# Interconnection System Impact Study and Facility Study Report Addendum
# Generation Interconnection Request # GI-2016-9

480MW Solar Photovoltaic Generating Facility
San Luis Valley 230kV Substation
Alamosa County, Colorado

Xcel Energy - Transmission Planning West
Xcel Energy
July 30, 2019

This report is an update to the GI-2016-9 System Impact Study report posted on November 14, 2017 and the Facilities Study report posted on October 24, 2018. The purpose of this updated report is to identify study results and cost estimates due to the withdrawal of the higher-queued requests: GI-2015-1 and GI-2016-6. In addition, the revised study has modeled the delivery of the 480MW to the PSCo native loads by simulating a heavy south to north flow on the Comanche – Midway – Jackson Fuller – Daniels Park transmission system.

**Serial Cumulative Power Flow Case Creation**

The Base Case used for the power flow analysis originated from the 2023HS case built for the 2018 TPL1 work group of the Colorado Coordinated Planning Group (CCPG). As part of the case build effort for the TPL1 work group, the case has been reviewed by PSCo and the neighboring utilities within the CCPG foot print. Public Service Company of Colorado (PSCo) then made the following changes to the 2023HS case to create the Base Case.

All transmission planned projects in PSCo's 10 year transmission plan (http://www.oasis.oati.com/woa/docs/PSCO/PSCOdocs/Q1_2019_Transmission_Plan.pdf) that are expected to be in-service before July 2023 are modeled in the Base Case, consistent with the case season and year. This includes the following projects:

- Shortgrass 345kV Switching Station – ISD 2020
- Shortgrass – Cheyenne Ridge 345kV line – ISD 2020
- Graham Creek 115kV Substation – ISD 2021
- Husky 230/115kV Substation – ISD 2021
- Cloverly 115kV Substation – ISD 2021
- Ault – Husky 230kV line – ISD 2021
- Husky - Graham Creek – Cloverly 115kV line – ISD 2021
- Monument – Flying Horse 115kV Series Reactor – ISD 2021
- Gilman – Avon 115kV line – ISD 2022
- Upgrade Villa Grove – Poncha 69kV Line – ISD 2021
- Upgrade Poncha – San Luis Valley 115kV line – ISD 2021

The following PSCo FAC8 terminal equipment upgrade operational and maintenance projects for which PSCo has plans to increase the line ratings have been modeled at their future ratings in the Base Case:

- Waterton – Martin2 tap 115kV line was modeled at 189MVA
- Malta – Twin Lakes 115kV line was modeled at 143MVA
- Twin Lakes – Otero 115kV line was modeled at 143MVA
- Otero – Buena Vista 115kV line was modeled at 150MVA
- Buena Vista – Ray Lewis 115kV line was modeled at 136MVA
- Ray Lewis – Poncha 115kV line was modeled at 164MVA
- Arapahoe – SantaFe – Daniels Park 230kV line was modeled at 560MVA
- Daniels Park – Prairie1 230kV line was modeled at 576MVA
- Greenwood – Monaco 230kV line was modeled at 503MVA
- Leetsdale – Monaco 230kV line was modeled at 470MVA
- Poncha – Smelter town 115kV line was modeled at 114MVA

- San Luis Valley – Sargent 115kV line was modeled at 120MVA

The Base Case also modeled the Sargent – Poncha 115kV line closed.

The following additional changes were made to Tri-State Generation and Transmission (TSGT) model in the Base Case per further review and comment from TSGT:

- 30MW San Isabel Solar tapping Ludlo Tap – Pinon Canyon 115kV line – ISD 2021
- 80MW TSGT_0809 solar facility tapping Gladstone – Walsenburg 230kV line – ISD 2020
- 80MW TSGT_STEM_PV solar facility at Stem Beach 115kV bus – ISD 2021
- Fuller – Vollmer – Black Squirrel 115 kV line modeled at 173 MVA

The following additional changes were made to Black Hills Energy (BHE) model in the Base Case per further review and comment from BHE:

- Fountain Valley – DesertCove 115kV line was modeled at 171MVA – ISD 1/2021
- Fountain Valley – MidwayBR 115kV line was modeled at 171MVA – ISD 1/2021
- Pueblo West Substation – ISD 1/2021
- Skyline Ranch Substation – ISD 10/2021
- West Station – Greenhorn 115kV line Rebuild – ISD 9/2022

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

- The Cottonwood – Tesla 34.5kV line is modeled open and Kettle Creek – Tesla 34.5kV line is modeled closed on the CSU system
- Grazing Yak Solar – ISD 2020
- Cottonwood 230/115kV auto-transformer replacement – ISD 2019
- Nixon – Kelker 230kV line uprate – ISD 2019

The Base Case model includes the existing PSCo generation resources at the time of this study.

The Base Case was updated to include the higher-queued generation with Large Generator Interconnection Agreements (LGIAs) (active or suspended) and their associated Network Upgrades that were not included in the Base Case. In addition, all higher-

queued generation in the current PSCo Generator Interconnection Request (GIR) queue and their associated upgrades are modeled. The higher-queued LGIAs modeled are GI-2009-8, GI-2010-8, GI-2014-2, GI-2014-12, GI-2014-13 and GI-2014-14. The higher-queued GIRs modeled are: GI-2014-6, GI-2014-8, GI-2014-9, GI-2016-4 and GI-2016-7. While the higher-queued Network Resource Interconnection Service (NRIS) requests are dispatched at 100% nameplate, the higher-queued Energy Resource Interconnection Service (ERIS) requests are dispatched at 0MW.

The following PSCo Network Upgrades identified in the higher-queued GIs are modeled in the GI-2016-7 Base Case:

- MidwayPS 230/115kV, 100MVA transformer replaced with 150MVA unit – Network Upgrade assigned to GI-2014-12
- Increase Greenwood – Prairie3 230kV line rating to 637MVA – Network Upgrade assigned to GI-2016-7
- Increase Daniels Park – Fuller 230kV line rating to 577MVA – Network Upgrade assigned to GI-2016-7

The Benchmark Case was created from the Base Case by changing the generation dispatch to reflect a heavy south to north flow on the Comanche – Midway – Jackson Fuller – Daniels Park transmission system. This was accomplished by adopting the generation dispatch given in Table 6 below. The generation dispatch of the neighboring systems is provided by the neighboring utilities.

For the power flow analysis, the Study Case for GI-2016-9 was created by adding GI-2016-9 model to the Benchmark Case. The 480MW output from GI-2016-9 was sunk uniformly to the PSCo units outside the study area.

The studies performed by the San Luis Valley Subcommittee of the Colorado Coordinated Planning Group concluded that the existing system does not have any transfer capability out of the San Luis Valley area due to single contingency outage of the existing San Luis Valley – PonchaBR 230kV line. The Subcommittee concluded that a second San Luis Valley – PonchaBR 230kV line and a new PonchaBR – MidwayPS 230kV line are needed to deliver any new generation out of the San Luis Valley area. Therefore these two 230kV lines are needed to deliver the GI-2016-9 output out of the San Luis Valley area, and are modeled in the GI-2016-9 Study Case.

During the LGIA negotiations, the Customer requested that because the San Luis Valley – PonchaBR 230kV line was filed as a planned project filed in TSGT's long term transmission plan[1], although the line is identified as Contingent Facilities for interconnection service, the Customer is not be responsible for funding the construction of the San Luis Valley – PonchaBR 230kV

[1] Tri-State Generation and Transmission has reported the SanLuis Valley – PonchaBR 230kV line #2 project as a planned project with a 2022 in-service date. https://www.tristategt.org/copuc-rule-3627-filing-2016

line. It is the Customer's responsibility to work with the Affected System (TSGT) to ensure the new San Luis Valley – PonchaBR 230kV line is in-service in sufficient time to achieve full NRIS. The Customer will also have to procure transmission service from TSGT to deliver their generation to PSCo Network Load.

A power flow analysis was performed and the results of the Benchmark Case and Study Case were compared to determine the impacts of the interconnection of GI-2016-9.

The steady state analysis was performed using PTI's PSSE Ver. 33.6.0 program and the ACCC contingency analysis tool.

Transient stability analysis was performed using General Electric's PSLF Ver.21.0_02 program. Three phase faults were simulated for selected single and multiple contingencies using standard clearing times. The voltage and frequency of transmission busses in the study area, and the relative rotor angle of generators in the study area were recorded and analyzed. PSLF's DYTOOLS EPCL program was used to simulate the disturbances.

The power flow analysis identifies thermal and voltage violations in the PSCo system and the neighboring systems as a result of the interconnection of GI-2016-9. Several single contingencies were studied. The transient stability analysis verifies that all generating units within the PSCo transmission system and the neighboring systems remain stable (in synchronism), have positive damping and satisfy acceptable dynamic performance criteria. The study area is the electrical system consisting of PSCo's transmission system and the neighboring transmission systems that are impacted or that will impact the interconnection of GI-2016-9. The study area for GI-2016-9 includes the WECC designated zones 121, 700, 703, 704, 705, 709, 710, 712, 752 and 757.

## Power Flow Analysis Results

**Note** – Thermal overloads for single contingencies are calculated using the normal rating of the facility. All overloads are in red.

**Table 1 – Summary of Thermal Violations from Single Contingency Analysis**

| | | | | Facility Loading Without GI-2016-9 | | Facility Loading With GI-2016-9 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Monitored Facility (Line or Transformer)** | **Type** | **Owner** | **Branch Rating MVA (Norm)** | **N-1 Flow MVA (Norm)** | **N-1 Flow % of Rating (Norm)** | **N-1 Flow MVA (Norm)** | **N-1 Flow % of Rating (Norm)** | **% Change** | **NERC Single Contingency** | **Network Upgrade Assigned to GI** |
| Ray Lewis – Buena Vista Tap 115kV | Line | PSCo | 136 | 43.1 | 31.7% | 138.0 | 101.5% | 69.8% | PonchaBR – Curecanti 230kV | GI-2016-9 |
| Daniels Park – Prairie3 230kV | Line | PSCo | 561 | 538.6 | 96.1% | 592.4 | 105.6% | 9.5% | Daniels Park – Prairie1 230kV | GI-2016-9 |
| Daniels Park – Prairie1 230kV | Line | PSCo | 576 | 544.3 | 94.5% | 597.3 | 103.7% | 9.2% | Daniels Park – Prairie3 230kV | GI-2016-9 |
| Daniels Park – Fuller 230kV | Line | PSCo | 557 | 476.8 | 85.6% | 560.9 | 100.7% | 15.1% | Waterton 345/230kV | GI-2016-9 |
| Greenwood – Prairie1 230kV | Line | PSCo | 478 | 471.8 | 98.7% | 525.3 | 109.9% | 11.2% | Daniels Park – Prairie3 230kV | GI-2016-9 |
| Greenwood – Monaco 230kV | Line | PSCo | 503 | 468.3 | 93.1% | 506.5 | 100.7% | 7.6% | Buckley – Smokyhill 230kV | GI-2016-9 |
| Palmer Lake – Monument 115kV | Line | CSU | 108 | 137.0 | 126.9% | 168.3 | 155.8% | 28.9% | Daniels Park – Fuller 230kV | GI-2014-8 |
| Vollmer – BLK SQMV 115kV | Line | TSGT | 143 | 176.5 | 102.0% | 197.6 | 114.2% | 12.2% | Daniels Park – Fuller 230kV | GI-2016-7 |
| Vollmer – Fuller 115kV | Line | TSGT | 143 | 176.6 | 102.0% | 197.6 | 114.2% | 12.2% | Daniels Park – Fuller 230kV | GI-2016-7 |
| Black Forest – Black Squirrel MV 115kV | Line | TSGT | 143 | 147.6 | 103.2% | 168.6 | 117.9% | 14.7% | Daniels Park – Fuller 230kV | GI-2016-7 |
| Briargate S – Cottonwood S 115kV | Line | CSU | 150 | 162.7 | 108.5% | 170.5 | 113.7% | 5.2% | Cottonwood N – KettleCreek S 115kV | GI-2014-8 |
| Cottonwood N – KettleCreek S 115kV | Line | CSU | 162 | 168.5 | 104% | 176.7 | 109.1% | 5.1% | Briargate S – Cottonwood S 115kV | GI-2014-12 |

