DISIS-2021-004

Phase 1 Study Report

07/29/2022

Table of Contents

List of Tables

List of Figures

1.0 Summary

The Phase 1 of the DISIS-2021-004 Definitive Interconnection Study Cluster includes eighteen (18) Generator Interconnection Requests (GIRs):

GI-2021-12 is a 250 MW_{ac} net rated Solar Photovoltaic (PV) plus Battery Energy Storage System (BESS) Hybrid Generating Facility requesting Energy Resource Interconnection Service (ERIS). The requested Point of Interconnection (POI) is a tap on the Comanche – Mirasol 230 kV line.

GI-2021-13 is a 250 MW_{ac} net rated Solar PV Generating Facility requesting ERIS. The requested POI is Mirasol 230 kV substation.

GI-2021-14 is a 199 MW_{ac} net rated Solar PV plus BESS Hybrid Generating Facility requesting Network Resource Interconnection Service (NRIS). The requested POI is Green Valley 230 kV substation.

GI-2021-16 is a 199 MW_{ac} net rated BESS Generating Facility requesting ERIS. The requested POI is Harvest Mile 345 kV substation.

GI-2021-18 is a 49 MW_{ac} net rated Solar PV Generating Facility requesting ERIS. The requested POI is Collbran 138 kV substation.

GI-2021-19 is a 500 MW_{ac} net rated Wind Generating Facility requesting ERIS. The requested POI is Tundra 345 kV Switching Station.

GI-2021-20 is a 500 MW_{ac} net rated Wind Generating Facility requesting ERIS. The requested POI is Tundra 345 kV Switching Station.

GI-2021-21 is a 300 MW_{ac} net rated Solar PV Generating Facility requesting NRIS. The requested POI is a tap on the Boone – Midway 230 kV line.

GI-2021-22 is a 150 MW_{ac} net rated BESS Generating Facility requesting NRIS. The requested POI is a tap on the Boone – Midway 230 kV line.

GI-2021-23 is a 95 MW_{ac} net rated BESS Generating Facility requesting NRIS. The requested POI is the San Luis Valley 115 kV substation.

GI-2021-24 is a 183.7 MW_{ac} net rated Solar PV plus BESS Hybrid Generating Facility requesting ERIS. The requested POI is Mirasol 230 kV substation.

GI-2021-25 is a 362 MW_{ac} net rated Wind Generating Facility requesting ERIS. The requested POI is Pawnee 345 kV substation.

GI-2021-26 is a 183.7 MW_{ac} net rated Solar PV plus BESS Hybrid Generating Facility requesting ERIS. The requested POI is Pawnee 345 kV substation.

GI-2021-27 is a 180 MW_{ac} net rated Solar PV plus BESS Hybrid Generating Facility requesting NRIS. The requested POI is Missile Site 230 kV substation.

GI-2021-28 is a 170 MW_{ac} net rated Solar PV plus BESS Hybrid Generating Facility requesting ERIS. The requested POI is San Luis Valley 230 kV substation.

GI-2021-29 is a 199.5 MW_{ac} net rated Solar PV plus BESS Hybrid Generating Facility requesting NRIS. The requested POI is a tap on the Pawnee – Missile Site 230 kV line.

GI-2021-30 is a 500 MW_{ac} net rated Solar PV Generating Facility requesting NRIS. The requested POI is Pawnee 345 kV substation.

GI-2021-31 is a 250 MW_{ac} net rated BESS Generating Facility requesting NRIS. The requested POI is Pawnee 345 kV substation.

- The following GIRs are in the Southern Colorado study pocket:
  - GI-2021-12
  - GI-2021-13
  - GI-2021-19
  - GI-2021-20
  - GI-2021-21
  - GI-2021-22
  - GI-2021-24
- The following GIR is in the Metro Colorado study pocket:
  - GI-2021-14
- The following GIRs are in the Eastern Colorado study pocket:
  - GI-2021-16
  - GI-2021-25
  - GI-2021-26
  - GI-2021-27
  - GI-2021-29
  - GI-2021-30
  - GI-2021-31
- The following GIRs are in the San Luis Valley study pocket:
  - GI-2021-23
  - GI-2021-28
- The following GIR is in the Western Slope study pocket:
  - GI-2021-18

The Interconnection Service determined for GIRs in this report in and of itself does not convey any transmission service.

1.1 GI-2021-12 Results

The total cost of the upgrades required to interconnect GI-2021-12 on the Comanche – Mirasol 230 kV line for ERIS is $18.094 million (Table 47, Table 69, and Table 85)

Maximum allowable output of GI-2021-12 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-12 is 250 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

The Grid charging study for the 125 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.2 GI-2021-13 Results

The total cost of the upgrades required to interconnect GI-2021-13 at the Mirasol 230 kV Switching Station for ERIS is $6.566 million (Table 48, Table 73, and Table 85)

Maximum allowable output of GI-2021-13 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-13 is 250 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.3 GI-2021-14 Results

The total cost of the upgrades required to interconnect GI-2021-14 at the Green Valley 230 kV Substation for NRIS is $6.185 million (Table 49, and Table 70).

NRIS of GI-2021-14 is 199 MW.

1.4 GI-2021-16 Results

The total cost of the upgrades required to interconnect GI-2021-16 at the Harvest Mile 345 kV Substation for ERIS is $3.885 million (Table 50, and Table 71).

Maximum allowable output of GI-2021-16 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-16 is 199 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

The Grid charging study for the 199 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.5 GI-2021-18 Results

The total cost of the upgrades required to interconnect GI-2021-18 at the Collbran 138 kV Substation for ERIS is $4.692 million (Table 51, and Table 68).

Maximum allowable output of GI-2021-18 without requiring additional System Network Upgrades is 49 MW.

ERIS of GI-2021-18 is 49 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.6 GI-2021-19 Results

The total cost of the upgrades required to interconnect GI-2021-19 at the Tundra 345 kV Switching Station for ERIS is $10.745 million (Table 52, Table 81, and Table 85).

Maximum allowable output of GI-2021-19 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-19 is 500 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.7 GI-2021-20 Results

The total cost of the upgrades required to interconnect GI-2021-20 at the Tundra 345 kV Switching Station for ERIS is $10.745 million (Table 53, Table 81, and Table 85).

Maximum allowable output of GI-2021-20 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-20 is 500 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.8 GI-2021-21 Results

The total cost of the upgrades required to interconnect GI-2021-21 on the Boone – Midway 230 kV line NRIS is $188.974 million (Table 54, Table 67, Table 84, and Table 85).

NRIS of GI-2021-21 is 300 MW.

1.9 GI-2021-22 Results

The total cost of the upgrades required to interconnect GI-2021-22 on the Boone – Midway 230 kV line NRIS is $99.621 million (Table 55, Table 67, Table 84, and Table 85).

NRIS of GI-2021-22 is 150 MW.

The Grid charging study for the 150 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.10 GI-2021-23 Results

The total cost of the upgrades required to interconnect GI-2021-23 at the San Luis Valley 115 kV Substation for NRIS is $9.771 million (Table 56, Table 78, Table 82, and Table 83).

NRIS of GI-2021-23 is 95 MW.

The Grid charging study for the 80 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.11 GI-2021-24 Results

The total cost of the upgrades required to interconnect GI-2021-24 at the Mirasol 230 kV Switching Station for ERIS is $6.478 million (Table 57, Table 73, and Table 85).

Maximum allowable output of GI-2021-24 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-24 is 183.7 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.12 GI-2021-25 Results

The total cost of the upgrades required to interconnect GI-2021-25 at the Pawnee 345 kV Substation for ERIS is $5.792 million (Table 58, Table 75, Table 76).

Maximum allowable output of GI-2021-25 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-25 is 362 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.13 GI-2021-26 Results

The total cost of the upgrades required to interconnect GI-2021-26 at the Pawnee 345 kV Substation for ERIS is $5.930 million (Table 59, Table 75, Table 76).

Maximum allowable output of GI-2021-26 without requiring additional System Network Upgrades is 0 MW.

ERIS of GI-2021-26 is 183.7 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

1.14 GI-2021-27 Results

The total cost of the upgrades required to interconnect GI-2021-27 at the Missile Site 230 kV Substation for NRIS is $58.451 million (Table 60, Table 74, and Table 86).

NRIS of GI-2021-27 is 180 MW.

The Grid charging study for the 90 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.15 GI-2021-28 Results

The total cost of the upgrades required to interconnect GI-2021-28 at the San Luis Valley 230 kV Substation for ERIS is $6.829 million (Table 61, Table 79, Table 83).

Maximum allowable output of GI-2021-28 without requiring additional System Network Upgrades is 31.6 MW.

ERIS of GI-2021-28 is 170 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.

The Grid charging study for the 85 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.16 GI-2021-29 Results

The total cost of the upgrades required to interconnect GI-2021-29 on the Pawnee – Missile Site 230 kV line for NRIS is $64.359 million (Table 62, Table 77, and Table 86).

NRIS of GI-2021-29 is 199.5 MW.

1.17 GI-2021-30 Results

The total cost of the upgrades required to interconnect GI-2021-30 at the Pawnee 345 kV Substation for NRIS is $130.658 million (Table 63, Table 76, and Table 86).

NRIS of GI-2021-30 is 500 MW.

1.18 GI-2021-31 Results

The total cost of the upgrades required to interconnect GI-2021-31 at the Pawnee 345 kV Substation for NRIS is $68.589 million (Table 64, Table 76, and Table 86).

NRIS of GI-2021-31 is 250 MW.

The Grid charging study for the 250 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

2.0 Introduction

Public Service Company of Colorado (PSCo) received twenty-one (21) GIRs in the DISIS-2021-004 out of which eighteen (18) GIRs moved to Phase 1. The total Interconnection Service requested in the DISIS-2021-004 Phase 1 is 4520.9 MW.

Of the eighteen (18) GIRs, ten (10) requested Energy Resource Interconnection Service (ERIS)[1]: GI-2021-12, GI-2021-13, GI-2021-16, GI-2021-18, GI-2021-19, GI-2021-20, GI-2021-24, GI-2021-25, and GI-2021-26, and GI-2021-28 and eight (8) requested Network Resource Interconnection Service (NRIS)[2]: GI-2021-14, GI-2021-21, GI-2021-22, GI-2021-23, GI-2021-27, GI-2021-29, GI-2021-30, and GI-2021-31. A summary and description of the requests is shown in Table 1.

[1] Energy Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an as available basis. Energy Resource Interconnection Service in and of itself does not convey transmission service

[2] Network Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission system (1) in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an RTO or ISO with market-based congestion management, in the same manner as all other Network Resources. Network Resource Interconnection Service in and of itself does not convey transmission service.

Table 1 – Summary of GIRs in DISIS-2021-004

GI#	Resource Type	Interconnection Service (MW)	COD	POI	Location	Service Type
GI-2021-12	PV Solar + BESS	250	10/31/2024	Comanche to Mirasol 230 kV line	Pueblo County, CO	ERIS
GI-2021-13	PV Solar	250	12/31/2025	Mirasol 230 kV	Pueblo County, CO	ERIS
GI-2021-14	PV Solar + BESS	199	06/01/2025	Green Valley 230 kV	Adams County, CO	NRIS
GI-2021-16	BESS	199	12/31/2025	Harvest Mile 345 kV	Arapahoe County, CO	ERIS
GI-2021-18	PV Solar	49	12/31/2025	Collbran 138 kV	Mesa County, CO	ERIS
GI-2021-19	Wind	500	12/31/2025	Tundra 345 kV	Kiowa County, CO	ERIS
GI-2021-20	Wind	500	12/31/2025	Tundra 345 kV	Kiowa County, CO	ERIS
GI-2021-21	PV Solar	300	12/01/2024	Boone to Midway 230 kV line	Pueblo County, CO	NRIS
GI-2021-22	BESS	150	12/01/2024	Boone to Midway 230 kV line	Pueblo County, CO	NRIS
GI-2021-23	BESS	95	10/01/2025	San Luis Valley 115 kV	Alamosa County, CO	NRIS
GI-2021-24	PV Solar + BESS	183.7	12/31/2023	Mirasol 230 kV	Pueblo County, CO	ERIS
GI-2021-25	Wind	362	12/31/2024	Pawnee 345 kV	Sedgewick County, CO	ERIS
GI-2021-26	PV Solar + BESS	183.7	12/31/2024	Pawnee 345 kV	Phillips & Sedgewick County, CO	ERIS
GI-2021-27	PV Solar + BESS	180	12/01/2024	Missile Site 230 kV	Arapahoe County, CO	NRIS
GI-2021-28	PV Solar + BESS	170	12/31/2024	San Luis Valley 230 kV	Alamosa County, CO	ERIS
GI-2021-29	PV Solar +BESS	199.5	12/31/2024	Pawnee to Missile Site 230 kV	Adams County, CO	NRIS
GI-2021-30	PV Solar	500	12/01/2024	Pawnee 345 kV	Morgan County, CO	NRIS
GI-2021-31	BESS	250	12/02/2024	Pawnee 345 kV	Morgan County, CO	NRIS
Total		4520.9				ERIS+NRIS

The approximate geographical locations of the POIs within the Transmission System are shown in Figure 1.

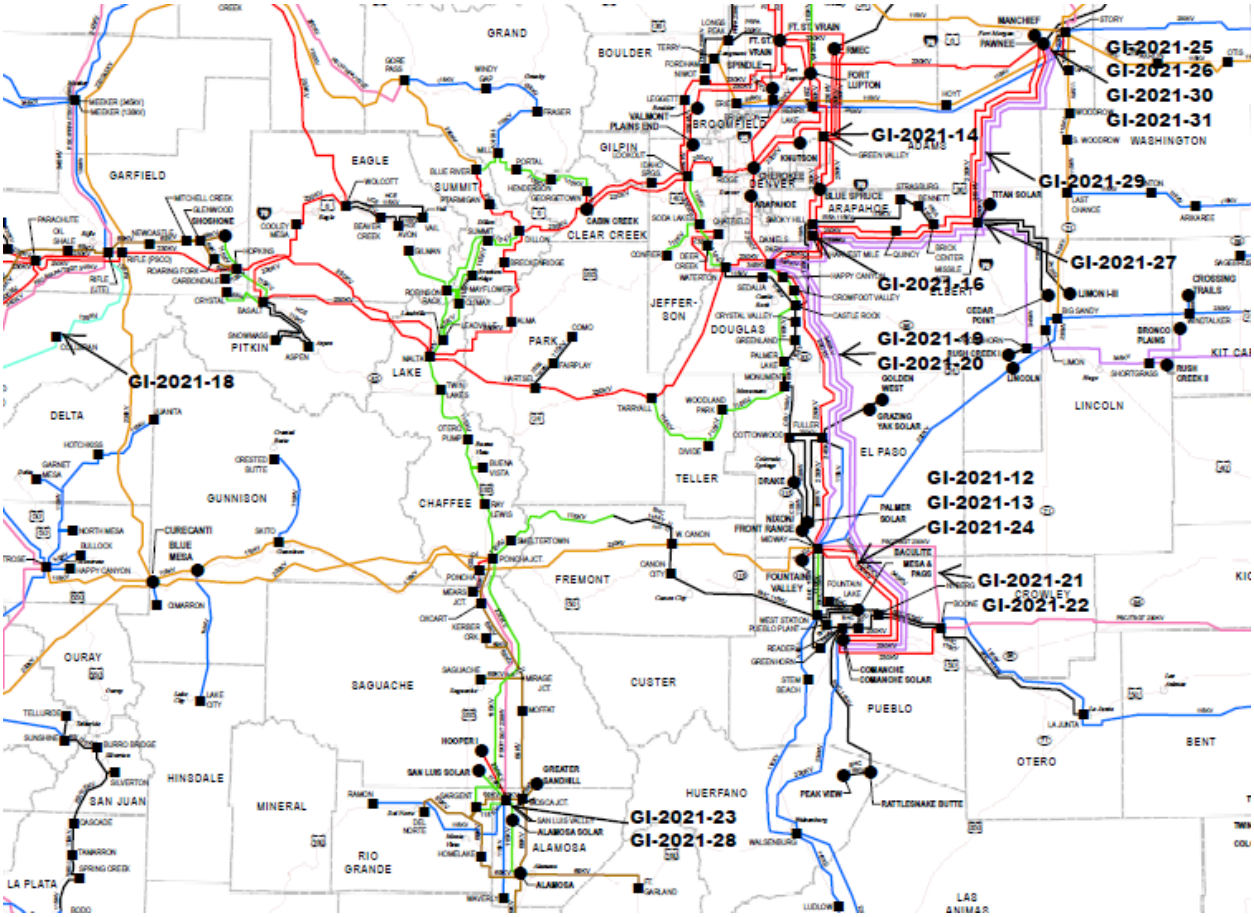

Figure 1 – Approximate Locations of DISIS-2021-004 Generator Interconnection POIs

3.0 Description of the GIRs

3.1 GI-2021-12

GI-2021-12 is a 250 MW_{ac} net rated AC-coupled Hybrid Generating Facility located in Pueblo County, Colorado. The Hybrid Generating Facility is composed of a 250 MW_{ac} Solar PV Generating Facility and a 125 MW_{ac} BESS Generating Facility, with the net output at the POI limited to 250 MW. The Solar Generating Facility will consist of eighty (80) Sungrow SG3600UD PV inverters, each with its own 34.5/0.63 kV, 3.6 MVA Delta/Wye, Z=5.75%, X/R=7 pad-mount transformer and the BESS Generating Facility will consist of Forty (40) Power Electronics PCSM FP3510K storage inverters, each with its own 34.5/0.66 kV, 3.63 MVA Delta/Wye, Z=8.5%, X/R=10.808 pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to one (1) 230/34.5 kV, 186/247.4/309.2 MVA Wye-grounded/Wye-grounded Z=10.5% and X/R=45.64 main step-up transformer which will connect to the PSCo transmission system via a 230 kV, 0.3-mile generation tie-line. The POI is a tap on the Comanche – Mirasol 230 kV line. The tap point at the POI will require a new switching station which is referred to as "GI-2021-12 230 kV Switching Station" in this report.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed Commercial Operation Date (COD) is October 31, 2024. The back-feed date is assumed to be April 31, 2024, approximately six (6) months before the COD.

3.2 GI-2021-13

GI-2021-13 is a 250 MW_{ac} net rated Solar PV Generating Facility located in Pueblo County, Colorado. The PV Generating Facility will consist of seventy-two (72) TMEIC PVU-L0840GR inverters each rated at 4.05 MVA, each with its own 34.5/0.63 kV, 4.2 MVA Delta/Wye-grounded, Z=5.75%, X/R=7.5 pad-mount transformer. The 34.5 kV collector system will connect to two (2) 230/34.5/13.8 kV, 93.6/125/156 MVA Wye-grounded/Wye-grounded/Delta Z=9% and X/R=40 main step-up transformer which will connect to the PSCo transmission system via with a 230 kV, 1-mile generation tie-line. The POI is the Mirasol 230 kV Switching Station.

The proposed COD of GI-2021-13 is December 31, 2025. The back-feed date is assumed to be June 31, 2025, approximately six (6) months before the COD.

3.3 GI-2021-14

GI-2021-14 is a 199 MW_{ac} net rated AC-coupled Hybrid Generating Facility located in Adams County, Colorado. The Hybrid Generating Facility will consist of sixty-two (62) SMA SC 4000 UP-US PV, 4.0 MVA inverters, each with its own 34.5/0.6 kV, 4.0 MVA Delta/Wye Z=6.8%, X/R=7.5 pad-mount transformer, and seventy-four (74) SMA SCS 3450 UP-US BESS, 3.450 inverters, each with its own 34.5/0.6 kV, 3.450 MVA Delta/Wye Z=6.8%, X/R=7.5 pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to one (1) 230/34.5/13.8 kV, 132.5/176.3/220 MVA Wye-grounded/Wye-grounded/Delta Z=9% and X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 345 kV, 0.047-mile generation tie-line. The POI is the Green Valley 230 kV Substation.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD of GI-2021-14 is June 1, 2025. The back-feed date is assumed to be December 1, 2024, approximately six (6) months before the COD.

3.4 GI-2021-16

GI-2021-16 is a 199 MW_{ac} net rated BESS Facility located in Arapahoe County, Colorado. The BESS Facility will consist of sixty-two (62) Power Electronics FP3670K inverters, each with its own 34.5/0.69 kV, 3.8 MVA Delta/Wye-grounded Z=5.75%, X/R=10 pad-mount transformer. The 34.5 kV collector system will connect to one (1) 345/34.5/13.8 kV, 129/172/215 MVA Wye-grounded/Wye-grounded/Delta Z=9%, X/R=40.2 main step-up transformer which will connect to the PSCo transmission system via a 345 kV, 0.19-mile generation tie-line. The POI is the Harvest Mile 345 kV Substation.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD is December 31, 2025. The back-feed date is assumed to be June 31, 2025, approximately six (6) months before the COD.

3.5 GI-2021-18

GI-2021-18 is a 49 MW_{ac} net rated Solar PV Generating Facility located in Mesa County, Colorado. The PV Generating Facility will consist of fourteen (14) TMEIC PVU-L0840GR inverters each rated at 4.05 MVA, each with its own 34.5/0.63 kV, 4.2 MVA Delta/Wye Z=5.75%, X/R=7.5 pad-mount transformer. The 34.5 kV collector system of the PV will connect to one (1)

138/34.5/13.8 kV, 40.2/54/67 MVA Wye-grounded/Wye-grounded/Delta Z=9% and X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 138 kV, 1-mile generation tie-line. The POI is the Collbran 138 kV Substation

The proposed COD of GI-2021-18 is December 31, 2025. The back-feed date is assumed to be June 31, 2025, approximately six (6) months before the COD.

3.6 GI-2021-19

GI-2021-19 is a 500 MW_{ac} net rated Wind Generating Facility located in Kiowa County, Colorado. The Wind Generating Facility will consist of one-hundred twenty-six (126) Vestas V150 4.2 MVA wind turbines, each with its own 34.5/0.72 kV, 4.6512 MVA, Delta/Wye-grounded Z=9.9%, X/R=7.7 pad-mount transformers. The 34.5 kV collector system of the wind resources will connect to three (3) 345/34.5/13.8 kV, 129.6/173/216 MVA, Wye-grounded/Wye-grounded/Delta Z=9% and X/R=39.72 main step-up transformers which will connect to the PSCo transmission system via a 345 kV, 120-mile generation tie-line. The POI is the Tundra 345 kV Switching Station.

The proposed COD of GI-2021-19 is December 31, 2025. The back-feed date is assumed to be June 31, 2025, approximately six (6) months before the COD.

3.7 GI-2021-20

GI-2021-20 is a 500 MW_{ac} net rated Wind Generating Facility located in Kiowa County, Colorado. The Wind Generating Facility will consist of one-hundred twenty-six (126) Vestas V150 4.2 MVA wind turbines, each with its own 34.5/0.72 kV, 4.6512 MVA, Delta/Wye-grounded Z=9.9%, X/R=7.7 pad-mount transformers. The 34.5 kV collector system of the wind resources will connect to three (3) 345/34.5/13.8 kV, 129.6/173/216 MVA, Wye-grounded/Wye-grounded/Delta Z=9% and X/R=39.72 main step-up transformers which will connect to the PSCo transmission system via a 345 kV, 120-mile generation tie-line. The POI is the Tundra 345 kV Switching Station.

The proposed COD of GI-2021-20 is December 31, 2025. The back-feed date is assumed to be June 31, 2025, approximately six (6) months before the COD.

3.8 GI-2021-21

GI-2021-21 is a 300 MW_{ac} net rated Solar PV Generating Facility located in Pueblo County, Colorado. The PV Generating Facility will consist of ninety-six (96) Power Electronics FS3430M PV inverters rated at 3.43 MVA, each with its own inbuilt pad-mount transformer. The 34.5 kV

collector system of the PV resources will connect to two (2) 230/34.5/13.8 kV, 102/136/170 MVA Wye-grounded/Wye-grounded/Delta Z=8.5% and X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 230 kV,1-mile generation tie-line. The POI is a tap on the Boone – Midway 230 kV line. The tap point at the POI will require a new switching station which is referred to as “GI-2021-21/22 230 kV Switching Station” in this report.

Per the Interconnection Request, the NRIS output of GI-2021-21 will be serving PSCo native load.

The proposed COD of GI-2021-21 is December 1, 2024. The back-feed date is assumed to be June 31, 2024, approximately six (6) months before the COD.

3.9 GI-2021-22

GI-2021-22 is a 150 MW_{ac} net rated BESS Generating Facility located in Pueblo County, Colorado. The BESS Facility will consist of forty-eight (48) Power Electronics FP3430K inverters rated at 3.43 MVA, each with its own inbuilt pad-mount transformer. The 34.5 kV collector system will connect to one (1) 230/34.5/13.8 kV, 102/136/170 MVA Wye-grounded/Wye-grounded/Delta Z=8.5%, X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 230 kV, 1-mile generation tie-line. The POI is a tap on the Boone – Midway 230 kV line. The tap point at the POI will require a new switching station which is referred to as “GI-2021-21/22 230 kV Switching Station” in this report.

Per the Interconnection Request, the NRIS output of GI-2021-22 will be serving PSCo native load.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD of GI-2021-22 is December 1, 2024. The back-feed date is assumed to be June 31, 2024, approximately six (6) months before the COD.

3.10 GI-2021-23

GI-2021-23 is a 95 MW_{ac} net rated BESS Facility located in Alamosa County, Colorado. The BESS Facility will consist of thirty (30) SMA SCS-3950UP-XT inverters rated at 3.957 MVA, each with its own 34.5/0.66 kV, 4.140 MVA Delta/Delta Z=8.5%, X/R=10 pad-mount transformer. The 34.5 kV collector system will connect to one (1) 115/34.5 kV, 78/98/130 MVA Wye/Delta Z=9.5%, X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 115 kV, 1.43-mile generation tie-line. The POI is the San Luis Valley 115 kV Substation.

Per the Interconnection Request, the NRIS output of GI-2021-23 will be serving PSCo native load.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD of GI-2021-23 is October 1, 2025. The back-feed date is assumed to be April 1, 2025, approximately six (6) months before the COD.

3.11 GI-2021-24

GI-2021-24 is a 183.7 MW_{ac} net rated DC-coupled Hybrid Generating Facility located in Pueblo County, Colorado. The Hybrid Generating Facility is composed of forty-seven (47) 4.2 MVA rated Power Electronics HEM FS4200M PV inverters each with its own 34.5/0.66 kV, 4.207 MVA Wye/Delta Z=8.9%, X/R=12.5 pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to two (2) 230/34.5/13.8 kV, 58/77/96.9 MVA Wye-grounded/Wye-grounded/Delta Z=10% and X/R=50 main step-up transformers which will connect to the PSCo transmission system via a 230 kV, 9.9-mile generation tie-line. The POI is the Mirasol 230 kV Switching Station.

The BESS facility has a maximum state of charge of 99% and minimum state of charge of 1%.

The proposed COD of GI-2021-24 is December 31, 2023. The back-feed date is assumed to be June 31, 2023, approximately six (6) months before the COD.

3.12 GI-2021-25

GI-2021-25 is a 362 MW_{ac} net rated Wind Generating Facility located in Phillips County, Colorado. The Wind Generating Facility will consist of one-hundred and twelve (112) 4.4 MVA Vestas V155 wind turbines, each with its own 34.5/0.63 kV, 4.4 MVA Delta/Wye Z=6.2%, X/R=50 pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to two (2) 345/34/5/13.8 kV, 114/152/191 MVA Wye-grounded/Wye-grounded/Delta Z=10% and X/R=50 main step-up transformers which will connect to the PSCo transmission system via a 345 kV, 96-mile generation tie-line. The POI is the Pawnee 345 kV Substation.

The proposed COD of GI-2021-25 is December 31, 2024. The back-feed date is assumed to be June 31, 2024, approximately six (6) months before the COD.

3.13 GI-2021-26

GI-2021-26 is a 183.7 MW_{ac} net rated DC-coupled Hybrid Generating Facility located in Phillips County, Colorado. The hybrid Generating Facility is composed of forty-seven (47) Power

Electronics HEM FS4200M PV inverters, each with its own 34.5/0.66 kV, 4.207 MVA Wye/Delta Z=8.9%, X/R=12.4 pad-mount transformer. The 34.5 kV collector system of the PV resource will connect to two (2) 345/34.5/13.8 kV, 58/77/96.9 MVA Wye-grounded/Wye-grounded/Delta Z=10% and X/R=50 main step-up transformers which will connect to the PSCo transmission system via a 345 kV, 96-mile generation tie-line. The POI is the Pawnee 345 kV Substation.

The BESS facility has a maximum state of charge of 99% and minimum state of charge of 1%.

The proposed COD of GI-2021-26 is December 31, 2024. The back-feed date is assumed to be June 31, 2024, approximately six (6) months before the COD.

3.14 GI-2021-27

GI-2021-27 is a 180 MW_{ac} net rated AC-coupled Hybrid Generating Facility located in Arapahoe County, Colorado. The Hybrid Generating Facility is composed of a 180 MW_{ac} Solar PV Generating Facility and a 90 MW_{ac} BESS Generating Facility, with the net output at the POI limited to 180 MW. The Solar Generating Facility will consist of fifty-eight (58) Power Electronics HEM FS3430M PV inverters and the BESS Generating Facility will consist of twenty-nine (29) Power Electronics PCSM FP3430M storage inverters, each with its own inbuilt pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to one (1) 230/34.5/13.8 kV, 119/158/198 MVA Wye-grounded/Wye-grounded/Delta Z=9.5% and X/R=42.7 main step-up transformer which will connect to the PSCo transmission system via a 230 kV, 0.2-mile generation tie-line. The POI is the Missile Site 230 kV Substation.

