Interconnection Feasibility and System Impact Study (Updated)
Generation Interconnection Request # GI-2014-9

70MW Solar Photovoltaic Generating Facility
Tapping Comanche – Midway 230kV Line
Pueblo County, Colorado

Transmission Planning West
Xcel Energy
August 2, 2018

Executive Summary

The GI-2014-9 is a 70MW solar photovoltaic generation facility that will be located in Pueblo County, Colorado. The Generating Facility (GF) will be made up of eighteen PROSOLAR GE LV5 Type 1 inverters. The proposed primary Point of Interconnection (POI) is a tap on the Comanche – Midway 230kV line at approximately 5.5 miles from the Comanche Substation. The tap point will consist of construction of a new station at the POI, which will be referred to as "GI-2014-9 230kV Switching Station" in this report. The GF will interconnect to the new station at the POI using a 230kV tie-line owned and constructed by the Interconnection Customer.

The Commercial Operation Date (COD) originally requested by the Customer was December 1, 2016. A Combined Feasibility and System Impact Study was performed for the originally requested COD and a final report was posted on February 15, 2016. On February 5, 2018, The Interconnection Customer changed the COD to May 1, 2022. This report provides the updated power flow, dynamic stability and short circuit study results due to the change in COD.

The power flow and stability analyses were performed using a study case derived from the Western Electricity Coordinating Council (WECC) approved 2022HS1 base case by simulating heavy south-north flow on the Comanche – Midway – Jackson Fuller – Daniels Park transmission path resulting from a high Southern Colorado generation dispatch.

As requested by the Interconnection Customer, this GIR was studied for both Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS).
For both ERIS and NRIS evaluation, the 70 MW rated output of GI-2014-9 is assumed to be delivered to PSCo native load, so existing PSCo generation is used as its sink.

The Affected Systems for this GI are: Black Hills Colorado Electric (BHCE), Colorado Springs Utilities (CSU), Tri-State Generation and Transmission Inc. (TSGT), Intermountain Rural Electric Association (IREA) and Western Area Power Administration (WAPA).

The power flow analyses identified the following single contingency overloads.

- Daniels Park – Prairie1 230kV line loading increased from 101.7% to 104.1% (PSCo facility)
- Greenwood – Monaco 230kV line loading increased from 112.8% to 115.3% (PSCo facility)
- Leetsdale – Monaco 230kV line loading increased from 105.4% to 107.9% (PSCo facility)
- Brairgate South – Cottonwood South 115kV line loading increased from 102.9% to 105.0% (CSU facility)
- Cottonwood North – Kettle Creek South 115kV line loading increased from 103.1% to 105.2% (CSU facility)

PSCo has planned FAC8 related Network Upgrades to mitigate the pre-existing overloads on Daniels Park – Prairie1 230kV line (new rating will be 576MVA), Greenwood – Monaco 230kV line (new rating will be 503MVA) and Leetsdale – Monaco 230kV line (new rating will be

470MVA). The new FAC8 ratings on these lines will be sufficient to mitigate the post-GI overloads after GI-2014-9 interconnection. Hence, GI-2014-9 is not required to fund additional Network Upgrades to mitigate these overloads.

PSCo has coordinated with CSU and has highlighted the overloads on the two CSU lines identified above. Mitigation measures for each of these CSU overloads must be identified and addressed in order for GI-2014-9 to achieve ERIS or NRIS.

All incremental overloads due to multiple contingencies – whether on transmission facilities in PSCo's System or in an Affected System (i.e. BHCE, CSU, WAPA or TSGT) – will be addressed by system readjustments (including generation curtailment) implemented via operating procedures that will be developed by PSCo prior to commercial operation of the GI interconnection.

The transient stability analysis determined that all generating units are stable (remain in synchronism), display positive damping and the maximum transient voltage dips are within acceptable dynamic performance criteria.

The short-circuit and breaker duty analysis determined that no breaker replacements are needed at the POI station and/or in neighboring PSCo stations.

The total estimated cost of the recommended system improvements to interconnect the project, is approximately $11.905 million and includes:

- $ 1.226 million for Transmission Provider's Interconnection Facilities
- $ 10.679 million for Network Upgrades required for Interconnection (either ERIS or NRIS)
- $ 0 million for additional Network Upgrades for NRIS

The total estimated cost of the transmission system improvements required for GI-2014-9 to qualify for:

- **ERIS is $11.905 Million (Tables 2 and 3); and**
- **NRIS is $11.905 Million (Tables 2, 3 and 4)**

For GI-2014-9 interconnection:

ERIS (after required mitigation to address CSU system overloads and planned PSCo FAC8 upgrades are in-service) = 70MW

(output delivery assumes the use of existing firm or non-firm capacity of the PSCo Transmission System on an as-available basis).

NRIS (after required mitigation to address CSU system overloads and planned PSCo FAC8 upgrades are in-service) = 70MW

Note: NRIS or ERIS, in and of itself, does not convey transmission service.

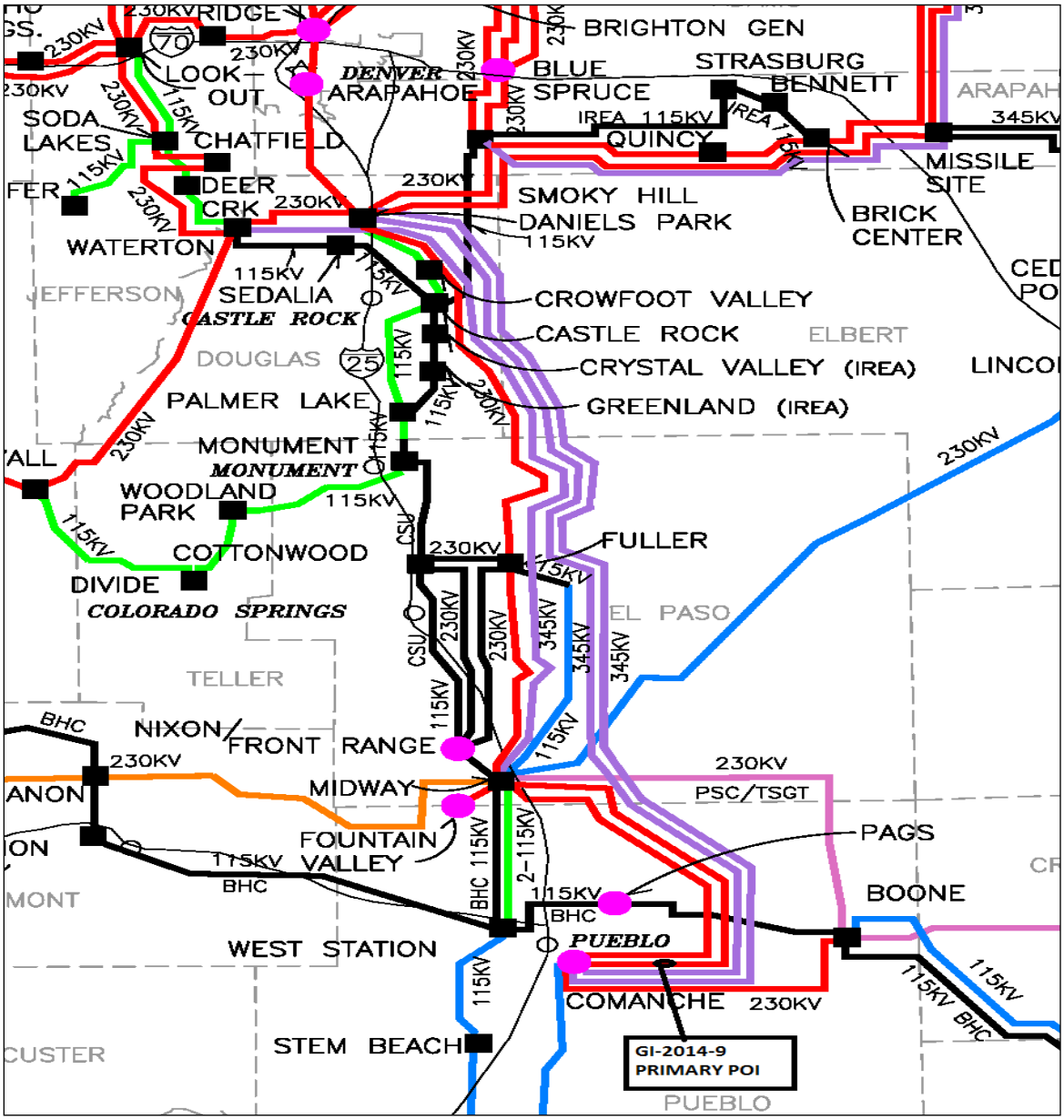

Figure 1 - GI-2014-9 Point of Interconnection and Study Area

Introduction

The GI-2014-9 is a 70MW solar photovoltaic generation facility that will be located in Pueblo County, Colorado. The Generating Facility (GF) will be made up of eighteen PROSOLAR GE LV5 Type 1 inverters. The proposed primary Point of Interconnection (POI) is a tap on the Comanche – Midway 230kV line at approximately 5.5 miles from the Comanche Substation. The tap point will consist of construction of a new station at the POI, which will be referred to as "GI-2014-9 230kV Switching Station" in this report. The GF will interconnect to the new station at the POI using a 230kV tie-line owned and constructed by the Interconnection Customer.

The Commercial Operation Date (COD) originally requested by the Customer was December 1, 2016. A Combined Feasibility and System Impact Study was performed for the originally requested COD and a final report was posted on February 15, 2016. A Facilities Study for GI-2014-9 was posted in 2016 and a draft LGIA was tendered at that time. On February 5, 2018, the Interconnection Customer requested to change the COD to May 1, 2022. This report provides the updated power flow, dynamic stability and short circuit study results due to the change in COD.

As requested by the Interconnection Customer, this GIR was studies for both Energy Resource Interconnection Service (ERIS)[1] and Network Resource Interconnection Service (NRIS)[2].
The Affected Systems for this GI are: Black Hills Colorado Electric (BHCE), Colorado Springs Utilities (CSU), Tri-State Generation and Transmission Inc. (TSGT), Intermountain Rural Electric Association (IREA) and Western Area Power Administration (WAPA).

Study Scope and Analysis Criteria

The scope of this report includes steady state (power flow) analysis, transient stability analysis, short circuit analysis and indicative level cost estimates. The power flow analysis identifies thermal and voltage violations in the PSCo system and the Affected System as a result of the interconnection of the GI. Several single contingencies were studied. Short circuit analysis determines the maximum available fault current at the POI and determines if any breakers at the POI and/or in the neighboring PSCo stations exceed their breaker duty ratings and need to be replaced.

[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.

PSCo adheres to applicable NERC Reliability Standards & Western Electricity Coordinating Council (WECC) Reliability Criteria, as well as its internal transmission planning criteria for studies. The steady state analysis criteria are as follows:

P0 - System Intact conditions:

Thermal Loading: <=100% of the normal facility rating
Voltage range: 0.95 to 1.05 per unit

P1-P2 – Single Contingencies:

Thermal Loading: <=100% Normal facility rating
Voltage range: 0.90 to 1.10 per unit
Voltage deviation: <=5% of pre-contingency voltage

P3-P7– Multiple Contingencies:

Thermal Loading: <=100% Emergency facility rating
Voltage range: 0.90 to 1.10 per unit
Voltage deviation: <=5% of pre-contingency voltage

For PSCo facilities – verified thermal violations initially attributable to the GI-2014-9 interconnection are mitigated by PSCo planned facilities. No thermal violations were identified for the GI-2014-9 interconnection if the line ratings are increased when PSCo's FAC8 projects are in-service.

The Interconnection Customer should work with the affected parties in order to find mitigation measures for any existing and new thermal overloads on non-PSCo facilities.

The study area is the electrical system consisting of PSCo's transmission system and the affected party's transmission system that is impacted or that will impact interconnection of GI-2014-9. The study area for GI-2014-9 includes WECC designated zones 121, 700, 703, 704, 705, 709, 710, 712, 752 and 757.

Transient stability criteria require that all generating machines remain in synchronism and all power swings should be well damped following a contingency event. Also, transient voltage performance should meet the following WECC Disturbance-Performance criteria:

- Following fault clearing, the voltage shall recover to 80% of the pre-contingency voltage within 20 seconds for all contingencies
- For all contingencies, following fault clearing and voltage recovery above 80%, voltage at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds.
- For contingencies without a fault, voltage dips at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds

Power Flow Study Models

The study was performed using the Western Electricity Coordinating Council (WECC) 2022HS1 power flow case released on 08/31/2016.

The generation dispatch in the WECC base case was adjusted to create 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-7 below. PSCo's generation in zones 704 and 712 was dispatched such that wind generation is dispatched at 85% of name plate capacity, solar generation is dispatched at 80% of name plate capacity, conventional non-coal generation is dispatched at 90% of name plate capacity and coal generation is dispatched at 100% of name plate capacity. For BHCE, the Baculite Mesa units were dispatched at 100% of name plate rating and the remaining generation is dispatched at Rattlesnake Wind.

The generation dispatch for CSU units was provided by CSU.

The Lamar DC tie, the Colorado Green and the Twin Buttes wind generators are dispatched such that the total combined injection at the Lamar 230kV bus was 350MW.

The NENM Phase-I and Phase-II projects were modeled out of service and Gladstone Phase Shifter flow is set to 180MW per review comments from TSGT.

The GI-2014-9 was modeled using the power flow modeling data provided by the GI Customer. However, for dynamic simulations, the dyd data provided for GI-2017-16, which is an extension of GI-2014-9 is used as a PSLF model was not provided.

Transient stability analysis was performed using General Electric's PSLF Ver.21.0_02 program. A study case was created by modeling GI-2014-9 in the 2022HS1 case. Three phase faults were simulated for selected single and multiple contingencies using standard clearing times. Bus voltage, bus frequency, and generator angle were recorded and analyzed. Also, any generators that went out of synchronism were recorded. PSLF's DYTOOLS EPCL program was used to simulate the disturbances.

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

Voltage Regulation and Reactive Power Capability

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, 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).

Power Flow Study Results

The results of the single contingency analysis (P1 and P2) are given in Table-5.

- Daniels Park – Prairie1 230kV line loading increased from 101.7% to 104.1% (PSCo facility)
- Greenwood – Monaco 230kV line loading increased from 112.8% to 115.3% (PSCo facility)
- Leetsdale – Monaco 230kV line loading increased from 105.4% to 107.9% (PSCo facility)
- Brairgate South – Cottonwood South 115kV line loading increased dfrom 102.9% to 105.0% (CSU facility)
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PSCO has planned FAC8 related Network Upgrades to mitigate the pre-existing overloads on Daniels Park – Prairie1 230kV line (new rating will be 576MVA), Greenwood – Monaco 230kV line (new rating will be 503MVA) and Leetsdale – Monaco 230kV line (new rating will be 470MVA). The new FAC8 ratings on these lines will be sufficient to mitigate the post-GI overloads after GI-2014-9 interconnection. Hence, the three PSCo lines overloads are not assigned to GI-2014-9 interconnection. PSCo has coordinated with CSU and has highlighted the overloads on the two CSU lines identified above. Mitigation measures for each of these CSU overloads must be identified and addressed in order for GI-2014-9 to achieve ERIS or NRIS.

All incremental overloads due to multiple contingencies – whether on transmission facilities in PSCo's System or in an Affected System (i.e. BHCE, CSU, WAPA or TSGT) – will be addressed by system readjustments (including generation curtailment) implemented via operating procedures that will be developed by PSCo prior to commercial operation of the GI interconnection.

Transient Stability Study Results

The transient stability analysis for thisGI-2014-9 System Impact Study simulated eight disturbances for the study case (power flow case with GI-2014-9 modeled).

It is determined that GI-2014-9 produced no adverse system stability impact. The following results were obtained for every case and disturbance analyzed:

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

Transient stability plots showing surrounding bus voltages, bus frequencies, generator terminal voltages, generator relative angles, generator speeds, and generator power output for each of the disturbances run for each study scenario have been created and documented in Appendix A.

