GEN-2013-022
Impact Restudy for Generator Modification (Inverter Change)

June 2017
Generator Interconnection

Southwest Power Pool

Revision History

Date	Author	Change Description
6/12/2017	SPP	GEN-2013-022 Impact Restudy for Generator Modification Report Issued

Executive Summary

The GEN-2013-022 Interconnection Customer has requested a modification to its Generator Interconnection Request to change Photovoltaic (PV) solar inverters. The previously studied project configuration consisted of twenty-five (25) Advanced Energy 1000NX 1.0 MW PV solar inverters for a total nameplate capacity of 25.0 MW which is equal to the GEN-2013-022/IFS-2013-002-02 interconnection queue position capacity. The interconnection customer proposed revised project configuration consists of thirteen (13) SMA Sunny Central 2200-US 2.2 MW PV solar inverters for a total nameplate capacity of 28.6 MW. In order for the proposed change in inverters to remain within the assigned queue position, the interconnection customer may only request to interconnect no more than eleven (11) SMA Sunny Central 2200-US 2.2 MW PV solar inverters for a total nameplate capacity of 24.2 MW. Per GIP 4.4.2 the nameplate capacity above 25.0 MW is considered a material modification and will require the customer to submit a new Generator Interconnection Request for the incremental 3.6 MW nameplate capacity to achieve the proposed 28.6 MW project configuration. The point of interconnection (POI) remains as the Southwestern Public Service, Inc. (SPS) Norton 115 kV substation.

The study models used were the 2016 winter, 2017 summer, and 2025 summer models that included Interconnection Requests and assigned network upgrades through DISIS-2015-002-1.

Stability analysis has determined with all assigned Network Upgrades in service, generators in the monitored areas remained stable and within the pre-contingency, voltage recovery, and post fault voltage recovery criterion of 0.7pu to 1.2pu for the entire modeled disturbances. With the SMA Sunny Central inverter "Dynamic Grid Support" option installed, the project was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

Power factor analysis for each generation project was performed on the current study 2016 winter peak, 2017 summer peak, and 2025 summer peak cases with identified system upgrades. As reactive power is required for GEN-2013-022, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the point of interconnection.

An analysis was conducted to determine the capacitive effects on the transmission system caused by the generator lead and collector system during periods of reduced generation. The generating facility is required to provide reactive compensation of approximately 0.3 MVAR of inductive reactance during periods of reduced generation. Such compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

Short Circuit analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS-2015-002-1 in place, GEN-2013-022 with no more than eleven (11) SMA Sunny Central 2200-US 2.2 MW PV solar inverters with the "Dynamic Grid Support" option installed should be able to interconnect reliably to the SPP transmission grid. This proposed change with no more than eleven (11) SMA Sunny Central 2200-US 2.2 MW PV solar inverters is not a Material Modification. The customer may submit a new Generator Interconnection

Request for the incremental 3.6 MW nameplate capacity to achieve the proposed 28.6 MW project configuration.

It should be noted that this study analyzed the requested modification to change inverter technology, manufacturer, and layout. Powerflow analysis was not performed. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

Table of Contents

1. Introduction

The GEN-2013-022 Interconnection Customer has requested a modification to its Generator Interconnection Request to change PV solar inverters from Advanced Energy 1000NX 1.0 MW PV solar inverters to SMA Sunny Central 2200-US 2.2 MW PV solar inverters with the total nameplate capacity remaining at or under 25.0 MW.

The requested change is shown in **Table 1-1**.

Table 1-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2013-022	24.2	SMA Sunny Central 2200-US 2.2 MW PV solar inverters	Norton 115 kV (524502)

The POI is the SPS Norton 115kV substation. Other queued generation projects in the model are listed in **Table 1-2**.

Table 1-2: Other Queued Interconnection Requests in the Model

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2001-033	180	Mitsubishi MWT-1000a 1.0 MW Wind Turbine Generators (WTGs) (524890, 524896)	San Juan Mesa 230kV (524885)
GEN-2001-036	80	Mitsubishi MWT-1000A 1.0 MW WTGs (583316)	Norton 115kV (524502)
GEN-2004-015	150	GENROU (527164)	Mustang 230kV (527149)
GEN-2006-015	150	GENROU (527165)	Mustang 230kV (527149)
GEN-2006-018	170	GENSAL (525841, 525842, 525843)	TUCO 230kV (525830)
GEN-2006-026	510 Summer 604 Winter	GENROU (527901, 527902, 527903)	Hobbs 115kV (527891) Hobbs 230kV (527894)
GEN-2008-022	300	Vestas V100 & V110 VCSS 2.0 MW WTGs (577100, 577110, 577120)	Crossroads 345kV (527656)
GEN-2010-006	180 Summer 205 Winter	GENROU (526333)	Jones 230kV (526337)
ASGI-2010-010	42.2	GENSAL (528331)	Lovington 115kV (528334)
ASGI-2010-020	30	GE 116m 2.3 MW WTGs (580088)	Tap LE-Tatum to LE-Crsroads 69kV (560360)
ASGI-2010-021	15	Mitsubishi MPS-1000A 1.0 MW WTGs (580083)	Tap LE-Saundrtp to LE-Anderson 69kV (560364)
GEN-2010-046	56	GENSAL (580043)	TUCO 230kV (525830)
ASGI-2011-001	27.3	Suzlon S97 2.1 MW WTGs (579423)	Lovington 115kV (528334)
ASGI-2011-003	10	Sany 2.0 MW WTGs (579433)	Hendricks 69kV (525943)
ASGI-2011-004	19.8	Sany 1.8 MW WTGs (583193, 583196)	Crosby 69kV (525915)
GEN-2011-025	78.76	GE 1.7-100 1.79 MW WTGs (581140)	Tap Floyd County to Crosby County 115kV line (562004)
GEN-2011-045	180 Summer 205 Winter	GENROU (526334)	Jones 230kV (526337)
GEN-2011-046	23 Summer 27 Winter	GENROU (524471)	Lopez 115kV (524472)
GEN-2011-048	165 Summer 175 Winter	GENROU (527166)	Mustang 230kV (527149)
GEN-2012-001	61.2	CCWE 3.6 MW WTGs (599126)	Cirrus Wind 230kV (526679)
ASGI-2012-002	18.15	Vestas V82 1.65 MW WTGs (583283)	FE-Clovis 115kV (524808)

