DRAFT

GENERATION INTERCONNECTION

REQUEST # GI-2010-11

RE-STUDY – SYSTEM IMPACT STUDY REPORT

52 MW PV SOLAR, ALAMOSA COUNTY, COLORADO

Performed by: TranServ International, Inc.

Reviewed by: PSCo Transmission Planning

XCEL ENERGY SERVICES - TRANSMISSION PLANNING WEST

November 2014

Executive Summary

Initially PSCO received an interconnection request (GI-2010-11) for a 52 MW PV solar generation interconnection using 26 SMA 2.0 MW CPs ("Kodiak") inverters, each connected to a 34.5 kV feeder through a 2200 kVA, .360/34.5 kV step-up transformer with the primary point of interconnection located at San Luis Valley 230 kV substation. The report dated 07/22/2014 contains the results of that System Impact Study. Subsequently, PSCO received an updated dynamic inverter model for the same interconnection request using SMA Sunny Central HE solar inverters and a corresponding dynamic file for the modeling of the inverter (DGSMod =0). Consequently, an analysis was performed to simulate the inverter in partial dynamic grid support mode, with no inverter reactive power feed-in capability. The report titled "GI-2010-11 SIS Report Addendum" dated 9/5/2014 contains the results of this subsequent analysis.

Subsequent to the issuance of the GI-2010-11 SIS Report Addendum, the customer again provided updated modeling. As a result the analysis documented in this "additional stability study" report was performed. Thus this "additional stability study" report effectively replaces the stability analysis sections of the original SIS report and also replaces the SIS addendum report in its entirety. The modeling of the request for this study included SMA Sunny Central HE solar inverter modeling as included in an updated dynamic file provided by the customer on 10/22/2014. The inverter was modeled in full dynamic grid support mode (DGSMod =1), which allows the inverter to inject active and/or reactive power following a fault.

Stability Analysis Results

The stability analysis results indicate that with the proposed addition of the GI-2010-11 generation, the system is stable with satisfactory damping for all studied disturbances. Also the voltage and frequency responses of all monitored buses are within WECC criteria for all studied disturbances.

Conclusion

No stability constraints were identified thus no transmission upgrades are required to mitigate for stability impacts.

Study Scope and Analysis

This is a joint SIS report by PSCo and TranServ. The SIS evaluated the transmission impacts associated with the proposed generation increase. It consisted of power flow, short circuit and dynamic analyses. The power flow analysis identified any thermal or voltage limit violations resulting from the generation addition and an identification of network upgrades required to deliver the proposed generation to PSCo loads. The short circuit analysis evaluated the impact on the transmission system of the increase in available fault current due to the generation addition. The short circuit analysis was performed by PSCo. The dynamic analyses were performed by TranServ under PSCo direction. The dynamic analysis identified any transient and oscillatory stability impacts due to the addition of the new generation. The study report was written by PSCo. The stability portion of the study report was written by TranServ under PSCo direction. PSCo made the determination of injection constraints that are required to be mitigated by the interconnection Customer and developed the mitigation plan for interconnection. Planning level cost estimates were provided by PSCo.

This Generation Interconnection SIS analyzed the impact of this addition, located in South Central Colorado, in accordance with PSCo's study criteria. PSCo adheres to NERC & WECC Reliability Criteria, as well as internal Company criteria for planning studies. The criterion used to identify thermal injection constraints met or exceeded the following criteria:

- There was a detrimental change in the facility loading due to the subject request.
- The resultant facility loading exceeded 100% of the continuous rating (Rate A in PSS/E) system intact or post contingent.

The criterion used to identify voltage injection constraints met or exceeded the following criteria.

- There was a detrimental change in bus voltage due to the subject request.
- The resultant bus voltage was outside of the acceptable range of 0.95 to 1.05 pu system intact or 0.90 to 1.05 pu post contingent.

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

- Following fault clearing for Category B contingencies, voltage may not dip more than 25% of the pre-fault voltage at load buses, more than 30% at non-load buses, or more than 20% for more

than 20 cycles at load buses**.(For this study the voltages were monitored after voltage recovery following clearing the fault)**

- Following fault clearing for Category C contingencies, voltage may not dip more than 30% of the pre-fault voltage at any bus or more than 20% for more than 40 cycles at load buses.

In addition, transient frequency performance should meet the following criteria:

- Following fault clearing for Category B contingencies, frequency should not dip below 59.6 Hz for 6 cycles or more at a load bus.
- Following fault clearing for Category C contingencies, frequency should not dip below 59.0 Hz for 6 cycles or more at a load bus.

Note that load buses include generating unit auxiliary loads.

This project was studied as a Network Resource. NRIS shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission System in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load Customers. NRIS in and of itself does not convey transmission service.

Modeling of Request

The modeling of the request for this study included SMA Sunny Central HE solar inverter modeling as included in an updated dynamic file provided by the customer on 10/22/2014. The inverter was modeled in full dynamic grid support mode (DGSMod =1), which allows the inverter to inject active and/or reactive power following a fault.

The POI is San Luis Valley 230 kV substation.

Dynamic Stability Results

An analysis was performed to assess the transient stability system performance with the GI-2010-11 generation at 52 MW net. The examined disturbances are provided in Appendix A. The list of evaluated disturbances was limited to that necessary to adequately assess the transient stability performance of the system with the proposed addition as determined by PSCo.

The WECC dynamic voltage criteria are defined as a voltage changes rather than voltage magnitudes. The PSSE simulation results provide voltage magnitudes. For the purposes of this analysis a pre-disturbance

voltage of 1.0 pu was initially assumed. If potential violations were identified, the actual pre-disturbance voltage was obtained and the voltage change was calculated to determine if a WECC criteria violation was indicated. To perform the analyses, plots of generator power output, line MW flow, bus voltage, and bus frequency were produced for each disturbance. Minimum transient bus voltage magnitudes, maximum transient bus voltage changes (when applicable) and maximum transient frequency deviations, occurring after the fault was cleared, were also determined. The results can be found in Appendix B. Plots of generator power output, line MW flow, bus voltage, and bus frequency can be found in Appendix C. PSCo determined that all and only Zone 710 buses should be monitored in this study. The results indicate that with the proposed addition of generation the system is stable with satisfactory damping for all modeled disturbances.

Disturbance 01s

As shown in Table 1, a potential WECC criteria violation was found for Disturbance 01s in the Post GI-2010-11 analysis. Further analysis revealed that the FTGARLND 69 kV bus transient voltage dip was only 14%. Thus the results listed in Table 1 are not considered constraints to the requested service because the transient voltage dip does not exceed the WECC criteria transient voltage dip threshold of 20%.

Table 1

Load Buses	Initial Post Voltage	Post Minimum Voltage	Post Deviation	No of cycles below WECC criterion	Transient Voltage dip %
FTGARLND 69	0.9263	0.7949	0.1314	7	14.18

Disturbance 11s

As shown in Table 2, potential WECC criteria violations were found for Disturbance 011s in the Post GI-2010-11 analysis. Further analysis revealed that the transient voltage dip seen at the FTGARLND and ANTONITO 69 kV buses was only 15%. Thus the FTGARLND and ANTONITO 69 kV buses results listed in Table 2 are not considered constraints to the requested service because the transient voltage dips do not exceed the WECC criteria transient voltage dip threshold of 20%.

