GEN-2013-027
Impact Restudy for Generator Modification (Turbine Change)

August 2017
Generator Interconnection

Southwest Power Pool

Revision History

Date	Author	Change Description
8/23/2017	SPP	GEN-2013-027 Impact Restudy for Generator Modification Report Issued

Southwest Power Pool

Executive Summary

The GEN-2013-027 Interconnection Customer has requested a modification to its Generator Interconnection Request to change wind turbine generators for its project. Previously, it consisted of sixty-one (61) Siemens 108m 2.3MW and four (4) Siemens 108m with Powerboost 2.415MW wind turbines for a total of 149.96 MW. The requested change is for forty-three (43) Vestas V126 GulfStream (GS) 3.45MW wind for a total of 148.35 MW. The Point of Interconnection (POI) is the new Southwestern Public Service Company (SPS) Needmore 230 kV Substation.

The study models used were the 2016 winter, 2017 summer, and 2025 summer models that included Interconnection Requests through the facility study queue at DISIS-2015-002. Additionally, DISIS-2015-001 models were also created from the DISIS-2015-002 models in order to provide a baseline verification for the turbine change. The baseline verification was used to identify Network Upgrade(s) triggered by the addition of the lower queued DISIS-2015-002 generation.

The restudy showed that the stability analysis has determined 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. Additionally, the project wind farm 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 the study generation project was performed on the 2016 winter peak, 2017 summer peak, and 2025 summer peak cases with identified system upgrades up to the DISIS-2015-001 queue position. As reactive power is required for GEN-2013-027, 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. To offset these effects, the generating facility is required to provide reactive compensation of approximately 4 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 in place, GEN-2013-027 with the Vestas V126 GS 3.45MW wind turbine generators should be able to interconnect reliably to the SPP transmission grid. At this time, the change in wind turbine generator is not a Material Modification.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. Power flow 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-2013-027 Interconnection Customer has requested a modification to its Generator Interconnection Request to change its generators from Siemens 2.3 MW and 2.415 MW wind turbines to Vestas V126 GS 3.45MW wind turbines. Previously, sixty-one (61) Siemens 108m 2.3MW and four (4) Siemens 108m with Powerboost 2.415MW wind turbines. The requested change is shown in **Table 1-1**.

Table 1-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2013-027	148.35	43 x Vestas V126 GS G114 3.45MW	Tap Tolk (525531) – Yoakum (526935) 230kV, Needmore 230 kV

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 1000 (524890, 524896)	San Juan Mesa 230kV (524885)
GEN-2001-036	80	Mitsubishi 1000 (583316)	Norton 115kV (524502)
GEN-2006-018	170	GENSAL (525841 A1, 525842 B1, 525843 C1)	Tuco 230kV (525830)
GEN-2006-026	502	GENROU (527901, 527902, 527903)	Hobbs 115kV(527891) Hobbs 230kV (527894)
GEN-2008-022	300	Vestas (577100, 577110, 577120)	Tap on Eddy County – Tolk 345kV line (G08-022-POI, 560007)
GEN-2010-006	180 Summer 205 Winter	GENROU (526333)	Jones_bus2 230kV(526337)
ASGI-2010-010	42	GENSAL (528331)	Lovington 115kV (528334)
ASGI-2010-020	30	GE 2.3MW (580088)	Tap LE-Tatum to LE-Crsroads 69kV (AS10-020-POI, 560360)
ASGI-2010-021	15	Mitsubishi MPS-1000A 1.0MW (580083)	Tap LE-Saundrtp to LE-Anderson 69kV (ASGI-021-POI, 560364)
GEN-2010-046	56	GENSAL (580043)	Tuco 230kV (525830)
ASGI-2011-001	27.3	Suzlon S97 2.1MW (579423)	Lovington 115kV (528334)
ASGI-2011-003	10	Sany 2.0MW (579433)	Hendricks 69kV (525943)
ASGI-2011-004	19.8	Sany 1.8MW (583193, 583196)	Crosby 69kV (525915)
GEN-2011-025	80	GE 1.79MW (581140)	Tap on Floyd County - Crosby County 115kV line (G11-025-POI, 562004)
GEN-2011-045	180 Summer 205 Winter	GENROU (526334)	Jones_bus2 230kV (526337)
GEN-2011-046	23 Summer 27 Winter	GENROU (524471)	Quay County 115kV (524472)
GEN-2011-048	165 Summer 175 Winter	GENROU	Mustang 230kV (527151)