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.

Short Circuit and Breaker Duty Analysis

The GI-2014-9 POI is a new 230kV switching station; therefore, the circuit breakers installed will be adequately rated. The calculated short circuit levels and Thevenin system equivalent impedances at the POI are tabulated below.

Table 1 – Short Circuit Parameters at the GI-2014-9 230kV Switching Station POI for Standalone/cumulative analysis

	Before GI-2014-9 Interconnection	After GI-2014-9 Interconnection
Three Phase Current	15,878.5 A	19,095.6A
Single Line to Ground Current	13,686.9A	15,942.6A
Positive Sequence Impedance	0.70725+j8.33295 ohms	0.59501+j6.92847 ohms
Negative Sequence Impedance	0.72648+j8.34069 ohms	0.61054+j6.93402 ohms
Zero Sequence Impedance	3.00915+j12.0914 ohms	2.3651+j10.8690 ohms

A preliminary breaker duty study did not identify any circuit breakers that became overstressed as a result of adding this generation.

Conclusion

For GI-2014-9 interconnection:

ERIS (after required mitigation to address CSU system overloads and planned PSCo FAC8 upgrades are in-service) = 70MW
(output delivery assumes the use of existing firm or non-firm capacity of the PSCo Transmission System on an as-available basis).

NRIS (after required mitigation to address CSU system overloads and planned PSCo FAC8 upgrades are in-service) = 70MW

Note: NRIS or ERIS, in and of itself, does not convey transmission service.

Costs Estimates and Assumptions

The cost estimates are in 2018 dollars with escalation and contingencies applied (AFUDC is not included) and are based upon typical construction costs for previously performed similar construction (+/- 30% accuracy). These estimated costs include all applicable labor and overheads associated with the siting support, engineering, design, and construction of these new PSCo facilities. This estimate does not include the cost for any Customer owned equipment and associated design and engineering.

The estimated total cost for the required upgrades is $11,905,000. These estimates do not include costs for any Customer owned equipment and associated design and engineering.

Figure 1 below is a conceptual one-line of the 2014-9 Switching Station tapping the Comanche – Midway 230kV line (L5413) for the Point of Interconnection.

Tables 2, 3 and 4 list the improvements required to accommodate the interconnection of the customer's 70 MW solar facility generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to revision as a more detailed and refined design is produced.

- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The Solar Generation Facility is not in PSCo's retail service territory. Therefore, no costs for retail load metering are included in these estimates.
- PSCo (or its Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- The estimated time to design, procure and construct the interconnection facilities is approximately 36 months after authorization to proceed has been obtained.
- A CPCN will be required for the interconnection facilities construction.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- 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.
- Power Quality Metering (PQM) will be required on the Customer's 230 kV line terminating into PSCo's proposed new Substation.
- Line and substation bus outages will be required during the construction period. Outage restrictions due to seasonal loading or other limiting factors may delay any proposed construction schedule.

Table 2 –Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Millions)
GI-2014-9 Switching Station	Interconnect Customer to the 230kV bus at GI-2014-9 Switching Station. The new equipment includes: • One (1) 230kV gang switch • Three (3) 230kV combination CT/PT metering units • Power Quality Metering (230kV line from Customer) • Three (3) 230kV lightning arresters • One (1) relay panel (transformer breaker panel) • Associated communications, supervisory and SCADA equipment • Associated line relaying and testing • Associated bus, wiring and equipment • Associated foundations and structures • Associated transmission line communications, relaying and testing	**$1.151**
	Transmission line tap into substation.	**$0.050**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	**$0.025**
	Total Cost Estimate for Transmission Provider's Interconnection Facilities	**$1.226**
Time Frame	**Design, procure and construct**	**18 Months**

Table 3 - Network Upgrades for Interconnection (ERIS or NRIS)

Element	Description	Cost Estimate (Millions)
GI-2014-9 Switching Station	Construction of PSCo's proposed new 230kV Substation. The new equipment includes: • Three (3) 230kV Circuit Breakers • Nine (9) 230kV gang switch • Six (6) 230kV lightning arresters • Six (6) relay panels • Electrical Equipment Enclosure (EEE) • Associated communications, supervisory and SCADA equipment • Associated line relaying and testing • Associated bus, wiring and equipment • Associated foundations and structures • Associated transmission line communications, relaying and testing	**$9.341**
	Transmission line terminations into substation; Removal of existing line segment, terminate two lines into new switching station"	**$1.258**
	Siting and Land Rights support for substation land acquisition and construction.	**$0.080**
	Total Cost Estimate for Network Upgrades for Interconnection (ERIS)	**$10.679**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 4 – Additional Network Upgrades for NRIS

Element	Description	Cost Est. (Millions)
	Total Cost Estimate for Network Upgrades for Delivery (NRIS)	**$0.0**
	Design, procure and construct	**N/A**
	Total Project Estimate	**$11.905**

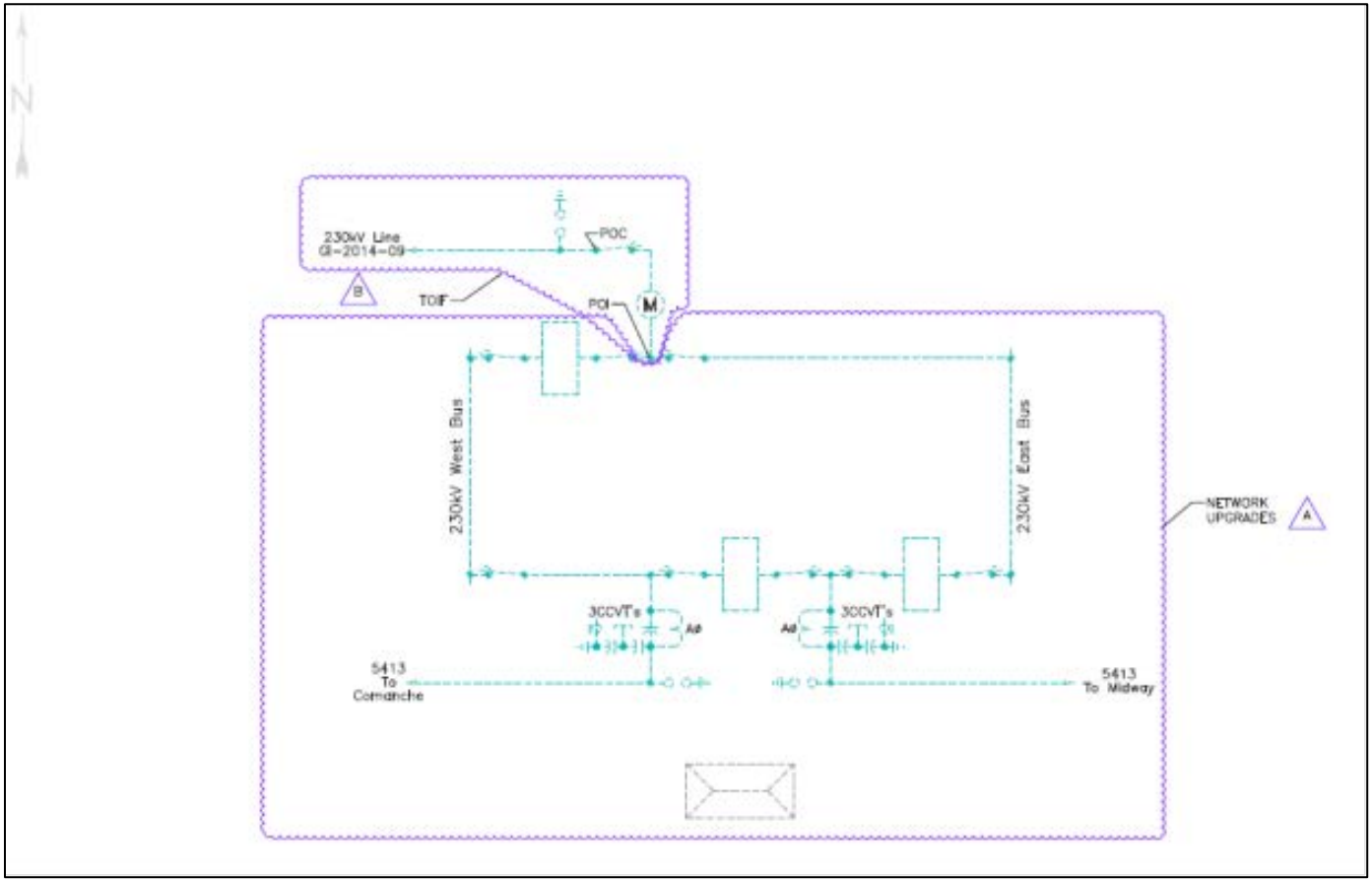


Figure 1 – Preliminary one-line of GI-2014-9 Switching Station at the Primary POI

Appendix - A

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 5 – Summary of Thermal Violations from Single Contingency Analysis									
				Facility Loading Without GI-2014-9		Facility Loading With GI-2014-9			
Monitored Facility (Line or Transformer)	**Type**	**Owner**	**Branch Rating MVA (Norm/Emer)**	**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**
Daniels Park – Prairie1 230kV	Line	PSCo	478/478	486.1	101.7%	497.6	104.1%	2.4%	Daniels Park – Prarire3 230kV
Greenwood – Monaco 230kV	Line	PSCo	405/481	456.8	112.8%	467.0	115.3%	2.5%	Smoky – Buckley 230kV
Leetsdale – Monaco 230kV	Line	PSCo	396/436	417.4	105.4%	427.3	107.9%	2.5%	Smoky – Buckley 230kV
Briargate S – Cottonwood S 115kV	Line	CSU	150/192	154.4	102.9%	157.5	105.0%	2.1%	KettleCreek S – KettleCreek N 115kV
Cottonwood N – KettleCreek S 115kV	Line	CSU	162/180	167.0	103.1%	170.4	105.2%	2.2%	Briargate S – Briargate N 115kV

Table-6 Transient Stability Analysis Results

Stability Scenarios						
#	Fault Location	Fault Type	Facility Tripped	Clearing Time (cycles)	Post-Fault Voltage Recovery	Angular Stability
1	Comanche 230kV	3ph	Comanche – GI-2014-9 Switching Station 230kV line	Primary (5.0)	Maximum transient voltage dips within criteria	Stable with positive damping
2	MidwayPS 230kV	3ph	MidwayPS – GI-2014-9 Switching Station 230kV line	Primary (5.0)	Maximum transient voltage dips within criteria	Stable with positive damping
3	Comanche 230kV	3ph	Comanche – GI-2014-9 Switching Station 230kV & Comanche – MidwayPS 230kV #2	Primary (5.0)	Maximum transient voltage dips within criteria	Stable with positive damping
4	MidwayPS 230kV	3ph	MidwayPS – GI-2014-9 Switching Station 230kV & Comanche – MidwayPS 230kV #2	Primary (5.0)	Maximum transient voltage dips within criteria	Stable with positive damping
5	Comanche 345 kV	3ph	Trip Comanche#3	Primary (4.0)	Maximum transient voltage dips within criteria	Stable with positive damping
6	MidwayPS 230kV	3ph	All Fountain Valley gas units	Primary (5.0)	Maximum transient voltage dips within criteria	Stable with positive damping
7	MidwayPS 345kV	3ph	MidwayPS – Waterton 345kV line & Midway 230/345kV xfmr	Primary (5.0)	Maximum transient voltage dips within criteria	Stable with positive damping
8	Comanche 345kV	3ph	Primary (4.0)	Maximum	transient voltage dips within criteria	Stable with positive damping

Table 7 – Generation Dispatch in the Study area (MW is Gross Capacity)

PSCo:

Bus	Gen ID	MW
Comanche PV	S1	120
Comanche	C1	360
Comanche	C2	365
Comanche	C3	805
Lamar DC Tie	DC	101
Fountain Valley	G1	36
Fountain Valley	G2	36
Fountain Valley	G3	36
Fountain Valley	G4	36
Fountain Valley	G5	36
Fountain Valley	G6	36
Colorado Green	W1	64.8
Colorado Green	W2	64.8
Twin Butte	W1	60
Twin Butte-II	W1	60
Jackson Fuller	W1&W2	151.9

BHE:

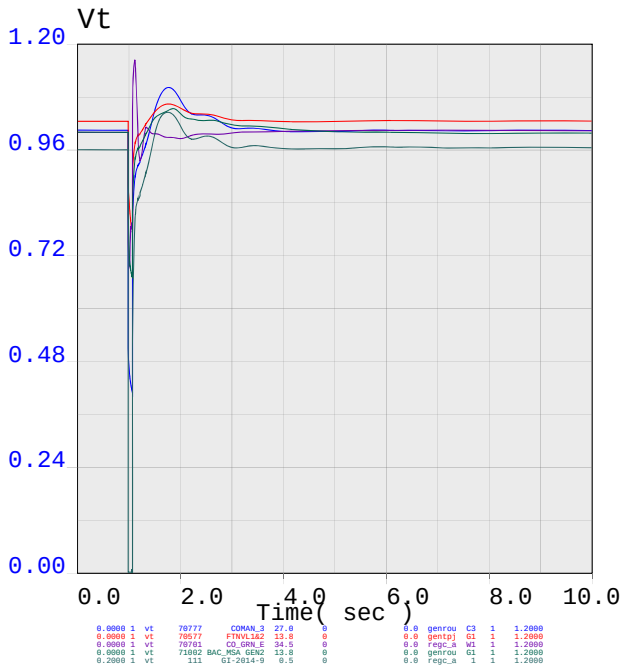
Bus	Gen ID	MW
BUSCHWRTG1	G1	28.8
BUSCHWRTG2	G2	28.8
BUSCHWRTG2	G3	28.8
E Canon	G1	0
PP_MINE	G1	0

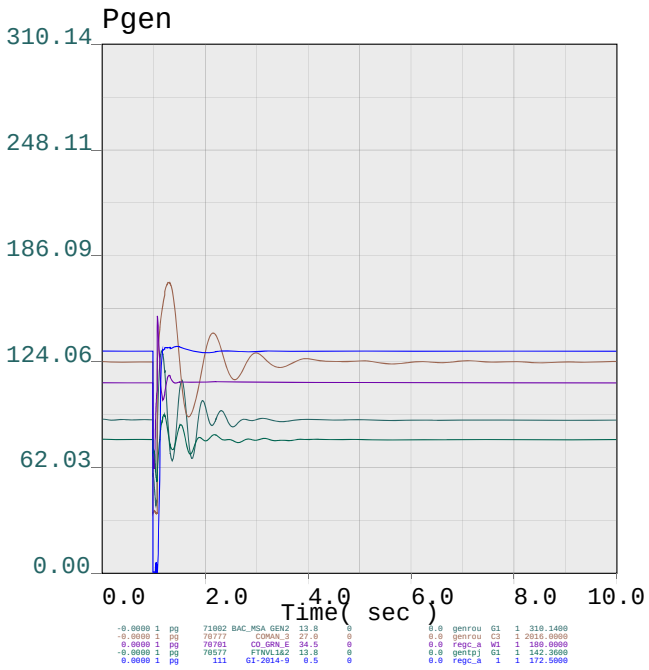
PuebloDiesels	G1	0
Pueblo Plant	G1	0
Pueblo Plant	G2	0.0
R.F. Diesels	G1	0.0
Airport Diesels	G1	0.0
Canyon City	C1	0
Canyon City	C1	0
Baculite 1	G1	90
Baculite 2	G1	90
Baculite 3	G1	40.0
Baculite 3	G2	40.0
Baculite 3	S1	24
Baculite 4	G1	20
Baculite 4	G2	24
Baculite 4	S1	24
Baculite 5	G1	0