As also shown in Table 2, the transient voltage dip seen at the ALMSACT2 13.8 kV and the ALMSA_TM 115 kV buses was found to exceed 20%, but for only 3 cycles. Thus, the ALMSACT2 13.8 kV and the ALMSA_TM 115 kV bus results listed in Table 2 are not considered constraints to the requested service because the transient voltage dips does not exceed 20% for more than the WECC criteria transient voltage dip/cycle threshold of 20%dip for 20cycles.

Table 2

Load Buses	Initial Post Voltage	Post Minimum Voltage	Post Deviation	No of cycles below WECC criterion	Transient Voltage dip %
ALMSACT2 13.8	0.9830	0.7782	0.2048	3	21
ALMSA_TM 115	0.9899	0.7785	0.2114	3	21
FTGARLND 69	0.9263	0.7890	0.1373	1	15
ANTONITO 69	0.9396	0.7941	0.1455	1	15

Disturbance 12s

As shown in Table 3, potential WECC criteria violations were found for Disturbance 012s in the Post GI-2010-11 analysis. Further analysis revealed that the transient voltage dip seen at the FTGARLND, ANTONITO, ROMEO and REATAP 69 kV buses was only 17%. Thus the FTGARLND, ANTONITO, ROMEO and REATAP 69 kV buses results listed in Table 3 are not considered constraints to the requested service because the transient voltage dips do not exceed the WECC criteria transient voltage dip threshold of 20%.

As also shown in Table 3, the transient voltage dip seen at the ALMSACT2 13.8 kV and the ALMSA_TM 115 kV buses was found to exceed 20%, but for only 7 cycles. Thus the ALMSACT2 13.8 kV and the ALMSA_TM 115 kV bus results listed in Table 3 are not considered constraints to the requested service because the transient voltage dips does not exceed 20% for more than the WECC criteria transient voltage dip/cycle threshold of 20%dip for 20cycles.

Table 3

Load Buses	Initial Post Voltage	Post Minimum Voltage	Post Deviation	No of cycles below WECC criterion	Transient Voltage dip %
ALMSACT2 13.8	0.9830	0.7580	0.2250	7	23
ALMSA_TM 115	0.9899	0.7583	0.2316	7	23
FTGARLND 69	0.9263	0.7699	0.1564	5	17
ANTONITO 69	0.9396	0.7780	0.1616	2	17
ROMEO 69	0.9431	0.7816	0.1615	2	17
REATAP 69	0.9498	0.7885	0.1613	1	17

Appendix A
Listing of Disturbances Tested

Disturbance Scenario #	Fault Type	Clearing Time	Faulted Bus	Disturbance Description
01s	Three Phase	4 Cycles	San Luis Valley 230 kV	Fault on the San Luis Valley - Poncha 230 kV line: clear the fault by tripping the San Luis Valley - Poncha 230 kV line.
02s	Three Phase	4 Cycles	Poncha 230 kV	Fault on the Poncha - San Luis Valley 230 kV line: clear the fault by tripping the Poncha - San Luis Valley 230 kV line.
03s	Three Phase	5 Cycles	Poncha 115 kV	Fault on the Poncha - Sargent 115 kV line: clear the fault by tripping the Poncha - Sargent 115 kV line.
04s	Three Phase	5 Cycles	Sargent 115 kV	Fault on the Poncha - Sargent 115 kV line: clear the fault by tripping the Poncha - Sargent 115 kV line.
05s	Three Phase	5 Cycles	Sargent 115 kV	Fault on the San Luis Valley - Sargent 115 kV line: clear the fault by tripping the San Luis Valley - Sargent 115 kV line.
06s	Three Phase	5 Cycles	San Luis Valley 115 kV	Fault on the Sargent - San Luis Valley 115 kV line: clear the fault by tripping the Sargent - San Luis Valley 115 kV line.
07s	Three Phase	5 Cycles	San Luis Valley 115 kV	Fault on the San Luis Valley - BlancaPeak 115 kV line: clear the fault by tripping the San Luis Valley - BlancaPeak 115 kV line.
08s	Three Phase	5 Cycles	BlancaPeak 115 kV	Fault on the BlancaPeak - San Luis Valley 115 kV line: clear the fault by tripping the BlancaPeak - San Luis Valley 115 kV line.
09s	Three Phase	5 Cycles	Almosa 115 kV	Fault on the Almosa 115-69 kV Tx: clear the fault by tripping the Almosa 115-69 kV Tx.
10s	Three Phase	5 Cycles	Almosa 69 kV	Fault on the Almosa 115-69 kV Tx: clear the fault by tripping the Almosa 115-69 kV Tx.
11s	Three Phase	5 Cycles	Almosa 115 kV	Fault on the Almosa - BlancaPeak 115 kV line: clear the fault by tripping the Almosa - BlancaPeak 115 kV line.
12s	Three Phase	5 Cycles	BlancaPeak 115 kV	Fault on the BlancaPeak - Almosa 115 kV line: clear the fault by tripping the BlancaPeak - Almosa 115 kV line.
13s	Three Phase	5 Cycles	Sargent 115 kV	Fault on the Sargent 115-69 kV Tx: clear the fault by tripping the Sargent 115-69 kV Tx.
14s	Three Phase	5 Cycles	Sargent 69 kV	Fault on the Sargent 115-69 kV Tx: clear the fault by tripping the Sargent 115-69 kV Tx.
15s	Three Phase	5 Cycles	San Luis Valley 230 kV	Fault on the San Luis Valley 230-115 kV Tx #2: clear the fault by tripping the San Luis Valley 230-115 kV Tx #2.
16s	Three Phase	5 Cycles	San Luis Valley 115 kV	Fault on the San Luis Valley 230-115 kV Tx #2: clear the fault by tripping the San Luis Valley 230-115 kV Tx #2.

Appendix B

Transient Stability Study Results
Minimum Voltage and Frequency Found for each Studied Disturbance

Disturbance Scenario #	Transient Voltage			Minimum Transient Frequency		
	Bus	Minimum Voltage (pu)	Time at or Below WECC Limit (cycles)	Bus	Minimum Frequency (Hz)	Time at or Below WECC Limit (cycles)
01s	FTGARLND 69 kV	0.79	6	SOLAR_ALM 34.5	59.76	0
02s	FTGARLND 69 kV	0.81	0	SOLAR_ALM 34.5	59.82	0
03s	FTGARLND 69 kV	0.90	0	SOLAR_ALM 34.5	59.96	0
04s	FTGARLND 69 kV	0.89	0	SOLAR_ALM 34.5	59.92	0
05s	FTGARLND 69 kV	0.89	0	SOLAR_ALM 34.5	59.93	0
06s	FTGARLND 69 kV	0.88	0	SOLAR_ALM 34.5	59.86	0
07s	ALMSACT2 13.8 kV	0.83	0	SOLAR_ALM 34.5	59.69	0
08s	ALMSACT2 13.8 kV	0.83	0	SOLAR_ALM 34.5	59.70	0
09s	FTGARLND 69 kV	0.85	0	SOLAR_ALM 34.5	59.97	0
10s	FTGARLND 69 kV	0.85	0	SLVSOLAR 34.5	59.96	0
11s	ALMSACT2 13.8 kV	0.78	3	ALMSA_ST 69	59.96	0
12s	ALMSACT2 13.8 kV	0.76	3	SOLAR_ALM 34.5	59.88	0
13s	FTGARLND 69 kV	0.88	0	SOLAR_ALM 34.5	59.92	0
14s	FTGARLND 69 kV	0.89	0	SOLAR_ALM 34.5	59.94	0
15s	FTGARLND 69 kV	0.88	0	SOLAR_ALM 34.5	59.86	0
16s	FTGARLND 69 kV	0.88	0	SOLAR_ALM 34.5	59.85	0