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

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2012-001	61.2	CCWE 3.6MW (WT4) (599126)	Tap Grassland to Borden 230kV (526679)
ASGI-2012-002	18	Vestas 1.65MW V82 (583283)	Clovis 115kV (524808)
GEN-2012-020	478	GE 1.68MW (583343, 583346)	Tuco 230kV (525830)
GEN-2012-034	7 MW increase (Pgen=157MW)	GENROU (unit 4; 527164)	Mustang 230kV (527151)
GEN-2012-035	7 MW increase (Pgen=157MW)	GENROU (unit 5; 527165)	Mustang 230kV (527151)
GEN-2012-036	7 MW increase (Pgen=172MW Summer/185MW Winter)	GENROU (unit 6; 527166)	Mustang 230kV (527151)
GEN-2012-037	196 Summer 203 Winter	GENROU (525844)	Tuco 345kV (525832)
GEN-2013-016	191 Summer 203 Winter	GENROU (525845)	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 (ASGI-2012-002)	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	Solaron 500kW (583313)	Caprock 115kV (524486)
GEN-2013-027	150.0	Vestas V126 3.45MW (583843)	Tap on Yoakum to Tolk 230kV (562480)
GEN-2014-012 (Only in 2020SP, 2020WP, & 2025SP)	186 Summer 225 Winter	GENROU (528501)	Tap Hobbs (527894) to Andrews (528604) 230kV (Tap bus is 528611)
ASGI-2014-001	2.5	GE 107m 2.5MW (583816)	Erskine 69kV (526109)
GEN-2014-033	70	GE LV5 4.0MW Inverters and Schneider XC 680 0.68MVA Inverters (583953, 583956)	Chaves County 115kV
GEN-2014-034	70	GE LV5 4.0MW Inverters (583963)	Chaves County 115kV
GEN-2014-035	30	GE LV5 4.0MW Inverters (583973)	Chaves County 115kV
GEN-2014-047	40	AE 500NX 0.5 MW PV inverters (584263)	Tap Tolk - Eddy County (Crossroads) 345kV

A stability analysis was performed for the change in wind turbines. 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.

The 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.

The power factor analysis determines the power factor at the point of interconnection (POI) for the wind 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**.

A reduced (low wind/no wind) 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 wind conditions.

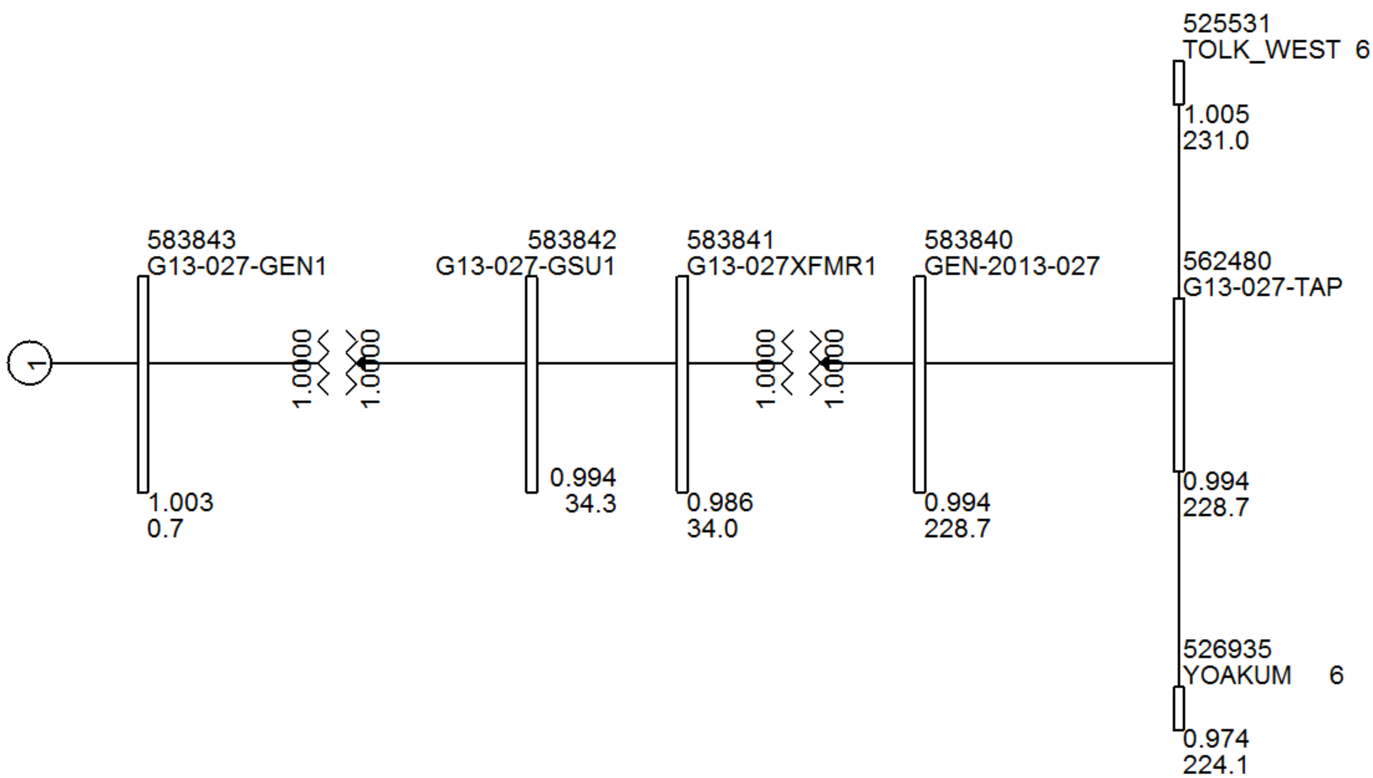
Short Circuit analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases. The results from the Short circuit analysis are shown in **Appendix F**.