Per the Interconnection Request, the NRIS output of GI-2021-27 will be serving PSCo native load.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD of GI-2021-27 is December 1, 2024. The back-feed date is assumed to be June 1, 2024, approximately six (6) months before the COD.

3.15 GI-2021-28

GI-2021-28 is a 170 MW_{ac} net rated AC-coupled Hybrid Generating Facility located in Alamosa County, Colorado. The Hybrid Generating Facility is composed of a 173.8 MW_{ac} Solar PV Generating Facility and a 95.85 MW_{ac} BESS Generating Facility, with the net output at the POI limited to 170 MW. The Solar PV Generating Facility will consist of fifty-five (55) Power Electronics HEM FS3430M PV inverters and the BESS Generating Facility will consist of twenty-seven (27)

Power Electronics PCSM FP3430M storage inverters, each with its own inbuilt pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to one (1) 230/34.5/13.8 kV, 112/150/187 MVA Wye/Wye/Delta Z=9.5% and X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 230 kV, 0.35-mile generation tie-line. The POI is the San Luis Valley 230 kV Substation.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD is December 1, 2024. The back-feed date is assumed to be June 1, 2024, approximately six (6) months before the COD.

3.16 GI-2021-29

GI-2021-29 is a 199.5 MW_{ac} net rated AC-coupled Hybrid Generating Facility located in Adams County, Colorado. The Hybrid Generating Facility is composed of a 199.5 MW_{ac} Solar PV Generating Facility and a 50 MW_{ac} BESS Generating Facility, with the net output at the POI limited to 199.5 MW. The Solar Generating Facility will consist of sixty-six (66) Power Electronics HEM FS3350M PV inverters and the BESS Generating Facility will consist of seventeen (17) Power Electronics PSK FP3000K storage inverters, each with its own 34.5/0.63 kV, 3.465 MVA Delta/Wye Z=5.75%, X/R=10.5 pad-mount transformer. The 34.5 kV collector system of the PV and BESS resources will connect to one (1) 230/34.5/13.8 kV, 136/181/226 MVA Wye-grounded/Wye-grounded/Buried Delta Tertiary Z=9.5% and X/R=33 main step-up transformer which will connect to the PSCo transmission system via a 230 kV, 3-mile generation tie-line. The POI is a tap on the Pawnee – Missile Site 230 kV line, at the proposed GI-2020-6 Switching Station.

Per the Interconnection Request, the NRIS output of GI-2021-29 will be serving PSCo native load.

The BESS facility has a maximum state of charge of 99% and minimum state of charge of 1%.

The proposed COD of GI-2021-29 is December 31, 2024. The back-feed date is assumed to be June 31, 2024, approximately six (6) months before the COD.

3.17 GI-2021-30

GI-2021-30 is a 500 MW_{ac} net rated Solar PV Generating Facility located in Morgan County, Colorado. The PV Generating Facility will consist of one hundred fifty-six (156) Power Electronics FS3430M inverters rated at 3.43 MVA, each with its own inbuilt pad-mount transformer. The 34.5

kV collector system will connect to two (2) 345/34.5/13.8 kV, 168/224/280 MVA Wye-grounded/Wye-grounded/Delta Z=16.5% and X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 345 kV, a 1-mile generation tie-line. The POI is the Pawnee 345 kV Substation.

Per the Interconnection Request, the NRIS output of GI-2021-30 will be serving PSCo native load.

The proposed COD of GI-2021-30 is December 1, 2024. The back-feed date is assumed to be June 1, 2024, approximately six (6) months before the COD.

3.18 GI-2021-31

GI-2021-31 is a 250 MW_{ac} net rated BESS Facility located in Morgan County, Colorado. The BESS Facility will consist of seventy-eight (78) Power Electronics FP3430K inverters each rated at 3.43 MVA, each with its own inbuilt pad-mount transformer. The 34.5 kV collector system will connect to one (1) 345/34.5/13.8 kV, 168/224/280 MVA Wye-grounded/Wye-grounded/Delta Z=16.5%, X/R=40 main step-up transformer which will connect to the PSCo transmission system via a 1-mile 345 kV generation tie-line. The POI is the Pawnee 345 kV Substation.

Per the Interconnection Request, the NRIS output of GI-2021-31 will be serving PSCo native load.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD of GI-2021-31 is December 1, 2024. The back-feed date is assumed to be June 1, 2024, approximately six (6) months before the COD.

4.0 Study Scope

The purpose of the Phase 1 study is to determine the system impact of interconnecting eighteen (18) GIRs for the DISIS-2021-004 for Interconnection Service. Each GIR will be studied for impacts on the specific study pocket to determine the full impact of the proposed generation.

The scope of the study includes steady-state (thermal and voltage) analysis, reactive power evaluation, and cost estimates. The non-binding cost estimates provide total costs and each GIR's cost responsibility for Transmission Provider Interconnection Facilities (TPIF), Station Network Upgrades, and System Network Upgrades.

Additionally, GIRs that include BESS and specified grid charging were studied at their respective charging rate in a Grid Charging Study Case.

4.1 Study Pockets

The GIRs were grouped by pocket, as defined below. Each study pocket analysis only modeled the GIRs with POI in that study pocket.

- The following GIRs are in the Southern Colorado study pocket:
    - GI-2021-12
    - GI-2021-13
    - GI-2021-19
    - GI-2021-20
    - GI-2021-21
    - GI-2021-22
    - GI-2021-24
- The following GIR is in the Metro Colorado study pocket:
    - GI-2021-14
- The following GIRs are in the Eastern Colorado study pocket:
    - GI-2021-16
    - GI-2021-25
    - GI-2021-26
    - GI-2021-27
    - GI-2021-29
    - GI-2021-30
    - GI-2021-31
- The following GIRs are in the San Luis Valley study pocket:
    - GI-2021-23
    - GI-2021-28
- The following GIR is in the Western Slope study pocket:
    - GI-2021-18

4.2 Study Areas

The study area for the Southern Colorado study pocket includes the WECC base case zones 704, 710, 712, 751, 757, and 785. The Affected Systems included in the analysis are Tri-State Generation and Transmission Inc. (TSGT), Black Hills Energy (BHE), Colorado Spring Utilities (CSU), CORE, and Western Area Power Administration (WAPA) transmission systems in the study area.

The study area for the Northern Colorado study pocket includes the WECC base case zones 700, 703 and 706. The Affected Systems included in the analysis is the TSGT transmission system in the study area.

The study area for the San Luis Valley study pocket includes the WECC base case zone 710. The Affected Systems included in the analysis are TSGT and WAPA transmission systems in the study area.

The study area for the Eastern Colorado study pocket includes the WECC base case zone 706. The Affected Systems included in the analysis is the TSGT transmission system in the study area.

The study area for the Western Slope study pocket includes the WECC base case zone 708.

The study area for the Metro study pocket includes the WECC base case zone 700.

4.3 Study Criteria

The following steady-state analysis criteria is used to identify violations on the PSCo system and the Affected Systems:

P0 - System Intact conditions:
Thermal Loading: ≤ 100% of the normal facility rating
Voltage range: 0.95 to 1.05 per unit

P1 & P2-1 – Single Contingencies:
Thermal Loading: ≤ 100% normal facility rating
Voltage range: 0.90 to 1.10 per unit
Voltage deviation: ≤ 8% of pre-contingency voltage

P2 (except P2-1), P4, P5 & P7 – Multiple Contingencies:
Thermal Loading: ≤ 100% emergency facility rating
Voltage range: 0.90 to 1.10 per unit
Voltage deviation: ≤ 8% of pre-contingency voltage

4.4 Study Methodology

The steady-state power flow assessment is performed using the PowerGEM TARA software. The generation redispatch for ERIS is identified using TARA's Security Constrained Redispatch (SCRD) tool.

Thermal violations are identified if a facility (i) resulted in a thermal loading >100% in the Study Case after the study pocket GIR cluster addition and (ii) contributed to an incremental loading increase of 1% or more to the benchmark case loading.

Voltage violations are identified if a bus (i) resulted in a bus voltage >1.1 p.u. (or <0.9 p.u.) in the Study Case after the study pocket GIR cluster addition and (ii) contributed to an adverse impact of +0.005 p.u. (or -0.005 p.u.) compared to the Benchmark Case voltage.

DFAX criteria for identifying contribution to thermal overloads is ≥1%. DFAX criteria for identifying contribution to the voltage violations is 0.005 p.u.

When the study pocket has a mix of NRIS and ERIS requests, it is studied by first modeling the NRIS GIRs at their full requested amount and modeling the ERIS GIRs offline. Network Upgrades required to mitigate the thermal and/or voltage violations are only allocated to NRIS requests because other GIR's output is modeled at zero.

The NRIS GIRs and their associated Network Upgrades are then modeled in the NRIS Study Case, and ERIS GIRs are dispatched at 100% to study the system impact. Violations are identified and the study evaluates if a generation redispatch combination eliminates the violation. If generation redispatch is unable to eliminate the violation, upgrades will be identified.

The resources included in the Optimal Power Flow (OPF) redispatch are:

1. All PSCo and Non-PSCo resources connected to the PSCo Transmission System
2. Higher-queued NRIS generation in the PSCo queue
3. Generation connected to an Affected System Transmission System if that generation is a designated network resource to serve load connected to PSCo
4. All other generation connected to an Affected System Transmission System and Stressed in the Study Case may be dispatched to the Base Case level

Maximum allowable ERIS generation is calculated for each GIR using its distribution factor(s) (DFAX) for overloads identified at full output, such that all identified overloads are eliminated.

5.0 Base Case Modeling Assumptions

The 2026HS2a1 WECC case released on July 31, 2020, was selected as the starting case. The Base Case was created from the Starting Case by including the following modeling changes. The following approved transmission projects in PSCo's 10-year transmission plan, with an in-service date before summer 2026 were modeled: (http://www.oasis.oati.com/woa/docs/PSCO/PSCOdocs/FERC_890_Q1_2020_Transmission_Plan_Presentation.pdf)

- Cloverly 115 kV Substation – ISD 2021
- Graham Creek 115 kV Substation – ISD 2022
- Husky 230/115 kV Substation – ISD 2022
- Mirasol 230 kV Substation – ISD 2022
- Avery Substation – ISD 2021
- Barker Substation – Bank1 ISD: 2021, Bank 2 ISD: 2022
- High Point Substation – ISD 2022
- Titan Substation – ISD 2022
- Dove Valley Substation – ISD 2023
- Stock Show – ISD 2026
- Monument – Flying Horse 115 kV Series Reactor – ISD 2024
- Ault – Husky 230 kV line – ISD 2022
- Husky – Graham Creek – Cloverly 115 kV line – ISD 2022
- Gilman – Avon 115 kV line – ISD 2022
- Climax – Robinson Rack – Gilman 115 kV – ISD 2022
- Greenwood – Arapahoe – Denver Terminal 230 kV – ISD 2022
- Upgrade Villa Grove – Poncha 69 kV Line to 73 MVA – ISD 2021
- Upgrade Poncha – Sargent - San Luis Valley 115 kV line to 120 MVA – ISD 2021
- Upgrade Antonito – Romeo – Old40 Tap – Alamosa Terminal – Alamosa Switchyard 69 kV line to 143 MVA – ISD 2023
- Tundra Switching Station 345 kV – ISD 2022
- Upgrade Allison – SodaLakes 115 kV line to 318 MVA – ISD 2022

The following additional changes were made to the TSGT model in the Base Case per further review and comment from TSGT:

- Fuller – Vollmer – Black Squirrel 115 kV line modeled at 144 MVA – ISD 2022
- Beaver Creek – Adena 115 kV line modeled at 114 MVA
- Fuller 230/115 kV, 100 MVA #2 transformer – ISD 2023
- The Paddock – Shaw Ranch – Calhan Tap – Santa Fe Springs 115 kV Loop was modeled open

The following additional changes were made to the CSU model in the Base Case per further review and comment from CSU:

- The Cottonwood – Tesla 34.5 kV line is modeled open and Kettle Creek – Tesla 34.5 kV line is modeled closed on the CSU system – ISD 2023
- Briargate South 115/230 kV transformer project tapping the Cottonwood – Fuller 230 kV line – ISD 2023

The Base Case model includes the existing PSCo generation resources and all Affected Systems' existing resources.

In addition, the following higher-queued generation from PSCo's queue were modeled in the Base Case:

- Individual GIRs (GI-2014-2, GI-2014-5, GI-2014-6, GI-2014-7, GI-2014-9, GI-2014-13, GI-2014-14, GI-2016-4, and GI-2016-15)
- Transitional Cluster (GI-2018-24, and GI-2019-6)
- DISIS-2020-001 (GI-2020-1, GI-2020-3, GI-2020-4, GI-2020-6, GI-2020-7, and GI-2020-10)
- 2RSC-2020-05
- DISIS-2020-002 (GI-2020-12, GI-2020-13, GI-2020-14, GI-2020-15 and GI-2020-16)
- DISIS-2021-003 (GI-2021-1, GI-2021-2, GI-2021-3, GI-2021-4, GI-2021-6, GI-2021-8, and GI-2021-9)

While the higher-queued NRIS requests were dispatched at 100%, the higher-queued ERIS requests were modeled offline.

6.0 Voltage and Reactive Power Capability Evaluation

The following voltage regulation and reactive power capability requirements are applicable to non-synchronous generators:

- Xcel Energy's OATT requires all non-synchronous generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the high side of the generator substation. Furthermore, Xcel Energy requires every Generating Facility to have dynamic voltage control capability to assist in maintaining the POI voltage schedule specified by the Transmission Operator.
- It is the responsibility of the Interconnection Customer to determine the type (switched shunt capacitors and/or switched shunt reactors, etc.), the size (Mvar), and the locations (on the Interconnection Customer's facility) of any additional static reactive power compensation needed within the generating plant in order to have adequate reactive capability to meet the +/- 0.95 power factor at the high side of the main step-up transformer.
- It is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under no load conditions.

The following voltage regulation and reactive power capability requirements are applicable to synchronous generators:

- Xcel Energy's OATT requires all synchronous Generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the POI.
- The reactive power analysis performed in this report is an indicator of the reactive power requirements at the POI and the capability of the generator to meet those requirements. The Interconnection Customer is required to demonstrate to the satisfaction of PSCo Transmission Operations prior to the commercial in-service date of the generating plant that it can safely and reliably operate within the required power factor and the regulating voltage of the POI.

All proposed reactive devices in customer provided models are switched favorably to provide appropriate reactive compensation in each test, therefore identified deficiencies are in addition to any proposed reactive compensation.

All the summary tables representing GIRs' Voltage and Reactive Power Capability tests adhere to the following color formatting representing the different aspects of the tests:

- Values highlighted in red indicate a failed reactive power requirement.
- Voltages outside the range of 0.95 p.u. to 1.05 p.u. are highlighted in yellow to provide additional information.

6.1 GI-2021-12

The GI-2021-12 GIR is modeled as follows:

PV Generator: Pmax = 254.9 MW, Pmin = 0.0 MW, Qmax = 133.9 Mvar, Qmin= -133.9 Mvar

BESS Generator: Pmax = 128.5 MW, Pmin = -128.5 MW, Qmax = 67.6 Mvar, Qmin= -67.6 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-12 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-12 are summarized in Table 2.

Table 2 – Reactive Capability Evaluation for GI-2021-12

PV Generator Terminals					BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
169.7	90.4	133.9	-133.9	1.03	84.9	45.2	67.6	-67.6	1.03	250.1	87.4	1.03	0.944	250.0	87.2	1.03	0.944
169.7	-24.9	133.9	-133.9	0.99	84.9	-12.5	67.6	-67.6	1.00	250.2	-85.7	1.00	-0.946	250.2	-85.9	1.00	-0.946
254.9	133.6	133.9	-133.9	1.05	OFFLINE					249.7	83.3	1.03	0.949	249.7	83.1	1.03	0.949
OFFLINE					128.4	60.8	67.6	-67.6	1.05	125.0	42.1	1.02	0.948	124.9	42.1	1.02	0.948
254.9	-35.3	133.9	-133.9	0.99	OFFLINE					249.9	-86.5	1.00	-0.945	249.8	-86.7	1.00	-0.945
OFFLINE					128.4	-24.4	67.6	-67.6	1.00	125.0	-42.6	1.01	-0.947	125.0	-42.6	1.01	-0.947
0.0	-2.5	133.9	-133.9	1.00	0.0	-0.9	67.6	-67.6	1.00	0.0	-2.1	1.00	N/A	0.0	-2.1	1.00	N/A

6.2 GI-2021-13

The GI-2021-13 GIR is modeled as follows:

PV Generator 1: Pmax = 127.6 MW, Pmin = 0.0 MW, Qmax = 70.5 Mvar, Qmin = -70.5 Mvar

PV Generator 2: Pmax = 127.6 MW, Pmin = 0.0 MW, Qmax = 70.5 Mvar, Qmin = -70.5 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-13 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request at the POI.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-13 are summarized in Table 3.

Table 3 – Reactive Capability Evaluation for GI-2021-13

PV Generator 1 Terminals					PV Generator 1 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
127.2	70.5	70.5	-70.5	1.06	127.6	70.5	70.5	-70.5	1.06	250.0	91.4	1.03	0.939	250.0	91.4	1.03	0.939
127.2	-20.6	70.5	-70.5	1.00	127.6	-20.6	70.5	-70.5	1.00	250.6	-84.2	1.00	-0.948	250.6	-84.2	1.00	-0.948
0.0	0.1	70.5	-70.5	1.01	0.0	0.1	70.5	-70.5	1.01	0.0	2.7	1.01	N/A	0.0	2.7	1.01	N/A

6.3 GI-2021-14

The GI-2021-14 GIR is modeled as follows:

PV Generator: Pmax = 209.0 MW, Pmin = 0.0 MW, Qmax = 116.7 Mvar, Qmin= -84.2 Mvar

BESS Generator: Pmax = 202.3 MW, Pmin = -202.3 MW, Qmax = 109.0 Mvar, Qmin= -78.5 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-14 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request at the POI.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-14 are summarized in Table 4.

Table 4 – Reactive Capability Evaluation of GI-2021-14

PV Generator Terminals					BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
106.3	54.4	116.7	-84.2	1.06	100.8	54.4	109.0	-78.5	1.06	204.0	70.6	1.01	0.945	203.9	70.6	1.01	0.945
106.3	-18.8	116.7	-84.2	0.92	100.8	-18.8	109.0	-78.5	1.00	203.8	-78.8	1.00	-0.933	203.8	-78.8	1.00	-0.933
208.0	116.7	116.7	-84.2	1.09	OFFLINE					200.0	66.5	1.01	0.949	200.0	66.5	1.01	0.949
OFFLINE					202.3	109.0	109.0	-78.5	1.07	202.4	67.8	1.01	0.948	202.4	67.8	1.01	0.948
208.0	-14.7	116.7	-84.2	0.93	OFFLINE					199.7	-66.5	0.99	-0.948	199.7	-66.5	0.99	-0.948
OFFLINE					202.3	-24.0	109.0	-78.5	0.94	202.3	-68.0	1.00	-0.948	202.3	-68.0	1.00	-0.948
0.0	1.9	116.7	-84.2	0.96	0.0	1.9	109.0	-78.5	0.98	0.0	6.9	1.00	N/A	0.0	7.0	1.00	N/A

6.4 GI-2021-16

The GI-2021-16 GIR is modeled as follows:

BESS Generator: Pmax = 205.0 MW, Pmin = -205 MW, Qmax = 116.2 Mvar, Qmin= -116.2 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-16 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request at the POI.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-16 are summarized in Table 5.

Table 5 – Reactive Capability Evaluation of GI-2021-16

BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
205.0	116.2	-116.2	116.2	1.04	199.1	68.6	1.00	0.945	199.1	68.7	1.00	0.945
205.0	-32.0	-116.2	116.2	1.00	199.4	-72.0	0.99	-0.941	199.4	-71.8	0.99	-0.941
0.0	-2.4	-116.2	116.2	0.99	-3.6	-2.3	0.99	N/A	-3.6	-2.1	0.99	N/A

6.5 GI-2021-18

The GI-2021-18 GIR is modeled as follows:

PV Generator: Pmax = 50.1 MW, Pmin = 0.0 MW, Qmax = 26.6 Mvar, Qmin= -26.6 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-18 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request at the POI.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions

The Voltage and Reactive Power Capability tests performed for GI-2021-18 are summarized in Table 6.

Table 6 – Reactive Capability Evaluation of GI-2021-18

PV Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
50.1	26.6	26.6	-26.6	1.03	49.3	17.5	1.03	0.942	49.3	17.6	1.04	0.942
50.1	-24.9	26.6	-26.6	0.99	49.4	-16.7	1.00	-0.947	49.4	-16.7	1.00	-0.947
0.0	-0.5	26.6	-26.6	0.99	0.0	-0.2	1.01	N/A	0.0	-0.3	1.01	N/A

6.6 GI-2021-19

The GI-2021-19 GIR is modeled as follows:

Wind Generator 1: Pmax = 174.8 MW, Pmin = 0.0 MW, Qmax = 87.2 Mvar, Qmin= -65.3 Mvar

Wind Generator 2: Pmax = 174.8 MW, Pmin = 0.0 MW, Qmax = 87.2 Mvar, Qmin= -65.3 Mvar

Wind Generator 3: Pmax = 174.8 MW, Pmin = 0.0 MW, Qmax = 87.2 Mvar, Qmin= -65.3 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-19 is:

- The GIR is **not capable** of meeting 0.95 lagging pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI, but it was capable of meeting 0.95 leading pf at the high side of the main step-up transformer.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-19 are summarized in Table 7.

Table 7 – Reactive Capability Evaluation of GI-2021-19

Generator 1 Terminals					Generator 2 Terminals					Generator 3 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
174.8	87.2	87.2	-65.3	1.03	174.8	87.2	87.2	-65.3	1.0	174.8	87.2	87.2	-65.3	1.03	507.0	145.9	1.06	0.961	499.9	135.7	0.98	0.965
174.8	1.4	87.2	-65.3	0.80	174.8	1.4	87.2	-65.3	0.78	174.8	1.4	87.2	-65.3	0.78	501.2	-165.6	0.74	-0.950	488.2	-334.4	0.88	-0.825
0.0	-18.8	87.2	-65.3	0.90	0.0	-18.8	87.2	-65.3	0.90	0.0	-18.8	87.2	-65.3	0.90	-0.2	-48.1	0.99	N/A	-0.2	69.6	0.98	N/A

6.7 GI-2021-20

The GI-2021-20 GIR is modeled as follows:

Wind Generator 1: Pmax = 174.8 MW, Pmin = 0.0 MW, Qmax = 87.2 Mvar, Qmin= -65.3 Mvar

Wind Generator 2: Pmax = 174.8 MW, Pmin = 0.0 MW, Qmax = 87.2 Mvar, Qmin= -65.3 Mvar

Wind Generator 3: Pmax = 174.8 MW, Pmin = 0.0 MW, Qmax = 87.2 Mvar, Qmin= -65.3 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-20 is:

- The GIR is **not capable** of meeting the 0.95 lagging pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI, but it is capable of meeting 0.95 leading pf at the high side of the main step-up transformer.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-20 are summarized in Table 8.

Table 8 – Reactive Capability Evaluation of GI-2021-20

Wind Generator 1 Terminals					Wind Generator 2 Terminals					Wind Generator 3 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
174.8	87.2	87.2	-65.3	1.06	174.8	87.2	87.2	-65.3	1.06	174.8	87.2	87.2	-65.3	1.06	507.9	152.7	1.10	0.958	501.0	155.7	1.01	0.955
174.8	-16.3	87.2	-65.3	0.88	174.8	-16.3	87.2	-65.3	0.88	174.8	-16.3	87.2	-65.3	0.88	505.2	-177.9	0.85	-0.943	495.3	-270.0	0.96	-0.878
0.0	-25.4	87.2	-65.3	0.92	0.0	-25.4	87.2	-65.3	0.92	0.0	-25.4	87.2	-65.3	0.92	-0.3	-68.4	0.99	N/A	-0.3	51.7	1.00	N/A

6.8 GI-2021-21

The GI-2021-21 GIR is modeled as follows:

PV Generator: Pmax = 304.5 MW, Pmin = 0.0 MW, Qmax = 102.4 Mvar, Qmin= -102.4 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-21 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-21 are summarized in Table 9.

Table 9 – Reactive Capability Evaluation of GI-2021-21

PV Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
304.5	74.1	102.4	-102.4	1.12	300.5	102.6	1.06	0.946	300.3	101.7	1.06	0.947
304.5	-56.3	102.4	-102.4	0.97	300.4	-100.0	0.97	-0.949	300.1	-101.2	0.97	0.948
0.0	-1.9	102.4	-102.4	1.01	0.0	-0.2	1.01	N/A	0.0	0.1	1.01	N/A

6.9 GI-2021-22

The GI-2021-22 GIR is modeled as follows:

BESS Generator: Pmax = 153.7 MW, Pmin = -153.7 MW, Qmax = 51.2 Mvar, Qmin= -51.2 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-22 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-22 are summarized in Table 10.

Table 10 – Reactive Capability Evaluation of GI-2021-22

BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
153.7	23.6	51.2	-51.2	1.11	150.5	51.1	1.04	0.947	150.5	51.1	1.04	0.947
153.7	-19.4	51.2	-51.2	0.95	150.1	-54.3	0.99	0.940	150.1	-54.4	0.99	0.940
0.0	0.2	51.2	-51.2	1.01	0.0	0.2	1.01	N/A	0.0	0.5	1.01	N/A

6.10 GI-2021-23

The GI-2021-23 GIR is modeled as follows:

BESS Generator: Pmax = 95.9 MW, Pmin = -94.2 MW, Qmax = 70.1 Mvar, Qmin= -70.1 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-23 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-23 are summarized in Table 11.

Xcel Energy

Table 11 – Reactive Capability Evaluation of GI-2021-23

BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
95.9	47.3	70.1	-70.1	1.08	95.1	32.7	1.02	0.946	94.9	32.1	1.01	0.947
95.9	-21.3	70.1	-70.1	0.96	95.1	-36.9	1.00	0.932	94.9	-37.6	1.00	0.930
0.0	-4.4	70.1	-70.1	1.02	0.0	-4.1	1.02	N/A	0.0	-4.0	1.02	N/A

6.11 GI-2021-24

The GI-2021-24 GIR is modeled as follows:

PV Generator 1: Pmax = 95.4 MW, Pmin = 0.0 MW, Qmax = 32.6 Mvar, Qmin= -32.6 Mvar

PV Generator 2: Pmax = 91.3 MW, Pmin = 0.0 MW, Qmax = 31.6 Mvar, Qmin= -31.6 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-24 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-24 are summarized in Table 12.

Table 12 – Reactive Capability Evaluation of GI-2021-24

PV Generator 1 Terminals					PV Generator 2 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
95.4	32.6	32.6	-32.6	1.04	91.3	31.6	31.6	-31.6	1.04	183.9	67.1	1.02	0.939	183.4	66.7	1.01	0.940
95.4	-15.0	32.6	-32.6	0.98	91.3	-15.0	31.6	-31.6	0.98	184.0	-63.0	1.00	-0.946	183.5	-63.5	1.01	-0.945
0.0	-9.2	32.6	-32.6	1.00	0.0	-9.0	31.6	-31.6	1.00	0.0	-4.2	1.01	N/A	0.0	-4.3	1.01	N/A

6.12 GI-2021-25

The GI-2021-25 GIR is modeled as follows:

PV Generator 1: Pmax = 187.0 MW, Pmin = 0.0 MW, Qmax = 132.5 Mvar, Qmin= -132.5 Mvar

PV Generator 2: Pmax = 186.8 MW, Pmin = 0.0 MW, Qmax = 132.5 Mvar, Qmin= -132.5 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-25 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-25 are summarized in Table 13.

Table 13 – Reactive Capability Evaluation of GI-2021-25

PV Generator 1 Terminals					PV Generator 2 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
187.0	132.5	132.5	-132.5	1.16	186.8	132.5	132.5	-132.5	1.16	367.0	177.6	1.15	0.900	360.4	212.3	1.03	0.862
187.0	-22.2	132.5	-132.5	1.00	186.8	-22.2	132.5	-132.5	1.00	367.6	-123.8	0.97	-0.948	360.7	-107.9	1.01	-0.958
0.0	-27.8	132.5	-132.5	0.98	0.0	-27.8	132.5	-132.5	0.98	0.0	-52.2	1.01	N/A	-0.1	37.0	1.02	N/A

6.13 GI-2021-26

The GI-2021-26 GIR is modeled as follows:

PV Generator 1: Pmax = 95.7 MW, Pmin = 0.0 MW, Qmax = 31.7 Mvar, Qmin= -31.7 Mvar

PV Generator 2: Pmax = 91.8 MW, Pmin = 0.0 MW, Qmax = 30.1 Mvar, Qmin= -30.1 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-26 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-26 are summarized in Table 14.