Appendix B Detailed results:

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
Disturbance 01s – Three phase fault at San Luis Valley on the San Luis Valley - Poncha 230 kV line		
ALMSA_ST 69	0.8497	59.78
ALMSA_TM 115	0.8611	59.78
ALMSA_TM 69	0.8522	59.78
ALMSACT1 13.8	0.8518	59.78
ALMSACT2 13.8	0.8608	59.78
ANSEL_TS 69	0.8787	59.79
ANTONITO 69	0.8077	59.78
CARMEL 69	0.883	59.79
CARMEL 115	0.883	59.79

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
CENTER 69	0.859	59.78
COCENTER 69	0.8791	59.79
CREEDE 69	0.8774	59.79
DELNORTE 69	0.8578	59.79
FTGARLND 69	0.7949	59.78
GI-2010-011G	0.9224	59.82
GI-2010-011M 34.5	0.9149	59.81
HILANDSL 69	0.8808	59.79
HOMELAKE 69	0.8556	59.79
HOOPER 69	0.8571	59.78
HOOPERTP 69	0.8607	59.78
KERBERCK 69	0.9879	59.96
LAGARITA 69	0.8595	59.78
MIRGEJCT 69	0.8629	59.78
MOFFAT 69	0.8664	59.78
MOSCA 69	0.8795	59.78
OLD16TAP 69	0.8482	59.78
OLD40TAP 69	0.8506	59.78
OXCART 69	0.9881	59.96
PLAZA 115	0.8827	59.79
PLAZA 69	0.8758	59.79
PONCHA 115	0.9945	59.96
PONCHA 230	1.023	59.97
RAMON 115	0.8822	59.79
RAMON 69	0.8828	59.79
REATAP 69	0.8181	59.78
RIOGRAND 69	0.8614	59.79
RIOGRDTP 69	0.8734	59.79
ROMEO 69	0.8113	59.78
S.ACACIO 115	0.884	59.79
SAGUACHE 69	0.8569	59.78
SANLSVLY 115	0.8869	59.79
SANLSVLY 230	0.896	59.79
SANLSVLY 69	0.8783	59.79
SARGENT 115	0.8871	59.8

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
SARGENT 69	0.8794	59.79
SFORK_SL 69	0.8826	59.79
SLVSOLAR 34.5	0.8823	59.77
SOLAR_ALM 34.5	0.8877	59.76
SOLAR_ALMT 115	0.8843	59.78
SOLAR_SANLU 34.5	0.8906	59.77
STANLEY 115	0.8856	59.79
STOCKADE 115	0.8839	59.79
SWT_RACK 115	0.883	59.79
VILLA 69	0.9883	59.96
WAVERLY 115	0.8835	59.79
ZINZER 69	0.883	59.79
ZINZER 115	0.883	59.79
Disturbance 02s – Three phase fault at Poncha on the San Luis Valley - Poncha 230 kV line		
ALMSA_ST 69	0.864	59.84
ALMSA_TM 115	0.8752	59.84
ALMSA_TM 69	0.8664	59.84
ALMSACT1 13.8	0.8661	59.84
ALMSACT2 13.8	0.8749	59.84
ANSEL_TS 69	0.8926	59.85
ANTONITO 69	0.822	59.84
CARMEL 69	0.8971	59.85
CARMEL 115	0.8971	59.85
CENTER 69	0.8731	59.85
COCENTER 69	0.893	59.85
CREEDE 69	0.8916	59.85
DELNORTE 69	0.8717	59.85
FTGARLND 69	0.8092	59.84
GI-2010-011G	0.926	59.86
GI-2010-011M 34.5	0.9246	59.87
HILANDSL 69	0.895	59.85
HOMELAKE 69	0.8696	59.85
HOOPER 69	0.8712	59.85
HOOPERTP 69	0.8749	59.85
KERBERCK 69	0.9882	59.96
LAGARITA 69	0.8737	59.85
MIRGEJCT 69	0.8779	59.84

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
MOFFAT 69	0.8814	59.84
MOSCA 69	0.8943	59.84
OLD16TAP 69	0.8625	59.84
OLD40TAP 69	0.8649	59.84
OXCART 69	0.9884	59.96
PLAZA 115	0.8968	59.85
PLAZA 69	0.8898	59.85
PONCHA 115	0.9948	59.96
PONCHA 230	1.023	59.97
PONCHA 69	0.8964	59.96
RAMON 115	0.8964	59.85
RAMON 69	0.897	59.85
REATAP 69	0.8325	59.84
RIOGRAND 69	0.8753	59.85
RIOGRDTP 69	0.8872	59.85
ROMEO 69	0.8256	59.84
S.ACACIO 115	0.8982	59.85
SAGUACHE 69	0.8719	59.84
SANLSVLY 115	0.9009	59.85
SANLSVLY 230	0.91	59.85
SANLSVLY 69	0.8924	59.85
SARGENT 115	0.9012	59.85
SARGENT 69	0.8932	59.85
SFORK_SL 69	0.8968	59.85
SLVSOLAR 34.5	0.8968	59.84
SOLAR_ALM 34.5	0.9016	59.82
SOLAR_ALMT 115	0.8984	59.84
SOLAR_SANLU 34.5	0.9043	59.83
STANLEY 115	0.8997	59.85
STOCKADE 115	0.898	59.85
SWT_RACK 115	0.8971	59.85
VILLA 69	0.9886	59.96
WAVERLY 115	0.8977	59.85
ZINZER 69	0.8971	59.85
ZINZER 115	0.8971	59.85
Disturbance 03s –Three phase fault at Poncha on the Poncha - Sargent 115 kV line		
ALMSA_ST 69	0.9549	59.97
ALMSA_TM 115	0.9662	59.97

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
ALMSA_TM 69	0.9576	59.97
ALMSACT1 13.8	0.9572	59.97
ALMSACT2 13.8	0.9658	59.97
ANSEL_TS 69	0.9811	59.97
ANTONITO 69	0.9136	59.97
CARMEL 69	0.9912	59.97
CARMEL 115	0.9912	59.97
CENTER 69	0.9629	59.97
COCENTER 69	0.9813	59.97
CREEDE 69	0.986	59.97
DELNORTE 69	0.9601	59.97
FTGARLND 69	0.9002	59.97
GI-2010-011M 34.5	1.02	59.98
HILANDSL 69	0.9892	59.97
HOMELAKE 69	0.9587	59.97
HOOPER 69	0.9608	59.97
HOOPERTP 69	0.9646	59.97
KERBERCK 69	0.9969	59.97
LAGARITA 69	0.9644	59.97
MEARSJCT 69	1.003	59.97
MIRGEJCT 69	0.9645	59.97
MOFFAT 69	0.9679	59.97
MOSCA 69	0.9805	59.97
OLD16TAP 69	0.9534	59.97
OLD40TAP 69	0.9561	59.97
OXCART 69	0.9971	59.97
PLAZA 115	0.9907	59.97
PLAZA 69	0.9826	59.97
PONCHA 115	1.003	59.98
PONCHA 230	1.029	59.98
PONCHA 69	1.007	59.98
RAMON 115	0.9905	59.97
RAMON 69	0.9912	59.97
REATAP 69	0.9239	59.97
RIOGRAND 69	0.9637	59.97
RIOGRDTP 69	0.9756	59.97
ROMEO 69	0.9172	59.97
S.ACACIO 115	0.9925	59.97