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-2013-027. The POI is the new SPS Needmore 230 kV substation.

Figure 2-1*:* GEN-2013-027 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. 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-one (31) 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 Company (SPS)

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
0	FLT_000_NOFAULT	No Fault Conditions
1	FLT_01_CROSSROADS7_EDDYCNTY7_345kV_3PH	3 phase fault on Crossroads 345kV (527656) to Eddy County 345kV (527802) CKT 1, near Crossroads. a. Apply fault at the Crossroads 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.
2	FLT_02_CROSSROADS7_TOLK7_345kV_3PH	3 phase fault on Crossroads 345kV (527656) to Tolk 345kV (525549) CKT 1, Crossroads. a. Apply fault at the Crossroads 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.
3	FLT_03_TOLKTAP6_TOLK7_230_345kV_3PH	3 phase fault on the Tolk Tap 230kV (525543) to Tolk 345kV (525549) to Tolk 13.2kV (525537) XFMR CKT 1, near Tolk Tap 230kV. a. Apply fault at the Tolk Tap 230kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
4	FLT_04_G13027TAP_TOLKWEST6_230kV_3PH	3 phase fault on the GEN-2013-027 (562480) to Tolk West (525531) 230 kV line, near GEN-2013-027. a. Apply fault at the GEN-2013-027 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.
5	FLT_05_G13027TAP_YOAKUM6_230kV_3PH	3 phase fault on the GEN-2013-027 (562480) to Yoakum (526935) 230 kV line, near GEN-2013-027. a. Apply fault at the GEN-2013-027 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.
6	FLT_06_YOAKUM6_AMOCOSS6_230kV_3PH	3 phase fault on the Yoakum (526935) to Amoco-SS (526460) 230 kV line, near Yoakum. a. Apply fault at the Yoakum 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
7	FLT_07_YOAKUM6_OXYBRUTP6_230kV_3PH	3 phase fault on the Yoakum (526935) to OxyBru Tap (527010) 230 kV line, near Yoakum. a. Apply fault at the Yoakum 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.
8	FLT_08_YOAKUM6_MUSTANG6_230kV_3PH	3 phase fault on the Yoakum (526935) to Mustang (527149) 230 kV line, near Yoakum. a. Apply fault at the Yoakum 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.
9	FLT_09_YOAKUM6_G1579G1580T_230kV_3PH	3 phase fault on the Yoakum (526935) to G1579&G1580T (560059) 230 kV line, near Yoakum. a. Apply fault at the Yoakum 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.
10	FLT_10_YOAKUM6_YOAKUM3_230_115kV_3PH	3 phase fault on the Yoakum 230kV (526935) to Yoakum 115 kV (526934)/13.2 kV (526931) transformer circuit #1, near Yoakum. a. Apply fault at the Yoakum 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer and remove fault.
11	FLT_11_TOLKWEST6_ROSEVELTN6_230kV_3PH	3 phase fault on Tolk West 230kV (525531) to Roosevelt 230kV (524909) CKT 2, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
12	FLT_12_TOLKWEST6_PLANTX6_230kV_3PH	3 phase fault on the Tolk West (525531) to Plant X (525481) 230 kV circuit #1 line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
13	FLT_13_TOLK7_TOLKTAP6_345_230kV_3PH	3 phase fault on the Tolk 345 kV (525549) to Tolk Tap 230 kV (525543)/ 13.2 kV (525537) transformer, near Tolk 345 kV. a. Apply fault at the Tolk 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
14	FLT_14_TOLKWEST6_LAMBCNTY6_230kV_3PH	3 phase fault on the Tolk West (525531) to Lamb Co (525637) 230 kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
15	FLT_15_TUCOINT7_BORDER7_345kV_3PH	3 phase fault on the Tuco (525832) to Border (515458) 345kV line circuit 1, near Tuco. a. Apply fault at the 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.
16	FLT_16_BORDER7_WWRDEHV7_345kV_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.
17	FLT_17_TUCOINT7_OKU7_345kV_3PH	3 phase fault on the Tuco (525832) to OKU (511456) 345kV line circuit 1, near Tuco. a. Apply fault at the 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.
18	FLT_18_TOLKWEST6_G13027TAPSB_230kV_1PH	**Single phase fault with stuck breaker** on the Tolk West (525531) to GEN-2013-027 (562480) 230 kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Run 5 cycles, and then open GEN-2013-027 end of the faulted line. c. Run 10 cycles, and then clear the fault, disconnect Tolk West (525531) 230 kV bus, drop the Tolk 2 machine and disconnect the bus at 525562.
19	FLT_19_YOAKUM6_G13027TAPSB_230kV_1PH	**Single phase fault with stuck breaker** on the Yoakum (526935) to GEN-2013-027 (562480) 230 kV line, near Yoakum. a. Apply fault at the Yoakum 230kV bus. b. At 5 cycles, open GEN-2013-027 end of the faulted line. c. At 15 cycles, clear the fault and open Yoakum end of the line in (b) and trip Yoakum (526935) to Yoakum 115 (526934)/13.2 kV (526931) transformer circuit #1.
