



# **INTERCONNECTION FACILITIES STUDY REPORT**

**GEN-2021-040**

Published August 2025

By SPP Generator Interconnections Dept.

## REVISION HISTORY

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| DATE OR VERSION<br>NUMBER | AUTHOR | CHANGE DESCRIPTION           |
|---------------------------|--------|------------------------------|
| August 20, 2025           | SPP    | Initial draft report issued. |
| August 27, 2025           | SPP    | Final report issued.         |
|                           |        |                              |

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# SUMMARY

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## INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2021-040 is for a 200 MW generating facility located in Cass 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 11/30/2029.

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 one-hundred thirty-six (136) 2.986026 MW Power Electronics FP3510M inverters for a total generating nameplate capacity of 200 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 345 kV transformation substation with associated 34.5 kV and 345 kV switchgear;
- Two 345 kV/34.5 kV 162/216/271 MVA (ONAN/ONAF/ONAF) step-up transformers to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- An Approximately 0.55 mile overhead 345 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 345 kV bus at existing Transmission Owner substation ("OPPD District, Cass County Power Plant Substation, 345kV Bus") 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 (\$) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|------------------------------|
| <u>Transmission Owner's OPPD District, Cass County Power Plant Sub, 345kV Bus GEN-2021-040 Interconnection (TOIF) (UID 157100): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2021-040 (200/Battery/Storage), into the Point of Interconnection (POI) at OPPD District, Cass County Power Plant Substation, 345kV Bus. Estimated Lead Time: 0 Months</u> | \$0                      | 100.00%               | \$0                          |
| <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>\$0</b>               |                       | <b>\$0</b>                   |

*Table 2: Non-Shared Network Upgrade(s)*

| Non-Shared Network Upgrades Description                                                                                                                                                                                                                                                                                                                                                                                                    | ILTCR      | Total Cost Estimate (\$) | Allocated Percent (%) | Allocated Cost Estimate (\$) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------|-----------------------|------------------------------|
| <u>Transmission Owner's OPPD District, Cass County Power Plant Sub 345kV Bus GEN-2021-040 Interconnection (Non-shared NU) (UID 157101): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2021-040 (200/Battery/Storage), into the Point of Interconnection (POI) at OPPD District, Cass County Power Plant Substation, 345kV Bus. Estimated Lead Time: 0 Months</u> | Ineligible | \$0                      | 100.00%               | \$0                          |
| <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                               |            | <b>\$0</b>               |                       | <b>\$0</b>                   |

## 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 (\$) |
|-------------------------------------|-------|--------------------------|-----------------------|------------------------------|
| <u>NA</u>                           |       |                          |                       |                              |
| <b>Total</b>                        |       | <b>\$0</b>               |                       | <b>\$0</b>                   |

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                                   |                          |                       |                              |
| <b>Total</b>                         | <b>\$0</b>               |                       | <b>\$0</b>                   |

## CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 200 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                     |
| <b>Total</b>                                             | <b>\$0</b>              |

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

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**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).

# DISIS-2021-001 Interconnection Facilities Study



## **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   |
| <b>Combined Cycle</b>     | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Combustion Turbine</b> | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Diesel Engine</b>      | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Hydro</b>              | 50%    | 100% | 50%    | 100% | 50%   | 100% |
| <b>Nuclear</b>            | 100%   | 100% | 100%   | 100% | 100%  | 100% |
| <b>Storage</b>            | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Coal</b>               | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Oil</b>                | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Waste Heat</b>         | 100%   | 100% | 100%   | 100% | 0%    | 100% |
| <b>Wind</b>               | 20%    | 100% | 20%    | 100% | 60%   | 100% |
| <b>Solar</b>              | 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.

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

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% |

|                   |      |      |      |      |     |      |
|-------------------|------|------|------|------|-----|------|
| <b>Coal</b>       | 100% | 100% | 100% | 100% | 0%  | 100% |
| <b>Oil</b>        | 100% | 100% | 100% | 100% | 0%  | 100% |
| <b>Waste Heat</b> | 100% | 100% | 100% | 100% | 0%  | 100% |
| <b>Wind</b>       | 20%  | 100% | 20%  | 100% | 60% | 100% |
| <b>Solar</b>      | 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:

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

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

- 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:

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

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

**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  $0.70 < V_{\text{transient}} \leq 1.20$  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 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.