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
SAGUACHE 69	0.9585	59.97
SANLSVLY 115	0.995	59.97
SANLSVLY 69	0.9821	59.97
SARGENT 115	0.9904	59.97
SARGENT 69	0.9814	59.97
SFORK_SL 69	0.9911	59.97
SLVSOLAR 34.5	0.978	59.97
SOLAR_ALM 34.5	0.9872	59.96
SOLAR_ALMT 115	0.9912	59.97
SOLAR_SANLU 34.5	0.9909	59.96
STANLEY 115	0.9937	59.97
STOCKADE 115	0.9923	59.97
SWT_RACK 115	0.9911	59.97
VILLA 69	0.9973	59.97
WAVERLY 115	0.9918	59.97
ZINZER 69	0.9911	59.97
ZINZER 115	0.9911	59.97
Disturbance 04s –Three phase fault at Sargent on the Poncha - Sargent 115 kV line		
ALMSA_ST 69	0.942	59.94
ALMSA_TM 115	0.955	59.94
ALMSA_TM 69	0.9449	59.94
ALMSACT1 13.8	0.9445	59.94
ALMSACT2 13.8	0.9546	59.94
ANSEL_TS 69	0.9698	59.94
ANTONITO 69	0.9008	59.94
CARMEL 69	0.9805	59.94
CARMEL 115	0.9805	59.94
CENTER 69	0.9501	59.94
COCENTER 69	0.97	59.94
CREEDE 69	0.9752	59.94
DELNORTE 69	0.9486	59.94
FTGARLND 69	0.8874	59.94
GI-2010-011M 34.5	1.011	59.97
HILANDSL 69	0.9785	59.94
HOMELAKE 69	0.9462	59.94
HOOPER 69	0.9478	59.94
HOOPERTP 69	0.9519	59.94
KERBERCK 69	0.9922	59.98

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
LAGARITA 69	0.9517	59.94
MEARSJCT 69	0.9987	59.98
MIRGEJCT 69	0.9541	59.93
MOFFAT 69	0.9575	59.93
MOSCA 69	0.9702	59.93
OLD16TAP 69	0.9406	59.94
OLD40TAP 69	0.9433	59.94
OXCART 69	0.9924	59.98
PLAZA 115	0.98	59.94
PLAZA 69	0.971	59.94
PONCHA 115	0.9987	59.98
PONCHA 230	1.023	59.97
RAMON 115	0.9797	59.94
RAMON 69	0.9805	59.94
REATAP 69	0.9111	59.94
RIOGRAND 69	0.9522	59.94
RIOGRDTP 69	0.9641	59.94
ROMEO 69	0.9044	59.94
S.ACACIO 115	0.9818	59.94
SAGUACHE 69	0.9481	59.93
SANLSVLY 115	0.9849	59.94
SANLSVLY 230	1.002	59.95
SANLSVLY 69	0.9709	59.94
SARGENT 115	0.9799	59.94
SARGENT 69	0.9701	59.94
SFORK_SL 69	0.9803	59.94
SLVSOLAR 34.5	0.967	59.93
SOLAR_ALM 34.5	0.9758	59.92
SOLAR_ALMT 115	0.981	59.94
SOLAR_SANLU 34.5	0.9797	59.92
STANLEY 115	0.9833	59.94
STOCKADE 115	0.9816	59.94
SWT_RACK 115	0.9804	59.94
VILLA 69	0.9926	59.98
WAVERLY 115	0.9811	59.94
ZINZER 69	0.9804	59.94
ZINZER 115	0.9804	59.94
Disturbance 05s –Three phase fault at Sargent on the San Luis Valley - Sargent 115 kV line		

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
ALMSA_ST 69	0.9442	59.9
ALMSA_TM 115	0.9589	59.9
ALMSA_TM 69	0.9471	59.9
ALMSACT1 13.8	0.9467	59.9
ALMSACT2 13.8	0.9586	59.9
ANSEL_TS 69	0.9662	59.91
ANTONITO 69	0.903	59.9
CARMEL 69	0.9858	59.9
CARMEL 115	0.9858	59.9
CENTER 69	0.9526	59.9
COCENTER 69	0.9653	59.91
CREEDE 69	0.9804	59.91
DELNORTE 69	0.9438	59.91
FTGARLND 69	0.8896	59.9
GI-2010-011M 34.5	1.016	59.96
HILANDSL 69	0.9837	59.91
HOMELAKE 69	0.9436	59.91
HOOPER 69	0.9503	59.9
HOOPERTP 69	0.9544	59.9
KERBERCK 69	0.9935	59.96
LAGARITA 69	0.955	59.9
MEARSJCT 69	0.9999	59.96
MIRGEJCT 69	0.9559	59.89
MOFFAT 69	0.9593	59.89
MOSCA 69	0.9719	59.89
OLD16TAP 69	0.9427	59.9
OLD40TAP 69	0.9455	59.9
OXCART 69	0.9937	59.96
PLAZA 115	0.9852	59.9
PLAZA 69	0.9763	59.9
PONCHA 115	1	59.96
PONCHA 230	1.025	59.96
PONCHA 69	1.003	59.9
RAMON 115	0.9849	59.91
RAMON 69	0.9857	59.9

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
REATAP 69	0.9133	59.91
RIOGRAND 69	0.9475	59.91
RIOGRDTP 69	0.9594	59.9
ROMEO 69	0.9066	59.9
S.ACACIO 115	0.9872	59.89
SAGUACHE 69	0.9499	59.9
SANLSVLY 115	0.9902	59.92
SANLSVLY 69	0.9727	59.9
SARGENT 115	0.9712	59.92
SARGENT 69	0.965	59.91
SFORK_SL 69	0.9855	59.91
SLVSOLAR 34.5	0.9688	59.89
SOLAR_ALM 34.5	0.9806	59.87
SOLAR_ALMT 115	0.986	59.9
SOLAR_SANLU 34.5	0.9846	59.87
STANLEY 115	0.9886	59.91
STOCKADE 115	0.9869	59.9
SWT_RACK 115	0.9857	59.91
VILLA 69	0.9938	59.96
WAVERLY 115	0.9864	59.9
ZINZER 69	0.9857	59.91
ZINZER 115	0.9857	59.91
Disturbance 06s –Three phase fault at San Luis Valley on the San Luis Valley - Sargent 115 kV line		
ALMSA_ST 69	0.936	59.9
ALMSA_TM 115	0.9507	59.9
ALMSA_TM 69	0.9389	59.9
ALMSACT1 13.8	0.9385	59.9
ALMSACT2 13.8	0.9503	59.9
ANSEL_TS 69	0.9592	59.91
ANTONITO 69	0.8948	59.9
CARMEL 69	0.9779	59.9
CARMEL 115	0.9779	59.9
CENTER 69	0.944	59.9
COCENTER 69	0.9583	59.91
CREEDE 69	0.9727	59.91