| Table 1 – Summary of Thermal Violations from Single Contingency Analysis | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Facility Loading Without GI-2016-9 | | Facility Loading With GI-2016-9 | | | | |
| Monitored Facility (Line or Transformer) | Type | Owner | Branch Rating MVA (Norm) | N-1 Flow MVA (Norm) | N-1 Flow % of Rating (Norm) | N-1 Flow MVA (Norm) | N-1 Flow % of Rating (Norm) | % Change | NERC Single Contingency | Network Upgrade Assigned to GI |
| Kelker E – Templeton 115kV | Line | TSGT | 131 | 134.5 | 102.7% | 141.2 | 107.8% | 5.1% | Kelker W – Rock Island 115kV | GI-2016-7 |
| Kelker W – Rock Island 115kV | Line | CSU | 162 | 161.2 | 99.5% | 168.2 | 103.8% | 4.3% | Kelker E – Templeton 115kV | GI-2016-9 |
| Monument – Gresham 115kV | Line | CSU | 145 | 138.9 | 95.8% | 159.9 | 110.3% | 14.5% | Daniels Park – Fuller 230kV | GI-2016-9 |

The results of the single contingency analysis (P1 and P2) are given in Table 1 above.

The following unbuilt facilities are required for GI-2016-9, as explained above:

- San Luis Valley – PonchaBR 230kV line #2 – TSGT's planned project
- PonchaBR – MidwayPS 230kV line

The following overloads on the PSCo system are assigned to GI-2016-9:

- Ray Lewis – Buena Vista Tap 115kV line – increase line rating to the next feasible highest rating of 150MVA, by replacing structures and hardware.
- Daniels Park – Prairie3 230kV line – increase line rating to the next feasible highest rating of 797MVA, by replacing conductor and terminal equipment.
- Daniels Park – Prairie1 230kV line – increase line rating to the next feasible highest rating of 797MVA, by replacing conductor and terminal equipment.
- Daniels Park – Fuller 230kV line – increase line rating to the next feasible highest rating of 802MVA, by replacing terminal equipment limitations.
- Greenwood – Prairie1 230kV line – increase line rating to the next feasible highest rating of 637MVA, by replacing terminal equipment limitations.

- Greenwood – Monaco 230kV line – increase line rating to the next feasible highest rating of 637MVA, by replacing conductor and terminal equipment.

The cost of PSCo Network Upgrades to mitigate overloads on the two PSCo facilities is given in Table 5 below.

The following new overloads on the neighboring systems are assigned to GI-2016-9:

- Monument – Gresham 115kV line loading increased from 95.8% to 110.3% (TSGT facility)
- Kelker W – Rock Island 115kV line loading increased from 99.5% to 103.8% (CSU facility)

The following overloads assigned to higher-queued GIs are subjected to increase in overloads due to the interconnection of GI-2016-9:

- Palmer Lake – Monument 115kV line (CSU facility)
- Vollmer – BLK SQMV 115kV line (TSGT facility)
- Vollmer – Fuller 115kV line (TSGT facility)
- Black Forest – Black Squirrel MV 115kV line (TSGT facility)
- Briargate S – Cottonwood S 115kV line (CSU facility)
- Cottonwood N – KettleCreek S 115kV line (CSU facility)

In addition to PSCo system overloads, GI-2016-9 caused new overloads on the CSU and TSGT facilities as explained above. Therefore, CSU and TSGT have been identified as Affected Systems for GI-2016-9. PSCo has informed the Affected Systems regarding the contingency overloads on their facilities. Mitigation measures for each of the contingency overloads on the Affected Systems must be identified and addressed by the Affected Systems in order for GI-2016-9 to achieve an ERIS or NRIS of 480MW. For facility overloads that existed in the Benchmark Case and where the addition of GI-2016-9 caused an increase in the pre-existing Benchmark Case overload, the overloads are assigned to higher-queued GI's as noted in Table 1. However, GI-2016-9 is responsible to mitigate overloads on facilities caused by the GI-2016-9 project itself, taking into consideration the Network Upgrades that would be mitigated by the higher queued projects.

**Voltage Regulation and Reactive Power Capability**

The Interconnection Customer is required to interconnect its Large Generating Facility with Public Service of Colorado's (PSCo) Transmission System in accordance with the *Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW* (available at:

http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.pdf).

In addition, any wind generating plant interconnections must also fulfill the performance requirements specified in FERC Order 661-A. Accordingly, the following voltage regulation and reactive power capability requirements at the POI are applicable to this interconnection request:

- To ensure reliable operation, all Generating Facilities interconnected to the PSCo transmission system are expected to adhere to the *Rocky Mountain Area Voltage Coordination Guidelines (RMAVCG)*. Accordingly, since the POI for this interconnection request is located within Southeast Colorado - Region 4 defined in the *RMAVCG*; the applicable ideal transmission system voltage profile range is 1.02 – 1.03 per unit at regulated buses and 1.0 – 1.03 per unit at non-regulated buses.
- Xcel Energy's OATT (Attachment N effective 10/14/2016) requires all non-synchronous Generator Interconnection (GI) 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 as long as the Generating Facility does not have to operate outside its 0.95 lag – 0.95 lead dynamic power factor range capability.
- 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 (34.5kV or 230kV bus) 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 and the 1.02 – 1.03 per unit voltage range standards at the POI. Further, for wind generating plants to meet the LVRT (Low Voltage Ride Through) performance requirements specified in FERC Order 661-A, an appropriately sized and located dynamic reactive power device (DVAR, SVC, etc.) may also need to be installed within the generating plant. Finally, 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 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 voltage ranges (noted above).

**Transient Stability Study Results**

| Table 2 - Stability Analysis Results | | | | | | |
|---|---|---|---|---|---|---|
| # | Fault Location | Fault Type | Facility Tripped | Clearing Time (cycles) | Post-Fault Voltage Recovery | Angular Stability |
| 1 | PonchaBR 230kV | 3ph | PonchaBR – San Luis Valley 230kV Line #1 | Primary (5.0) | Maximum transient voltage dips within criteria | Stable with positive damping |
| 2 | San Luis Valley 230kV | 3ph | PonchaBR – San Luis Valley 230kV Line #1 | Primary (5.0) | Maximum transient voltage dips within criteria | Stable with positive damping |
| 3 | Poncha 115kV | 3ph | Poncha – Sargent 115kV Line | Primary (6.0) | Maximum transient voltage dips within criteria | Stable with positive damping |
| 4 | San Luis valley 115kV | 3ph | Sargent – San Luis Valley 115kV | Primary (6.0) | Maximum transient voltage dips within criteria | Stable with positive damping |
| 5 | Poncha_PS 230kV bus | 3ph | Poncha_PS 230/115kV and Poncha_PS – PonchaBR 230kV tie | Primary (5.0) | Maximum transient voltage dips within criteria | Stable with positive damping |

The transient stability analysis for GI-2016-9 System Impact Study simulated five disturbances on the Study Case.

It is determined that GI-2016-9 produced no adverse system stability impact. The following results were obtained for each disturbance analyzed:

- ✓ No machines lost synchronism with the system
- ✓ No transient voltage drop violations were observed
- ✓ Machine rotor angles displayed positive damping

Furthermore, it is the responsibility of the Interconnection Customer to ensure that its generating facility is capable of meeting the voltage ride-through and frequency ride-through (VRT and FRT) performance specified in the NERC Reliability Standard PRC-024.

**Costs Estimates**

**Table 3: Transmission Providers Interconnection Facilities (no change from FAS report posted on Oct 24, 2018)**

| Element | Description | Cost Est. (Millions) |
|---|---|---|
| PSCo's San Luis Valley 230kV Bus | Interconnect Customer to tap at the San Luis Valley 230kV Bus. The new equipment includes:<br>• One 230kV gang switch with MOD<br>• Three 230kV arresters<br>• Three 230kV metering CTs<br>• Three 230kV metering PTs<br>• Station controls<br>• Associated electrical equipment, bus, wiring and grounding<br>• Associated foundations and structures<br>• Associated transmission line communications, fiber, relaying and testing. | $1.052 |
| | Transmission line tap into substation: | $0.055 |
| | Siting and Land Rights support for siting studies, land and ROW acquisition and construction: | $0.020 |
| | **Total Cost Estimate for Transmission Providers Interconnection Facilities** | **$1.127** |
| **Time Frame** | **Site, design, procure and construct** | **18 Months** |

**Table 4: Network Upgrades for Interconnection (ERIS or NRIS) * (no change from FAS report posted on Oct 24, 2018)**

| Element | Description | Cost Est. (Millions) |
|---|---|---|
| PSCo's San Luis Valley 230kV Bus | Interconnect Customer to tap at the San Luis Valley 230kV Bus. This also includes upgrading the bus to breaker and a half The new equipment includes:<br>• Five 230kV breakers<br>• Ten 230kV Switches<br>• Associated electrical equipment, bus, wiring and grounding<br>• Associated foundations and structures<br>• Associated transmission line communications, fiber, relaying and testing. | $5.991 |
| San Luis Valley's 230kV Yard | Communications scope to add a new EEE to the San Luis Valley's 230kV yard | $0.758 |
| | Siting and Land Rights support for substation construction: | $0.020 |
| | **Total Cost Estimate for Network Upgrades for Interconnection** | **$6.769** |
| **Time Frame** | **Site, design, procure and construct** | **18 Months** |