20	FLT_20_YOAKUM6_YOAKUM3PO_230_115kV_3PH_16WP	**(Prior Outage)** Yoakum (526935) – Amoco-SS (526460) 230 kV out of service then 3 phase fault on the Yoakum 230 kV (526935) to Yoakum 115 kV (526934)/13.2 kV (526931) transformer circuit #1, near Yoakum. Switch Yoakum (526935) – Amoco-SS (526460) out of service then solve. a. Apply fault at the Yoakum 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer and remove fault.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
21	FLT_21_YOAKUM6_AMOCOSS6SB_230kV_1PH	**Single phase fault with stuck breaker** on the Yoakum (526935) to Amoco-SS (526460) 230 kV line, near Yoakum. a. Apply fault at the Yoakum 230kV bus. b. At 5 cycles, open Amoco-SS end of the faulted line. c. At 15 cycles, clear the fault and trip Yoakum 230 kV (526935) bus.
22	FLT_22_TOLKWEST6_ROSEVELTN6SB_230kV_1PH	**Single phase fault with stuck breaker** on the Tolk West (525531) to Roosevelt N (524909) 230 kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Run 5 cycles, and then open Roosevelt N end of the faulted line. c. Run 10 cycles, and then clear the fault, disconnect Tolk West (525531) 230 kV bus, drop the Tolk 2 machine and disconnect the bus at 525562.
23	FLT_23_TOLKWEST6_PLANTX6SB_230kV_1PH	**Single phase fault with stuck breaker** on the Tolk West (525531) to Plant X (525481) 230 kV circuit #1 line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Run 5 cycles, and then open Plant X end of the faulted line. c. Run 10 cycles, and then clear the fault, disconnect Tolk West (525531) 230 kV bus, drop the Tolk 2 machine and disconnect the bus at 525562.
24	FLT_24_TOLKWEST6_LAMBCNTY6SB_230kV_1PH	**Single phase fault with stuck breaker** on the Tolk West (525531) to Lamb Co (525637) 230 kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Run 5 cycles, and then open Lamb Co end of the faulted line. c. Run 10 cycles, and then clear the fault, disconnect Tolk West (525531) 230 kV bus, drop the Tolk 2 machine and disconnect the bus at 525562.
25	FLT_25_TOLKEAST6_PLANTX6PO_230kV_3PH_16WP	**(Prior Outage)** Tolk West (525531) – Plant X (525481) 230 kV circuit #1 out of service then 3 phase fault on the Tolk East 230 kV (525524) to Plant X (525481) 230 kV circuit #2, near Tolk East. Switch Tolk West (525531) – Plant X (525481) 230 kV circuit #1 out of service then solve. a. Apply fault at the Tolk East 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
26	FLT_26_TOLKEAST6_PLANTX6SB_230kV_1PH	**Single phase fault with stuck breaker** on the Tolk East (525524) to Plant X (525481) 230 kV line circuit #2, near Tolk East. a. Apply fault at the Tolk East 230kV bus. b. Run 5 cycles, and then open Plant X end of the faulted line. c. Run 10 cycles, and then clear the fault, disconnect Tolk East (525524) 230 kV bus, drop the Tolk 1 machine and disconnect the bus at 525561.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
27	FLT_27_HOBBSINT6_ANDREWS6SB_230kV_1PH_16WP17SP **(16WP-17SP Only)**	**Single phase fault with stuck breaker** (4K125) on the Hobbs (527894) to Andrews (528604) 230 kV circuit #1 line, near Hobbs. a. Apply fault at the Hobbs 230kV bus. b. At 5 cycles, open Andrews end of the faulted line. c. At 15 cycles, clear the fault and open Hobbs end of the line in (b) and trip Hobbs Plt (527903).
28	FLT_28_HOBBSINT6_GAINESGENTP6SB_230kV_1PH_20SP25SP **(25SP Only)**	**Single phase fault with stuck breaker** (4K125) on the Hobbs (527894) to Gaines Generation Tap (528611) 230 kV circuit #1 line, near Hobbs. a. Apply fault at the Hobbs 230kV bus. b. At 5 cycles, open Gaines Generation Tap end of the faulted line. c. At 15 cycles, clear the fault and open Hobbs end of the line in (b) and trip Hobbs Plt (527903).
29	FLT_29_HOBBSINT6_ANDREWS6SB_230kV_1PH_16WP17SP **(16WP-17SP Only)**	**Single phase fault with stuck breaker** (4K120) on the Hobbs (527894) to Andrews (528604) 230 kV circuit #1 line, near Hobbs. a. Apply fault at the Hobbs 230kV bus. b. At 5 cycles, open Andrews end of the faulted line. c. At 15 cycles, clear the fault and open Hobbs end of the line in (b) and trip Hobbs (527894) to Cunnigham (527865) and Hobbs to G1579&G1580T (560059).
30	FLT_30_HOBBSINT6_GAINESGENTP6SB_230kV_1PH_20SP25SP **(25SP Only)**	**Single phase fault with stuck breaker** (4K120) on the Hobbs (527894) to Gaines Generation Tap (528611) 230 kV circuit #1 line, near Hobbs. a. Apply fault at the Hobbs 230kV bus. b. At 5 cycles, open Andrews end of the faulted line. c. At 15 cycles, clear the fault and open Hobbs end of the line in (b) and trip Hobbs (527894) to Cunnigham (527865) and Hobbs to G14-070-TAP (560018).
31	FLT_31_HOBBSINT6_G1579G1580T_230kV_3PH	3 phase fault on the Hobbs (527894) G1579&G1580T (560059) 230 kV line, near Hobbs. a. Apply fault at the Hobbs 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.