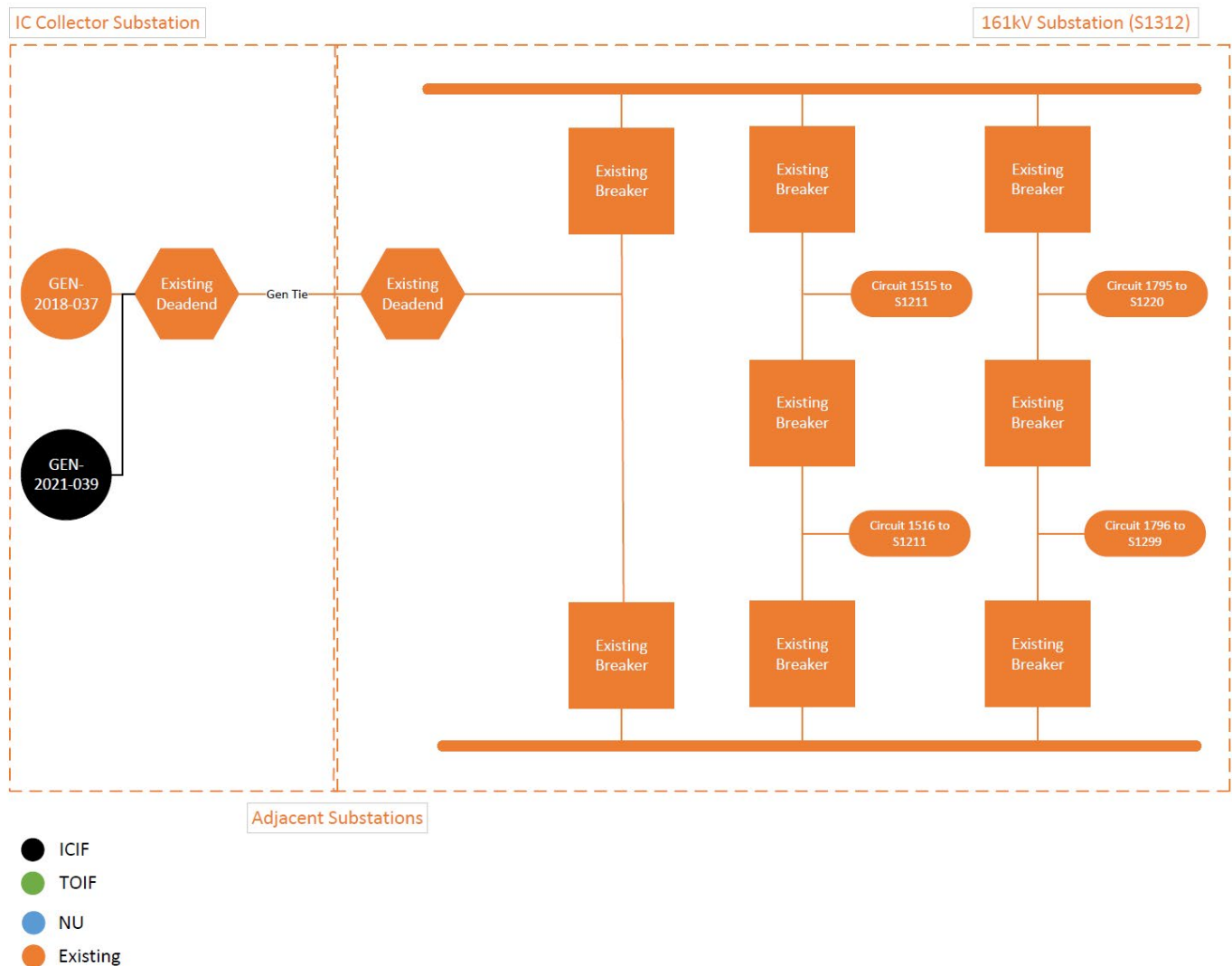


## SECTION 5: Detailed Cost Estimates and Schedule

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.

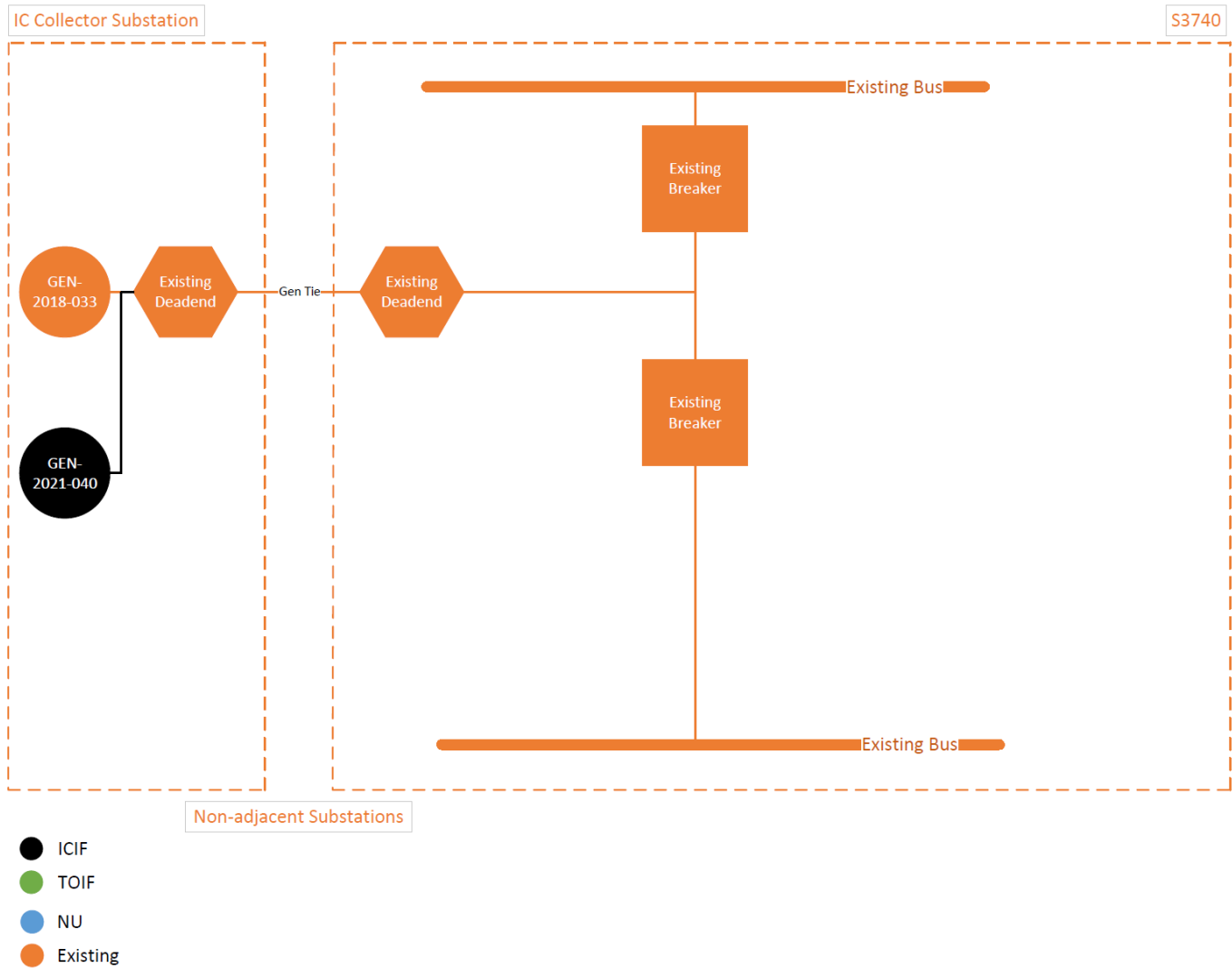
### GEN-2021-039

| 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                |
|        |          |      | <b>Total</b> | <b>\$0</b>       | <b>\$0</b>   | <b>0%</b> |                    |



