GEN-2014-033
GEN-2014-034
GEN-2014-035
Impact Restudy for Generator Modification (Inverter change)

July 2016
Generator Interconnection

Southwest Power Pool

Revision History

Date	Author	Change Description
6/7/2016	SPP	Restudy for Generator Modification (Inverter Change) issued.
7/13/2016	SPP	1. Corrected quantity and manufacturer models of GEN-2014-033 inverters. 2. Changed low solar irradiance/no solar irradiance in place of low wind/no wind. 3. Removed requirement for shunt reactors to compensate for low irradiance/no irradiance conditions.

Executive Summary

The GEN-2014-033/034/035 Interconnection Customer(s) have requested a modification to its Generator Interconnection Request to change to the following configuration of inverters -

Interconnection Request	Quantity	Manufacturer/Model
GEN-2014-033	Seventeen (17) Two (2) Five (5)	General Electric LV5 (4MVA) General Electric LV5 (1MVA) Schneider Electric (680kVA)
GEN-2014-034	Eighteen (18)	General Electric LV5 (4MVA)
GEN-2014-035	Eight (8)	General Electric LV5 (4MVA)

The point of interconnection (POI) is the Southwestern Public Service Company (SPS) Chaves 115kV Substation. Burns & McDonnell (B&M) performed the study for this modification request, and B&M's report on the study follows this summary.

The study models used were the 2016 winter, the 2017 summer, and the 2025 summer cases and included Interconnection Requests through DISIS-2015-001. The study showed that no stability problems were found with the contingencies studied during the summer and the winter peak conditions as a result of changing to the GE LV5 and Schneider inverters. Additionally, the solar projects were found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements.

A power factor analysis was performed for the study and it was found that the solar projects will be required to meet the 0.95 power factor lagging (providing vars) and 0.95 power factor leading (absorbing vars) at the POI. A short circuit analysis was performed and is detailed in the B&M report.

A low solar irradiance/no solar irradiance condition analysis was performed for this modification request. The analysis showed that the project will inject approximately 1.15, 0.88, and 0.36Mvars (for GEN-2014-033, GEN-2014-034, and GEN-2014-035, respectively) into the POI during periods of low solar/no solar irradiance. Due to the low Mvar injection at the POI, GEN-2014-033, GEN-2014-034, and GEN-2014-035 will not be required to have shunt reactors to offset the capacitive injection.

With the assumptions outlined in this report and with all required network upgrades in place, GEN-2014-033, GEN-2014-034, and GEN-2014-035 will be able to reliably interconnect to the SPP transmission grid with the new inverter configuration.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. 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 transmission service. If the Customer wishes to obtain deliverability to a specific customer, a separate request for transmission service shall be requested on Southwest Power Pool's OASIS.

Interconnection Impact Study GEN-2014-033/034/035 Report

Southwest Power Pool

GEN-2014-033/034/035
Project No. 90477

06/10/2016

Interconnection Impact Study
GEN-2014-033/034/035 Report

prepared for

Southwest Power Pool
GEN-2014-033/034/035
Little Rock, AR

Project No. 90477

06/10/2016

prepared by

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EXECUTIVE SUMMARY

Southwest Power Pool (SPP) retained Burns & McDonnell to perform an Impact Restudy for Generator Modification for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects. This study included short circuit analysis, power factor analysis, reactive power analysis, and stability analysis to find impacts on the transmission system caused by the interconnections of GEN-2014-033, GEN-2014-034, and GEN-2014-035.

GEN-2014-033, GEN-2014-034, and GEN-2014-035 consists of three (3) generator interconnection projects as shown in Table ES-1. The three (3) projects were proposed to interconnect within the SPP control area. The combined capacity of the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects for summer and winter approximately totaled to 170 MW. All analyses were performed using the PTI PSS/E software and the results are summarized below.

Table ES-1: GEN-2014-033/034/035 Interconnection Projects

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2014-033	70	17 x GE LV5 4MVA Inverters, 2 x GE LV5 1MVA Inverters, & 5 x Schneider XC 680kVA PV Inverters	Chaves County 115 kV (527482)
GEN-2014-034	70	18 x GE LV5 4MVA Inverters	Chaves County 115 kV (527482)
GEN-2014-035	30	8 x GE LV5 4MVA Inverters	Chaves County 115 kV (527482)

ES.1 Short Circuit Analysis

The short circuit analysis was performed using the 2017 and 2025 Summer Peak (SP) models. Three phase fault currents were calculated for the 69 kV and above buses within 5 buses of each generator's point of interconnection. The fault current levels were then compared to the fault currents without the generator to determine the impact of the generation interconnection.

The results from short circuit analysis showed that the maximum change in the fault currents in the immediate systems at or near GEN-2014-033, GEN-2014-034, and GEN-2014-035 were negligible (within 1% of the existing system levels) for the 2017 summer peak and the 2025 summer peak cases. All three phase current levels with the GEN-2014-033, GEN-2014-034, and GEN-2014-035 generators online were below 34,000 A.

ES.2 Power Factor Analysis

The GEN-2014-033, GEN-2014-034, and GEN-2014-035 project generators were turned off for the power factor analysis. Each of the interconnection generators was replaced with a generator modeled at the high side bus of the collector substation transformers. The replacement generators were modeled to reflect the real power (MW) output of each of the interconnection request generators and were set to maintain a voltage schedule at the point of interconnection consistent with the voltage schedule in the provided base case or 1.0 pu voltage, whichever was higher. The GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects were analyzed under numerous single element contingencies and the necessary power factor was calculated.

For the contingencies tested, the lowest power factor was found to be 0.968 (-18.017 MVAr contribution) in the 2016 WP case for loss of the Chaves County to Eddy North 230 kV line for GEN-2014-033 and GEN-2014-034. The lowest power factor was found to be .857 (-18.017 MVAr contribution) for GEN-2014-035, also for loss of the Chaves County to Eddy North 230 kV line. The Schneider XC inverter documentation[1] shows a +/- 0.8 power factor capability. The GE LV5 4 MW inverter documentation[2] shows a power factor capability of 0.743 leading and 0.781 lagging when in Q-priority mode. There were no contingency events studied for which the required power factor at the POI exceeded the capability of the GE LV5 or Schneider XC inverter. Per tariff requirements, the Generating Facilities will be required to meet the standard 95% power factor requirement at the Point of Interconnection. The customer may be required to add capacitor and/or reactor banks depending upon its final collector system design.

ES.3 Reactive Power Analysis

The reactive power analysis was performed for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects with POI voltage at 115 kV to determine the reactive power contribution from the project's interconnection line and collector transformer and cables. The goal of the analysis is to size shunt reactors at the project substation high side bus to reduce POI reactive power value to approximately zero.

The reactive power analysis results showed that a shunt reactor with values of 1.15 MVAr, 0.88 MVAr, and 0.36 MVAr at GEN-2014-033, GEN-2014-034, and GEN-2014-035, respectively, at the high side is needed to reduce the net reactive power injection at the POI to approximately zero during low/no solar irradiance while the generation interconnection project is still connected to the grid.

ES.4 Stability Analysis

The stability analysis was performed for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects. The Stability Analysis evaluated the system during three load scenarios (2016 winter peak, 2017 summer peak and 2025 summer peak) simulating up to 30 faults that included three phase and single-line-to-ground

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[1] Modeling of Schneider Electric's XC Series Photovoltaic Inverters for Power Flow and Stability Studies with PSS/E Versions 32 and 33, Revision A6, June 6, 2013.

[2] LV5 PSS/E Model Version 3 User Manual, Revision 002 2015-05-15.

faults including faults on prior outage cases and stuck breakers. The Stability Analysis results indicated that the machine rotor angle damping and transient voltage recovery criteria were met for all faults studied. The stability analysis showed no generator tripping, machine rotor angle damping violations or transient voltage recovery violations associated with the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects for the simulated fault events. There were no system stability issues caused by the interconnection of the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects which required mitigation.

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1.0 INTRODUCTION

Burns & McDonnell was retained by Southwest Power Pool (SPP) to perform an Impact Restudy for Generator Modification for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects. This study included short circuit analysis, power factor analysis, reactive power analysis, and stability analysis to find impacts on the transmission system caused by the interconnections of GEN-2014-033, GEN-2014-034, and GEN-2014-035.

GEN-2014-033, GEN-2014-034, and GEN-2014-035 consists of three (3) solar inverter generator interconnection projects as shown in Table 1-1. All three projects are proposed to interconnect within the SPP control area. The combined capacity of GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects for summer and winter totaled approximately 170 MW.