Results

The stability analysis was performed and the results are summarized in **Table 3-2**. The stability analysis has shown that for the contingencies simulated the generators in the monitored areas remained stable and the system voltages recovered to acceptable levels.

The stability plots will be available upon customer request.

Table 3-2: Results

Contingency Number and Name		2016WP	2017SP	2025SP
0	FLT_000_NOFAULT	STABLE	STABLE	STABLE
1	FLT_01_CROSSROADS7_EDDYCNTY7_345kV_3PH	STABLE	STABLE	STABLE
2	FLT_02_CROSSROADS7_TOLK7_345kV_3PH	STABLE	STABLE	STABLE
3	FLT_03_TOLKTAP6_TOLK7_230_345kV_3PH	STABLE	STABLE	STABLE
4	FLT_04_G13027TAP_TOLKWEST6_230kV_3PH	STABLE	STABLE	STABLE
5	FLT_05_G13027TAP_YOAKUM6_230kV_3PH	STABLE	STABLE	STABLE
6	FLT_06_YOAKUM6_AMOCOSS6_230kV_3PH	STABLE	STABLE	STABLE
7	FLT_07_YOAKUM6_OXYBRUTP6_230kV_3PH	STABLE	STABLE	STABLE
8	FLT_08_YOAKUM6_MUSTANG6_230kV_3PH	STABLE	STABLE	STABLE
9	FLT_09_YOAKUM6_G1579G1580T_230kV_3PH	STABLE	STABLE	STABLE
10	FLT_10_YOAKUM6_YOAKUM3_230_115kV_3PH	STABLE	STABLE	STABLE
11	FLT_11_TOLKWEST6_ROSEVELTN6_230kV_3PH	STABLE	STABLE	STABLE
12	FLT_12_TOLKWEST6_PLANTX6_230kV_3PH	STABLE	STABLE	STABLE
13	FLT_13_TOLK7_TOLKTAP6_345_230kV_3PH	STABLE	STABLE	STABLE
14	FLT_14_TOLKWEST6_LAMBCNTY6_230kV_3PH	STABLE	STABLE	STABLE
15	FLT_15_TUCOINT7_BORDER7_345kV_3PH	STABLE	STABLE	STABLE
16	FLT_16_BORDER7_WWRDEHV7_345kV_3PH	STABLE	STABLE	STABLE
17	FLT_17_TUCOINT7_OKU7_345kV_3PH	STABLE	STABLE	STABLE
18	FLT_18_TOLKWEST6_G13027TAPSB_230kV_1PH	STABLE	STABLE	STABLE
19	FLT_19_YOAKUM6_G13027TAPSB_230kV_1PH	STABLE	STABLE	STABLE
20	FLT_20_YOAKUM6_YOAKUM3PO_230_115kV_3PH_16WP	STABLE	STABLE	STABLE
21	FLT_21_YOAKUM6_AMOCOSS6SB_230kV_1PH	STABLE	STABLE	STABLE
22	FLT_22_TOLKWEST6_ROSEVELTN6SB_230kV_1PH	STABLE	STABLE	STABLE
23	FLT_23_TOLKWEST6_PLANTX6SB_230kV_1PH	STABLE	STABLE	STABLE
24	FLT_24_TOLKWEST6_LAMBCNTY6SB_230kV_1PH	STABLE	STABLE	STABLE
25	FLT_25_TOLKEAST6_PLANTX6PO_230kV_3PH_16WP	STABLE	STABLE	STABLE
26	FLT_26_TOLKEAST6_PLANTX6SB_230kV_1PH	STABLE	STABLE	STABLE
27	FLT_27_HOBBSINT6_ANDREWS6SB_230kV_1PH_16WP17SP **(16WP-17SP Only)**	STABLE	STABLE	
28	FLT_28_HOBBSINT6_GAINESGENTP6SB_230kV_1PH_20SP25SP **(25SP Only)**			STABLE
29	FLT_29_HOBBSINT6_ANDREWS6SB_230kV_1PH_16WP17SP **(16WP-17SP Only)**	STABLE	STABLE	
30	FLT_30_HOBBSINT6_GAINESGENTP6SB_230kV_1PH_20SP25SP **(25SP Only)**			STABLE
31	FLT_31_HOBBSINT6_G1579G1580T_230kV_3PH	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 tested to meet Order 661A LVRT provisions. GEN-2013-027 was found to be in compliance with FERC Order 661A.