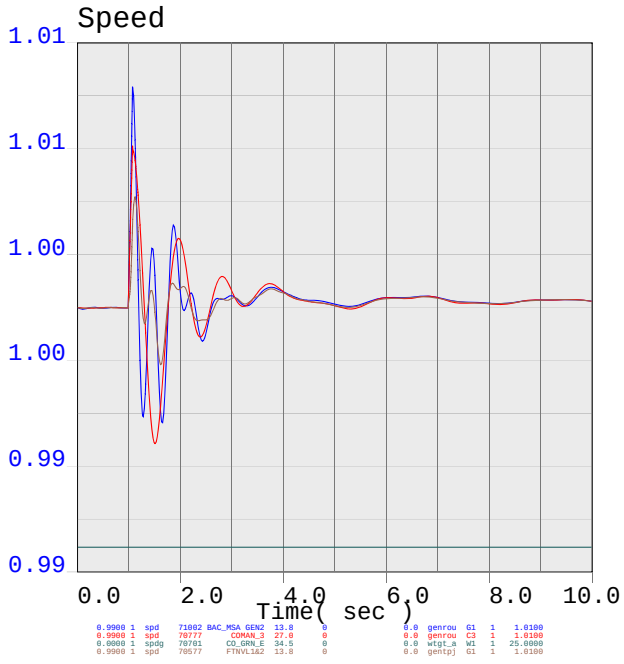
CSU:

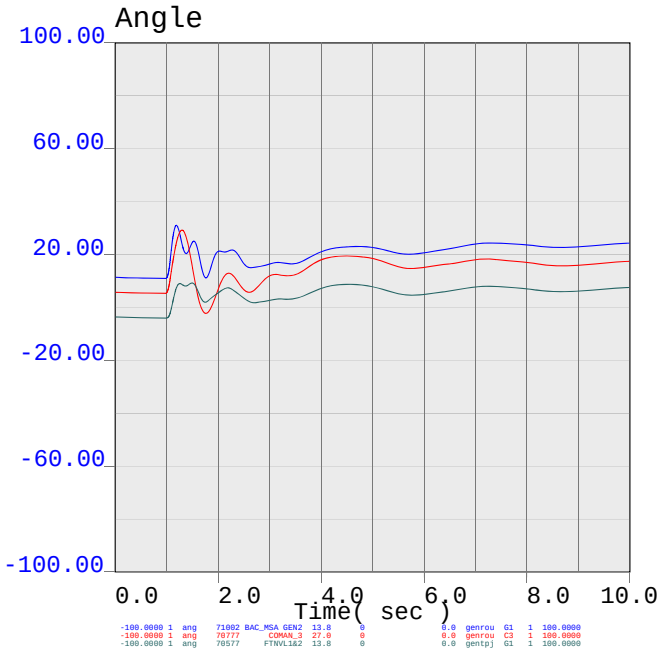
Bus	**Gen ID**	**MW**
Birdsale1	1	0.0
Birdsale 2	1	0.0
Birdsale 3	1	0.0
RD_Nixon	1	220.5
Tesla	1	13.2
Drake 5	1	0.0
Drake 6	1	80.6
Drake 7	1	137.1
Nixon CT 1	1	0.0
Nixon CT 2	1	0.0

Front Range CC 1	1	137.3
Front Range CC 2	1	136.9
Front Range CC 3	1	161.3

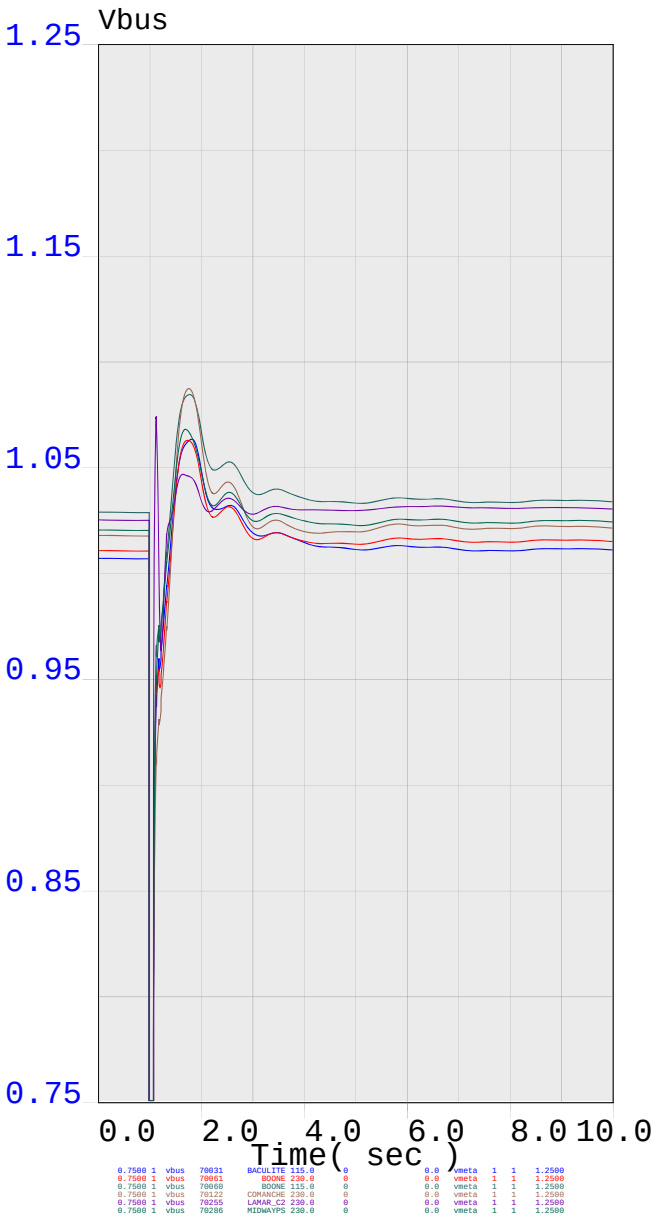


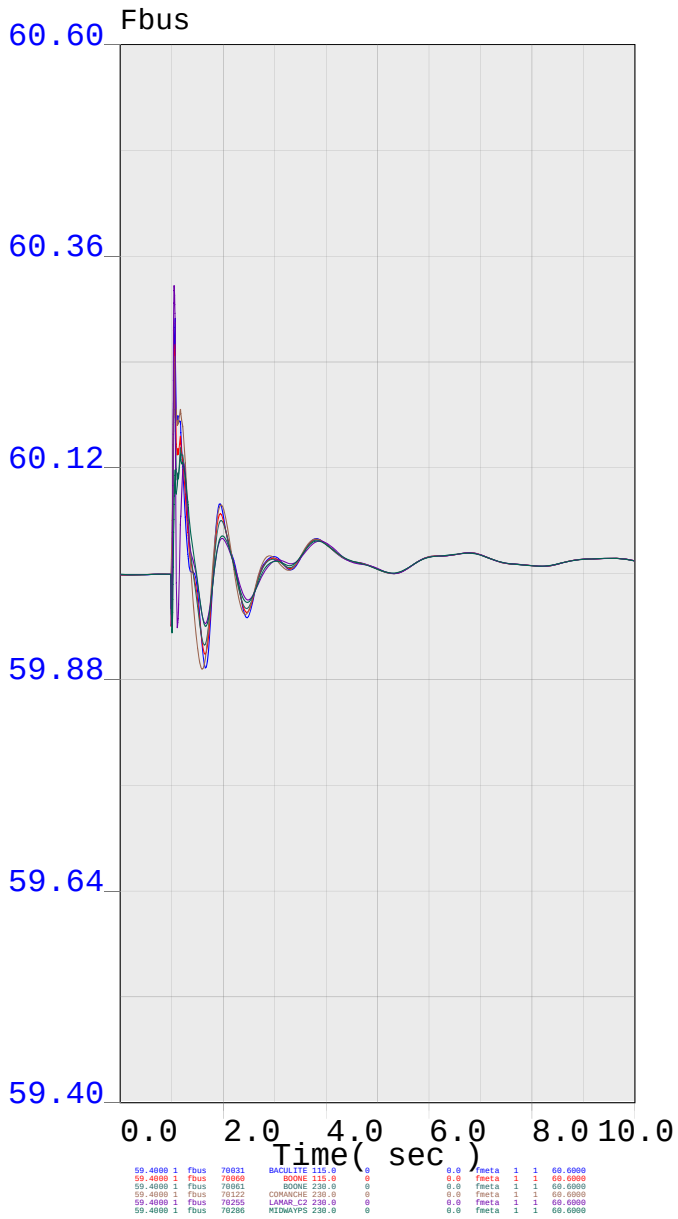




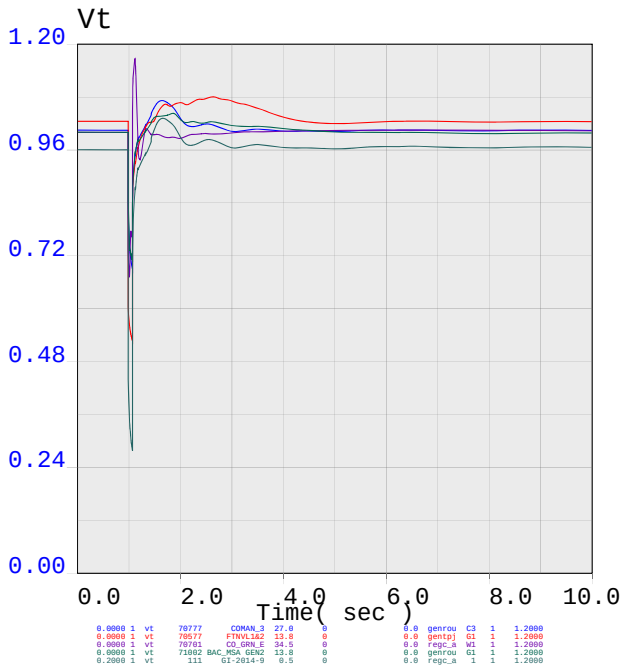


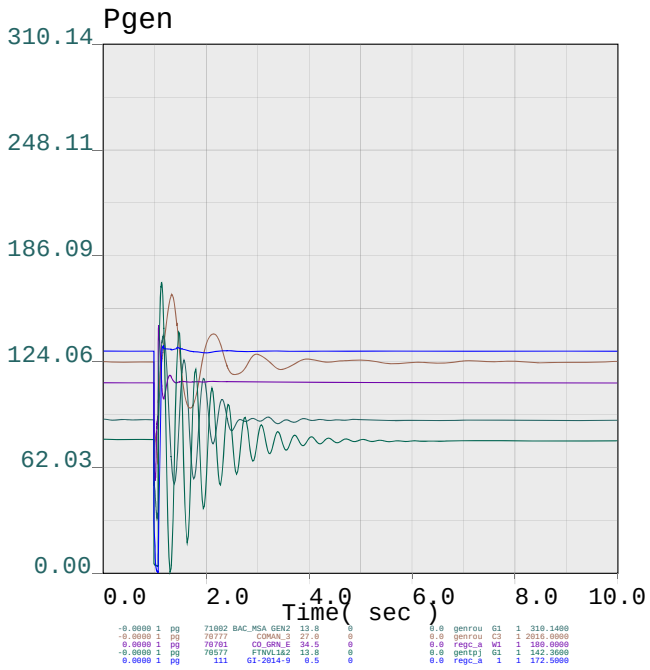
Fault_1
Comanche 230kV bus fault, lose Comanche - Tap point 230kV line

