into the Point of Interconnection (POI) at New 161kV substation looping in OPPD 161kV lines S1211 to S1220 and S1211 to S1299. Estimated Lead Time: 0 Months	Ineligible	$0	100.00%	$0
Total		**$0**		**$0**

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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
NA				
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
NA		

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 either MISO or AECI 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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
NA			
Total	**$0**		**$0**

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 100 MW can be granted. Full Interconnection Service will be delayed until the TOIF, Non-Shared NU, Shared NU, Contingent NU, Affected System Upgrades that are required for full interconnection service are completed. The Interconnection Customer's estimated cost responsibility for full interconnection service is summarized in the table below.

Table 6: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilities Upgrade(s)	$0
Non-Shared Network Upgrade(s)	$0
Shared Network Upgrade(s)	$0
Affected System Upgrade(s)	$0
Total	**$0**

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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OPPD

Omaha Public Power District

DISIS-2021-001 Interconnection Facilities Study

Omaha Public Power District

Rev 0a – August 18, 2025

Executive Summary

This study evaluates the interconnection of new generation sites in the Omaha Public Power District (OPPD) service area. The interconnection was evaluated for the steady state, stability and fault current impacts to the OPPD and adjacent transmission system per North American Electric Reliability Corporation (NERC) Standard FAC-002 “Facility Interconnection Studies”.

The generation sites evaluated are:

- GEN-2021-039 is an 100MW capacity addition to the GEN-2018-037 battery request located near the existing 161kV substation S1211. This request will interconnect to a new 161kV substation on the existing S1211-S1220 via the same generation tie line as GEN-2018-037.
- GEN-2021-040 is an 200MW capacity addition to the GEN-2018-033 battery request located near the existing 345kV substation S3740. This request will interconnect via the same generation tie line as GEN-2018-033.
- GEN-2021-108 is an 182.5MW solar facility located near the existing 345kV substation S3740. This request will interconnect directly to that substation.

The results of the study indicate that no issues are created by the addition of the new generation.

Note that this study does not evaluate the ability to charge the battery storage included in the GEN-2021-039 and GEN-2021-040 requests. A separate FAC-002 charging study will be required by the generation interconnection agreement prior to interconnection.

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SECTION 1: POWER FLOW

Models

Southwest Power Pool (SPP) Integrated Transmission Planning (ITP) 2025 Base Reliability (BR) models. This will include the 5- and 10-year light, summer peak and winter peak models.

Base Model Changes

Prior queued generation and any OPPD transmission system upgrades assigned to those requests will also be included. Prior queued generation will be modeled with the most recent information available.

- GEN-2017-105 is a 75MW wind farm located in Burt County. This request will interconnect to a new 161kV substation S1300.
- GEN-2017-198 is a 11MW battery located near the existing 69kV substation S901. This request will interconnect directly to the substation.
- GEN-2018-025 is a 200MW battery located near the existing 345kV substation S3451. This request will interconnect directly to the substation.
- GEN-2018-033 is a 200MW battery located near the existing 345kV substation S3740. This request will interconnect directly to the substation.
- GEN-2018-037 is a 100MW battery located near the existing 161kV substation S1211. This request will interconnect to a new 161kV substation on the existing S1211-S1220 and S1211-S1299 161kV circuits.
- GEN-2018-043 is a 500MW solar facility located southeast of the city of Tekamah. This request will interconnect to a new 345kV substation on the S3451-Raun 345kV line.
- GEN-2019-009 is a 100MW solar facility located near the existing 161kV substation S1263. This request will interconnect directly to the substation.
- GEN-2020-002 is an 81MW solar facility located at the existing 69kV substation S6846. This request will interconnect directly to the substation.
- GEN-2020-025 is a 255MW combustion turbine located at a new 161kV substation S1363. This substation interconnects to a 161kV line between existing substations S1281 and S1362.
- GEN-2020-028 is a 255MW combustion turbine located at a new 161kV substation S1363. This substation interconnects to a 161kV line between existing substations S1281 and S1362.
- GEN-2020-031 is a 272MW combustion turbine located at a new 161kV substation S1363. This substation interconnects to a 161kV line between existing substations S1281 and S1362.
- GEN-2020-038 is a 272MW combustion turbine located at the existing 345kV substation S3740. This request will interconnect directly to the substation.
- GEN-2020-043 is a 56.52MW reciprocating internal combustion engine bank of three units located at a new 161kV substation S1347. This substation interconnects to a 161kV line between existing substations S1209 and S1252.

- GEN-2020-044 is a 56.52MW reciprocating internal combustion engine bank of three units located at a new 161kV substation S1347. This substation interconnects to a 161kV line between existing substations S1209 and S1252.
- GEN-2020-045 is a 56.52MW reciprocating internal combustion engine bank of three units located at a new 161kV substation S1347. This substation interconnects to a 161kV line between existing substations S1209 and S1252.
- GEN-2020-078 is a 100MW solar facility located at a new 161kV substation S1344. This substation interconnects to a 161kV line between existing substations S1237 and S1226.
- GEN-2020-084 is a 350MW solar facility located at prior queued 345kV substation S3450 on the existing Raun to S3451 345kV line. This request will interconnect directly to the substation.
- GEN-2020-094 is a 250MW solar facility located at a new 345kv substation S3787. This substation interconnects to a 345kV line between existing substations S3458 and Rokeby.
- DISIS-2020-001 network upgrade to uprate 345kV line S3451 to GEN-2018-043.

The following approved system topology changes will also be added to reflect expected in-service dates.

- S1255-S1259 Uprate (2025)
- NOS Boiler Load (2025)(Winter Only)
- S3456-CBLUFFS Uprate (2026)
- New S1252-S1358 (2026)
- S971 Cap (2026)
- S968 Cap (2026)
- S3763 w/ auto (2027)
- S3763-S3761 (2027)
- S3455-S3740 Uprate (2027)
- Uprate S1211-SUB701 (2028)
- New S3452 345kV substation (2032)
- New S3452-Raun 345kV line (2032)
- New S3771 345kV substation (2032)
- New S3771-Hoyt 345kV line (2032)

Approved AQ Load Changes (MW)						
Sub	2029S			2034S		
	Base	Study	Delta	Base	Study	Delta
S1362	181	213	32	181	240	59
S1361	385	385	0	380	385	5
S1260	160	160	0	160	180	20
S1358	233	233	0	400	400	0
S1237	0	5	5	0	5	5
S1255	0	10	10	0	10	10
S1298	0	8	8	0	8	8
S1363	0	21.75	21.75	0	21.75	21.75
S1320	0	17.1	17.1	0	17.1	17.1
S1380	0	15.7	15.7	0	15.7	15.7
S6875	0	10	10	0	10	10
S1210	0	10.5	10.5	0	10.5	10.5

Generation Dispatch

The new generation under study (CQ) and any prior queued (PQ) generation will be dispatched per the table below. This generation will be sunk externally to OPPD by simply allowing the excess generation to export to the entire interchange via swing machine reduction. This maximizes loading on the OPPD system to identify potential outlet issues and provided a sensitivity to the SPP DISIS; which reduces existing generation to sink the new generation uniformly.

	Summer		**Winter**		**Light**	
	PQ	**CQ**	**PQ**	**CQ**	**PQ**	**CQ**
Combined Cycle	100%	100%	100%	100%	0%	100%
Combustion Turbine	100%	100%	100%	100%	0%	100%
Diesel Engine	100%	100%	100%	100%	0%	100%
Hydro	50%	100%	50%	100%	50%	100%
Nuclear	100%	100%	100%	100%	100%	100%
Storage	100%	100%	100%	100%	0%	100%
Coal	100%	100%	100%	100%	0%	100%
Oil	100%	100%	100%	100%	0%	100%
Waste Heat	100%	100%	100%	100%	0%	100%
Wind	20%	100%	20%	100%	60%	100%
Solar	40%	100%	10%	100%	0%	100%

OPPD reserves the right, at its sole discretion, to utilize SPP's DISIS electrically equivalent dispatch methodology when appropriate. The following prior queued requests will be dispatched to 100% due to electrically equivalent currently queued generation.

- GEN-2018-033
- GEN-2018-037
- GEN-2018-038

Study Generation

The modeling data for the new generation will be extracted from the SPP DISIS models.

Contingency Selection

NERC TPL-001-4 "Transmission System Planning Performance Requirements" Table 1 contingency events that do not allow for the interruption of firm transmission service will be evaluated. Not running the events that allow interruption of firm transmission service is supported by the fact that any issue introduced by the new generation would also be mitigated by reducing that generation per the TPL-001-4 allowance.

This contingency set also includes contingencies from neighboring utilities.

New contingencies will be developed when PSSE auto generated contingencies are determined to be inadequate.

Monitoring

The OPPD system and five buses beyond will be monitored for both voltage and thermal impacts.

Thermal monitoring will use Rate 1/A for system intact, and Rate 2/B for post-contingent loading. Any thermal loading greater than 100% will be identified.

Transfer Distribution Factor (TDF) will be calculated for each generation request. TDFs on facilities that exceed 20% will be considered significantly impacted facilities. TDFs on facilities that exceed 3% will be provided for information only.

$$TDF = 100 \times \frac{MVA\ flow\ (with\ Project) - MVA\ flow\ (w/o\ Project)}{Project\ MW}$$

Voltage monitoring will be performed as follows: all voltages for greater than 1.05pu, >100kV for less than 0.95pu and <100kV for less than 0.90pu.