Table 14 – Reactive Capability Evaluation of GI-2021-26

PV Generator 1 Terminals					PV Generator 2 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
95.5	26.1	30.1	-30.1	1.06	91.8	26.1	31.7	-31.7	1.06	185.6	61.7	1.08	0.949	183.9	139.3	1.03	0.797
95.5	-16.5	30.1	-30.1	1.00	91.8	-16.5	31.7	-31.7	1.00	185.5	-65.4	1.01	-0.943	184.1	7.8	1.02	-0.999
0.0	-29.2	30.1	-30.1	0.96	0.0	-29.2	31.7	-31.7	0.96	-0.2	-52.2	1.01	-0.004	-0.2	36.9	1.02	-0.005

6.14 GI-2021-27

The GI-2021-27 GIR is modeled as follows:

PV Generator: Pmax = 183.3 MW, Pmin = 0.0 MW, Qmax = 93.8 Mvar, Qmin= -93.8 Mvar

BESS Generator: Pmax = 92.8 MW, Pmin = -89.5 MW, Qmax = 44.6 Mvar, Qmin= -44.6 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-27 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-27 are summarized in Table 15.

Table 15 – Reactive Capability Evaluation of GI-2021-27

PV Generator Terminals					BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
121.0	49.7	93.8	-93.8	1.06	62.0	44.6	44.6	-44.6	1.06	181.9	68.1	1.02	0.937	181.8	68.0	1.02	0.937
121.0	-19.6	93.8	-93.8	0.99	62.0	-19.6	44.6	-44.6	1.00	181.8	-67.0	1.00	-0.938	181.7	-67.1	1.00	-0.938
183.3	93.8	93.8	-93.8	1.06	OFFLINE					180.5	97.7	1.02	0.879	180.5	67.6	1.02	0.879
OFFLINE					92.8	44.6	44.6	-44.6	1.02	92.3	39.7	1.01	0.919	92.3	39.7	1.01	0.919
183.3	-39.2	93.8	-93.8	0.99	OFFLINE					180.5	-67.1	1.00	-0.937	180.4	-67.1	1.00	-0.937
OFFLINE					92.8	-44.6	44.6	-44.6	0.94	92.3	-50.9	1.00	-0.876	92.3	-50.9	1.00	-0.876
0.0	-2.1	93.8	-93.8	0.98	0.0	-2.1	44.6	-44.6	0.98	-0.2	-1.3	1.01	N/A	-0.2	-1.3	1.01	N/A

6.15 GI-2021-28

The GI-2021-28 GIR is modeled as follows:

PV Generator: Pmax = 173.8 MW, Pmin = 0.0 MW, Qmax = 89.0 Mvar, Qmin= -89.0 Mvar

BESS Generator: Pmax = 86.4 MW, Pmin = -84.5 MW, Qmax = 41.5 Mvar, Qmin= -41.5 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-28 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-28 are summarized in Table 16.

Table 16 – Reactive Capability Evaluation of GI-2021-28

PV Generator Terminals					BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
113.9	59.8	89.0	-89.0	1.07	57.2	41.5	41.5	-41.5	1.07	169.9	75.8	1.02	0.913	169.9	75.7	1.02	0.913
113.9	-15.5	89.0	-89.0	0.92	57.2	-15.5	41.5	-41.5	0.98	169.9	-57.9	0.98	-0.947	169.9	-58.0	0.98	-0.946
173.8	89.0	89.0	-89.0	1.07	OFFLINE					169.9	64.6	1.03	0.935	169.9	64.5	1.02	0.935
OFFLINE					86.4	41.5	41.5	-41.5	1.03	86.0	37.0	1.02	0.919	86.0	37.1	1.02	0.918
173.8	-46.5	89.0	-89.0	0.90	OFFLINE					169.9	-76.2	0.97	-0.912	169.9	-76.3	0.97	-0.912
OFFLINE					86.4	-41.2	41.5	-41.5	0.89	86.0	-38.5	0.95	-0.913	85.4	-48.2	0.99	-0.871
0.0	-1.3	89.0	-89.0	0.97	0.0	-1.3	41.5	-41.5	0.97	-0.2	-0.2	1.00	-0.707	-0.2	-0.1	1.00	-0.894

6.16 GI-2021-29

The GI-2021-29 GIR is modeled as follows:

PV Generator: Pmax = 218.3 MW, Pmin = 0.0 MW, Qmax = 81.1 Mvar, Qmin = -81.1 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-29 is:

- The GIR is **not capable** of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-29 are summarized in Table 17.

Table 17 – Reactive Capability Evaluation of GI-2021-29

PV Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
203.0	81.1	81.1	-81.1	1.09	200.2	44.1	1.02	0.977	200.0	43.1	1.02	0.978
204.0	25.2	81.1	-81.1	0.97	200.9	-67.2	1.00	-0.948	200.6	-68.4	1.00	-0.946
0.0	0.7	81.1	-81.1	1.01	0.0	1.1	1.01	0.000	0.0	1.9	1.01	0.000

6.17 GI-2021-30

The GI-2021-30 GIR is modeled as follows:

PV Generator: Pmax = 507.2 MW, Pmin = 0.0 MW, Qmax = 167.4 Mvar, Qmin= -167.4 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-30 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-30 are summarized in Table 18.

Xcel Energy

Table 18 – Reactive Capability Evaluation of GI-2021-30

PV Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
507.0	145.8	167.4	-167.4	1.07	500.1	180.7	1.01	0.940	499.7	179.3	1.00	0.941
507.2	-106.1	167.4	-167.4	0.97	502.8	-177.1	0.99	-0.944	502.5	-178.5	0.99	-0.942
0.0	3.1	167.4	-167.4	1.00	0.0	5.7	1.00	N/A	0.0	6.3	1.00	N/A

6.18 GI-2021-31

The GI-2021-31 GIR is modeled as follows:

BESS Generator: Pmax = 254.3 MW, Pmin = -254.3 MW, Qmax = 83.2 Mvar, Qmin= -83.2 Mvar

The summary for the Voltage and Reactive Power Capability Evaluation for GI-2021-31 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for GI-2021-31 are summarized in

Table 19

Xcel Energy

Table 19 – Reactive Capability Evaluation of GI-2021-31

BESS Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
253.0	83.2	83.2	-83.2	1.07	250.2	82.8	0.99	0.949	250.1	82.9	0.99	0.949
253.0	-23.8	83.2	-83.2	0.94	249.8	-83.9	0.97	-0.948	249.7	-83.6	0.97	-0.948
0.0	0.7	83.2	-83.2	0.99	0.0	0.7	0.99	N/A	0.0	1.3	0.99	N/A

7.0 Southern Colorado Study Pocket Analysis

7.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case by changing the study pocket generation dispatch to reflect heavy generation in the South study pocket. This was accomplished by adopting the generation dispatch in Table 20.

Table 20 – Generation Dispatch Used to Create the Southern Colorado Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70010	TBII_GEN	0.69	W	1	60.8	80.0
70665	GLDNWST_W1	0.7	W1	1	99.3	125.9
70666	GLDNWST_W2	0.7	W2	1	100.0	125.9
70701	CO_GRN_E	34.5	W1	1	64.8	81.0
70702	CO_GRN_W	34.5	W2	1	64.8	81.0
70703	TWNBUTTE	34.5	W1	1	60.0	75.0
70934	COMAN_S1	0.42	S1	1	102.0	125.0
70726	SPANPKS2_GEN	0.63	2	1	40.0	46.3
70017	SI_GEN	0.6	1	1	30.0	30.1
70777	COMAN_3	27	C3	1	859.0	869.0
70125	COMAN_1	24	C1	1	360.0	390.2
70120	COMAN_2	24	C2	1	365.0	395.2
70577	FTNVL1&2	13.8	G1	1	36.0	40.0
70577	FTNVL1&2	13.8	G2	1	36.0	40.0
70578	FTNVL3&4	13.8	G4	1	36.0	40.0
70578	FTNVL3&4	13.8	G3	1	36.0	40.0
70579	FTNVL5&6	13.8	G5	1	36.0	40.0
70579	FTNVL5&6	13.8	G6	1	36.0	40.0
970285	GI-2014-6	34.5	S1	1	85.3	152.2
970122	GI-2014-9	34.5	WS	1	70.2	70.0
101	GI-20-10 G1	34.5	1	1	239.4	239.0
Total					2816.6	3125.8

7.2 Study Case Modeling

The South Pocket NRIS Study Case was developed from the Benchmark Case by modeling GI-2021-21 and GI-2021-22 at a new POI tapping the Boone to Midway 230 kV line. The total 450

MW generation from GI-2021-21 and GI-2021-22 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The South Pocket ERIS Study Case was created from the NRIS Study Case (along with any System Network Upgrades for NRIS) by modeling GI-2021-12 at a new POI tapping the Comanche to Mirasol segment of the Comanche to Midway 230 kV line, GI-2021-13 and GI-2021-24 at Mirasol 230 kV, GI-2021-19 and GI-2021-20 at Tundra 345 kV. The total 1683.7 MW of ERIS output from GI-2021-12, GI-2021-13, GI-2021-19, GI-2021-20, and GI-2021-24 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

7.3 Steady-State Analysis – NRIS Study Case

Contingency analysis was performed on the South pocket NRIS Study Case.

The results for the system-intact analysis on the NRIS Study Case are shown in Table 21.

The results of the single contingency analysis on the NRIS Study Case are shown in Table 22.

The results of the multiple contingency analysis on the NRIS Study Case are shown in Table 23.

All the system-intact and single contingency overloads identified in Table 21 and Table 22 are mitigated by the NRIS System Network Upgrades tabulated in Table 24.

Per TPL-001-4, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or operator actions. None of the multiple contingency overloads are attributed to the study GIRs.

Single contingency and multiple contingency analysis showed no voltage violations attributed to the NRIS study GIRs.

Table 21 – South Pocket NRIS – System Intact Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1	Line	TSGT	143.0	170.6	119.3	133.8	133.8	14.48	System Intact Condition
VOLLMERT (72413) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	143.0	165.8	116.0	130.4	130.4	14.41	System Intact Condition
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	502.0	105.0	125.6	125.6	20.57	System Intact Condition
DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1	Line	PSCo	607.0	569.1	93.8	100.0	100.0	6.24	System Intact Condition

Table 22 – South Pocket NRIS – Single Contingency Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1	Line	TSGT	143.0	229.6	160.5	264.7	185.1	24.55	DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1
VOLLMERT (72413) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	143.0	224.6	157.1	259.5	181.5	24.43	DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	659.4	138.0	802.4	167.9	29.91	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2
FTN_VLY (70193) TO MIDWAYBR (73412) 115 kV CKT #1	Line	BHE	171.0	244.2	142.8	275.1	160.9	18.04	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
MIDWAYPS (70286) TO MIDWAYPS (70465) 230/345 kV CKT #T3	Xfmr	PSCo	560.0	762.2	136.1	885.3	158.1	21.98	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
GI-2020-13 P (990051) TO MIDWAYPS (70286) 230 kV CKT #1	Line	PSCo	319.0	208.8	65.5	502.8	157.6	92.15	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
PALMER (70308) TO MONUMENT (73414) 115 kV CKT #1	Line	PSCo	151.0	191.9	127.1	233.3	154.5	27.38	DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1
DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2	Line	PSCo	598.0	830.7	138.9	886.9	148.3	9.39	DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1
DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1	Line	PSCo	607.0	838.0	138.1	894.2	147.3	9.26	DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2
CTTNWD N (78658) TO KETTLECK S (78673) 115 kV CKT #1	Line	CSU	162.0	221.2	136.5	235.6	145.4	8.87	BRIARGATE N (78656) TO BRIARGATE S (78657) 115 kV CKT #1
COMANCHE (70122) TO COMANCHE (70654) 230/345 kV CKT #T4	Xfmr	PSCo	560.0	676.4	120.8	810.8	144.8	24.01	COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T3
COMANCHE (70122) TO COMANCHE (70654) 230/345 kV CKT #T3	Xfmr	PSCo	560.0	676.4	120.8	810.8	144.8	24.01	COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T4

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
GREENWD (70212) TO PRAIRIE3 (70323) 230 kV CKT #1	Line	PSCo	576.0	777.9	135.1	833.6	144.7	9.68	DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1
MONUMENT (73414) TO GRESHAM (73445) 115 kV CKT #1	Line	TSGT	145.0	175.7	121.2	209.4	144.4	23.28	DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1
GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1	Line	PSCo	1195.0	1495.4	125.1	1705.9	142.8	17.61	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2
GREENWD (70212) TO PRAIRIE1 (70331) 230 kV CKT #2	Line	PSCo	576.0	760.1	132.0	816.1	141.7	9.73	DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2
DESRTCOV (70449) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	222.0	273.5	123.2	305.6	137.7	14.46	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
DEERCRK (70142) TO SODALAKE (70400) 115 kV CKT #1	Line	PSCo	120.0	143.2	119.3	154.1	128.4	9.12	CHATFLD (70100) TO WATERTON (70464) 230 kV CKT #1
BLKFORTP (73455) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	173.0	185.4	107.1	219.4	126.8	19.69	DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1
MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	480.1	100.4	603.4	126.2	25.81	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
PUEBPLNT (70339) TO READER (70352) 115 kV CKT #1	Line	BHE	160.0	189.7	118.6	201.4	125.9	7.35	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
FTN_VLY (70193) TO DESRTCOV (70449) 115 kV CKT #1	Line	BHE	222.0	245.6	110.6	276.5	124.6	13.94	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
WATERTON (70464) TO WATERTON (70466) 230/345 kV CKT #T3	Xfmr	PSCo	560.0	630.0	112.5	694.9	124.1	11.59	WATERTON (70464) TO WATERTON (70466) 230/345 kV CKT T4
GRESHAM (73445) TO BLKFORTP (73455) 115 kV CKT #1	Line	TSGT	173.0	179.9	104.0	213.8	123.6	19.59	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2
WATERTON (70464) TO WATERTON (70466) 230/345 kV CKT #T4	Xfmr	PSCo	560.0	626.1	111.8	688.8	123.0	11.19	WATERTON (70464) TO WATERTON (70466) 230/345 kV CKT T3
BOONE (70060) TO BOONE (70061) 115/230 kV CKT #T1	Xfmr	PSCo	147.0	89.2	60.7	179.0	121.7	61.07	1 GI-2020-13 (99005) TO MIDWAYPS (70286) 230 kV CKT #1
GREENWD (70212) TO MONACO12 (70481) 230 kV CKT #1	Line	PSCo	560.0	653.6	116.7	667.4	119.2	2.46	BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1
BRIARGATE S (78657) TO CTTNWD S (78659) 115 kV CKT #1	Line	CSU	150.0	159.7	106.5	176.6	117.7	11.23	CTTNWD N (78658) TO KETTLECK S (78673) 115 kV CKT #1
DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2	Line	PSCo	1195.0	1226.0	102.6	1403.2	117.4	14.83	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
W.CANON (70550) TO HOGBACK115 (71025) 115 kV CKT #1	Line	BHE	120.0	119.7	99.8	139.4	116.2	16.40	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1	Line	PSCo	637.0	566.7	89.0	739.8	116.1	27.17	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
MIRASOL (70652) TO GI-2014-9 (970999) 230 kV CKT #1	Line	PSCo	478.0	513.5	107.4	547.6	114.6	7.14	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
FULLER (78854) TO FULLER (73481) 230/115 kV CKT #2	Xfmr	PSCo	100.0	105.0	105.0	112.6	112.6	7.64	MIDWAYBR (73412) TO RANCHO (73416) 115 kV CKT #1
FULLER (78854) TO FULLER (73481) 230/115 kV CKT #1	Xfmr	PSCo	100.0	105.0	105.0	112.6	112.6	7.64	MIDWAYBR (73412) TO RANCHO (73416) 115 kV CKT #1
MONACO12 (70481) TO SULLIVN2 (70365) 230 kV CKT #1	Line	PSCo	560.0	616.4	110.1	629.7	112.5	2.38	BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1
WATERTON (70463) TO WATERTN_TP (70484) 115 kV CKT #1	Line	PSCo	189.0	200.0	105.8	210.9	111.6	5.78	CHATFLD (70100) TO WATERTON (70464) 230 kV CKT #1
HARRISPS (70215) TO LEETSDAL2 (70282) 115 kV CKT #1	Line	PSCo	141.0	154.5	109.6	156.2	110.8	1.18	SANDOWN (70377) TO LEETSDAL1 (70259) 115 kV CKT #1
WATERTON (70466) TO GI-12-14 (71938) 345 kV CKT #1	Line	PSCo	1138.0	1090.8	95.9	1246.7	109.6	13.70	DANIELPK (70601) TO GI-12-14 (71938) 345 kV CKT #1
W.CANON (70550) TO W CANON (73551) 115/230 kV CKT #T1	Xfmr	BHE	100.0	89.6	89.6	108.6	108.6	19.05	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
HYDEPARK (70236) TO PUEBPLNT (70339) 115 kV CKT #1	Line	BHE	160.0	162.6	101.6	173.5	108.4	6.79	GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1
MIDWAYBR (73412) TO RANCHO (73416) 115 kV CKT #1	Line	TSGT	145.0	136.4	94.1	156.6	108.0	13.93	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2
BRIARGATE N (78656) TO KETTLECK N (78672) 115 kV CKT #1	Line	CSU	186.0	183.8	98.8	197.0	105.9	7.11	CTTNWD N (78658) TO KETTLECK S (78673) 115 kV CKT #1
RANCHO (73416) TO LORSONRH (73458) 115 kV CKT #1	Line	TSGT	145.0	133.1	91.8	153.1	105.6	13.79	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2
DANIELPK (70601) TO GI-12-14 (71938) 345 kV CKT #1	Line	PSCo	1195.0	1057.2	88.5	1228.2	102.8	14.31	WATERTON (70466) TO GI-12-14 (71938) 345 kV CKT #1
PORTLAND (70330) TO SKALA (70390) 115 kV CKT 1	Line	BHE	120.0	110.6	92.2	123.2	102.7	10.48	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
CLAREMNT (78850) TO FULLER (78854) 230 kV CKT #1	Line	CSU	376.0	327.8	87.2	383.2	101.9	14.73	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
BONNY CK (73025) TO SO. FORK (73185) 115 kV CKT #1	Line	TSGT	147.0	133.0	90.5	147.2	100.2	9.69	BURLNGTN (73036) TO WRAY (73224) 230 kV CKT #1

Table 23 – South Pocket NRIS – Multiple Contingency Overloads

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[3]
				MVA Flow	% Loading	MVA Flow	% Loading		
FTN_VLY (70193) TO MIDWAYBR (73412) 115 kV CKT #1	Line	BHE	171.0	310.0	181.3	387.7	226.7	45.39	BF_217
DESRTCOV (70449) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	222.0	338.8	152.6	417.1	187.9	35.28	BF_217
VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1	Line	TSGT	143.0	228.0	159.4	262.8	183.8	24.33	BF_095
VOLLMERT (72413) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	143.0	223.1	156.0	257.7	180.2	24.21	BF_095
FTN_VLY (70193) TO DESRTCOV (70449) 115 kV CKT #1	Line	BHE	222.0	311.4	140.3	389.0	175.2	34.96	BF_217
MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1	Line	PSCo	637.0	858.2	134.7	1104.1	173.3	38.61	P7_066
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	670.4	140.3	814.8	170.5	30.21	P7_064
GI-2020-13 P (990051) TO MIDWAYPS (70286) 230 kV CKT #1	Line	PSCo	319.0	205.4	64.4	506.2	158.7	94.27	BF_090
MONUMENT (73414) TO GRESHAM (73445) 115 kV CKT #1	Line	TSGT	145.0	174.2	120.2	207.7	143.2	23.08	BF_095
PALMER (70308) TO MONUMENT (73414) 115 kV CKT #1	Line	PSCo	162.0	189.6	117.0	230.7	142.4	25.41	BF_095
DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2	Line	PSCo	598.0	773.8	129.4	840.0	140.5	11.06	BF_096
CLAREMNT (78850) TO FULLER (78854) 230 kV CKT #1	Line	CSU	376.0	435.3	115.8	520.7	138.5	22.71	P7_066
GREENWD (70212) TO PRAIRIE3 (70323) 230 kV CKT #1	Line	PSCo	576.0	721.0	125.2	786.8	136.6	11.42	BF_096
GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1	Line	PSCo	1195.0	1377.0	115.2	1579.3	132.2	16.93	BF_098
MIDWAYBR (73412) TO RANCHO (73416) 115 kV CKT #1	Line	TSGT	145.0	160.5	110.7	184.6	127.3	16.58	P7_066
PUEBPLNT (70339) TO READER (70352) 115 kV CKT #1	Line	BHE	160.0	188.2	117.6	203.6	127.3	9.64	BF_090
W.CANON (70550) TO HOGBACK115 (71025) 115 kV CKT #1	Line	BHE	120.0	126.2	105.2	151.9	126.6	21.44	BF_217

[3] Contingency Definitions corresponding to Contingency Names are given in Appendix A.

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[3]
				MVA Flow	% Loading	MVA Flow	% Loading		
BLKFORTP (73455) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	173.0	183.8	106.3	217.6	125.8	19.52	BF_095
RANCHO (73416) TO LORSONRH (73458) 115 kV CKT #1	Line	TSGT	145.0	157.3	108.5	181.2	124.9	16.46	P7_066
DANIELPK (70139) TO SURREYRG (70284) 230 kV CKT #1	Line	PSCo	478.0	550.8	115.2	596.9	124.9	9.65	P7_048
DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2	Line	PSCo	1195.0	1258.0	105.3	1465.7	122.7	17.38	BF_090
GRESHAM (73445) TO BLKFORTP (73455) 115 kV CKT #1	Line	TSGT	173.0	178.5	103.2	212.1	122.6	19.42	BF_095
MIDWAYBR (73413) TO RD_NIXON (78857) 230 kV CKT #1	Line	CSU	531.0	516.9	97.4	641.9	120.9	23.53	P7_066
DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1	Line	PSCo	607.0	679.2	111.9	732.2	120.6	8.74	BF_153
MIDWAYBR (73412) TO RD_NIXON (78676) 115 kV CKT #1	Line	CSU	195.0	176.2	90.3	234.7	120.3	30.00	BF_217
W.CANON (70550) TO W CANON (73551) 115/230 kV CKT #T1	Xfmr	BHE	100.0	95.1	95.1	118.1	118.1	22.96	BF_217
DANIELPK (70139) TO SANTEFE (70527) 230 kV CKT #1	Line	PSCo	560.0	630.3	112.6	660.9	118.0	5.46	BF_155
WATERTON (70463) TO WATERTN_TP (70484) 115 kV CKT #1	Line	PSCo	189.0	211.2	111.8	220.8	116.8	5.06	BF_328
MIDWAYPS (70285) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	80.0	71.2	89.0	91.3	114.1	25.08	BF_217
MIRASOL (70652) TO GI-2014-9 (970999) 230 kV CKT #1	Line	PSCo	478.0	503.8	105.4	545.1	114.0	8.65	BF_090
GREENWD (70212) TO PRAIRIE1 (70331) 230 kV CKT #2	Line	PSCo	576.0	602.3	104.6	655.3	113.8	9.20	BF_153
FULLER (78854) TO FULLER (73481) 230/115 kV CKT #1	Xfmr	PSCo	100.0	100.3	100.3	112.0	112.0	11.69	BF_095
FULLER (78854) TO FULLER (73481) 230/115 kV CKT #2	Xfmr	PSCo	100.0	100.3	100.3	112.0	112.0	11.69	BF_095
GREENWD (70212) TO MONACO12 (70481) 230 kV CKT #1	Line	PSCo	560.0	603.5	107.8	618.7	110.5	2.71	P7_049
PORTLAND (70330) TO SKALA (70390) 115 kV CKT #1	Line	BHE	120.0	114.9	95.8	131.8	109.9	14.07	BF_217
HYDEPARK (70236) TO PUEBPLNT (70339) 115 kV CKT #1	Line	BHE	160.0	161.1	100.7	175.3	109.6	8.86	BF_090
COMANCHE (70122) TO COMANCHE (70654) 230/345 kV CKT #T4	Xfmr	PSCo	756.0	688.9	91.1	823.4	108.9	17.80	BF_085

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[3]
				MVA Flow	% Loading	MVA Flow	% Loading		
HARRISPS (70215) TO LEETSDAL2 (70282) 115 kV CKT #1	Line	PSCo	155.0	165.7	106.9	167.9	108.3	1.45	BF_105
LEETSDAL (70260) TO MONROEPS (70291) 230 kV CKT #1	Line	PSCo	438.0	466.1	106.4	472.7	107.9	1.51	BF_193
MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	432.2	90.4	511.1	106.9	16.51	P7_064
ARAPAHOE (70038) TO SANTEFE (70527) 230 kV CKT #1	Line	PSCo	560.0	568.4	101.5	598.3	106.8	5.34	BF_155
GRAY_ST. (70208) TO LAKEWOD2 (70252) 115 kV CKT #2	Line	PSCo	120.0	126.3	105.3	127.7	106.4	1.15	BF_361
DEERCRK (70142) TO SODALAKE (70400) 115 kV CKT #1	Line	PSCo	154.0	153.9	100.0	163.4	106.1	6.13	BF_328
MIDWAYPS (70286) TO MIDWAYPS (70465) 230/345 kV CKT #T3	Xfmr	PSCo	756.0	631.0	83.5	798.7	105.7	22.18	BF_217
FALCONMV (73402) TO GEESEN (73405) 115 kV CKT #1	Line	TSGT	145.0	130.4	89.9	153.1	105.6	15.66	P7_066
WATERTON (70463) TO MARTIN_TP (70483) 115 kV CKT #1	Line	PSCo	189.0	190.6	100.8	199.1	105.3	4.50	P7_044
CANONCTY (70086) TO SKALA (70390) 115 kV CKT #1	Line	BHE	119.0	107.8	90.6	124.3	104.4	13.80	BF_217
MONACO12 (70481) TO SULLIVN2 (70365) 230 kV CKT #1	Line	PSCo	560.0	566.6	101.2	581.3	103.8	2.63	BF_313
LITTLET1 (70263) TO MARTIN_TP (70483) 115 kV CKT #1	Line	PSCo	175.0	171.7	98.1	180.1	102.9	4.80	P7_044
GRAY_ST. (70208) TO LAKEWOD1 (70251) 115 kV CKT #1	Line	PSCo	120.0	120.0	100.0	121.3	101.1	1.11	BF_361
CHATFLD (70100) TO WATERTON (70464) 230 kV CKT #1	Line	PSCo	557.0	523.4	94.0	558.7	100.3	6.35	BF_155

Table 24 – South Pocket NRIS – System Network Upgrades

Network Upgrade	Facility Type
New Comanche to Harvest Mile 345 kV CKT #1	Line
New Comanche 230/345 kV Xfmr	Transformer
New Vilas 69/115 kV Xfmr	Transformer
New Boone 115/230 kV Xfmr	Transformer
New Fuller 230/115 kV Xfmr	Transformer
New Harvest Mile 345/230 kV Xfmr	Transformer
Upgrade Vollmert to Fuller 115 kV CKT #1	Line
Upgrade Vollmert to Blk Sqmv 115 kV CKT #1	Line
Upgrade Boone to GI-2020-13 P 230 kV CKT #1	Line
Upgrade GI-2020-13 P to MidwayPS 230 kV CKT #1	Line
Upgrade GI-2020-3POI to Comanche 230 kV CKT #1	Line
Upgrade Cottonwood N to KettleCreek S 115 kV CKT #1	Line
Upgrade Daniels Park to Fuller 230 kV CKT #1	Line
Upgrade Palmer to Monument 115 kV CKT #1	Line
Upgrade Monument to Gresham 115 kV CKT #1	Line
Upgrade Greenwood to Monaco12 230 kV CKT #1	Line
Upgrade Canon City to NCanon_W 69 kV CKT #1	Line
Upgrade Monaco12 to Sullivan2 230 kV CKT #1	Line
Upgrade Harris PS to Leetsdal2 115 kV CKT #1	Line
Upgrade Buckley 2 to Tolgate 230 kV CKT #1	Line
Upgrade Boone to GI-2020-3POI 230 kV CKT #1	Line
Upgrade Midway PS to Fuller 230 kV CKT #1	Line
Upgrade Blkfortp to Blk Sqmv 115 kV CKT #1	Line
Upgrade Briargate S to Cottonwood S 115 kV CKT #1	Line
Upgrade Buckley 2 to Smoky Hill 230 kV CKT #1	Line
Upgrade Gresham to Blkfortp 115 kV CKT #1	Line
Upgrade Leetsdal to Monroe PS 230 kV CKT #1	Line

7.4 Steady-State Analysis – ERIS Study Case

The ERIS Study Case was created from the NRIS Study Case (along with identified NRIS System Network Upgrades from Table 24), by modeling GI-2021-12 at a new POI tapping the Comanche to Mirasol segment of the Comanche to Midway 230 kV line, GI-2021-13 at Mirasol 230 kV, GI-2021-19 at Tundra 345 kV, GI-2021-20 at Tundra 345 kV, and GI-2021-24 at Mirasol 230 kV. The total 1683.7 MW of ERIS output from GI-2021-12, GI-2021-13, GI-2021-19, GI-2021-20, and GI-2021-24 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The ERIS Study Case contingency analysis was performed using OPF to redispatch to alleviate any single and system intact overloads according to Section 4.4. Table 25 shows the single overloads which cannot be mitigated by redispatch using OPF. This shows the need for required System Network Upgrades for ERIS GIRs, tabulated in Table 26.

The system intact overloads for ERIS Study Case (including required ERIS System Network Upgrades tabulated in Table 26) are shown in Table 27.