*** Contingent upon completion of the Network Upgrades for Interconnection listed in #1 and #2 of Attachment 1.**

**Table 5 – Additional Network Upgrades for NRIS ** (new network upgrades in red font)**

| Element | Description | Cost Est. (Millions) |
|---|---|---|
| Midway 230kV Bus | New Line Termination at Xcel's 230kV Midway Bus | $2.001 |
| PonchaBR – MidwayPS 230kV * | New 230kV Transmission Line between Xcel's Midway Substation and WAPA's Poncha Substation | $137.742 |
| Ray Lewis - Buena Vista 115kV Line | Increase line rating to 150MVA | $0.371 |
| Daniels Park-Prairie 3 230kV Line/Sub | Increase line rating to 797MVA | $1.235 |
| Daniels Park-Prairie 1 230kV Line/Sub | Increase line rating to 797MVA | $1.427 |

| | | |
|---|---|---|
| Daniels Park - Fuller 230kV Line | Upgrade the 230kV terminal to Jackson Fuller | $1.934 |
| Greenwood – Prairie1 230kV Line | Upgrade 230kV terminal at Greenwood | $0.320 |
| Greenwood-Monaco 230kV Line/Sub | Increase line rating to 797MVA | $17.980 |
| | **Total Cost Estimate for Network Upgrades for Delivery** | **$163.01** |
| **Time Frame** | **Site, design, procure and construct** | **48 Months** |

***The construction of the PonchaBR – MidwayPS 230kV line requires approval of a Certificate of Public Necessity and Convenience (CPCN) from the Colorado Public Utilities Commission.**
****Contingent on completion of the Network Upgrades listed in Attachment 1.**

The total estimated cost of the PSCo transmission system improvements required for GI-2016-9 to qualify for:

- ERIS is $7.896 Million (Tables 3 and 4); and
- NRIS is $170.906 Million (Tables 3, 4 and 5)

For GI-2016-9 interconnection:

NRIS (after required transmission system improvements) = 480MW
ERIS (after required transmission system improvements) = 480MW (output delivery assumes the use of existing firm or non-firm capacity of the PSCo Transmission System on as as-available basis).

The ERIS and NRIS results above are contingent upon the completion of the Contingent Facilities listed in Attachment 1.

If there is a change in status of one or more higher-queued Interconnection Requests due to withdrawal from the queue or changing from NRIS to ERIS, and the Network Upgrades identified for the higher-queued Interconnection Requests are not constructed, the Network Upgrade costs would become the responsibility of GI-2016-9 to the extent they are necessary to interconnect GI-2016-9. A restudy will be performed as needed to identify the new Network Upgrade and Contingent Facility responsibilities.

**Table 6 – Generation Dispatch Used to Stress the Benchmark Case (MW is Gross Capacity)**

| Bus Name | ID | Status | PGen (MW) | PMax (MW) | Owner |
|---|---|---|---|---|---|
| APT_DSLS 4.1600 | G1 | 0 | 0 | 10 | BHE |
| BAC_MSA GEN113.800 | G1 | 1 | 90 | 90 | BHE |
| BAC_MSA GEN213.800 | G1 | 1 | 90 | 90 | BHE |
| BAC_MSA GEN413.800 | G1 | 1 | 35 | 40 | BHE |
| BAC_MSA GEN413.800 | G2 | 1 | 35 | 40 | BHE |
| BAC_MSA GEN413.800 | S1 | 1 | 20 | 24.8 | BHE |
| BAC_MSA GEN513.800 | G1 | 1 | 30 | 40 | BHE |
| BAC_MSA GEN513.800 | G2 | 1 | 30 | 40 | BHE |
| BAC_MSA GEN513.800 | S1 | 1 | 20 | 24.8 | BHE |
| BAC_MSA GEN613.800 | G1 | 1 | 0 | 40 | BHE |
| BUSCHRNCH_LO0.7000 | 1 | 1 | 20 | 60 | BHE |
| BUSCHRWTG1 0.7000 | G1 | 1 | 14 | 28.8 | BHE |
| E_CANON 69.000 | G1 | 0 | 0 | 8 | BHE |
| PP_MINE 69.000 | G1 | 0 | 0 | 3 | BHE |
| PUB_DSLS 4.1600 | G1 | 0 | 0 | 10 | BHE |
| R.F.DSLS 4.1600 | G1 | 0 | 10 | 10 | BHE |
| RTLSNKWNDLO 0.7000 | G1 | 1 | 22 | 60 | BHE |
| ALMSACT1 13.800 | G1 | 0 | 17 | 17 | PSCo |
| ALMSACT2 13.800 | G2 | 0 | 19 | 14 | PSCO |
| COGENTRIX_PV34.500 | S3 | 1 | 19.5 | 30 | PSCO |
| COMAN_1 24.000 | 1 | 1 | 357 | 360 | PSCO |
| COMAN_2 24.000 | C2 | 1 | 365 | 365 | PSCO |
| COMAN_3 27.000 | C3 | 1 | 788 | 780 | PSCO |
| COMAN_PV 34.500 | S1 | 1 | 102 | 120 | PSCO |
| CO_GRN_E 34.500 | W1 | 1 | 64.8 | 81 | PSCo |
| CO_GRN_W 34.500 | W2 | 1 | 64.8 | 81 | PSCo |

| | | | | | |
|---|---|---|---|---|---|
| FTNVL1&2 13.800 | G1 | 1 | 36 | 40 | PSCO |
| FTNVL1&2 13.800 | G2 | 1 | 36 | 40 | PSCO |
| FTNVL3&4 13.800 | G3 | 1 | 36 | 40 | PSCO |
| FTNVL3&4 13.800 | G4 | 1 | 36 | 40 | PSCO |
| FTNVL5&6 13.800 | G5 | 1 | 36 | 40 | PSCO |
| FTNVL5&6 13.800 | G6 | 1 | 36 | 40 | PSCO |
| GSANDHIL_PV 34.500 | S1 | 1 | 12.4 | 19 | PSCO |
| JKFULGEN 0.6900 | W1 | 1 | 200 | 249.43 | PSCO |
| LAMAR_DC 230.00 | DC | 0 | 101 | 210 | PSCO |
| SOLAR_GE 34.500 | S2 | 1 | 19.5 | 30 | PSCO |
| SUNPOWER 34.500 | S1 | 1 | 33.8 | 52 | PSCO |
| TWNBUTTE 34.500 | W1 | 1 | 60 | 75 | PSCO |
| SI_GEN 0.6000 | 1 | 1 | 6.1 | 30 | TSGT |
| STEM_PV 0.4800 | PV | 1 | 80 | 100 | TSGT |
| TBII_GEN 0.6900 | W | 1 | 60 | 76 | TSGT |
| TSGT_0809 0.6200 | PV | 1 | 80 | 100 | TSGT |

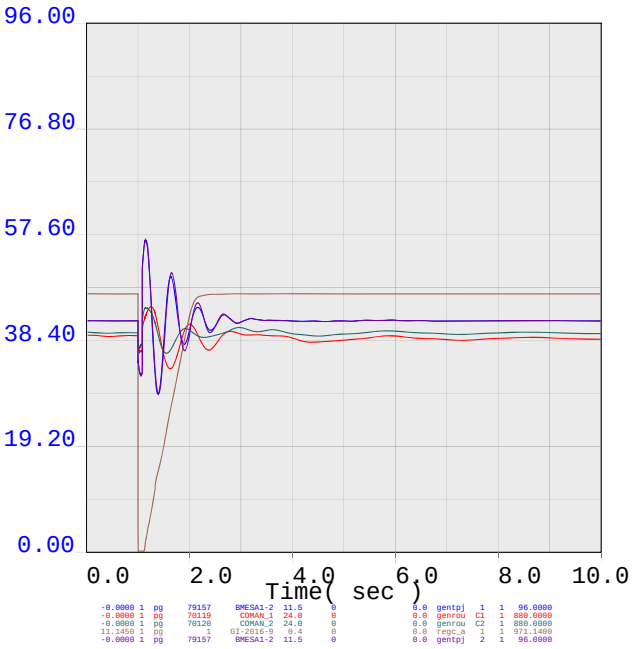
**Attachment 1 – Contingent Facilities Assigned to GI-2016-9**

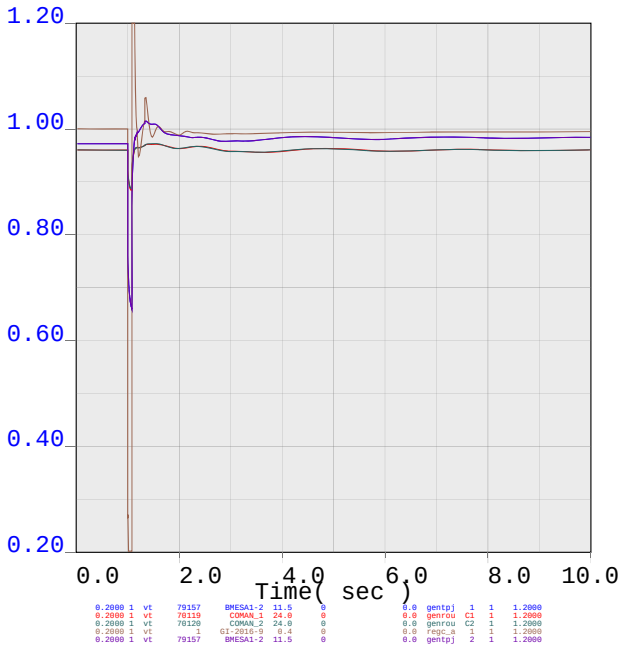
Following is the list of the unbuilt Interconnection Facilities and Network Upgrades upon which the GI-2016-9 request's costs, timing, and study findings are dependent, and if delayed or not built, could cause a need for re-studies of the Interconnection Request or a reassessment of the Interconnection Facilities and/or Network Upgrades and/or costs and timing.