Voltage impacts that exceed 0.02pu will be considered significantly impacted facilities.

N-1 & Multiple Element Contingency Results

Steady State

No thermal or voltage issues were identified.

SECTION 2: Stability

Modeling

Southwest Power Pool (SPP) Generation Interconnection DISIS-2021-001 Dynamic models will be utilized. This will include 2025 summer and winter peak models.

Base Model Changes

The following approved system topology changes will also be added.

- S1255-S1259 Uprate
- NOS Boiler Load (Winter Only)
- S3456-CBLUFFS Uprate
- New S1358 161kV substation
- Turn off non-DISIS exploratory generation S1363

Approved AQ Load Changes (MW)						
Sub	2025S			2025W		
	Base	Study	Delta	Base	Study	Delta
S1362	180	180	0	180	180	0
S1361	300	300	0	300	300	0
S1260	155.2	155.2	0	155.2	155.2	0
S1358	0	150	150	0	150	150
S1237	0	5	5	0	5	5
S1255	0	10	10	0	10	10
S1298	0	8	8	0	8	8

Generation Dispatch

The new generation (CQ) under study and any prior queued (PQ) generation will be dispatched per the table below. This generation will be sunk externally to OPPD by simply allowing the excess generation to export to the entire interchange via swing machine reduction. This maximizes loading on the OPPD system to identify potential outlet issues and provided a sensitivity to the SPP DISIS; which reduces existing generation to sink the new generation uniformly.

	Summer		**Winter**		**Light**	
	PQ	**CQ**	**PQ**	**CQ**	**PQ**	**CQ**
Combined Cycle	100%	100%	100%	100%	0%	100%
Combustion Turbine	100%	100%	100%	100%	0%	100%
Diesel Engine	100%	100%	100%	100%	0%	100%
Hydro	50%	100%	50%	100%	50%	100%
Nuclear	100%	100%	100%	100%	100%	100%
Storage	100%	100%	100%	100%	0%	100%

Coal	100%	100%	100%	100%	0%	100%
Oil	100%	100%	100%	100%	0%	100%
Waste Heat	100%	100%	100%	100%	0%	100%
Wind	20%	100%	20%	100%	60%	100%
Solar	40%	100%	10%	100%	0%	100%

OPPD reserves the right, at its sole discretion, to utilize SPP's DISIS electrically equivalent dispatch methodology when appropriate. The following prior queued requests will be dispatched to 100% due to electrically equivalent currently queued generation.

- GEN-2018-033
- GEN-2018-037
- GEN-2018-038

Study Generation

The modeling data for the new generation will be extracted from the DISIS models.

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 will.
- 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.

In addition, three phase fault events will be added to any new POI substations.

See Appendix 2 for a list of events.

Stability Monitoring

All simulations were performed using Siemens PSSE.

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 (conventional generation only) – Rotor angles were monitored for all OPPD area generators (Area 645).

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 are 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 < Vtransient ≤ 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 subsequent tripping was required. If it was determined 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.

Scenarios

Requests will be studied simultaneously unless issues are identified. If issues are identified, then they will be run independently to determine the source of the issue.

Stability Results

The results of the study indicate that no issues are created by the addition of the new generation.

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.

Modeling

Southwest Power Pool (SPP) Integrated Transmission Planning (ITP) 2025 Short Circuit (BR) models. This will include the 5 year summer peak max fault model.

Base Model Changes

Prior queued generation and any OPPD transmission system upgrades assigned to those requests will also be included. Prior queued generation will be modeled with the most recent information available.

- GEN-2017-105 is a 75MW wind farm located in Burt County. This request will interconnect to a new 161kV substation S1300.
- GEN-2017-198 is a 11MW battery located near the existing 69kV substation S901. This request will interconnect directly to the substation.
- GEN-2018-025 is a 200MW battery located near the existing 345kV substation S3451. This request will interconnect directly to the substation.
- GEN-2018-033 is a 200MW battery located near the existing 345kV substation S3740. This request will interconnect directly to the substation.
- GEN-2018-037 is a 100MW battery located near the existing 161kV substation S1211. This request will interconnect to a new 161kV substation on the existing S1211-S1220 and S1211-S1299 161kV circuits.
- GEN-2018-043 is a 500MW solar facility located southeast of the city of Tekamah. This request will interconnect to a new 345kV substation on the S3451-Raun 345kV line.
- GEN-2019-009 is a 100MW solar facility located near the existing 161kV substation S1263. This request will interconnect directly to the substation.
- GEN-2020-002 is an 81MW solar facility located at the existing 69kV substation S6846. This request will interconnect directly to the substation.
- GEN-2020-025 is a 255MW combustion turbine located at a new 161kV substation S1363. This substation interconnects to a 161kV line between existing substations S1281 and S1362.
- GEN-2020-028 is a 255MW combustion turbine located at a new 161kV substation S1363. This substation interconnects to a 161kV line between existing substations S1281 and S1362.
- GEN-2020-031 is a 272MW combustion turbine located at a new 161kV substation S1363. This substation interconnects to a 161kV line between existing substations S1281 and S1362.
- GEN-2020-038 is a 272MW combustion turbine located at the existing 345kV substation S3740. This request will interconnect directly to the substation.

- GEN-2020-043 is a 56.52MW reciprocating internal combustion engine bank of three units located at a new 161kV substation S1347. This substation interconnects to a 161kV line between existing substations S1209 and S1252.

The following approved system topology changes will also be added to reflect expected in-service dates.

- S1255-S1259 Uprate (2025)
- NOS Boiler Load (2025)(Winter Only)
- S3456-CBLUFFS Uprate (2026)
- New S1252-S1358 (2026)
- S971 Cap (2026)
- S968 Cap (2026)
- S3763 w/ auto (2027)
- S3763-S3761 (2027)
- S3455-S3740 Uprate (2027)
- Uprate S1211-SUB701 (2028)
- New S3452 345kV substation (2032)
- New S3452-Raun 345kV line (2032)
- New S3771 345kV substation (2032)
- New S3771-Hoyt 345kV line (2032)

Generation Dispatch

All generation will be placed in service to maximize fault current values.

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.

Contingency Selection

A contingency analysis will not be performed for the short circuit analysis. The intact system provides the most paths for fault current to flow, thereby resulting in the worst case. Any circuit breaker loaded greater than 100% will be identified for replacement.

Short Circuit Results

No issues were identified.

Fault current results are listed in Appendix 1.

SECTION 4: MITIGATIONS

The results of the study indicate that no issues are created by the addition of the new generation.

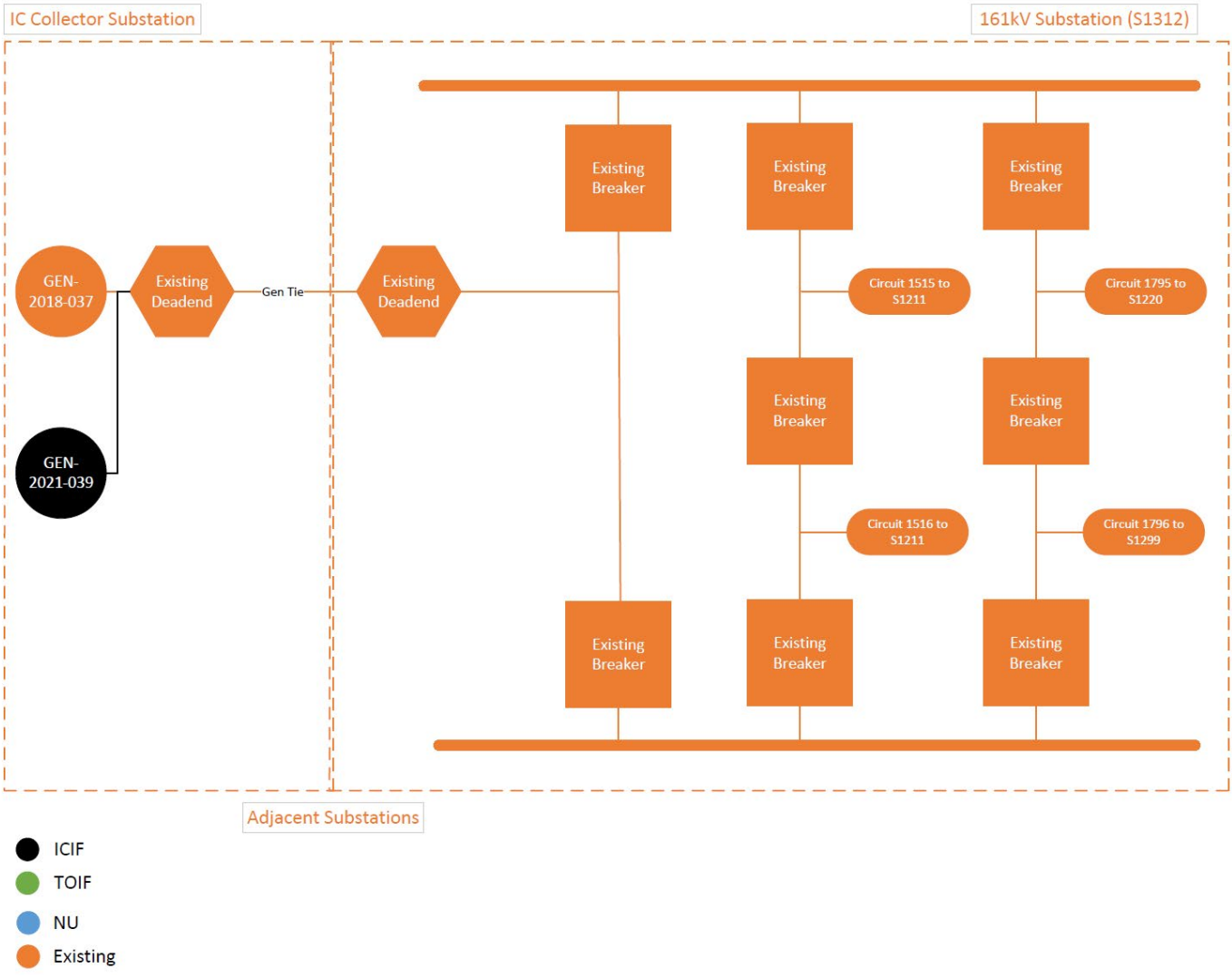
Note that this study does not evaluate the ability to charge the battery storage included in the GEN-2021-039 and GEN-2021-040 requests. A separate FAC-002 charging study will be required by the generation interconnection agreement prior to interconnection.