The single-contingency overloads for ERIS Study Case (including required ERIS System Network Upgrades tabulated in Table 26) are shown in Table 28.

The single-contingency overloads identified show that ERIS GIRs contribute to existing overloads in the ERIS Benchmark Case. Therefore, the maximum allowable ERIS generation for GIRs GI-2021-12, GI-2021-13, GI-2021-19, GI-2021-20, and GI-2021-24 including additional System Network Upgrades in Table 26, is calculated to be 0 MW each.

Table 25 – South Pocket ERIS (After Redispatch) – Single Contingency Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (After Redispatch)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2	Line	PSCo	1195	310.7	26.0	1270.5	106.3	80.30	TUNDRA (70653) TO GI-2020-7-POI (70651) 345 kV CKT #2
GI-2020-7-POI (70651) TO COMANCHE (70654) 345 kV CKT #2	Line	PSCo	1195	327.4	27.4	1242.8	104.0	76.60	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2
TUNDRA (70653) TO GI-2020-7-POI (70651) 345 kV CKT #2	Line	PSCo	1195	327.4	27.4	1241.5	103.9	76.50	DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2

Table 26 – South Pocket ERIS – System Network Upgrades

Network Upgrade	Type
Upgrade Daniels Park to Tundra 345 kV CKT #2	Line
Upgrade GI-2020-7-POI to Comanche 345 kV CKT #2	Line
Upgrade Tundra to GI-2020-7-POI 345 kV CKT #2	Line

Table 27 – South Pocket ERIS (Including ERIS System Network Upgrades) – System Intact Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (Including ERIS System Network Upgrades)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1	Line	PSCo	607.0	535.3	88.2	644.5	106.2	18.0	System Intact Condition
DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2	Line	PSCo	598.0	521.2	87.2	630.5	105.4	18.3	System Intact Condition
GREENWD (70212) TO PRAIRIE3 (70323) 230 kV CKT #1	Line	PSCo	576.0	468.5	81.3	577.0	100.2	18.8	System Intact Condition
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	643.3	500.7	77.8	709.4	110.3	32.4	System Intact Condition
FTN_VLY (70193) TO MIDWAYBR (73412) 115 kV CKT #1	Line	BHE	171.0	127.0	74.3	199.5	116.6	42.4	System Intact Condition
GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1	Line	PSCo	1195.0	867.2	72.6	1348.3	112.8	40.3	System Intact Condition
DESRTCOV (70449) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	222.0	155.7	70.1	229.1	103.2	33.1	System Intact Condition
MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1	Line	PSCo	637.0	386.5	60.7	638.1	100.2	39.5	System Intact Condition

Table 28 – South Pocket ERIS (Including ERIS System Network Upgrades) – Single Contingency Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (Including ERIS System Network Upgrades)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
FTN_VLY (70193) TO MIDWAYBR (73412) 115 kV CKT #1	Line	BHE	171.0	189.7	110.9	323.3	189.1	78.2	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
DESRTCOV (70449) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	222.0	217.8	98.1	352.6	158.8	60.7	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2	Line	PSCo	598.0	777.8	130.1	940.9	157.3	27.3	DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1
DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1	Line	PSCo	607.0	785.2	129.4	948.3	156.2	26.9	DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2
GREENWD (70212) TO PRAIRIE3 (70323) 230 kV CKT #1	Line	PSCo	576.0	725.0	125.9	887.1	154.0	28.2	DANIELPK (70139) TO PRAIRIE1 (70331) 230 kV CKT #1

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (Including ERIS System Network Upgrades)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1	Line	PSCo	637.0	616.7	96.8	963.8	151.3	54.5	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
GREENWD (70212) TO PRAIRIE1 (70331) 230 kV CKT #2	Line	PSCo	576.0	707.0	122.8	869.4	150.9	28.2	DANIELPK (70139) TO PRAIRIE3 (70323) 230 kV CKT #2
MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	518.9	509.7	98.2	777.4	149.8	51.6	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
FTN_VLY (70193) TO DESRTCOV (70449) 115 kV CKT #1	Line	BHE	222.0	191.0	86.0	324.7	146.2	60.2	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
DEERCRK (70142) TO SODALAKE (70400) 115 kV CKT #1	Line	PSCo	120.0	141.0	117.5	174.5	145.4	27.9	CHATFLD (70100) TO WATERTON (70464) 230 kV CKT #1
W.CANON (70550) TO HOGBACK115 (71025) 115 kV CKT #1	Line	BHE	120.0	118.1	98.4	174.1	145.1	46.7	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
WATERTON (70464) TO WATERTON (70466) 345/230 kV CKT #T3	Xfmr	PSCo	560.0	593.7	106.0	800.6	143.0	37.0	WATERTON (70464) TO WATERTON (70466) 345/230 kV CKT #T4
WATERTON (70464) TO WATN-MID (999013) 345/230 kV CKT #T4	Xfmr	PSCo	560.0	590.6	105.5	790.2	141.1	35.6	WATERTON (70464) TO WATERTON (70466) 345/230 kV CKT #T3
W.CANON (70550) TO W CANON (73551) 230/115 kV CKT #T1	Xfmr	BHE	100.0	87.9	87.9	140.7	140.7	52.8	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
WATERTON (70464) TO WATERTON (70466) 345/230 kV CKT #T3	Line	PSCo	560.0	590.1	105.4	777.4	138.8	33.5	WATERTON (70464) TO WATN-MID (999013) 345/230 kV CKT #T4
WATERTON (70464) TO WATN-MID (999013) 345/230 kV CKT #T4	Line	PSCo	560.0	591.2	105.6	772.8	138.0	32.4	WATERTON (70464) TO WATN-MID (999013) 345/230 kV CKT #T3
B.SANDY (73017) TO LSCHANCE (73125) 115 kV CKT #1	Line	WAPA	109.0	91.6	84.0	149.1	136.8	52.8	LANDSMCK (72710) TO BURLNGTN (73036) 230 kV CKT #1
PAWNEE (70598) TO PAWNEE (70311) 345 kV CKT #T2	Line	PSCo	560.0	239.3	42.7	689.6	123.1	80.4	PAWNEE (70598) TO PAWNEE (70311) 345 kV CKT #T3
PAWNEE (70598) TO PAWNEE (70311) 345 kV CKT #T3	Line	PSCo	560.0	239.3	42.7	689.6	123.1	80.4	PAWNEE (70598) TO PAWNEE (70311) 345 kV CKT #T2
WATERTON (70463) TO WATERTN_TP (70484) 115 kV CKT #1	Line	PSCo	189.0	198.2	104.9	231.5	122.5	17.6	CHATFLD (70100) TO WATERTON (70464) 230 kV CKT #1
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	643.3	553.9	86.1	785.7	122.1	36.0	VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1
GI-12-14 (71938) TO COMANCHE (70654) 345 kV CKT #1	Line	PSCo	1195.0	909.9	76.1	1454.3	121.7	45.6	MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #1
PORTLAND (70330) TO SKALA (70390) 115 kV CKT #1	Line	BHE	120.0	109.7	91.4	145.7	121.4	30.0	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
CLAREMNT (78850) TO FULLER (78854) 230 kV CKT #1	Line	CSU	376.0	333.7	88.8	455.1	121.0	32.3	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (Including ERIS System Network Upgrades)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
MONUMENT (73414) TO GRESHAM (73445) 115 kV CKT #1	Line	TSGT	177.5	157.7	88.8	214.5	120.9	32.0	FLYHORSE S (78665) TO KETTLECK N (78672) 115 kV CKT #1
MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #1	Line	PSCo	478.0	283.3	59.3	576.5	120.6	61.3	MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #2
MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #2	Line	PSCo	478.0	283.3	59.3	576.5	120.6	61.3	MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #1
BRIARGATE (78657) TO CTTNWD S (78659) 115/S 115 kV CKT #1	Line	CSU	161.9	159.1	98.3	194.8	120.3	22.1	CTTNWD N (78658) TO KETTLECK S (78673) 115 kV CKT #1
GRESHAM (73445) TO BLKFORTP (73455) 115 kV CKT #1	Line	TSGT	181.8	161.9	89.0	218.7	120.3	31.3	FLYHORSE S (78665) TO KETTLECK N (78672) 115 kV CKT #1
BLKFORTP (73455) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	187.2	167.2	89.3	224.2	119.8	30.4	FLYHORSE S (78665) TO KETTLECK N (78672) 115 kV CKT #1
BONNY CK (73025) TO SO. FORK (73185) 115 kV CKT #1	Line	TSGT	147.0	137.5	93.6	175.5	119.4	25.8	BURLNGTN (73036) TO WRAY (73224) 230 kV CKT #1
VOLLMERT (72413) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	226.5	206.6	91.2	265.5	117.2	26.0	FLYHORSE S (78665) TO KETTLECK N (78672) 115 kV CKT #1
VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1	Line	TSGT	231.5	211.5	91.4	270.6	116.9	25.5	FLYHORSE S (78665) TO KETTLECK N (78672) 115 kV CKT #1
PUEBPLNT (70339) TO READER (70352) 115 kV CKT #1	Line	BHE	160.0	112.2	70.1	186.9	116.8	46.7	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
LEETSDAL (70260) TO MONROEPS (70291) 230 kV CKT #1	Line	PSCo	407.0	413.6	101.6	472.9	116.2	14.6	GREENWD (70212) TO ARAPAHOE (70038) 230 kV CKT #1
CANONCTY (70086) TO SKALA (70390) 115 kV CKT #1	Line	BHE	119.0	102.8	86.4	137.9	115.9	29.6	MIDWAYBR (73413) TO W CANON (73551) 230 kV CKT #1
MIDWAYBR (73412) TO RANCHO (73416) 115 kV CKT #1	Line	TSGT	145.0	126.2	87.0	166.1	114.6	27.6	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
BRIARGATE (78656) TO KETTLECK N (78672) 115/N 115 kV CKT #1	Line	CSU	186.0	181.6	97.6	209.4	112.6	15.0	CTTNWD N (78658) TO KETTLECK S (78673) 115 kV CKT #1
RANCHO (73416) TO LORSONRH (73458) 115 kV CKT #1	Line	TSGT	145.0	123.0	84.8	162.8	112.3	27.4	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
CTTNWD N (78658) TO KETTLECK S (78673) 115 kV CKT #1	Line	CSU	223.4	219.1	98.1	250.3	112.0	14.0	BRIARGATE N (78656) TO BRIARGATE S (78657) 115 kV CKT #1
MIDWAYPS (70286) TO mid pt (99534) 345/230 kV CKT #T3	Xfmr	PSCo	560.0	473.1	84.5	625.5	111.7	27.2	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
mon_sr (973414) TO FLYHORSE N (78664) 115 kV CKT #1	Line	PSCo	142.0	117.3	82.6	156.8	110.5	27.8	VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1
MONUMENT (73414) TO mon_sr (973414) 115 kV CKT #1	Line	CSU	142.0	117.3	82.6	156.8	110.4	27.8	VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (Including ERIS System Network Upgrades)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
MIDWAYPS (70465) TO mid pt (99534) 345 kV CKT #T3	Line	PSCo	560.0	474.0	84.6	617.2	110.2	25.6	MIDWAYPS (70286) TO MIDWAYBR (73413) 230 kV CKT #1
LEETSDAL (70260) TO SULLIVN2 (70365) 230 kV CKT #1	Line	PSCo	560.0	559.2	99.9	616.7	110.1	10.3	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
DANIELPK (70601) TO TUNDRA (70653) 345 kV CKT #2	Line	PSCo	1195.0	729.3	61.0	1313.1	109.9	48.9	MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #2
DANIELPK (70139) TO DANIELPK (70601) 345/230 kV CKT #T5	Xfmr	PSCo	560.0	506.1	90.4	613.7	109.6	19.2	DANIELPK (70139) TO DANIELPK (70601) 345/230 kV CKT #T
DANIELPK (70139) TO DANIELPK (70601) 345/230 kV CKT #T4	Xfmr	PSCo	560.0	506.1	90.4	613.7	109.6	19.2	DANIELPK (70139) TO DANIELPK (70601) 345/230 kV CKT #T
DANIELPK (70139) TO DANIELPK (70601) 345/230 kV CKT #T3	Xfmr	PSCo	560.0	506.1	90.4	613.7	109.6	19.2	DANIELPK (70139) TO DANIELPK (70601) 345/230 kV CKT #T
CASTLRCK (70091) TO PALMER (70308) 115 kV CKT #1	Line	PSCo	128.0	97.1	75.9	140.2	109.6	33.7	PALMER (70308) TO GREENLND (70582) 115 kV CKT #1
MONACO12 (70481) TO SULLIVN2 (70365) 230 kV CKT #1	Line	PSCo	635.0	636.5	100.2	693.7	109.2	9.0	BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1
COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T5	Xfmr	PSCo	560.0	542.0	96.8	609.7	108.9	12.1	COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T
COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T3	Xfmr	PSCo	560.0	542.0	96.8	609.7	108.9	12.1	COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T
COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T4	Xfmr	PSCo	560.0	542.0	96.8	609.7	108.9	12.1	COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T
GREENWD (70212) TO MONACO12 (70481) 230 kV CKT #1	Line	PSCo	672.3	673.7	100.2	731.7	108.8	8.6	BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1
PALMER (70308) TO MONUMENT (73414) 115 kV CKT #1	Line	PSCo	193.5	147.8	76.4	210.5	108.8	32.4	EMIL AND (73400) TO MONUMENT (73414) 115 kV CKT #1
HARRISPS (70215) TO LEETSDAL2 (70282) 115 kV CKT #1	Line	PSCo	158.9	159.5	100.4	172.8	108.8	8.4	LEESDAL1 (70259) TO SANDOWN (70377) 115 kV CKT #1
CHATFLD (70100) TO WATERTON (70464) 230 kV CKT #1	Line	PSCo	478.0	417.8	87.4	511.0	106.9	19.5	WATERTON (70463) TO WATERTN_TP (70484) 115 kV CKT #1
KELKER E (78670) TO TEMPLTON (78681) 115 kV CKT #1	Line	CSU	131.0	116.8	89.2	139.1	106.2	17.0	KELKER E (78670) TO ROCKISLD (78677) 115 kV CKT #1
DENVTM (70149) TO LACOMBE (70324) 230 kV CKT #1	Line	PSCo	486.0	393.0	80.9	512.3	105.4	24.6	LOOKOUT (70266) TO RIDGE (70355) 230 kV CKT #1
BONNY CK (73025) TO BURLNGTN (73035) 115 kV CKT #1	Line	TSGT	173.0	142.7	82.5	180.8	104.5	22.1	BURLNGTN (73036) TO WRAY (73224) 230 kV CKT #1
LITTLET1 (70263) TO MARTIN_TP (70483) 115 kV CKT #1	Line	PSCo	159.0	147.5	92.8	166.1	104.5	11.7	WATERTON (70463) TO WATERTN_TP (70484) 115 kV CKT #1

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (Including ERIS System Network Upgrades)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
DRAKE E (78660) TO FONTERO E (78666) 115 kV CKT #1	Line	CSU	167.0	140.3	84.0	174.2	104.3	20.3	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
FLYHORSE S (78665) TO KETTLECK N (78672) 115 kV CKT #1	Line	CSU	162.0	128.8	79.5	168.9	104.3	24.8	VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	544.9	553.8	101.6	559.5	102.7	1.1	GREENWD (70212) TO MONACO12 (70481) 230 kV CKT #1
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	545.1	553.9	101.6	559.6	102.7	1.0	GREENWD (70212) TO MONACO12 (70481) 230 kV CKT #1
MIDWAYBR (73413) TO RD_NIXON (78857) 230 kV CKT #1	Line	CSU	531.0	371.6	70.0	540.3	101.8	31.8	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1	Line	PSCo	159.0	159.0	100.0	161.3	101.5	1.5	HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2
GI-2020-13 (990051) TO MIDWAYPS (70286) 230/P 230 kV CKT #1	Line	PSCo	461.2	390.1	84.6	467.5	101.4	16.8	MIDWAYPS (70286) TO MIRASOL (70652) 230 kV CKT #1
LSCHANCE (73125) TO SWOODROW (73194) 115 kV CKT #1	Line	WAPA	109.0	67.0	61.4	110.0	101.0	39.5	BURLNGTN (73036) TO WRAY (73224) 230 kV CKT #1
FONTERO W (78667) TO RAMPART S (78675) 115 kV CKT #1	Line	CSU	154.0	122.4	79.5	155.3	100.9	21.4	MIDWAYPS (70286) TO FULLER (78854) 230 kV CKT #1
ELATI1 (70163) TO MONROEPS (70291) 230 kV CKT #1	Line	PSCo	398.0	338.4	85.0	401.4	100.9	15.8	GREENWD (70212) TO ARAPAHOE (70038) 230 kV CKT #1
KELKER E (78670) TO ROCKISLD (78677) 115 kV CKT #1	Line	CSU	162.0	139.5	86.1	163.1	100.7	14.5	KELKER E (78670) TO TEMPLTON (78681) 115 kV CKT #1

7.5 Affected Systems

TSGT, BHE, CSU and WAPA are identified as Affected Systems as a result of overloads on their facilities as listed in Table 21, Table 22, Table 23, Table 27 and Table 28.

7.6 Summary of Southern Study Pocket Analysis

NRIS identified for GI-2021-21 is 300 MW.

NRIS identified for GI-2021-22 is 150 MW.

The NRIS study identified all the overloads caused by the NRIS study GIRs. The study also identified all the suitable mitigations necessary to alleviate the overloads caused by NRIS study GIRs.

The ERIS study was performed taking into consideration all the NRIS System Network Upgrades identified. The ERIS study showed single contingency overloads that cannot be alleviated by performing OPF redispatch. Hence, it is identified that there are additional network upgrades needed for ERIS requested.

A DFAX analysis with respect to thermal overloads was performed to compute the maximum allowable output for each ERIS GIR. The maximum allowable output of the ERIS GIRs (including required ERIS System Network Upgrades tabulated in Table 26) is:

- ERIS of GI-2021-12 is 0 MW
- ERIS of GI-2021-13 is 0 MW
- ERIS of GI-2021-19 is 0 MW
- ERIS of GI-2021-20 is 0 MW
- ERIS of GI-2021-24 is 0 MW

ERIS, when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis is:

- GI-2021-12 is 250 MW
- GI-2021-13 is 250 MW
- GI-2021-19 is 500 MW
- GI-2021-20 is 500 MW
- GI-2021-24 is 183.7 MW

Additionally, a Grid Charging study was performed for GI-2021-12, GI-2021-22. The study did not identify any voltage or thermal overloads attributed to these GIRs. Grid Charging capabilities without any additional System Network Upgrades for:

- GI-2021-12 is 125 MW.
- GI-2021-22 is 150 MW.

8.0 Metro Colorado Study Pocket Analysis

8.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case by adopting the generation dispatch in Table 29 to reflect heavy generation in the Denver Metro region.

Table 29 – Generation Dispatch Used to Create the Metro Colorado Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70553	ARAP5&6	13.8	G5	1	35.5	39.5
70553	ARAP5&6	13.8	G6	1	37.3	41.4
70554	ARAP7	13.8	ST	1	44.3	49.2
70580	PLNENDG1_1	13.8	G0	1	3.5	5.4
70587	PLNENDG1_2	13.8	G0	1	3.5	5.4
70106	CHEROK4	22	G4	1	366.0	600.0
70580	PLNENDG1_1	13.8	G1	1	3.5	5.4
70580	PLNENDG1_1	13.8	G2	1	3.5	5.4
70580	PLNENDG1_1	13.8	G3	1	3.5	5.4
70580	PLNENDG1_1	13.8	G4	1	3.5	5.4
70580	PLNENDG1_1	13.8	G5	1	3.5	5.4
70580	PLNENDG1_1	13.8	G6	1	3.5	5.4
70580	PLNENDG1_1	13.8	G7	1	3.5	5.4
70580	PLNENDG1_1	13.8	G8	1	3.5	5.4
70580	PLNENDG1_1	13.8	G9	1	3.5	12.2
70585	PLNENDG2_1	13.8	G1	1	4.7	8.1
70585	PLNENDG2_1	13.8	G2	1	4.7	8.1
70585	PLNENDG2_1	13.8	G3	1	4.7	8.1
70585	PLNENDG2_1	13.8	G4	1	4.7	8.1
70585	PLNENDG2_1	13.8	G5	1	4.7	8.1
70585	PLNENDG2_1	13.8	G6	1	4.7	8.1
70585	PLNENDG2_1	13.8	G7	1	4.7	10.6
70586	PLNENDG2_2	13.8	G1	1	4.7	8.1
70586	PLNENDG2_2	13.8	G2	1	4.7	8.1
70586	PLNENDG2_2	13.8	G3	1	4.7	8.1
70586	PLNENDG2_2	13.8	G4	1	4.7	8.1
70586	PLNENDG2_2	13.8	G5	1	4.7	8.1
70586	PLNENDG2_2	13.8	G6	1	4.7	10.6
70586	PLNENDG2_2	13.8	G7	1	4.7	11.2
70587	PLNENDG1_2	13.8	G1	1	3.5	8.1

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70587	PLNENDG1_2	13.8	G2	1	3.5	8.1
70587	PLNENDG1_2	13.8	G3	1	3.5	8.1
70587	PLNENDG1_2	13.8	G4	1	3.5	5.4
70587	PLNENDG1_2	13.8	G5	1	3.5	8.1
70587	PLNENDG1_2	13.8	G6	1	3.5	8.1
70587	PLNENDG1_2	13.8	G7	1	3.5	5.4
70587	PLNENDG1_2	13.8	G8	1	3.5	5.4
70587	PLNENDG1_2	13.8	G9	1	3.5	7.9
70145	CHEROKEE5	18	G5	1	182.5	202.8
70146	CHEROKEE6	18	G6	1	174.6	194.0
70147	CHEROKEE7	18	ST	1	229.5	255.0
Total					1205.5	1634.2

8.2 Study Case Modeling

The NRIS Study Case was created from the Benchmark Case by modeling GI-2021-14 at Green Valley 230 kV. The 199 MW NRIS output of GI-2021-14 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

8.3 Steady-State Analysis – NRIS Study Case

The single contingency analysis on the NRIS Study Case did not identify any overloads.

The multiple contingency analysis on the NRIS Study Case did not identify any overloads.

8.4 Affected Systems

The study did not identify any impacts to Affected Systems.

8.5 Summary of Metro Study Pocket Analysis

The NRIS identified for GI-2021-14 is 199 MW.

The study did not identify any voltage violations or thermal overloads attributed to the NRIS GIR.

9.0 Eastern Colorado Study Pocket Analysis

9.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case by adopting the generation dispatch in Table 30 to reflect heavy generation in the Eastern Colorado pocket.

Table 30 – Generation Dispatch Used to Create the Eastern Colorado Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
999010	GI-2014-5	34.5	G1	1	42.0	50.0
70629	RUSHCK_W1	34.5	W1	1	304.0	380.0
70631	RUSHCK_W2	34.5	W2	1	176.0	220.0
70635	LIMON1_W	34.5	W1	1	160.8	201.0
70636	LIMON2_W	34.5	W2	1	160.8	201.0
70637	LIMON3_W	34.5	W3	1	160.8	201.0
70670	CEDARPT_W1	0.69	W1	1	100.0	125.0
70671	CEDARPT_W2	0.69	W2	1	100.0	125.0
70710	PTZLOGN1	34.5	W1	1	160.8	201.0
70712	PTZLOGN2	34.5	W2	1	96.0	120.0
70713	PTZLOGN3	34.5	W3	1	63.6	79.5
70714	PTZLOGN4	34.5	W4	1	140.0	175.0
70733	CHEYRGE_W1	0.69	W1	1	99.2	124.0
70736	CHEYRGE_W2	0.69	W2	1	100.8	126.0
70739	CHEYRGW_W1	0.69	W1	1	99.2	124.0
70742	CHEYRGW_W2	0.69	W2	1	100.8	126.0
70753	BRONCO_W1	0.69	W1	1	240.0	300.0
70314	MANCHEF1	16	G1	1	136.1	151.3
70315	MANCHEF2	16	G2	1	136.1	151.3
70310	PAWNEE	22	C1	1	536.0	536.0
88884	GI-2021-6	34.5	G1	1	199.0	199.0
88889	GI-2021-8	34.5	G1	1	400.0	400.0
Total					3712.0	4316.1

9.2 Study Case Modeling

An NRIS Study Case was developed from the Benchmark Case by modeling GI-2021-27 at Missile Site 230 kV, GI-2021-29 at a new tap point on the Pawnee to Missile Site 230 kV line, and GI-2021-30 and GI-2021-31 at Pawnee 345 kV. The total 1129.5 MW output of GI-2021-27, GI-

2021-29, GI-2021-30, and GI-2021-31 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The ERIS Study Case was developed from the NRIS Study Case (along with any System Network Upgrades for NRIS) by modeling GI-2021-16 at Harvest Mile 345 kV, and GI-2021-25 and GI-2021-26 at Pawnee 345 kV. The total 744.7 MW of ERIS output from GI-2021-16, GI-2021-25, and GI-2021-26 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

9.3 Steady-State Analysis – NRIS Study Case

Contingency analysis was performed on the East pocket NRIS Study Case.

The results of the system-intact analysis on the NRIS Study Case are shown in Table 31.

The results of the single contingency analysis on the NRIS Study Case are shown in Table 32.

The results of the multiple contingency analysis on the NRIS Study Case are shown in Table 33.

All the system-intact and single contingency overloads identified in Table 31 and Table 32 are attributed to the NRIS study GIRs. All the identified overloads are mitigated by System Network Upgrades for NRIS summarized in Table 34. Xcel PSCo identified the Ref. No. 3 upgrade from Table 34 as a network upgrade attributed 100% to GI-2021-8 in the study report for DISIS-2021-003. Hence this upgrade is not attributable to study GIRs. Note GI-2021-8 was withdrawn since this study was started. The study model in Phase 2 of this Fall 2021 DISIS will reflect the removal of both the generating facility and associated upgrade required to mitigate an overload caused by this GI request.

Per TPL-001-4, multiple contingency overloads identified in Table 33 are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or operator actions. None of the multiple contingency overloads are attributed to the NRIS study GIRs.

Single contingency and multiple contingency analysis showed no voltage violations attributed to the NRIS study GIRs.