Table 1-2: Other Queued Interconnection Requests in the Model

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2012-020	477.12	GE 1.68 MW WTGs (583343, 583346)	TUCO 230kV (525830)
GEN-2012-034	7 MW increase (157 MW total)	GENROU (527164)	Mustang 230kV (527149)
GEN-2012-035	7 MW increase (157 MW total)	GENROU (527165)	Mustang 230kV (527149)
GEN-2012-036	7 MW increase (172 MW Summer 182 MW Winter)	GENROU (527166)	Mustang 230kV (527149)
GEN-2012-037	196 Summer 203 Winter	GENROU (525844)	TUCO 345kV (525832)
GEN-2013-016	193 Summer 203 Winter	GENROU (525845)	TUCO 345kV (525832)
ASGI-2013-002	18.4	Siemens 2.3 MW VS WTGs (583613)	FE-Tucumcari 115kV (524509)
ASGI-2013-003	18.4	Siemens 2.3 MW VS WTGs (583623)	FE-Clovis 115kV (524808)
ASGI-2013-005	1.65 MW increase (19.8 MW total)	Vestas V82 1.65 MW WTGs (583283)	FE-Clovis 115kV (524808)
ASGI-2013-006	2	Gamesa G114 2.0 MW WTGs (583813)	SP-Erskine 115kV (526109)
GEN-2013-027	150.0	Siemens 2.3 & 2.415 MW WTGs (583843, 583846)	Tap Tolk to Yoakum 230kV (562480)
ASGI-2014-001	2.5	GE 107m 2.5 MW WTGs (583816)	SP-Erskine 69kV (526109)
GEN-2014-012	186 Summer 225 Winter	GENROU (528501)	Sidewinder 230kV (528611)
GEN-2014-033	70	GE Prolec 4 MVA, GE Prolec 1 MVA, & Schneider XC680 0.680 MVA PV solar inverters (583953, 583956)	Chaves County 115kV (527482)
GEN-2014-034	70	GE Prolec 4 MVA PV solar inverter (583963)	Chaves County 115kV (527482)
GEN-2014-035	30	GE Prolec 4 MVA PV solar inverters (583973)	Chaves County 115kV (527482)
GEN-2014-047	40	AE 500NX 0.5 MW PV solar inverters (584263)	Crossroads 345kV (527656)
GEN-2014-074	152.0	Vestas V100 2.0 MW WTGs (584443)	Tap OKU to TUCO 345kV (560027)
ASGI-2015-002	2.0	GE 2.0 MW WTGs (584723)	Yuma Interchange 115/69kV (526469)
GEN-2015-014	150.0	Vestas V110 2.0MW WTGs (584563)	Tap Cochran to LG Plains 115kV (560030)
GEN-2015-020	100.0	Eaton Power Xpert 1.67 MW PV solar inverters (584623)	Oasis 115kV (524874)
GEN-2015-022	112.0	GE LV5 4.0 MW PV solar inverters (584643)	Swisher 115kV (525212)
GEN-2015-031	150.53	GE 2.3 MW & GE 1.79 MW WTGs (584757, 584758)	Tap Swisher to Amarillo South 230 kV (560050)
GEN-2015-056	101	GE 2.3 MW WTGs (584943)	Crossroads 345kV (527656)
GEN-2015-058	50	Toshiba Mitsubishi Electric Industrial Systems Corporation (TMEIC) Solar Ware Samurai PVL-L1833GRQ 1.667 MW PV solar inverters (584963)	Atoka 115kV (527786)
GEN-2015-068	300	GE 2.0 MW WTGs (585063)	TUCO 345kV (525832)
GEN-2015-075	51.48	GE LV5 3.96 MW PV solar inverters (585123)	Carlisle 69kV (526159)
GEN-2015-079	129.2	GE LV5 3.8 MW PV solar inverters (585163)	Tap Hobbs to Yoakum 230 kV (560059)
GEN-2015-080	129.2	GE LV5 3.8 MW PV solar inverters (585172)	Tap Hobbs to Yoakum 230 kV (560059)

A stability analysis was performed for the change in PV solar inverters. The analysis was performed on three (3) seasonal models including 2016 winter peak (16WP), the 2017 summer peak (17SP), and the 2025 summer peak (25SP) cases. These cases are modified versions of the 2015 model series of Model Development Working Group (MDWG) dynamic study models that included upgrades and Interconnection Requests through DISIS-2015-002-1.

Stability Analysis determines the impacts of the new interconnecting project on the stability and voltage recovery of the nearby systems and the ability of the interconnecting project to meet FERC Order 661A. If problems with stability or voltage recovery are identified, the need for reactive compensation or system upgrades is investigated. The contingencies listed in **Table 3-1** were used in the stability analysis.

Power Factor Analysis determines the power factor at the point of interconnection (POI) for the interconnection projects for pre-contingency and post-contingency conditions. The contingencies used in the power factor analysis are a subset of the stability analysis contingencies shown in **Table 3-1**.

Reduced Generation Analysis was performed to determine reactor inductive amounts to compensate for the capacitive effects on the transmission system caused by the interconnecting project's generator lead transmission line and collector systems during low or reduced generation conditions. The results of the analysis are illustrated in **Figure 5-2**.

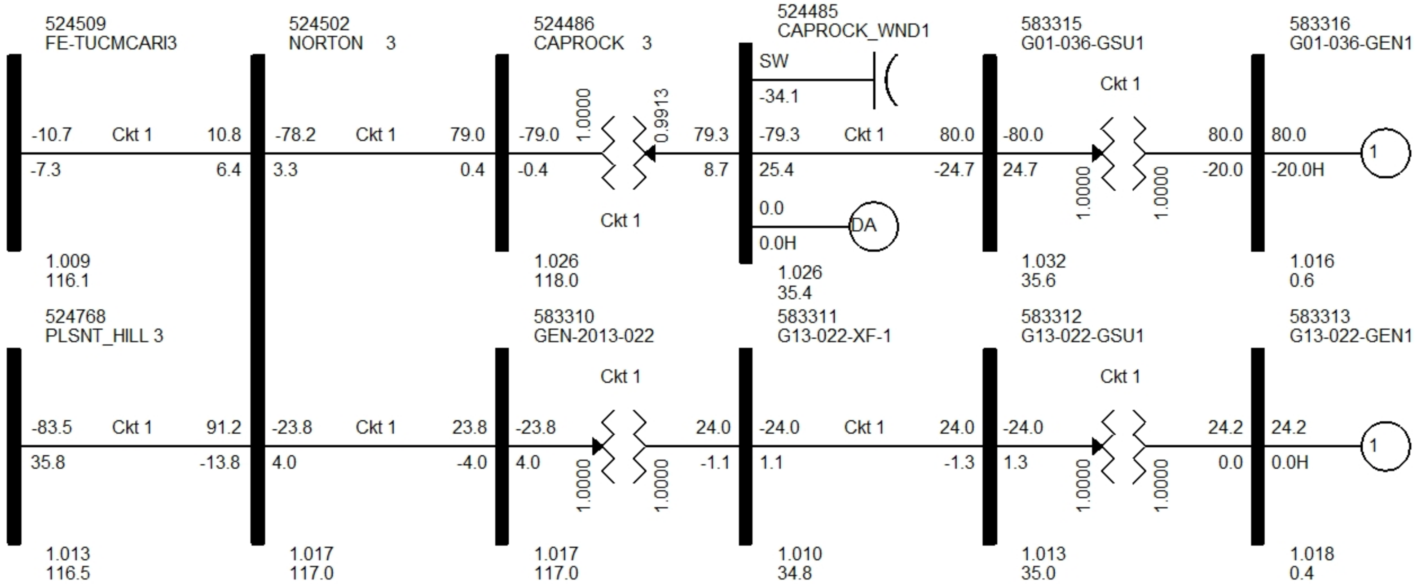
Short Circuit Analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases. The results from the Short circuit analysis are shown in **Appendix E**.