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. Figures are also provided below to clarify the interconnection scope and the cost allocation.

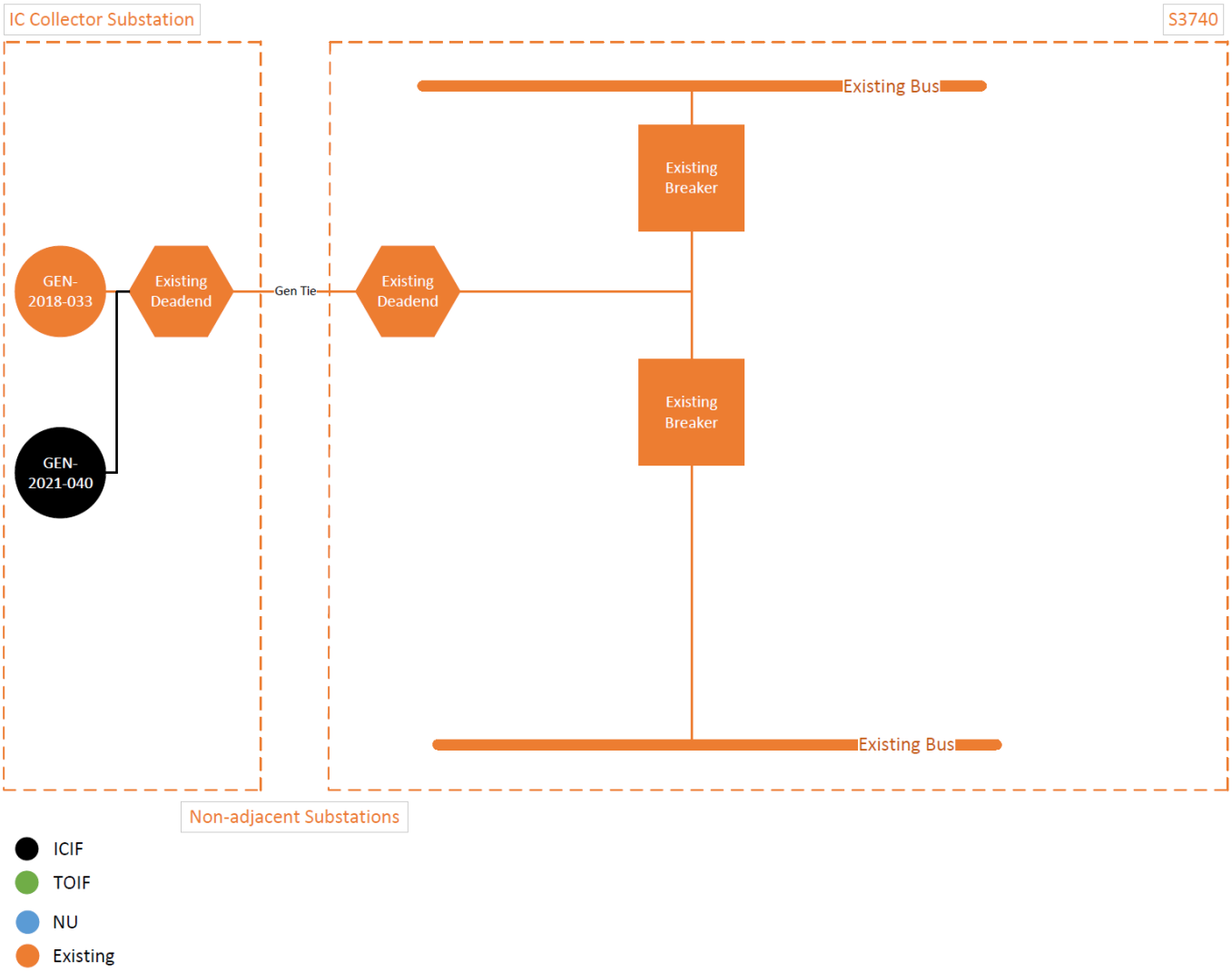
GEN-2021-039

SCERT	Category	Scope	Phase 2 Estimate	IFS Estimate	% Change	Lead Time (months)
157088	TOIF	None	$0	$0	0%	N/A
157089	NU	None	$0	$0	0%	N/A
		Total	$0	$0	0%	



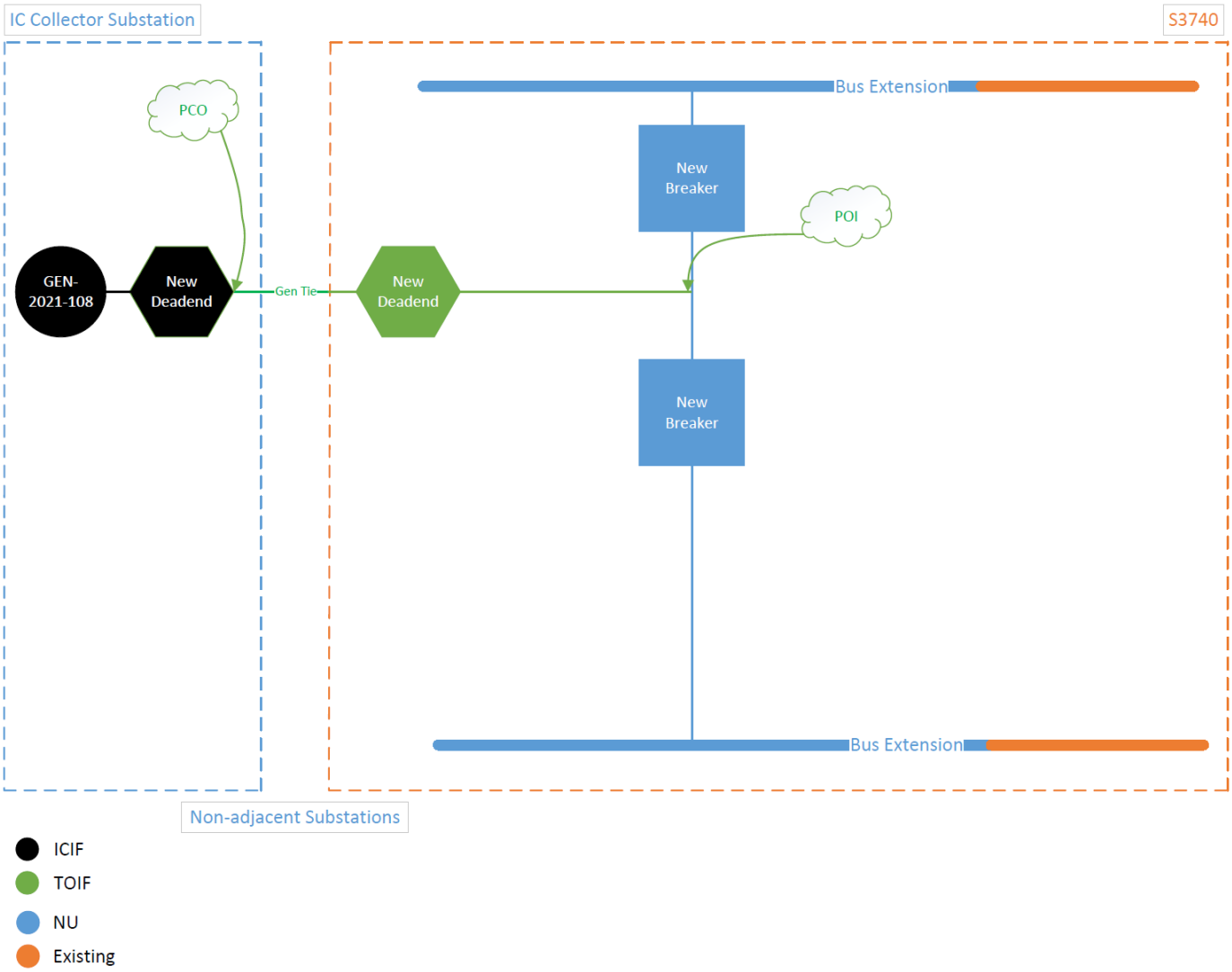
GEN-2021-040

SCERT	Category	Scope	Phase 2 Estimate	IFS Estimate	% Change	Lead Time (months)
157100	TOIF	None	$0	$0	0%	N/A
157101	NU	None	$0	$0	0%	N/A
		Total	$0	$0	0%	



GEN-2021-108

SCERT	Category	Scope	Phase 2 Estimate	IFS Estimate	% Change	Lead Time (months)
157098	TOIF	2 mile 345kV Gen Tie line, S3740 deadend and line jumpers.	$6,505,609	$6,505,609	0%	36
157099	NU	Two breaker bay addition at S3740.	$8,318,292	$8,318,292	0%	48
		Total	$14,823,901	$14,823,901	0%	