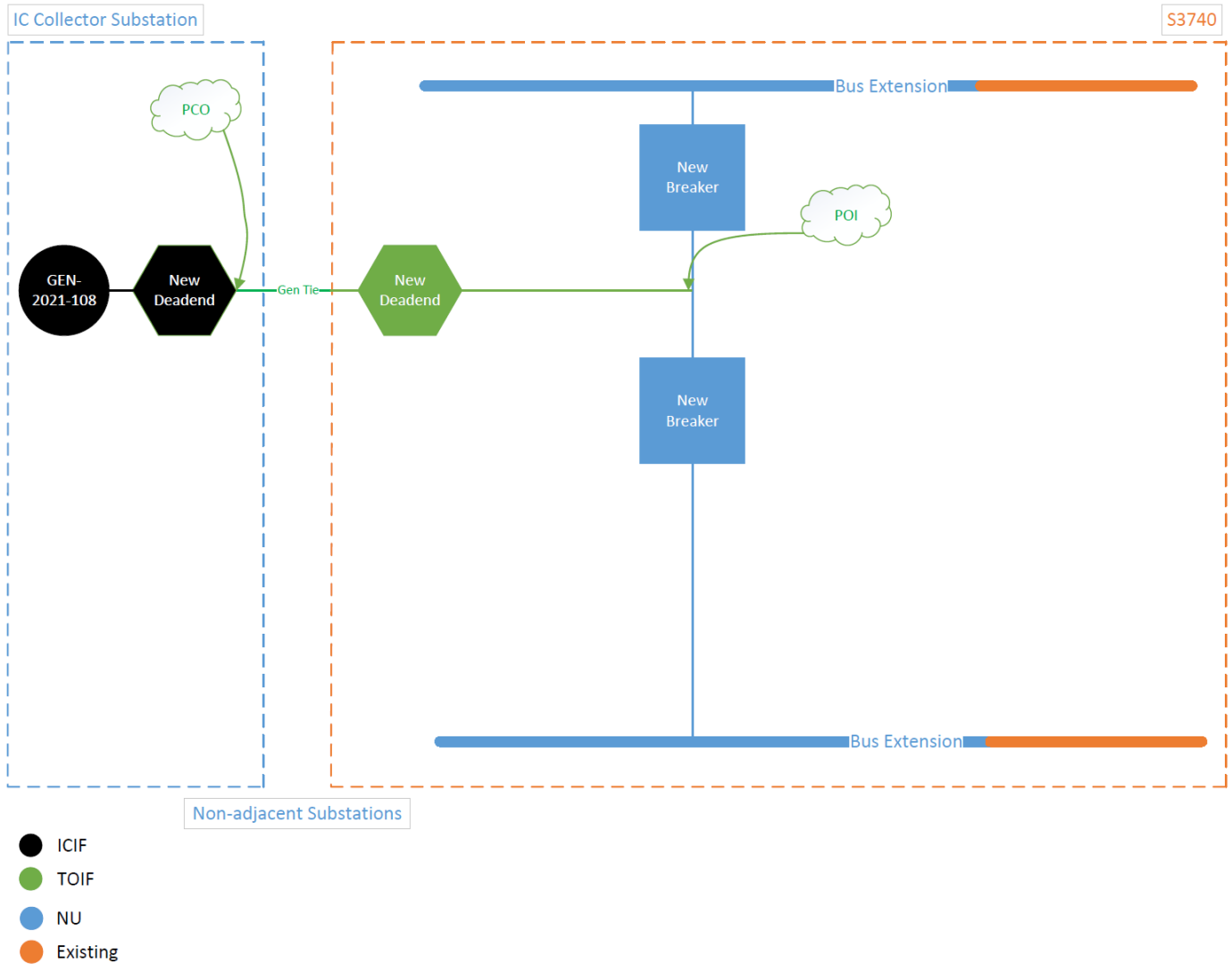
**GEN-2021-040**

| 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                |
|        |          |      | <b>Total</b> | \$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<br>903 | CB 683       | 69      | 40.00                       | 6.43                     | 16%  |
| NCU<br>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/<br>Set Scale (MW, Max, Min) | Action | Element              | From Bus | To Bus | Tertiary Bus | Circuit ID | Clear Fault | Description                                                                                  |
|       | 1                 | P1_2     | 3PH         | S3458<br>3  | 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         | S3740<br>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<br>3  | 345.00       | 645455     | 932              | -<br>10192 | MVA   | 7.5                                         |        |                      |          |        |              |            | Yes         |                                                                                              |
|       | 3                 | P1_2     | 3PH         | S1206<br>5  | 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   |        |              | 00         |             |                                                                                              |
|       |                   |          |             |             |              |            |                  |            |       | 600                                         |        |                      |          |        |              |            |             |                                                                                              |
|       |                   |          | SLG         | S1232<br>5  | 161.00       | 646232     | 1434             | -<br>9156  | MVA   | 5.5                                         |        |                      |          |        |              |            | Yes         |                                                                                              |
|       | 4                 | P1_2     | 3PH         | S1211<br>5  | 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             | -<br>18493 | MVA   | 8.5                                         |        |                      |          |        |              |            | Yes         |                                                                                              |
|       | 5                 | P1_2     | 3PH         | S1211<br>5  | 161.00       | 646211     |                  |            |       | 6                                           | Open   | Transmission Circuit | 646211   | 762712 |              | 2          | Yes         | 3-PH fault at S1211 on S1211-G18-                                                            |