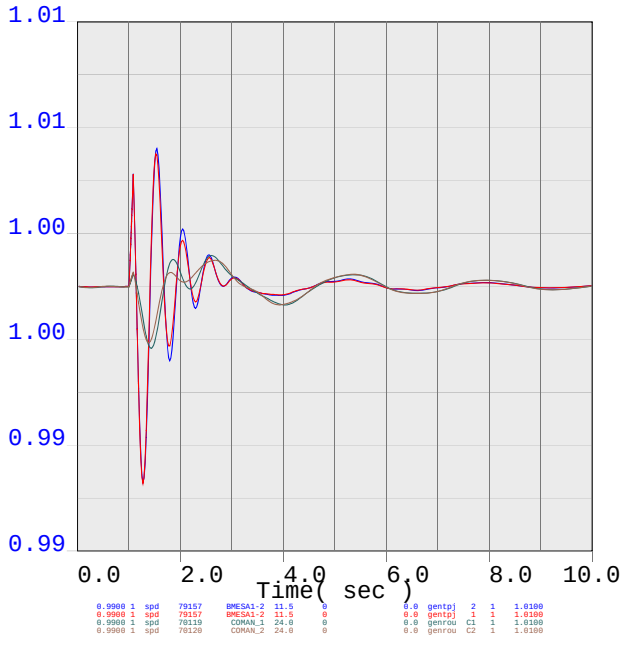
1. Network Upgrades for Interconnection identified for higher-queued Generation Interconnection Requests: GI-2014-13 (please refer to the corresponding Facilities study reports for details)
2. Network Upgrades for Interconnection identified for GI-2016-9 (please refer to Table 3 and 4 above)
3. The following Network Upgrades assigned to the higher-queued Generation Interconnection Requests
   - MidwayPS 230/115kV, 100MVA transformer replaced with 150MVA unit – Network Upgrade assigned to GI-2014-12
   - Increase Greenwood – Prairie3 230kV line rating to 637MVA – Network Upgrade assigned to GI-2016-7
   - Increase Daniels Park – Fuller 230kV line rating to 577MVA – Network Upgrade assigned to GI-2016-7
4. The following Network Upgrades required for GI-2016-9 (refer to Table 5 above for PSCo facilities costs )
   - San Luis Valley – PonchaBR 230kV line #2 – TSGT's planned project
   - Uprate the Ray Lewis – Buena Vista Tap 115kV line to 150MVA (PSCo facility)
   - Uprate the Daniels Park – Prairie3 230kV line to 797MVA (PSCo facility)
   - Uprate the Daniels Park – Prairie1 230kV line to 797MVA (PSCo facility)
   - Uprate the Daniels Park – Fuller 230kV line to 802MVA (PSCo facility)
   - Uprate the Greenwood – Prairie1 230kV line to 637MVA (PSCo facility)
   - Uprate the Greenwood – Monaco 230kV line to 637MVA (PSCo facility)
   - Project to be identified by TSGT to mitigate overload on the Monument – Gresham 115kV line
   - Project to be identified by CSU to mitigate overload on the Kelker W – Rock Island 115kV
   - Project to be identified by CSU to mitigate overload on the Palmer Lake – Monument 115kV line
   - Project to be identified by TSGT to mitigate overload on the Vollmer – BLK SQMV 115kV line
   - Project to be identified by TSGT to mitigate overload on the Vollmer – Fuller 115kV line
   - Project to be identified by TSGT to mitigate overload on the Black Forest – Black Squirrel MV 115kV line
   - Project to be identified by CSU to mitigate overload on the Briargate S – Cottonwood S 115kV line
   - Project to be identified by CSU to mitigate overload on the Cottonwood N – KettleCreek S 115kV line
4. The following unbuilt transmission projects modeled in the Base Case
   - PSCo's Monument – Flying Horse 115kV Series Reactor project
   - PSCo's project to upgrade Villa Grove – Poncha 69kV Line

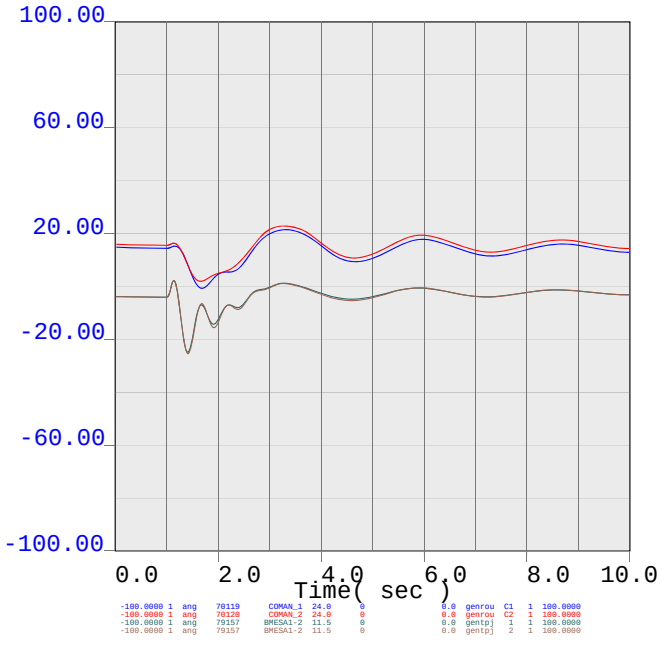
- PSCo's project to upgrade Poncha – San Luis Valley 115kV line
- PSCo's terminal upgrade project to uprate the Waterton – Martin2 tap 115kV line to 189MVA
- PSCo's terminal upgrade project to uprate the Malta – Twin Lakes 115kV line to 143MVA
- PSCo's terminal upgrade project to uprate the Twin Lakes – Otero 115kV line to 143MVA
- PSCo's terminal upgrade project to uprate the Otero – Buena Vista 115kV line to 150MVA
- PSCo's terminal upgrade project to uprate the Buena Vista – Ray Lewis 115kV line to 136MVA
- PSCo's terminal upgrade project to uprate the Ray Lewis – Poncha 115kV line to 164MVA
- PSCo's terminal upgrade project to uprate the Arapahoe – SantaFe – Daniels Park 230kV to 560MVA
- PSCo's terminal upgrade project to uprate the Daniels Park – Prairie1 230kV line to 576MVA
- PSCo's terminal upgrade project to uprate the Greenwood – Monaco 230kV line to 503MVA
- PSCo's terminal upgrade project to uprate the Leetsdale – Monaco 230kV line to 470MVA
- PSCo's terminal upgrade project to uprate the Poncha – Smelter town 115kV line to 114MVA
- PSCo's terminal upgrade project to uprate the San Luis Valley – Sargent 115kV line to 120MVA
- TSGT's planned project to uprate the Fuller – Vollmer – Black Squirrel 115 kV line to 173 MVA
- BHE's planed project to uprate the Fountain Valley – DesertCove 115kV line to 171MVA
- BHE's planned project to urpate the Fountain Valley – MidwayBR 115kV line to 171MVA
- BHE's Pueblo West Substation
- BHE's Skyline Ranch Substation
- BHE's West Station – Greenhorn 115kV line Rebuild project
- CSU's project to close Tesla - Cottonwood 34.5kV line and open the Kettle Creek – Tesla 34.5kV line
- CSU's new Cottonwood 230/115kV auto-transformer replacement
- CSU's Nixon – Kelker 230kV line uprate project

The higher-queued GIRs modeled in this study report are: GI-2009-8, GI-2010-8, GI-2014-2, GI-2014-6, GI-2014-8, GI-2014-9, GI-2014-12, GI-2014-13, GI-2014-14, GI-2016-4 and GI-2016-7. In case of withdrawal of any of these higher-queued GIs or change in status from NRIS to ERIS, the Contingent Facilities assigned to GI-2016-9 would be updated as needed.