Appendix 1 – Short Circuit Results

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
900	CB 1	69	23.00	8.52	37%
900	CB 2	69	23.00	8.52	37%
900	CB 3	69	23.00	8.52	37%
900	CB 5	69	23.00	8.52	37%
900	CB 6	69	23.00	8.52	37%
901	Circuit 613 (CB-1)	69	40.00	30.71	77%
901	Circuit 605 (CB-2)	69	40.00	30.71	77%
901	Circuit 601 GT 2 (CB-3)	69	40.00	30.71	77%
901	Circuit 603 (CB-5)	69	40.00	30.71	77%
901	Circuit 615 GT 1 (CB-4)	69	40.00	30.71	77%
902	CB 1	69	23.00	9.57	42%
902	CB 2	69	23.00	9.57	42%
902	CB 3	69	23.00	9.57	42%
904	CB-1	69	40.00	9.16	23%
906	BT-61	69	50.00	35.12	70%
906	BT-62	69	50.00	35.12	70%
906	BT-63	69	50.00	35.12	70%
906	CB-621	69	50.00	35.12	70%
906	CB-623	69	50.00	35.12	70%
906	CB-624	69	50.00	35.12	70%
906	CB-625	69	50.00	35.12	70%
906	CB-626	69	50.00	35.12	70%
906	CB-628	69	50.00	35.12	70%
906	CB-629	69	50.00	35.12	70%
906	CB-631	69	50.00	35.12	70%
906	CB-632	69	50.00	35.12	70%
906	CB-634	69	50.00	35.12	70%
906	CB-635	69	50.00	35.12	70%
906	CB-636	69	50.00	35.12	70%
906	CB-637	69	50.00	35.12	70%
906	CB-658	69	50.00	35.12	70%
907	CB-1	69	40.00	18.92	47%
908	CB-1	69	35.59	19.72	55%
908	CB-2	69	35.59	19.72	55%
909	CB-651	69	40.00	28.27	71%
909	CB-648	69	50.00	28.27	57%
909	CB-649	69	50.00	28.27	57%
909	CB-652	69	50.00	28.27	57%
909	CB-653	69	50.00	28.27	57%
910	613	69	40.00	27.82	70%
910	646 B	69	40.00	27.82	70%
910	647	69	40.00	27.82	70%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
911	CB-661	69	40.00	25.94	65%
911	CB-662	69	40.00	25.94	65%
911	CB-665	69	40.00	25.94	65%
911	CB-668	69	40.00	25.94	65%
911	CB-664	69	50.00	25.94	52%
912	CB-1	69	40.00	23.37	58%
912	CB-2	69	40.00	23.37	58%
912	CB-3	69	40.00	23.37	58%
913	CB-1	69	40.00	17.13	43%
913	CB-2	69	40.00	17.13	43%
914	CB-1	69	40.00	8.17	20%
916	CB 636	69	40.00	24.17	60%
916	CB 680	69	40.00	24.17	60%
917	CB 1	69	40.00	27.19	68%
917	CB 3	69	40.00	27.19	68%
917	CB-2	69	40.00	27.19	68%
918	CB-651	69	40.00	23.52	59%
918	CB-661D	69	40.00	23.52	59%
918	CB-675B	69	40.00	23.52	59%
919	CB-1	69	40.00	22.37	56%
919	CB-2	69	40.00	22.37	56%
919	CB-3	69	40.00	22.37	56%
921	CB 640	69	40.00	26.65	67%
921	CB 653	69	40.00	26.65	67%
921	CB 679	69	40.00	26.65	67%
921	CB 680	69	40.00	26.65	67%
923	CB-1	69	23.00	19.64	85%
923	CB-2	69	23.00	19.64	85%
923	CB 3	69	40.00	19.64	49%
924	CB-1	69	40.00	25.17	63%
928	CB-1	69	40.00	17.69	44%
930	CB 1	69	40.00	22.11	55%
930	CB 2	69	40.00	22.11	55%
938	CB 2	69	31.50	22.40	71%
938	CB-1	69	40.00	22.40	56%
939	CB-1	69	40.00	20.38	51%
939	CB-2	69	40.00	20.38	51%
940	680	69	40.00	20.99	52%
940	680-B	69	40.00	20.99	52%
942	CB-1	69	40.00	16.52	41%
942	CB-2	69	40.00	16.52	41%
960	CB-20	69	40.00	8.47	21%
961	CB-1	69	40.00	5.18	13%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
962	682	69	31.50	5.90	19%
962	694	69	31.50	5.90	19%
962	697	69	31.50	5.90	19%
963	683	69	40.00	12.16	30%
963	684	69	40.00	12.16	30%
963	689	69	40.00	12.16	30%
963	690	69	40.00	12.16	30%
968	CB-1	69	40.00	4.59	11%
968	CB-2	69	40.00	4.59	11%
970	CB-1	69	40.00	4.44	11%
971	687	69	40.00	4.92	12%
971	693	69	40.00	4.92	12%
971	694	69	40.00	4.92	12%
972	CB-1	69	50.00	4.55	9%
974	CB-602	69	40.00	5.77	14%
974	CB-604	69	40.00	5.77	14%
975	CB-23	69	23.00	8.87	39%
975	CB-21	69	40.00	8.87	22%
975	CB-22	69	40.00	8.87	22%
975	CB-24	69	40.00	8.87	22%
976	CB-1	69	50.00	13.98	28%
982	CB-1	69	40.00	4.12	10%
983	CB-1	69	40.00	7.90	20%
984	CB-1	69	40.00	8.34	21%
985	CB 2	69	23.00	8.63	38%
985	CB1	69	23.00	8.63	38%
991	CB-1	69	40.00	13.20	33%
991	CB-2	69	40.00	13.20	33%
1201	CB-4	161	50.00	35.50	71%
1201	CB-7	161	50.00	35.50	71%
1201	CB-8	161	50.00	35.50	71%
1201	CB-1	161	63.00	35.50	56%
1201	CB-2	161	63.00	35.50	56%
1201	CB-3	161	63.00	35.50	56%
1201	CB-5	161	63.00	35.50	56%
1201	CB-6	161	63.00	35.50	56%
1201	CB-9	161	63.00	35.50	56%
1206	CB-10	161	63.00	58.52	93%
1206	CB-11	161	63.00	58.52	93%
1206	CB-12	161	63.00	58.52	93%
1206	CB-13	161	63.00	58.52	93%
1206	CB-14	161	63.00	58.52	93%
1206	CB-15	161	63.00	58.52	93%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1206	CB-16	161	63.00	58.52	93%
1206	CB-17	161	63.00	58.52	93%
1206	CB-18	161	63.00	58.52	93%
1206	CB-19	161	63.00	58.52	93%
1206	CB-7	161	63.00	58.52	93%
1206	CB-8	161	63.00	58.52	93%
1206	CB-9	161	63.00	58.52	93%
1209	CB-21	161	63.00	54.25	86%
1209	CB-22	161	63.00	54.25	86%
1209	CB-23	161	63.00	54.25	86%
1209	CB-24	161	63.00	54.25	86%
1209	CB-25	161	63.00	54.25	86%
1209	CB-26	161	63.00	54.25	86%
1209	CB-27	161	63.00	54.25	86%
1209	CB-28	161	63.00	54.25	86%
1209	CB-30	161	63.00	54.25	86%
1209	CB-31	161	63.00	54.25	86%
1209	CB-32	161	63.00	54.25	86%
1210	CB-1	161	50.00	35.90	72%
1210	CB-2	161	50.00	35.90	72%
1210	CB-676	69	40.00	27.82	70%
1211	CB 13	161	45.83	40.39	88%
1211	CB 14	161	45.83	40.39	88%
1211	CB 16	161	45.83	40.39	88%
1211	CB 17	161	45.83	40.39	88%
1211	CB 22	161	45.83	40.39	88%
1211	CB 23	161	45.83	40.39	88%
1211	CB-15	161	50.00	40.39	81%
1211	CB-18	161	50.00	40.39	81%
1211	CB-21	161	50.00	40.39	81%
1211	CB-24	161	50.00	40.39	81%
1211	CB-31	161	50.00	40.39	81%
1211	CB-32	161	50.00	40.39	81%
1211	CB-33	161	50.00	40.39	81%
1211	CB-7	161	50.00	40.39	81%
1211	CB-8	161	50.00	40.39	81%
1211	CB-9	161	50.00	40.39	81%
1211	CB 19	161	63.00	40.39	64%
1211	CB 20	161	63.00	40.39	64%
1214	CB-1	161	40.00	14.67	37%
1214	CB-2	161	40.00	14.67	37%
1214	CB-3	161	40.00	14.67	37%
1214	CB-11	69	40.00	13.03	33%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1214	CB-12	69	40.00	13.03	33%
1214	CB-13	69	40.00	13.03	33%
1214	CB-14	69	40.00	13.03	33%
1216	CB-1	161	50.00	33.33	67%
1217	CB-11	161	50.00	37.07	74%
1217	CB-1579	161	50.00	37.07	74%
1217	CB-1580	161	50.00	37.07	74%
1217	CB-1619	161	50.00	37.07	74%
1220	CB-1	161	50.00	31.33	63%
1221	1541	161	40.00	37.63	94%
1221	CB-1550	161	63.00	37.63	60%
1222	CB 1	161	40.00	32.92	82%
1226	CB 1	161	50.00	26.73	53%
1226	CB 3	161	50.00	26.73	53%
1226	CB 4	161	50.00	26.73	53%
1226	CB 5	161	50.00	26.73	53%
1226	CB 6	161	50.00	26.73	53%
1226	CB 7	161	50.00	26.73	53%
1226	CB 8	161	50.00	26.73	53%
1226	CB 9	161	50.00	26.73	53%
1226	CB-2	161	63.00	26.73	42%
1227	CB-1	161	50.00	34.66	69%
1229	CB 1	161	45.83	32.87	72%
1231	CB-7	161	50.00	46.36	93%
1231	CB-8	161	50.00	46.36	93%
1231	CB-9	161	50.00	46.36	93%
1231	CB-1	161	63.00	46.36	74%
1231	CB-2	161	63.00	46.36	74%
1231	CB-3	161	63.00	46.36	74%
1231	CB-4	161	63.00	46.36	74%
1231	CB-6	161	63.00	46.36	74%
1232	CB-1	161	50.00	28.22	56%