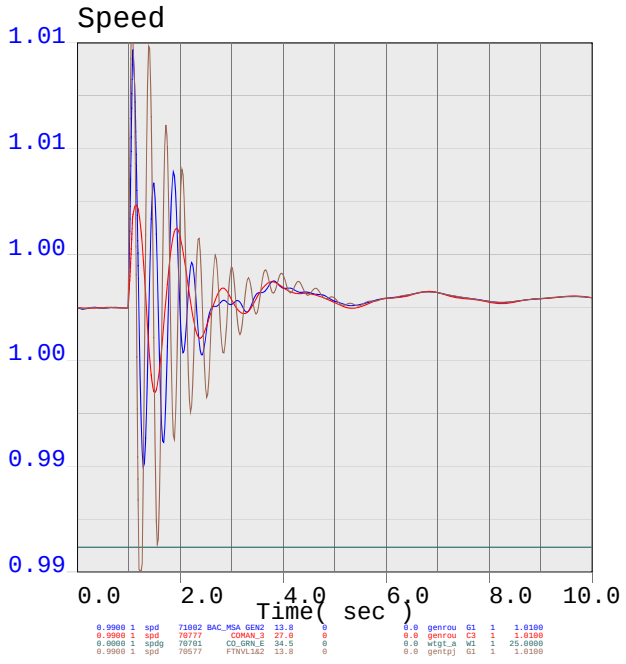


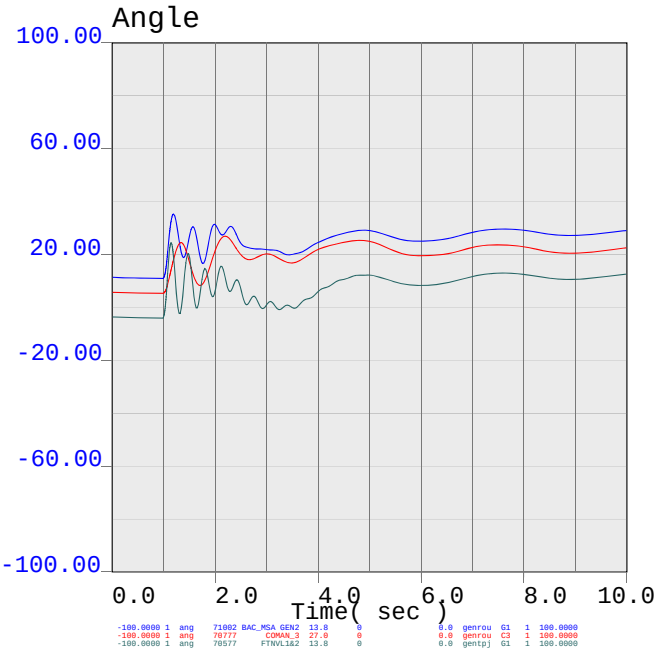


Fault_1
Comanche 230kV bus fault, lose Comanche - Tap point 230kV line

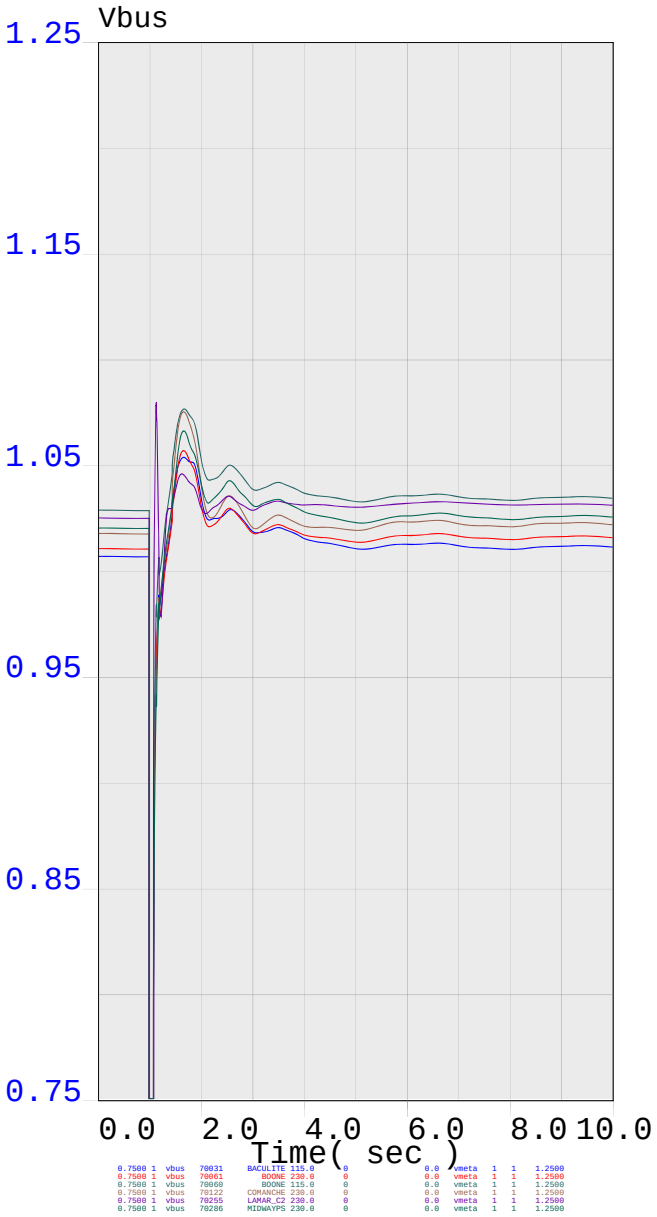


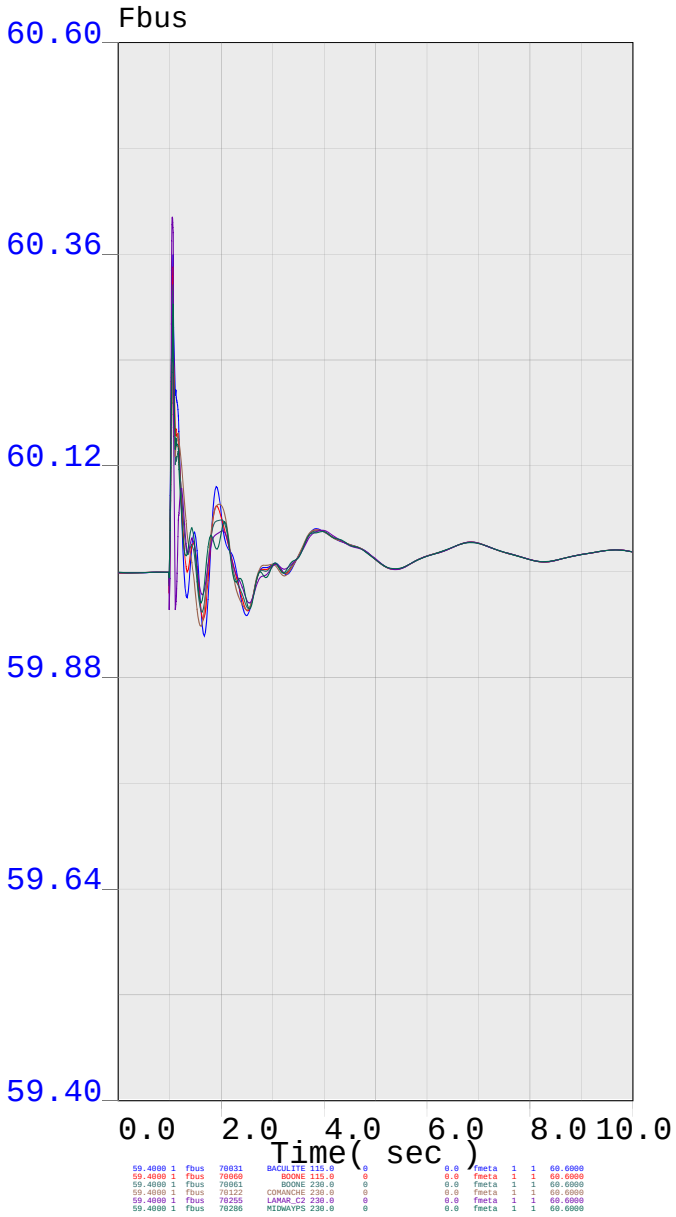




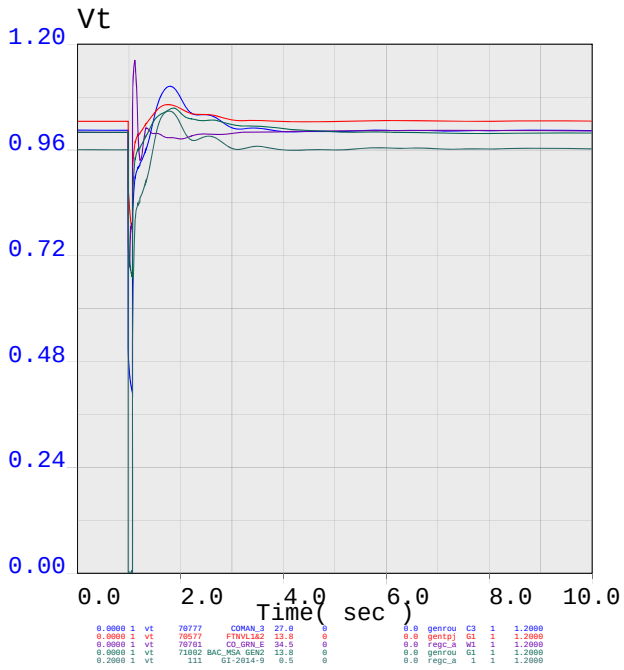


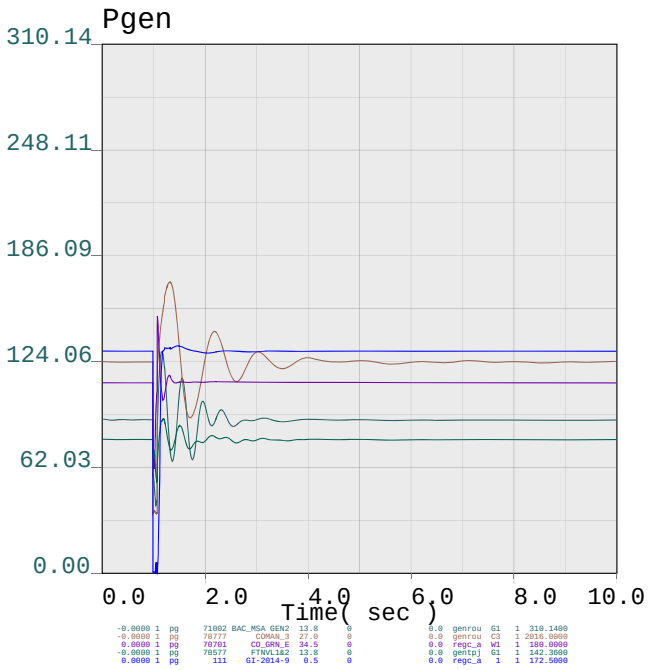
Fault_2
MidwayPS 230kV bus fault, lose Midwayps - Tap point 230kV line

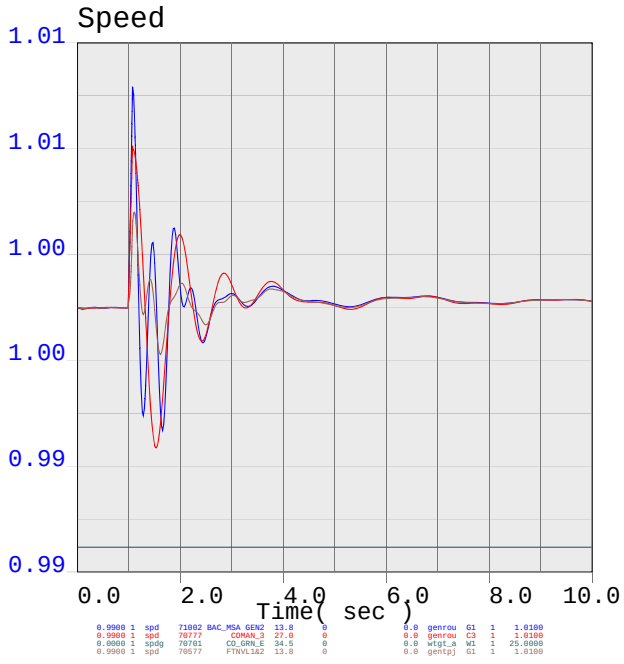


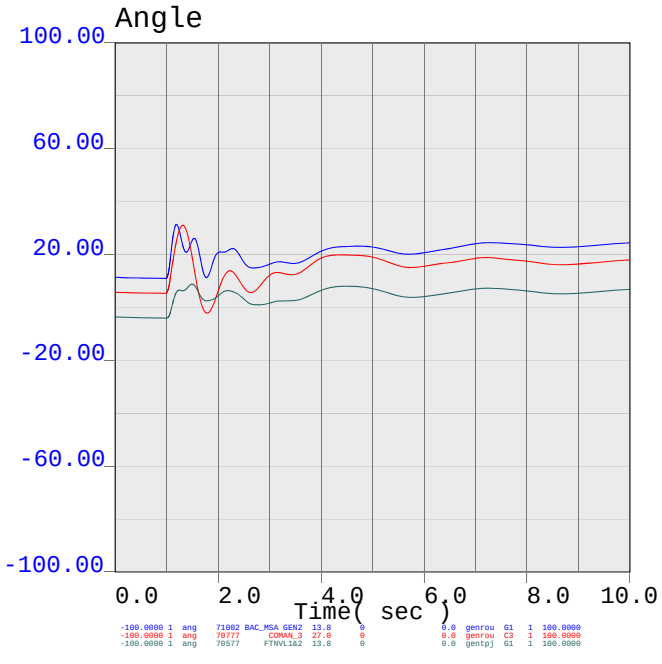


Fault_2
MidwayPS 230kV bus fault, lose Midwayps - Tap point 230kV line

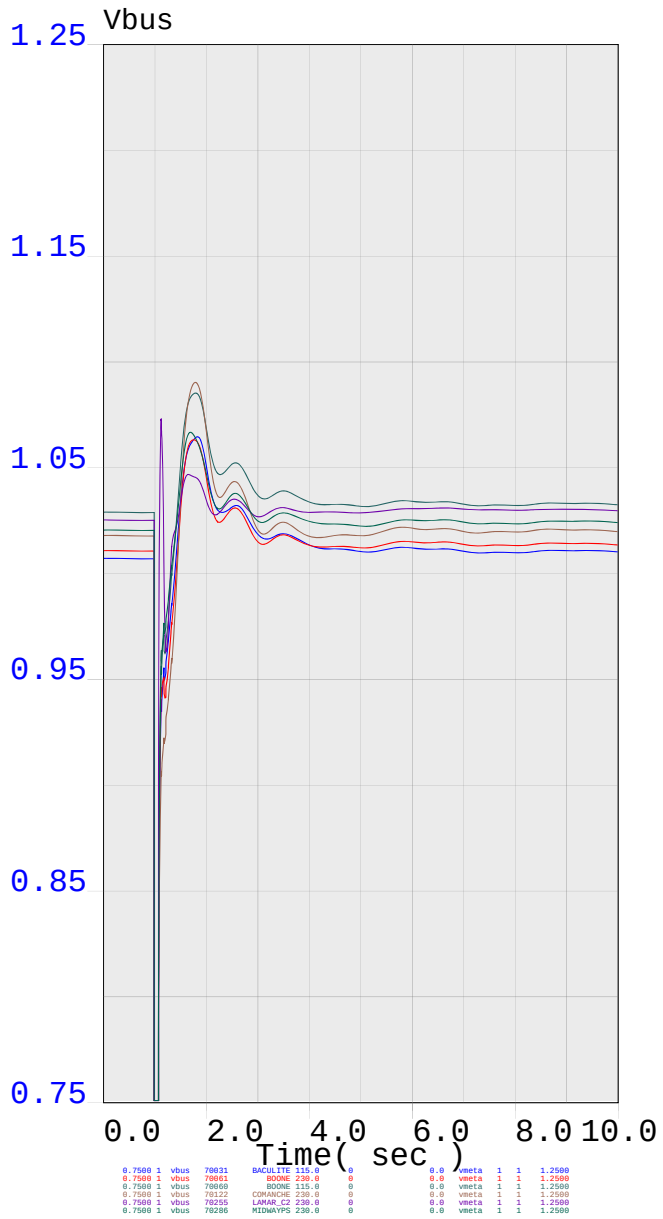


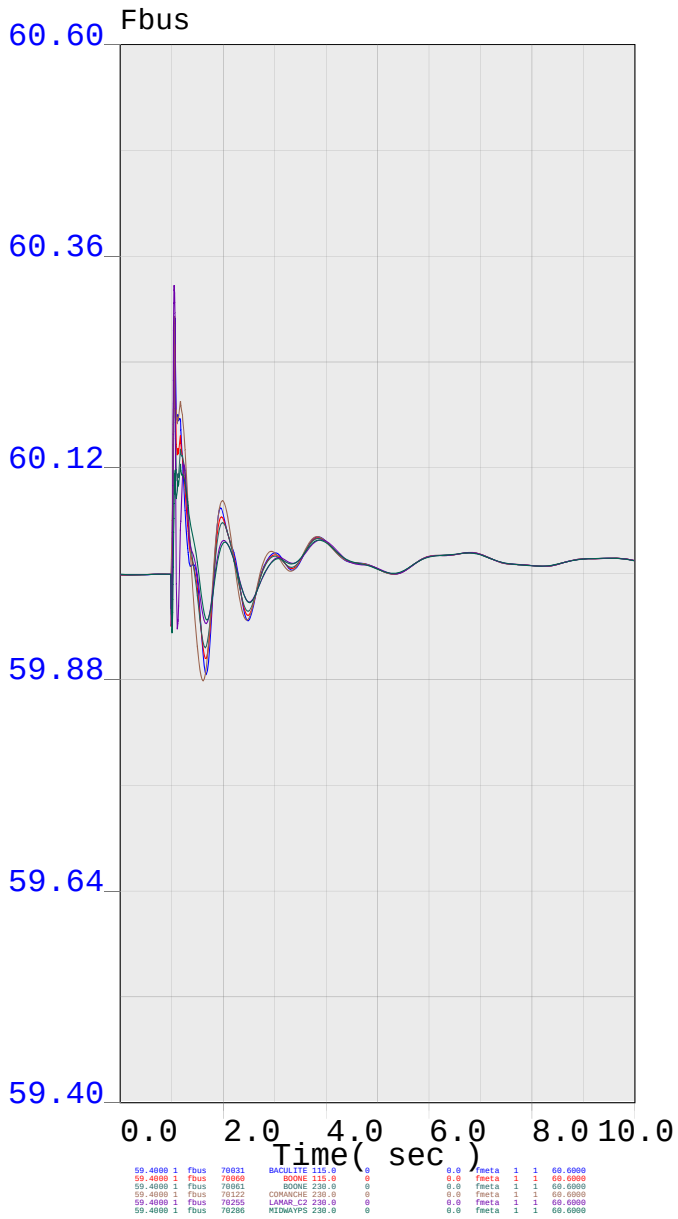






Fault_3
Line Fault, lose Comanche - Midway 230kV and Comanche - Tap Point 230kV line





Fault_3
Line Fault, lose Comanche - Midway 230kV and Comanche - Tap Point 230kV line