Table 31 – East Pocket NRIS – System Intact Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	581.0	416.2	71.64	616.6	106.12	34.48	System Intact Condition

Table 32 – East Pocket NRIS – Single Contingency Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
NCANON_W (70294) TO VICTOR (70451) 69 kV CKT #1	Line	BHE	23.0	41.7	181.52	42.1	182.98	1.46	AREQUGCH (70378) TO W.CANON (70550) 115 kV CKT #1
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	581.0	665.9	114.62	990.3	170.45	55.83	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
BMONT_TP (70054) TO OVERTON (70305) 69 kV CKT #1	Line	BHE	45.0	69.1	153.46	69.9	155.26	1.80	ASPEN_TP (70042) TO BLENDE (70051) 69 kV CKT #1
DANIELPK (70139) TO MIS_SITE (70623) 230 kV CKT #1	Line	PSCo	741.0	733.9	99.04	1001.6	135.17	36.13	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
HUDSON (70234) TO COLFER (70648) 115 kV CKT #1	Line	PSCo	40.0	46.7	116.71	53.5	133.70	16.99	DAVIS_PS (70190) TO COLFER (70648) 115 kV CKT #1
SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1	Line	PSCo	1686.0	1699.5	100.80	2216.1	131.44	30.64	DANIELPK (70601) TO MIS_SITE (70624) 345 kV CKT #1
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	331.0	332.6	100.49	433.8	131.06	30.57	DANIELPK (70601) TO MIS_SITE (70624) 345 kV CKT #1
DANIELPK (70601) TO MIS_SITE (70624) 345 kV CKT #1	Line	PSCo	1449.0	1396.5	96.38	1892.7	130.62	34.24	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
BEAVER_CK1 (70398) TO B.CRK_PS (70399) 230/115 kV CKT #T1	Xfmr	WAPA	221.0	270.9	122.57	281.4	127.35	4.78	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
WL_CHILD (72818) TO ARCHER (73009) 230 kV CKT #1	Line	TSGT	394.0	437.8	111.12	488.3	123.94	12.82	AULT (73012) TO LAR.RIVR (73108) 345 kV CKT #1
B.CK TRI (73015) TO B.CK TRI (73016) 230/115 kV CKT #1	Xfmr	TSGT	224.0	233.3	104.14	273.4	122.05	17.91	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
FTLUPTON (70192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	482.0	437.4	90.75	578.7	120.06	29.31	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
CAPHILL (70087) TO DENVTM (70148) 115 kV CKT #1	Line	PSCo	131.0	144.2	110.06	156.6	119.53	9.47	ARGO (70039) TO CHEROKEE_S (70108) 115 kV CKT #1
SMOKYHIL (70599) TO SMOKYHIL (70396) 230/345 kV CKT #T4	Xfmr	PSCo	560.0	533.1	95.19	661.1	118.05	22.86	HARVEST_MI (70597) TO SMOKYHIL (70599) 345 kV CKT #2
SMOKYHIL (70599) TO SMOKYHIL (70396) 230/345 kV CKT #T5	Xfmr	PSCo	560.0	533.1	95.19	661.1	118.05	22.86	HARVEST_MI (70597) TO SMOKYHIL (70599) 345 kV CKT #2

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
MIS_SITE (70623) TO MIS_SITE (70624) 345/230 kV CKT #T1	Xfmr	PSCo	560.0	380.4	67.92	659.3	117.73	49.81	DANIELPK (70139) TO MIS_SITE (70623) 230 kV CKT #1
APT_PARK (70030) TO BACULITE (70031) 115 kV CKT #1	Line	BHE	188.0	185.0	98.43	220.3	117.16	18.73	NYBERG (70022) TO BACULITE (70031) 115 kV CKT #1
B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line	TSGT	239.0	232.2	97.14	273.5	114.43	17.29	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
EFMORGTP (73305) TO FMWEST (73379) 115 kV CKT #1	Line	WAPA	121.0	122.2	101.00	135.4	111.93	10.93	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1
PUEB_TP (70336) TO STMBEACH (70412) 115 kV CKT #1	Line	TSGT	92.0	97.9	106.45	102.4	111.28	4.83	COMANCHE (70122) TO WALSENBG (70459) 230 kV CKT #1
LAMAR_CO (70254) TO LAMAR_DC (70560) 230 kV CKT #1	Line	PSCo	239.0	251.9	105.39	264.4	110.61	5.22	BOONE (70060) TO LAJUNTAT (70247) 115 kV CKT #1
MIDWAYPS (70285) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	80.0	58.9	73.58	86.6	108.30	34.72	MIDWAYPS (70285) TO NTHRIDGE (70301) 115 kV CKT #1
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	564.0	521.3	92.43	607.4	107.70	15.27	BUCKLEY1 (70067) TO SMOKYHIL (70396) 230 kV CKT #2
BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1	Line	PSCo	347.0	325.1	93.69	368.4	106.16	12.47	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
BEAVERCK (73020) TO BRUSHTAP (73031) 115 kV CKT #1	Line	WAPA	163.0	159.7	97.99	172.8	106.02	8.03	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1
HPCYN (70115) TO DANIELPK (70138) 115 kV CKT #1	Line	CORE	132.0	112.1	84.89	137.7	104.31	19.42	CASTLRCK (70091) TO BAYOU_IR (70518) 115 kV CKT #1
BELMONT (70049) TO OVERTON (70305) 69 kV CKT #1	Line	BHE	59.0	60.6	102.71	61.3	103.94	1.23	ASPEN_TP (70042) TO BLENDE (70051) 69 kV CKT #1
BRUSHTAP (73031) TO EFMORGTP (73305) 115 kV CKT #1	Line	WAPA	163.0	156.3	95.88	169.4	103.93	8.05	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1
B.CRK_PS (70399) TO STORY (73192) 230 kV CKT #1	Line	PSCo	276.0	271.1	98.21	283.8	102.83	4.62	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
APT_PARK (70030) TO APT_MEM (70549) 115 kV CKT #1	Line	BHE	188.0	156.7	83.36	192.5	102.40	19.04	NYBERG (70022) TO BACULITE (70031) 115 kV CKT #1
CALIFOR (70073) TO CHEROKEE (70108) _S 115 kV CKT #1	Line	PSCo	137.0	136.4	99.57	139.6	101.92	2.35	CHEROKEE_S (70108) TO MAPLETO1 (70276) 115 kV CKT #2
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	484.0	443.9	91.71	486.4	100.49	8.78	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
FTLUPTON (70191) TO FTLUPTON (70192) 230/115 kV CKT #T3	Xfmr	PSCo	273.0	267.9	98.12	274.0	100.36	2.24	LAFAYETT (70244) TO VALMONT (70444) 115 kV CKT #1
HENRYLAK (70606) TO HENRYLAK (70605) 230/115 kV CKT #T1	Xfmr	TSGT	100.0	94.4	94.38	100.2	100.19	5.81	BARRLAKE (70047) TO REUNION (70610) 230 kV CKT #1

Table 33 – East Pocket NRIS – Multiple Contingency Analysis

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[4]
				MVA Flow	% Loading	MVA Flow	% Loading		
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	589.0	671.6	114.02	1025.4	174.10	60.08	BF_225
SMOKYHIL (70599) TO SMOKYHIL (70396) 230/345 kV CKT #T4	Xfmr	PSCo	756.0	918.3	121.47	1140.1	150.81	29.34	BF_326
SMOKYHIL (70599) TO SMOKYHIL (70396) 230/345 kV CKT #T5	Xfmr	PSCo	756.0	918.3	121.47	1140.1	150.81	29.34	BF_327
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	364.0	436.4	119.88	533.1	146.46	26.58	BF_313
DENVTM (70148) TO GRAY_ST. (70208) 115 kV CKT #1	Line	PSCo	239.0	305.0	127.63	312.9	130.91	3.28	BF_361
DANIELPK (70139) TO MIS_SITE (70623) 230 kV CKT #1	Line	PSCo	797.0	734.9	92.21	1007.6	126.42	34.21	BF_225
CAPHILL (70087) TO DENVTM (70148) 115 kV CKT #1	Line	PSCo	145.0	165.3	113.97	181.4	125.08	11.11	P7_060A
SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1	Line	PSCo	1775.0	1697.1	95.61	2216.4	124.87	29.26	BF_100
FTLUPTON (70192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	483.0	439.4	90.97	593.1	122.80	31.83	BF_225
HUDSON (70234) TO COLFER (70648) 115 kV CKT #1	Line	PSCo	40.0	47.3	118.20	49.0	122.38	4.18	BF_125
WL_CHILD (72818) TO ARCHER (73009) 230 kV CKT #1	Line	TSGT	394.0	385.5	97.85	467.8	118.73	20.88	BF_225
HENRYLAK (70606) TO HENRYLAK (70605) 230/115 kV CKT #T1	Xfmr	TSGT	100.0	109.0	108.99	117.1	117.09	8.10	P7_012
BMONT_TP (70054) TO OVERTON (70305) 69 kV CKT #1	Line	BHE	45.0	41.1	91.33	52.4	116.51	25.18	BF_099
SANLSVLY (70376) TO SANLSVLY (70374) 115/69 kV CKT #T4	Xfmr	PSCo/TSGT	42.0	47.8	113.72	48.5	115.56	1.84	BF_296
B.CK TRI (73015) TO B.CK TRI (73016) 230/115 kV CKT #1	Xfmr	TSGT	224.0	217.1	96.93	257.8	115.08	18.15	BF_028
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	621.0	611.3	98.43	710.0	114.33	15.90	BF_313
DANIELPK (70601) TO MIS_SITE (70624) 345 kV CKT #1	Line	PSCo	1696.0	1395.1	82.26	1892.1	111.56	29.30	BF_325

[4] Contingency Definitions corresponding to Contingency Names are given in Appendix A.

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[4]
				MVA Flow	% Loading	MVA Flow	% Loading		
PUEB_TP (70336) TO STMBEACH (70412) 115 kV CKT #1	Line	TSGT	92.0	96.9	105.37	101.7	110.58	5.21	BF_082
CALIFOR (70073) TO CHEROKEE_S (70108) 115 kV CKT #1	Line	PSCo	151.0	158.8	105.19	162.0	107.29	2.10	P7_057
B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line	TSGT	239.0	214.9	89.93	255.8	107.05	17.12	BF_028
PALMER (70308) TO MONUMENT (73414) 115 kV CKT #1	Line	PSCo	162.0	70.0	43.22	172.4	106.45	63.23	P7_065
MIDWAYPS (70285) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	80.0	53.1	66.41	85.1	106.43	40.02	BF_099
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line	PSCo	403.0	332.7	82.56	427.6	106.10	23.54	P7_049
GRAY_ST. (70208) TO LAKEWOD2 (70252) 115 kV CKT #2	Line	PSCo	120.0	122.4	102.04	123.9	103.23	1.19	BF_361
KIOWA_IR (70571) TO ELIZABTH_IR (70583) 115 kV CKT #1	Line	CORE	120.0	96.9	80.78	123.4	102.84	22.06	P7_083
LAMAR_CO (70254) TO LAMAR_DC (70560) 230 kV CKT #1	Line	PSCo	239.0	241.6	101.08	245.0	102.50	1.42	BF_039
HPCYN (70115) TO DANIELPK (70138) 115 kV CKT #1	Line	CORE	132.0	103.3	78.22	135.3	102.47	24.25	P7_065
EFMORGTP (73305) TO FMWEST (73379) 115 kV CKT #1	Line	WAPA	121.0	104.6	86.43	123.2	101.84	15.41	BF_225
BARRLAKE (70047) TO REUNION (70610) 230 kV CKT #1	Line	PSCo	478.0	461.9	96.63	481.1	100.64	4.01	P7_035

Table 34 – East Pocket NRIS – System Network Upgrades

Ref. No.	Network Upgrade	Facility Type
1	New Missile Site to Harvest Mile 345 kV CKT #1	Line
2	New Missile Site 345/230 kV Xfmr	Transformer
3	New Story to Pawnee 230 kV CKT #2	Line
4	New Harvest Mile 345/230 kV Xfmr	Transformer
5	New Ft. Lupton 230/115 kV Xfmr	Transformer
6	New Smoky Hill 345/230 kV Xfmr	Transformer
7	Upgrade Clark to Jordan 230 kV CKT #1	Line
8	Upgrade Meadow Hill to Smoky Hill 230 kV CKT #1	Line
9	Upgrade Clark to Greenwood 230 kV CKT #1	Line
10	Upgrade Buckley to Tollgate 230 kV CKT #1	Line
11	Upgrade Midway PS to W. Station 115 kV CKT #1	Line
12	Upgrade Buckley to Smoky Hill 230 kV CKT #1	Line
13	Upgrade Happy Canyon to Daniels Park 115 kV CKT #1	Line
14	Upgrade Jordan to Orchard 230 kV CKT #1	Line

9.4 Steady-State Analysis – ERIS Study Case

The ERIS study case was developed from the NRIS Study Case (along with System Network Upgrades for NRIS in Table 34) by modeling GI-2021-16 at Harvest Mile 345 kV, and GI-2021-25 and GI-2021-26 at Pawnee 345 kV. The total 744.7 MW of ERIS output from GI-2021-16, GI-2021-25, and GI-2021-26 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The ERIS Study Case showed no system intact violations. Single contingency overloads for ERIS Study Case are shown in Table 35. All the identified single overloads can be alleviated/mitigated using OPF redispatch as explained in Section 4.4, therefore there are no System Network Upgrades required for the ERIS GIRs. The analysis also showed no voltage violations attributed to the ERIS GIRs. The single-contingency overloads identified show that ERIS GIRs contribute to existing overloads in the ERIS Benchmark Case. Therefore, the maximum allowable ERIS generation for GIRs GI-2021-16, GI-2021-25, GI-2021-26 is calculated to be 0 MW each.

Table 35 – East Pocket ERIS – Single Contingency Analysis

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
NCANON_W (70294) TO VICTOR (70451) 69 kV CKT #1	Line	BHE	23.0	41.7	181.52	42.1	182.98	1.46	AREQUGCH (70378) TO W.CANON (70550) 115 kV CKT #1
PALMER (70308) TO MONUMENT (73414) 115 kV CKT #1	Line	PSCo	151.0	141.0	93.38	202.6	134.14	40.76	DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line	PSCo	367.0	425.8	116.03	471.9	128.58	12.55	HARVEST_MI (70597) TO DANIELPK (70601) 345 kV CKT #1
JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	566.0	584.6	103.28	696.0	122.96	19.68	HARVEST_MI (70597) TO DANIELPK (70601) 345 kV CKT #1
MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	637.0	637.8	100.13	778.8	122.26	22.13	HARVEST_MI (70597) TO DANIELPK (70601) 345 kV CKT #1
DANIELPK (70139) TO WATERTON (70464) 230 kV CKT #1	Line	PSCo	478.0	429.0	89.74	559.5	117.05	27.31	DANIELPK (70601) TO GI-12-14 (71938) 345 kV CKT #1
EFMORGTP (73305) TO FMWEST (73379) 115 kV CKT #1	Line	WAPA	121.0	129.9	107.33	140.1	115.78	8.45	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	581.0	508.4	87.51	652.5	112.30	24.79	STORY (73192) TO PAWNEE (70311) 230 kV CKT #2
STORY (73192) TO PAWNEE (70311) 230 kV CKT #2	Line	PSCo	581.0	508.4	87.51	652.5	112.30	24.79	STORY (73192) TO PAWNEE (70311) 230 kV CKT #1
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	506.0	559.7	110.61	567.6	112.18	1.57	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1	Line	PSCo	347.0	352.7	101.64	385.1	110.99	9.35	B.CK TRI (73016) TO STORY (73192) 230 kV CKT #1
BEAVERCK (73020) TO BRUSHTAP (73031) 115 kV CKT #1	Line	WAPA	163.0	167.2	102.55	177.9	109.13	6.58	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1
BUCKLEY1 (70067) TO SMOKYHIL (70396) 230 kV CKT #2	Line	PSCo	506.0	475.6	94.00	549.6	108.62	14.62	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	484.0	457.7	94.57	523.9	108.24	13.67	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
BRUSHTAP (73031) TO EFMORGTP (73305) 115 kV CKT #1	Line	WAPA	163.0	163.7	100.46	174.4	107.02	6.56	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1
DANIELPK (70139) TO MIS_SITE (70623) 230 kV CKT #1	Line	PSCo	741.0	685.9	92.56	761.4	102.75	10.19	4 MIS_SITE (7062) TO R mid pt (3WXFM) /345 kV CKT #
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	343.1	71.77	481.3	100.68	28.91	DANIELPK (70601) TO GI-12-14 (71938) 345 kV CKT #1
BIJOUTAP (73023) TO FMWEST (73379) 115 kV CKT #1	Line	WAPA	120.0	110.0	91.64	120.0	100.02	8.38	BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1

9.5 Affected Systems

TSGT, BHE, CORE and WAPA are identified as Affected Systems as a result of overloads on their facilities as listed in Table 32, Table 33 and Table 35.

9.6 Summary of Eastern Study Pocket Analysis

NRIS identified for GI-2021-27 is 180 MW.

NRIS identified for GI-2021-29 is 199.5 MW.

NRIS identified for GI-2021-30 is 500 MW.

NRIS identified for GI-2021-31 is 250 MW.

The NRIS study identified all the overloads caused by the NRIS study GIRs. The study also identified all the suitable NRIS System Network Upgrades as mitigations necessary to alleviate the overloads caused by the NRIS study GIRs.

The ERIS study was performed taking into consideration all the NRIS System Network Upgrades identified. The ERIS study showed single contingency overloads, all of which were alleviated by performing OPF redispatch. Therefore, the study did not identify any required System Network Upgrades for the ERIS GIRs.

A DFAX analysis with respect to thermal overloads was performed to compute the maximum allowable output for each ERIS GIR. The maximum allowable output of the ERIS GIRs without requiring any additional System Network Upgrades is:

- ERIS of GI-2021-16 is 0 MW.
- ERIS of GI-2021-25 is 0 MW.
- ERIS of GI-2021-26 is 0 MW.

ERIS, when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis is:

- GI-2021-16: 199 MW
- GI-2021-25: 362 MW
- GI-2021-26: 183.7 MW

Additionally, a Grid Charging study was performed for GI-2021-16, GI-2021-27, and GI-2021-31. The study did not identify any voltage or thermal overloads attributed to these GIRs. Grid Charging capabilities without any additional System Network Upgrades for:

- GI-2021-16 is 199 MW.
- GI-2021-27 is 90 MW.
- GI-2021-31 is 250 MW.

10.0 San Luis Valley Study Pocket Analysis

The San Luis Valley (SLV) study pocket analysis was performed for both heavy summer and a light load scenario.

10.1 Benchmark Case Modeling

The heavy summer Benchmark Case was created from the Base Case by adopting the generation dispatch in Table 36.

Table 36 – Generation Dispatch Used to Create the SLV Heavy Load Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70485	ALMSACT1	13.8	G1	1	17.5	19.4
70486	ALMSACT2	13.8	G2	1	16.2	18.0
70933	COGENTRIX_PV	34.5	S3	1	25.5	30.0
88881	GI-2021-4	34.5	G1	1	42.0	42.0
70931	GSANDHIL_PV	34.5	S1	1	10.5	12.4
70932	HOOPER_PV	34.5	S2	1	25.5	30.0
70935	SUNPOWER	34.5	S1	1	44.2	52.0
Total					181.4	203.8

The light load Benchmark Case was created from the heavy summer Benchmark Case by scaling the San Luis Valley area loads down and turning off Alamosa CT1 and Alamosa CT2 and adopting the generation dispatch in Table 37.

Table 37 – Generation Dispatch Used to Create the SLV Light Load Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70485	ALMSACT1	13.8	G1	1	0.0	19.4
70486	ALMSACT2	13.8	G2	1	0.0	19.0
70933	COGENTRIX_PV	34.5	S3	1	25.5	30.0
88881	GI-2021-4	34.5	G1	1	42.0	42.0
70931	GSANDHIL_PV	34.5	S1	1	10.5	16.1
70932	HOOPER_PV	34.5	S2	1	25.5	30.0
70935	SUNPOWER	34.5	S1	1	44.2	52.0
Total					147.7	203.8

10.2 Study Case Modeling

The San Luis Valley heavy summer NRIS Study Case and San Luis Valley light load NRIS Study Cases were developed from the respective Benchmark Cases by modeling GI-2021-23 at San Luis Valley 115 kV. The 95 MW NRIS output of GI-2021-23 is balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The San Luis Valley heavy load ERIS Study Case and San Luis Valley light load ERIS Study Case were developed from the NRIS Study Cases (along with any System Network Upgrades for NRIS) by modeling GI-2021-28 at San Luis Valley 230 kV. The 170 MW of ERIS output from GI-2021-28 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

10.3 Steady-State Analysis – NRIS Study Case

The study was performed on both heavy load and light load San Luis Valley pocket NRIS Study Cases. The light load NRIS Study Case is identified as the worst-case scenario for all identified overloads, hence the rest of the results ahead reference the results of the light load scenario.

The results of the system intact analysis showed no violations.

The results of the single contingency analysis on the light load NRIS Study Case are shown in Table 38.

The results of the multiple contingency analysis on the light load NRIS Study Case are shown in Table 39.

Xcel PSCo identified that the single contingency overloads tabulated in Table 38 are mitigated by the System Network Upgrades tabulated in Table 40. Xcel PSCo identified that Ref. No. 1 and Ref. No. 3 upgrades from Table 40 are part of Xcel PSCo's planned transmission project, Line 9811 Rebuild Project (ISD 2025), therefore these upgrades are not attributable to the study GIRs.

Table 39 shows the multiple contingency analysis on the Study Case. Per TPL-001-4, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or system operator actions. None of the listed multiple contingency overloads are attributed to the study GIRs.

Both single and multiple contingency analysis showed no voltage violations attributed to the study GIRs.

Table 38 – San Luis Valley Study Pocket (LL Scenario) NRIS Results – Single Contingency Analysis

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
PONCHA (70327) TO SARGENT (70379) 115 kV CKT #1	Line	PSCo	120.0	130.1	108.45	216.0	180.00	71.55	PONCHABR (79054) TO SANLSVLY (70575) 230 kV CKT #1 DROP LOADS AT BUSES 70092, 70229, 70245, 70325, 70467, 70129, 70221, 70383, 70411 (Total of 8.8 MW)
SANLSVLY (70375) TO PONCHABR (79054) 230 kV CKT #1	Line	PSCo/ TSGT	180.0	119.4	66.33	212.7	118.18	51.85	SANLSVLY (70374) TO SARGENT (70379) TO PONCHA (70327) 115 kV CKT #1
SANLSVLY (70374) TO SARGENT (70379) 115 kV CKT #1	Line	PSCo	162.0	106.3	65.62	186.0	114.80	49.18	PONCHABR (79054) TO SANLSVLY (70575) 230 kV CKT #1 DROP LOADS AT BUSES 70092, 70229, 70245, 70325, 70467, 70129, 70221, 70383, 70411 (Total of 8.8 MW)

Table 39 – San Luis Valley Study Pocket (LL Scenario) NRIS Results – Multiple Contingency Analysis

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[5]
				MVA Flow	% Loading	MVA Flow	% Loading		
FTN_VLY (70193) TO MIDWAYBR (73412) 115 kV CKT #1	Line	BHE	171.0	311.8	182.31	316.6	185.15	1.74	P7_063
PONCHA (70327) TO SARGENT (70379) 115 kV CKT #1	Line	PSCo	120.0	113.6	94.68	202.4	168.66	1.73	BF_300
DESRTCOV (70449) TO W.STATON (70456) 115 kV CKT #1	Line	BHE	222.0	341.5	153.85	346.5	156.09	1.73	P7_063
FTN_VLY (70193) TO DESRTCOV (70449) 115 kV CKT #1	Line	BHE	222.0	313.2	141.06	318.0	143.25	1.45	P7_063
EAST PORTAL (73000) TO WEST PORTAL (73001) 69 kV CKT #1	Line	WAPA	30.0	41.2	137.35	43.0	143.21	1.00	P7_020a

[5] Contingency Definitions corresponding to Contingency Names are given in Appendix A.

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIRs	Contingency Name[5]
				MVA Flow	% Loading	MVA Flow	% Loading		
MARYLKSB (78066) TO MARYLKSB (73436) 69/115 kV CKT #1	Xfmr	WAPA	30.0	40.1	133.70	41.9	139.54	14.81	P7_020a
EAST PORTAL (73000) TO MARYLKSB (73436) 69 kV CKT #1	Line	WAPA	30.0	39.7	132.47	41.5	138.30	1.15	P7_020a
WEST PORTAL (73001) TO MCKENZIE (73132) 69 kV CKT #1	Line	WAPA	36.0	41.6	115.54	43.4	120.42	1.15	P7_020a
SANLSVLY (70375) TO PONCHABR (79054) 230 kV CKT #1	Line	PSCo/TSGT	180.0	107.0	59.46	211.8	117.65	1.15	BF_296
VOLLMERT (72413) TO FULLER (73481) 115 kV CKT #1	Line	TSGT	143.0	159.6	111.63	164.2	114.81	1.15	P7_065
VOLLMERT (72413) TO BLK SQMV (73460) 115 kV CKT #1	Line	TSGT	143.0	154.7	108.21	159.3	111.38	1.15	P7_065
COMANCHE (70122) TO COMANCHE (70654) 345/230 kV CKT #T4	Xfmr	PSCo	756.0	815.3	107.85	826.1	109.27	1.15	BF_085
SANLSVLY (70375) TO mid pt (70971) 115/230 kV CKT #T2	Xfmr	TSGT	150.0	68.0	45.33	162.7	108.49	1.15	BF_296
DANIELPK (70139) TO FULLER (78854) 230 kV CKT #1	Line	PSCo	478.0	499.0	104.40	517.7	108.31	1.15	P7_063
SANLSVLY (70374) TO mid pt (70971) 115 kV CKT #T2	Line	TSGT	150.0	61.2	40.79	159.6	106.40	1.15	BF_296
MONUMENT (73414) TO GRESHAM (73445) 115 kV CKT #1	Line	TSGT	145.0	143.9	99.21	149.2	102.90	1.15	P7_065
MIDWAYBR (73412) TO RANCHO (73416) 115 kV CKT #1	Line	TSGT	145.0	145.8	100.54	148.4	102.34	1.15	P7_063
RANCHO (73416) TO LORSONRH (73458) 115 kV CKT #1	Line	TSGT	145.0	142.5	98.30	145.1	100.07	1.15	P7_063

Table 40 – San Luis Valley Study Pocket NRIS – System Network Upgrades

Ref. No.	Network Upgrade	Facility Type
1	Upgrade Poncha to Sargent 115 kV CKT #1	Line
2	Upgrade San Luis Valley to Poncha 230 kV CKT #1	Line
3	Upgrade San Luis Valley to Sargent 115 kV CKT #1	Line

10.4 Steady-State Analysis – ERIS Study Case

The San Luis Valley light load ERIS Study Case was developed from the NRIS Study Case (along with the System Network Upgrades for NRIS) by modeling GI-2021-28 at San Luis Valley 230 kV. The 170 MW of ERIS output from GI-2021-28 was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The ERIS Study Case contingency analysis is performed using OPF to redispatch to alleviate any single and system intact overloads according to Section 4.4. Table 41 shows the single overloads which could not be mitigated by redispatch using OPF. This shows the need for additional upgrades for the facilities tabulated in Table 42. Xcel PSCo identified that Ref. No. 1 and Ref. No. 3 upgrades from Table 42 are part of Xcel PSCo's planned transmission project, Line 9811 Rebuild Project (ISD 2025), therefore these upgrades are not attributable to the study GIRs.

The system intact overloads for the ERIS Study Case (including required ERIS System Network Upgrades tabulated in Table 42) are shown in Table 43.

The single-contingency overloads for the ERIS Study Case (including required ERIS System Network Upgrades tabulated in Table 42) are shown in Table 44. The maximum allowable ERIS generation is calculated using each GIR's distribution factor (DFAX) for each of the overloads, such that all the identified overloads in Table 43 and Table 44 are eliminated.

Table 41 – San Luis Valley Study Pocket ERIS (After Redispatch) – Single Contingency Overloads

Overloaded Facility	Type	Owner	Normal Rating (MVA)	ERIS Benchmark Case		ERIS Study Case (After Redispatch)		Loading % Change Due to Study GIRs	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
PONCHA (70327) TO SARGENT (70379) 115 kV CKT #1	Line	PSCo	216.0	216.0	100.00	253.6	117.40	17.40	PONCHABR (79054) TO SANLSVLY (70575) 230 kV CKT #1 DROP LOADS AT BUSES 70092, 70229, 70245, 70325, 70467, 70129, 70221, 70383, 70411 (Total of 8.8 MW)
SANLSVLY (70375) TO PONCHABR (79054) 230 kV CKT #1	Line	PSCo/ TSGT	213.0	212.7	99.85	240.0	112.70	12.85	SANLSVLY (70374) TO SARGENT (70379) TO PONCHA (70327) 115 kV CKT #1
SANLSVLY (70374) TO SARGENT (70379) 115 kV CKT #1	Line	PSCo	186.0	186.0	100.00	228.5	122.87	22.87	PONCHABR (79054) TO SANLSVLY (70575) 230 kV CKT #1 DROP LOADS AT BUSES 70092, 70229, 70245, 70325, 70467, 70129, 70221, 70383, 70411 (Total of 8.8 MW)

Table 42 – San Luis Valley Study Pocket ERIS – System Network Upgrades

Ref. No.	Network Upgrade	Facility Type
1	Upgrade Poncha to Sargent 115 kV CKT #1	Line
2	Upgrade San Luis Valley to Poncha 230 kV CKT #1	Line
3	Upgrade San Luis Valley to Sargent 115 kV CKT #1	Line

Table 43 – San Luis Valley Study Pocket ERIS (Including ERIS System Network Upgrades) – System Intact Overloads

Overloaded Facility	Type	Owner	ERIS Benchmark Case			ERIS Study Case (Including ERIS System Network Upgrades)			Loading MVA Change Due to Study Pocket GIRs	Contingency Definition
			Normal Rating (MVA)	MVA Flow	% Loading	Normal Rating (MVA)	MVA Flow	% Loading		
SANLSVLY (70375) TO PONCHABR (79054) 230 kV CKT #1	Line	PSCo/TSGT	213.0	173.8	81.62	240.0	323.0	134.60	149.18	System Intact Condition

Table 44 – San Luis Valley Study Pocket ERIS (Including ERIS System Network Upgrades) – Single Contingency Overloads

Overloaded Facility	Type	Owner	ERIS Benchmark Case			ERIS Study Case (Including ERIS System Network Upgrades)			Loading MVA Change Due to Study Pocket GIRs	Contingency Definition
			Normal Rating (MVA)	MVA Flow	% Loading	Normal Rating (MVA)	MVA Flow	% Loading		
SANLSVLY (70375) TO PONCHABR (79054) 230 kV CKT #1	Line	PSCo/TSGT	213.0	203.9	95.72	240.0	380.8	158.69	176.96	SANLSVLY (70374) TO SARGENT (70379) TO PONCHA (70327) 115 kV CKT #1
CURECANT (79020) TO SOCANAL (79192) 115 kV CKT #1	Line	WAPA	137.0	121.0	88.31	137.0	141.8	103.52	20.84	CURECANT (79021) TO NORTHFRK (79070) 230 kV CKT #1

10.5 Affected Systems

WAPA, BHE and TSGT are identified as impacted Affected Systems as result of overloads on their facilities as listed in Table 38, Table 39, Table 43 and Table 44 .

10.6 Summary of San Luis Valley Study Pocket Analysis

NRIS identified for GI-2021-23 is 95 MW.

The NRIS study identified the overloads caused by the NRIS GIRs and identified suitable System Network Upgrades for the identified overloads. Xcel PSCo identified that these System Network Upgrades are not attributable to the study GIRs as being part of the planned transmission projects.

The ERIS study was performed, taking into consideration all the NRIS System Network Upgrades identified. The ERIS study showed single contingency overloads which could not be alleviated by performing OPF redispatch. These overloads require System Network Upgrades for the ERIS GIRs requested as shown in Table 42. After further review, Xcel PSCo further identified that two of the identified System Network Upgrades are part of a planned transmission project and are not attributable to the study GIRs.