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

2. Facilities

A one-line PSS/E slider drawing from the 16WP case is shown in **Figure 2-1** for GEN-2013-022. GEN-2001-036 has been included in the one-line because each project interconnects to the same POI substation.

Figure 2-1: GEN-2013-022 One-line Diagram



3. Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request.

Model Preparation

Transient stability analysis was performed using modified versions of the 2015 series of Model Development Working Group (MDWG) dynamic study models including the 2016 winter peak, 2017 summer peak, and the 2025 summer peak seasonal models. The cases are then loaded with prior queued interconnection requests and network upgrades assigned to those interconnection requests through DISIS-2015-002-1. Finally the prior queued and study generation are dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

Disturbances

Thirty (30) contingencies were identified for use in this study and are listed in **Table 3-1**. These contingencies are faults at locations defined by SPP Generation Interconnection Staff. These contingencies include three-phase and single-phase N-1. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

Except for transformer faults, the typical sequence of events for a three-phase and single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for five (5) cycles, clear the fault by tripping the faulted facility
3. after an additional twenty (20) cycles, re-close the previous facility back into the fault
4. continue fault for five (5) additional cycles
5. trip the faulted facility and remove the fault

Transformer faults are typically modeled as three-phase faults, unless otherwise noted. The sequence of events for a transformer fault is as follows:

1. apply fault for five (5) cycles
2. clear the fault by tripping the affected transformer facility (unless otherwise noted there will be no re-closing into a transformer fault)

The SPP areas monitored during the stability analysis were:

- 520: American Electric Power (AEPW)
- 524: Oklahoma Gas and Electric Company (OKGE)
- 525: Western Farmers Electric Cooperative (WFEC)
- 526: Southwestern Public Service (SPS)
- 531: Midwest Energy, Inc. (MIDW)

- 534: Sunflower Electric Power Corp. (SUNC)
- 536: Westar Energy, Inc. (WERE)