Table 1-1: GEN-2014-033/034/035 Interconnection Project

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2014-033	70	17 x GE LV5 4MVA Inverters, 2 x GE LV5 1MVA Inverters, & 5 x Schneider XC 680kVA PV Inverters	Chaves County 115 kV (527482)
GEN-2014-034	70	18 x GE LV5 4MVA Inverters	Chaves County 115 kV (527482)
GEN-2014-035	30	8 x GE LV5 4MVA Inverters	Chaves County 115 kV (527482)

1.1 Study Scope

This study is presented in the following seven main parts:

1. Introduction
2. Study Assumptions
3. Short Circuit Analysis
4. Power Factor Analysis
5. Reactive Power Analysis
6. Stability Analysis
7. Conclusions

1.2 Limitations

In the preparation of this report, the information provided to Burns & McDonnell by others was used by Burns & McDonnell to make certain assumptions with respect to conditions which may exist in the future. While Burns & McDonnell believes the assumptions made are reasonable for the purposes of this report, Burns & McDonnell makes no representation that the conditions assumed will, in fact, occur. In addition, while Burns & McDonnell has no reason to believe that the information provided by others, and on which this report is based, is inaccurate in any material respect, Burns & McDonnell has not independently verified such information and cannot guarantee its accuracy or completeness. To the extent that actual future conditions differ from those assumed herein or from the information provided to Burns & McDonnell, the actual results will vary from those presented.

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2.0 STUDY ASSUMPTIONS

The short circuit, power factor, reactive power, and stability analyses were performed using the PTI PSS/E software version 32.

2.1 Disturbance Performance Requirement

The following SPP Disturbance Performance Requirements were applied to the Bulk Electric System for the stability analysis. These requirements establish the minimum requirements for machine rotor angle damping and transient voltage recovery.

2.1.1 Rotor Angle Damping Requirement

The machine rotor angles shall exhibit well damped angular oscillations and acceptable power swings following a disturbance on the Bulk Electric System for all NERC events. Well damped angular oscillation is defined as:

1. The Successive Positive Peak Ratio (SPPR) must be less than or equal to 0.95 where SPPR is calculated as:

$$\text{SPPR} = \frac{\text{Peak Rotor Angle of 2nd Positive Swing Peak}}{\text{Peak Rotor Angle of 1st Positive Swing Peak}} \leq 0.95$$

   Or, Damping Factor % = $(1 – \text{SPPR}) \times 100\% \geq 5\%$

   The machine rotor angle damping ratio may be determined by appropriate modal analysis (i.e. Prony Analysis) where the following equivalent requirement must be met:

   Damping Ratio ≥ 0.0081633

2. Successive Positive Peak Ratio Five (SPPR5) must be less than or equal to 0.774 where SPPR5 is calculated as follows:

$$\text{SPPR5} = \frac{\text{Peak Rotor Angle of 5th Positive Swing Peak}}{\text{Peak Rotor Angle of 1st Positive Swing Peak}} \leq 0.774$$

   Or, Damping Factor % = $(1 – \text{SPPR5}) \times 100\% \geq 22.6\%$

   The machine rotor angle damping ratio may be determined by appropriate modal analysis (i.e. Prony Analysis) where the following equivalent requirement must be met:

   Damping Ratio ≥ 0.0081633.

Burns & McDonnell only calculated these damping values where oscillations were not well damped by the end of the simulation through visual inspection.

2.1.2 Transient Voltage Recovery Requirement:

Any time after a disturbance is cleared; bus voltages on the Bulk Electric System shall recover above 0.70 per unit, 2.5 seconds after the fault is cleared and not swing above 1.20 per unit after the fault is cleared.

2.2 Study System

The study system consisted of facilities at or above 69 kV within seven (7) buses away from the Chaves County POI. Machines within this study area were monitored for the study.

2.3 Study Models

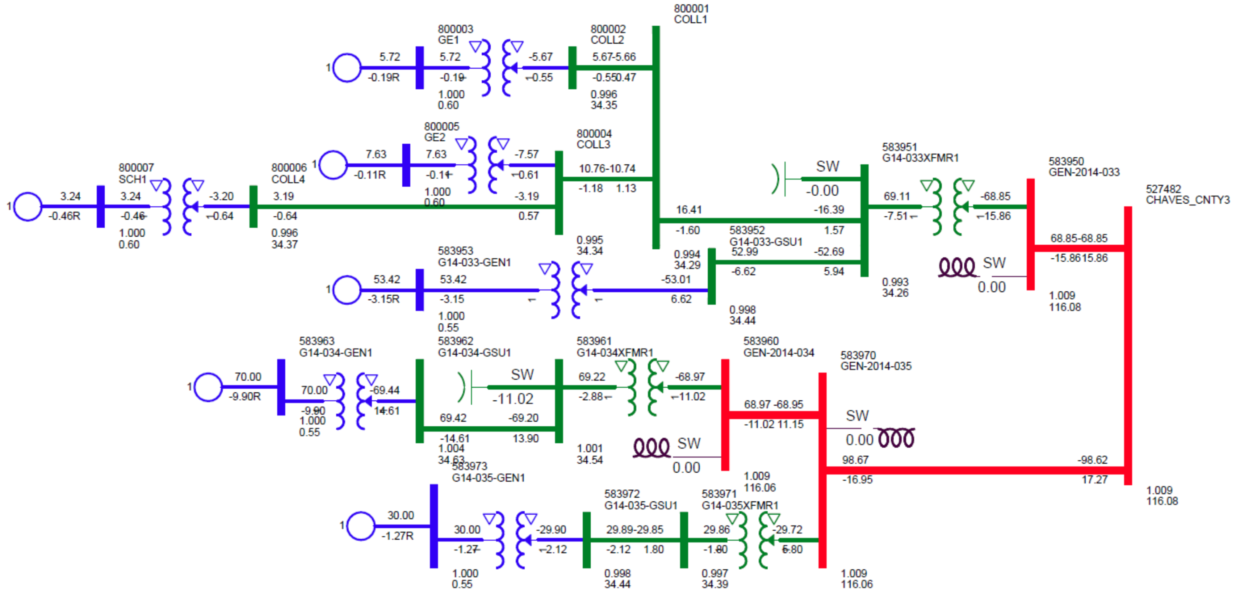
The short circuit, power factor, reactive power and stability analyses were performed using models developed from the 2015 Southwest Power Pool (SPP) Model Development Working Group (MDWG) PSS/E models. The base cases provided by SPP model the 2016 Winter Peak, 2017 Summer Peak and 2025 Summer Peak study conditions. The cases were developed with a single interconnection request added to the base case with dispatch adjustments made per SPP's supplied dispatch requirements. Table 2-1 summarizes the study models used for each of the analyses.

Table 2-1: Study Models for Stability Analysis

Model	GEN-2014-033	GEN-2014-034	GEN-2014-035
MDWG15-16WP_DIS1402_G06.sav	X	X	X
MDWG15-17SP_DIS1402_G06.sav	X	X	X
MDWG15-25SP_DIS1402_G06.sav	X	X	X

A single-line diagram for GEN-2014-033, GEN-2014-034, and GEN-2014-035 is provided in Figure 2-1.

Figure 2-1: GEN-2015-004 Single-line Diagram



2.4 Prior Queued Projects

All study cases contained the Prior Queued Projects listed in Table 2-2 below.