A DFAX analysis with respect to thermal overloads was performed to compute the maximum allowable output for each ERIS GIR. The maximum allowable output of the ERIS GIRs (including the required System Network Upgrades from Table 42) is:

- ERIS of GI-2021-28 is 36.1 MW

ERIS, when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis is:

- GI-2021-28: 170 MW

Additionally, a Grid Charging study was performed for GI-2021-23 and GI-2021-28. The study did not identify any voltage or thermal overloads attributed to these GIRs. Charging capabilities without any additional System Network Upgrades for:

- GI-2021-23 is 80 MW.
- GI-2021-28 is 85 MW.

11.0 Western Slope Study Pocket Analysis

11.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case by adopting the generation dispatch in Table 45. The WECC TOT5 Path flow in the Benchmark Case was set to 1200 MW.

Table 45 – Generation Dispatch Used to Create the Western Slope Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70069	CABCRKA	13.8	HA	1	150.0	183.0
70070	CABCRKB	13.8	HB	1	150.0	183.0
70180	FRUITA	13.8	G1	1	20.0	20.0
79015	CRAIG 1	22.0	1	1	500.0	500.0
79016	CRAIG 2	22.0	1	1	500.0	500.0
79040	HAYDEN1	18.0	1	1	212.0	212.0
79041	HAYDEN2	22.0	1	1	285.0	285.0
Total					1817.0	1883.0

11.2 Study Case Modeling

The ERIS Study Case was created from the Benchmark Case by modeling GI-2021-18 at Collbran 138 kV. The 49 MW ERIS output of GI-2021-18 was balanced against PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

11.3 Steady-State Analysis – ERIS Study Case

The single contingency analysis did not identify any thermal or voltage violations.

The multiple contingency analysis did not identify any thermal or voltage violations.

11.4 Affected Systems

The study did not identify any impacts to Affected Systems.

11.5 Summary of Western Slope Study Pocket Analysis

A DFAX analysis with respect to thermal overloads was performed to compute the maximum allowable output for each ERIS GIR. The maximum allowable output of the ERIS GIRs is:

- GI-2021-18 is 49 MW

ERIS, when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis is:

- GI-2021-18: 49 MW

12.0 Cost Estimates and Assumptions

There are three types of costs identified in the study:

- Transmission Provider's Interconnection Facilities (TPIF) which are directly assigned to each GIR
- Station equipment Network Upgrades, which are allocated each GIR connecting to that station on a per-capita basis per Section 4.2.4(a) of the LGIP
- All System Network Upgrades which are allocated by the proportional impact per Section 4.2.4(b) of the LGIP

12.1 Total Cost of Transmission Provider's Interconnecting Facilities

The total cost of Transmission Provider's Interconnection Facilities for each POI and each GIRs cost assignment are given in Table 46.

Table 46 – Total Cost of Transmission Provider's Interconnection Facilities by GIR

GIR	POI	Total Cost (million)
GI-2021-12	GI-2021-12 230 kV Switching Station	$1.690
GI-2021-13	Mirasol 230 kV Switching Station	$1.564
GI-2021-14	Green Valley 230 kV Substation	$1.680
GI-2021-16	Harvest Mile 345 kV Substation	$2.586
GI-2021-18	Collbran 138 kV Substation	$1.263
GI-2021-19	Tundra 345 kV Switching Station	$2.513
GI-2021-20	Tundra 345 kV Switching Station	$2.513
GI-2021-21	GI-2021-21/22 230 kV Switching Station	$1.741
GI-2021-22	GI-2021-21/22 230 kV Switching Station	$1.734
GI-2021-23	San Luis Valley 115 kV Substation	$1.300
GI-2021-24	Mirasol 230 kV Switching Station	$1.562
GI-2021-25	Pawnee 345 kV Substation	$2.401
GI-2021-26	Pawnee 345 kV Substation	$2.539
GI-2021-27	Missile Site 230 kV Substation	$1.683
GI-2021-28	San Luis Valley 230 kV Substation	$1.600
GI-2021-29	GI-2020-6 230 kV Switching Station	$1.909
GI-2021-30	Pawnee 345 kV Substation	$2.287
GI-2021-31	Pawnee 345 kV Substation	$2.547

Table 47 through Table 64 specify each GIR's Transmission Provider's Interconnection Facilities and the corresponding costs.

12.1.1 GI-2021-12 TPIF

Table 47 – GI-2021-12 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's New GI-2021-12 230 kV Switching Station	Interconnection GI-2021-12 at the new Switching Station tapping the Mirasol - Comanche 230 kV Line 5411. The new equipment includes: • (1) 230 kV deadend structure • (1) 230 kV 3-phase surge arrester • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.590
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.690**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.2 GI-2021-13 TPIF

Table 48 – GI-2021-13 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Mirasol 230 kV Switching Station	Interconnection GI-2021-13 at the existing Mirasol 230 kV Switching Station. The new equipment includes: • (2) 230 kV deadend structures • (3) 230 kV surge arresters • (1) 230 kV disconnect switch • (3) CTs • (3) CCVTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.464
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.564**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.3 GI-2021-14 TPIF

Table 49 – GI-2021-14 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Green Valley 230 kV Substation	Interconnection GI-2021-14 at the existing Green Valley 230 kV Substation. The new equipment includes: • (2) 230 kV deadend structures • (3) 230 kV surge arresters • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing	$1.580
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.680**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.4 GI-2021-16 TPIF

Table 50 – GI-2021-16 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Harvest Mile 345 kV Substation	Interconnection GI-2021-16 at the existing Harvest Mile 345 kV Substation. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (2) 345 kV wave traps • (3) PTs • (3) CTs • (3) CCVTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.486
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.586**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.5 GI-2021-18 TPIF

Table 51 – GI-2021-18 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's Collbran 138 kV Substation	Interconnection GI-2021-18 at the existing Collbran 138 kV Substation. The new equipment includes: • (1) 115 kV deadend structure • (3) 115 kV surge arresters • (1) 115 kV disconnect switch • (1) CT/PT combination 3-phase metering unit • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.163
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.263**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.6 GI-2021-19 TPIF

Table 52 – GI-2021-19 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Tundra 345 kV Switching Station	Interconnection GI-2021-19 at the existing Tundra 345 kV Switching Station. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (3) PTs • (3) CTs • (2) CVTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.413
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.513**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.7 GI-2021-20 TPIF

Table 53 – GI-2021-20 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Tundra 345kV Switching Station	Interconnection GI-2021-20 at the existing Tundra 345 kV Switching Station. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (3) PTs • (3) CTs • (2) CVTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.413
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.513**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.8 GI-2021-21 TPIF

Table 54 – GI-2021-21 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's New GI-2021-21/22 230 kV Switching Station	Interconnection GI-2021-21 at the new Switching Station tapping the Boone - Midway 230 kV Line 5335. The new equipment includes: • (2) 230 kV deadend structures • (1) 230 kV 3-phase surge arrester • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.641
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.741**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.9 GI-2021-22 TPIF

Table 55 – GI-2021-22 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's New GI-2021-21/22 230 kV Switching Station	Interconnection GI-2021-22 at the new Switching Station tapping the Boone - Midway 230 kV Line 5335. The new equipment includes: • (2) 230 kV deadend structures • (1) 230 kV 3-phase surge arrester • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.634
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.734**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.10 GI-2021-23 TPIF

Table 56 – GI-2021-23 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's San Luis Valley 115 kV Substation	Interconnection GI-2021-23 at the existing San Luis Valley 115 kV Substation. The new equipment includes: • (1) 115 kV deadend structure • (3) 115 kV surge arresters • (1) 115 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.200
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.300**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.11 GI-2021-24 TPIF

Table 57 – GI-2021-24 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Mirasol 230 kV Switching Station	Interconnection GI-2021-24 at the existing Mirasol 230 kV Switching Station. The new equipment includes: • (2) 230 kV deadend structures • (3) 230 kV surge arresters • (1) 230 kV disconnect switch • (3) CTs • (3) CCVTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.462
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.562**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.12 GI-2021-25 TPIF

Table 58 – GI-2021-25 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Pawnee 345 kV Substation	Interconnection GI-2021-25 at the existing Pawnee 345 kV Substation. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (3) PTs • (3) CTs • (2) CVTs • (2) Wave traps • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.301
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.401**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.13 GI-2021-26 TPIF

Table 59 – GI-2021-26 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Pawnee 345 kV Substation	Interconnection GI-2021-26 at the existing Pawnee 345 kV Substation. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (3) PTs • (3) CTs • (2) CVTs • (2) Wave traps • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.439
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.539**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.14 GI-2021-27 TPIF

Table 60 – GI-2021-27 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Missile 230 kV Substation	Interconnection GI-2021-27 at the existing Missile 230 kV Substation. The new equipment includes: • (2) 230 kV deadend structures • (3) 230 kV surge arresters • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.583
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.683**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.15 GI-2021-28 TPIF

Table 61 – GI-2021-28 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's San Luis Valley 230 kV Substation	Interconnection GI-2021-28 at the existing San Luis Valley 230 kV Substation. The new equipment includes: • (1) 230 kV deadend structure • (3) 230 kV surge arresters • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.500
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.600**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.16 GI-2021-29 TPIF

Table 62 – GI-2021-29 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's GI-2020-6 230 kV Switching Station	Interconnection GI-2021-29 at the GI-2020-6 Switching Station. The new equipment includes: • (1) 230 kV deadend structure • (1) 230 kV 3-phase surge arrester • (1) 230 kV disconnect switch • (3) PTs • (3) CTs • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$1.809
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$1.909**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.17 GI-2021-30 TPIF

Table 63 – GI-2021-30 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Pawnee 345 kV Substation	Interconnection GI-2021-30 at the existing Pawnee 345 kV Substation. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (3) PTs • (3) CTs • (2) CVTs • (2) Wave traps • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.187
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.287**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.1.18 GI-2021-31 TPIF

Table 64 – GI-2021-31 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Pawnee 345 kV Substation	Interconnection GI-2021-31 at the existing Pawnee 345 kV Substation. The new equipment includes: • (2) 345 kV deadend structures • (3) 345 kV surge arresters • (1) 345 kV disconnect switch • (3) PTs • (3) CTs • (2) CVTs • (2) Wave traps • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	$2.447
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.100
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.547**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2 Total Cost of Station Network Upgrades

The total cost of Station Network Upgrades for each GIR is given in Table 65.

Table 65 – Total Cost of Station Network Upgrades by GIR

GIR	POI	Total Cost (million)
GI-2021-12	GI-2021-12 230 kV Switching Station	$16.049
GI-2021-13	Mirasol 230 kV Switching Station	$4.676
GI-2021-14	Green Valley 230 kV Substation	$4.505
GI-2021-16	Harvest Mile 345 kV Substation	$1.299
GI-2021-18	Collbran 138 kV Substation	$3.429
GI-2021-19	Tundra 345 kV Switching Station	$3.234
GI-2021-20	Tundra 345 kV Switching Station	$3.234
GI-2021-21	GI-2021-21/22 230 kV Switching Station	$8.569
GI-2021-22	GI-2021-21/22 230 kV Switching Station	$8.569
GI-2021-23	San Luis Valley 115 kV Substation	$3.100
GI-2021-24	Mirasol 230 kV Switching Station	$4.676
GI-2021-25	Pawnee 345 kV Substation	$3.391
GI-2021-26	Pawnee 345 kV Substation	$3.391
GI-2021-27	Missile Site 230 kV Substation	$2.250
GI-2021-28	San Luis Valley 230 kV Substation	$2.600
GI-2021-29	GI-2021-29 230 kV Switching Station	$4.500
GI-2021-30	Pawnee 345 kV Substation	$3.391
GI-2021-31	Pawnee 345 kV Substation	$3.391

12.2.1 Boone to Midway 230 kV Switching Station

The details of the Station Network Upgrades required at the Boone to Midway 230 kV new POI Substation are shown in Table 66. These Station Network Upgrade costs are shared according to Table 67.

Table 66 – Station Network Upgrades – GI-2021-21/22 230 kV Switching Station

Element	Description	Cost Est. (million)
PSCo's New GI-2021-21/22 230 kV Switching Station	Install a new 230 kV Switching Station tapping the Mirasol - Comanche 230 kV line to accommodate GI-2021-21 and GI-2021-22 interconnections. The new equipment includes: • (4) 230 kV circuit breakers • (10) 230 kV disconnect switches • (6) CCVTs • (2) SSVTs • (2) 230 kV 3-phase surge arresters • (2) 230 kV deadend structures • (1) Electrical Equipment Enclosure • (2) 230 kV wave traps • Station controls and wiring • Associated foundations and structures	$12.231
PSCo's New GI-2021-21/22 230kV Switching Station	Install required communication in the EEE	$0.591
PSCo's New GI-2021-21/22 230kV Switching Station	Tap line 5335 and route into GI-2021-21/22 230 kV Switching Station.	$1.685
PSCo's Midway 230 kV Substation	Remote end upgrades at the Midway 230 kV Substation. The new equipment includes: • (1) CCVT • (1) 230 kV wave trap • Station controls and wiring • Associated foundations and structures	$0.889
PSCo's Boone 230 kV Substation	Remote end upgrades at the Midway 230 kV Substation. The new equipment includes: • (1) CCVT • (1) 230 kV wave trap • Station controls and wiring • Associated foundations and structures	$0.881
	Siting and Land Rights support for substation construction	$0.861
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$17.138**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 67 – Allocation of GI-2021-21/22 230 kV Switching Station Upgrade Cost by GIR

GIR	% Share per Section 4.2.4(a) of Attachment N	Costs Allocated to GIR (million)
GI-2021-21	50.0%	$8.569
GI-2021-22	50.0%	$8.569

12.2.2 Collbran 138 kV Substation

The details of the Station Network Upgrades required at the Collbran 138 kV Substation are shown in Table 68. These Station Network Upgrade costs are 100% assigned to GI-2021-18.

Table 68 – Station Network Upgrades – Collbran 138 kV Substation

Element	Description	Cost Est. (million)
PSCo's Collbran Substation 138 kV Substation	Expand the existing Collbran 138 kV Substation to accommodate GI-2021-18 interconnection. The new equipment includes: • (1) 161 kV circuit breaker • (3) 161 kV disconnect switches • Relocate existing controls to south Electrical Equipment Enclosure • Station controls and wiring • Associated foundations and structures	$3.329
	Siting and Land Rights support for substation construction	$0.100
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$3.429**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.3 Comanche to Midway 230 kV Switching Station

The details of the Station Network Upgrades required at the Comanche to Midway 230 kV new POI Substation are shown in Table 69. These Station Network Upgrade costs are 100% assigned to GI-2021-12.

Table 69 – Station Network Upgrades – GI-2021-12 230 kV Switching Station

Element	Description	Cost Est. (million)
PSCo's New GI-2021-12 230 kV Switching Station	Install a new 230 kV Switching Station tapping the Mirasol - Comanche 230 kV line to accommodate GI-2021-12 interconnection. The new equipment includes: • (3) 230 kV circuit breakers • (8) 230 kV disconnect switches • (6) CCVTs • (2) SSVTs • (2) 230 kV 3-phase surge arresters • (3) 230 kV deadend structures • (1) Electrical Equipment Enclosure • (2) 230 kV 2-phase wave traps • Station controls and wiring • Associated foundations and structures	$12.936
PSCo's New GI-2021-12 230 kV Switching Station	Install required communication in the EEE	$0.574
PSCo's New GI-2021-12 230 kV Switching Station	Tap line 5411 and route into GI-2021-12 230 kV Switching Station.	$1.672
	Siting and Land Rights support for substation construction	$0.867
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$16.049**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.4 Green Valley 230 kV Substation

The details of the Station Network Upgrades required at the Green Valley 230 kV Substation are shown in Table 70. These Station Network Upgrade costs are 100% assigned to GI-2021-14.

Table 70 – Station Network Upgrades – Green Valley 230 kV Substation

Element	Description	Cost Est. (million)
PSCo's Green Valley 230 kV Substation	Expand the existing Green Valley 230 kV Substation to accommodate GI-2021-14 interconnection. The new equipment includes: • (2) 230 kV circuit breakers • (4) 230 kV disconnect switches • Yard improvements • Station controls and wiring • Associated foundations and structures	$4.005
	Siting and Land Rights support for substation construction	$0.500
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$4.505**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.5 Harvest Mile 345 kV Substation

The details of the Station Network Upgrades required at the Harvest Mile 345 kV Substation are shown in Table 71. These Station Network Upgrade costs are 100% assigned to GI-2021-16.

Table 71 – Station Network Upgrades – Harvest Mile 345 kV Substation

Element	Description	Cost Est. (million)
PSCo's Harvest Mile 345 kV Substation	Expand the existing Harvest Mile 345 kV Substation to accommodate GI-2021-16 interconnection. The new equipment includes: • (1) 345 kV circuit breaker • (2) 345 kV disconnect switches • Station controls and wiring • Associated foundations and structures	$1.199
	Siting and Land Rights support for substation construction	$0.100
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$1.299**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.6 Mirasol 230 kV Switching Station

The details of the Station Network Upgrades required at the Mirasol 230 kV Switching Station are shown in Table 72. These Station Network Upgrade costs are shared according to Table 73.

Table 72 – Station Network Upgrades – Mirasol 230 kV Switching Station

Element	Description	Cost Est. (million)
PSCo's Mirasol 230 kV Switching Station	Expand the existing Mirasol 230 kV Switching Station to accommodate GI-2021-13 and GI-2021-24 interconnections. The new equipment includes: • (4) 230 kV circuit breakers • (10) 230 kV disconnect switches • Station controls and wiring • Associated foundations and structures	$8.295
	Siting and Land Rights support for substation construction	$1.056
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$9.351**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 73 – Allocation of Mirasol 230 kV Switching Station Upgrade Cost by GIR

GIR	% Share per Section 4.2.4(a) of Attachment N	Costs Allocated to GIR (million)
GI-2021-13	50.0%	$4.676
GI-2021-24	50.0%	$4.676

12.2.7 Missile Site 230 kV Substation

The details of the Station Network Upgrades required at the Missile Site 230 kV Substation are shown in Table 74. These Station Network Upgrade costs are 100% assigned to GI-2021-27.

Table 74 – Station Network Upgrades – Missile Site 230 kV Substation

Element	Description	Cost Est. (million)
PSCo's Missile Site 230 kV Substation	Expand the existing Missile Site 230 kV Substation to accommodate GI-2021-27 interconnection. The new equipment includes: • (1) 230 kV circuit breaker • (3) 230 kV disconnect switches • Station controls and wiring • Associated foundations and steel structures	$2.150
	Siting and Land Rights support for substation construction	$0.100
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$2.250**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.8 Pawnee 345 kV Substation

The details of the Station Network Upgrades required at the Pawnee 345 kV Substation are shown in Table 75. These Station Network Upgrade costs are shared according to Table 76.

Table 75 – Station Network Upgrades – Pawnee 345 kV Substation

Element	Description	Cost Est. (million)
PSCo's Pawnee 345 kV Substation	Expand the existing Pawnee 345 kV Substation to accommodate GI-2021-25, GI-2021-26, GI-2021-30, and GI-2021-31 interconnections. The new equipment includes: • (8) 345 kV deadend structures • (9) 345 kV circuit breakers • (13) 345 kV disconnect switches • Yard expansion • (1) Electrical Equipment Enclosure • Station controls and wiring • Associated foundations and steel structures	$12.173
PSCo's Pawnee 345 kV Substation	Install required communication in the EEE	$0.590
	Siting and Land Rights support for substation construction	$0.800
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$13.563**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 76 – Allocation of Pawnee 345 kV Substation Upgrade Cost by GIR

GIR	% Share per Section 4.2.4(a) of Attachment N	Costs Allocated to GIR (million)
GI-2021-25	25.0%	$3.391
GI-2021-26	25.0%	$3.391
GI-2021-30	25.0%	$3.391
GI-2021-31	25.0%	$3.391

12.2.9 Pawnee to Missile Site 230 kV Switching Station

The details of the Station Network Upgrades required at the Pawnee to Missile Site 345 kV new POI Switching Station are shown in Table 77.These Station Network Upgrade costs are 100% assigned to GI-2021-29.

Table 77 – Station Network Upgrades – GI-2020-6 230 kV Switching Station

Element	Description	Cost Est. (million)
PSCo's GI-2020-6 230 kV Switching Station	Expand the planned GI-2020-6 230 kV Switching Station to accommodate GI-2021-29 interconnection. The new equipment includes: • (1) 230 kV deadend structure • (2) 230 kV circuit breakers • (3) 230 kV disconnect switches • Yard improvements • Station controls and wiring • Associated foundations and structures	$4.000
	Siting and Land Rights support for substation construction	$0.500
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$4.500**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.10 San Luis Valley 115 kV Substation

The details of the Station Network Upgrades required at the San Luis Valley 115 kV Substation are shown in Table 78. These Station Network Upgrade costs are 100% assigned to GI-2021-23.

Table 78 – Station Network Upgrades – San Luis Valley 115 kV Substation

Element	Description	Cost Est. (million)
PSCo's San Luis Valley 115 kV Substation	Expand the existing San Luis Valley 115 kV Substation to accommodate GI-2021-23 interconnections The new equipment includes: • (1) 115 kV deadend structure • (1) 115 kV circuit breaker • (3) 115 kV disconnect switches • Station controls and wiring • Associated foundations and steel structures	$3.000
	Siting and Land Rights support for substation construction	$0.100
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$3.100**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.11 San Luis Valley 230 kV Substation

The details of the Station Network Upgrades required at the San Luis Valley 230 kV Substation are shown in Table 79. These Station Network Upgrade costs are 100% assigned to GI-2021-28.

Table 79 – Station Network Upgrades – San Luis Valley 230 kV Substation

Element	Description	Cost Est. (million)
PSCo's San Luis Valley 230 kV Substation	Expand the existing San Luis Valley 230 kV Substation to accommodate GI-2021-28 interconnections The new equipment includes: • (1) 230 kV deadend structure • (1) 230 kV circuit breaker • (3) 230 kV disconnect switches • Station controls and wiring • Associated foundations and steel structures	$2.500
	Siting and Land Rights support for substation construction	$0.100
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$2.600**
Time Frame	**Site, design, procure and construct**	**36 Months**

12.2.12 Tundra 345 kV Switching Station

The details of the Station Network Upgrades required at the Tundra 345 kV Switching Station are shown in Table 80. These Station Network Upgrade costs are shared per GIR according to Table 81.

Table 80 – Station Network Upgrades – Tundra 345 kV Switching Station

Element	Description	Cost Est. (million)
PSCo's Tundra 345 kV Switching Station	Expand the existing Tundra 345 kV Switching Station to accommodate GI-2021-19 and GI-2021-20 interconnections. The new equipment includes: • (4) 345 kV deadend structures • (6) 345 kV circuit breakers • (9) 345 kV disconnect switches • Station controls and wiring • Associated foundations and structures	$6.367
	Siting and Land Rights support for substation construction	$0.100
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$6.467**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 81 – Allocation of Tundra 345 kV Switching Station Upgrade Cost by GIR

GIR	% Share per Section 4.2.4(a) of Attachment N	Costs Allocated to GIR (million)
GI-2021-19	50.0%	$3.234
GI-2021-20	50.0%	$3.234

12.3 Total Cost of System Network Upgrades

Steady-state analysis discovered System Network Upgrades as a result of NRIS GIRs in three of the five study pockets: San Luis Valley, Southern Colorado, and Eastern Colorado. There were additional System Network Upgrades as a result of ERIS GIRs in two of the five study pockets: San Luis Valley and Southern Colorado. The costs and allocations of these are described in this section.

12.3.1 San Luis Valley Study Pocket

The San Luis Valley Study Pocket includes one NRIS GIR, GI-2021-23, and one ERIS GIR, GI-2021-28. The System Network Upgrade costs associated with these GIRs are described in Table 82 and Table 83.

Table 82 – System Network Upgrades – San Luis Valley Study Pocket for NRIS

System Network Upgrade	Total Cost (million)	GI-2021-23	
		Cost Allocation	Cost (million)
Upgrade Poncha to Sargent 115 kV CKT #1 (Currently included in planned Line 9811 Rebuild project with 2025 ISD)	N/A	N/A	N/A
Upgrade San Luis Valley to Poncha 230 kV CKT #1	$4.000	100.00%	$4.000
Upgrade San Luis Valley to Sargent 115 kV CKT #1 (Currently included in planned Line 9811 Rebuild project with 2025 ISD)	N/A	N/A	N/A
Total Cost by GIR		**-**	**$4.000**

Table 83 – System Network Upgrades – San Luis Valley Study Pocket for ERIS

System Network Upgrade	Total Cost (million)	GI-2021-23		GI-2021-28	
		Cost Allocation	Cost (million)	Cost Allocation	Cost (million)
Upgrade Poncha to Sargent 115 kV CKT #1 (Currently included in planned Line 9811 Rebuild project with 2025 ISD)	N/A	N/A	N/A	N/A	N/A
Upgrade San Luis Valley to Poncha 230 kV CKT #1	$4.000	34.28%	$1.371	65.72%	$2.629
Upgrade San Luis Valley to Sargent 115 kV CKT #1 (Currently included in planned Line 9811 Rebuild project with 2025 ISD)	N/A	N/A	N/A	N/A	N/A
Total Cost by GIR		**-**	**$1.371**	**-**	**$2.629**

12.3.2 Southern Colorado Study Pocket

The Southern Colorado Study Pocket includes two NRIS GIRs: GI-2021-21 and GI-2021-22. The System Network Upgrade costs associated with these NRIS GIRs are described in Table 84. The Southern Colorado Study Pocket includes five ERIS GIRs: GI-2021-12, GI-2021-13, GI-2021-19, GI-2021-20, and GI-2021-24. The System Network Upgrade costs associated with these ERIS GIRs are described in Table 85.

Table 84 – System Network Upgrades – Southern Colorado Study Pocket for NRIS

System Network Upgrade	Total Cost (million)	GI-2021-21		GI-2021-22	
		Cost Allocation	Cost (million)	Cost Allocation	Cost (million)
New Comanche to Harvest Mile 345 kV CKT #1	$24.000	66.67%	$16.001	33.33%	$7.999
New Comanche 230/345 kV Transformer	$20.000	66.67%	$13.334	33.33%	$6.666
New Vilas 69/115 kV Transformer TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
New Boone 115/230 kV Transformer	$9.000	66.67%	$6.000	33.33%	$3.000
New Fuller 230/115 kV Transformer TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
New Harvest Mile 345/230 kV Transformer	$10.000	66.67%	$6.667	33.33%	$3.333
Upgrade Vollmert to Fuller 115 kV CKT #1 TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Vollmert to Blk Sqmv 115 kV CKT #1 TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Boone to GI-2020-13 P 230 kV CKT #1	$4.900	66.67%	$3.267	33.33%	$1.633
Upgrade GI-2020-13 P to MidwayPS 230 kV CKT #1	$4.900	66.67%	$3.267	33.33%	$1.633
Upgrade GI-2020-3POI to Comanche 230 kV CKT #1	$4.000	66.67%	$2.667	33.33%	$1.333
Upgrade Cottonwood N to KettleCreek S 115 kV CKT #1 CSU Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Daniels Park to Fuller 230 kV CKT #1	$4.000	66.67%	$2.667	33.33%	$1.333
Upgrade Palmer to Monument 115 kV CKT #1 CSU Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Monument to Gresham 115 kV CKT #1 TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Greenwood to Monaco12 230 kV CKT #1	$32.600	66.67%	$21.734	33.33%	$10.866
Upgrade Canon City to NCanon_W 69 kV CKT #1 BHE Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Monaco12 to Sullivan2 230 kV CKT #1	$20.600	66.67%	$13.734	33.33%	$6.866
Upgrade Harris PS to Leetsdal2 115 kV CKT #1	$60.400	66.67%	$40.269	33.33%	$20.131
Upgrade Buckley 2 to Tolgate 230 kV CKT #1	$9.600	66.67%	$6.400	33.33%	$3.200
Upgrade Boone to GI-2020-3POI 230 kV CKT #1	$4.000	66.67%	$2.667	33.33%	$1.333
Upgrade Midway PS to Fuller 230 kV CKT #1	$4.000	66.67%	$2.667	33.33%	$1.333
Upgrade Blkfortp to Blk Sqmv 115 kV CKT #1 TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Briargate S to Cottonwood S 115 kV CKT #1 CSU Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Buckley 2 to Smoky Hill 230 kV CKT #1	$18.900	66.67%	$12.601	33.33%	$6.299
Upgrade Gresham to Blkfortp 115 kV CKT #1 TSGT Asset - Estimated Cost Unavailable	TBD	66.67%	TBD	33.33%	TBD
Upgrade Leetsdal to Monroe PS 230 kV CKT #1	$36.000	66.67%	$24.001	33.33%	$11.999
Total Cost by GIR		**-**	**$177.942**	**-**	**$88.957**

Table 85 – System Network Upgrades – Southern Colorado Study Pocket for ERIS

System Network Upgrade	Total Cost (million)	GI-2021-12		GI-2021-13		GI-2021-19		GI-2021-20		GI-2021-21		GI-2021-22		GI-2021-24	
		Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)
Upgrade Daniels Park to Tundra 345 kV CKT #2	$4.000	8.88%	$0.355	8.16%	$0.326	32.74%	$1.310	32.75%	$1.310	7.65%	$0.306	3.82%	$0.153	6.00%	$0.240
Upgrade GI-2020-7-POI to Comanche 345 kV CKT #2	$4.000	0.00%	$0.000	0.00%	$0.000	46.10%	$1.844	46.10%	$1.844	5.20%	$0.208	2.60%	$0.104	0.00%	$0.000
Upgrade Tundra to GI-2020-7-POI 345 kV CKT #2	$4.000	0.00%	$0.000	0.00%	$0.000	46.10%	$1.844	46.10%	$1.844	5.20%	$0.208	2.60%	$0.104	0.00%	$0.000
Total Cost by GIR		**-**	**$0.355**	**-**	**$0.326**	**-**	**$4.998**	**-**	**$4.998**	**-**	**$0.722**	**-**	**$0.361**	**-**	**$0.240**

12.3.3 Eastern Colorado Study Pocket

The Eastern Colorado study pocket includes four NRIS GIRs: GI-2021-27, GI-2021-29, GI-2021-30, and GI-2021-31. The System Network Upgrade costs associated with this pocket are described in Table 86.