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
0	FLT_000_NOFAULT	No Fault Conditions
1	FLT_001_NORTON3_FETUCMCARI3_115kV	Fault on the Norton (524502) to FE-Tucumcari (524509) 115kV line, near Norton. a. Apply fault at the Norton 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT_002_NORTON3_CAPROCK3_115kV_G1146ON	**GEN-2011-046 online at 100% output:** Fault on the Caprock Wind (524486) to Norton (524502) 115kV line, near Norton. a. Apply fault at the Norton 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
3	FLT_003_NORTON3_CAPROCK3_115kV_G1146OFF	**GEN-2011-046 offline:** Fault on the Caprock Wind (524486) to Norton (524502) 115kV line, near Norton. a. Apply fault at the Norton 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT_004_FETUCMCARI3_CEILOTAPN_115_69kV_G1146ON	**GEN-2011-046 online at 100% output:** Fault on the FE-Ceilo Tap N (583610) to FE-Tucumcari (524509) 115kV line, near FE-Tucumcari. a. Apply fault at the FE-Tucumcari 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
5	FLT_005_FETUCMCARI3_CEILOTAPN_115_69kV_G1146OFF	**GEN-2011-046 offline:** Fault on the FE-Ceilo Tap N (583610) to FE-Tucumcari (524509) 115kV line, near FE-Tucumcari. a. Apply fault at the FE-Tucumcari 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT_006_PLSNTHILL3_ECLOVIS3_115kV_G1146ON	**GEN-2011-046 online at 100% output:** Fault on the Pleasant Hill (524768) to E Clovis (524773) 115kV line, near Pleasant Hill. a. Apply fault at the Pleasant Hill 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
7	FLT_007_PLSNTHILL3_ECLOVIS3_115kV_G1146OFF	**GEN-2011-046 offline:** Fault on the Pleasant Hill (524768) to E Clovis (524773) 115kV line, near Pleasant Hill. a. Apply fault at the Pleasant Hill 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
8	FLT_008_PLSNTHILL3_NCLOVISTP3_115kV	Fault on the Pleasant Hill (524768) to N Clovis Tap (524776) 115kV line, near Pleasant Hill. a. Apply fault at the Pleasant Hill 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
9	FLT_009_PLSNTHILL3_FEHOLLAND3_115kV	Fault on the Pleasant Hill (524768) to FE-Holland (524831) 115kV line, near Pleasant Hill. a. Apply fault at the Pleasant Hill 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
10	FLT_010_PLSNTHILL3_ECLOVIS3_115kV_PO	**Prior outage** of Pleasant Hill (524770) 230kV to (524768) 115kV to (524767) 13.2kV transformer. Fault on the Pleasant Hill (524768) 115kV to N Clovis Tap (524776) 115kV, near Pleasant Hill 115kV. a. Prior outage Pleasant Hill 230kV to 115kV to 13.2kV transformer b. Apply fault at the Pleasant Hill 115kV bus. c. Clear fault after 5 cycles by tripping the faulted line. d. Wait 20 cycles, and then re-close the line in (c) back into the fault. e. Leave fault on for 5 cycles, then trip the line in (c) and remove fault.
11	FLT_011_HEREFORD3_DS63_115kV	Fault on the Deaf Smith #6 (524629) to Hereford (524606) 115kV line, near Hereford. a. Apply fault at the Hereford 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
12	FLT_012_PLSNTHILL3_PLSNTHILL6_115_230kV	Fault on the Pleasant Hill (524770) 230kV to (524768) 115kV to (524767) 13.2kV transformer, near Pleasant Hill 115kV. a. Apply fault at the Pleasant Hill 115kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
13	FLT_013_PLSNTHILL6_OASIS6_230kV	Fault on the Pleasant Hill (524770) to Oasis (524875) 230kV line, near Pleasant Hill. a. Apply fault at the Pleasant Hill 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
14	FLT_014_PLSNTHILL6_ROSEVELTN6_230kV	Fault on the Pleasant Hill (524770) to Roosevelt N (524909) 230kV line, near Pleasant Hill. a. Apply fault at the Pleasant Hill 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
15	FLT_015_ROSEVELTN6_TOLKWEST6_230kV	Fault on the Roosevelt N (524909) to Tolk West (525531) to 230kV circuit #2, near Roosevelt N. a. Apply fault at the Roosevelt N 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
16	FLT_016_OASIS6_SNJUANTAP6_230kV	Fault on the Oasis (524875) to San Juan Tap (524885) 230 kV line circuit 1, near Oasis. a. Apply fault at the Oasis 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
17	FLT_017_SNJUANTAP6_CHAVESCNTY6_230kV	Fault on Chaves County (527483) to San Juan Tap 230 kV (524885) CKT 1, near San Juan Tap. a. Apply fault at the San Juan Tap 230 kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
18	FLT_018_TOLKEAST6_TUCOINT6_230kV	Fault on the Tolk East (525524) to TUCO (525830) 230kV line, near Tolk East. a. Apply fault at the Tolk East 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. (the following steps were omitted for the 3-Phase fault simulations) c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
19	FLT_019_PLANTX6_DEAFSMITH6_230kV	Fault on the Deaf Smith (560051) to Plant X (525481) 230 kV line, near Plant X. a. Apply fault at the Plant X 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
20	FLT_020_TOLK7_CROSSROADS7_345kV	Fault on the Crossroads (527656) to Tolk (525549) 345kV line, near Tolk. a. Apply fault at the Tolk 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and the Tolk 345/230kV transformer then remove the fault.
21	FLT_021_CROSSROADS7_EDDYCNTY7_345kV	Fault on the Crossroads (527656) to Eddy County (527802) 345kV line, near Crossroads. a. Apply fault at the Crossroads 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and the Eddy County 345/230kV transformer then remove the fault.
22	FLT_022_RIOBLANCO7_OKU7_345kV	Fault on the OKU (511456) to Rio Blanco (560027) 345kV line, near Rio Blanco. a. Apply fault at the near Rio Blanco 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
23	FLT_023_RIOBLANCO7_OKU7_345kV_PO	**Prior Outage** of the TUCO 345 kV (525832) to 230 kV (525830) to 13.2 kV (525824) XFMR CKT 1; Fault on the Rio Blanco 345 kV (560027) to OKU (511456) 345 kV line circuit 1, near Rio Blanco. a. Prior outage TUCO 345kV to 230kV to 13.2kV transformer b. Apply fault at the Rio Blanco 345 kV bus. c. Clear fault after 5 cycles by tripping the faulted line. d. Wait 20 cycles, and then re-close the line in (b) back into the fault. e. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
24	FLT_024_TUCOINT7_TUCOINT6_345_230kV	Fault on the TUCO 345 kV (525832) to 230 kV (525830) to 13.2 kV (525824) XFMR CKT 1, near TUCO 345 kV bus. a. Apply fault at the TUCO 345 kV bus. b. Clear fault after 5 cycles by tripping the transformer
25	FLT_025_TUCOINT7_CRAWDRAW7_345kV	Fault on the Crawfish Draw (560022) to TUCO (525832) 345kV line, near TUCO. a. Apply fault at the near TUCO 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
26	FLT_026_CRAWDRAW7_BORDER7_345kV	Fault on the Crawfish Draw (560022) to Border (515458) 345 kV line circuit 1, near Crawfish Draw. a. Apply fault at the Crawfish Draw 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
27	FLT_027_CHISHOLM7_WWRDEHV7_345kV	Fault on the Chisholm (511553) to Woodward (515375) 345 kV line circuit 1, near Chisholm. a. Apply fault at the Chisholm 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
28	FLT_028_CHISHOLM7_GRACMNT7_345kV	Fault on the Chisholm (511553) to Gracemont (560078) 345 kV line circuit 1, near Chisholm. a. Apply fault at the Chisholm 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
29	FLT_029_CHISHOLM7_CHISHOLM6_345_230kV	Fault on the Chisholm 345 kV (511553) to 230 kV (511557) to 13.2 kV (511558) XFMR CKT 1, near Chisholm 345 kV bus. a. Apply fault at the Chisholm 345 kV bus. b. Clear fault after 5 cycles by tripping the transformer

Results

The stability analysis was performed and the results are summarized in ***Table 3-2***. The stability plots will be available upon customer request.

Table 3-2: Contingency Results

Contingency Number and Name		Single Phase			Three Phase		
		2016WP	2017SP	2025SP	2016WP	2017SP	2025SP
0	FLT_000_NOFAULT	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
1	FLT_001_NORTON3_FETUCMCARI3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
2	FLT_002_NORTON3_CAPROCK3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
3	FLT_003_NORTON3_CAPROCK3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
4	FLT_004_FETUCMCARI3_CEILOTAPN_115_69kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
5	FLT_005_FETUCMCARI3_CEILOTAPN_115_69kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
6	FLT_006_PLSNTHILL3_ECLOVIS3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
7	FLT_007_PLSNTHILL3_ECLOVIS3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
8	FLT_008_PLSNTHILL3_NCLOVISTP3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
9	FLT_009_PLSNTHILL3_FEHOLLAND3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
10	FLT_010_PLSNTHILL3_ECLOVIS3_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
11	FLT_011_HEREFORD3_DS#63_115kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
12	FLT_012_PLSNTHILL3_PLSNTHILL6_115_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
13	FLT_013_PLSNTHILL6_OASIS6_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
14	FLT_014_PLSNTHILL6_ROSEVELTN6_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
15	FLT_015_ROSEVELTN6_TOLKWEST6_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
16	FLT_016_OASIS6_SNJUANTAP6_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
17	FLT_017_SNJUANTAP6_CHAVESCNTY6_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
18	FLT_018_TOLKEAST6_TUCOINT6_230kV	STABLE	STABLE	STABLE	STABLE[1]	STABLE[1]	STABLE[1]
19	FLT_019_PLANTX6_DEAFSMITH6_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
20	FLT_020_TOLK7_CROSSROADS7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
21	FLT_021_CROSSROADS7_EDDYCNTY7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
22	FLT_022_RIOBLANCO7_OKU7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
23	FLT_023_RIOBLANCO7_OKU7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
24	FLT_024_TUCOINT7_TUCOINT6_345_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
25	FLT_025_TUCOINT7_CRAWDRAW7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
26	FLT_026_CRAWDRAW7_BORDER7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
27	FLT_027_CHISHOLM7_WWRDEHV7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
28	FLT_028_CHISHOLM7_GRACMNT7_345kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
29	FLT_029_CHISHOLM7_CHISHOLM6_345_230kV	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE

FERC LVRT Compliance

FERC Order 661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu. The faults listed below in **Table *3-3*** were

[1] During the 3-Phase fault, an SLNOS1 relay activated and tripped the Crossroads to Eddy County 345 kV circuit. The system response is stable with the circuit tripping and also with the tripping disabled.

tested to meet Order 661A LVRT provisions. It was observed that during faults that the inverters would decouple from the grid and remain decoupled for an extended period of time after the fault was cleared. To support the system after a fault is cleared, the decoupling response should not extend beyond the fault clearing. Since the permissible adjustments to the delay settings were not provided, individual parameter adjustments were not attempted. However enabling/installing the "Dynamic Grid Support" option of the SMA Sunny Central inverters resulted in a GEN-2013-022 response that was found to be in compliance with FERC Order 661A.