|    |      |             |            |                 |        |        |      |            |     |      |                 |                         |        |        |        |    |     |                                                                                                                                                        |
|----|------|-------------|------------|-----------------|--------|--------|------|------------|-----|------|-----------------|-------------------------|--------|--------|--------|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |      |             |            |                 |        |        |      |            |     |      |                 |                         |        |        |        |    |     | 037-TAP Ckt<br>2. Normal<br>clearing with<br>unsuccessful<br>reclosing.                                                                                |
|    |      |             |            |                 |        |        |      |            | 600 |      |                 |                         |        |        |        |    |     |                                                                                                                                                        |
|    |      |             | SLG        | G18-<br>037-TAP | 161.00 | 762712 | 2872 | -<br>18493 | MVA | 8.5  |                 |                         |        |        |        |    | Yes |                                                                                                                                                        |
| 6  | P1_2 | 3PH         | S1211<br>5 |                 | 161.00 | 646211 |      |            |     | 6.5  | Open            | Transmission<br>Circuit | 646211 | 646250 |        | 2  | Yes | 3-PH fault at<br>S1211 on<br>S1211-S1250<br>Cir 1520.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing.                                         |
|    |      |             |            |                 |        |        |      |            |     | 0    | Open            | Load                    | 646211 |        |        | 00 |     |                                                                                                                                                        |
|    |      |             |            |                 |        |        |      |            |     | 600  |                 |                         |        |        |        |    |     |                                                                                                                                                        |
|    |      |             | SLG        | S1250<br>5      | 161.00 | 646250 | 1454 | -<br>9334  | MVA | 5.5  |                 |                         |        |        |        |    | Yes |                                                                                                                                                        |
| 7  | P1_3 | 3PH         | S3451<br>3 |                 | 345.00 | 645451 |      |            |     | 7.5  | Open            | Three<br>Winding        | 645451 | 646251 | 648251 | 1  | Yes | 3-PH fault at<br>S3451 on<br>S3451 T3<br>transformer.<br>Normal<br>clearing.                                                                           |
| 8  | P2_2 | SCMU<br>L-G | S1217<br>5 |                 | 161.00 | 646217 |      |            |     | 5.75 | Open            | Trip Bus                | 646217 |        |        |    | Yes | SLG Fault at<br>S1217 on<br>161-kV bus.<br>Normal<br>clearing.                                                                                         |
| 9  | P3_2 |             |            |                 |        |        |      |            |     |      | Prior<br>Outage | Generator               | 635024 |        |        | 4  |     | Prior outage<br>of Council<br>Bluffs Unit 4.<br>3-PH fault at<br>S3458 on<br>S3458-<br>S3456.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing. |
|    |      |             | 3PH        | S3458<br>3      | 345.00 | 645458 |      |            |     | 5    | Open            | Transmission<br>Circuit | 645458 | 645456 |        | 1  | Yes |                                                                                                                                                        |
|    |      |             |            |                 |        |        |      |            |     | 600  |                 |                         |        |        |        |    |     |                                                                                                                                                        |
|    |      |             | SLG        | S3456<br>3      | 345.00 | 645456 | 411  | -<br>4361  | MVA | 7.5  |                 |                         |        |        |        |    | Yes |                                                                                                                                                        |
| 10 | P3_2 |             |            |                 |        |        |      |            |     |      | Prior<br>Outage | Generator               | 635024 |        |        | 4  |     | Prior outage<br>of Council<br>Bluffs Unit 4.<br>3-PH fault at<br>S3456 on<br>S3458-<br>S3456.                                                          |

|    |      |  |     |            |        |        |     |       |     |     |              |                      |        |        |  |   |     |                                                                                                                         |
|----|------|--|-----|------------|--------|--------|-----|-------|-----|-----|--------------|----------------------|--------|--------|--|---|-----|-------------------------------------------------------------------------------------------------------------------------|
|    |      |  |     |            |        |        |     |       |     |     |              |                      |        |        |  |   |     | Normal clearing with unsuccessful reclosing.                                                                            |
|    |      |  | 3PH | S3456<br>3 | 345.00 | 645456 |     |       |     | 5.5 | Open         | Transmission Circuit | 645458 | 645456 |  | 1 | Yes |                                                                                                                         |
|    |      |  |     |            |        |        |     |       |     | 600 |              |                      |        |        |  |   |     |                                                                                                                         |
|    |      |  | 3PH | S3456<br>3 | 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 | S3451<br>3 | 345.00 | 645451 |     |       |     | 5   | Open         | Transmission Circuit | 645451 | 645459 |  | 1 | Yes |                                                                                                                         |
|    |      |  |     |            |        |        |     |       |     | 20  | Close        | Transmission Circuit | 645451 | 645459 |  | 1 |     |                                                                                                                         |
|    |      |  | 3PH | S3451<br>3 | 345.00 | 645451 |     |       |     | 4.5 | Open         | Transmission Circuit | 645451 | 645459 |  | 1 | Yes |                                                                                                                         |
|    |      |  | SLG | S3459<br>3 | 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 | S3451<br>3 | 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<br>3 | 345.00 | 645459 |     |       |     | 5   | Open            | Transmission<br>Circuit | 645451 | 645459 |        | 1 | Yes |                                                                                                                                                      |
|    |      |             |            |            |        |        |     |       |     | 20  | Close           | Transmission<br>Circuit | 645451 | 645459 |        | 1 |     |                                                                                                                                                      |
|    |      |             | 3PH        | S3459<br>3 | 345.00 | 645459 |     |       |     | 4.5 | Open            | Transmission<br>Circuit | 645451 | 645459 |        | 1 | Yes |                                                                                                                                                      |
|    |      |             | SLG        | S3451<br>3 | 345.00 | 645451 | 994 | 11394 | MVA | 3   |                 |                         |        |        |        |   | Yes |                                                                                                                                                      |
| 14 | P3_2 |             |            |            |        |        |     |       |     |     | Prior<br>Outage | Generator               | 635024 |        |        | 4 |     | Prior outage<br>of Council<br>Bluffs Unit 4.<br>3-PH fault at<br>S3459 on<br>S3451-<br>S3459.<br>Normal<br>clearing with<br>successful<br>reclosing. |
|    |      |             | 3PH        | S3459<br>3 | 345.00 | 645459 |     |       |     | 5   | Open            | Transmission<br>Circuit | 645451 | 645459 |        | 1 | Yes |                                                                                                                                                      |
|    |      |             |            |            |        |        |     |       |     | 20  | Close           | Transmission<br>Circuit | 645451 | 645459 |        | 1 |     |                                                                                                                                                      |
| 15 | P4_2 | SCMU<br>L-G | S3451<br>3 | 345.00     | 645451 |        |     |       |     | 5   | Open            | Transmission<br>Circuit | 645451 | 762779 |        | 1 |     | SLG Fault<br>at S3451 on<br>S3451-G18-<br>043-TAP<br>followed by<br>a stuck<br>breaker<br>opening<br>S3451 T4.<br>Delayed<br>clearing.               |
|    |      | SCMU<br>L-G | S3451<br>3 | 345.00     | 645451 |        |     |       |     | 9.5 | Open            | Three<br>Winding        | 645451 | 646251 | 648351 | 1 | Yes |                                                                                                                                                      |
| 16 | P4_2 | SCMU<br>L-G | S3454<br>3 | 345.00     | 645454 |        |     |       |     | 5   | Open            | Transmission<br>Circuit | 645454 | 650185 |        | 1 | Yes | SLG Fault at<br>S3454 on<br>S3454-<br>Wagener<br>followed by<br>a stuck<br>breaker<br>opening<br>S3454-<br>S3455.<br>Delayed<br>clearing.            |
|    |      | SCMU<br>L-G | S3454<br>3 | 345.00     | 645454 |        |     |       |     | 9   | Open            | Transmission<br>Circuit | 645454 | 645455 |        | 1 | Yes |                                                                                                                                                      |
| 17 | P4_2 | SCMU<br>L-G | S3458<br>3 | 345.00     | 645458 |        |     |       |     | 5   | Open            | Transmission<br>Circuit | 645458 | 640139 |        | 1 | Yes | SLG Fault at<br>S3458 on<br>S3458-<br>Cooper                                                                                                         |