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
DELNORTE 69	0.9367	59.91
FTGARLND 69	0.8814	59.9
GI-2010-011M 34.5	1.001	59.96
HILANDSL 69	0.976	59.91
HOMELAKE 69	0.9359	59.91
HOOPER 69	0.9416	59.9
HOOPERTP 69	0.946	59.9
KERBERCK 69	0.992	59.96
LAGARITA 69	0.9462	59.9
MEARSJCT 69	0.9984	59.96
MIRGEJCT 69	0.9501	59.89
MOFFAT 69	0.9535	59.89
MOSCA 69	0.9662	59.89
OLD16TAP 69	0.9346	59.9
OLD40TAP 69	0.9374	59.9
OXCART 69	0.9922	59.96
PLAZA 115	0.9775	59.9
PLAZA 69	0.9682	59.9
PONCHA 115	0.9985	59.96
PONCHA 230	1.023	59.96
RAMON 115	0.9772	59.9
RAMON 69	0.978	59.91
REATAP 69	0.9051	59.9
RIOGRAND 69	0.9404	59.91
RIOGRDTP 69	0.9523	59.91
ROMEO 69	0.8984	59.9
S.ACACIO 115	0.9793	59.9
SAGUACHE 69	0.9441	59.89
SANLSVLY 115	0.983	59.9
SANLSVLY 230	1.001	59.92
SANLSVLY 69	0.9656	59.9
SARGENT 115	0.9661	59.92
SARGENT 69	0.958	59.91
SFORK_SL 69	0.9778	59.91
SLVSOLAR 34.5	0.9625	59.89

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
SOLAR_ALM 34.5	0.9707	59.87
SOLAR_ALMT 115	0.9786	59.9
SOLAR_SANLU 34.5	0.9751	59.87
STANLEY 115	0.9813	59.91
STOCKADE 115	0.9791	59.9
SWT_RACK 115	0.9779	59.91
VILLA 69	0.9923	59.96
WAVERLY 115	0.9786	59.9
ZINZER 69	0.9779	59.91
ZINZER 115	0.9779	59.91
Disturbance 07s –Three phase fault at San Luis Valley on the San Luis Valley - Sargent 115 kV line		
ALMSA_ST 69	0.8981	59.87
ALMSA_TM 115	0.8332	59.75
ALMSA_TM 69	0.8976	59.87
ALMSACT1 13.8	0.8972	59.87
ALMSACT2 13.8	0.8329	59.75
ANSEL_TS 69	0.966	59.93
ANTONITO 69	0.8533	59.87
CARMEL 69	0.9865	59.94
CARMEL 115	0.9865	59.94
CENTER 69	0.9471	59.93
COCENTER 69	0.9661	59.93
CREEDE 69	0.9807	59.94
DELNORTE 69	0.9431	59.93
FTGARLND 69	0.8434	59.87
GI-2010-011M 34.5	1.017	59.97
HILANDSL 69	0.984	59.94
HOMELAKE 69	0.9333	59.91
HOOPER 69	0.9445	59.93
HOOPERTP 69	0.9488	59.93
KERBERCK 69	0.9958	59.97
LAGARITA 69	0.9509	59.93
MEARSJCT 69	1.002	59.97
MIRGEJCT 69	0.9435	59.92
MOFFAT 69	0.9469	59.92

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
MOSCA 69	0.9597	59.92
OLD16TAP 69	0.8966	59.87
OLD40TAP 69	0.896	59.87
OXCART 69	0.996	59.97
PLAZA 115	0.9855	59.94
PLAZA 69	0.9728	59.94
PONCHA 115	1.002	59.97
PONCHA 230	1.027	59.97
PONCHA 69	1.006	59.97
RAMON 115	0.9852	59.94
RAMON 69	0.986	59.94
REATAP 69	0.8637	59.87
RIOGRAND 69	0.9468	59.93
RIOGRDTP 69	0.9587	59.93
ROMEO 69	0.8568	59.87
S.ACACIO 115	0.988	59.94
SAGUACHE 69	0.9375	59.92
SANLSVLY 115	0.9917	59.94
SANLSVLY 69	0.9672	59.93
SARGENT 115	0.9858	59.94
SARGENT 69	0.9662	59.93
SFORK_SL 69	0.9858	59.94
SLVSOLAR 34.5	0.9564	59.91
SOLAR_ALM 34.5	0.8426	59.69
SOLAR_ALMT 115	0.8435	59.72
SOLAR_SANLU 34.5	0.984	59.91
STANLEY 115	0.9899	59.94
STOCKADE 115	0.9878	59.94
SWT_RACK 115	0.9862	59.94
VILLA 69	0.9962	59.97
WAVERLY 115	0.9873	59.94
ZINZER 69	0.9862	59.94
ZINZER 115	0.9862	59.94
Disturbance 08s –Three phase fault at BlancaPk on the San Luis Valley - BlancaPk 115 kV line		
ALMSA_ST 69	0.9008	59.89

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
ALMSA_TM 115	0.8338	59.76
ALMSA_TM 69	0.9003	59.88
ALMSACT1 13.8	0.8999	59.88
ALMSACT2 13.8	0.8335	59.76
ANSEL_TS 69	0.9685	59.95
ANTONITO 69	0.856	59.88
CARMEL 69	0.9892	59.96
CARMEL 115	0.9892	59.96
CENTER 69	0.9506	59.96
COCENTER 69	0.9686	59.95
CREEDE 69	0.9833	59.96
DELNORTE 69	0.9458	59.95
FTGARLND 69	0.8461	59.89
GI-2010-011M 34.5	1.019	59.97
HILANDSL 69	0.9866	59.96
HOMELAKE 69	0.9364	59.93
HOOPER 69	0.9482	59.96
HOOPERTP 69	0.9523	59.96
KERBERCK 69	0.9962	59.98
LAGARITA 69	0.9545	59.96
MEARSJCT 69	1.003	59.98
MIRGEJCT 69	0.945	59.94
MOFFAT 69	0.9484	59.94
MOSCA 69	0.9611	59.94
OLD16TAP 69	0.8993	59.89
OLD40TAP 69	0.8987	59.88
OXCART 69	0.9963	59.98
PLAZA 115	0.9881	59.96
PLAZA 69	0.9759	59.96
PONCHA 115	1.003	59.98
PONCHA 230	1.027	59.98
PONCHA 69	1.006	59.98
RAMON 115	0.9878	59.96
RAMON 69	0.9886	59.96
REATAP 69	0.8664	59.88