Table 2-2: Prior Queued Projects

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2001-033	180	Mitsubishi 1000	San Juan Mesa 230kV (524885)
GEN-2001-036	80	Mitsubishi 1000	Norton 115kV (524502)
GEN-2006-018	170	GENSAL	Tuco 230kV (525830)
GEN-2006-026	502	GENROU (527901, 527902, 527903)	Hobbs 115kV(527891) Hobbs 230kV (527894)
GEN-2008-022	300	Vestas 2.0MW	Tap on Eddy County – Tolk 345kV line (G08-022-POI, 560007)
ASGI-2010-020	30	Nordex 2.5MW	Tap LE-Tatum to LE-Crsroads 69kV (AS10-020-POI, 560360)
ASGI-2010-021	15	Mitsubishi MPS-1000A 1.0MW	Tap LE-Saundrtp to LE-Anderson 69kV (ASGI-021-POI, 560364)
GEN-2010-046	56	GENSAL	Tuco 230kV (525830)
ASGI-2011-001	27.3	Suzlon 2.1MW	Lovington 115kV (528334)
ASGI-2011-003	10	Sany 2.0MW	Hendricks 69kV (525943)
ASGI-2011-004	19.8	Sany 1.8MW	Crosby 69kV (525915)
GEN-2011-025	80	GE 1.6MW	Tap on Floyd County - Crosby County 115kV line (G11-025-POI, 562004)
GEN-2011-045	180 Summer 205 Winter	GENROU	Jones_bus2 230kV (526337)
GEN-2011-046	23 Summer 27 Winter	GENROU	Quay County 115kV (524472)
GEN-2011-048	165 Summer 175 Winter	GENROU	Mustang 230kV (527151)
GEN-2012-001	61.2	CCWE 3.6MW (WT4)	Tap Grassland to Borden 230kV (526679)

Table 2-2: Prior Queued Projects (continued)

Request	Size (MW)	Generator Model	Point of Interconnection
ASGI-2012-002	18	Vestas 1.65MW V82	Clovis 115kV (524808)
GEN-2012-020	478	GE 1.68MW	Tuco 230kV (525830)
GEN-2012-034	7 MW increase (Pgen=172MW)	GENROU	Mustang 230kV (527151)
GEN-2012-035	7 MW increase (Pgen=172MW)	GENROU	Mustang 230kV (527151)
GEN-2012-036	7 MW increase (Pgen=172MW Summer/185MW Winter)	GENROU	Mustang 230kV (527151)
GEN-2012-037	196 Summer 203 Winter	GENROU	Tuco 345kV (525832)
GEN-2013-016	191 Summer 203 Winter	GENROU (583456)	Tuco 345kV (525832)
ASGI-2013-002	18.4	Siemens 2.3MW VS (583613)	Tucumcari 115kV (524509)
ASGI-2013-003	18.4	Siemens 2.3MW VS (583623)	Clovis 115kV (524808)
ASGI-2013-005	19.8	Vestas V82 1.65MW (583283)	FE-Clovis 115kV (524808)
ASGI-2013-006	2.0	Gamesa G114 2MW (583813)	Erskine 115kV (526109)
GEN-2013-022	25.0	Windon 500kW (583313)	Caprock 115kV (524486)
GEN-2013-027	150.0	Siemens 2.3/2.415	Tap on Yoakum to Tolk 230kV (562480)
GEN-2014-012	186 Summer 225 Winter	GENROU (528607)	Tap Hobbs (527894 in 2015SP/WP, 527896 in 2025SP) to Andrews (528604) 230kV (345kV in 2025SP) (Tap bus is 528611)
ASGI-2014-001	2.3	GE 107m 2.3MW (583816)	Erskine 69kV (526109)
GEN-2014-047	40	AE 500NX 0.5 MW PV inverters	Tap Tolk - Eddy County (Crossroads) 345kV
ASGI-2014-002	49.6	SMA 1.6MVA 630CP-US inverters	Santa Rosa tap - Tucumcari 69kV line
ASGI-2014-005	10	Wind PV inverter	Strata 69 kV - bus 528046
ASGI-2014-008	10	Wind PV inverter	South Loving 69 kV - bus 528218
ASGI-2014-009	10	Wind PV inverter	Wood Draw 115 kV - bus 528228
ASGI-2014-010	10	Wind PV inverter	Ochoa 115 kV - bus 528232
ASGI-2014-012	10	Wind PV inverter	Cooper Ranch 115 kV - bus 528554

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3.0 SHORT CIRCUIT ANALYSIS

Burns & McDonnell performed the short circuit analysis to determine the impact of the generation interconnection requests on the fault current levels in the study system. The analysis was performed using version 32 of the PTI PSS/E software. The following sections outline the methodology and results of the analysis.

3.1 Methodology

The short circuit analysis was performed using the 2017 and 2025 Summer Peak models. Three phase fault currents were calculated for the 69 kV and above buses within 5 buses of each generator's point of interconnection. The fault current levels were then compared to the fault currents without the generator to determine the impact of the generation interconnection.

3.2 Short Circuit Analysis Results

Table 3-1 through Table 3-2 summarize the three phase fault currents observed for facilities near GEN-2014-033, GEN-2014-034, and GEN-2014-035 for the 2017 and 2025 Summer Peak cases, respectively.

Table 3-1: 2017 Summer Peak GEN-2014-033, GEN-2014-034, and GEN-2014-035 Three-Phase Fault Currents

Bus Dist. From POI	BUS NUMBER	BUS NAME	Voltage (kV)	AREA	ZONE	3 Phase Fault Current (kA)		Difference (ON - OFF)	
						GenON	GenOFF	Change	%
0	527482	CHAVES_C	115	526	1507	6.2398	6.3029	-0.0631	-1.00%
1	527501	URTON	115	526	1507	5.2944	5.3399	-0.0455	-0.85%
1	527546	SAMSON	115	526	1507	4.95	4.9896	-0.0396	-0.79%
1	527483	CHAVES_C	230	526	1507	3.9658	3.9704	-0.0046	-0.12%
1	527481	CHAVES_C	69	526	1507	2.2318	2.2369	-0.0051	-0.23%
2	527522	ROSWELL_	115	526	1507	4.9812	5.0214	-0.0402	-0.80%
2	527564	ROSWLL_I	115	526	1507	5.0443	5.0848	-0.0405	-0.80%
2	524885	SN_JUAN_	230	526	1504	4.6327	4.6116	0.0211	0.46%
2	527799	EDDY_NOR	230	526	1507	7.2146	7.2008	0.0138	0.19%
2	527507	PRICE	69	526	1507	1.8432	1.8469	-0.0037	-0.20%
2	527800	EDDY_SOU	230	526	1507	7.2146	7.2008	0.0138	0.19%
2	599960	EPTNP-D6	230	999	999	7.2146	7.2008	0.0138	0.19%
2	527802	EDDY_CNT	345	526	1507	4.0521	4.0364	0.0157	0.39%
2	527793	EDDY_STH	115	526	1507	10.212	10.2149	-0.0029	-0.03%
3	527534	BRASHER_	115	526	1507	5.0251	5.0653	-0.0402	-0.79%
3	527541	CAPITAN	115	526	1507	3.3804	3.4001	-0.0197	-0.58%
3	527597	TWEEDY	115	526	1507	4.7241	4.7581	-0.034	-0.71%
3	527563	ROSWLL_I	69	526	1507	3.5587	3.5731	-0.0144	-0.40%
3	524875	OASIS	230	526	1504	7.3063	7.2949	0.0114	0.16%
3	524889	SN_JUAN_	230	526	1504	4.4474	4.4261	0.0213	0.48%
3	527514	CV-PINE	69	526	1507	1.6449	1.6479	-0.003	-0.18%
3	527865	CUNNINHA	230	526	1507	14.7157	14.7115	0.0042	0.03%
3	528095	7-RIVERS	230	526	1507	5.5332	5.53	0.0032	0.06%
3	527656	CROSSROA	345	526	1505	5.2288	5.2159	0.0129	0.25%
3	527821	CV-DAYTO	115	526	1507	6.5499	6.5537	-0.0038	-0.06%
3	528178	PECOS	115	526	1507	8.9382	8.9412	-0.003	-0.03%

Table 3-1: 2017 Summer Peak GEN-2014-033, GEN-2014-034, and GEN-2014-035 Three-Phase Fault Currents (continued)