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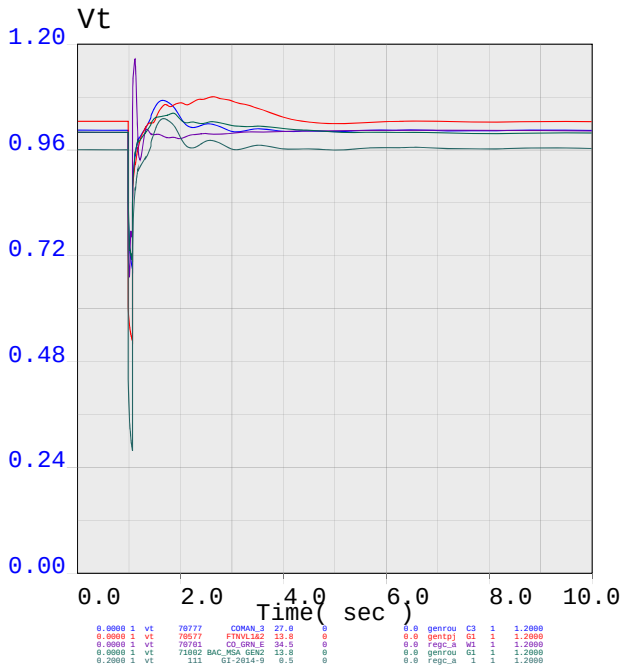
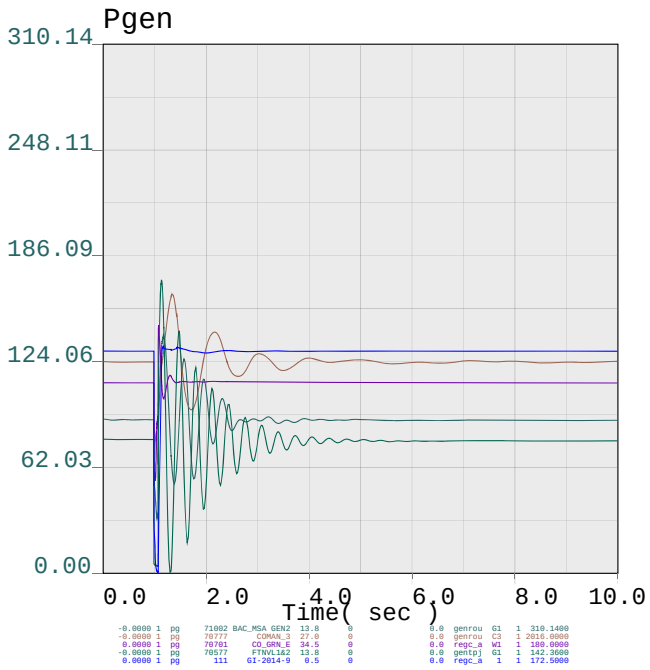
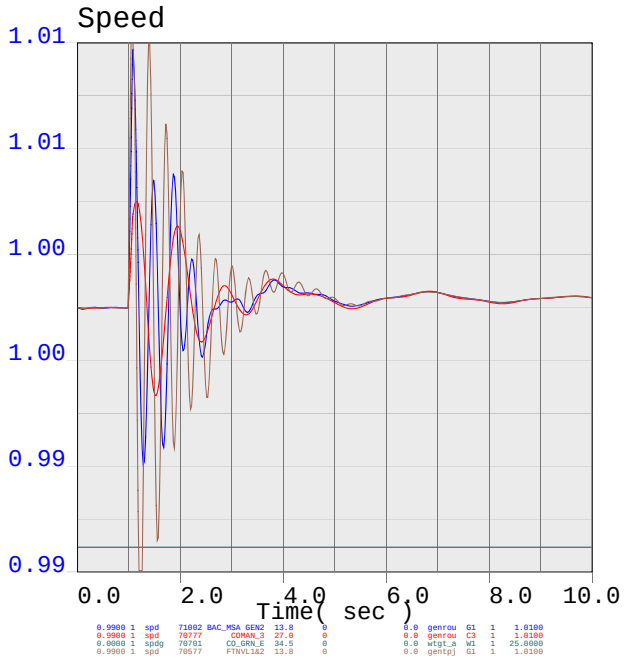
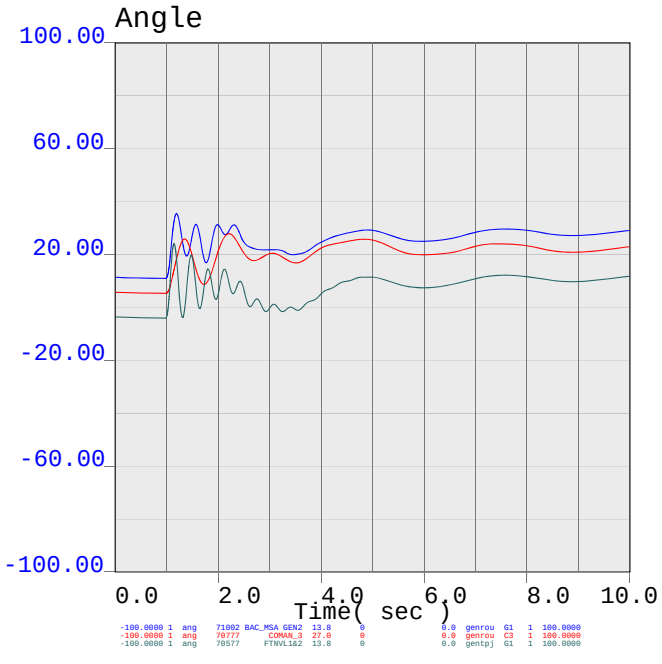
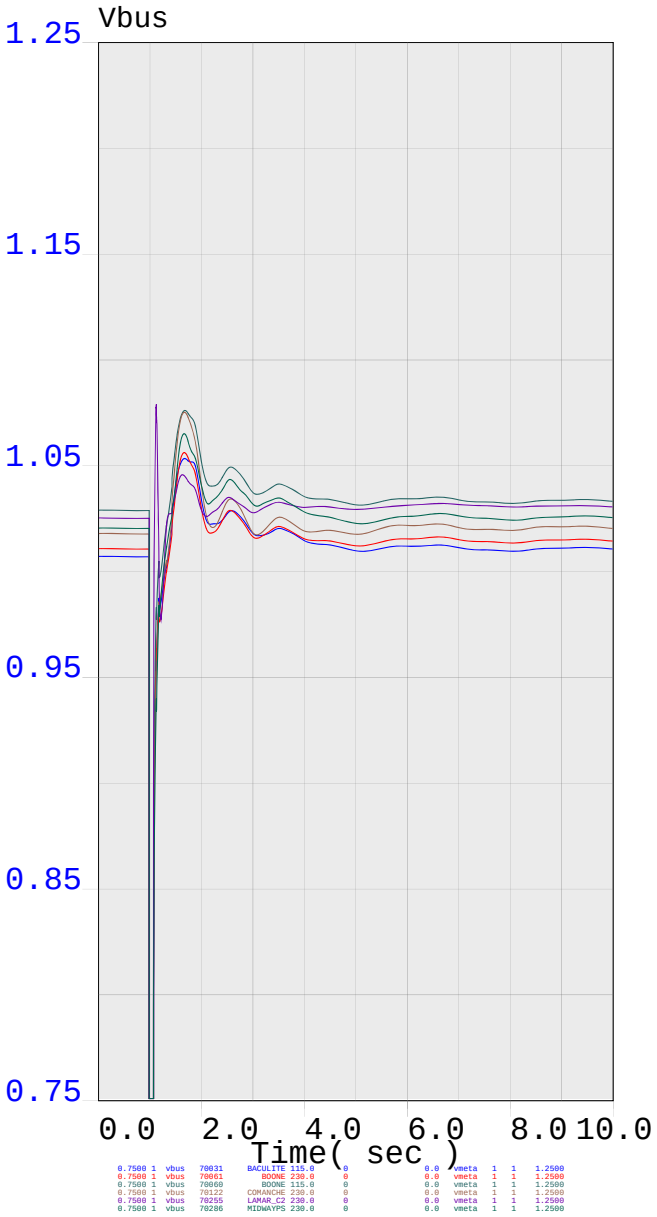


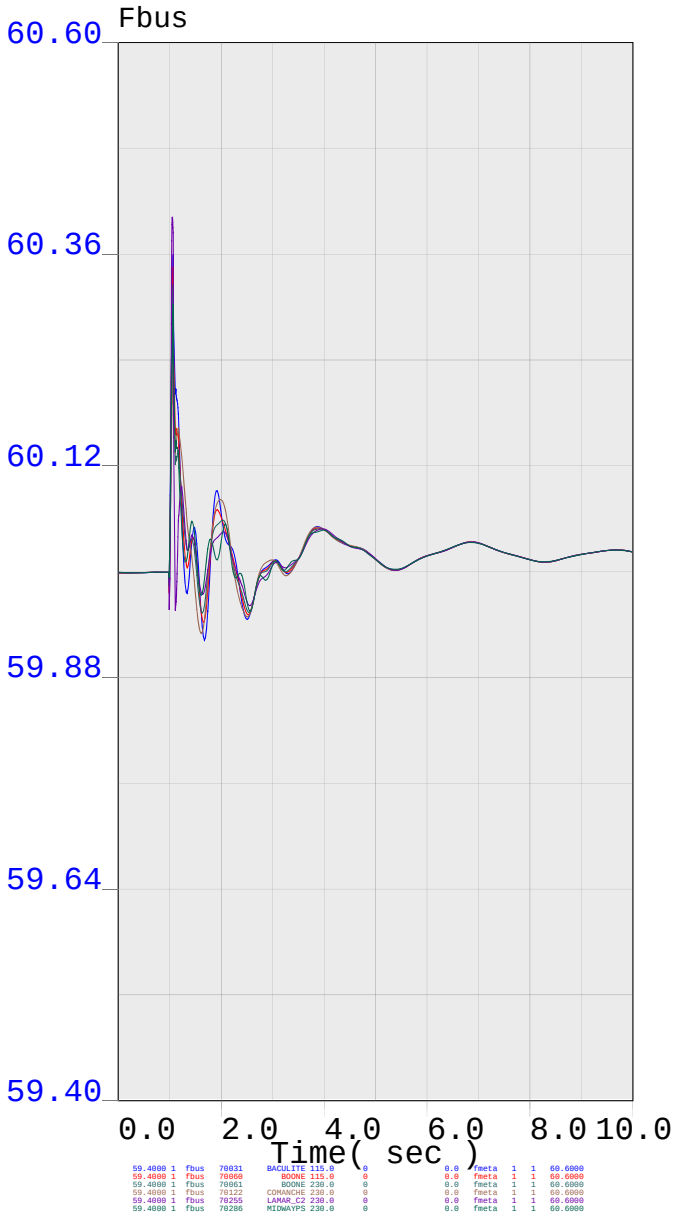




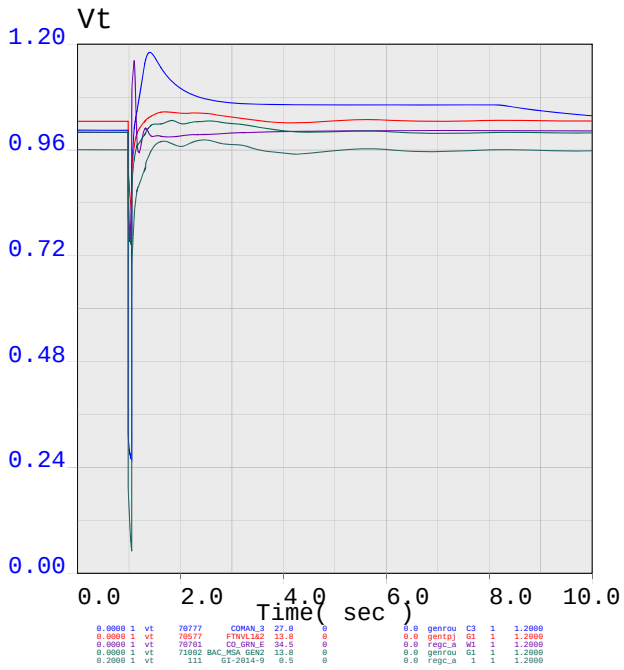


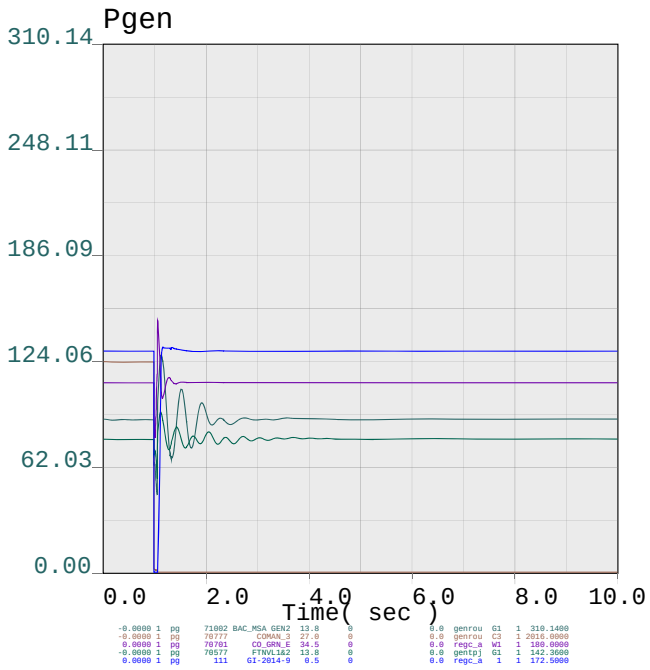
Fault_4
Line Fault, Comanche - Midway 230kV and MidwayPS - Tap Point 230kV line

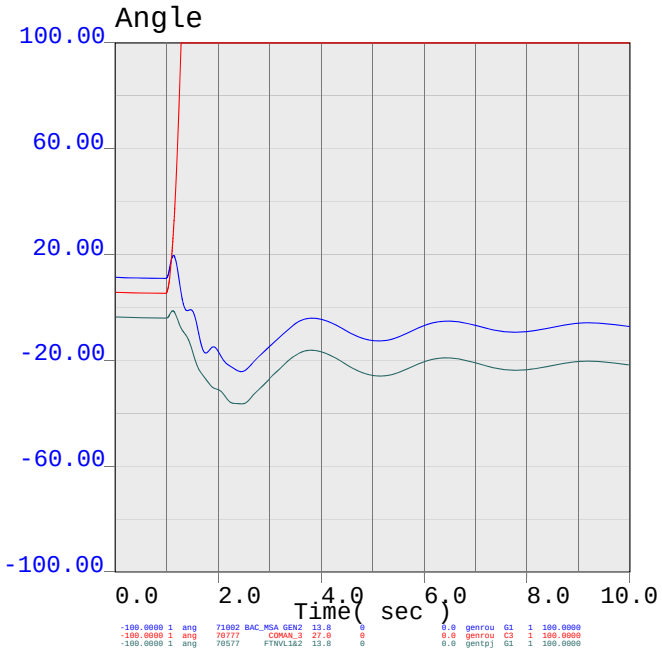




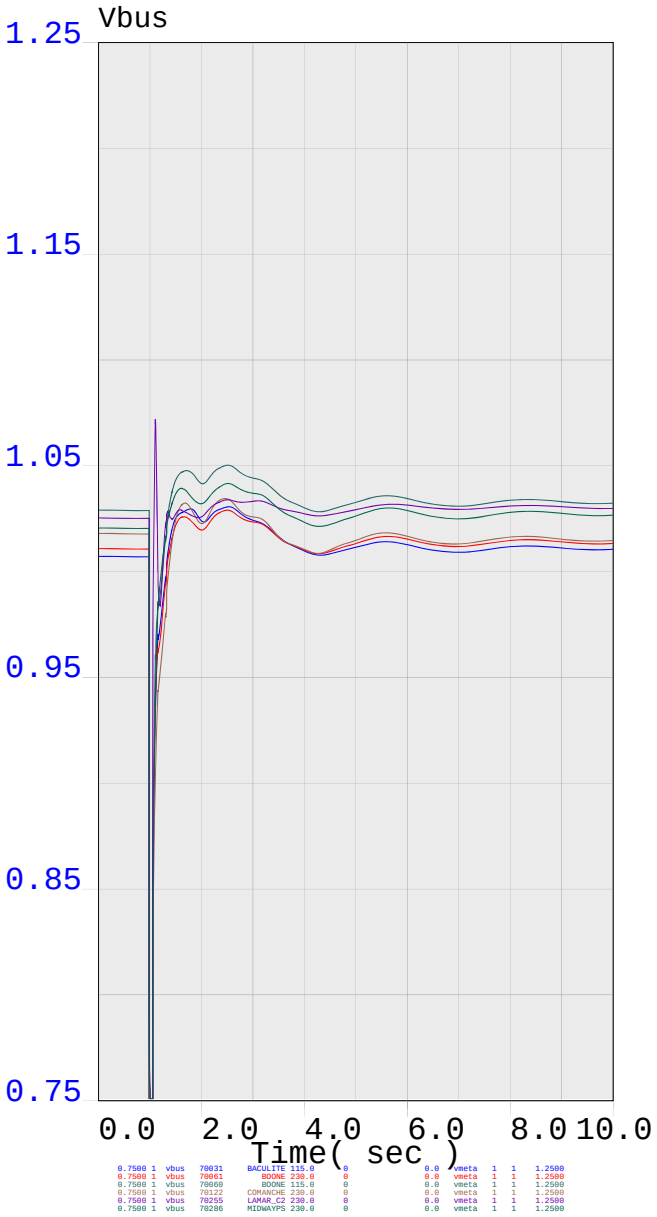
Fault_4
Line Fault, Comanche - Midway 230kV and MidwayPS - Tap Point 230kV line