Table 3-3 LVRT Contingencies

Contingency Name	Description
FLT_001_NORTON3_FETUCMCARI3_115kV	Fault on the Norton (524502) to FE-Tucumcari (524509) 115kV line, near Norton. a. Apply fault at the Norton 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_002_NORTON3_CAPROCK3_115kV	**GEN-2011-046 online at 100% output:** Fault on the Caprock Wind (524486) to Norton (524502) 115kV line, near Norton. a. Apply fault at the Norton 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_003_NORTON3_CAPROCK3_115kV	**GEN-2011-046 offline:** Fault on the Caprock Wind (524486) to Norton (524502) 115kV line, near Norton. a. Apply fault at the Norton 115kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

4. Power Factor Analysis

The power factor analysis was performed for each project included in this study and is designed to demonstrate the reactive power requirements at the point of interconnection (POI) using the current study upgrade cases. For all projects that require reactive power, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the POI.

Model Preparation

For each project included in this study, as well as previous queued projects modeled at the same POI, the projects were turned off for the power factor analysis. The projects were replaced by an equivalent generator located at the POI producing the total MW of the projects at that POI and 0.0 Mvar capability.

A Mvar generator without limits was modeled at the interconnection project POI to hold a voltage schedule at the POI consistent with the greater of the voltage schedule in the base case or unity (1.0 pu) voltage.

Disturbances

Each N-1 contingency evaluated in the Stability Analysis found in **Table 3-1** was also included in the determination of the power factor requirements.

Results

The power factor ranges are summarized in **Table 4-1** and the resultant ranges are shown **Table D-1**. The analysis showed that reactive power is required for the study project, the final requirement in the Generation Interconnection Agreement (GIA) for each project will be the pro-forma 95% lagging to 95% leading at the POI.

For analyzing power factor results a positive Q (Mvar) output indicates that the equivalent generator is supplying reactive power to the system, implying a lagging power factor. A negative Q (Mvar) output indicates that the equivalent generator is absorbing reactive power from the system, implying a leading power factor.

Table 4-1*: Summary of Power Factor Analysis at the POI*

Request	Capacity (MW)	Point of Interconnection (POI)	Fuel	Generator	Lagging (providing Mvars)	Leading (absorbing Mvars)
GEN-2013-022	25	Norton 115kV (524502)	Solar	SMA Sunny Central 2200-US 2.2 MW PV solar inverters	0.95	0.95

NOTE: As reactive power is required for the project, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the point of interconnection.

5. Reduced Generation Analysis

A low generation analysis was performed for GEN-2013-022 to determine the capacitive charging current injected at the POI from the generation facility.

The project inverters and capacitors (if any) were turned off in the study case. **Figure 5-1** shows the resulting reactive power injection (approximately 0.3 Mvar) at the POI that is due to the capacitance of the projects' 34.5 kV collector system transmission lines and of the transmission lead that connects the 115/34.5 kV transformer to the POI.

A shunt reactor was added at the GEN-2013-022 project substation 34.5 kV bus to bring the Mvar flow into the POI down to approximately zero as shown in **Figure 5-2**. A reactor of approximately 0.3 Mvar installed on the low side of the 115/34.5 kV transformer will negate the capacitive effect of the project at the POI. As the charging current is a small value (< 1 Mvar) this is shown for information only and not as a requirement unless the customer's installed equipment is capable of compensating for the charging current. However if there is uncompensated charging current and high voltages are experienced on the transmission system then the customer's facilities may be required to disconnect from the system.

Figure 5-1*: GEN-2013-022 with inverters turned off*

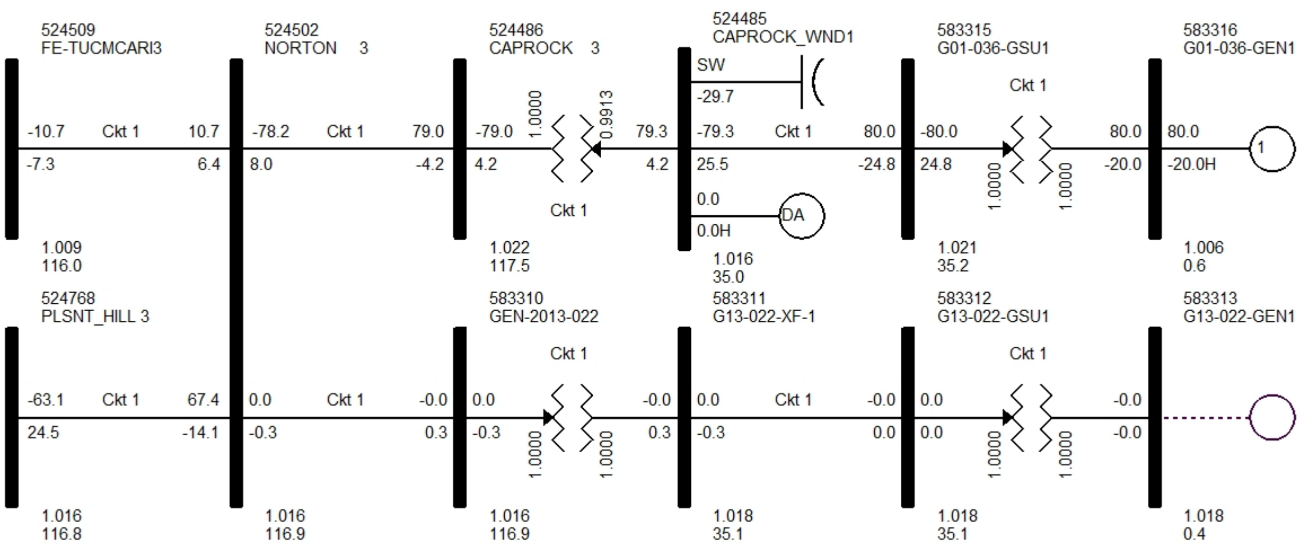
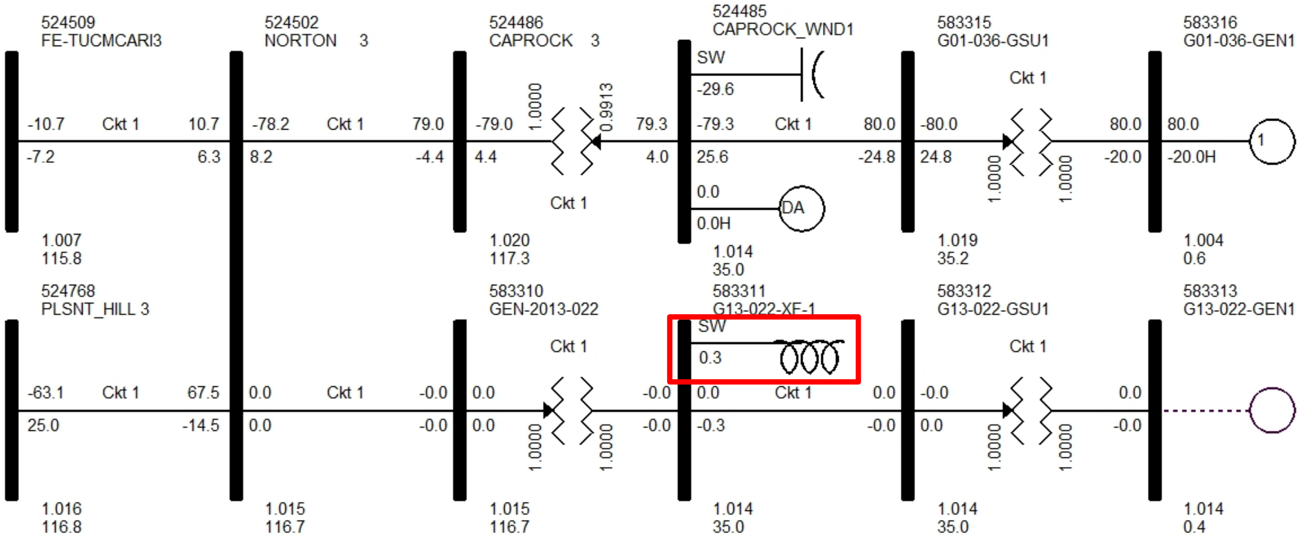