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
RIOGRAND 69	0.9495	59.95
RIOGRDTP 69	0.9614	59.95
ROMEO 69	0.8596	59.88
S.ACACIO 115	0.9906	59.96
SAGUACHE 69	0.9389	59.94
SANLSVLY 115	0.994	59.96
SANLSVLY 69	0.9697	59.95
SARGENT 115	0.9879	59.96
SARGENT 69	0.9688	59.95
SFORK_SL 69	0.9884	59.96
SLVSOLAR 34.5	0.9584	59.94
SOLAR_ALM 34.5	0.8426	59.69
SOLAR_ALMT 115	0.8439	59.72
SOLAR_SANLU 34.5	0.9878	59.95
STANLEY 115	0.9922	59.96
STOCKADE 115	0.9904	59.96
SWT_RACK 115	0.9888	59.96
VILLA 69	0.9965	59.98
WAVERLY 115	0.9899	59.96
ZINZER 69	0.9888	59.96
ZINZER 115	0.9888	59.96
Disturbance 09s –Three phase fault at Almosa 115 kV side on the Almosa 115-69 kV Tx		
ALMSA_ST 69	0.9094	59.98
ALMSA_TM 115	0.9889	59.98
ALMSA_TM 69	0.9098	59.98
ALMSACT1 13.8	0.9094	59.98
ALMSACT2 13.8	0.9885	59.98
ANSEL_TS 69	0.9806	59.98
ANTONITO 69	0.8656	59.98
CARMEL 69	0.9965	59.98
CARMEL 115	0.9965	59.98
CENTER 69	0.9649	59.98
COCENTER 69	0.9805	59.98
CREEDE 69	0.9911	59.98
DELNORTE 69	0.9565	59.98

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
FTGARLND 69	0.8547	59.98
GI-2010-011M 34.5	1.025	59.99
HILANDSL 69	0.9943	59.98
HOMELAKE 69	0.9422	59.98
HOOPER 69	0.9628	59.98
HOOPERTP 69	0.9665	59.98
KERBERCK 69	0.9977	59.99
LAGARITA 69	0.9674	59.98
MEARSJCT 69	1.004	59.99
MIRGEJCT 69	0.9593	59.98
MOFFAT 69	0.9627	59.98
MOSCA 69	0.9753	59.98
OLD16TAP 69	0.9079	59.98
OLD40TAP 69	0.9082	59.98
OXCART 69	0.9979	59.99
PLAZA 115	0.9958	59.98
PLAZA 69	0.9872	59.98
PONCHA 115	1.004	59.99
PONCHA 230	1.029	59.99
PONCHA 69	1.008	59.99
RAMON 115	0.9955	59.98
RAMON 69	0.9963	59.98
REATAP 69	0.8759	59.98
RIOGRAND 69	0.9602	59.98
RIOGRDTP 69	0.9721	59.98
ROMEO 69	0.8691	59.98
S.ACACIO 115	0.9979	59.98
SAGUACHE 69	0.9533	59.98
SANLSVLY 115	1	59.98
SANLSVLY 69	0.9828	59.98
SARGENT 115	0.9946	59.98
SARGENT 69	0.9805	59.98
SFORK_SL 69	0.9962	59.98
SLVSOLAR 34.5	0.9737	59.97
SOLAR_ALM 34.5	0.9951	59.97

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
SOLAR_ALMT 115	0.999	59.98
SOLAR_SANLU 34.5	0.9969	59.97
STANLEY 115	0.9989	59.98
STOCKADE 115	0.9976	59.98
SWT_RACK 115	0.9964	59.98
VILLA 69	0.9981	59.99
WAVERLY 115	0.9971	59.98
ZINZER 69	0.9964	59.98
ZINZER 115	0.9964	59.98
Disturbance 10s – Three phase fault at Almosa 69 kV side on the Almosa 115-69 kV Tx		
ALMSA_ST 69	0.9096	59.97
ALMSA_TM 115	0.993	59.98
ALMSA_TM 69	0.9101	59.97
ALMSACT1 13.8	0.9097	59.97
ALMSACT2 13.8	0.9926	59.98
ANSEL_TS 69	0.9827	59.98
ANTONITO 69	0.8659	59.97
CARMEL 69	0.9991	59.98
CARMEL 115	0.9991	59.98
CENTER 69	0.9672	59.98
COCENTER 69	0.9826	59.98
CREEDE 69	0.9936	59.98
DELNORTE 69	0.9586	59.98
FTGARLND 69	0.8549	59.97
GI-2010-011M 34.5	1.028	59.98
HILANDSL 69	0.9969	59.98
HOMELAKE 69	0.9437	59.98
HOOPER 69	0.9651	59.98
HOOPERTP 69	0.9687	59.98
KERBERCK 69	0.998	59.99
LAGARITA 69	0.9698	59.98
MEARSJCT 69	1.004	59.99
MIRGEJCT 69	0.9584	59.97
MOFFAT 69	0.9618	59.97
MOSCA 69	0.9745	59.97

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
OLD16TAP 69	0.9081	59.97
OLD40TAP 69	0.9085	59.97
OXCART 69	0.9981	59.99
PLAZA 115	0.9984	59.98
PLAZA 69	0.99	59.98
PONCHA 115	1.004	59.99
PONCHA 230	1.029	59.99
PONCHA 69	1.008	59.99
RAMON 115	0.9981	59.98
RAMON 69	0.9989	59.98
REATAP 69	0.8762	59.97
RIOGRAND 69	0.9622	59.98
RIOGRDTP 69	0.9741	59.98
ROMEO 69	0.8694	59.97
S.ACACIO 115	1	59.98
SAGUACHE 69	0.9524	59.97
SANLSVLY 115	1.003	59.98
SANLSVLY 69	0.9846	59.98
SARGENT 115	0.9967	59.98
SARGENT 69	0.9826	59.98
SFORK_SL 69	0.9987	59.98
SLVSOLAR 34.5	0.9726	59.96
SOLAR_ALM 34.5	0.9996	59.97
SOLAR_ALMT 115	1.002	59.98
SOLAR_SANLU 34.5	1.001	59.98
STANLEY 115	1.001	59.98
STOCKADE 115	1	59.98
SWT_RACK 115	0.999	59.98
VILLA 69	0.9983	59.99
WAVERLY 115	0.9997	59.98
ZINZER 69	0.999	59.98
ZINZER 115	0.999	59.98
Disturbance 11s – Three phase fault at Almosa 69 kV side on the Almosa 115-69 kV Tx		
ALMSA_ST 69	0.8438	59.96
ALMSA_TM 115	0.7785	59.98

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
ALMSA_TM 69	0.8416	59.96
ALMSACT1 13.8	0.8413	59.96
ALMSACT2 13.8	0.7782	59.98
ANSEL_TS 69	0.9678	59.98
ANTONITO 69	0.7971	59.97
CARMEL 69	0.9903	59.98
CARMEL 115	0.9903	59.98
CENTER 69	0.9547	59.98
COCENTER 69	0.9673	59.98
CREEDE 69	0.9846	59.98
DELNORTE 69	0.94	59.98
FTGARLND 69	0.789	59.97
GI-2010-011M 34.5	1.021	59.98
HILANDSL 69	0.9879	59.98
HOMELAKE 69	0.9103	59.97
HOOPER 69	0.9525	59.98
HOOPERTP 69	0.9562	59.98
KERBERCK 69	0.9952	59.99
LAGARITA 69	0.9581	59.98
MEARSJCT 69	1.002	59.99
MIRGEJCT 69	0.9418	59.97
MOFFAT 69	0.9452	59.97
MOSCA 69	0.9579	59.97
OLD16TAP 69	0.8423	59.96
OLD40TAP 69	0.8401	59.96
OXCART 69	0.9954	59.99
PLAZA 115	0.9894	59.98
PLAZA 69	0.9804	59.98
PONCHA 115	1.002	59.99
PONCHA 230	1.026	59.99
PONCHA 69	1.005	59.99
RAMON 115	0.9891	59.98
RAMON 69	0.9899	59.98
REATAP 69	0.8076	59.97
RIOGRAND 69	0.9437	59.98