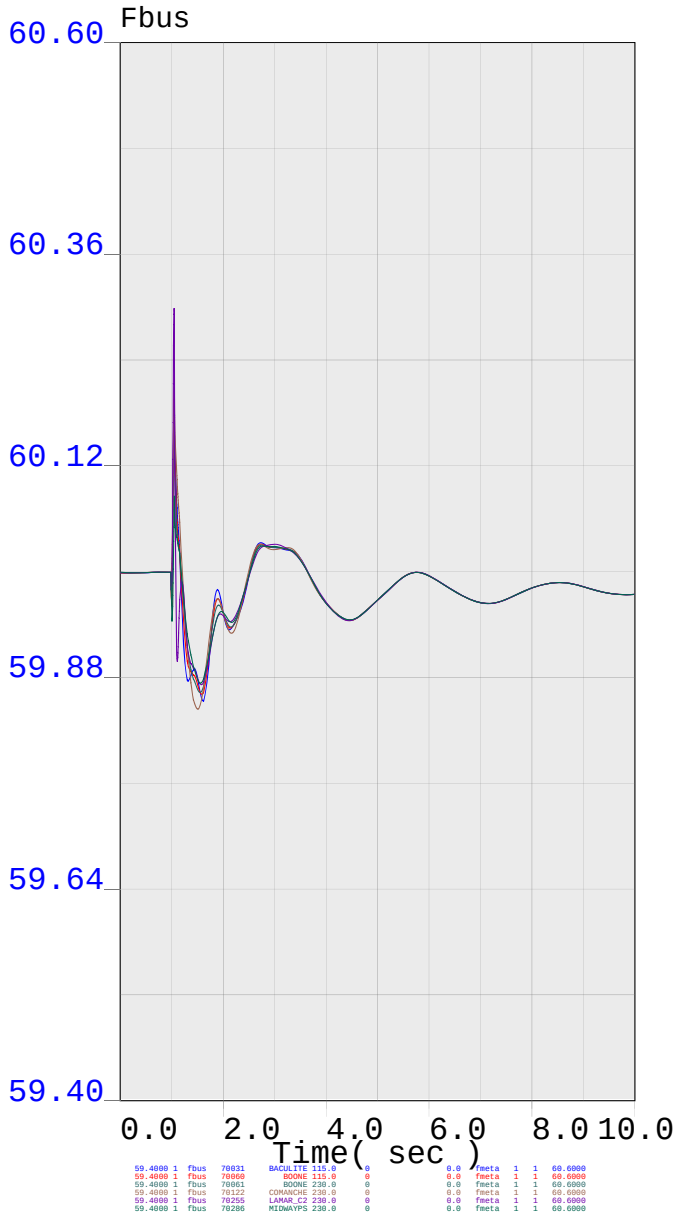




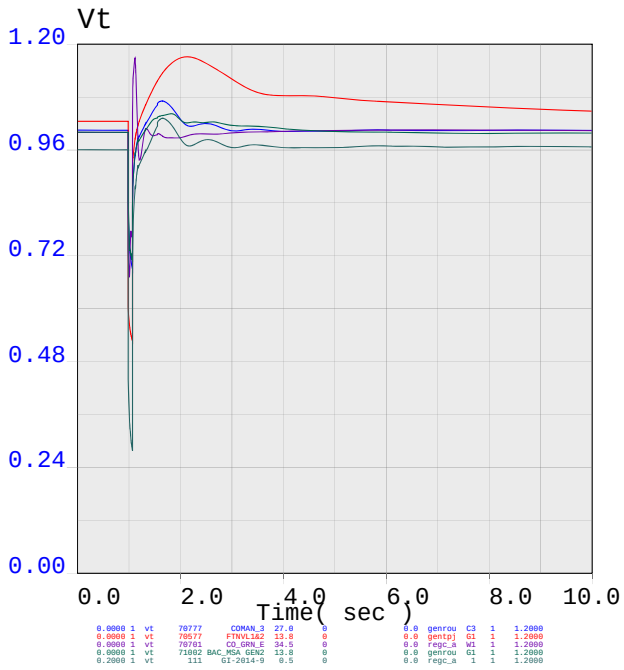


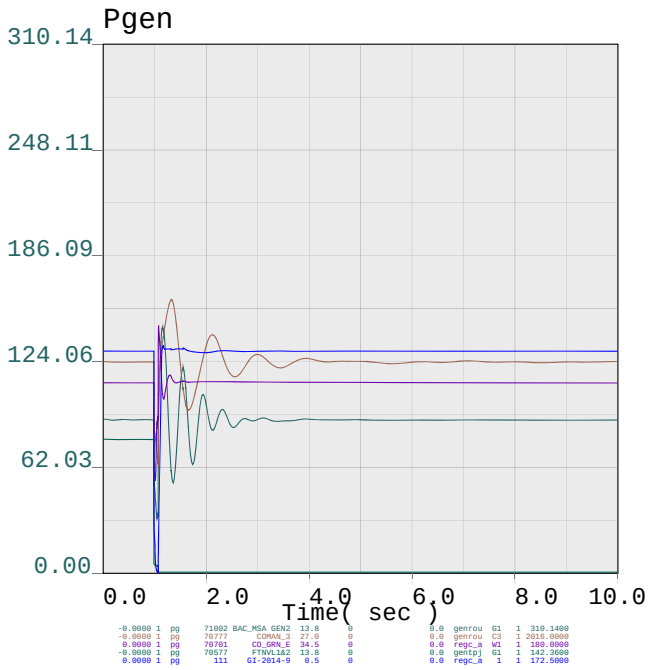
Fault_5
Fault at Comanche 345kV, lose Comanche 3

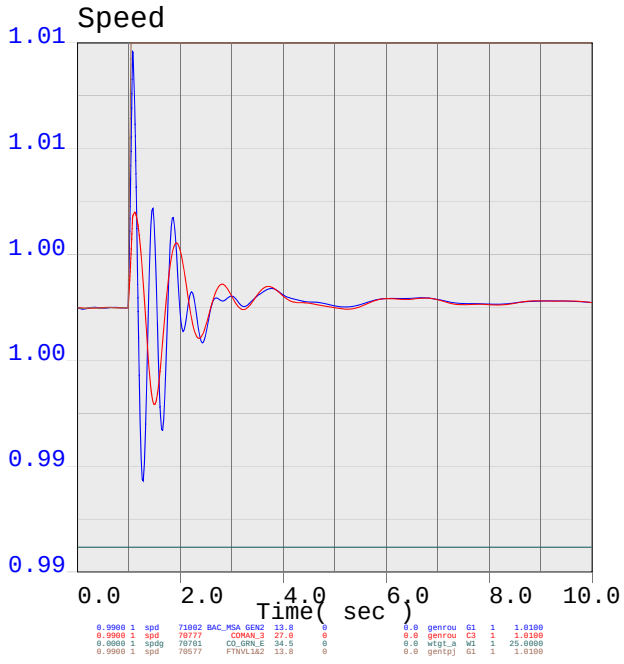


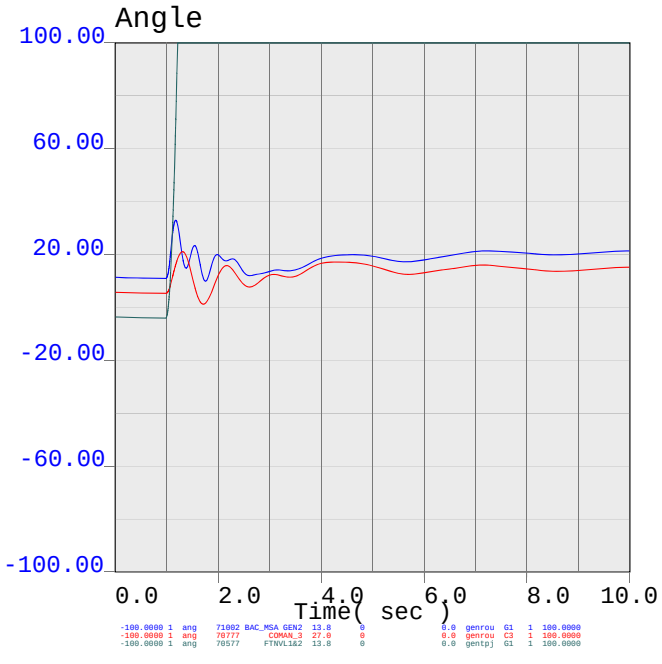


Fault_5
Fault at Comanche 345kV, lose Comanche 3

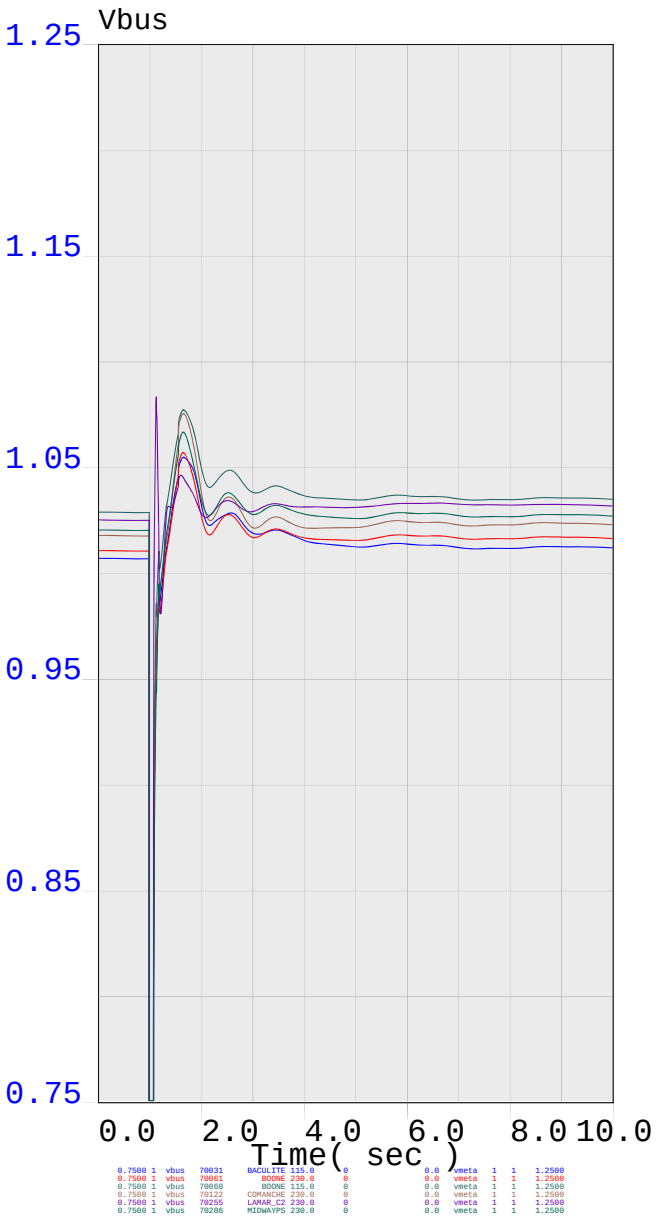


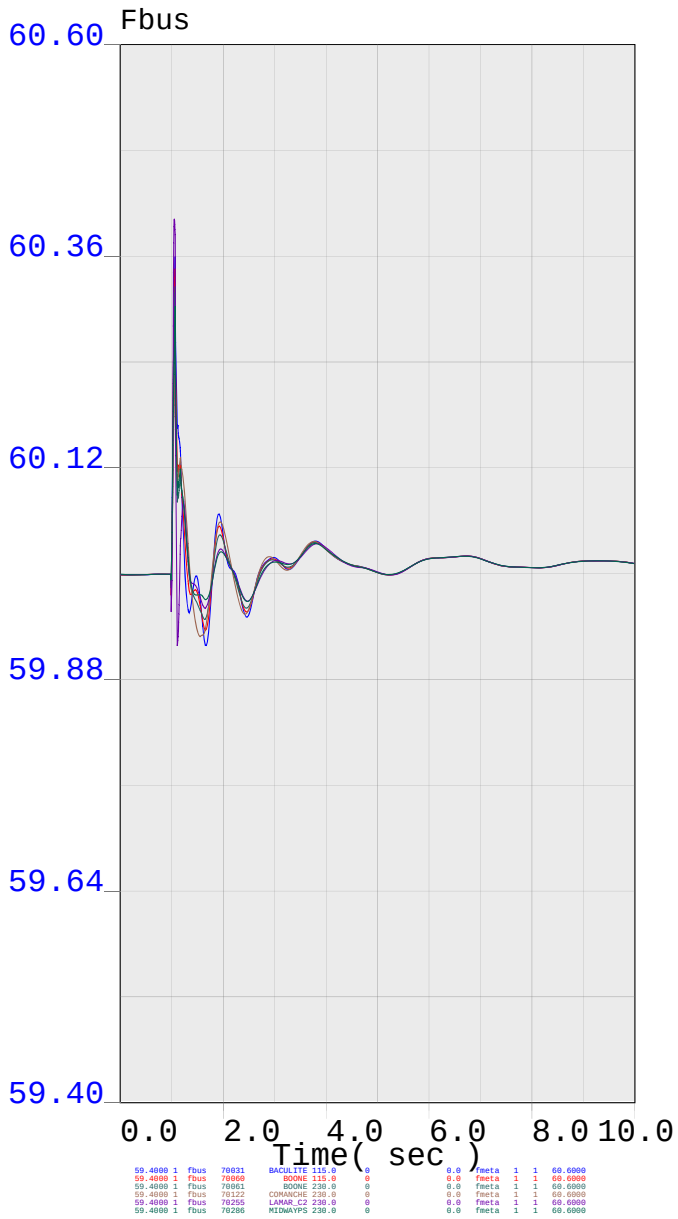




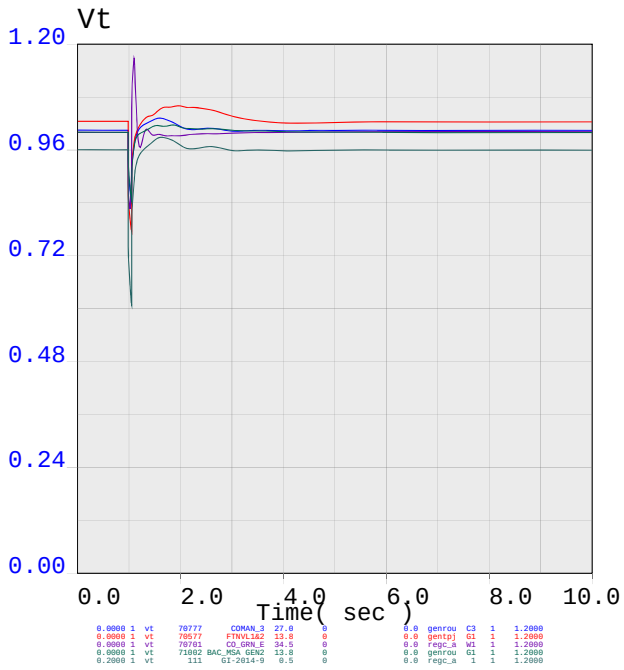


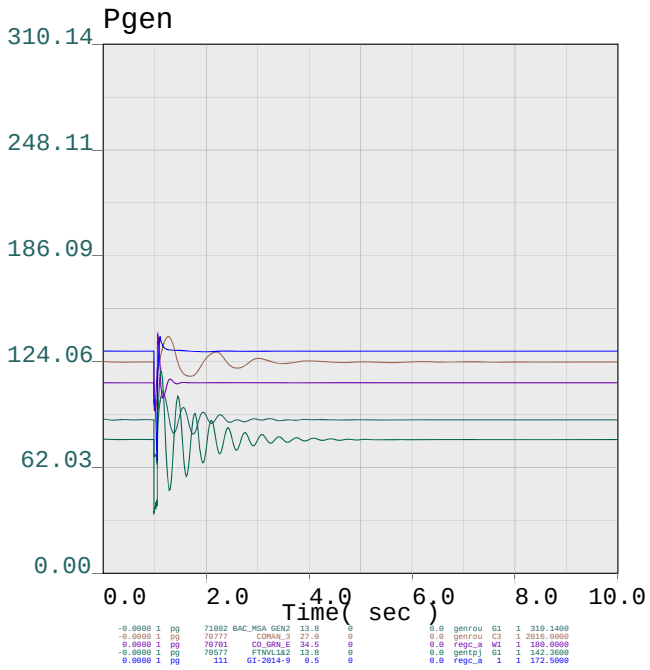
Fault_6
Fault at Midway 230kV, lose Fountain Valley gen