Bus Dist. From POI	BUS NUMBER	BUS NAME	Voltage (kV)	AREA	ZONE	3 Phase Fault Current (kA)		Difference (ON - OFF)	
						GenON	GenOFF	Change	%
4	527536	BRASHER	115	526	1507	4.6107	4.6452	-0.0345	-0.74%
4	527798	EDDY_NTH	115	526	1507	10.212	10.2149	-0.0029	-0.03%
4	527528	RIAC_TP	69	526	1507	3.3995	3.413	-0.0135	-0.40%
4	527575	SW_4702	69	526	1507	3.2334	3.2458	-0.0124	-0.38%
4	524770	PLSNT_HI	230	526	1504	6.2525	6.2436	0.0089	0.14%
4	524915	SW_4K33	230	526	1504	8.7547	8.7436	0.0111	0.13%
4	524874	OASIS	115	526	1504	9.3597	9.3412	0.0185	0.20%
4	527540	CAPITAN	69	526	1507	2.2035	2.2105	-0.007	-0.32%
4	524911	ROSEVELT	230	526	1504	8.7547	8.7436	0.0111	0.13%
4	527894	HOBBS_IN	230	526	1508	15.0792	15.0762	0.003	0.02%
4	527963	POTASH_J	230	526	1507	6.2848	6.2814	0.0034	0.05%
4	527864	CUNNINHA	115	526	1507	25.7065	25.7042	0.0023	0.01%
4	528179	PECOS	230	526	1507	5.7392	5.7368	0.0024	0.04%
4	528094	7-RIVERS	115	526	1507	7.35	7.3524	-0.0024	-0.03%
4	525549	TOLK	345	526	1505	6.8848	6.883	0.0018	0.03%
4	577103	GEN-2008	345	526	1507	4.9618	4.9496	0.0122	0.25%
4	584260	GEN-2014	345	526	1505	4.2478	4.2375	0.0103	0.24%
4	527786	ATOKA	115	526	1507	6.6298	6.6336	-0.0038	-0.06%
4	528070	CV-AZMES	115	526	1507	6.6021	6.605	-0.0029	-0.04%
4	528132	OCOTILLO	115	526	1507	5.3343	5.337	-0.0027	-0.05%
4	528137	N_CANAL	115	526	1507	7.0667	7.0697	-0.003	-0.04%
4	528160	CARLSBAD	115	526	1507	8.5287	8.5312	-0.0025	-0.03%
4	528226	HOPI_SUB	115	526	1507	3.9572	3.9597	-0.0025	-0.06%
4	599955	PNM-DC6	230	999	999	8.7547	8.7436	0.0111	0.13%
5	527711	EAGLE_CR	115	526	1507	6.8954	6.8999	-0.0045	-0.07%
5	527809	CV-8_MIL	115	526	1507	5.1644	5.1676	-0.0032	-0.06%
5	527552	RIAC	69	526	1507	2.9914	3.0027	-0.0113	-0.38%
5	527589	CV-ORCHA	69	526	1507	2.0156	2.0216	-0.006	-0.30%
5	524909	ROSEVELT	230	526	1504	8.7547	8.7436	0.0111	0.13%
5	524768	PLSNT_HI	115	526	1504	9.2844	9.2695	0.0149	0.16%
5	524797	PERIMETE	115	526	1504	6.2623	6.2501	0.0122	0.20%
5	524863	FE-CHZPL	115	526	1504	7.5268	7.5142	0.0126	0.17%
5	524924	PORTALES	115	526	1504	7.1737	7.1606	0.0131	0.18%
5	525524	TOLK_EAS	230	526	1505	25.7966	25.8037	-0.0071	-0.03%
5	526935	YOAKUM	230	526	1506	13.8762	13.8802	-0.004	-0.03%
5	528604	ANDREWS	230	526	1508	5.8629	5.8625	0.0004	0.01%
5	527891	HOBBS_IN	115	526	1508	29.0535	29.051	0.0025	0.01%
5	528027	RDRUNNER	230	526	1507	3.6186	3.6174	0.0012	0.03%
5	527962	POTASH_J	115	526	1507	8.5484	8.548	0.0004	0.00%
5	528348	BUCKEYE_	115	526	1508	8.1785	8.1788	-0.0003	0.00%
5	528355	MADDOX	115	526	1508	24.8834	24.8817	0.0017	0.01%
5	528394	QUAHADA	115	526	1508	7.2914	7.2873	0.0041	0.06%
5	528568	MONUMNT_	115	526	1508	9.6467	9.6455	0.0012	0.01%
5	528109	CV-LAKEW	115	526	1507	5.9645	5.9677	-0.0032	-0.05%
5	528093	7-RIVERS	69	526	1507	2.4694	2.4712	-0.0018	-0.07%
5	525543	TOLK_TAP	230	526	1505	25.7966	25.8037	-0.0071	-0.03%
5	577104	G08-022-	345	526	1507	4.6692	4.6577	0.0115	0.25%
5	528116	CV-IRISH	115	526	1507	6.0016	6.005	-0.0034	-0.06%
5	527785	ATOKA	69	526	1507	2.3129	2.3151	-0.0022	-0.10%
5	528076	CV-WALTC	115	526	1507	4.2662	4.2687	-0.0025	-0.06%
5	527930	PCA	115	526	1507	8.0882	8.0869	0.0013	0.02%
5	528151	FIESTA	115	526	1507	7.6812	7.6837	-0.0025	-0.03%
5	528159	CARLSBAD	69	526	1507	4.3151	4.3176	-0.0025	-0.06%
5	528182	NORTH_LO	115	526	1507	2.359	2.3607	-0.0017	-0.07%

Table 3-2: 2025 Summer Peak GEN-2014-033, GEN-2014-034, and GEN-2014-035 Three-Phase Fault Currents

Bus Dist. From POI	BUS NUMBER	BUS NAME	Voltage (kV)	AREA	ZONE	3 Phase Fault Current (kA)		Difference (ON - OFF)	
						GenON	GenOFF	Change	%
0	527482	CHAVES_C	115	526	1507	6.4444	6.5082	-0.0638	-0.98%
1	527501	URTON	115	526	1507	5.4485	5.4938	-0.0453	-0.82%
1	527508	PRICE	115	526	1507	5.0663	5.1054	-0.0391	-0.77%
1	527546	SAMSON	115	526	1507	5.1717	5.2121	-0.0404	-0.78%
1	527483	CHAVES_C	230	526	1507	4.1006	4.1036	-0.003	-0.07%
2	527522	ROSWELL_	115	526	1507	5.1809	5.2216	-0.0407	-0.78%
2	527515	CV-PINE	115	526	1507	4.7069	4.7404	-0.0335	-0.71%
2	527564	ROSWLL_I	115	526	1507	5.4173	5.4607	-0.0434	-0.79%
2	524885	SN_JUAN_	230	526	1504	4.6971	4.6708	0.0263	0.56%
2	527799	EDDY_NOR	230	526	1507	7.7662	7.7561	0.0101	0.13%
2	527800	EDDY_SOU	230	526	1507	7.7662	7.7561	0.0101	0.13%
2	599960	EPTNP-D6	230	999	999	7.7662	7.7561	0.0101	0.13%
2	527802	EDDY_CNT	345	526	1507	4.2347	4.2221	0.0126	0.30%
2	527793	EDDY_STH	115	526	1507	11.1451	11.1499	-0.0048	-0.04%
3	527541	CAPITAN	115	526	1507	4.5408	4.5717	-0.0309	-0.68%
3	527529	RIACBRSH	115	526	1507	5.0301	5.0679	-0.0378	-0.75%
3	527596	RIACTWTY	115	526	1507	5.1771	5.2154	-0.0383	-0.73%
3	527563	ROSWLL_I	69	526	1507	3.636	3.6494	-0.0134	-0.37%
3	524875	OASIS	230	526	1504	7.4635	7.4472	0.0163	0.22%
3	524889	SN_JUAN_	230	526	1504	4.5047	4.4784	0.0263	0.59%
3	527865	CUNNINHA	230	526	1507	17.6401	17.6387	0.0014	0.01%
3	528095	7-RIVERS	230	526	1507	6.0931	6.0933	-0.0002	0.00%
3	527798	EDDY_NTH	115	526	1507	11.1451	11.1499	-0.0048	-0.04%
3	527656	CROSSROA	345	526	1505	5.3142	5.3025	0.0117	0.22%
3	527821	CV-DAYTO	115	526	1507	7.0214	7.0262	-0.0048	-0.07%
3	528178	PECOS	115	526	1507	11.8809	11.8885	-0.0076	-0.06%
4	527536	BRASHER	115	526	1507	4.866	4.9016	-0.0356	-0.73%
4	527552	RIAC	115	526	1507	4.6211	4.6533	-0.0322	-0.69%
4	527597	TWEEDY	115	526	1507	5.0338	5.0693	-0.0355	-0.70%
4	527575	SW_4702	69	526	1507	3.3004	3.3117	-0.0113	-0.34%
4	524770	PLSNT_HI	230	526	1504	6.4292	6.4171	0.0121	0.19%
4	524915	SW_4K33	230	526	1504	8.9585	8.943	0.0155	0.17%
4	524874	OASIS	115	526	1504	9.505	9.4815	0.0235	0.25%
4	524911	ROSEVELT	230	526	1504	8.9585	8.943	0.0155	0.17%
4	527894	HOBBS_IN	230	526	1508	19.4957	19.4952	0.0005	0.00%
4	527963	POTASH_J	230	526	1507	6.9882	6.9906	-0.0024	-0.03%
4	527864	CUNNINHA	115	526	1507	30.0551	30.0562	-0.0011	0.00%
4	528179	PECOS	230	526	1507	6.4553	6.4575	-0.0022	-0.03%
4	528094	7-RIVERS	115	526	1507	8.1456	8.15	-0.0044	-0.05%
4	527711	EAGLE_CR	115	526	1507	7.3975	7.4034	-0.0059	-0.08%
4	527809	CV-8_MIL	115	526	1507	5.4237	5.427	-0.0033	-0.06%
4	525549	TOLK	345	526	1505	6.9789	6.9761	0.0028	0.04%
4	577103	GEN-2008	345	526	1507	5.0385	5.0274	0.0111	0.22%
4	584260	GEN-2014	345	526	1505	4.3094	4.3001	0.0093	0.22%
4	527786	ATOKA	115	526	1507	7.1191	7.1239	-0.0048	-0.07%
4	528070	CV-AZMES	115	526	1507	7.4025	7.4074	-0.0049	-0.07%
4	528132	OCOTILLO	115	526	1507	6.2124	6.2173	-0.0049	-0.08%
4	528137	N_CANAL	115	526	1507	8.74	8.7463	-0.0063	-0.07%
4	528160	CARLSBAD	115	526	1507	11.2542	11.2609	-0.0067	-0.06%
4	528226	HOPI_SUB	115	526	1507	6.7216	6.7258	-0.0042	-0.06%
4	599955	PNM-DC6	230	999	999	8.9585	8.943	0.0155	0.17%
5	527589	CV-ORCHA	69	526	1507	2.049	2.0543	-0.0053	-0.26%
5	524909	ROSEVELT	230	526	1504	8.9585	8.943	0.0155	0.17%