Table 3-3: LVRT Contingencies

Contingency Number and Name	Description
FLT_04_G13027TAP_TOLKWEST6_230kV_3PH	3 phase fault on the GEN-2013-027 (562480) to Tolk West (525531) 230 kV line, near GEN-2013-027. a. Apply fault at the GEN-2013-027 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.
FLT_05_G13027TAP_YOAKUM6_230kV_3PH	3 phase fault on the GEN-2013-027 (562480) to Yoakum (526935) 230 kV line, near GEN-2013-027. a. Apply fault at the GEN-2013-027 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.

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 project at that POI and 0.0 Mvar capability.

An 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 three phase 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-2013-027	148.35	Tap Tolk - Yoakum 230kV, Needmore 138kV	Wind	43 x Vestas V126 GS 3.45MW	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.

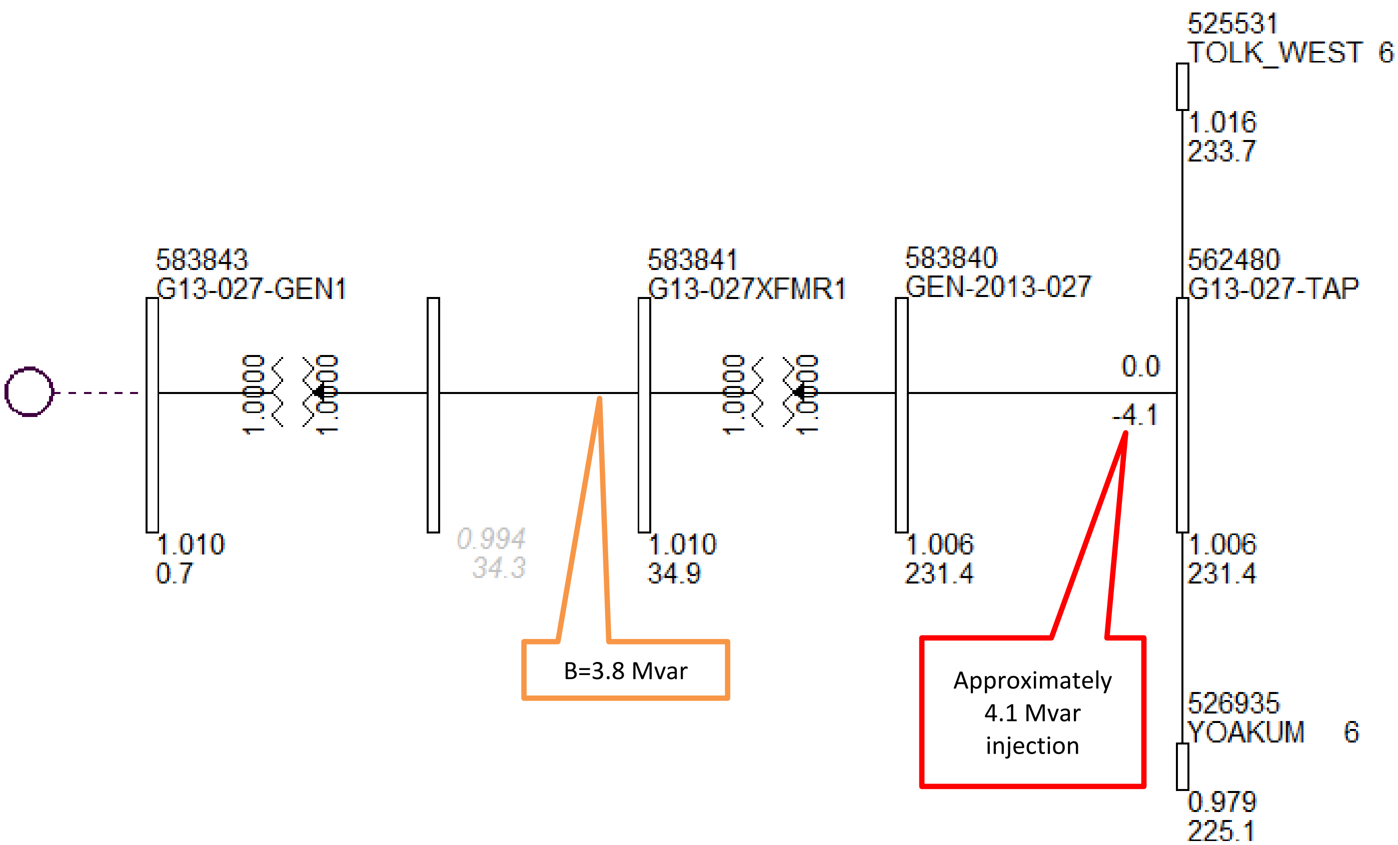
5. Reduced Wind Generation Analysis

A low wind analysis was performed for GEN-2013-027. SPP performed this low wind analysis to determine the capacitive charging current injected at the POI.