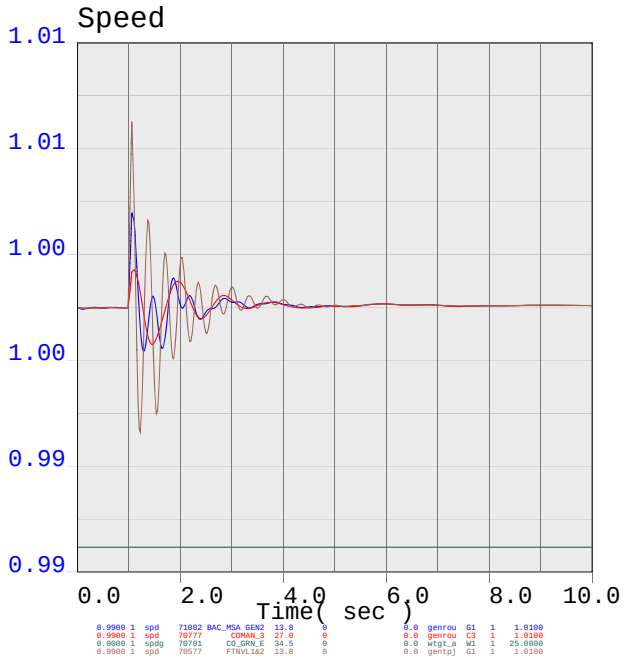


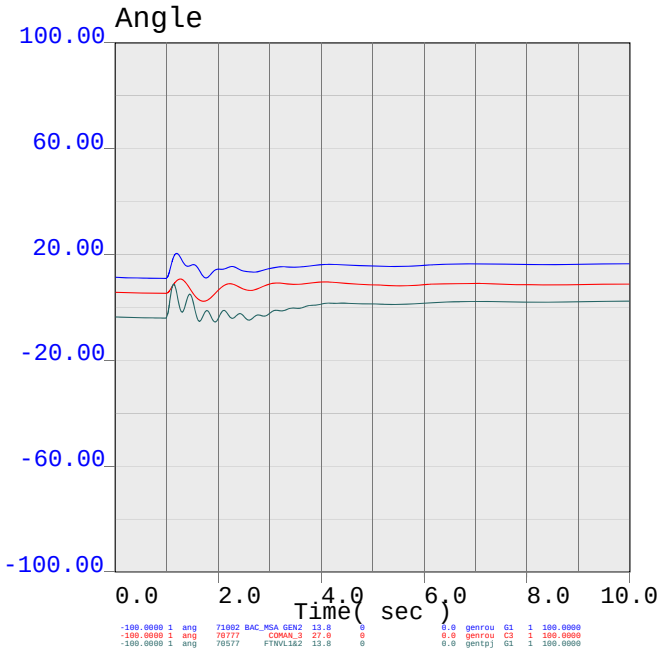


Fault_6
Fault at Midway 230kV, lose Fountain Valley gen

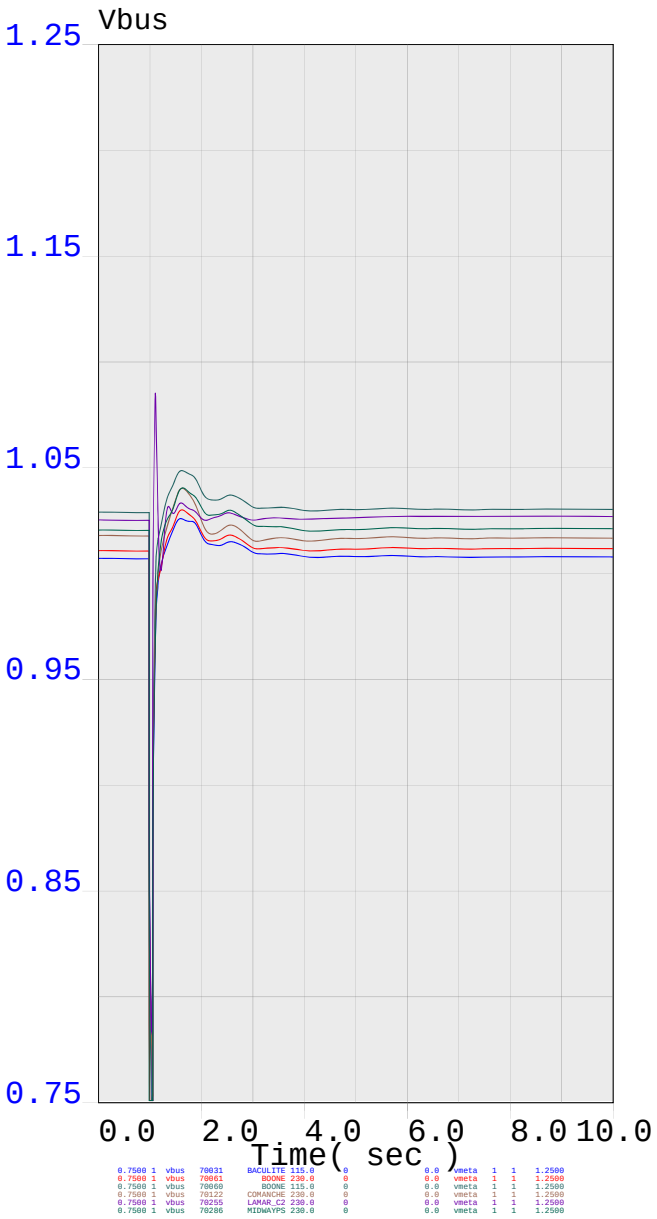


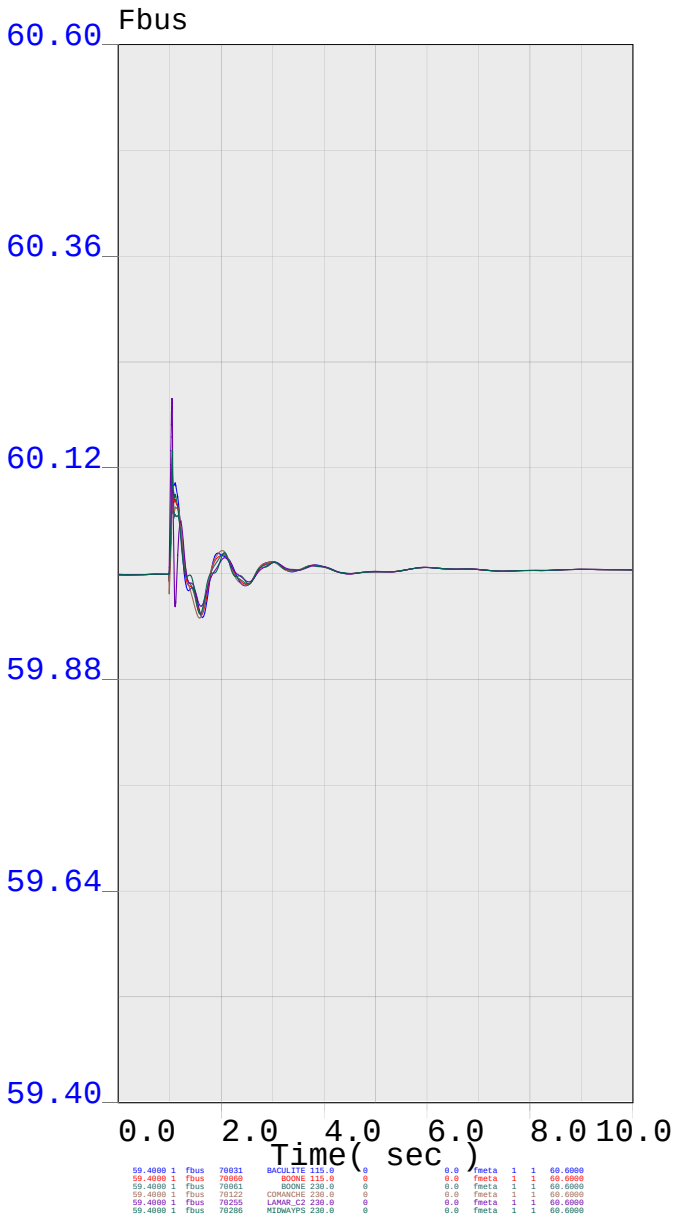




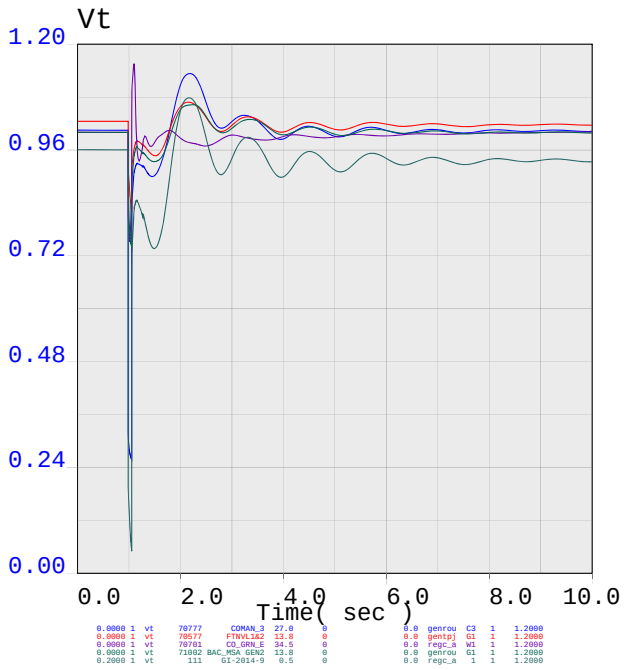


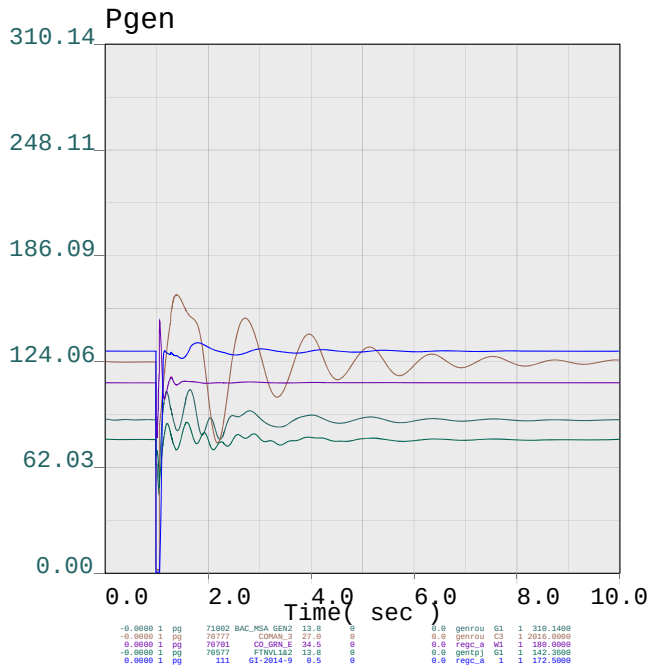
Fault_7
Fault at Midway 345kV, lose MidwayPS 345/20kV and MidwayPS - Waterton345kV line

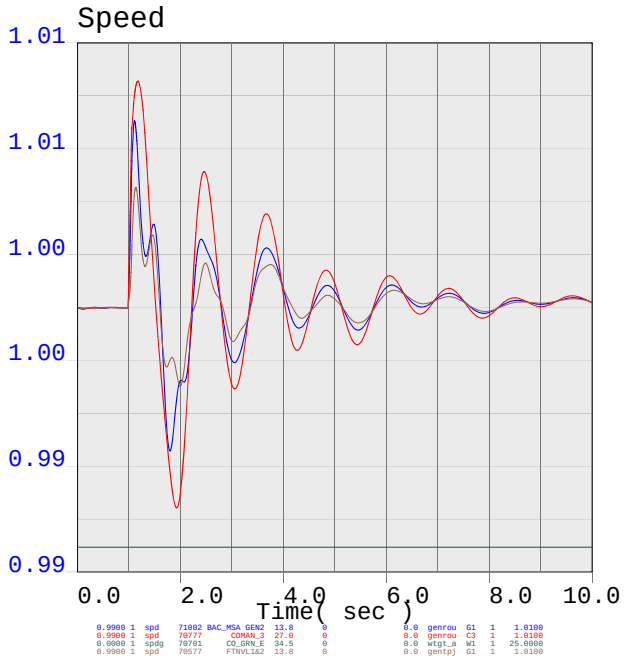


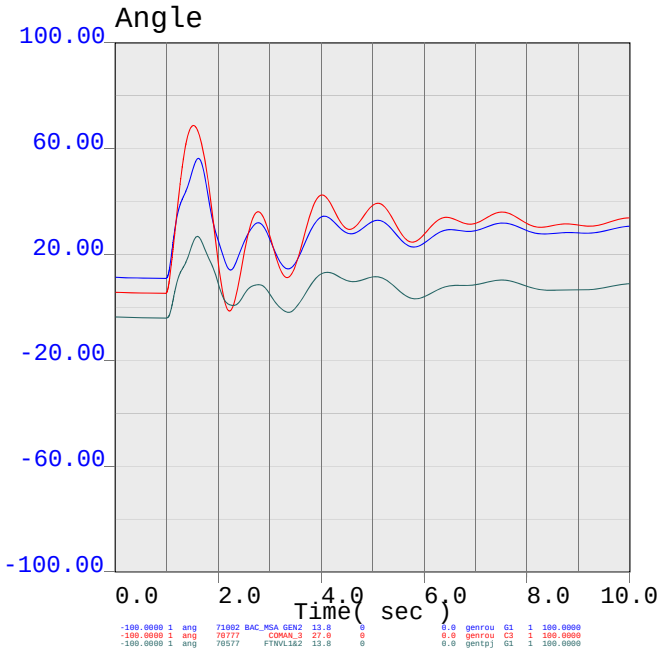


Fault_7
Fault at Midway 345kV, lose MidwayPS 345/20kV and MidwayPS - Waterton345kV line