1233	CB-1	161	50.00	31.05	62%
1234	CB-1	161	40.00	28.42	71%
1234	CB-2	161	50.00	28.42	57%
1235	CB-1	161	50.00	36.69	73%
1235	CB-2	161	50.00	36.69	73%
1235	CB-3	161	50.00	36.69	73%
1235	CB-4	161	50.00	36.69	73%
1236	CB 1	161	40.00	27.57	69%
1237	CB-1	161	50.00	24.14	48%
1237	CB-2	161	50.00	24.14	48%
1237	CB-3	161	50.00	24.14	48%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1244	CB-1	161	40.00	23.38	58%
1244	CB-2	161	50.00	23.38	47%
1247	All	161	63.00	27.60	44%
1249	CB 1	161	40.00	26.67	67%
1250	CB 2	161	50.00	38.75	77%
1250	CB 3	161	50.00	38.75	77%
1250	CB 4	161	50.00	38.75	77%
1250	CB 5	161	50.00	38.75	77%
1250	CB-1	161	63.00	38.75	62%
1250	CB-6	161	63.00	38.75	62%
1250	CB-11	69	40.00	23.90	60%
1251	CB-104	161	50.00	35.96	72%
1251	CB-105	161	50.00	35.96	72%
1251	CB-106	161	50.00	35.96	72%
1251	CB-107	161	50.00	35.96	72%
1251	CB-108	161	50.00	35.96	72%
1251	CB-109	161	50.00	35.96	72%
1251	CB-110	161	50.00	35.96	72%
1251	CB-111	161	50.00	35.96	72%
1251	CB-112	161	50.00	35.96	72%
1252	CB-1	161	63.00	38.97	62%
1252	CB-10	161	63.00	38.97	62%
1252	CB-11	161	63.00	38.97	62%
1252	CB-12	161	63.00	38.97	62%
1252	CB-2	161	63.00	38.97	62%
1252	CB-3	161	63.00	38.97	62%
1252	CB-4	161	63.00	38.97	62%
1252	CB-5	161	63.00	38.97	62%
1252	CB-6	161	63.00	38.97	62%
1252	CB-7	161	63.00	38.97	62%
1252	CB-8	161	63.00	38.97	62%
1252	CB-9	161	63.00	38.97	62%
1253	CB-22	161	40.00	29.59	74%
1253	CB-21	161	50.00	29.59	59%
1253	CB-23	161	50.00	29.59	59%
1253	CB-25	161	63.00	29.59	47%
1254	CB-11	161	50.00	37.68	75%
1254	CB-12	161	50.00	37.68	75%
1254	CB-13	161	63.00	37.68	60%
1254	CB-14	161	63.00	37.68	60%
1254	CB-15	161	63.00	37.68	60%
1255	CB-21	161	63.00	56.99	90%
1255	CB-22	161	63.00	56.99	90%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1255	CB-23	161	63.00	56.99	90%
1255	CB-25	161	63.00	56.99	90%
1255	CB-26	161	63.00	56.99	90%
1255	CB-27	161	63.00	56.99	90%
1255	CB-28	161	63.00	56.99	90%
1255	CB-29	161	63.00	56.99	90%
1255	CB-30	161	63.00	56.99	90%
1255	CB-32	161	63.00	56.99	90%
1256	CB-1	161	50.00	24.08	48%
1256	CB-6	161	63.00	24.08	38%
1258	CB-41	161	50.00	6.27	13%
1258	CB-42	161	50.00	6.27	13%
1258	CB-44	161	50.00	6.27	13%
1258	CB-45	161	50.00	6.27	13%
1258	CB-46	161	50.00	6.27	13%
1258	CB-48	161	50.00	6.27	13%
1258	CB-49	161	50.00	6.27	13%
1259	CB-1	161	63.00	42.26	67%
1259	CB-2	161	63.00	42.26	67%
1259	CB-3	161	63.00	42.26	67%
1259	CB-4	161	63.00	42.26	67%
1260	CB-1	161	63.00	47.57	76%
1260	CB-10	161	63.00	47.57	76%
1260	CB-11	161	63.00	47.57	76%
1260	CB-12	161	63.00	47.57	76%
1260	CB-13	161	63.00	47.57	76%
1260	CB-2	161	63.00	47.57	76%
1260	CB-3	161	63.00	47.57	76%
1260	CB-4	161	63.00	47.57	76%
1260	CB-5	161	63.00	47.57	76%
1260	CB-6	161	63.00	47.57	76%
1260	CB-7	161	63.00	47.57	76%
1260	CB-8	161	63.00	47.57	76%
1260	CB-9	161	63.00	47.57	76%
1263	CB-11	69	40.00	12.71	32%
1263	CB-12	69	40.00	12.71	32%
1263	CB-1	161	40.00	9.14	23%
1263	CB-2	161	40.00	9.14	23%
1263	CB-3	161	40.00	9.14	23%
1278	CB-1	161	50.00	29.24	58%
1280	CB-1	161	50.00	11.16	22%
1280	CB-2	161	50.00	11.16	22%
1280	CB-3	161	50.00	11.16	22%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1281	CB 1	161	63.00	42.12	67%
1281	CB 2	161	63.00	42.12	67%
1281	CB 3	161	63.00	42.12	67%
1281	CB 4	161	63.00	42.12	67%
1286	CB-1	161	40.00	28.85	72%
1287	CB-1	161	63.00	24.62	39%
1291	CB-21	161	40.00	7.33	18%
1298	CB-1	161	40.00	31.59	79%
1298	CB-2	161	50.00	31.59	63%
1298	CB-3	161	50.00	31.59	63%
1298	CB-4	161	50.00	31.59	63%
1299	CB-1	161	50.00	30.00	60%
1300	All	161	63.00	9.20	15%
1305	CB-1	161	50.00	29.83	60%
1305	CB-2	161	50.00	29.83	60%
1312	All	161	63.00	39.20	62%
1341	CB-1	161	50.00	28.95	58%
1344	All	161	63.00	17.08	27%
1345	CB-1	161	50.00	26.01	52%
1347	CB-1	161	63.00	36.02	57%
1347	CB-10	161	63.00	36.02	57%
1347	CB-13	161	63.00	36.02	57%
1347	CB-14	161	63.00	36.02	57%
1347	CB-15	161	63.00	36.02	57%
1347	CB-16	161	63.00	36.02	57%
1347	CB-19	161	63.00	36.02	57%
1347	CB-2	161	63.00	36.02	57%
1347	CB-20	161	63.00	36.02	57%
1347	CB-21	161	63.00	36.02	57%
1347	CB-22	161	63.00	36.02	57%
1347	CB-9	161	63.00	36.02	57%
1358	CB-21	161	63.00	40.02	64%
1358	CB-22	161	63.00	40.02	64%
1358	CB-23	161	63.00	40.02	64%
1358	CB-24	161	63.00	40.02	64%
1358	CB-25	161	63.00	40.02	64%
1358	CB-26	161	63.00	40.02	64%
1358	CB-27	161	63.00	40.02	64%
1358	CB-28	161	63.00	40.02	64%
1358	CB-29	161	63.00	40.02	64%
1358	CB-30	161	63.00	40.02	64%
1358	CB-31	161	63.00	40.02	64%
1358	CB-32	161	63.00	40.02	64%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1361	CB-23	161	63.00	50.45	80%
1361	CB-24	161	63.00	50.45	80%
1361	CB-25	161	63.00	50.45	80%
1361	CB-27	161	63.00	50.45	80%
1361	CB-28	161	63.00	50.45	80%
1361	CB-30	161	63.00	50.45	80%
1361	CB-31	161	63.00	50.45	80%
1361	CB-32	161	63.00	50.45	80%
1361	CB-33	161	63.00	50.45	80%
1361	CB-34	161	63.00	50.45	80%
1361	CB-35	161	63.00	50.45	80%
1361	CB-36	161	63.00	50.45	80%
1361	CB-37	161	63.00	50.45	80%
1361	CB-38	161	63.00	50.45	80%
1361	CB-39	161	63.00	50.45	80%
1361	CB-40	161	63.00	50.45	80%
1361	CB-41	161	63.00	50.45	80%
1361	CB-42	161	63.00	50.45	80%
1362	CB-21	161	63.00	44.51	71%
1362	CB-22	161	63.00	44.51	71%
1362	CB-23	161	63.00	44.51	71%
1362	CB-24	161	63.00	44.51	71%
1362	CB-25	161	63.00	44.51	71%
1362	CB-26	161	63.00	44.51	71%
1362	CB-27	161	63.00	44.51	71%
1362	CB-28	161	63.00	44.51	71%
1362	CB-29	161	63.00	44.51	71%
1362	CB-30	161	63.00	44.51	71%
1362	CB-31	161	63.00	44.51	71%
1362	CB-32	161	63.00	44.51	71%
1363	CB-26	161	80.00	56.35	70%
1363	CB-27	161	80.00	56.35	70%
1363	CB-34	161	80.00	56.35	70%
1363	CB-35	161	80.00	56.35	70%
1363	CB-36	161	80.00	56.35	70%
1363	CB-37	161	80.00	56.35	70%
1363	CB-38	161	80.00	56.35	70%
1363	CB-39	161	80.00	56.35	70%
1363	CB-40	161	80.00	56.35	70%
1363	CB-41	161	80.00	56.35	70%
1363	CB-44	161	80.00	56.35	70%
1363	CB-45	161	80.00	56.35	70%
1363	CB-46	161	80.00	56.35	70%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
1363	CB-47	161	80.00	56.35	70%
1363	CB-48	161	80.00	56.35	70%
1363	CB-49	161	80.00	56.35	70%
1366	CB-1	161	40.00	17.06	43%
1366	CB-2	161	40.00	17.06	43%
1367	CB-1	161	40.00	23.37	58%
1399	CB-1	161	50.00	7.15	14%
1399	CB-2	161	50.00	7.15	14%
1399	CB-3	161	50.00	7.15	14%
3451	CB 1 A PHASE	345	40.00	24.20	61%
3451	CB 1 B PHASE	345	40.00	24.20	61%
3451	CB 1 C PHASE	345	40.00	24.20	61%
3451	CB 10 A PHASE	345	40.00	24.20	61%
3451	CB 10 B PHASE	345	40.00	24.20	61%
3451	CB 10 C PHASE	345	40.00	24.20	61%