The project generators and capacitors (if any) were turned off in the base case. **Figure 5-1** shows the resulting reactive power injection (approximately 4 Mvar) at the POI that is due to the capacitance of the project's transmission lines and collector cables. Also, the figure shows how the capacitance is distributed throughout the project. In this impact restudy GEN-2013-027 is responsible for a 4 Mvar reactor needed to offset the capacitive effects of the collector system (3.8Mvar) and of the transmission lead (0.2Mvar) that connects into the transmission system under no/reduced wind generating conditions. The 4Mvar reactor will be required and would normally be installed on the low side of the 230/34.5kV transformer. The Interconnection Customer may use wind turbine manufacturing options for providing reactive power under no/reduced generation conditions.

Figure 5-2 shows a shunt reactor added at the GEN-2013-027 project substation 34.5 kV bus to bring the Mvar flow into the POI down to approximately zero.

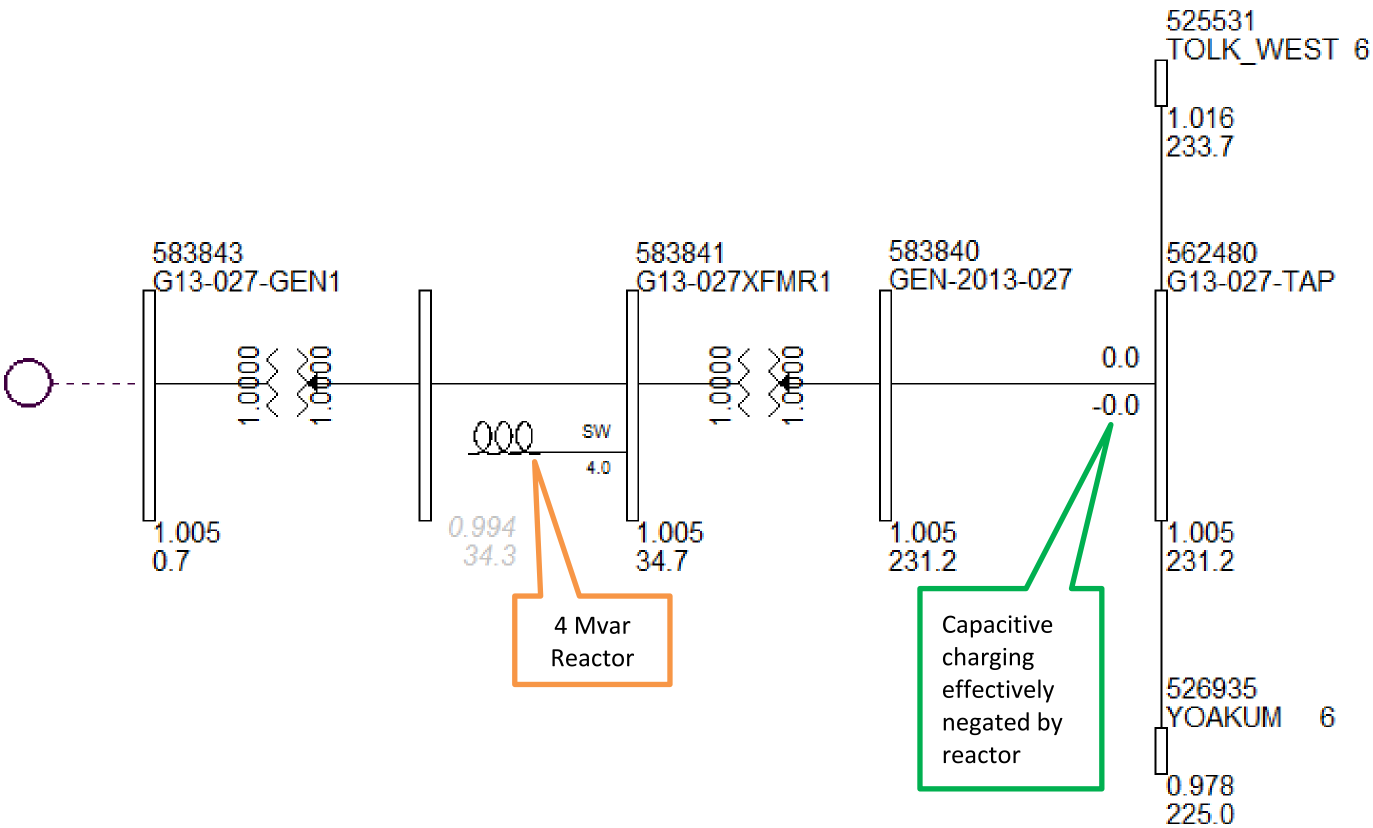
Figure 5-1: GEN-2013-027 with generators turned off