|    |        |          |          |        |        |        |  |  |      |              |                      |        |        |  |    |     |                                                                                                                                                    |                                                                     |
|----|--------|----------|----------|--------|--------|--------|--|--|------|--------------|----------------------|--------|--------|--|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
|    |        |          |          |        |        |        |  |  |      |              |                      |        |        |  |    |     |                                                                                                                                                    | followed by a stuck breaker opening the west bus. Delayed clearing. |
|    |        |          | SCMU L-G | S34583 | 345.00 | 645458 |  |  |      | 8.5          |                      |        |        |  |    |     | Yes                                                                                                                                                |                                                                     |
| 18 | P4_2   | SCMU L-G | S37403   | 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 | S37403   | 345.00 | 645740 |        |  |  | 8.5  |              |                      |        |        |  |    | Yes |                                                                                                                                                    |                                                                     |
| 19 | P4_2   | SCMU L-G | S12065   | 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 |        |  | 00 |     |                                                                                                                                                    |                                                                     |
|    |        | SCMU L-G | S12065   | 161.00 | 646206 |        |  |  | 11   | Open         | Transmission Circuit | 646206 | 646201 |  | 1  | Yes |                                                                                                                                                    |                                                                     |
|    |        |          |          |        |        |        |  |  | 0    | Open         | Load                 | 646206 |        |  | 00 |     |                                                                                                                                                    |                                                                     |
| 20 | P5_5   | SCMU L-G | S13055   | 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.<br>3-PH fault at<br>S3458 on<br>S3458-<br>Cooper.<br>Normal<br>clearing.                                                                                             |
|    |  |        | 3PH | S3458<br>3 | 345.00 | 645458 |     |            |     | 5   | Open            | Transmission<br>Circuit | 645458 | 640139 |  | 1 | Yes |                                                                                                                                                                             |
| 22 |  | P6_1_1 |     |            |        |        |     |            |     |     | Prior<br>Outage | Transmission<br>Circuit | 645458 | 764805 |  | 1 |     | Prior outage<br>of S3458-<br>G20-094-<br>TAP. 3-PH<br>fault at<br>S3458 on<br>S3458-<br>Cooper.<br>Normal<br>clearing.                                                      |
|    |  |        | 3PH | S3458<br>3 | 345.00 | 645458 |     |            |     | 5   | Open            | Transmission<br>Circuit | 645458 | 640139 |  | 1 | Yes |                                                                                                                                                                             |
| 23 |  | P6_1_1 |     |            |        |        |     |            |     |     | Prior<br>Outage | Transmission<br>Circuit | 645458 | 640139 |  | 1 |     | Prior outage<br>of S3458-<br>Cooper.<br>3-PH fault at<br>S3740 on<br>S3455-<br>S3740.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing.                              |
|    |  |        | 3PH | S3740<br>3 | 345.00 | 645740 |     |            |     | 5   | Open            | Transmission<br>Circuit | 645455 | 645740 |  | 1 | Yes |                                                                                                                                                                             |
|    |  |        |     |            |        |        |     |            |     | 600 |                 |                         |        |        |  |   |     |                                                                                                                                                                             |
|    |  |        | SLG | S3455<br>3 | 345.00 | 645455 | 932 | -<br>10192 | MVA | 7.5 |                 |                         |        |        |  |   | Yes |                                                                                                                                                                             |
| 24 |  | P6_1_1 |     |            |        |        |     |            |     |     | Prior<br>Outage | Transmission<br>Circuit | 646211 | 762712 |  | 1 |     | Prior<br>outage of<br>S1211-G18-<br>037-TAP Ckt<br>1. 3-PH<br>fault at<br>S1211 on<br>S1211-G18-<br>037-TAP Ckt<br>2. Normal<br>clearing with<br>unsuccessful<br>reclosing. |
|    |  |        | 3PH | S1211<br>5 | 161.00 | 646211 |     |            |     | 6   | Open            | Transmission<br>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<br>3  | 345.00 | 645456 | 2687 | 32674 | MVA | 3   |                 |                         |        |        |  | Yes |                                                                                                                                                         |
| 28 | P6_1_1 |  |     |             |        |        |      |       |     |     | Prior<br>Outage | Transmission<br>Circuit | 645454 | 645455 |  | 1   | Prior outage<br>of S3454-<br>S3455.<br>3-PH fault at<br>S3455 on<br>S3455-<br>S3456.<br>Normal<br>clearing with<br>successful<br>reclosing.             |
|    |        |  | 3PH | S3455<br>3  | 345.00 | 645455 |      |       |     | 5   | Open            | Transmission<br>Circuit | 645455 | 645456 |  | 1   | Yes                                                                                                                                                     |
|    |        |  |     |             |        |        |      |       |     | 20  | Close           | Transmission<br>Circuit | 645455 | 645456 |  | 1   |                                                                                                                                                         |
| 29 | P6_1_1 |  |     |             |        |        |      |       |     |     | Prior<br>Outage | Transmission<br>Circuit | 640139 | 300039 |  | 1   | Prior outage<br>of Cooper-<br>Fairport. 3-<br>PH fault at<br>Cooper on<br>Cooper-St.<br>Joe. Normal<br>clearing.                                        |
|    |        |  | 3PH | COOPER<br>3 | 345.00 | 640139 |      |       |     | 4.5 | Open            | Transmission<br>Circuit | 640139 | 541199 |  | 1   | Yes                                                                                                                                                     |
| 30 | P6_1_1 |  |     |             |        |        |      |       |     |     | Prior<br>Outage | Transmission<br>Circuit | 645458 | 764805 |  | 1   | Prior outage<br>of S3458-<br>G20-094-<br>TAP. 3-PH<br>fault at<br>S3458 on<br>S3458-<br>S3456.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing. |
|    |        |  | 3PH | S3458<br>3  | 345.00 | 645458 |      |       |     | 5   | Open            | Transmission<br>Circuit | 645458 | 645456 |  | 1   | Yes                                                                                                                                                     |
|    |        |  |     |             |        |        |      |       |     | 600 |                 |                         |        |        |  |     |                                                                                                                                                         |
|    |        |  | SLG | S3456<br>3  | 345.00 | 645456 | 411  | 4361  | MVA | 7.5 |                 |                         |        |        |  | Yes |                                                                                                                                                         |
| 31 | P6_1_2 |  |     |             |        |        |      |       |     |     | Prior<br>Outage | Transmission<br>Circuit | 645451 | 762779 |  | 1   | Prior<br>outage of<br>S3451-G18-<br>043-TAP.<br>3-PH fault at<br>S3451 on T3<br>transformer.<br>Normal<br>clearing.                                     |