3451	CB 11 A PHASE	345	40.00	24.20	61%
3451	CB 11 B PHASE	345	40.00	24.20	61%
3451	CB 11 C PHASE	345	40.00	24.20	61%
3451	CB 12 A PHASE	345	40.00	24.20	61%
3451	CB 12 B PHASE	345	40.00	24.20	61%
3451	CB 12 C PHASE	345	40.00	24.20	61%
3451	CB 2 A PHASE	345	40.00	24.20	61%
3451	CB 2 B PHASE	345	40.00	24.20	61%
3451	CB 2 C PHASE	345	40.00	24.20	61%
3451	CB 3 A PHASE	345	40.00	24.20	61%
3451	CB 3 B PHASE	345	40.00	24.20	61%
3451	CB 3 C PHASE	345	40.00	24.20	61%
3451	CB 4 A PHASE	345	40.00	24.20	61%
3451	CB 4 B PHASE	345	40.00	24.20	61%
3451	CB 4 C PHASE	345	40.00	24.20	61%
3451	CB 5 A PHASE	345	40.00	24.20	61%
3451	CB 5 B PHASE	345	40.00	24.20	61%
3451	CB 5 C PHASE	345	40.00	24.20	61%
3451	CB 6 A PHASE	345	40.00	24.20	61%
3451	CB 6 B PHASE	345	40.00	24.20	61%
3451	CB 6 C PHASE	345	40.00	24.20	61%
3454	CB 1 A PHASE	345	40.00	34.70	87%
3454	CB 1 B PHASE	345	40.00	34.70	87%
3454	CB 1 C PHASE	345	40.00	34.70	87%
3454	CB 2 A PHASE	345	40.00	34.70	87%
3454	CB 2 B PHASE	345	40.00	34.70	87%
3454	CB 2 C PHASE	345	40.00	34.70	87%
3454	CB 3 A Phase	345	40.00	34.70	87%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
3454	CB 3 B Phase	345	40.00	34.70	87%
3454	CB 3 C Phase	345	40.00	34.70	87%
3454	CB 6 A PHASE	345	40.00	34.70	87%
3454	CB 6 B PHASE	345	40.00	34.70	87%
3454	CB 6 C PHASE	345	40.00	34.70	87%
3455	CB 1 A Phase	345	40.00	38.57	96%
3455	CB 1 B Phase	345	40.00	38.57	96%
3455	CB 1 C Phase	345	40.00	38.57	96%
3455	CB 10 A Phase	345	40.00	38.57	96%
3455	CB 10 B Phase	345	40.00	38.57	96%
3455	CB 10 C Phase	345	40.00	38.57	96%
3455	CB 11 A Phase	345	40.00	38.57	96%
3455	CB 11 B Phase	345	40.00	38.57	96%
3455	CB 11 C Phase	345	40.00	38.57	96%
3455	CB 12 A Phase	345	40.00	38.57	96%
3455	CB 12 B Phase	345	40.00	38.57	96%
3455	CB 12 C Phase	345	40.00	38.57	96%
3455	CB 2 A Phase	345	50.00	38.57	77%
3455	CB 2 B Phase	345	50.00	38.57	77%
3455	CB 2 C Phase	345	50.00	38.57	77%
3455	CB 3 A Phase	345	50.00	38.57	77%
3455	CB 3 B Phase	345	50.00	38.57	77%
3455	CB 3 C Phase	345	50.00	38.57	77%
3455	CB 5	345	50.00	38.57	77%
3455	CB 6 A Phase	345	50.00	38.57	77%
3455	CB 6 B Phase	345	50.00	38.57	77%
3455	CB 6 C Phase	345	50.00	38.57	77%
3455	CB-7 A Phase	345	63.00	38.57	61%
3455	CB-7 B Phase	345	63.00	38.57	61%
3455	CB-7 C Phase	345	63.00	38.57	61%
3455	CB-9 A Phase	345	63.00	38.57	61%
3455	CB-9 B Phase	345	63.00	38.57	61%
3455	CB-9 C Phase	345	63.00	38.57	61%
3456	CB 1 A Phase	345	50.00	39.89	80%
3456	CB 1 B Phase	345	50.00	39.89	80%
3456	CB 1 C Phase	345	50.00	39.89	80%
3456	CB 2 A Phase	345	50.00	39.89	80%
3456	CB 2 B Phase	345	50.00	39.89	80%
3456	CB 2 C Phase	345	50.00	39.89	80%
3456	CB 3 A Phase	345	50.00	39.89	80%
3456	CB 3 B Phase	345	50.00	39.89	80%
3456	CB 3 C Phase	345	50.00	39.89	80%
3456	CB 4 A Phase	345	50.00	39.89	80%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
3456	CB 4 B Phase	345	50.00	39.89	80%
3456	CB 4 C Phase	345	50.00	39.89	80%
3456	CB 5 A Phase	345	50.00	39.89	80%
3456	CB 5 B Phase	345	50.00	39.89	80%
3456	CB 5 C Phase	345	50.00	39.89	80%
3456	CB 6 A Phase	345	50.00	39.89	80%
3456	CB 6 B Phase	345	50.00	39.89	80%
3456	CB 6 C Phase	345	50.00	39.89	80%
3458	CB 1 A Phase	345	50.00	37.71	75%
3458	CB 1 B Phase	345	50.00	37.71	75%
3458	CB 1 C Phase	345	50.00	37.71	75%
3458	CB 10 A Phase	345	50.00	37.71	75%
3458	CB 10 B Phase	345	50.00	37.71	75%
3458	CB 10 C Phase	345	50.00	37.71	75%
3458	CB 12 A Phase	345	50.00	37.71	75%
3458	CB 12 B Phase	345	50.00	37.71	75%
3458	CB 12 C Phase	345	50.00	37.71	75%
3458	CB 16 A Phase	345	50.00	37.71	75%
3458	CB 16 B Phase	345	50.00	37.71	75%
3458	CB 16 C Phase	345	50.00	37.71	75%
3458	CB 18 A Phase	345	50.00	37.71	75%
3458	CB 18 B Phase	345	50.00	37.71	75%
3458	CB 18 C Phase	345	50.00	37.71	75%
3458	CB 23 A Phase	345	50.00	37.71	75%
3458	CB 23 B Phase	345	50.00	37.71	75%
3458	CB 23 C Phase	345	50.00	37.71	75%
3458	CB 24 A Phase	345	50.00	37.71	75%
3458	CB 24 B Phase	345	50.00	37.71	75%
3458	CB 24 C Phase	345	50.00	37.71	75%
3458	CB 25 A Phase	345	50.00	37.71	75%
3458	CB 25 B Phase	345	50.00	37.71	75%
3458	CB 25 C Phase	345	50.00	37.71	75%
3458	CB-19 - A PHASE, POLE 1	345	50.00	37.71	75%
3458	CB-19 - B PHASE, POLE 2	345	50.00	37.71	75%
3458	CB-19 - C PHASE, POLE 3	345	50.00	37.71	75%
3458	CB-21 - A PHASE, POLE 1	345	50.00	37.71	75%
3458	CB-21 - B PHASE, POLE 2	345	50.00	37.71	75%
3458	CB-21 - C PHASE, POLE 3	345	50.00	37.71	75%
3458	CB-27 - A PHASE, POLE 1	345	50.00	37.71	75%
3458	CB-27 - B PHASE, POLE 2	345	50.00	37.71	75%
3458	CB-27 - C PHASE, POLE 3	345	50.00	37.71	75%
3458	CB-3 - A PHASE, POLE 1	345	50.00	37.71	75%
3458	CB-3 - B PHASE, POLE 2	345	50.00	37.71	75%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
3458	CB-3 - C PHASE, POLE 3	345	50.00	37.71	75%
3458	CB-4 - A PHASE, POLE 1	345	50.00	37.71	75%
3458	CB-4 - B PHASE, POLE 2	345	50.00	37.71	75%
3458	CB-4 - C PHASE, POLE 3	345	50.00	37.71	75%
3458	CB-6 - A PHASE, POLE 1	345	50.00	37.71	75%
3458	CB-6 - B PHASE, POLE 2	345	50.00	37.71	75%
3458	CB-6 - C PHASE, POLE 3	345	50.00	37.71	75%
3459	CB 1 A Phase	345	50.00	27.83	56%
3459	CB 1 B Phase	345	50.00	27.83	56%
3459	CB 1 C Phase	345	50.00	27.83	56%
3459	CB 2 A Phase	345	50.00	27.83	56%
3459	CB 2 B Phase	345	50.00	27.83	56%
3459	CB 2 C Phase	345	50.00	27.83	56%
3459	CB 3 A Phase	345	50.00	27.83	56%
3459	CB 3 B Phase	345	50.00	27.83	56%
3459	CB 3 C Phase	345	50.00	27.83	56%
3459	CB 4 A Phase	345	50.00	27.83	56%
3459	CB 4 B Phase	345	50.00	27.83	56%
3459	CB 4 C Phase	345	50.00	27.83	56%
3459	CB 5 A Phase	345	50.00	27.83	56%
3459	CB 5 B Phase	345	50.00	27.83	56%
3459	CB 5 C Phase	345	50.00	27.83	56%
3459	CB 6 A Phase	345	50.00	27.83	56%
3459	CB 6 B Phase	345	50.00	27.83	56%
3459	CB 6 C Phase	345	50.00	27.83	56%
3740	CB 2 A Phase	345	50.00	33.04	66%
3740	CB 2 B Phase	345	50.00	33.04	66%
3740	CB 2 C Phase	345	50.00	33.04	66%
3740	CB 3 A Phase	345	50.00	33.04	66%
3740	CB 3 B Phase	345	50.00	33.04	66%
3740	CB 3 C Phase	345	50.00	33.04	66%
3740	CB 4 A Phase	345	50.00	33.04	66%
3740	CB 4 B Phase	345	50.00	33.04	66%
3740	CB 4 C Phase	345	50.00	33.04	66%
3740	CB 5 A Phase	345	50.00	33.04	66%
3740	CB 5 B Phase	345	50.00	33.04	66%
3740	CB 5 C Phase	345	50.00	33.04	66%
3740	CB 6 A Phase	345	50.00	33.04	66%
3740	CB 6 B Phase	345	50.00	33.04	66%
3740	CB 6 C Phase	345	50.00	33.04	66%
3740	CB 7 A Phase	345	50.00	33.04	66%
3740	CB 7 B Phase	345	50.00	33.04	66%
3740	CB 7 C Phase	345	50.00	33.04	66%