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
RIOGRDTP 69	0.9556	59.98
ROMEO 69	0.8007	59.97
S.ACACIO 115	0.9917	59.98
SAGUACHE 69	0.9358	59.97
SANLSVLY 115	0.9942	59.98
SANLSVLY 69	0.9718	59.98
SARGENT 115	0.9864	59.98
SARGENT 69	0.9672	59.98
SFORK_SL 69	0.9897	59.98
SLVSOLAR 34.5	0.9572	59.97
SOLAR_ALM 34.5	0.991	59.96
SOLAR_ALMT 115	0.9945	59.97
SOLAR_SANLU 34.5	0.9913	59.97
STANLEY 115	0.9927	59.98
STOCKADE 115	0.9914	59.98
SWT_RACK 115	0.99	59.98
VILLA 69	0.9956	59.99
WAVERLY 115	0.9909	59.98
ZINZER 69	0.99	59.98
ZINZER 115	0.99	59.98
Disturbance 12s – Three phase fault at Almosa 69 kV side on the Almosa 115-69 kV Tx		
ALMSA_ST 69	0.8248	59.91
ALMSA_TM 115	0.7583	59.93
ALMSA_TM 69	0.8226	59.91
ALMSACT1 13.8	0.8223	59.91
ALMSACT2 13.8	0.758	59.93
ANSEL_TS 69	0.9526	59.92
ANTONITO 69	0.778	59.92
CARMEL 69	0.9759	59.92
CARMEL 115	0.9759	59.92
CENTER 69	0.937	59.92
COCENTER 69	0.9521	59.92
CREEDE 69	0.9702	59.92
DELNORTE 69	0.9245	59.92
FTGARLND 69	0.7699	59.91

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
GI-2010-011M 34.5	1.009	59.95
HILANDSL 69	0.9735	59.92
HOMELAKE 69	0.8929	59.92
HOOPER 69	0.9345	59.92
HOOPERTP 69	0.9387	59.92
KERBERCK 69	0.9911	59.97
LAGARITA 69	0.9407	59.92
MEARSJCT 69	0.9975	59.96
MIRGEJCT 69	0.9267	59.91
MOFFAT 69	0.9301	59.91
MOSCA 69	0.9429	59.91
OLD16TAP 69	0.8233	59.91
OLD40TAP 69	0.8211	59.91
OXCART 69	0.9913	59.97
PLAZA 115	0.975	59.92
PLAZA 69	0.9646	59.92
PONCHA 115	0.9976	59.96
PONCHA 230	1.022	59.96
RAMON 115	0.9747	59.92
RAMON 69	0.9754	59.92
REATAP 69	0.7885	59.91
RIOGRAND 69	0.9281	59.92
RIOGRDTP 69	0.94	59.92
ROMEO 69	0.7816	59.92
S.ACACIO 115	0.9773	59.92
SAGUACHE 69	0.9206	59.91
SANLSVLY 115	0.9807	59.92
SANLSVLY 230	0.9993	59.93
SANLSVLY 69	0.9564	59.92
SARGENT 115	0.9732	59.92
SARGENT 69	0.952	59.92
SFORK_SL 69	0.9753	59.92
SLVSOLAR 34.5	0.941	59.91
SOLAR_ALM 34.5	0.973	59.88
SOLAR_ALMT 115	0.9808	59.91

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
SOLAR_SANLU 34.5	0.9749	59.9
STANLEY 115	0.979	59.92
STOCKADE 115	0.977	59.92
SWT_RACK 115	0.9756	59.92
VILLA 69	0.9915	59.97
WAVERLY 115	0.9766	59.92
ZINZER 69	0.9756	59.92
ZINZER 115	0.9756	59.92
Disturbance 13s – Three phase fault at Sargent 115 kV side on the Sargent 115-69 kV Tx		
ALMSA_ST 69	0.9365	59.94
ALMSA_TM 115	0.9552	59.94
ALMSA_TM 69	0.9393	59.94
ALMSACT1 13.8	0.9389	59.94
ALMSACT2 13.8	0.9548	59.94
ANSEL_TS 69	0.9518	59.94
ANTONITO 69	0.8953	59.95
CARMEL 69	0.9837	59.95
CARMEL 115	0.9837	59.95
CENTER 69	0.9459	59.95
COCENTER 69	0.9496	59.95
CREEDE 69	0.9781	59.95
DELNORTE 69	0.9279	59.95
FTGARLND 69	0.8818	59.94
GI-2010-011M 34.5	1.014	59.97
HILANDSL 69	0.9814	59.95
HOMELAKE 69	0.9299	59.94
HOOPER 69	0.9435	59.95
HOOPERTP 69	0.9476	59.95
KERBERCK 69	0.9944	59.98
LAGARITA 69	0.9494	59.95
MEARSJCT 69	1.001	59.98
MIRGEJCT 69	0.9489	59.94
MOFFAT 69	0.9523	59.94
MOSCA 69	0.965	59.94
OLD16TAP 69	0.935	59.94

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
OLD40TAP 69	0.9378	59.94
OXCART 69	0.9946	59.98
PLAZA 115	0.9829	59.95
PLAZA 69	0.9735	59.95
PONCHA 115	1.001	59.98
PONCHA 230	1.025	59.97
PONCHA 69	1.004	59.98
RAMON 115	0.9827	59.95
RAMON 69	0.9834	59.95
REATAP 69	0.9056	59.94
RIOGRAND 69	0.9315	59.95
RIOGRDTP 69	0.9434	59.95
ROMEO 69	0.8988	59.94
S.ACACIO 115	0.9852	59.95
SAGUACHE 69	0.9429	59.94
SANLSVLY 115	0.9883	59.95
SANLSVLY 69	0.9653	59.94
SARGENT 115	0.9904	59.95
SARGENT 69	0.9485	59.95
SFORK_SL 69	0.9832	59.95
SLVSOLAR 34.5	0.9622	59.93
SOLAR_ALM 34.5	0.9787	59.92
SOLAR_ALMT 115	0.9839	59.94
SOLAR_SANLU 34.5	0.983	59.93
STANLEY 115	0.9867	59.95
STOCKADE 115	0.9849	59.95
SWT_RACK 115	0.9835	59.95
VILLA 69	0.9948	59.98
WAVERLY 115	0.9844	59.95
ZINZER 69	0.9835	59.95
ZINZER 115	0.9835	59.95
Disturbance 14s – Three phase fault at Sargent 69 kV side on the Sargent 115-69 kV Tx		
ALMSA_ST 69	0.9442	59.96
ALMSA_TM 115	0.9625	59.96
ALMSA_TM 69	0.947	59.96