|    |        |               |     |            |        |        |     |      |     |     |                 |                         |        |        |        |    |     |                                                                                                                                        |
|----|--------|---------------|-----|------------|--------|--------|-----|------|-----|-----|-----------------|-------------------------|--------|--------|--------|----|-----|----------------------------------------------------------------------------------------------------------------------------------------|
|    |        |               | 3PH | S3451<br>3 | 345.00 | 645451 |     |      |     | 7.5 | Open            | Three<br>Winding        | 645451 | 646251 | 648251 | 1  | Yes |                                                                                                                                        |
| 32 | P6_2_1 |               |     |            |        |        |     |      |     |     | Prior<br>Outage | Three<br>Winding        | 645456 | 646206 | 648256 | 1  |     | Prior outage<br>of S3456 T4.<br>3-PH fault at<br>S1206 on<br>S1201-<br>S1206.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing. |
|    |        |               | 3PH | S1206<br>5 | 161.00 | 646206 |     |      |     | 7   | Open            | Transmission<br>Circuit | 646206 | 646201 |        | 1  | Yes |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 0   | Open            | Load                    | 646206 |        |        | 00 |     |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 600 |                 |                         |        |        |        |    |     |                                                                                                                                        |
|    |        |               | SLG | S1201<br>5 | 161.00 | 646201 | 589 | 4038 | MVA | 10  |                 |                         |        |        |        |    | Yes |                                                                                                                                        |
| 33 | P7_1   | SCMU<br>L-L-G |     | S3451<br>3 | 345.00 | 645451 |     |      |     | 5   | Open            | Transmission<br>Circuit | 645451 | 645459 |        | 1  | Yes | DLG Fault at<br>S3451 on<br>S3451-S3459<br>and S3451-<br>S3454.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing.               |
|    |        |               |     |            |        |        |     |      |     | 0   | Open            | Transmission<br>Circuit | 645451 | 645454 |        | 1  |     |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 20  | Close           | Transmission<br>Circuit | 645451 | 645459 |        | 1  |     |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 0   | Close           | Transmission<br>Circuit | 645451 | 645454 |        | 1  |     |                                                                                                                                        |
|    |        | SCMU<br>L-L-G |     | S3451<br>3 | 345.00 | 645451 |     |      |     | 5   | Open            | Transmission<br>Circuit | 645451 | 645459 |        | 1  | Yes |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 0   | Open            | Transmission<br>Circuit | 645451 | 645454 |        | 1  |     |                                                                                                                                        |
| 34 | P7_1   | SCMU<br>L-L-G |     | S3451<br>3 | 345.00 | 645451 |     |      |     | 5   | Open            | Transmission<br>Circuit | 645451 | 645459 |        | 1  | Yes | DLG Fault at<br>S3451 on<br>S3451-S3459<br>and S3451-<br>S3454.<br>Normal<br>clearing with<br>successful<br>reclosing.                 |
|    |        |               |     |            |        |        |     |      |     | 0   | Open            | Transmission<br>Circuit | 645451 | 645454 |        | 1  |     |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 20  | Close           | Transmission<br>Circuit | 645451 | 645459 |        | 1  |     |                                                                                                                                        |
|    |        |               |     |            |        |        |     |      |     | 0   | Close           | Transmission<br>Circuit | 645451 | 645454 |        | 1  |     |                                                                                                                                        |
| 35 | P7_1   | SCMU<br>L-L-G |     | S1211<br>5 | 161.00 | 646211 |     |      |     | 6   | Open            | Transmission<br>Circuit | 646211 | 762712 |        | 1  | Yes | DLG Fault<br>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 |        |  | 00 |     |                                                                                                                   |
|    |      |            |        |             |        |        |      |        |     | 0   | Open | Load                 | 646250 |        |  | 00 |     |                                                                                                                   |
|    |      |            |        |             |        |        |      |        |     | 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<br>L-G | S3456<br>3 | 345.00 | 645456 |  |  |  | 5.5 | Open            | Transmission<br>Circuit | 645456 | 645455 |        | 1  | Yes | SLG Fault at<br>S3456 on<br>S3456-S3455<br>followed by<br>a stuck<br>breaker<br>opening<br>S3456-C.<br>Bluffs.<br>Delayed<br>clearing.           |
|    |        | SCMU<br>L-G | S3456<br>3 | 345.00 | 645456 |  |  |  | 11  | Open            | Transmission<br>Circuit | 645456 | 635000 |        | 1  | Yes |                                                                                                                                                  |
| 50 | P6_1_1 |             |            |        |        |  |  |  |     | Prior<br>Outage | Transmission<br>Circuit | 645456 | 645455 |        | 1  |     | Prior outage<br>of S3456-<br>S3455.<br>3-PH fault at<br>S3456 on<br>S3456-C.<br>Bluffs.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing. |
|    |        | 3PH         | S3456<br>3 | 345.00 | 645456 |  |  |  | 5.5 | Open            | Transmission<br>Circuit | 645456 | 635000 |        | 1  | Yes |                                                                                                                                                  |
|    |        |             |            |        |        |  |  |  | 600 |                 |                         |        |        |        |    |     |                                                                                                                                                  |
|    |        | 3PH         | S3456<br>3 | 345.00 | 645456 |  |  |  | 4.5 |                 |                         |        |        |        |    | Yes |                                                                                                                                                  |
| 51 | P1_3   | 3PH         | S1206<br>5 | 161.00 | 646206 |  |  |  | 6   | Open            | Three<br>Winding        | 645456 | 646206 | 648256 | 1  | Yes | 3-PH fault at<br>S1206 on<br>S3456 T4.<br>Normal<br>clearing.                                                                                    |
| 52 | P4_2   | SCMU<br>L-G | S1206<br>5 | 161.00 | 646206 |  |  |  | 6.5 | Open            | Transmission<br>Circuit | 646206 | 646216 |        | 1  | Yes | SLG Fault at<br>S1206 on<br>S1206-S1216<br>followed by<br>a stuck<br>breaker<br>opening<br>S3456 T4.<br>Delayed<br>clearing.                     |
|    |        |             |            |        |        |  |  |  | 0   | Open            | Load                    | 646216 |        |        | 00 |     |                                                                                                                                                  |
|    |        | SCMU<br>L-G | S1206<br>5 | 161.00 | 646206 |  |  |  | 10  | Open            | Three<br>Winding        | 645456 | 646206 | 648256 | 1  | Yes |                                                                                                                                                  |
| 53 | P4_3   | SCMU<br>L-G | S1206<br>5 | 161.00 | 646206 |  |  |  | 6   | Open            | Three<br>Winding        | 645456 | 646206 | 648256 | 1  | Yes | SLG Fault at<br>S1206 on<br>S3456 T4<br>followed by<br>a stuck<br>breaker<br>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 |        |        | 00 |     |                                                                                                                                 |
| 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 |        |        | 00 |     |                                                                                                                                 |
|    |        |  |          |         |        |        |      |         |     | 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<br>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<br>5 | 161.00 | 646263 | 261 | - | 1983 | MVA | 8.5 |              |                      |        |        |        |   | Yes |                                                                                                            |
| 59 | P1_2   | 3PH | S1258<br>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 |     |                                                                                                            |
| 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<br>5 | 161.00 | 646258 |     |   |      |     | 6   | Open         | Transmission Circuit | 646258 | 646263 |        | 1 | Yes |                                                                                                            |
|    |        |     |            |        |        |     |   |      |     | 20  |              |                      |        |        |        |   |     |                                                                                                            |
|    |        | SLG | S1263<br>5 | 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<br>5 | 161.00 | 646258 |     |   |      |     | 6   | Open         | Transmission Circuit | 646258 | 646263 |        | 1 | Yes |                                                                                                            |