Sub	Breaker	Base kV	Final Interrupt Rating (kA)	Final Fault Current (kA)	Duty
3740	CB 8 A Phase	345	50.00	33.04	66%
3740	CB 8 B Phase	345	50.00	33.04	66%
3740	CB 8 C Phase	345	50.00	33.04	66%
3750	All	345	63.00	17.57	28%
3761	CB-2 A Phase	345	63.00	32.26	51%
3761	CB-2 B Phase	345	63.00	32.26	51%
3761	CB-2 C Phase	345	63.00	32.26	51%
3763	All	345	63.00	34.68	55%
3787	All	345	63.00	18.91	30%
6815	CB-1	69	40.00	12.81	32%
6815	CB-2	69	40.00	12.81	32%
6846	CB-1	69	40.00	8.35	21%
6846	CB-2	69	40.00	8.35	21%
6846	CB-4	69	40.00	8.35	21%
6866	CB-11	69	40.00	21.39	53%
6866	CB-12	69	40.00	21.39	53%
6874	CB-1	69	29.85	8.54	29%
6874	CB-2	69	29.85	8.54	29%
NCU 903	CB 683	69	40.00	6.43	16%
NCU 903	CB 697	69	40.00	6.43	16%

Appendix 2 – Stability Events

Fault			Faulted Bus				Fault Admittance			Outage or System Adjustment								
	Previous Event ID	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
	1	P1_2	3PH	S34583	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	3-PH fault at S3458 on S3458-Cooper. Normal clearing.
	2	P1_2	3PH	S37403	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	S34553	345.00	645455	932	-10192	MVA	7.5							Yes	
	3	P1_2	3PH	S12065	161.00	646206				6.5	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	S12325	161.00	646232	1434	-9156	MVA	5.5							Yes	
	4	P1_2	3PH	S12115	161.00	646211				6	Open	Transmission Circuit	646211	762712		1	Yes	3-PH fault at S1211 on S1211-G18-037-TAP Ckt 1. Normal clearing with unsuccessful reclosing.
										600								
			SLG	G18-037-TAP	161.00	762712	2872	-18493	MVA	8.5							Yes	
	5	P1_2	3PH	S12115	161.00	646211				6	Open	Transmission Circuit	646211	762712		2	Yes	3-PH fault at S1211 on S1211-G18-

																		037-TAP Ckt 2. Normal clearing with unsuccessful reclosing.
									600									
			SLG	G18-037-TAP	161.00	762712	2872	-18493	MVA	8.5							Yes	
	6	P1_2	3PH	S12115	161.00	646211				6.5	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	S12505	161.00	646250	1454	-9334	MVA	5.5							Yes	
	7	P1_3	3PH	S34513	345.00	645451				7.5	Open	Three Winding	645451	646251	648251	1	Yes	3-PH fault at S3451 on S3451 T3 transformer. Normal clearing.
	8	P2_2	SCMU L-G	S12175	161.00	646217				5.75	Open	Trip Bus	646217				Yes	SLG Fault at S1217 on 161-kV bus. Normal clearing.
	9	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	S34583	345.00	645458				5	Open	Transmission Circuit	645458	645456		1	Yes	
										600								
			SLG	S34563	345.00	645456	411	-4361	MVA	7.5							Yes	
	10	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	S34563	345.00	645456				5.5	Open	Transmission Circuit	645458	645456		1	Yes	
										600								
			3PH	S34563	345.00	645456				4.5							Yes	
	11	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	S34513	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	
										20	Close	Transmission Circuit	645451	645459		1		
			3PH	S34513	345.00	645451				4.5	Open	Transmission Circuit	645451	645459		1	Yes	
			SLG	S34593	345.00	645459	994	-11394	MVA	3							Yes	
	12	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	S34513	345.00	645451				5	Open	Transmission Circuit	645451	645459		1	Yes	
										20	Close	Transmission Circuit	645451	645459		1		
	13	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	
	14	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		
	15	P4_2	SCMU L-G	S3451 3	345.00	645451				5	Open	Transmission Circuit	645451	762779		1		SLG Fault at S3451 on S3451-G18-043-TAP 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	
	16	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	
	17	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	
	18	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	
	19	P4_2	SCMU L-G	S1206 5	161.00	646206				6.5	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				11	Open	Transmission Circuit	646206	646201		1	Yes	
										0	Open	Load	646206			O0		
	20	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		
	21	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 of S3458-G20-094-TAP. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
	22										Prior Outage	Transmission Circuit	645458	764805		1		
			3PH	S3458 3	345.00	645458				5	Open	Transmission Circuit	645458	640139		1	Yes	
		P6_1_1																Prior outage of S3458-Cooper. 3-PH fault at S3740 on S3455-S3740. Normal clearing with unsuccessful reclosing.
	23										Prior Outage	Transmission Circuit	645458	640139		1		
			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 of S1211-G18-037-TAP Ckt 1. 3-PH fault at S1211 on S1211-G18-037-TAP Ckt 2. Normal clearing with unsuccessful reclosing.
	24										Prior Outage	Transmission Circuit	646211	762712		1		
			3PH	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	762712		2	Yes	
										600								

			SLG	G18-037-TAP	161.00	762712	2872	-18493	MVA	8.5						Yes	
	25	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	
	26	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		
	27	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	
	28	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		
	29	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	
	30	P6_1_1									Prior Outage	Transmission Circuit	645458	764805		1		Prior outage of S3458-G20-094-TAP. 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	
	31	P6_1_2									Prior Outage	Transmission Circuit	645451	762779		1		Prior outage of S3451-G18-043-TAP. 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	
	32	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				7	Open	Transmission Circuit	646206	646201		1	Yes	
										0	Open	Load	646206			O0		
										600								
			SLG	S1201 5	161.00	646201	589	-4038	MVA	10							Yes	
	33	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		
	34	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		
	35	P7_1	SCMU L-L-G	S1211 5	161.00	646211				6	Open	Transmission Circuit	646211	762712		1	Yes	DLG Fault at S1211 on

																	S1211-G18-037-TAP Ckt 1 and Ckt 2. Normal clearing with unsuccessful reclosing.
									0	Open	Transmission Circuit	646211	762712		2		
									600								
			SLG	G18-037-TAP	161.00	762712	2872	-18493	MVA 8.5							Yes	
	36	P7_1	SCMU L-L-G	S12115	161.00	646211			6.5	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	S12505	161.00	646250			5.5							Yes	
	47	P1_2	3PH	S34563	345.00	645456			5.5	Open	Transmission Circuit	645456	635000		1	Yes	3-PH fault at S3456 on S3456-C. Bluffs. Normal clearing with unsuccessful reclosing.
									600								
			3PH	S34563	345.00	645456			4.5							Yes	
	48	P4_2	SCMU L-G	S34563	345.00	645456			5.5	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	S34563	345.00	645456			11	Open	Transmission Circuit	645456	645455		1	Yes	