Xcel Energy

Table 86 – System Network Upgrades – Eastern Colorado Study Pocket for NRIS

System Network Upgrade	Total Cost (million)	GI-2021-27		GI-2021-29		GI-2021-30		GI-2021-31	
		Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)	Cost Allocation	Cost (million)
New Missile Site to Harvest Mile 345 kV Line	$24.000	17.35%	$4.165	18.17%	$4.361	42.95%	$10.307	21.53%	$5.167
New Missile Site 345/230 kV #2	$20.000	51.74%	$10.348	48.26%	$9.652	0.00%	$0.000	0.00%	$0.000
New Story to Pawnee 230 kV #2 Line	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A
New Harvest Mile 345/230 kV #2 Transformer	$20.000	17.95%	$3.590	18.57%	$3.715	42.28%	$8.457	21.20%	$4.239
New Ft. Lupton 230/115 kV #2 Transformer	$12.000	14.64%	$1.756	16.96%	$2.036	45.56%	$5.467	22.84%	$2.741
New Smoky Hill 345/230 kV #T6 Transformer	$20.000	17.90%	$3.580	18.54%	$3.708	42.34%	$8.467	21.22%	$4.245
Upgrade Clark to Jordan 230 kV Line	$56.700	14.43%	$8.184	16.27%	$9.224	46.16%	$26.172	23.14%	$13.120
Upgrade Meadow Hill to Smoky Hill 230 kV Line	$10.100	14.43%	$1.458	16.27%	$1.643	46.16%	$4.662	23.14%	$2.337
Upgrade Clark to Greenwood 230 kV Line	$60.000	14.43%	$8.660	16.27%	$9.761	46.16%	$27.696	23.14%	$13.883
Upgrade Buckley to Tollgate 230 kV Line	$18.900	16.56%	$3.129	17.87%	$3.377	43.68%	$8.255	21.90%	$4.138
Upgrade Midway PS to W. Station 115 kV Line	$3.000	11.28%	$0.338	15.21%	$0.456	48.96%	$1.469	24.54%	$0.736
Upgrade Buckley to Smoky Hill 230 kV Line	$43.000	16.56%	$7.119	17.87%	$7.684	43.68%	$18.782	21.90%	$9.415
Upgrade Happy Canyon to Daniels Park 115 kV Line	$8.400	19.21%	$1.614	20.02%	$1.682	40.48%	$3.400	20.29%	$1.704
Upgrade Jordan to Orchard 230 kV Line	$4.000	14.43%	$0.577	16.27%	$0.651	46.16%	$1.846	23.14%	$0.926
Total Cost by GIR		**-**	**$54.518**	**-**	**$57.950**	**-**	**$124.980**	**-**	**$62.651**

12.4 Summary of Costs per Generator Interconnection Request

12.4.1 Summary of Costs assigned to GI-2021-12

The total cost of the required upgrades for GI-2021-12 to interconnect at a new GI-2021-12 230 kV Switching Station on the Comanche to Midway 230 kV line is $18.094 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.690 million (**Table 47**)**
- **The cost of Station Network Upgrades is $16.049 million (**Table 69**)**
- **The cost of System Network Upgrades is $ 0.355 million (**Table 85**)**

Figure 2 is a conceptual one-line of the new GI-2021-12 230 kV Switching Station on the Comanche to Midway 230 kV line required for the interconnection for GI-2021-12.

The list of improvements required to accommodate the interconnection of GI-2021-12 are given in Table 47**,** Table 69, and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.2 Summary of Costs assigned to GI-2021-13

The total cost of the required upgrades to allow GI-2021-13 to interconnect at Mirasol 230 kV Switching Station is $6.566 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.564 million (**Table 48**)**
- **The cost of Station Network Upgrades is $4.676 million (**Table 73**)**
- **The cost of System Network Upgrades is $0.326 million (**Table 85**)**

Figure 3 is a conceptual one-line of the Mirasol 230 kV Switching Station for the interconnection of GI-2021-13.

The list of improvements required to accommodate the interconnection of GI-2021-13 are given in Table 48**,** Table 72**,** Table 73, and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.3 Summary of Costs assigned to GI-2021-14

The total cost of the required upgrades to allow GI-2021-14 to interconnect at Green Valley 230 kV Substation is $6.185 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.680 million (**Table 49**)**
- **The cost of Station Network Upgrades is $4.505 million (**Table 70**)**
- **The cost of System Network Upgrades is $0 million**

Figure 4 is a conceptual one-line of the Green Valley 230 kV Substation for the interconnection of GI-2021-14.

The list of improvements required to accommodate the interconnection of GI-2021-14 at the Green Valley 230 kV Substation are given in Table 49 and Table 70. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.4 Summary of Costs assigned to GI-2021-16

The total cost of the required upgrades to allow GI-2021-16 to interconnect at Harvest Mile 345 kV Substation is $3.885 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.586 million (**Table 50**)**
- **The cost of Station Network Upgrades is $1.299 million (**Table 71**)**
- **The cost of System Network Upgrades is $0 million**

Figure 5 is a conceptual one-line of Harvest Mile 345 kV Substation for the interconnection of GI-2021-16.

The list of improvements required to accommodate the interconnection of GI-2021-16 are given in Table 50 and Table 71. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.5 Summary of Costs assigned to GI-2021-18

The total cost of the required upgrades to allow GI-2021-18 to interconnect at Collbran 138 kV Substation is $4.692 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.263 million (**Table 51**)**
- **The cost of Station Network Upgrades is $3.429 million (**Table 68**)**
- **The cost of System Network Upgrades is $0 million**

Figure 6 is a conceptual one-line of Collbran 138 kV Substation for the interconnection of GI-2021-18.

The list of improvements required to accommodate the interconnection of GI-2021-18 are given in Table 51 and Table 68. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.6 Summary of Costs assigned to GI-2021-19

The total cost of the required upgrades to allow GI-2021-19 to interconnect at Tundra 345 kV Switching Station is $10.745 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.513 million (**Table 52**)**
- **The cost of Station Network Upgrades is $3.234 million (**Table 81**)**
- **The cost of System Network Upgrades is $4.998 million (**Table 85**)**

Figure 7 is a conceptual one-line of Tundra 345 kV Switching Station for the interconnection of GI-2021-19.

The list of improvements required to accommodate the interconnection of GI-2021-19 are given in Table 52, Table 80**,** Table 81, and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.7 Summary of Costs assigned to GI-2021-20

The total cost of the required upgrades to allow GI-2021-20 to interconnect at Tundra 345 kV Switching Station is $10.745 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.513 million (**Table 53**)**
- **The cost of Station Network Upgrades is $3.234 million (**Table 81**)**
- **The cost of System Network Upgrades is $4.998 million (**Table 85**)**

Figure 7 is a conceptual one-line of Tundra 345 kV Switching Station for the interconnection of GI-2021-20.

The list of improvements required to accommodate the interconnection of GI-2021-20 are given in Table 53, Table 80**,** Table 81, and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.8 Summary of Costs assigned to GI-2021-21

The total cost of the required upgrades to allow GI-2021-21 to interconnect at a new GI-2021-21/22 230 kV Switching Station on the Boone to Midway 230 kV line is $188.974 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.741 million (**Table 54**)**
- **The cost of Station Network Upgrades is $8.569 million (**Table 67**)**
- **The cost of System Network Upgrades is $178.664 million (**Table 84 and Table 85**)**

Figure 8 is a conceptual one-line of the new GI-2021-21/22 230 kV Switching Station on the Boone to Midway 230 kV line required for the interconnection of GI-2021-21.

The list of improvements required to accommodate the interconnection of GI-2021-21 are given in Table 54**,** Table 66, Table 67, Table 84**,** and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.9 Summary of Costs assigned to GI-2021-22

The total cost of the required upgrades to allow GI-2021-22 to interconnect at a new GI-2021-21/22 230 kV Switching Station on the Boone to Midway 230 kV line is $99.621 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.734 million (**Table 55**)**
- **The cost of Station Network Upgrades is $8.569 million (**Table 67**)**
- **The cost of System Network Upgrades is $89.318 million (**Table 84 and Table 85**)**

Figure 8 is a conceptual one-line of the new GI-2021-21/22 230 kV Switching Station on the Boone to Midway 230 kV line required for the interconnection of GI-2021-22.

The list of improvements required to accommodate the interconnection of GI-2021-22 are given in Table 55, Table 66**,** Table 67, Table 84**,** and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.10 Summary of Costs assigned to GI-2021-23

The total cost of the required upgrades to allow GI-2021-23 to interconnect at San Luis Valley 115 kV Substation is $9.771 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.300 million (**Table 56**)**

- **The cost of Station Network Upgrades is $3.100 million (**Table 78**)**
- **The cost of System Network Upgrades is $5.371 million (**Table 82 and Table 83**)**

Figure 9 is a conceptual one-line of San Luis Valley 115 kV Substation for interconnection of GI-2021-23.

The list of improvements required to accommodate the interconnection of GI-2021-23 are given in Table 56**,** Table 78, Table 82, and Table 83. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.11 Summary of Costs assigned to GI-2021-24

The total cost of the required upgrades to allow GI-2021-24 to interconnect at Mirasol 230 kV Switching Station is $6.478 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.562 million (**Table 57**)**
- **The cost of Station Network Upgrades is $4.676 million (**Table 73**)**
- **The cost of System Network Upgrades is $0.240 million (**Table 85**)**

Figure 3 is a conceptual one-line of Mirasol 230 kV Switching Station for the interconnection of GI-2021-24.

The list of improvements required to accommodate the interconnection of GI-2021-24 are given in Table 57, Table 72, Table 73, and Table 85. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.12 Summary of Costs assigned to GI-2021-25

The total cost of the required upgrades to allow GI-2021-25 to interconnect at Pawnee 345 kV Substation is $5.792 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.401 million (**Table 58**)**
- **The cost of Station Network Upgrades is $3.391 million (**Table 76**)**
- **The cost of System Network Upgrades is $0 million**

Figure 10 is a conceptual one-line of Pawnee 345 kV Substation for the interconnection of GI-2021-25.

The list of improvements required to accommodate the interconnection of GI-2021-25 are given in Table 58, Table 75, and Table 76. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.13 Summary of Costs assigned to GI-2021-26

The total cost of the required upgrades to allow GI-2021-26 to interconnection at Pawnee 345 kV Substation is $5.930 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.539 million (**Table 59**)**
- **The cost of Station Network Upgrades is $3.391 million (**Table 76**)**
- **The cost of System Network Upgrades is $0 million**

Figure 10 is a conceptual one-line of Pawnee 345 kV Substation for the interconnection of GI-2021-26.

The list of improvements required to accommodate the interconnection of GI-2021-26 are given in Table 59, Table 75**,** and Table 76. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.14 Summary of Costs assigned to GI-2021-27

The total cost of the required upgrades to allow GI-2021-27 to interconnect at Missile Site 230 kV Substation is $58.451 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.683 million (**Table 60**)**
- **The cost of Station Network Upgrades is $2.250 million (**Table 74**)**
- **The cost of System Network Upgrades is $54.518 million (**Table 86**)**

Figure 11 is a conceptual one-line of Missile Site 230 kV Substation for the interconnection of GI-2021-27.

The list of improvements required to accommodate the interconnection of GI-2021-27 are given in Table 60**,** Table 74, and Table 86. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.15 Summary of Costs assigned to GI-2021-28

The total cost of the required upgrades to allow GI-2021-28 to interconnect at San Luis Valley 230 kV Substation is $6.829 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.600 million (**Table 61**)**
- **The cost of Station Network Upgrades is $2.600 million (**Table 79**)**
- **The cost of System Network Upgrades is $2.629 million (**Table 83**)**

Figure 9 is a conceptual one-line of San Luis Valley 230 kV Substation for the interconnection of GI-2021-28.

The list of improvements required to accommodate the interconnection of GI-2021-28 are given in Table 61, Table 79, and Table 83. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.16 Summary of Costs assigned to GI-2021-29

The total cost of the required upgrades to allow GI-2021-29 to interconnect at a new POI Switching Station on the Pawnee to Missile Site 230 kV line is $64.359 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.909 million (**Table 62**)**
- **The cost of Station Network Upgrades is $4.500 million (**Table 77**)**
- **The cost of System Network Upgrades is $57.950 million (**Table 86**)**

Figure 12 is a conceptual one-line of the POI Switching Station on the Pawnee to Missile Site 230 kV line required for the interconnection of GI-2021-29.

The list of improvements required to accommodate the interconnection of GI-2021-29 are given in Table 62**,** Table 77, and Table 86. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.17 Summary of Costs assigned to GI-2021-30

The total cost of the required upgrades to allow GI-2021-30 to interconnect at Pawnee 345 kV Substation is $130.658 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.287 million (**Table 63**)**

- **The cost of Station Network Upgrades is $3.391 million (**Table 76**)**
- **The cost of System Network Upgrades is $124.980 million (**Table 86**)**

Figure 10 is a conceptual one-line of Pawnee 345 kV Substation for the interconnection of GI-2021-30.

The list of improvements required to accommodate the interconnection of GI-2021-30 are given in Table 63, Table 75, Table 76, and Table 86. System improvements are subject to revision as a more detailed and refined design is produced.

12.4.18 Summary of Costs assigned to GI-2021-31

The total cost of the required upgrades to allow GI-2021-31 to interconnect at Pawnee 345 kV Substation is $68.589 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.547 million (**Table 64**)**
- **The cost of Station Network Upgrades is $3.391 million (**Table 76**)**
- **The cost of System Network Upgrades is $62.651 million (**Table 86**)**

Figure 10 is a conceptual one-line of Pawnee 345 kV Substation interconnection for GI-2021-31.

The list of improvements required to accommodate the interconnection of GI-2021-31 are given in Table 64, Table 75, Table 76, and Table 86. System improvements are subject to revision as a more detailed and refined design is produced.

12.5 Cost Estimate Assumptions

The cost estimates are in 2021 dollars with escalation and contingencies applied. Allowances for Funds Used During Construction (AFUDC) is not included. These estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of these new PSCo facilities. This estimate does not include the cost for any Interconnection Customer owned equipment and associated design and engineering. A level of accuracy is not specified for the estimates.

- Labor is estimated for straight time only – no overtime included
- Lead times for materials were considered for the schedule
- The GIRs are not located in PSCo's retail service territory. Therefore, no costs for retail load metering are included in these estimates
- PSCo (or it's Contractor) crews will perform all construction, wiring, testing, and commissioning for PSCo owned and maintained facilities
- Customer will install two (2) redundant fiber optics circuits into the Transmission provider's substation as part of its interconnection facilities construction scope
- Breaker duty study determined that no breaker replacements are needed in neighboring substations
- Line outages will be necessary during the construction period. Outage availability could potentially be problematic and extend requested back-feed date
- Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI
- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer Substation. PSCo / Xcel will need indications, readings, and data from the LFAGC RTU

13.0 Summary of Generation Interconnection Service

This report is the Phase 1 study results and does not include short circuit or stability analysis. If there is a change in status of one or more higher-queued Interconnection Requests due to withdrawal from the queue, a restudy of the power flow analysis will be performed as needed during Phase 2 and study results and costs will be updated.

The Customer is required to design and build the Generating Facility to mitigate for any potential inverter interactions with the neighboring inverter based Generating Facility(ies) and/or the inverters of the hybrid Generating Facility. This report only evaluated Interconnection Service of GIRs in DISIS-2021-004 and Interconnection Service in and itself does not convey transmission service.

14.0 Single-Line Diagrams for Each Generator Interconnection Substation

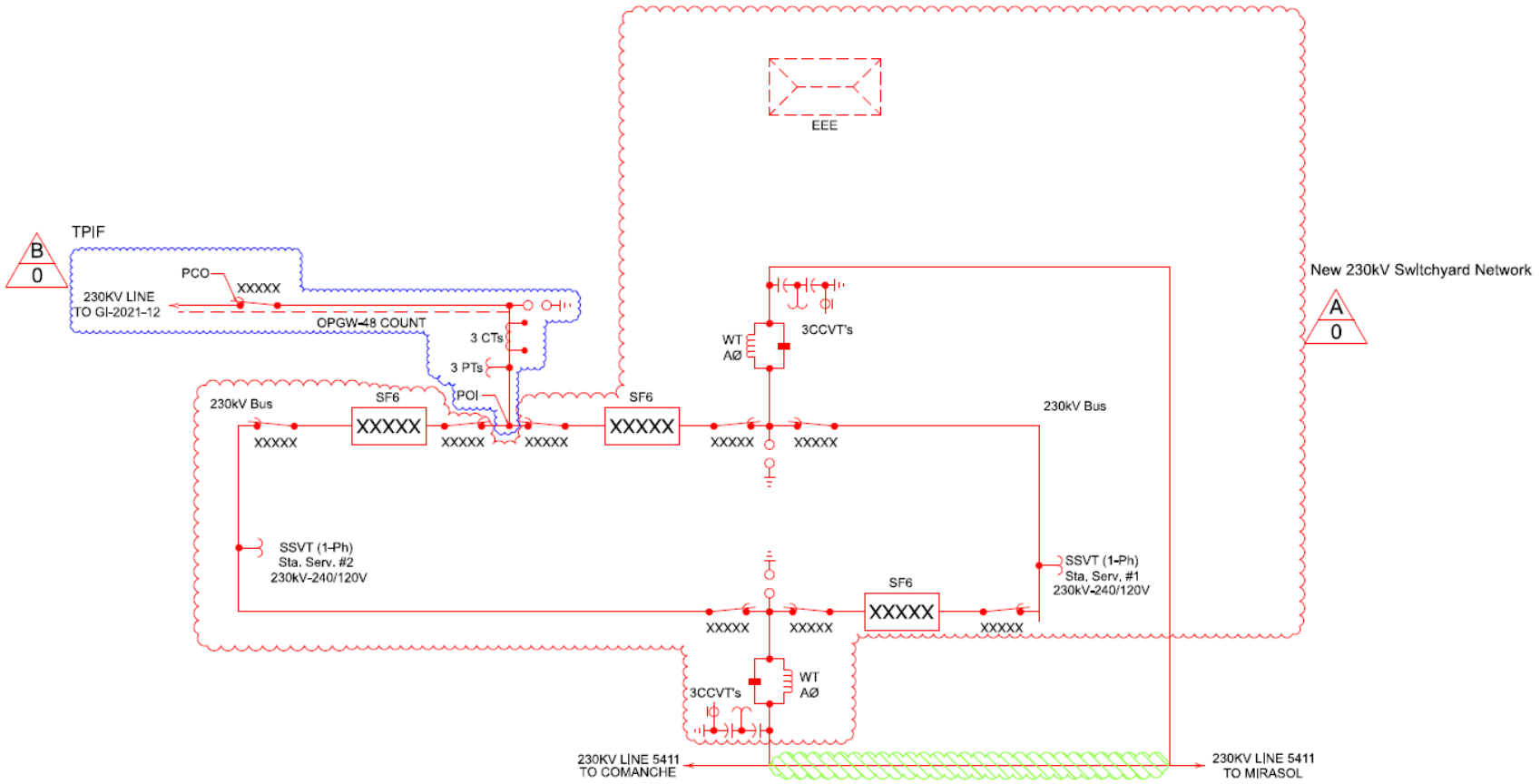

Figure 2 – Preliminary One-line of the GI-2021-12 new POI Switching Station on the Comanche to Midway 230 kV line

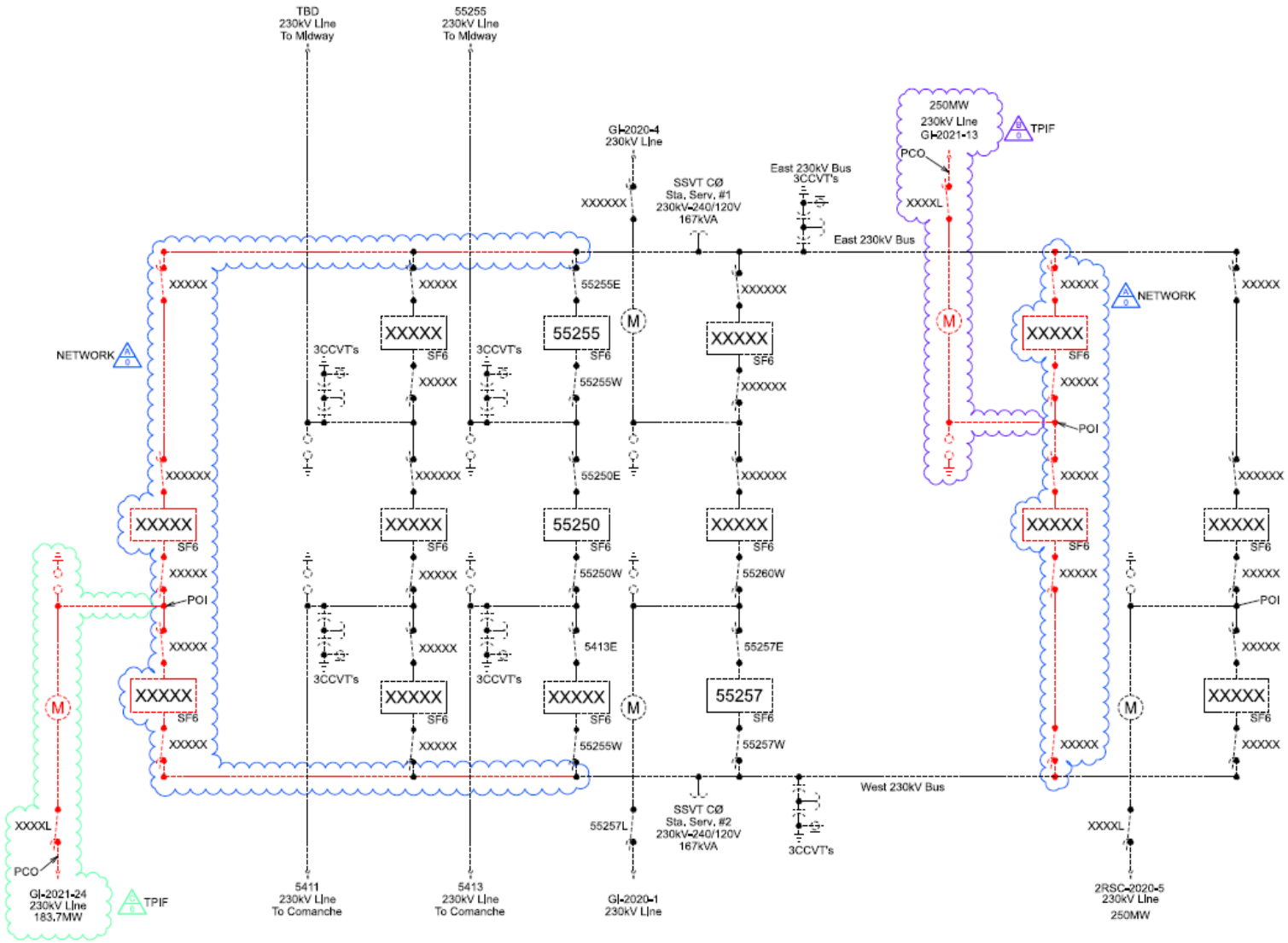

Figure 3 – Preliminary One-line of the GI-2021-13 and GI-2021-24 at Mirasol 230 kV Switching Station

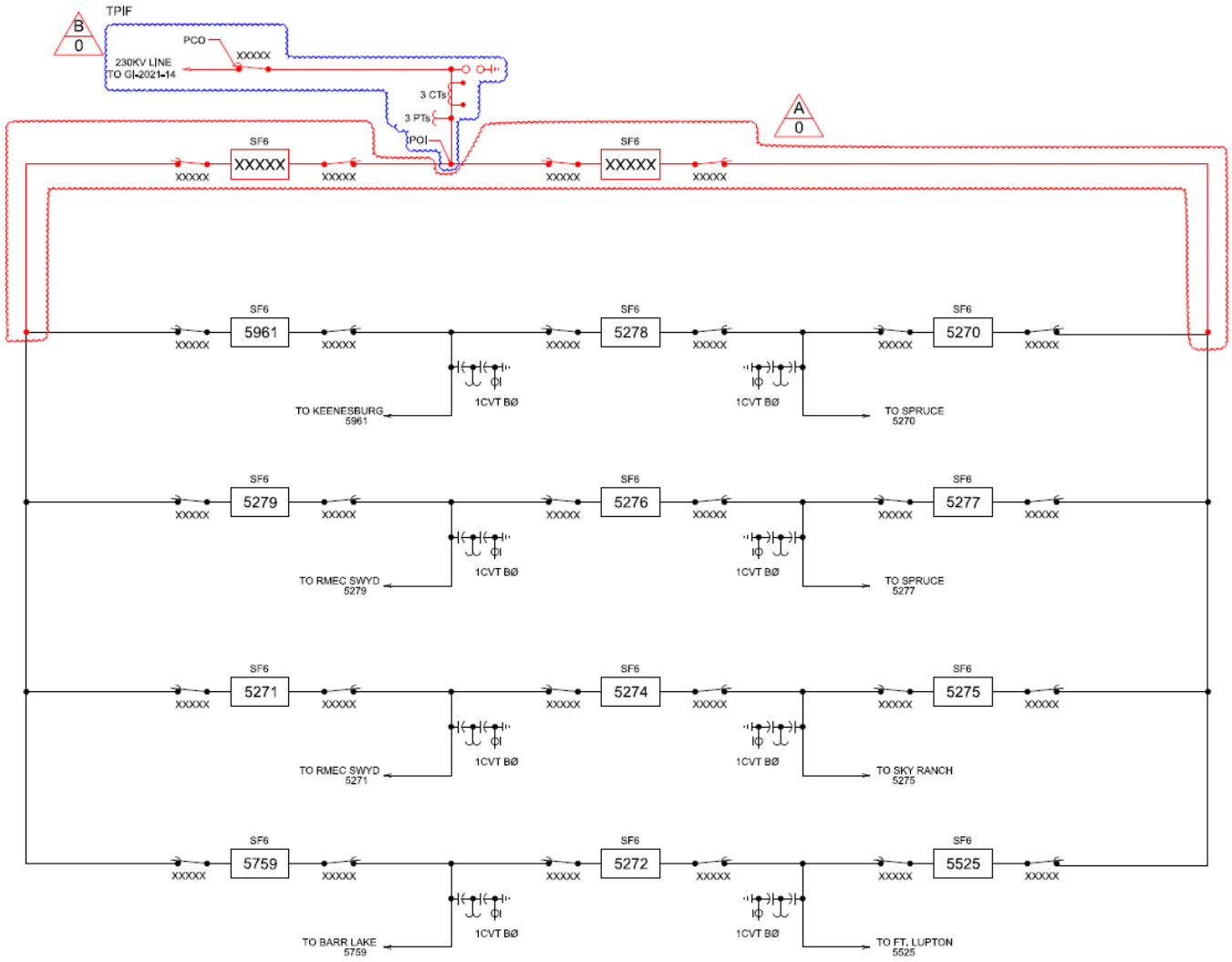

Figure 4 – Preliminary One-line of the GI-2021-14 at Green Valley 230 kV Substation