|    |        |             |            |        |        |  |  |  |  |      |                 |                         |        |        |  |   |     |                                                                                                      |
|----|--------|-------------|------------|--------|--------|--|--|--|--|------|-----------------|-------------------------|--------|--------|--|---|-----|------------------------------------------------------------------------------------------------------|
|    |        |             |            |        |        |  |  |  |  | 200  | Close           | Transmission<br>Circuit | 646258 | 646263 |  | 1 |     |                                                                                                      |
| 62 | P1_2   | 3PH         | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 6    | Open            | Transmission<br>Circuit | 646298 | 646251 |  | 1 | Yes | 3-PH fault at S1298 on S1298-S1251. Normal clearing with unsuccessful reclosing.                     |
|    |        |             |            |        |        |  |  |  |  | 20   |                 |                         |        |        |  |   |     |                                                                                                      |
|    |        | 3PH         | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 6    |                 |                         |        |        |  |   | Yes |                                                                                                      |
| 63 | P1_2   | 3PH         | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 6    | Open            | Transmission<br>Circuit | 646298 | 646251 |  | 1 | Yes | 3-PH fault at S1298 on S1298-S1251. Normal clearing with successful reclosing.                       |
|    |        |             |            |        |        |  |  |  |  | 200  | Close           | Transmission<br>Circuit | 646298 | 646251 |  | 1 |     |                                                                                                      |
| 64 | P4_2   | SCMU<br>L-G | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 6    | Open            | Transmission<br>Circuit | 646298 | 646251 |  | 1 | Yes | SLG Fault at S1298 on S1298-S1251 followed by a stuck breaker opening S1298-S1305. Delayed clearing. |
|    |        | SCMU<br>L-G | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 13.5 | Open            | Transmission<br>Circuit | 646298 | 646305 |  | 1 | Yes |                                                                                                      |
| 65 | P4_2   | SCMU<br>L-G | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 9    | Open            | Transmission<br>Circuit | 646298 | 646305 |  | 1 | Yes | SLG Fault at S1298 on S1298-S1305 followed by a stuck breaker opening S1298-S1251. Delayed clearing. |
|    |        | SCMU<br>L-G | S1298<br>5 | 161.00 | 646298 |  |  |  |  | 10.5 | Open            | Transmission<br>Circuit | 646298 | 646251 |  | 1 | Yes |                                                                                                      |
| 66 | P6_1_1 |             |            |        |        |  |  |  |  |      | Prior<br>Outage | Transmission<br>Circuit | 646298 | 646305 |  | 1 |     | Prior outage of S1298-S1305. 3-PH fault at S1298 on                                                  |