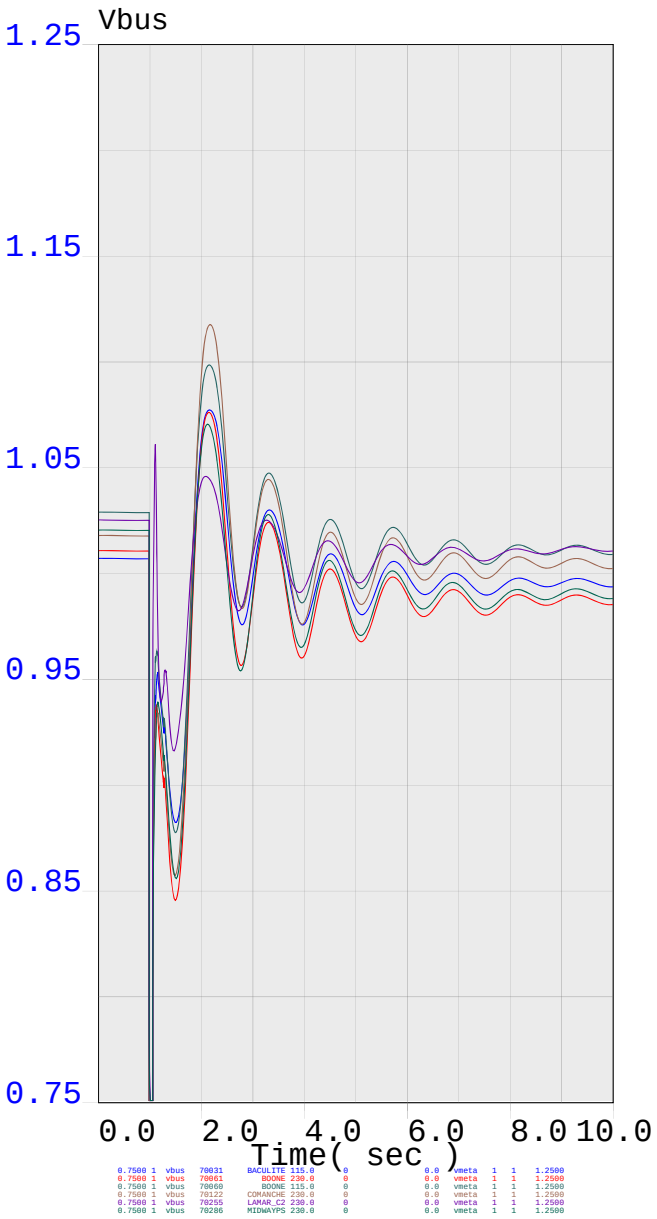


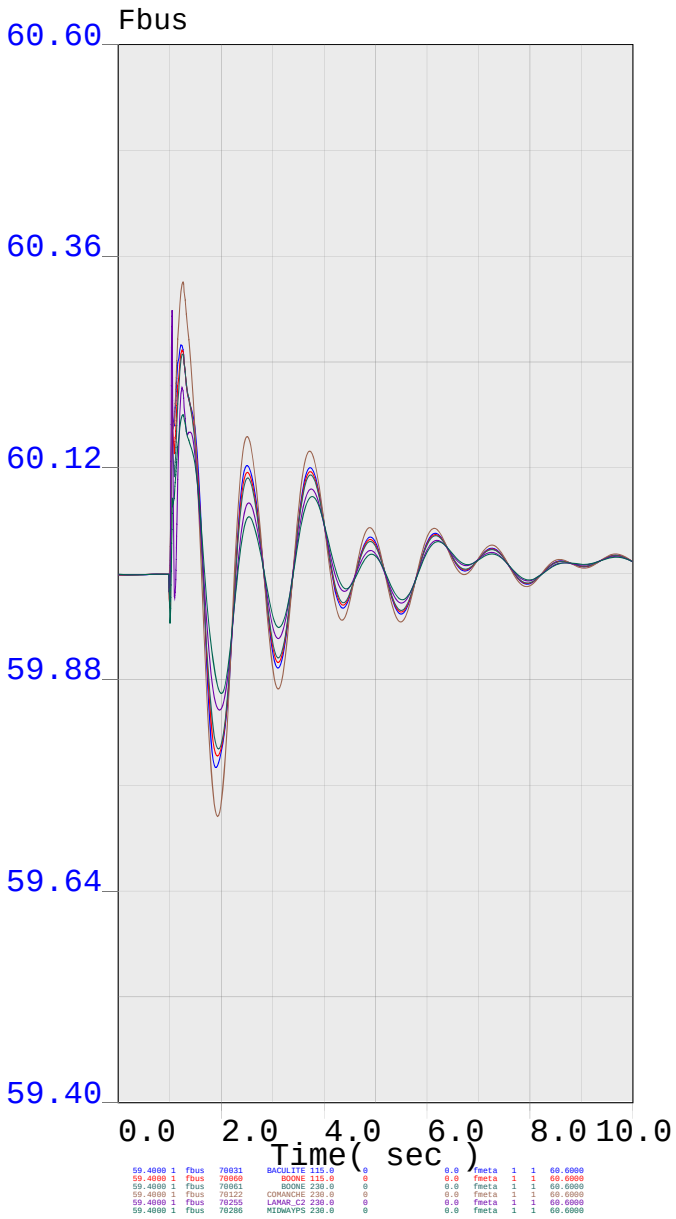




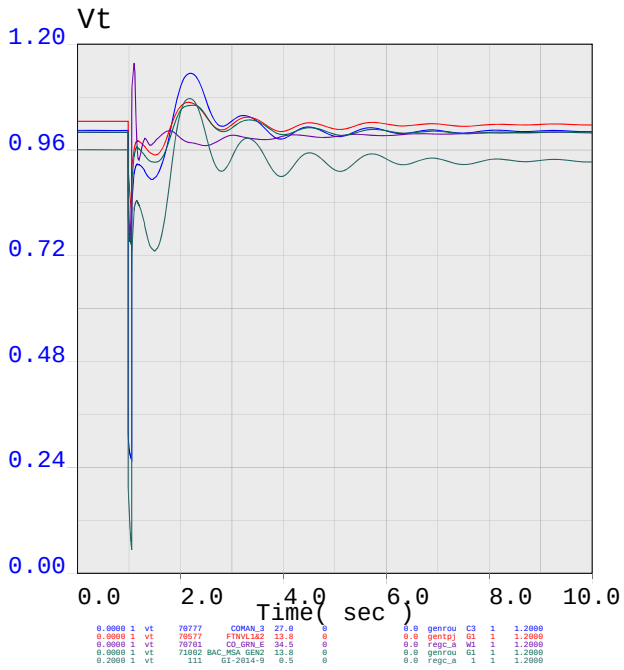


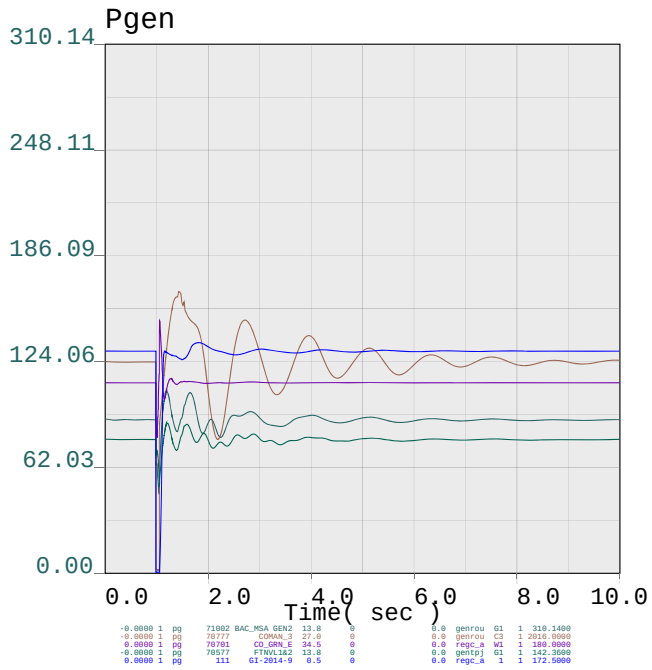
Fault_8
Fault at Comanche 345kV, lose Comanche - Daniels Park 345kV double circuit

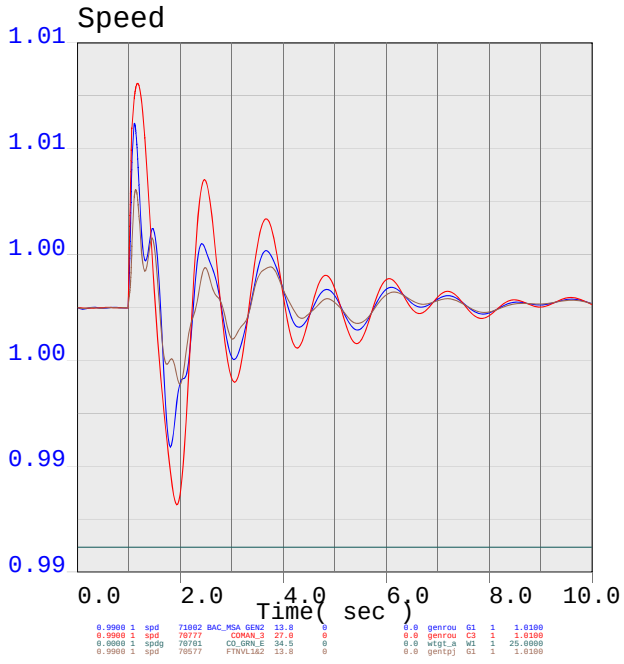


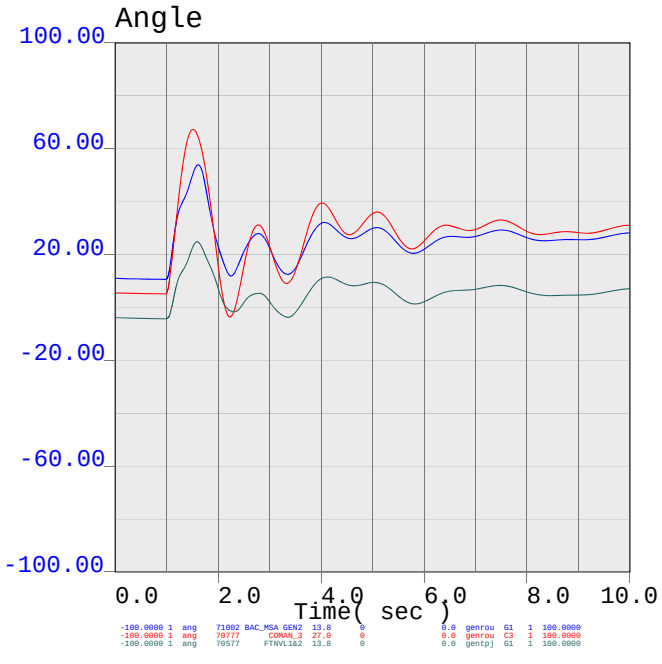


Fault_8
Fault at Comanche 345kV, lose Comanche - Daniels Park 345kV double circuit

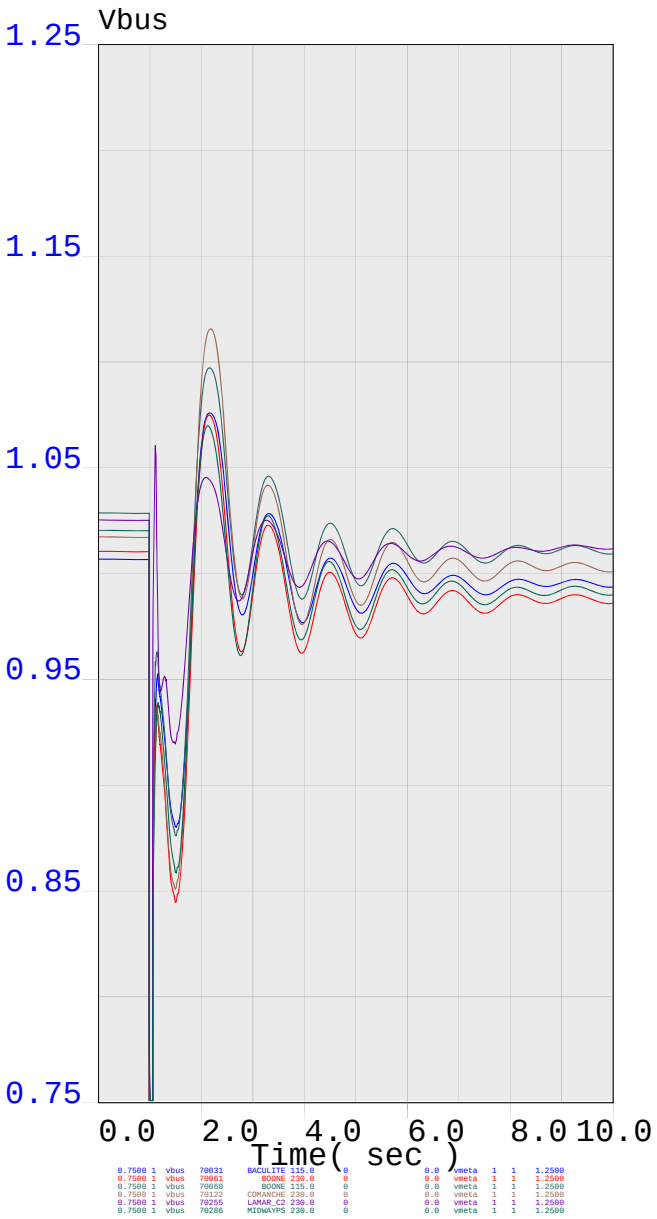


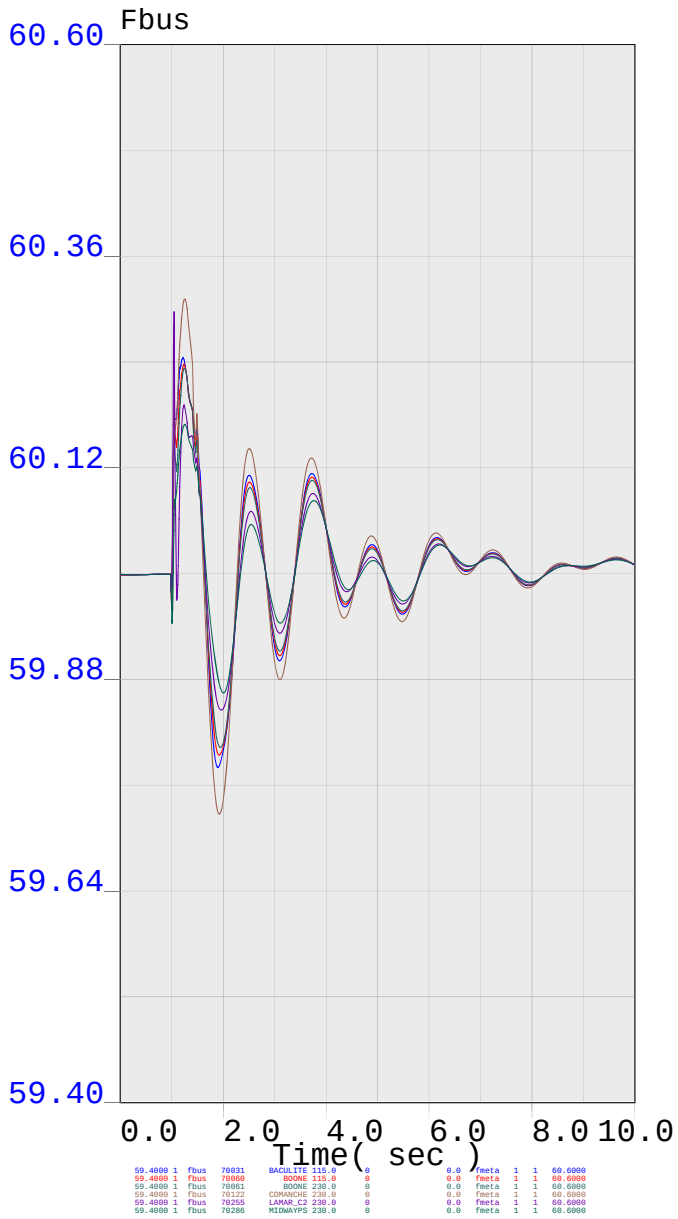






Fault_9
Fault at Comanche 345kV, lose Comanche - Daniels Park 345kV double circuit





Fault_9
Fault at Comanche 345kV, lose Comanche - Daniels Park 345kV double circuit