Table 3-2: 2025 Summer Peak GEN-2014-033, GEN-2014-034, and GEN-2014-035 Three-Phase Fault Currents (continued)

Bus Dist. From POI	BUS NUMBER	BUS NAME	Voltage (kV)	AREA	ZONE	3 Phase Fault Current (kA)		Difference (ON - OFF)	
						GenON	GenOFF	Change	%
5	524768	PLSNT_HI	115	526	1504	9.4666	9.447	0.0196	0.21%
5	524797	PERIMETE	115	526	1504	6.3282	6.3127	0.0155	0.25%
5	524863	FE-CHZPL	115	526	1504	7.6365	7.6197	0.0168	0.22%
5	524924	PORTALES	115	526	1504	7.2554	7.2385	0.0169	0.23%
5	525524	TOLK_EAS	230	526	1505	26.6142	26.62	-0.0058	-0.02%
5	526935	YOAKUM	230	526	1506	17.5784	17.5757	0.0027	0.02%
5	528611	GAINESGE	230	526	1508	10.238	10.2385	-0.0005	0.00%
5	527891	HOBBS_IN	115	526	1508	33.6995	33.7019	-0.0024	-0.01%
5	527896	HOBBS_IN	345	526	1508	8.541	8.5355	0.0055	0.06%
5	527962	POTASH_J	115	526	1507	14.6894	14.6973	-0.0079	-0.05%
5	528348	BUCKEYE_	115	526	1508	8.5843	8.5852	-0.0009	-0.01%
5	528355	MADDOX	115	526	1508	28.3823	28.3845	-0.0022	-0.01%
5	528394	QUAHADA	115	526	1508	8.5355	8.5352	0.0003	0.00%
5	528568	MONUMNT_	115	526	1508	10.2368	10.2373	-0.0005	0.00%
5	528109	CV-LAKEW	115	526	1507	6.4193	6.4236	-0.0043	-0.07%
5	528093	7-RIVERS	69	526	1507	2.5399	2.542	-0.0021	-0.08%
5	527707	ARTESIA	115	526	1507	6.8159	6.8214	-0.0055	-0.08%
5	527715	NAVAJO_2	115	526	1507	7.0597	7.0654	-0.0057	-0.08%
5	527736	NAVAJO_5	115	526	1507	7.0191	7.0247	-0.0056	-0.08%
5	527710	EAGLE_CR	69	526	1507	2.3172	2.3195	-0.0023	-0.10%
5	527822	CV-TURKY	115	526	1507	3.4835	3.4858	-0.0023	-0.07%
5	525543	TOLK_TAP	230	526	1505	26.6142	26.62	-0.0058	-0.02%
5	577104	G08-022-	345	526	1507	4.7373	4.7269	0.0104	0.22%
5	528116	CV-IRISH	115	526	1507	6.4374	6.4419	-0.0045	-0.07%
5	527785	ATOKA	69	526	1507	2.3624	2.3645	-0.0021	-0.09%
5	528076	CV-WALTC	115	526	1507	4.5829	4.5864	-0.0035	-0.08%
5	527930	PCA	115	526	1507	11.2924	11.2985	-0.0061	-0.05%
5	528151	FIESTA	115	526	1507	9.7949	9.8011	-0.0062	-0.06%
5	528159	CARLSBAD	69	526	1507	4.9512	4.9518	-0.0006	-0.01%
5	528182	NORTH_LO	115	526	1507	8.3777	8.3802	-0.0025	-0.03%

As shown in Table 3-1 and Table 3-2, the maximum fault current increase with the addition of GEN-2014-033, GEN-2014-034, and GEN-2014-035 was about 1% in both cases.

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4.0 POWER FACTOR ANALYSIS

Power factor analysis was performed to determine if the power factor requirement for the interconnection request is within the capabilities of the specified generators.

4.1 Methodology

The GEN-2014-033, GEN-2014-034, and GEN-2014-035 project generators were turned off for the power factor analysis. Each of the interconnection generators were replaced with a generator modeled at the high side bus of the collector substation transformers. The replacement generators were modeled to reflect the real power (MW) output of each of the interconnection request generators and were set to maintain a voltage schedule at the point of interconnection consistent with the voltage schedule in the provided base case or 1.0 pu voltage, whichever was higher. The replacement generators' reactive power capability was set to +/- 9999 MVAr to find the required power factor.

The base case voltages at the POI for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects are provided in Table 4-1.

Table 4-1: Base Case GEN-2014-033/034/035 POI Voltages

Machine	PF Capability	POI Bus Number	POI Bus Name	Initial POI Voltage (pu)		
				16WP	17SP	25SP
GEN-2014-033 GE LV5	-0.743 /+0.781	527482	CHAVES_CNTY3	1.012	1.008	1.013
GEN-2014-033 Schneider XC	-0.80 /+0.80	527482	CHAVES_CNTY3	1.012	1.008	1.013
GEN-2014-034 GE LV5	-0.743 /+0.781	527482	CHAVES_CNTY3	1.012	1.008	1.013
GEN-2014-035 GE LV5	-0.743 /+0.781	527482	CHAVES_CNTY3	1.012	1.008	1.013

The GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects were analyzed under the single element contingency conditions listed in Table 4-2.

Table 4-2: Power Factor Contingency Summary

Fault Event	Outage Details
FLT01-3PH	527482 [CHAVES_CNTY3115.00] - 527546 [SAMSON 3115.00] (1)
FLT02-3PH	527482 [CHAVES_CNTY3115.00] - 527501 [URTON 3115.00] (1)
FLT03-3PH	527482 [CHAVES_CNTY3115.00] - 527483 [CHAVES_CNTY6230.00] - 527478 [CHAVES_TR1 113.200] (1)
FLT04-3PH	527483 [CHAVES_CNTY6230.00] - 524885 [SN_JUAN_TAP6230.00] (1)
FLT05-3PH	527483 [CHAVES_CNTY6230.00] - 527799 [EDDY_NORTH 6230.00] (1)
FLT06-3PH	527546 [SAMSON 3115.00] - 527564 [ROSWLL_INT 3115.00] (1)
FLT07-3PH	527501 [URTON 3115.00] - 527522 [ROSWELL_CTY3115.00] (1)
FLT11-3PH	527798 [EDDY_NTH 3115.00] - 527800 [EDDY_SOUTH 6230.00] - 527797 [EDDY_TR2 113.200] (1)
FLT14-3PH	527799 [EDDY_NORTH 6230.00] - 527793 [EDDY_STH 3115.00] - 527795 [EDDY_TR3 113.200] (2)
FLT15-3PH	527799 [EDDY_NORTH 6230.00] - 527802 [EDDY_CNTY 7345.00] - 527796 [EDDY_TR 113.200] (1)
FLT16-3PH	527800 [EDDY_SOUTH 6230.00] - 527865 [CUNNINHAM 6230.00] (1)
FLT17-3PH	527800 [EDDY_SOUTH 6230.00] - 528095 [7-RIVERS 6230.00] (1)
FLT18-3PH	527564 [ROSWLL_INT 3115.00] - 527596 [RIACTWTY_TP3115.00] (1)
FLT19-3PH	515458 [BORDER 7345.00] - 515375 [WWRDEHV7 345.00] (1)
FLT20-3PH	515458 [BORDER 7345.00] - 525832 [TUCO_INT 7345.00] (1)
FLT21-3PH	525832 [TUCO_INT 7345.00] - 511456 [O.K.U.-7 345.00] (1)
FLT22-3PH	511456 [O.K.U.-7 345.00] - 511468 [L.E.S.-7 345.00] (1)
FLT26-3PH	527482 [CHAVES_CNTY3115.00] - 527483 [CHAVES_CNTY6230.00] - 527479 [CHAVES_TR2 113.200] (2)
FLT27-3PH	527482 [CHAVES_CNTY3115.00] - 527481 [CHAVES_CNTY269.000] - 527480 [CHAVES_TR3 113.200] (1)
FLT28-3PH	527799 [EDDY_NORTH 6230.00] - 599960 [EPTNP-D6 230.00] (1)
FLT29-3PH	527802 [EDDY_CNTY 7345.00] - 527656 [CROSSROADS 7345.00] (1)
FLT30-3PH	525549 [TOLK 7345.00] - 527656 [CROSSROADS 7345.00] (1)

The power factor requirements for each contingency event in Table 4-2 are listed in Table 4-3, Table 4-4, and Table 4-5 for GEN-2014-033, GEN-2014-033, and GEN-2014-035, respectively. For this analysis the MVAr contribution of each project was assumed equal and the power factor was calculated for each project from that value.