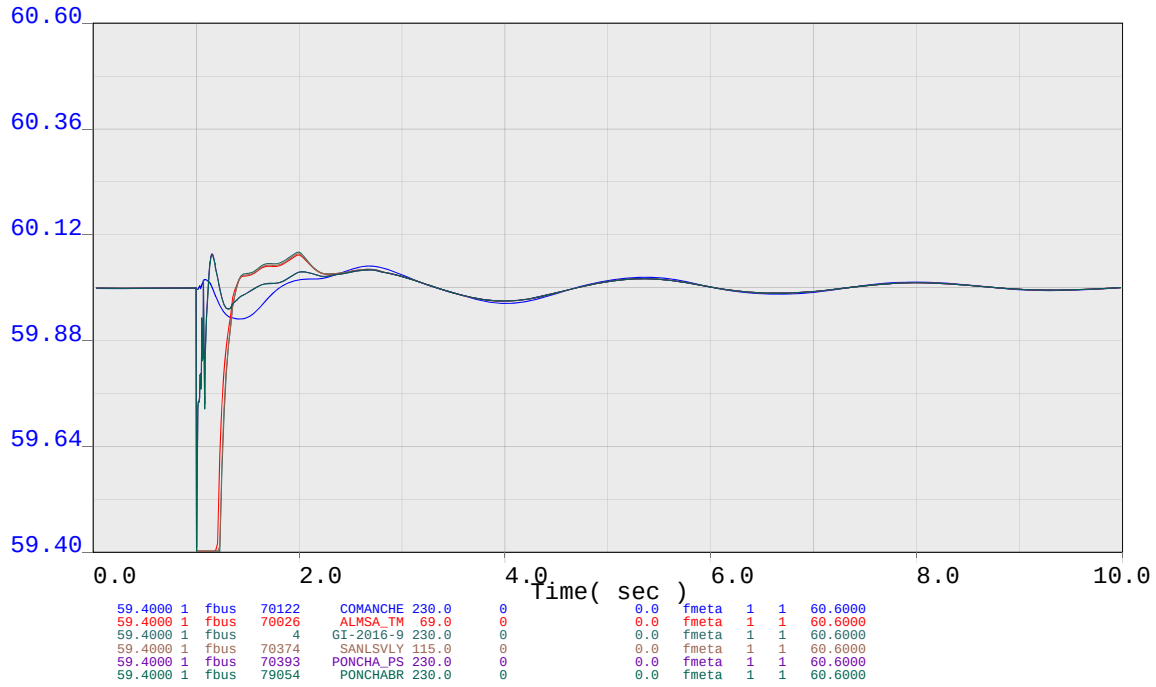


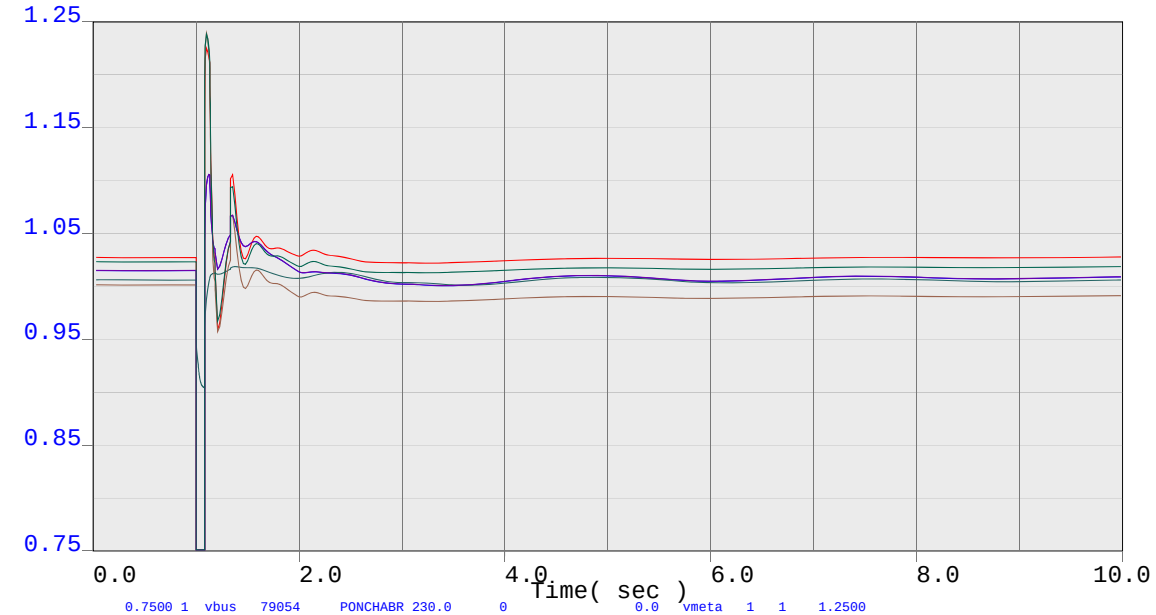




line_1
line PONCHABR to SANLSVLY 230, 5 cycle fault at PONCHABR 230kV end

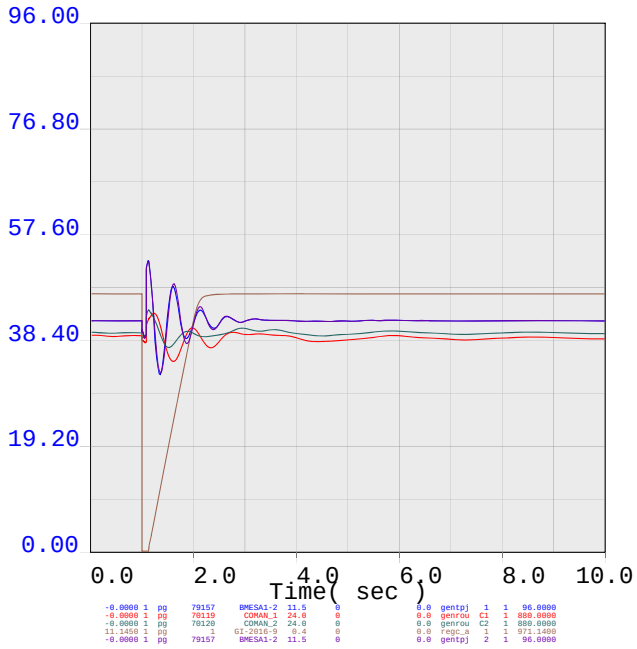


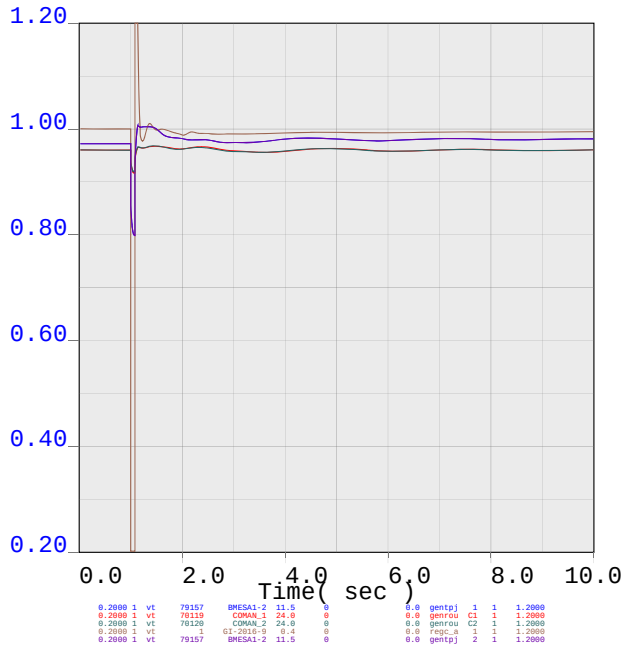

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.4000 | 1 | fbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |

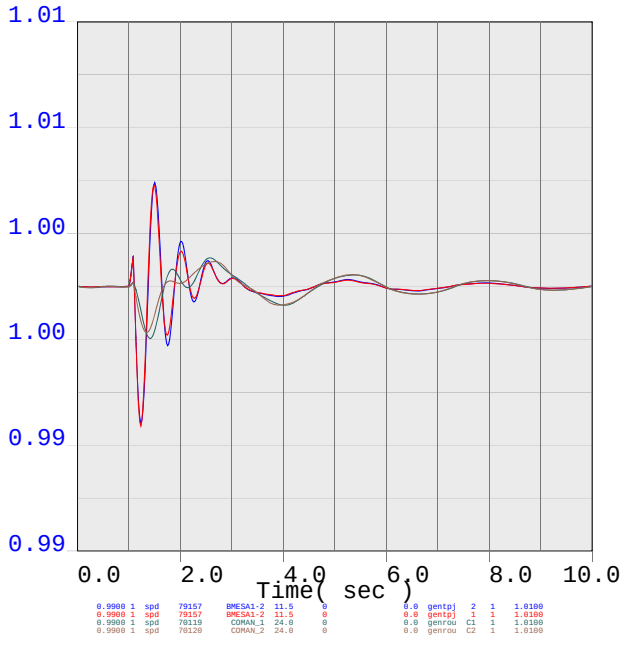


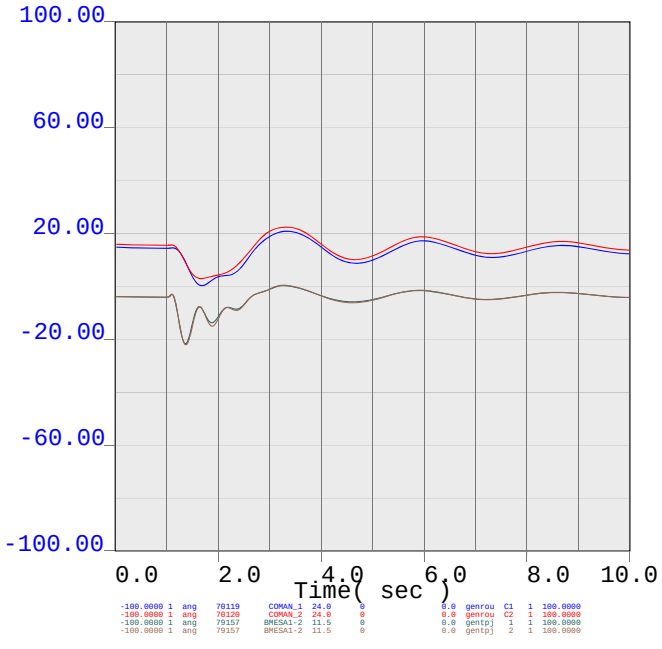

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.7500 | 1 | vbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |

line_1
line PONCHABR to SANLSVLY 230, 5 cycle fault at PONCHABR 230kV end

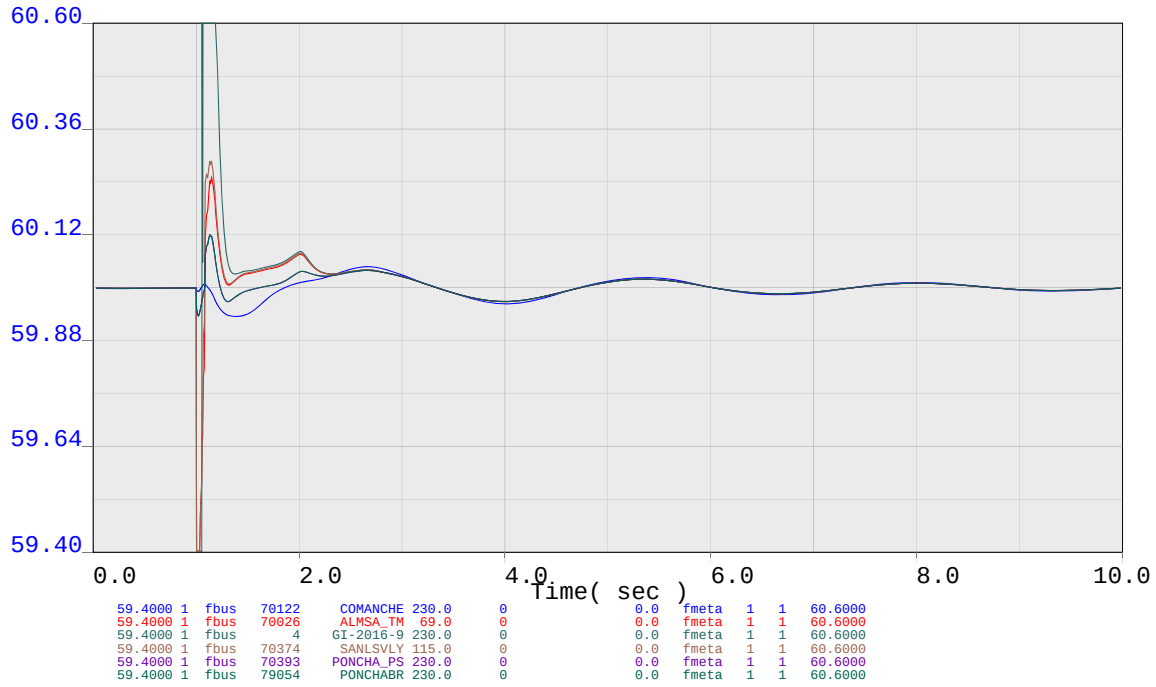


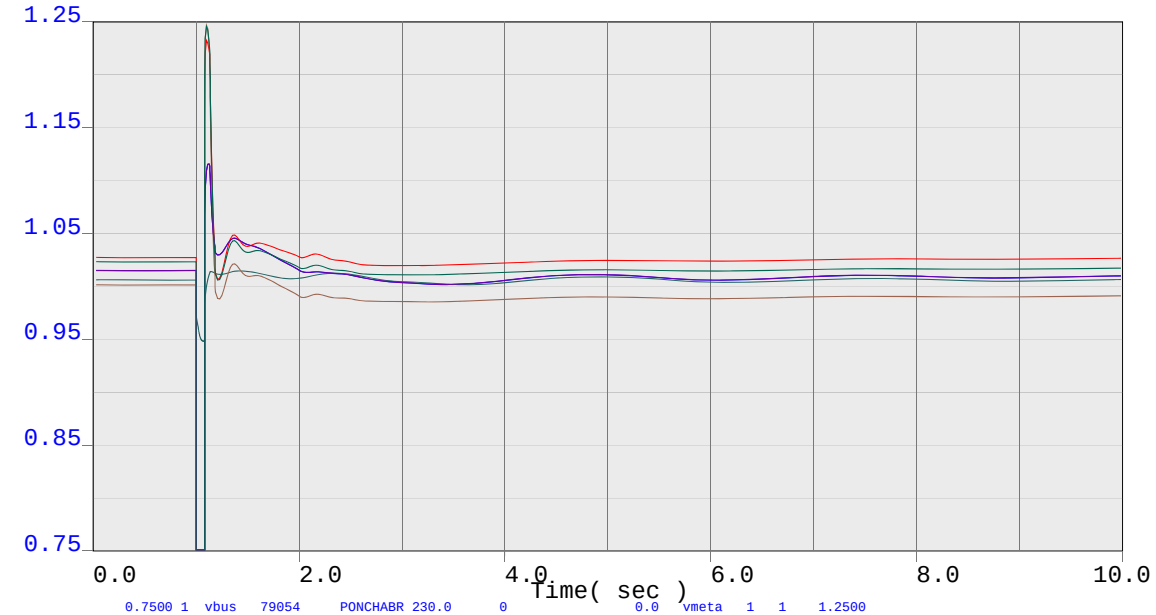




line_2
line PONCHABR to SANLSVLY 230, 5 cycle fault at SANLSVLY 230kV end

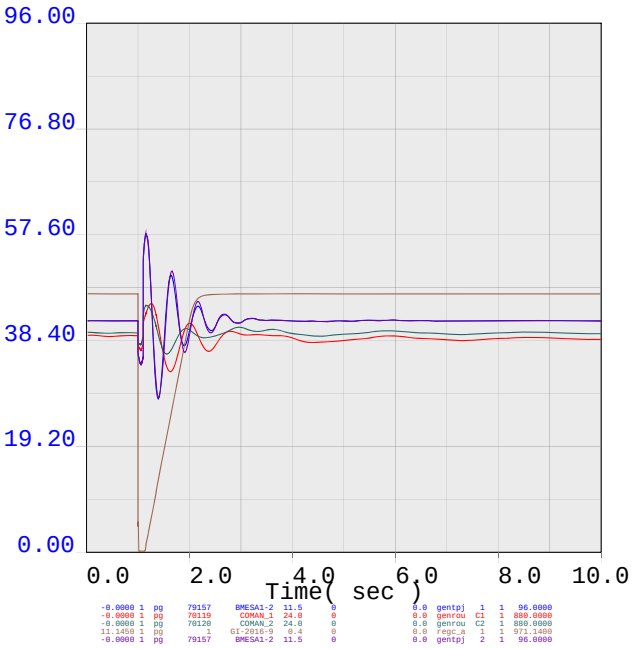


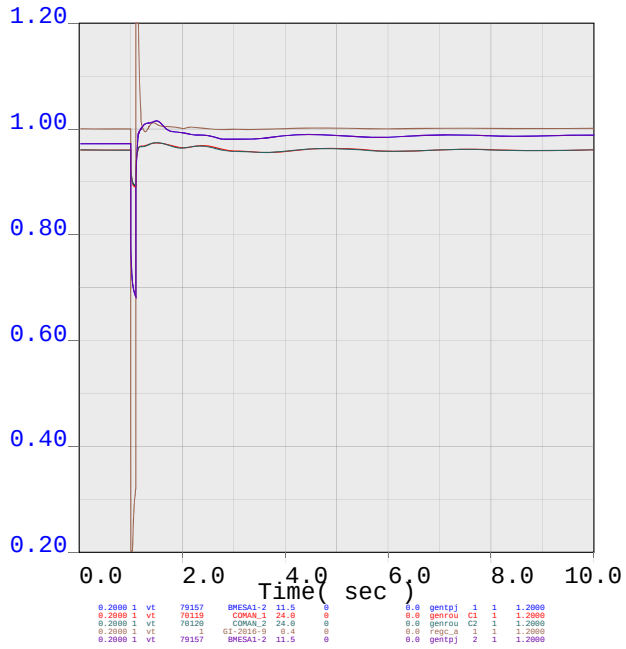

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.4000 | 1 | fbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |

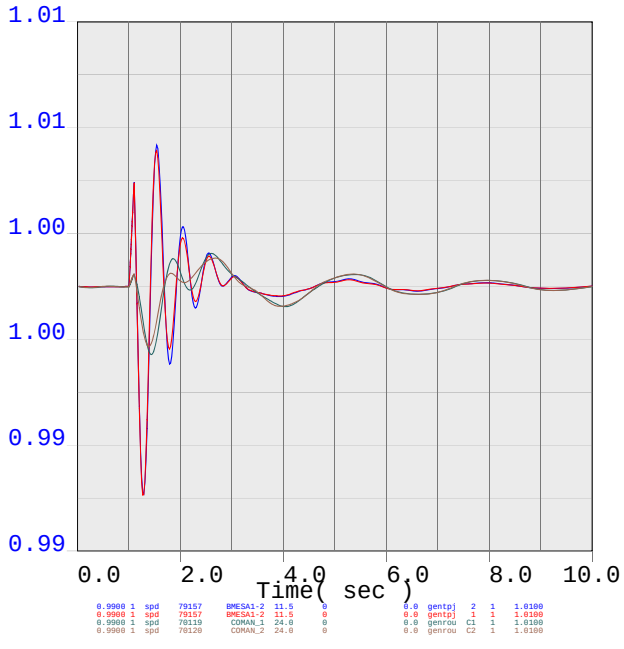


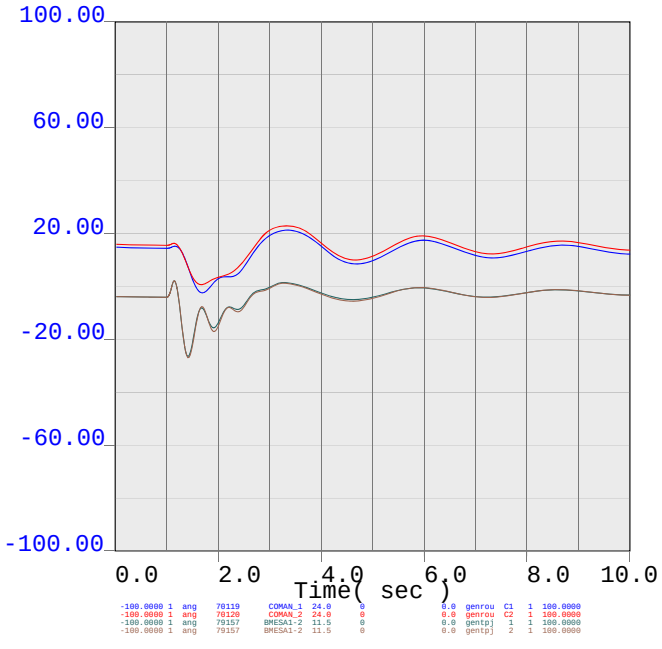

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.7500 | 1 | vbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |