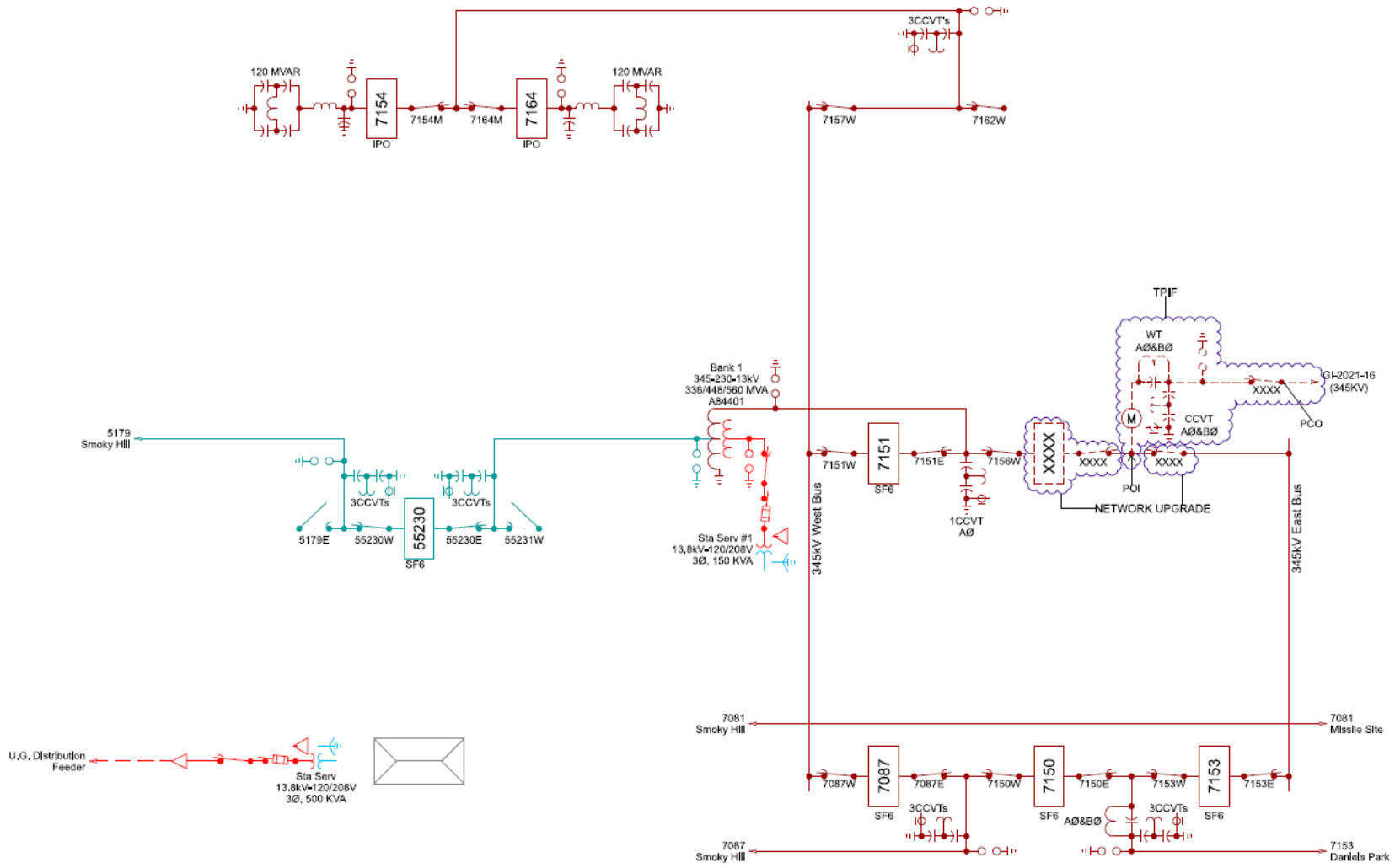

Figure 5 – Preliminary One-line of the GI-2021-16 at Harvest Mile 345 kV Substation

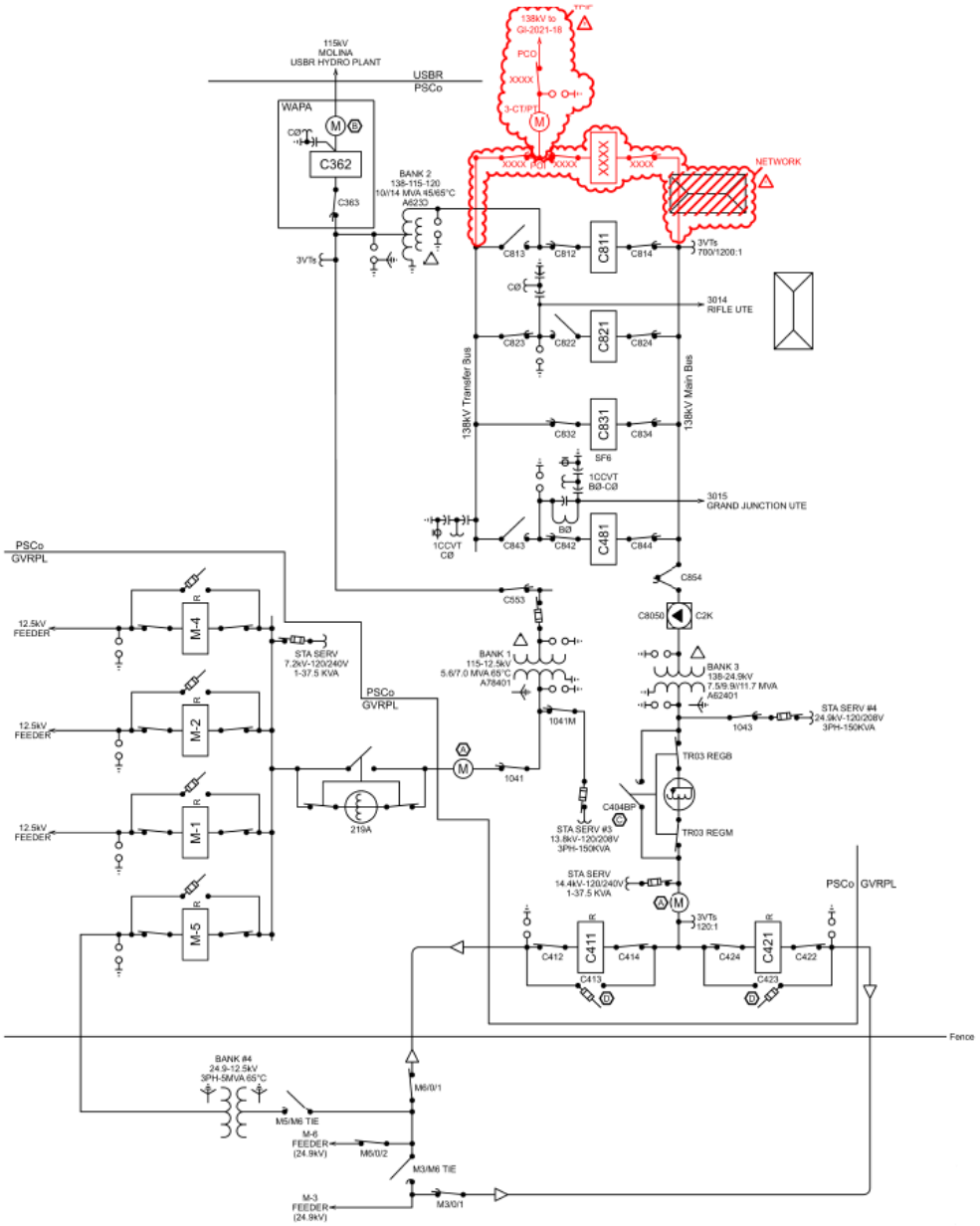

Figure 6 – Preliminary One-line of the GI-2021-18 at Collbran 138 kV Substation

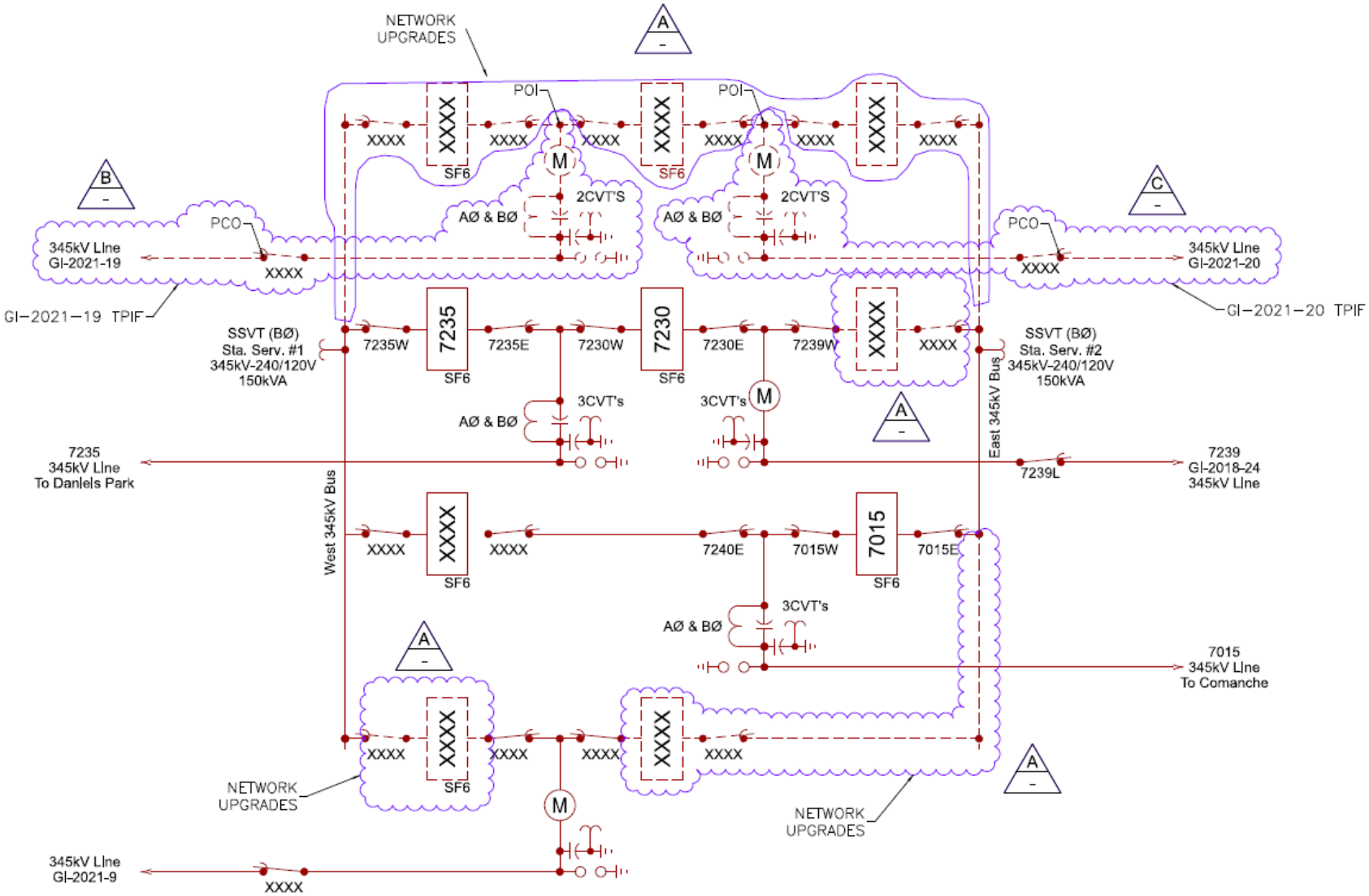

Figure 7 – Preliminary One-line of the GI-2021-19 and GI-2021-20 at Tundra 345 kV Switching Station

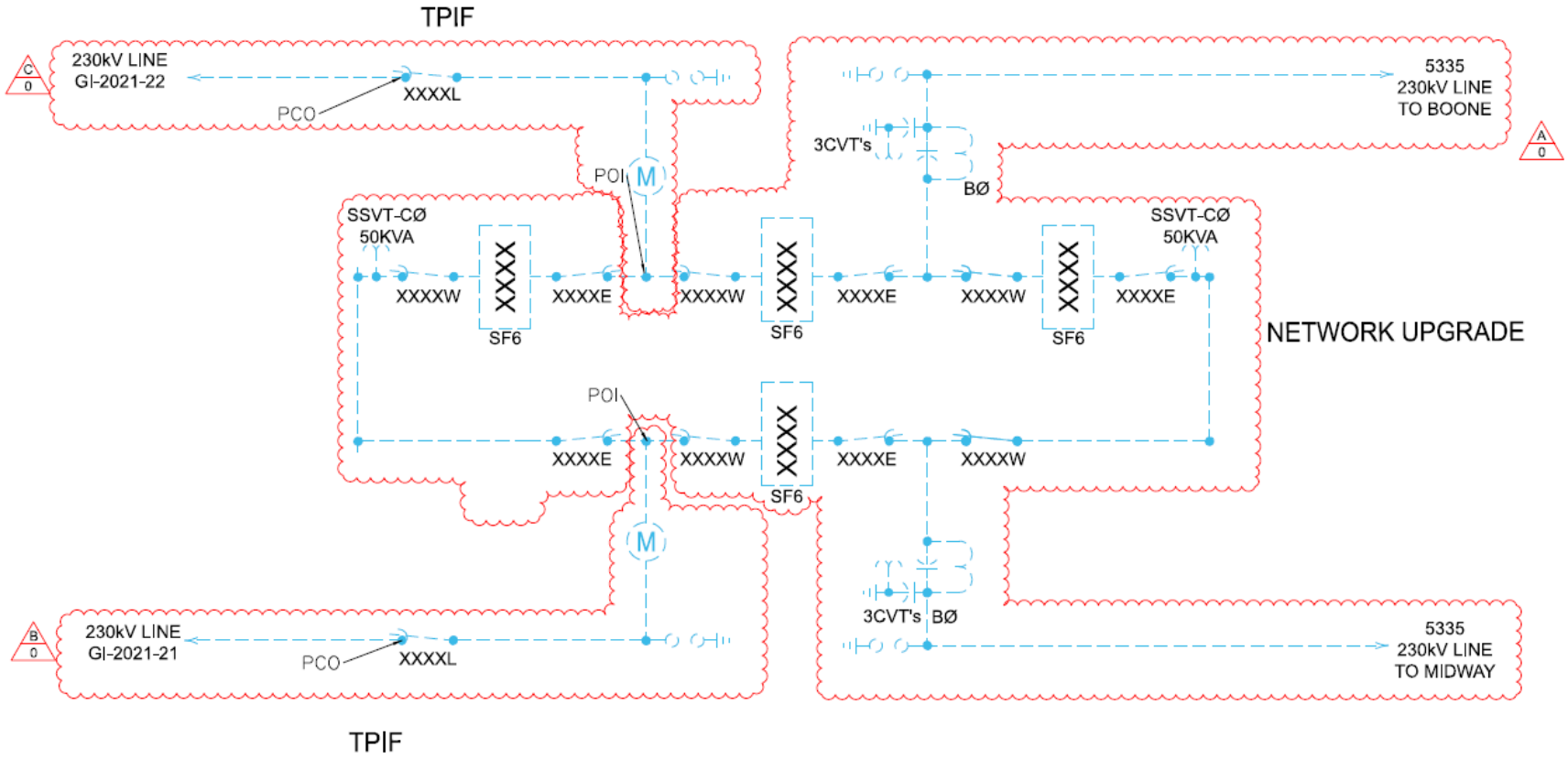

Figure 8 – Preliminary One-line of GI-2021-21 and GI-2021-22 at the GI-2021-21/22 230 kV Switching Station on the Boone to Midway 230 kV line

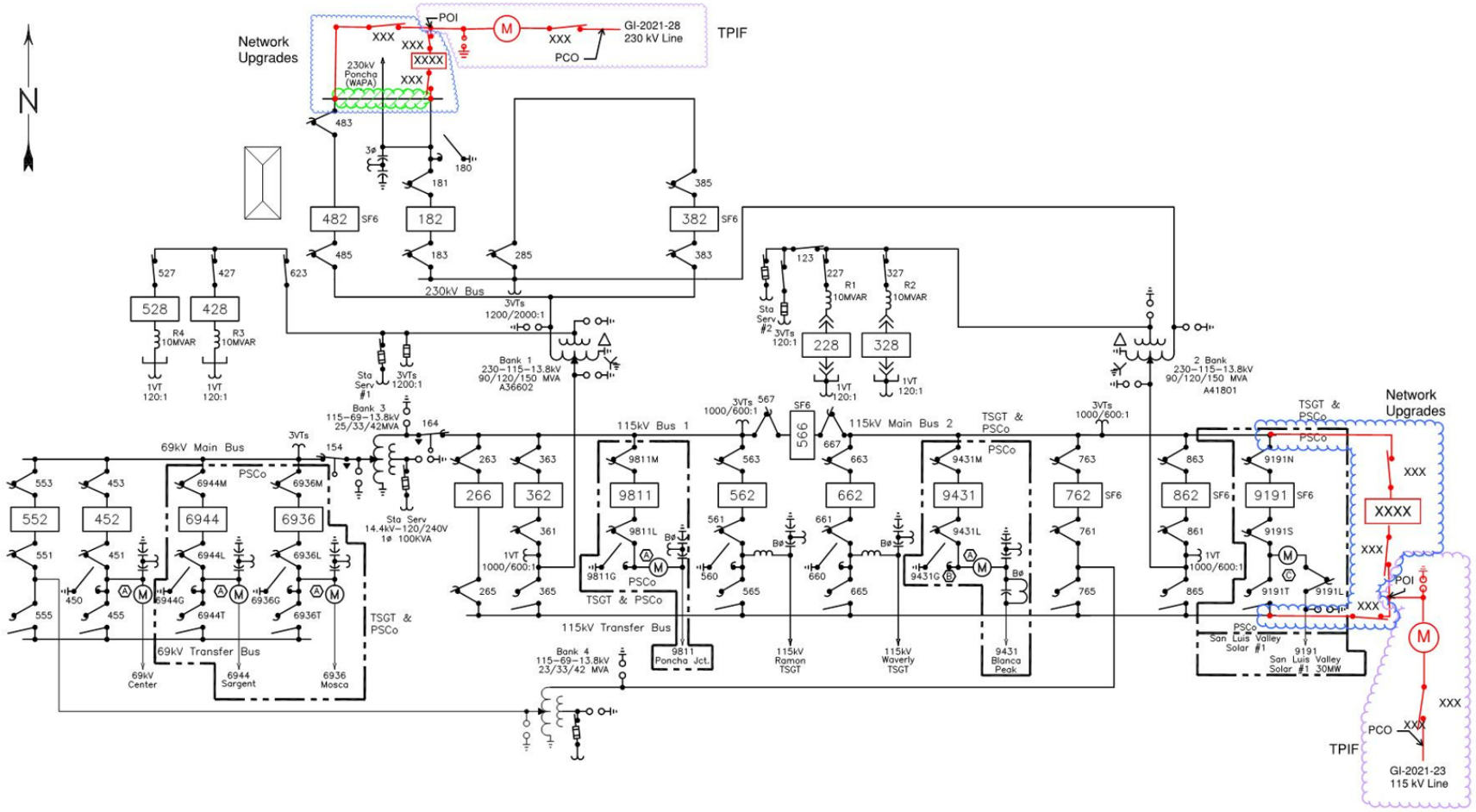

Figure 9 – Preliminary One-line of GI-2021-23 at San Luis Valley 115 kV Substation and GI-2021-28 at San Luis Valley 230 kV Substation

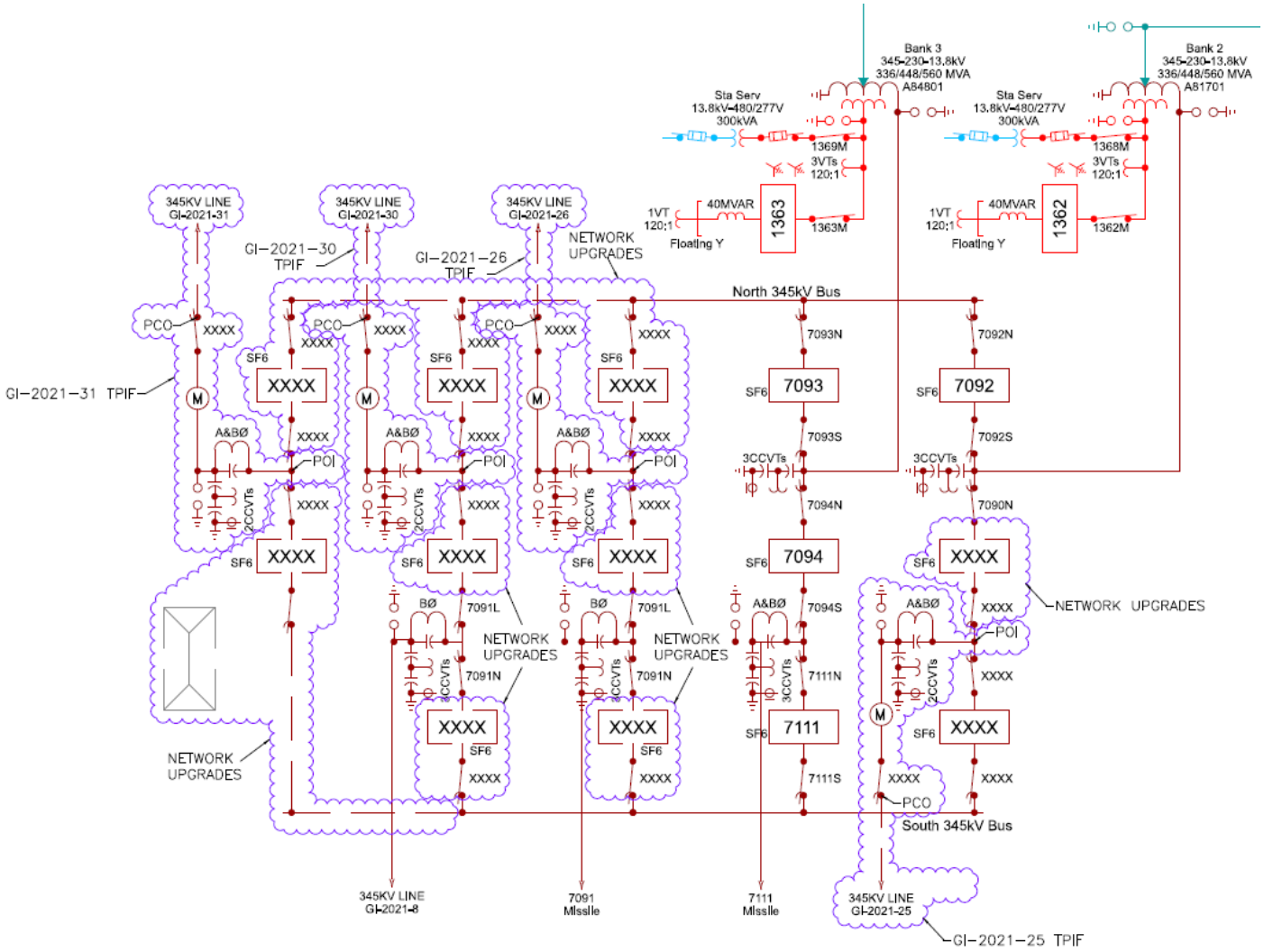

Figure 10 – Preliminary One-line of GI-2021-25, GI-2021-26, GI-2021-30, and GI-2021-31 at Pawnee 345 kV Substation

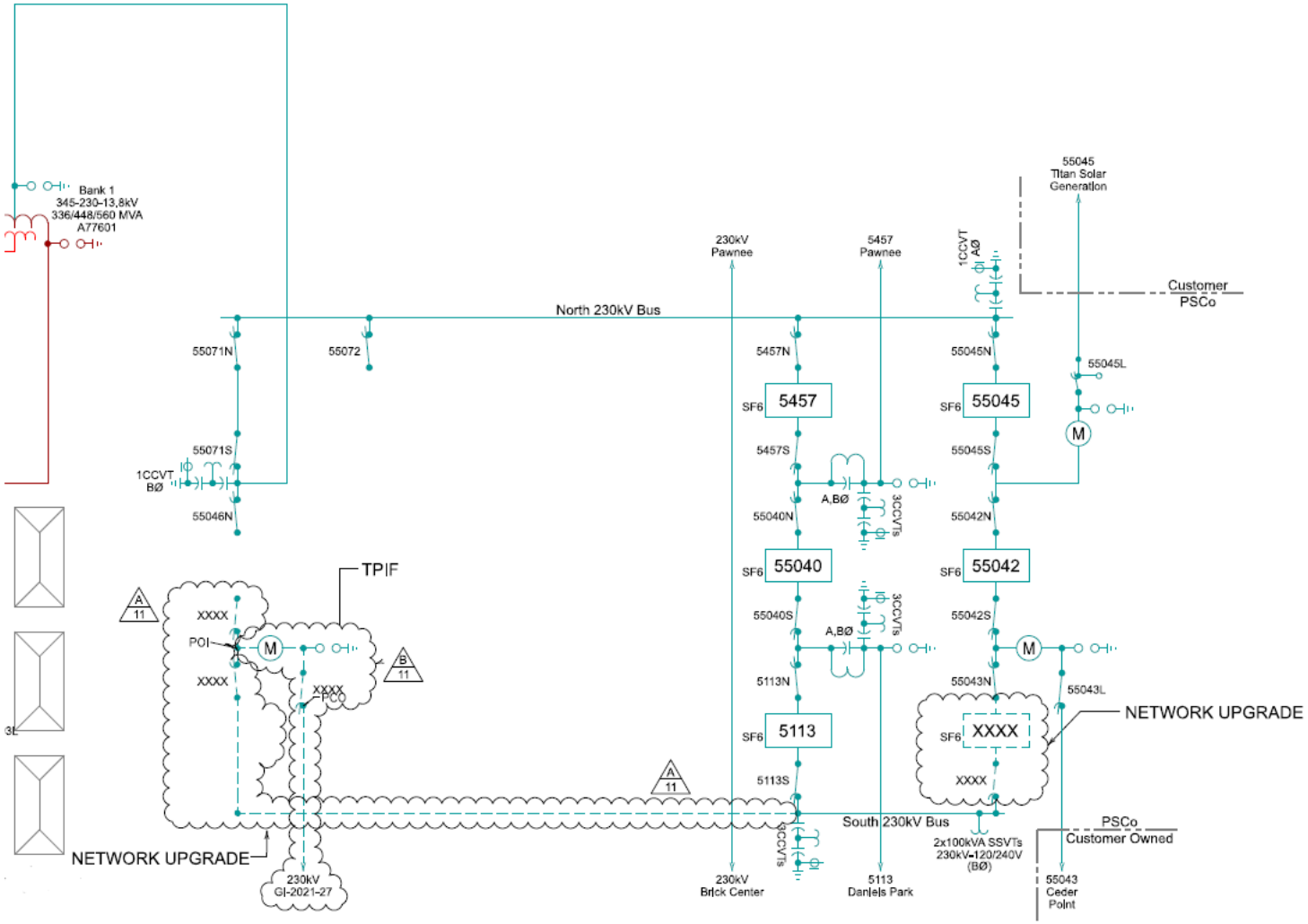

Figure 11 – Preliminary One-line of GI-2021-27 at Missile Site 230 kV Substation

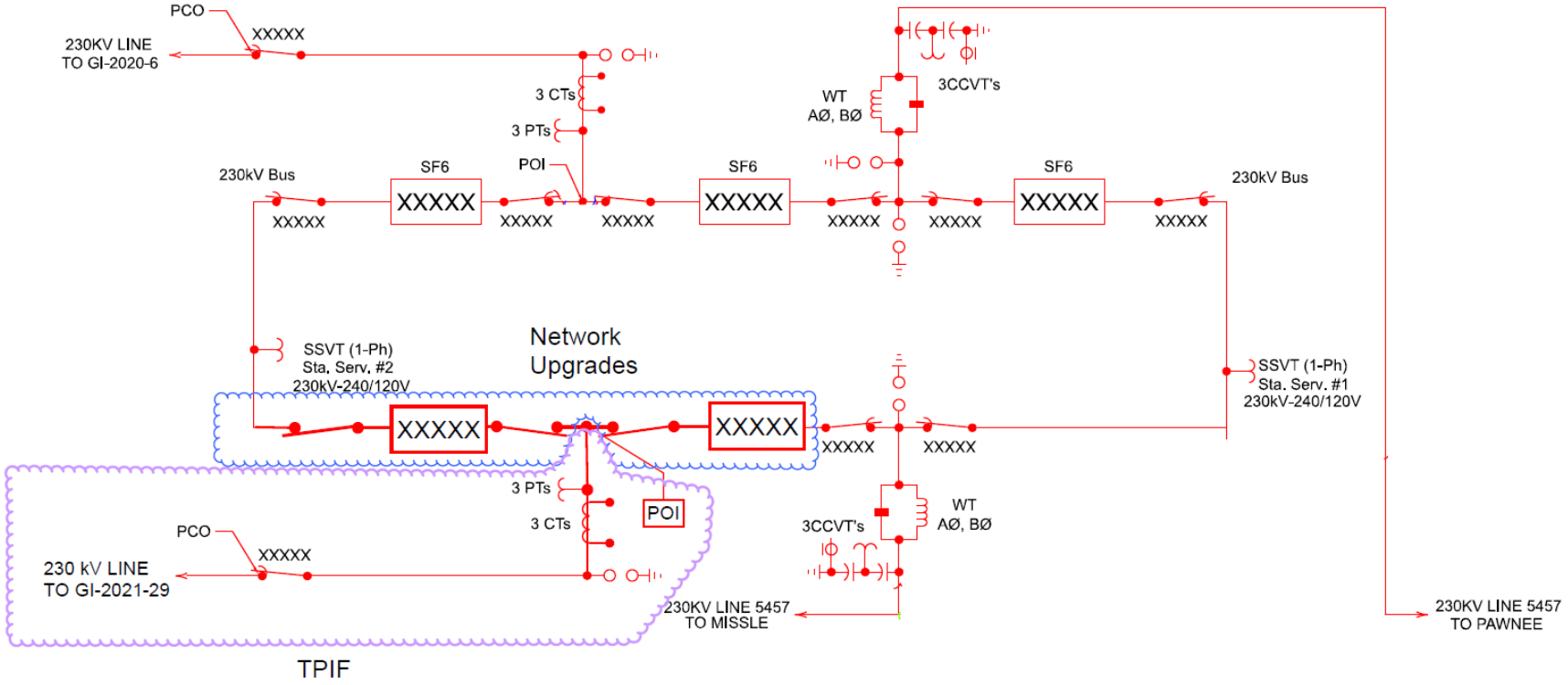

Figure 12 – Preliminary One-line of GI-2021-29 at GI-2020-6 230kV Switching Station on the Pawnee to Missile Site 230 kV line

15.0 Appendices

Appendix A: Multiple Contingency Definitions	Appendix A - Multiple Contingen