Table 4-3: GEN-2014-033 Power Factor Requirements

OUTAGE ID	16WP			17SP			25SP		
	GEN-2014-033 (MW)	GEN-2014-033 (MVAr)	GEN-2014-033 (PF)	GEN-2014-033 (MW)	GEN-2014-033 (MVAr)	GEN-2014-033 (PF)	GEN-2014-033 (MW)	GEN-2014-033 (MVAr)	GEN-2014-033 (PF)
FLT01-3PH	70	-9.042	0.992	70	-8.430	0.993	70	-8.673	0.992
FLT02-3PH	70	-8.599	0.993	70	-7.991	0.994	70	-8.194	0.993
FLT03-3PH	70	-6.292	0.996	70	-9.579	0.991	70	-8.986	0.992
FLT04-3PH	70	-12.759	0.984	70	-11.006	0.988	70	-12.894	0.983
FLT05-3PH	70	-18.017	0.968	70	-16.287	0.974	70	-11.461	0.987
FLT06-3PH	70	-9.163	0.992	70	-8.593	0.993	70	-8.854	0.992
FLT07-3PH	70	-9.105	0.992	70	-8.487	0.993	70	-8.725	0.992
FLT11-3PH	70	-9.597	0.991	70	-9.726	0.990	70	-9.137	0.992
FLT14-3PH	70	-9.608	0.991	70	-9.735	0.990	70	-9.201	0.991
FLT15-3PH	70	3.362	0.999	70	-3.513	0.999	70	-3.616	0.999
FLT16-3PH	70	-10.143	0.990	70	-9.337	0.991	70	-9.411	0.991
FLT17-3PH	70	-9.419	0.991	70	-9.355	0.991	70	-9.576	0.991
FLT18-3PH	70			70			70	-7.837	0.994
FLT19-3PH	70	-9.521	0.991	70	-9.477	0.991	70	-9.530	0.991
FLT20-3PH	70	-9.496	0.991	70	-9.500	0.991	70	-9.502	0.991
FLT21-3PH	70	-9.583	0.991	70	-9.516	0.991	70	-9.534	0.991
FLT22-3PH	70	-9.713	0.991	70	-9.538	0.991	70	-9.670	0.991
FLT26-3PH	70	-9.039	0.992	70	-9.518	0.991	70	-8.844	0.992
FLT27-3PH	70	-13.502	0.982	70	-14.098	0.980	70		
FLT28-3PH	70	-9.371	0.991	70	-9.461	0.991	70	-9.407	0.991
FLT29-3PH	70	3.366	0.999	70	-3.511	0.999	70	-3.615	0.999
FLT30-3PH	70	-9.626	0.991	70	-10.354	0.989	70	-10.131	0.990

Table 4-4: GEN-2014-034 Power Factor Requirements

OUTAGE ID	16WP			17SP			25SP		
	GEN-2014-034 (MW)	GEN-2014-034 (MVAr)	GEN-2014-034 (PF)	GEN-2014-034 (MW)	GEN-2014-034 (MVAr)	GEN-2014-034 (PF)	GEN-2014-034 (MW)	GEN-2014-034 (MVAr)	GEN-2014-034 (PF)
FLT01-3PH	70	-9.042	0.992	70	-8.430	0.993	70	-8.673	0.992
FLT02-3PH	70	-8.599	0.993	70	-7.991	0.994	70	-8.194	0.993
FLT03-3PH	70	-6.292	0.996	70	-9.579	0.991	70	-8.986	0.992
FLT04-3PH	70	-12.759	0.984	70	-11.006	0.988	70	-12.894	0.983
FLT05-3PH	70	-18.017	0.968	70	-16.287	0.974	70	-11.461	0.987
FLT06-3PH	70	-9.163	0.992	70	-8.593	0.993	70	-8.854	0.992
FLT07-3PH	70	-9.105	0.992	70	-8.487	0.993	70	-8.725	0.992
FLT11-3PH	70	-9.597	0.991	70	-9.726	0.990	70	-9.137	0.992
FLT14-3PH	70	-9.608	0.991	70	-9.735	0.990	70	-9.201	0.991
FLT15-3PH	70	3.362	0.999	70	-3.513	0.999	70	-3.616	0.999
FLT16-3PH	70	-10.143	0.990	70	-9.337	0.991	70	-9.411	0.991
FLT17-3PH	70	-9.419	0.991	70	-9.355	0.991	70	-9.576	0.991
FLT18-3PH	70			70			70	-7.837	0.994
FLT19-3PH	70	-9.521	0.991	70	-9.477	0.991	70	-9.530	0.991
FLT20-3PH	70	-9.496	0.991	70	-9.500	0.991	70	-9.502	0.991
FLT21-3PH	70	-9.583	0.991	70	-9.516	0.991	70	-9.534	0.991
FLT22-3PH	70	-9.713	0.991	70	-9.538	0.991	70	-9.670	0.991
FLT26-3PH	70	-9.039	0.992	70	-9.518	0.991	70	-8.844	0.992
FLT27-3PH	70	-13.502	0.982	70	-14.098	0.980	70		
FLT28-3PH	70	-9.371	0.991	70	-9.461	0.991	70	-9.407	0.991
FLT29-3PH	70	3.366	0.999	70	-3.511	0.999	70	-3.615	0.999
FLT30-3PH	70	-9.626	0.991	70	-10.354	0.989	70	-10.131	0.990

Table 4-5: GEN-2014-035 Power Factor Requirements

OUTAGE ID	16WP			17SP			25SP		
	GEN-2014-035 (MW)	GEN-2014-035 (MVAr)	GEN-2014-035 (PF)	GEN-2014-035 (MW)	GEN-2014-035 (MVAr)	GEN-2014-035 (PF)	GEN-2014-035 (MW)	GEN-2014-035 (MVAr)	GEN-2014-035 (PF)
FLT01-3PH	30	-9.042	0.957	30	-8.430	0.963	30	-8.673	0.961
FLT02-3PH	30	-8.599	0.961	30	-7.991	0.966	30	-8.194	0.965
FLT03-3PH	30	-6.292	0.979	30	-9.579	0.953	30	-8.986	0.958
FLT04-3PH	30	-12.759	0.920	30	-11.006	0.939	30	-12.894	0.919
FLT05-3PH	30	-18.017	0.857	30	-16.287	0.879	30	-11.461	0.934
FLT06-3PH	30	-9.163	0.956	30	-8.593	0.961	30	-8.854	0.959
FLT07-3PH	30	-9.105	0.957	30	-8.487	0.962	30	-8.725	0.960
FLT11-3PH	30	-9.597	0.952	30	-9.726	0.951	30	-9.137	0.957
FLT14-3PH	30	-9.608	0.952	30	-9.735	0.951	30	-9.201	0.956
FLT15-3PH	30	3.362	0.994	30	-3.513	0.993	30	-3.616	0.993
FLT16-3PH	30	-10.143	0.947	30	-9.337	0.955	30	-9.411	0.954
FLT17-3PH	30	-9.419	0.954	30	-9.355	0.955	30	-9.576	0.953
FLT18-3PH	30			30			30	-7.837	0.968
FLT19-3PH	30	-9.521	0.953	30	-9.477	0.954	30	-9.530	0.953
FLT20-3PH	30	-9.496	0.953	30	-9.500	0.953	30	-9.502	0.953
FLT21-3PH	30	-9.583	0.953	30	-9.516	0.953	30	-9.534	0.953
FLT22-3PH	30	-9.713	0.951	30	-9.538	0.953	30	-9.670	0.952
FLT26-3PH	30	-9.039	0.957	30	-9.518	0.953	30	-8.844	0.959
FLT27-3PH	30	-13.502	0.912	30	-14.098	0.905	30		
FLT28-3PH	30	-9.371	0.955	30	-9.461	0.954	30	-9.407	0.954
FLT29-3PH	30	3.366	0.994	30	-3.511	0.993	30	-3.615	0.993
FLT30-3PH	30	-9.626	0.952	30	-10.354	0.945	30	-10.131	0.947

The Schneider XC inverter documentation[1] shows a +/- 0.8 power factor capability. The GE LV5 4 MW inverter documentation[2] shows a power factor capability of 0.743 leading and 0.781 lagging when in Q-priority mode. There were no contingency events studied for which the required power factor at the POI exceeded the capability of the GE LV5 or Schneider XC inverter.