Figure 5-2*:* GEN-2013-022 with inverters turned off and 0.3Mvar reactor at 34.5kV bus



6. Short Circuit Analysis

The short circuit analysis was performed on the 2017 & 2025 Summer Peak power flow cases using the PSS/E ASCC program. Since the power flow model does not contain negative and zero sequence data, only three-phase symmetrical fault current levels were calculated at the point of interconnection up to and including five levels away.

Short Circuit Analysis was conducting using flat conditions with the following PSS/E ASCCC program settings:

- BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
- GENERATOR P=0, Q=0
- TRANSFORMER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
- LINE CHARGING=0.0 IN +/-/0 SEQUENCE
- LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
- LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
- DC LINES AND FACTS DEVICES BLOCKED
- TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

Results

The results of the short circuit analysis are shown in **Appendix E**; 2017 summer peak results in ***Table E-1*** and 2025 summer peak results in ***Table E-2***.

7. Conclusion

The GEN-2013-022 Interconnection Customer has requested a modification to its Generator Interconnection Request to change Photovoltaic (PV) solar inverters. The proposed revised project configuration consists of eleven (11) SMA Sunny Central 2200-US 2.2 MW PV solar inverters for a total nameplate capacity of 24.2 MW. The point of interconnection (POI) is the Southwestern Public Service, Inc. (SPS) Norton 115 kV substation.

Stability analysis has determined that with all previously assigned Network Upgrades in service, generators in the monitored areas remained stable and within the pre-contingency, voltage recovery, and post fault voltage recovery criterion of 0.7pu to 1.2pu for the entire modeled disturbances. With the SMA Sunny Central inverter "Dynamic Grid Support" option installed the project was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

A power factor analysis was performed for the modification request. As reactive power is required for GEN-2013-022, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the POI.

An analysis was conducted to determine the capacitive effects on the transmission system caused by the generator lead and collector system during periods of reduced generation. The generating facility is required to provide reactive compensation of approximately 0.3 MVAR of inductive reactance during periods of reduced generation. Such compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

Short Circuit analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS 2015-002-1 in place, GEN-2013-022 with no more than eleven (11) SMA Sunny Central 2200-US 2.2 MW PV solar inverters with the "Dynamic Grid Support" option installed should be able to interconnect reliably to the SPP transmission grid. The change with no more than eleven (11) SMA Sunny Central 2200-US 2.2 MW inverters is not a Material Modification. The customer may submit a new Generator Interconnection Request for the incremental 3.6 MW nameplate capacity to achieve the proposed 28.6 MW project configuration.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. Powerflow analysis was not performed. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

Appendix A – 2016 Winter Peak Stability Plots

(Available on request)

Appendix B – 2017 Summer Peak Stability Plots

(Available on request)

Appendix C – 2025 Summer Peak Stability Plots

(Available on request)