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
ALMSACT1 13.8	0.9466	59.96
ALMSACT2 13.8	0.9621	59.96
ANSEL_TS 69	0.9589	59.96
ANTONITO 69	0.903	59.96
CARMEL 69	0.9907	59.96
CARMEL 115	0.9907	59.96
CENTER 69	0.9538	59.96
COCENTER 69	0.9566	59.96
CREEDE 69	0.985	59.96
DELNORTE 69	0.935	59.96
FTGARLND 69	0.8895	59.96
GI-2010-011M 34.5	1.021	59.97
HILANDSL 69	0.9883	59.96
HOMELAKE 69	0.9372	59.96
HOOPER 69	0.9514	59.96
HOOPERTP 69	0.9554	59.96
KERBERCK 69	0.9967	59.98
LAGARITA 69	0.9572	59.96
MEARSJCT 69	1.003	59.98
MIRGEJCT 69	0.9549	59.96
MOFFAT 69	0.9583	59.96
MOSCA 69	0.971	59.96
OLD16TAP 69	0.9427	59.96
OLD40TAP 69	0.9455	59.96
OXCART 69	0.9969	59.98
PLAZA 115	0.9898	59.96
PLAZA 69	0.9809	59.96
PONCHA 115	1.003	59.98
PONCHA 230	1.028	59.98
PONCHA 69	1.007	59.98
RAMON 115	0.9895	59.96
RAMON 69	0.9903	59.96
REATAP 69	0.9133	59.96
RIOGRAND 69	0.9386	59.96
RIOGRDTP 69	0.9505	59.96

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
ROMEO 69	0.9066	59.96
S.ACACIO 115	0.9921	59.96
SAGUACHE 69	0.9489	59.96
SANLSVLY 115	0.9948	59.96
SANLSVLY 69	0.9723	59.96
SARGENT 115	0.9967	59.96
SARGENT 69	0.9556	59.96
SFORK_SL 69	0.9901	59.96
SLVSOLAR 34.5	0.9681	59.95
SOLAR_ALM 34.5	0.9868	59.94
SOLAR_ALMT 115	0.9907	59.96
SOLAR_SANLU 34.5	0.9909	59.95
STANLEY 115	0.9933	59.96
STOCKADE 115	0.9918	59.96
SWT_RACK 115	0.9905	59.96
VILLA 69	0.9971	59.98
WAVERLY 115	0.9913	59.96
ZINZER 69	0.9905	59.96
ZINZER 115	0.9905	59.96
Disturbance 15s –Three phase fault at San Luis Valley 230 kV side on the San Luis Valley 230-115 kV Tx #2		
ALMSA_ST 69	0.9366	59.89
ALMSA_TM 115	0.9493	59.89
ALMSA_TM 69	0.9393	59.89
ALMSACT1 13.8	0.9389	59.89
ALMSACT2 13.8	0.9489	59.89
ANSEL_TS 69	0.9655	59.89
ANTONITO 69	0.8953	59.89
CARMEL 69	0.9747	59.9
CARMEL 115	0.9747	59.9
CENTER 69	0.9444	59.89
COCENTER 69	0.9658	59.89
CREEDE 69	0.9695	59.9
DELNORTE 69	0.9443	59.89
FTGARLND 69	0.8819	59.89
GI-2010-011M 34.5	1.008	59.94

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
HILANDSL 69	0.9728	59.9
HOMELAKE 69	0.9415	59.89
HOOPER 69	0.9421	59.89
HOOPERTP 69	0.9463	59.89
KERBERCK 69	0.995	59.96
LAGARITA 69	0.9459	59.89
MEARSJCT 69	1.001	59.96
MIRGEJCT 69	0.9505	59.88
MOFFAT 69	0.9539	59.88
MOSCA 69	0.9666	59.88
OLD16TAP 69	0.9351	59.89
OLD40TAP 69	0.9378	59.89
OXCART 69	0.9952	59.96
PLAZA 115	0.9744	59.9
PLAZA 69	0.965	59.89
PONCHA 115	1.001	59.96
PONCHA 230	1.026	59.96
PONCHA 69	1.005	59.96
RAMON 115	0.9741	59.9
RAMON 69	0.9748	59.9
REATAP 69	0.9056	59.89
RIOGRAND 69	0.948	59.89
RIOGRDTP 69	0.9599	59.89
ROMEO 69	0.8988	59.89
S.ACACIO 115	0.9761	59.9
SAGUACHE 69	0.9445	59.88
SANLSVLY 115	0.9795	59.9
SANLSVLY 69	0.9659	59.89
SARGENT 115	0.9768	59.9
SARGENT 69	0.966	59.9
SFORK_SL 69	0.9747	59.9
SLVSOLAR 34.5	0.9632	59.87
SOLAR_ALM 34.5	0.9689	59.86
SOLAR_ALMT 115	0.9756	59.89
SOLAR_SANLU 34.5	0.9728	59.87

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
STANLEY 115	0.9779	59.9
STOCKADE 115	0.9759	59.9
SWT_RACK 115	0.9747	59.9
VILLA 69	0.9954	59.96
WAVERLY 115	0.9754	59.9
ZINZER 69	0.9747	59.9
ZINZER 115	0.9747	59.9
Disturbance 16s – Three phase fault at San Luis Valley 115 kV side on the San Luis Valley 230-115 kV Tx #2		
ALMSA_ST 69	0.9303	59.88
ALMSA_TM 115	0.9436	59.88
ALMSA_TM 69	0.9332	59.88
ALMSACT1 13.8	0.9328	59.88
ALMSACT2 13.8	0.9432	59.88
ANSEL_TS 69	0.96	59.88
ANTONITO 69	0.889	59.88
CARMEL 69	0.9693	59.89
CARMEL 115	0.9693	59.89
CENTER 69	0.9381	59.88
COCENTER 69	0.9603	59.88
CREEDE 69	0.9642	59.89
DELNORTE 69	0.9388	59.88
FTGARLND 69	0.8757	59.88
GI-2010-011M 34.5	1.013	59.93
HILANDSL 69	0.9675	59.89
HOMELAKE 69	0.9356	59.88
HOOPER 69	0.9357	59.88
HOOPERTP 69	0.9401	59.88
KERBERCK 69	0.993	59.95
LAGARITA 69	0.9396	59.88
MEARSJCT 69	0.9994	59.95
MIRGEJCT 69	0.9451	59.87
MOFFAT 69	0.9486	59.87
MOSCA 69	0.9613	59.87
OLD16TAP 69	0.9289	59.88
OLD40TAP 69	0.9316	59.88

Bus	Transient Voltage Dip Minimum Voltage Dip (pu)	Minimum Transient Frequency Minimum Frequency (Hz)
OXCART 69	0.9932	59.95
PLAZA 115	0.969	59.89
PLAZA 69	0.9592	59.88
PONCHA 115	0.9995	59.95
PONCHA 230	1.024	59.95
PONCHA 69	1.003	59.95
RAMON 115	0.9687	59.89
RAMON 69	0.9694	59.89
REATAP 69	0.8994	59.88
RIOGRAND 69	0.9425	59.88
RIOGRDTP 69	0.9544	59.88
ROMEO 69	0.8926	59.88
S.ACACIO 115	0.9707	59.89
SAGUACHE 69	0.9391	59.87
SANLSVLY 115	0.9744	59.88
SANLSVLY 69	0.9604	59.88
SARGENT 115	0.9719	59.89
SARGENT 69	0.9606	59.88
SFORK_SL 69	0.9693	59.89
SLVSOLAR 34.5	0.9577	59.86
SOLAR_ALM 34.5	0.9629	59.85
SOLAR_ALMT 115	0.9704	59.88
SOLAR_SANLU 34.5	0.967	59.86
STANLEY 115	0.9727	59.89
STOCKADE 115	0.9705	59.89
SWT_RACK 115	0.9693	59.89
VILLA 69	0.9934	59.95
WAVERLY 115	0.97	59.89
ZINZER 69	0.9693	59.89
ZINZER 115	0.9693	59.89

Appendix C

Transient Stability Study Plots – Provided separately