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[1] Modeling of Schneider Electric’s XC Series Photovoltaic Inverters for Power Flow and Stability Studies with PSS/E Versions 32 and 33, Revision A6, June 6, 2013.

[2] LV5 PSS/E Model Version 3 User Manual, Revision 002 2015-05-15.

5.0 REACTIVE POWER ANALYSIS

The reactive power analysis was performed for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects with POI voltage at 115 kV to determine the reactive power contribution from the project's interconnection line and collector transformer and cables during low/no solar irradiance conditions while the project is still connected to the grid. The goal of the analysis is to size shunt reactors at the project substation high side bus to reduce POI reactive power value to approximately zero.

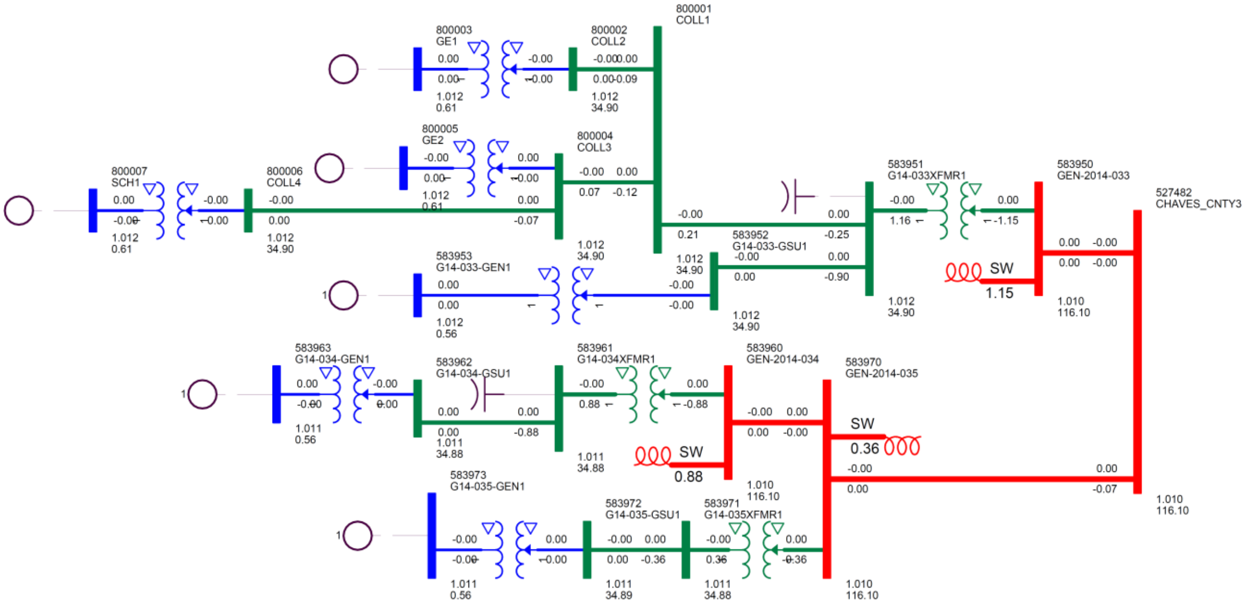
5.1 Methodology

For the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects, all the generators and capacitor banks were switched out of service while other collector system elements remained in-service. Shunt reactors were tested at the study project substation high side bus to bring the MVAr flow into the POI down to approximately zero.

5.2 Reactive Power Analysis Results

The results from the reactive power analysis showed that the GEN-2014-033, GEN-2014-034, and GEN-2014-035 interconnection system requires approximately 1.15, 0.88, and 0.36 MVAr shunt reactance at the high side of the GEN-2014-033, GEN-2014-033, and GEN-2014-035, respectively, to reduce the POI MVAr to zero. This represents the contributions from the project collector systems. See Figure 5-1 illustrating the shunt reactor size required to reduce the POI voltage to approximately zero.

Figure 5-1: GEN-2014-033, GEN-2014-034 and GEN-2014-035 Single-line Diagram



6.0 STABILITY ANALYSIS

Burns & McDonnell performed stability analysis to identify impacts on the system stability resulting from the interconnection of GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects.

6.1 Methodology

The Stability Analysis was performed using all the GEN-2014-033, GEN-2014-034, and GEN-2014-035 project cases. The power flow models and associated dynamics database were initialized (no-fault test) to confirm that there were no errors in the initial conditions of the system and the dynamic data. The dynamics model data for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 projects is provided in Appendix A. The stability analysis was performed using PSS/E version 32.

During the fault simulations, the active power (PELEC), reactive power (QELEC), terminal voltage (ETERM), angle (ANGL) and speed (SPD) were monitored for the GEN-2014-033, GEN-2014-034, and GEN-2014-035 generation interconnection requests and prior queued projects listed in Table 1-1 and Table 2-2. The study area for the stability analysis is defined as seven (7) buses away from the POI of GEN-2014-033, GEN-2014-034, and GEN-2014-035. The machine rotor angle for synchronous machines and speed for asynchronous machines within this study area including those within area 526 (SPS) were monitored. In addition, the voltages of all 69 kV and above buses within the study area were monitored.

6.2 Fault Definitions

SPP provided fault descriptions for twenty-five (25) normal clearing, stuck breaker, and prior outage contingency events. Burns & McDonnell defined five (5) additional contingency events. All thirty (30) contingency events were studied and are listed in Table 6-1. These contingencies were applied for the 2016 Winter Peak and 2017 Summer Peak and the 2025 Summer Peak models.

Table 6-1: Fault Definitions

Proposed Name	Description
FLT01-3PH	**3 phase fault on Chaves County 115 kV (527482) to Samson 115 kV (527546) CKT 1, near Chaves County**
	a. Apply fault at the Chaves County 115 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.
FLT02-3PH	**3 phase fault on Chaves County 115 kV (527482) to Urton 115 kV (527501) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves County 115 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.
FLT03-3PH	**3 phase fault on the Chaves County 115 kV (527482) to Chaves County 230 kV (527483) to Chaves County 13.2 kV (527478) XFMR CKT 1, near Chaves County 115 kV.**
	a. Apply fault at the Chaves County 115 kV bus.
	b. Clear fault after 5 cycles and trip the faulted transformer.
FLT04-3PH	**3 phase fault on Chaves County 230 kV (527483) to San Juan Tap 230 kV (524885) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves County 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.
FLT05-3PH	**3 phase fault on Chaves County 230 kV (527483) to Eddy North 230 kV (527799) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves County 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.
FLT06-3PH	**3 phase fault on Samson 115 kV (527546) to Roswell_Int 115 kV (527564) CKT 1, near Samson.**
	a. Apply fault at the Samson 115 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.
FLT07-3PH	**3 phase fault on Urton 115 kV (527501) to Roswell City 115 kV (527522) CKT 1, near Urton.**
	a. Apply fault at the Urton 115 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.
FLT08-PO	**Prior Outage of Chaves County 115 kV (527482) to Samson 115 kV (527546) CKT 1; 3 phase fault on Chaves County 115 kV (527482) to Urton 115 kV (527501) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves 115 kV bus.
	b. Clear fault after 5 cycles by tripping the faulted line.
FLT09-PO	**Prior Outage of Chaves County 115 kV (527482) to Urton 115 kV (527501) CKT 1; 3 phase fault on Chaves County 115 kV (527482) to Samson 115 kV (527546) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves 115 kV bus.
	b. Clear fault after 5 cycles by tripping the faulted line.
FLT10-SB	**Single phase fault with stuck breaker at Chaves County (527482)**
	a. Apply fault at the Chaves 115 kV bus.
	b. Clear fault after 16 cycles and trip the following elements
	c. Chaves County 115 kV (527482)/ 230 kV (527483)/13.2 kV (527479) transformer
	d. Chaves County (527482) - Samson (527546) 115 kV
FLT11-3PH	**3 phase fault on the Eddy North 115kV (527798) to Eddy South 230kV (527800) to Eddy 13.2kV (527797) XFMR CKT 1, near Eddy North 115kV.**
	a. Apply fault at the Eddy North 115kV bus.
	b. Clear fault after 5 cycles and trip the faulted transformer.