Appendix D – Power Factor Analysis Results

Table D-1: GEN-2013-022 Power Factor Analysis Results

Leading power factor is absorbing vars; Lagging power factor is providing vars										
	GEN-2013-022 POI: Norton 115 kV (524502) Power at POI (MW): 105	2016 Winter Peak POI Voltage = 1.000 pu			2017 Summer Peak POI Voltage = 1.000 pu			2025 Summer Peak POI Voltage = 1.000 pu		
	Contingency Name	**Mvars at POI**	**Power Factor**		**Mvars at POI**	**Power Factor**		**Mvars at POI**	**Power Factor**	
0	FLT_000_NOFAULT	-11.7148	0.9938	LEAD	-9.5164	0.9959	LEAD	-8.5589	0.9967	LEAD
1	FLT_001_NORTON3_FETUCMCARI3_115kV	-16.2564	0.9882 [2]	LEAD	-15.6322	0.9891	LEAD	-14.7376	0.9903	LEAD
2	FLT_002_NORTON3_CAPROCK3_115kV_G1146ON (25 MW)	-9.5836	0.9337	LEAD	-7.9636	0.9528	LEAD	-5.9381	0.9729	LEAD
3	FLT_003_NORTON3_CAPROCK3_115kV_G1146OFF (25 MW)	-11.7148	0.9055	LEAD	-9.5164	0.9346	LEAD	0.7358	0.9996 [3]	LAG
4	FLT_004_FETUCMCARI3_CEILOTAPN_115_69kV_G1146ON	-13.4584	0.9919	LEAD	-8.5689	0.9967	LEAD	-6.8165	0.9979	LEAD
5	FLT_005_FETUCMCARI3_CEILOTAPN_115_69kV_G1146OFF	-15.5253	0.9892	LEAD	-12.7651	0.9927	LEAD	-7.2853	0.9976	LEAD
6	FLT_006_PLSNTHILL3_ECLOVIS3_115kV_G1146ON	-5.5790	0.9986	LEAD	-7.0640	0.9977	LEAD	-12.9923	0.9924	LEAD
7	FLT_007_PLSNTHILL3_ECLOVIS3_115kV_G1146OFF	-10.9078	0.9946	LEAD	-8.9780	0.9964	LEAD	-10.4564	0.9951	LEAD
8	FLT_008_PLSNTHILL3_NCLOVISTP3_115kV	-12.1923	0.9933	LEAD	-10.4312	0.9951	LEAD	-9.3819	0.9960	LEAD
9	FLT_009_PLSNTHILL3_FEHOLLAND3_115kV	-10.6580	0.9949	LEAD	-8.8757	0.9964	LEAD	-7.7751	0.9973	LEAD
11	FLT_011_HEREFORD3_DS63_115kV	-9.6732	0.9958	LEAD	-7.3132	0.9976	LEAD	-6.8678	0.9979	LEAD
12	FLT_012_PLSNTHILL3_PLSNTHILL6_115_230kV	-11.1192	0.9944	LEAD	-6.5940	0.9980	LEAD	-5.5820	0.9986	LEAD
13	FLT_013_PLSNTHILL6_OASIS6_230kV	-11.2084	0.9944	LEAD	-8.6560	0.9966	LEAD	-7.7631	0.9973	LEAD
14	FLT_014_PLSNTHILL6_ROSEVELTN6_230kV	-11.3234	0.9942	LEAD	-8.8625	0.9965	LEAD	-7.8005	0.9973	LEAD
15	FLT_015_ROSEVELTN6_TOLKWEST6_230kV	-12.5397	0.9929	LEAD	-10.7059	0.9948	LEAD	-9.3037	0.9961	LEAD
16	FLT_016_OASIS6_SNJUANTAP6_230kV	-11.2807	0.9943	LEAD	-8.3130	0.9969	LEAD	-7.0094	0.9978	LEAD
17	FLT_017_SNJUANTAP6_CHAVESCNTY6_230kV	-11.2334	0.9943	LEAD	-8.2129	0.9970	LEAD	-8.1943	0.9970	LEAD
18	FLT_018_TOLKEAST6_TUCOINT6_230kV	-11.7029	0.9938	LEAD	-9.4099	0.9960	LEAD	-8.4896	0.9967	LEAD
19	FLT_019_PLANTX6_DEAFSMITH6_230kV	-11.3277	0.9942	LEAD	-8.7610	0.9965	LEAD	-7.9240	0.9972	LEAD
20	FLT_020_TOLK7_CROSSROADS7_345kV	-11.6663	0.9939	LEAD	-9.1481	0.9962	LEAD	-8.6637	0.9966	LEAD
21	FLT_021_CROSSROADS7_EDDYCNTY7_345kV	-11.4214	0.9941	LEAD	-8.8955	0.9964	LEAD	-7.9512	0.9971	LEAD
22	FLT_022_RIOBLANCO7_OKU7_345kV	-11.5687	0.9940	LEAD	-9.4018	0.9960	LEAD	-8.5136	0.9967	LEAD
24	FLT_024_TUCOINT7_TUCOINT6_345_230kV	-11.7083	0.9938	LEAD	-9.5126	0.9959	LEAD	-8.5555	0.9967	LEAD
25	FLT_025_TUCOINT7_CRAWDRAW7_345kV	-11.6978	0.9939	LEAD	-9.4954	0.9959	LEAD	-8.5641	0.9967	LEAD
26	FLT_026_CRAWDRAW7_BORDER7_345kV	-11.6482	0.9939	LEAD	-9.4564	0.9960	LEAD	-8.5338	0.9967	LEAD
27	FLT_027_CHISHOLM7_WWRDEHV7_345kV	-11.6868	0.9939	LEAD	-9.4955	0.9959	LEAD	-8.5468	0.9967	LEAD
28	FLT_028_CHISHOLM7_GRACMNT7_345kV	-11.701	0.9938	LEAD	-9.508	0.9959	LEAD	-8.5551	0.9967	LEAD
29	FLT_029_CHISHOLM7_CHISHOLM6_345_230kV	-11.716	0.9938	LEAD	-9.5101	0.9959	LEAD	-8.5559	0.9967	LEAD