	49	P4_2	SCMU L-G	S3456 3	345.00	645456				5.5	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				11	Open	Transmission Circuit	645456	635000		1	Yes	
	50	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				5.5	Open	Transmission Circuit	645456	635000		1	Yes	
										600								
			3PH	S3456 3	345.00	645456				4.5							Yes	
	51	P1_3	3PH	S1206 5	161.00	646206				6	Open	Three Winding	645456	646206	648256	1	Yes	3-PH fault at S1206 on S3456 T4. Normal clearing.
	52	P4_2	SCMU L-G	S1206 5	161.00	646206				6.5	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	
	53	P4_3	SCMU L-G	S1206 5	161.00	646206				6	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				11.5	Open	Transmission Circuit	646206	646216		1	Yes	
										0	Open	Load	646216			O0		
	54	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				6	Open	Three Winding	645456	646206	648256	1	Yes	
	55	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				6.5	Open	Transmission Circuit	646211	646250		2	Yes	
										0	Open	Load	646211			O0		
										600								
			SLG	S1250 5	161.00	646250	1454	-9334	MVA	5.5							Yes	
	56	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	
	57	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		
	58	P1_2	3PH	S1258	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	161.00	646263	261	-1983	MVA 8.5							Yes	
	59	P1_2	3PH	S1258	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		
	60	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	161.00	646258			6	Open	Transmission Circuit	646258	646263		1	Yes	
									20								
			SLG	S1263	161.00	646263	261	-1983	MVA 8.5							Yes	
	61	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	161.00	646258			6	Open	Transmission Circuit	646258	646263		1	Yes	

										200	Close	Transmission Circuit	646258	646263		1		
	62	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	
	63	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		
	64	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	
	65	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	
	66	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	
	67	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		
	68	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	
	69	P0		System Intact														System Intact.
	70	P4_2	SCMU L-G	S1260 5	161.00	646260				6	Open	Transmission Circuit	646260	646362		1	Yes	SLG Fault at S1260 on S1260-S1362

																	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		
	71	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	
	72	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	
	73	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	
	74	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		
	80	P1_2	3PH	S13475	161.00	646347			6	Open	Transmission Circuit	646209	646347		1	Yes	3-PH fault at S1347 on S1347-S1209. Normal clearing with unsuccessful reclosing.
									600								
			SLG	S12095	161.00	646209	1931	-13978	MVA 8.5							Yes	
	81	P1_2	3PH	S13475	161.00	646347			6	Open	Transmission Circuit	646209	646347		1	Yes	3-PH fault at S1347 on S1347-S1209. Normal clearing with successful reclosing.
									620	Close	Transmission Circuit	646209	646347		1		
	82	P6_1_1								Prior Outage	Transmission Circuit	646236	646252		1		Prior outage of S1236-S1252. 3-PH fault at S1347 on S1347-S1209. Normal clearing with unsuccessful reclosing.
			3PH	S13475	161.00	646347			6	Open	Transmission Circuit	646209	646347		1	Yes	
									600								
			SLG	S12095	161.00	646209	1931	-13978	MVA 8.5							Yes	
	83	P6_1_1								Prior Outage	Transmission Circuit	646236	646252		1		Prior outage of S1236-S1252. 3-PH fault at S1347 on S1347-S1209. Normal clearing with successful reclosing.
			3PH	S13475	161.00	646347			6	Open	Transmission Circuit	646209	646347		1	Yes	

									620	Close	Transmission Circuit	646209	646347		1		
	84	P1_2	3PH	S1347 5	161.00	646347			6	Open	Transmission Circuit	646252	646347		1	Yes	3-PH fault at S1347 on S1347-S1252. Normal clearing with unsuccessful reclosing.
									0	Open	Load	646252			O0		
									600								
			SLG	S1252 5	161.00	646252	1931	-13978	MVA 8.5							Yes	
	85	P1_2	3PH	S1347 5	161.00	646347			6	Open	Transmission Circuit	646252	646347		1	Yes	3-PH fault at S1347 on S1347-S1252. Normal clearing with successful reclosing.
									0	Open	Load	646252			O0		
									620	Close	Transmission Circuit	646252	646347		1		
	86	P6_2_1								Prior Outage	Three Winding	645459	646209	648359	1		Prior outage of S3459 T6. 3-PH fault at S1347 on S1347-S1252. Normal clearing with unsuccessful reclosing.
			3PH	S1347 5	161.00	646347			6	Open	Transmission Circuit	646252	646347		1	Yes	
									0	Open	Load	646252			O0		
									600								
			SLG	S1252 5	161.00	646252	1931	-13978	MVA 8.5							Yes	
	87	P6_2_1								Prior Outage	Three Winding	645459	646209	648359	1		Prior outage of S3459 T6. 3-PH fault at S1347 on S1347-S1252. Normal clearing with successful reclosing.
			3PH	S1347 5	161.00	646347			6	Open	Transmission Circuit	646252	646347		1	Yes	
									0	Open	Load	646252			O0		

									620	Close	Transmission Circuit	646252	646347		1		
	88	P1_2	3PH	S1363 5	161.00	646363			6	Open	Transmission Circuit	646362	646363		1	Yes	3-PH fault at S1363 on S1363-S1362 Ckt 1. Normal clearing with unsuccessful reclosing.
									600								
			SLG	S1362 5	161.00	646362	1133	-9911	MVA 8.5							Yes	
	89	P1_2	3PH	S1363 5	161.00	646363			6	Open	Transmission Circuit	646362	646363		1	Yes	3-PH fault at S1363 on S1363-S1362 Ckt 1. Normal clearing with successful reclosing.
									620	Close	Transmission Circuit	646362	646363		1		
	90	P6_1_1								Prior Outage	Transmission Circuit	646362	646363		2		Prior outage of S1362-S1363 Ckt 2. 3-PH fault at S1363 on S1363-S1362 Ckt 1. Normal clearing with unsuccessful reclosing.
			3PH	S1363 5	161.00	646363			6	Open	Transmission Circuit	646362	646363		1	Yes	
									600								
			SLG	S1362 5	161.00	646362	1133	-9911	MVA 8.5							Yes	
	91	P6_1_1								Prior Outage	Transmission Circuit	646362	646363		2		Prior outage of S1362-S1363 Ckt 2. 3-PH fault at S1363 on S1363-S1362 Ckt 1. Normal clearing with successful reclosing.
			3PH	S1363 5	161.00	646363			6	Open	Transmission Circuit	646362	646363		1	Yes	
									620	Close	Transmission Circuit	646362	646363		1		

	92	P1_2	3PH	S1363 5	161.00	646363				6	Open	Transmission Circuit	646281	646363		1	Yes	3-PH fault at S1363 on S1363-S1281. Normal clearing with unsuccessful reclosing.
										600								
			SLG	S1281 5	161.00	646281	972	-8495	MVA	8.5							Yes	
	93	P1_2	3PH	S1363 5	161.00	646363				6	Open	Transmission Circuit	646281	646363		1	Yes	3-PH fault at S1363 on S1363-S1281. Normal clearing with successful reclosing.
										620	Close	Transmission Circuit	646281	646363		1		
	94	P6_1_1									Prior Outage	Transmission Circuit	646362	646363		2		Prior outage of S1362-S1363 Ckt 2. 3-PH fault at S1363 on S1363-S1281. Normal clearing with unsuccessful reclosing.
			3PH	S1363 5	161.00	646363				6	Open	Transmission Circuit	646281	646363		1	Yes	
										600								
			SLG	S1281 5	161.00	646281	972	-8495	MVA	8.5							Yes	
	95	P6_1_1									Prior Outage	Transmission Circuit	646362	646363		2		Prior outage of S1362-S1363 Ckt 2. 3-PH fault at S1363 on S1363-S1281. Normal clearing with successful reclosing.
			3PH	S1363 5	161.00	646363				6	Open	Transmission Circuit	646281	646363		1	Yes	
										620	Close	Transmission Circuit	646281	646363		1		
	96	P1_2	3PH	G17-105TAP	161.00	762069				20	Open	Transmission Circuit	762069	635201		1	Yes	3-PH fault at G17-105TAP-

																	Raun. Delayed clearing.
	97	P1_2	3PH	G18-043-TAP	345.00	762779				20	Open	Transmission Circuit	762779	635200		1	Yes	3-PH fault at G18-043-TAP-Raun. Delayed clearing.
	98	P1_2	3PH	S1263 5	161.00	646263				20	Open	Transmission Circuit	646263	646280		1	Yes	3-PH fault at S1263-S1280. Delayed clearing.
	99	P1_2	3PH	S6846 8	69.00	647846				20	Open	Transmission Circuit	647846	647014		1	Yes	3-PH fault at S6846-S914. Delayed clearing.
	100	P1_2	3PH	G20-078-TAP	161.00	764775				20	Open	Transmission Circuit	764775	646237		1	Yes	3-PH fault at G20-078-TAP-S1237. Delayed clearing.
	101	P1_2	3PH	G20-094-TAP	345.00	764805				20	Open	Transmission Circuit	764805	650189		1	Yes	3-PH fault at G20-094-TAP-103&Rokeby. Delayed clearing.