|    |  |        |          |                  |        |        |  |  |  |       |                 |                         |        |        |        |   |     |                                                                                                                                                                                                         |
|----|--|--------|----------|------------------|--------|--------|--|--|--|-------|-----------------|-------------------------|--------|--------|--------|---|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |  |        |          |                  |        |        |  |  |  |       |                 |                         |        |        |        |   |     | S1298-S1251. Normal clearing with unsuccessful reclosing.                                                                                                                                               |
|    |  |        | 3PH      | S1298<br>5       | 161.00 | 646298 |  |  |  | 6     | Open            | Transmission<br>Circuit | 646298 | 646251 |        | 1 | Yes |                                                                                                                                                                                                         |
|    |  |        |          |                  |        |        |  |  |  | 20    |                 |                         |        |        |        |   |     |                                                                                                                                                                                                         |
|    |  |        | 3PH      | S1298<br>5       | 161.00 | 646298 |  |  |  | 6     |                 |                         |        |        |        |   | Yes |                                                                                                                                                                                                         |
| 67 |  | P6_1_1 |          |                  |        |        |  |  |  |       | Prior<br>Outage | Transmission<br>Circuit | 646298 | 646305 |        | 1 |     | Prior outage of S1298-S1305. 3-PH fault at S1298 on S1298-S1251. Normal clearing with successful reclosing.                                                                                             |
|    |  |        | 3PH      | S1298<br>5       | 161.00 | 646298 |  |  |  | 6     | Open            | Transmission<br>Circuit | 646298 | 646251 |        | 1 | Yes |                                                                                                                                                                                                         |
|    |  |        |          |                  |        |        |  |  |  | 200   | Close           | Transmission<br>Circuit | 646298 | 646251 |        | 1 |     |                                                                                                                                                                                                         |
| 68 |  | P5_5   | SCMU L-G | S1210<br>5       | 161.00 | 646210 |  |  |  | 25.5  | Open            | Transmission<br>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<br>5       | 161.00 | 646210 |  |  |  | 4.0   | Open            | Transmission<br>Circuit | 646210 | 646217 |        | 1 | Yes |                                                                                                                                                                                                         |
|    |  |        | SCMU L-G | S1210<br>5       | 161.00 | 646210 |  |  |  | 103.0 | Open            | Three<br>Winding        | 646210 | 647910 | 648210 | 1 | Yes |                                                                                                                                                                                                         |
| 69 |  | P0     |          | System<br>Intact |        |        |  |  |  |       |                 |                         |        |        |        |   |     | System<br>Intact.                                                                                                                                                                                       |
| 70 |  | P4_2   | SCMU L-G | S1260<br>5       | 161.00 | 646260 |  |  |  | 6     | Open            | Transmission<br>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 |        |        | 00 |     |                                                                                                       |
| 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 | S1347<br>5 | 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 | S1209<br>5 | 161.00 | 646209 | 1931 | -<br>13978 | MVA |  | 8.5 |              |                      |        |        |  |   | Yes |                                                                                                               |
| 81 | P1_2   | 3PH | S1347<br>5 | 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 | S1347<br>5 | 161.00 | 646347 |      |            |     |  | 6   | Open         | Transmission Circuit | 646209 | 646347 |  | 1 | Yes |                                                                                                               |
|    |        |     |            |        |        |      |            |     |  | 600 |              |                      |        |        |  |   |     |                                                                                                               |
|    |        | SLG | S1209<br>5 | 161.00 | 646209 | 1931 | -<br>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 | S1347<br>5 | 161.00 | 646347 |      |            |     |  | 6   | Open         | Transmission Circuit | 646209 | 646347 |  | 1 | Yes |                                                                                                               |

|    |        |     |            |        |        |      |            |     |     |                 |                         |        |        |        |    |     |                                                                                                                                        |
|----|--------|-----|------------|--------|--------|------|------------|-----|-----|-----------------|-------------------------|--------|--------|--------|----|-----|----------------------------------------------------------------------------------------------------------------------------------------|
|    |        |     |            |        |        |      |            |     | 620 | Close           | Transmission<br>Circuit | 646209 | 646347 |        | 1  |     |                                                                                                                                        |
| 84 | P1_2   | 3PH | S1347<br>5 | 161.00 | 646347 |      |            |     | 6   | Open            | Transmission<br>Circuit | 646252 | 646347 |        | 1  | Yes | 3-PH fault at<br>S1347 on<br>S1347-<br>S1252.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing.                                 |
|    |        |     |            |        |        |      |            |     | 0   | Open            | Load                    | 646252 |        |        | 00 |     |                                                                                                                                        |
|    |        |     |            |        |        |      |            |     | 600 |                 |                         |        |        |        |    |     |                                                                                                                                        |
|    |        | SLG | S1252<br>5 | 161.00 | 646252 | 1931 | -<br>13978 | MVA | 8.5 |                 |                         |        |        |        |    | Yes |                                                                                                                                        |
| 85 | P1_2   | 3PH | S1347<br>5 | 161.00 | 646347 |      |            |     | 6   | Open            | Transmission<br>Circuit | 646252 | 646347 |        | 1  | Yes | 3-PH fault at<br>S1347 on<br>S1347-<br>S1252.<br>Normal<br>clearing with<br>successful<br>reclosing.                                   |
|    |        |     |            |        |        |      |            |     | 0   | Open            | Load                    | 646252 |        |        | 00 |     |                                                                                                                                        |
|    |        |     |            |        |        |      |            |     | 620 | Close           | Transmission<br>Circuit | 646252 | 646347 |        | 1  |     |                                                                                                                                        |
| 86 | P6_2_1 |     |            |        |        |      |            |     |     | Prior<br>Outage | Three<br>Winding        | 645459 | 646209 | 648359 | 1  |     | Prior outage<br>of S3459 T6.<br>3-PH fault at<br>S1347 on<br>S1347-<br>S1252.<br>Normal<br>clearing with<br>unsuccessful<br>reclosing. |
|    |        | 3PH | S1347<br>5 | 161.00 | 646347 |      |            |     | 6   | Open            | Transmission<br>Circuit | 646252 | 646347 |        | 1  | Yes |                                                                                                                                        |
|    |        |     |            |        |        |      |            |     | 0   | Open            | Load                    | 646252 |        |        | 00 |     |                                                                                                                                        |
|    |        |     |            |        |        |      |            |     | 600 |                 |                         |        |        |        |    |     |                                                                                                                                        |
|    |        | SLG | S1252<br>5 | 161.00 | 646252 | 1931 | -<br>13978 | MVA | 8.5 |                 |                         |        |        |        |    | Yes |                                                                                                                                        |
| 87 | P6_2_1 |     |            |        |        |      |            |     |     | Prior<br>Outage | Three<br>Winding        | 645459 | 646209 | 648359 | 1  |     | Prior outage<br>of S3459 T6.<br>3-PH fault at<br>S1347 on<br>S1347-<br>S1252.<br>Normal<br>clearing with<br>successful<br>reclosing.   |
|    |        | 3PH | S1347<br>5 | 161.00 | 646347 |      |            |     | 6   | Open            | Transmission<br>Circuit | 646252 | 646347 |        | 1  | Yes |                                                                                                                                        |
|    |        |     |            |        |        |      |            |     | 0   | Open            | Load                    | 646252 |        |        | 00 |     |                                                                                                                                        |

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

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

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