[2] Most leading power factor

[3] Most lagging power factor

Appendix E – Short Circuit Analysis Results

Table E-1: GEN-2013-022 Short Circuit Analysis Results (2017SP)

```
                          PSS(R)E-32.2.2 ASCC SHORT CIRCUIT CURRENTS          MON, MAR 20 2017  11:04
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 17S WITH MMWG 15S, MRO 16W TOPO/16S PROF, SERC 16S

OPTIONS USED:
    - FLAT CONDITIONS
         - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
         - GENERATOR P=0, Q=0
         - TRANSFOMRER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
         - LINE CHARGING=0.0 IN +/-/0 SEQUENCE
         - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
         - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
         - DC LINES AND FACTS DEVICES BLOCKED
         - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

                                  THREE PHASE FAULT
X---------- BUS ----------X          /I+/    AN(I+)
524502 [NORTON     3115.00] AMP     2715.2   -80.50
524486 [CAPROCK    3115.00] AMP     2851.8   -83.04
524509 [FE-TUCMCARI3115.00] AMP     1929.3   -78.51
524768 [PLSNT_HILL 3115.00] AMP     9588.7   -80.71
583310 [GEN-2013-022115.00] AMP     2665.7   -80.51
524472 [LOPEZ      3115.00] AMP     1743.8   -77.99
524770 [PLSNT_HILL 6230.00] AMP     5977.8   -81.80
524773 [E_CLOVIS   3115.00] AMP     8252.1   -78.55
524776 [N_CLOVIS_TP3115.00] AMP     7023.9   -78.61
524831 [FE-HOLLAND 3115.00] AMP     8493.9   -79.25
583610 [CEILO-TAP-N 69.000] AMP      745.1   -77.99
524477 [CAMPBELL_ST3115.00] AMP     1739.5   -77.98
524777 [N_CLOVIS   3115.00] AMP     6373.3   -76.08
524808 [FE-CLVS_INT3115.00] AMP     6567.1   -78.26
524822 [CURRY      3115.00] AMP    10241.7   -79.53
524838 [FE-CLOVIS2 3115.00] AMP     9726.6   -79.30
524875 [OASIS      6230.00] AMP     7170.2   -81.92
524909 [ROSEVELT_N 6230.00] AMP     8595.4   -82.08
524669 [DS-#20     3115.00] AMP     4766.0   -68.32
524764 [NORRIS_TP  3115.00] AMP    10216.2   -79.52
524784 [W_CLOVIS   3115.00] AMP     6016.7   -77.88
524821 [CURRY      269.000] AMP     4313.7   -85.64
524874 [OASIS      3115.00] AMP     9372.5   -81.67
524885 [SN_JUAN_TAP6230.00] AMP     4616.8   -83.04
524908 [ROOSEVELT  3115.00] AMP    10065.1   -81.83
524915 [SW_4K33    6230.00] AMP     8595.4   -82.08
525531 [TOLK_WEST  6230.00] AMP    25459.9   -86.18
560032 [G15-018T    115.00] AMP     5171.6   -77.30
583280 [ASGI2012-002115.00] AMP     1052.2   -77.70
524662 [PARMER_CO  3115.00] AMP     4066.8   -66.87
524783 [W_CLOVIS   269.000] AMP     2403.9   -75.30
524790 [CANNON_TP  3115.00] AMP     5734.0   -77.81
524797 [PERIMETER  3115.00] AMP     6243.4   -78.47
524801 [NORRIS     3115.00] AMP     9406.6   -78.14
524846 [FARWELL    269.000] AMP     2072.5   -73.40
524863 [FE-CHZPLT  3115.00] AMP     7530.2   -78.57
524889 [SN_JUAN_WND6230.00] AMP     4431.7   -83.11
524911 [ROSEVELT_S 6230.00] AMP     8595.4   -82.08
524924 [PORTALES   3115.00] AMP     7121.0   -78.83
525028 [BAILEYCO   3115.00] AMP     4865.5   -76.00
```

```
    525481 [PLANT_X    6230.00] AMP    21940.0   -85.25
    525543 [TOLK_TAP   6230.00] AMP    25459.9   -86.18
    525637 [LAMB_CNTY  6230.00] AMP     5319.2   -81.86
    527483 [CHAVES_CNTY6230.00] AMP     3969.9   -82.11
    562480 [G13-027-TAP 230.00] AMP     8947.3   -83.19
    583620 [CIELO-TAP-S 115.00] AMP     1052.2   -77.70
    584620 [GEN-2015-020115.00] AMP     9142.2   -81.64
```

Table E-2: GEN-2013-022 Short Circuit Analysis Results (2025SP)

```
                              PSS(R)E-32.2.2 ASCC SHORT CIRCUIT CURRENTS         MON, MAR 20 2017  11:04
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 2025S WITH MMWG 2024S, MRO & SERC 2025 SUMMER

OPTIONS USED:
    - FLAT CONDITIONS
         - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
         - GENERATOR P=0, Q=0
         - TRANSFOMRER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
         - LINE CHARGING=0.0 IN +/-/0 SEQUENCE
         - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
         - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
         - DC LINES AND FACTS DEVICES BLOCKED
         - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

                                  THREE PHASE FAULT
X---------- BUS ----------X          /I+/    AN(I+)
524502 [NORTON     3115.00] AMP     3311.2   -81.48
524486 [CAPROCK    3115.00] AMP     3216.6   -83.57
524509 [FE-TUCMCARI3115.00] AMP     2602.1   -80.92
524768 [PLSNT_HILL 3115.00] AMP     9824.7   -80.58
583310 [GEN-2013-022115.00] AMP     3237.9   -81.47
524472 [LOPEZ      3115.00] AMP     2440.3   -80.96
524770 [PLSNT_HILL 6230.00] AMP     6067.1   -81.76
524773 [E_CLOVIS   3115.00] AMP     8420.5   -78.42
524776 [N_CLOVIS_TP3115.00] AMP     7135.8   -78.49
524831 [FE-HOLLAND 3115.00] AMP     8673.4   -79.13
583610 [CEILO-TAP-N 69.000] AMP      774.3   -77.99
524477 [CAMPBELL_ST3115.00] AMP     2432.0   -80.94
524777 [N_CLOVIS   3115.00] AMP     6464.6   -75.93
524808 [FE-CLVS_INT3115.00] AMP     6660.5   -78.14
524822 [CURRY      3115.00] AMP    10502.7   -79.45
524838 [FE-CLOVIS2 3115.00] AMP     9961.2   -79.22
524875 [OASIS      6230.00] AMP     7277.1   -81.86
524909 [ROSEVELT_N 6230.00] AMP     8734.6   -82.02
524669 [DS-#20     3115.00] AMP     4807.8   -68.22
524764 [NORRIS_TP  3115.00] AMP    10475.6   -79.44
524784 [W_CLOVIS   3115.00] AMP     6090.9   -77.76
524821 [CURRY      269.000] AMP     4340.9   -85.66
524874 [OASIS      3115.00] AMP     9504.7   -81.58
524885 [SN_JUAN_TAP6230.00] AMP     4661.8   -82.99
524908 [ROOSEVELT  3115.00] AMP    10226.1   -81.74
524915 [SW_4K33    6230.00] AMP     8734.6   -82.02
525531 [TOLK_WEST  6230.00] AMP    26367.8   -86.09
560032 [G15-018T    115.00] AMP     5475.0   -77.51
583280 [ASGI2012-002115.00] AMP     1053.0   -77.68
524662 [PARMER_CO  3115.00] AMP     4094.0   -66.80
524783 [W_CLOVIS   269.000] AMP     2412.3   -75.27
524790 [CANNON_TP  3115.00] AMP     5796.7   -77.70
524797 [PERIMETER  3115.00] AMP     6309.4   -78.37
524801 [NORRIS     3115.00] AMP     9625.7   -78.03
524846 [FARWELL    269.000] AMP     2078.7   -73.37
524863 [FE-CHZPLT  3115.00] AMP     7640.4   -78.48
524889 [SN_JUAN_WND6230.00] AMP     4471.5   -83.06
```

```
524911 [ROSEVELT_S 6230.00] AMP     8734.6   -82.02
524924 [PORTALES   3115.00] AMP     7198.1   -78.73
525028 [BAILEYCO   3115.00] AMP     6368.2   -77.41
525481 [PLANT_X    6230.00] AMP    23319.8   -85.26
525543 [TOLK_TAP   6230.00] AMP    26367.8   -86.09
525637 [LAMB_CNTY  6230.00] AMP     5540.2   -82.21
527483 [CHAVES_CNTY6230.00] AMP     4065.7   -82.00
562480 [G13-027-TAP 230.00] AMP     9124.0   -83.14
583620 [CIELO-TAP-S 115.00] AMP     1053.0   -77.68
584620 [GEN-2015-020115.00] AMP     9268.0   -81.55
```