Table 6-1: Fault Definitions (continued)

Proposed Name	Description
FLT12-3PH	**3 phase fault on Oasis 230kV (524875) to Pleasant Hill 230kV (524770) CKT 1, near Oasis.**
	a. Apply fault at the Oasis 230kV 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.
FLT13-3PH	**3 phase fault on Oasis 230kV (524875) to SW_4K33 230kV (524915) CKT 1, near Oasis.**
	a. Apply fault at the Oasis 230kV 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.
FLT14-3PH	**3 phase fault on the Eddy North 230kV (527799) to Eddy South 115kV (527793) to Eddy 13.2kV (527795) XFMR CKT 2, near Eddy North 230kV.**
	a. Apply fault at the Eddy North 230kV bus.
	b. Clear fault after 5 cycles and trip the faulted transformer.
FLT15-3PH	**3 phase fault on the Eddy North 230kV (527799) to Eddy County 345kV (527802) to Eddy 13.2kV (527796) XFMR CKT 1, near Eddy North 230kV.**
	a. Apply fault at the Eddy North 230kV bus.
	b. Clear fault after 5 cycles and trip the faulted transformer.
FLT16-3PH	**3 phase fault on Eddy South 230kV (527800) to Cunningham 230kV (527865) CKT 1, near Eddy South**
	a. Apply fault at the Eddy South 230kV 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.
FLT17-3PH	**3 phase fault on Eddy South 230kV (527800) to 7 Rivers 230kV (528095) CKT 1, near Eddy South.**
	a. Apply fault at the Eddy South 230kV 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.
FLT18-3PH	**3 phase fault on Roswell Int 115kV (527564) to RIACTWTY_TP 115kV (527596) CKT 1, near Roswell Int.**
	a. Apply fault at the Roswell Int 115kV 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.
FLT19-3PH	**3 phase fault on the Border (515458) to Woodward (515375) 345kV line circuit 1, near Border.**
	a. Apply fault at the Border 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.
FLT20-3PH	**3 phase fault on the Border (515458) to TUCO Int (525832) 345kV line circuit 1, near Border.**
	a. Apply fault at the Border 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.
FLT21-3PH	**3 phase fault on the TUCO Int (525832) to OKU (511456) 345kV line circuit 1, near TUCO Int.**
	a. Apply fault at the TUCO Int 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.
FLT22-3PH	**3 phase fault on the OKU (511456) to LES (511468) 345kV line circuit 1, near OKU.**
	a. Apply fault at the OKU 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.
FLT23-PO	**Prior Outage of Chaves County 230 kV (527483) to Eddy North (527799)CKT 1; 3 phase fault on Chaves County 115 kV (527482) to Urton 115 kV (527501) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves 115 kV bus.
	b. Clear fault after 5 cycles by tripping the faulted line.

Table 6-1: Fault Definitions (continued)

Proposed Name	Description
FLT24-PO	**Prior Outage of Chaves County 230 kV (527483) to Eddy North (527799) ; 3 phase fault on Chaves County 115 kV (527482) to Samson 115 kV (527546) CKT 1, near Chaves County.**
	a. Apply fault at the Chaves 115 kV bus.
	b. Clear fault after 5 cycles by tripping the faulted line.
FLT25-SB	**Stuck Breaker Chaves 230kV**
	a. Apply fault at the Chaves (527483) 230kV bus
	b. Clear fault after 16 cycles and trip the following elements
	c. Chaves County 115 kV (527482)/ 230 kV (527483)/13.2 kV (527479) transformer
	d. Chaves County (527483) - Eddy North (527799) 230 kV
FLT26-3PH	**3 phase fault on the Chaves County 115 kV (527482) to Chaves County 230 kV (527483) to Chaves County 13.2 kV (527479) XFMR CKT 2, near Chaves County 115 kV.**
	a. Apply fault at the Chaves County 115 kV bus.
	b. Clear fault after 5 cycles and trip the faulted transformer.
FLT27-3PH	**3 phase fault on the Chaves County 115 kV (527482) to Chaves County 69 kV (527481) to Chaves County 13.2 kV (527480) XFMR CKT 1, near Chaves County 115 kV.**
	a. Apply fault at the Chaves County 115 kV bus.
	b. Clear fault after 5 cycles and trip the faulted transformer.
FLT28-3PH	**3 phase fault on Eddy North 230kV (527799) to EPTNP-D6 230kV (599960) CKT 1, near Eddy North**
	a. Apply fault at the Eddy North 230kV 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.
FLT29-3PH	**3 phase fault on Eddy County 345kV (527802) to Crossroads 345kV (527656) CKT 1, near Eddy County.**
	a. Apply fault at the Eddy County 345kV 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.
FLT30-3PH	**3 phase fault on TOLK 345kV (525549) to Crossroads 345kV (527656) CKT 1, near TOLK.**
	a. Apply fault at the TOLK 345kV 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.

Single-line-to-ground (SLG) fault strengths were determined by applying a 3-phase fault on the base case large enough to produce a 0.6 pu voltage value on the faulted bus. This SLG value was used for the SLG faults in FLT25-SB and FLT-10-SB.

6.3 Results

For the analysis, the machine rotor angle damping and transient voltage recovery criteria were met for all faults studied. The dynamic stability plots are provided in Appendix B.

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7.0 CONCLUSIONS

The purpose of this study was to evaluate the impacts of the proposed GEN-2014-033, GEN-2014-034, and GEN-2014-035 generation interconnection projects on the SPP transmission system. Short circuit analysis, power factor analysis, reactive power analysis and stability analysis were performed for the evaluation.

7.1 Short Circuit Analysis

The results from short circuit analysis showed that the maximum change in the fault current in the immediate systems at or near GEN-2014-033, GEN-2014-034, and GEN-2014-035 was negligible for the 2017 summer peak case and the 2025 summer peak case. All three phase current levels with the GEN-2014-033, GEN-2014-034, and GEN-2014-035 generators online were below 34,000 A.

7.2 Power Factor Analysis

For the contingencies tested, the lowest power factor was found to be 0.968 (-18.017 MVAr contribution) in the 2016 WP case for loss of the Chaves County to Eddy North 230 kV line for GEN-2014-033 and GEN-2014-034. The lowest power factor was found to be .857 (-18.017 MVAr contribution) for GEN-2014-035, also for loss of the Chaves County to Eddy North 230 kV line. The Schneider XC inverter documentation[1] shows a +/- 0.8 power factor capability. The GE LV5 4 MW inverter documentation[2] shows a power factor capability of 0.743 leading and 0.781 lagging when in Q-priority mode. There were no contingency events tested for which the required power factor at the POI exceeded the capability of the GE LV5 or Schneider XC inverter. Per tariff requirements, the Generating Facilities will be required to meet the standard 95% power factor requirement at the Point of Interconnection. The customer may be required to add capacitor and/or reactor banks depending upon its final collector system design.

7.3 Reactive Power Analysis

The reactive power analysis showed that a shunt reactor with values of 1.15 MVAr, 0.88 MVAr, and 0.36 MVAr at GEN-2014-033, GEN-2014-034, and GEN-2014-035, respectively, is needed to reduce the net reactive power injection at the POI to approximately zero during low/no solar irradiance while the generation interconnection project is still connected to the grid.

7.4 Stability Analysis

The stability analysis showed no generator tripping, machine rotor angle damping violations or transient voltage recovery violations associated with the GEN-2014-033, GEN-2014-034, and GEN-2014-035

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[1] Modeling of Schneider Electric's XC Series Photovoltaic Inverters for Power Flow and Stability Studies with PSS/E Versions 32 and 33, Revision A6, June 6, 2013.

[2] LV5 PSS/E Model Version 3 User Manual, Revision 002 2015-05-15.

project for the simulated fault events. There were no system stability issues caused by the interconnection of the GEN-2014-033, GEN-2014-034, and GEN-2014-035 project which required mitigation. It should be noted that the results of this study are based on available data and assumptions made at the time of this study. If any of the data and/or assumptions change, the results provided in this report may not apply.

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