line_2
line PONCHABR to SANLSVLY 230, 5 cycle fault at SANLSVLY 230kV end

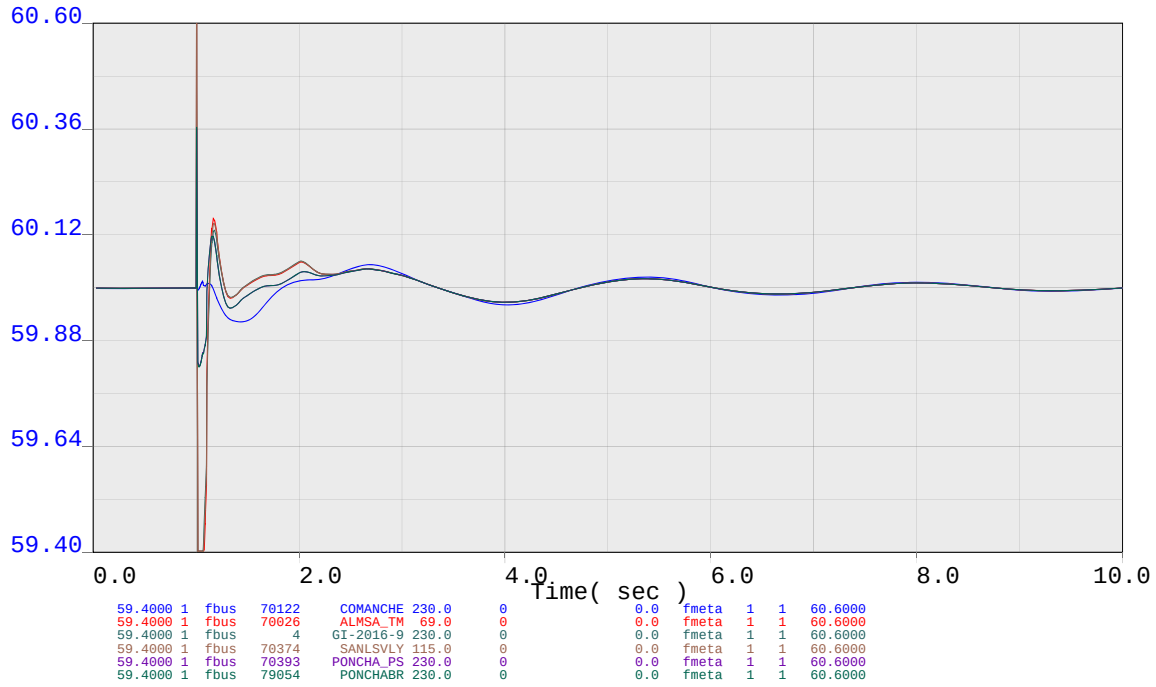


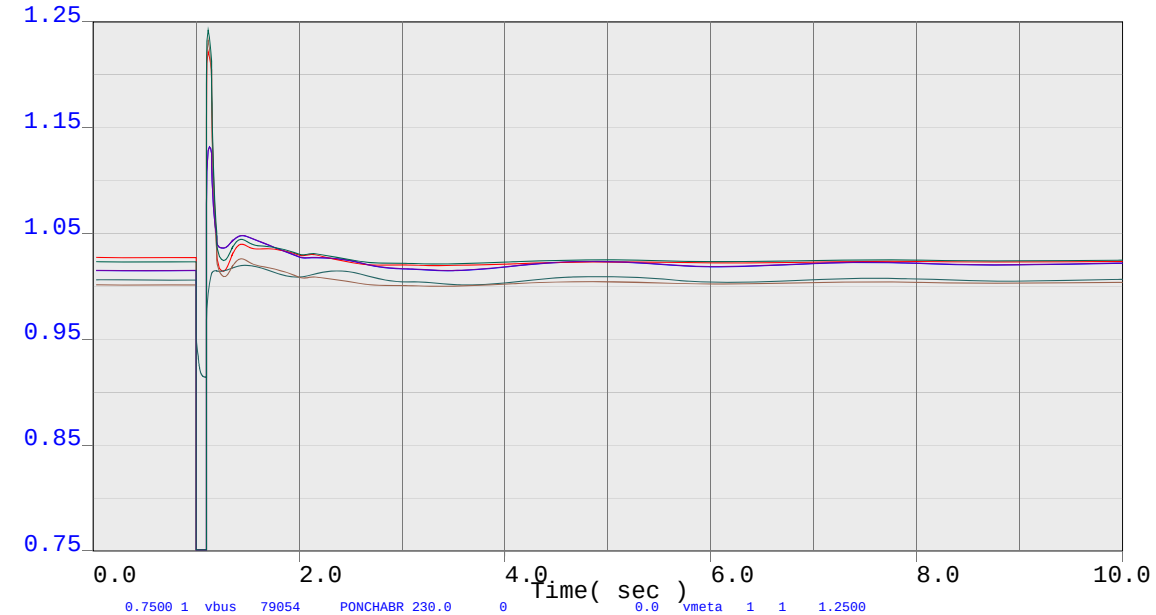




line_3
line PONCHA to SARGENT 115, 6 cycle fault at PONCHA 115kV end

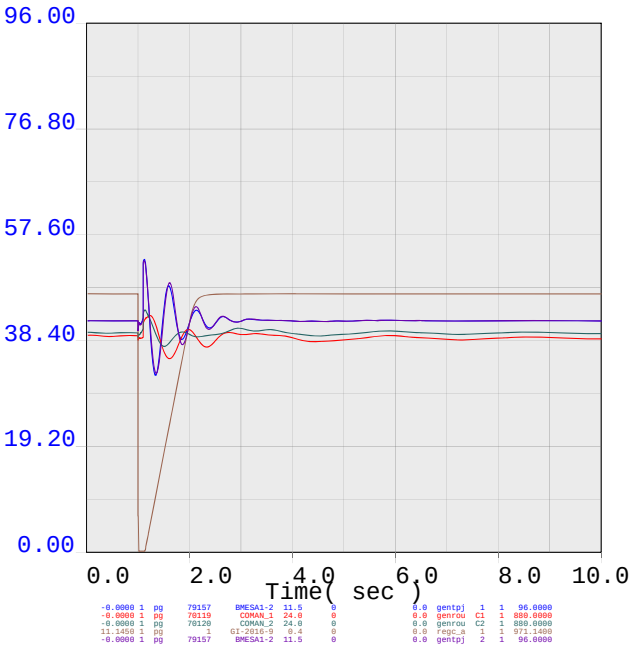


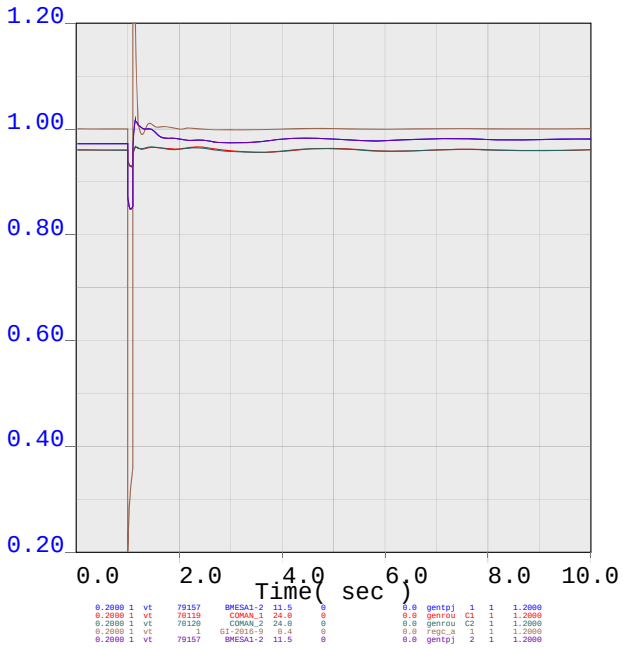

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.4000 | 1 | fbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |

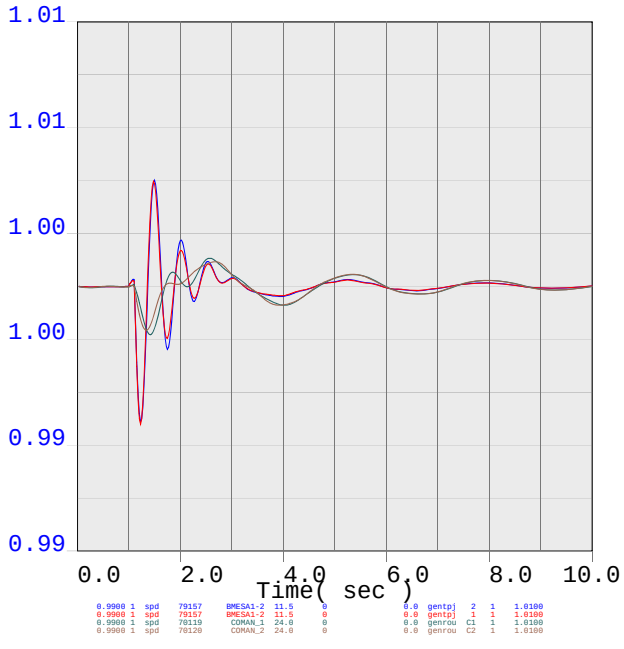


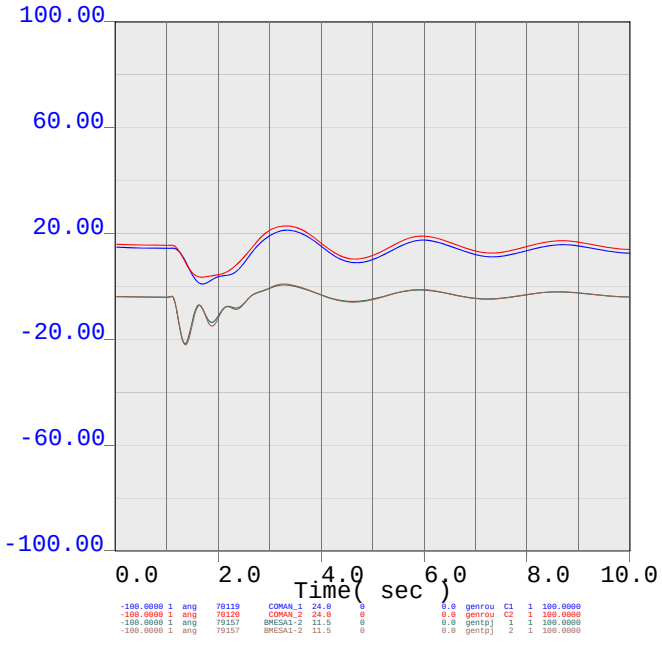

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.7500 | 1 | vbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |

line_3
line PONCHA to SARGENT 115, 6 cycle fault at PONCHA 115kV end

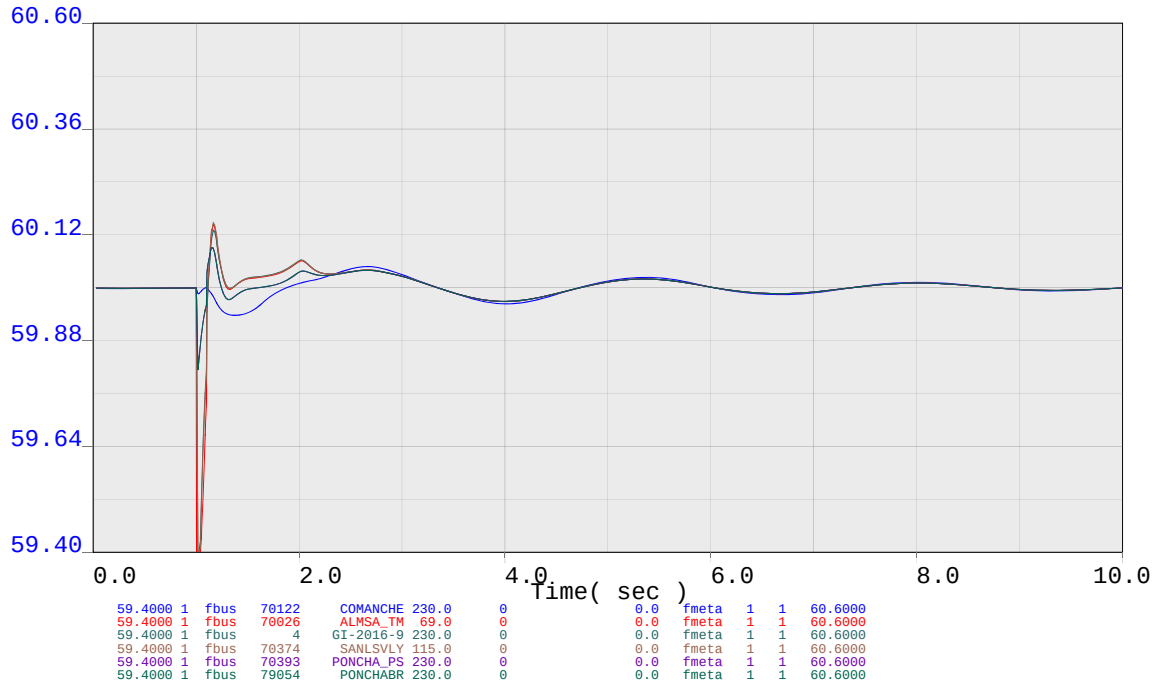


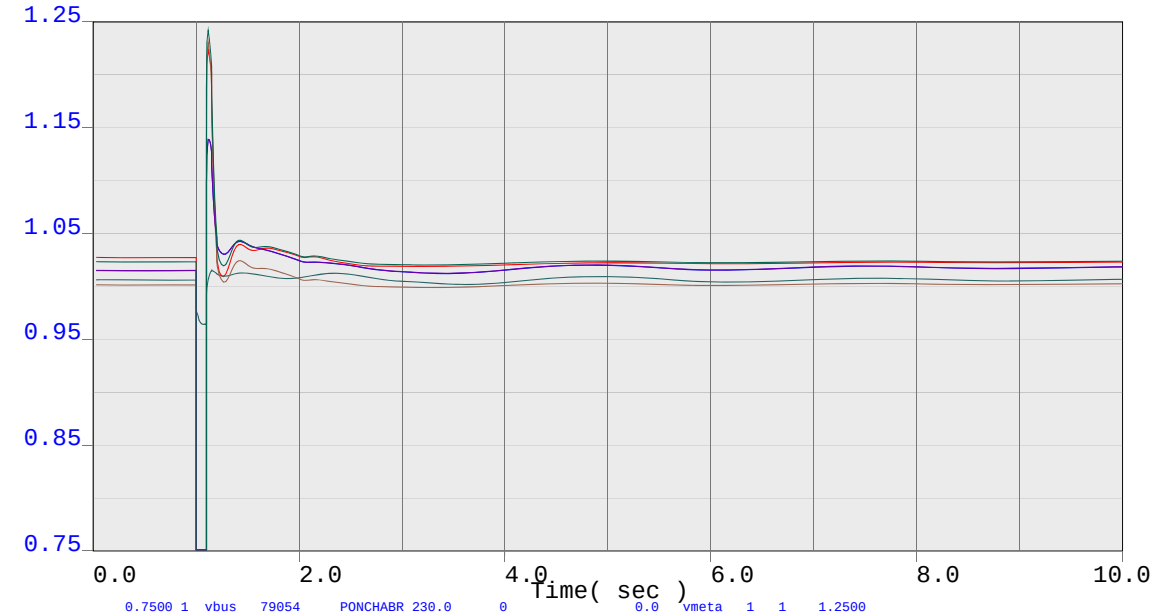




line_4
line SARGENT to SANLSLY 115, 6 cycle fault at SANLSLY 115kV end

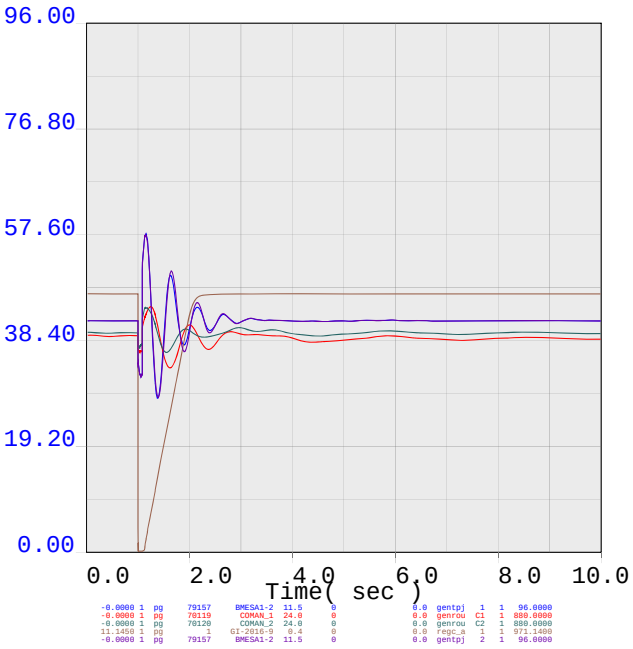


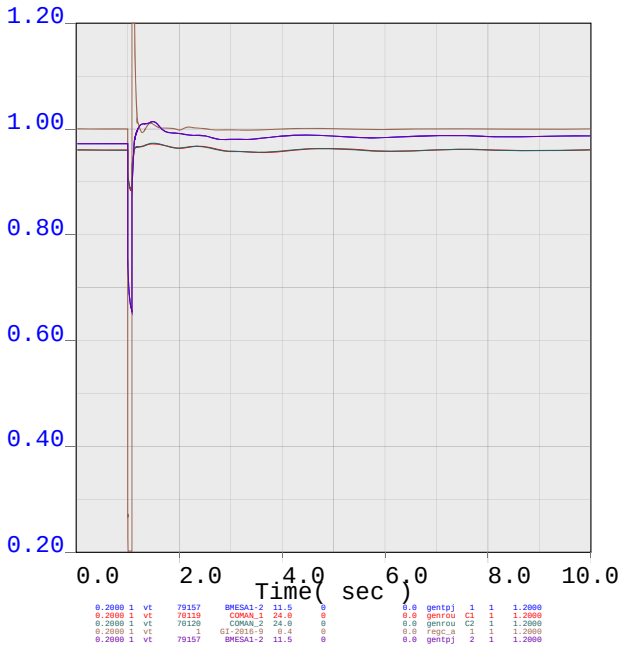

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.4000 | 1 | fbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |

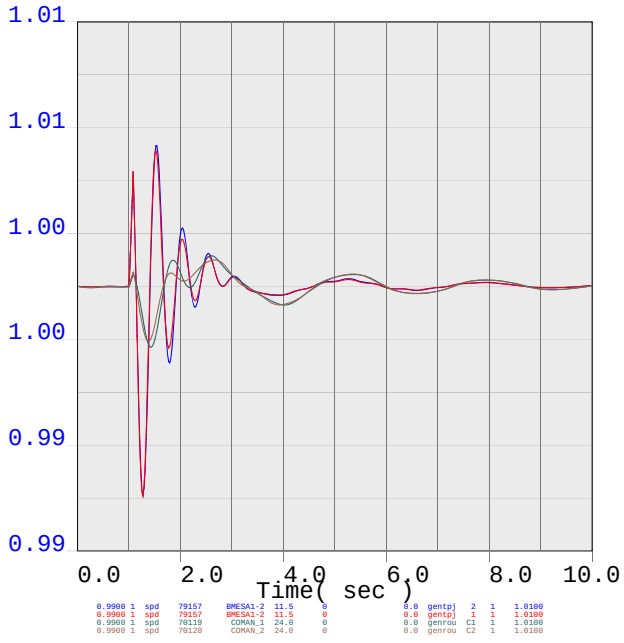


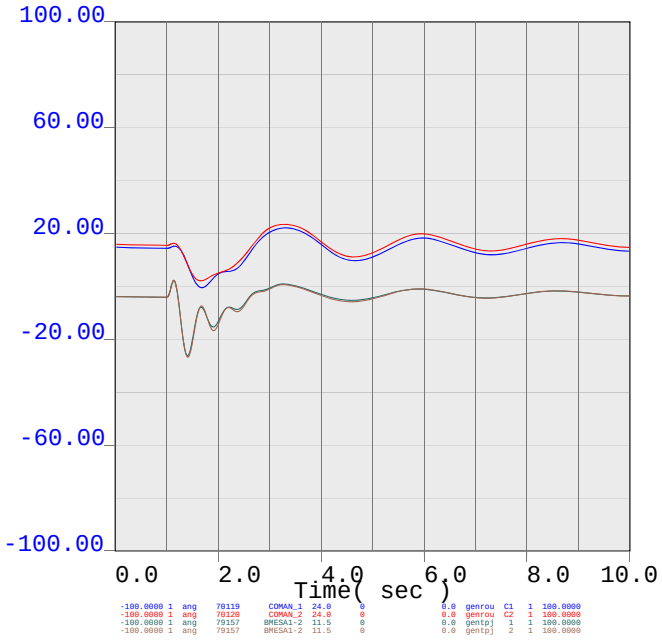

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.7500 | 1 | vbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |

line_4
line SARGENT to SANLSLY 115, 6 cycle fault at SANLSLY 115kV end

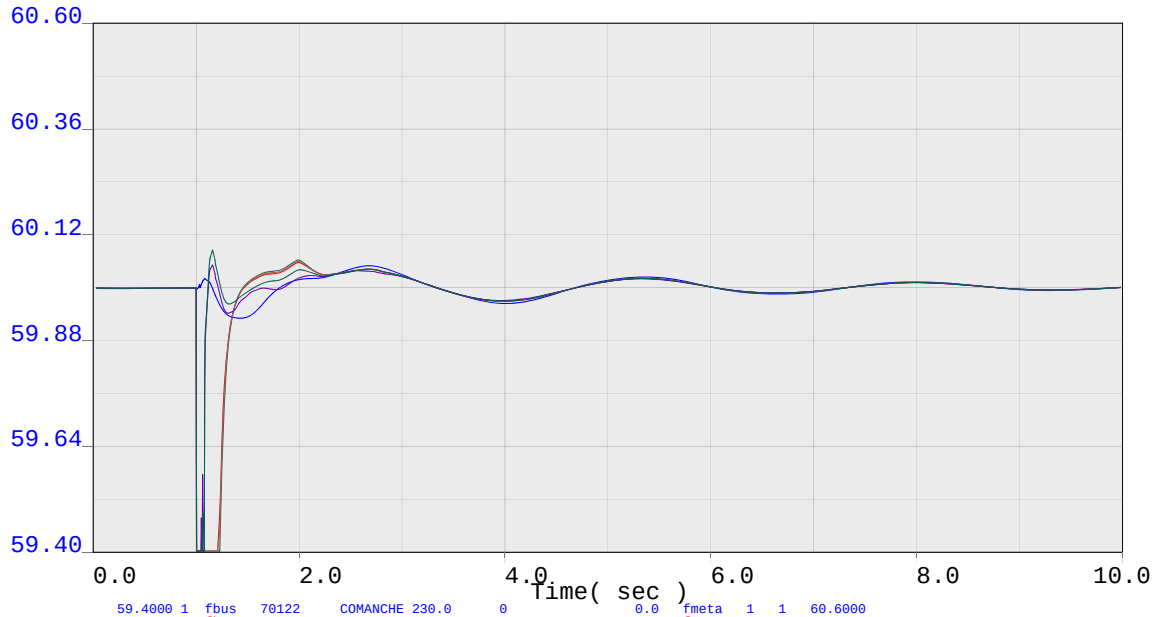


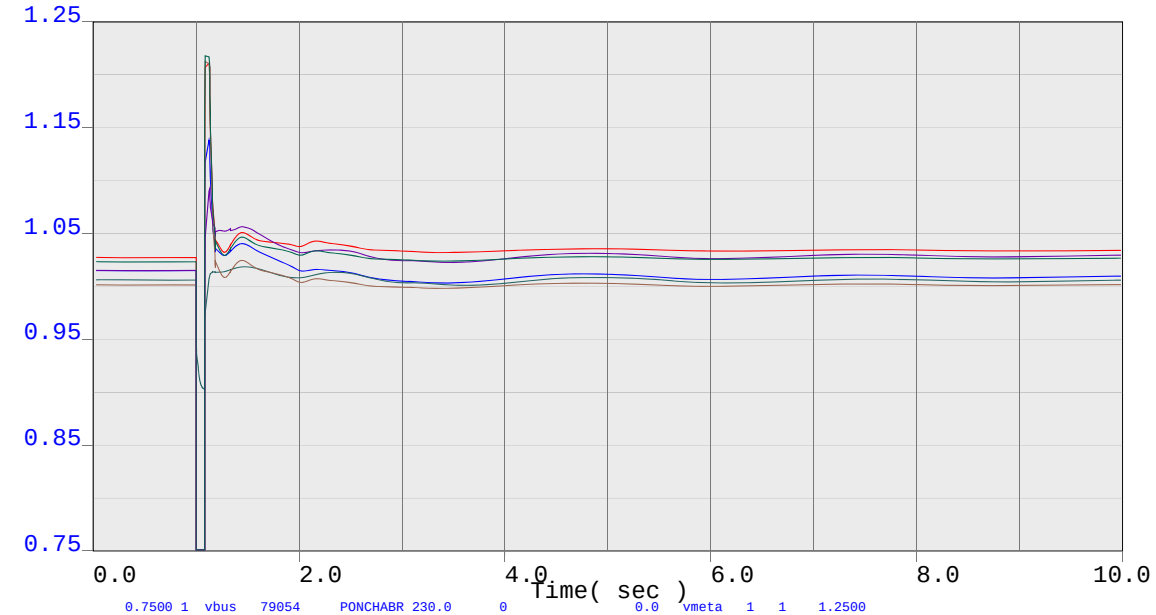




bus_5
bus fault at PONCHA_PS  230, Lose PonchaPS230/115kv bank and Poncha 230kVtie




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.4000 | 1 | fbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |
| 59.4000 | 1 | fbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | fmeta | 1 | 1 | 60.6000 |




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.7500 | 1 | vbus | 79054 | PONCHABR | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70026 | ALMSA_TM | 69.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70122 | COMANCHE | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 4 | GI-2016-9 | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70393 | PONCHA_PS | 230.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |
| 0.7500 | 1 | vbus | 70374 | SANLSVLY | 115.0 | 0 | 0.0 | vmeta | 1 | 1 | 1.2500 |

bus_5
bus fault at PONCHA_PS  230, Lose PonchaPS230/115kv bank and Poncha 230kVtie