Notes:

1. Amber box shows distribution of charging capacitance in the facility. The charging capacitance on the transmission line from the generation facility to the POI is negligible.
2. Red box shows the net effect of all the charging capacitances at the POI

Figure 5-2: GEN-2013-027 with generators turned off and shunt reactor added to the 34.5kV side of the customer substation



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 F, Table F-1 *GEN-2013-027 Short Circuit Analysis Results (2017SP)*** and **Table F-2 *GEN-2013-027 Short Circuit Analysis Results (2025SP)***.

7. Conclusion

The GEN-2013-027 Interconnection Customer has requested a modification to its Generator Interconnection Request to change wind turbine generators for its project. Previously, it consisted of sixty-one (61) Siemens 108m 2.3MW and four (4) Siemens 108m with Powerboost 2.415MW wind turbines for a total of 149.96 MW. The requested change is for forty-three (43) Vestas V126 GulfStream (GS) 3.45MW wind for a total of 148.35 MW. The Point of Interconnection (POI) is the new Southwestern Public Service Company (SPS) Needmore 230 kV Substation.

The study models used were the 2016 winter, 2017 summer, and 2025 summer models that included Interconnection. Requests through the facility study queue at DISIS-2015-002. Additionally, DISIS-2015-001 models were also created from the DISIS-2015-002 models in order to provide a baseline verification for the turbine change. The baseline verification was used to identify Network Upgrade(s) triggered by the addition of the lower queued DISIS-2015-002 generation.

The restudy showed that the stability analysis has determined 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. Additionally, the project wind farm 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 the study generation project was performed on the 2016 winter peak, 2017 summer peak, and 2025 summer peak cases with identified system upgrades up to the DISIS-2015-001 queue position. As reactive power is required for GEN-2013-027, 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. To offset these effects, the generating facility is required to provide reactive compensation of approximately 4 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.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. Power flow 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-2013-027 Power Factor Analysis Results

Leading power factor is absorbing vars; Lagging power factor is providing vars										
	GEN-2013-027 POI: Leonard 138 kV (561000) Power at POI (MW): 148.35	2016 Winter Peak POI Voltage = 1.014 pu			2017 Summer Peak POI Voltage = 1.015 pu			2025 Summer Peak POI Voltage = 1.013 pu		
	Contingency Name	**Mvars at POI**	**Power Factor**		**Mvars at POI**	**Power Factor**		**Mvars at POI**	**Power Factor**	
0	FLT_00_NoFault	-19.1175	0.991799	LEAD	4.254371	0.999589	LAG	2.273539	0.999883	LAG
1	FLT_01_CROSSROADS7_EDDYCNTY7_345kV	16.50787	0.993866	LAG	37.23049	0.969922	LAG	29.92099	0.98026	LAG
2	FLT_02_CROSSROADS7_TOLK7_345kV	-20.3464	0.990725	LEAD	2.559471	0.999851	LAG	1.880084	0.99992	LAG
3	FLT_03_TOLKTAP6_TOLK7_230_345kV	-20.3527	0.99072	LEAD	2.554942	0.999852	LAG	1.877785	0.99992	LAG
4	FLT_04_G13027TAP_TOLKWEST6_230kV	4.311256	0.999578	LAG	16.09273	0.994168	LAG	2.116214	0.999898	LAG
5	FLT_05_G13027TAP_YOAKUM6_230kV	-62.3837	0.921812	LEAD	-44.7708	0.957353	LEAD	-38.3462	0.968179	LEAD
6	FLT_06_YOAKUM6_AMOCOSS6_230kV	-13.4913	0.99589	LEAD	6.1329	0.999147	LAG	0.221952	0.999999	LAG
7	FLT_07_YOAKUM6_OXYBRUTP6_230kV	-19.1331	0.991785	LEAD	4.459285	0.999549	LAG	1.676351	0.999936	LAG
8	FLT_08_YOAKUM6_MUSTANG6_230kV	-18.6211	0.992214	LEAD	5.009104	0.99943	LAG	2.117167	0.999898	LAG
9	FLT_09_YOAKUM6_G1579&G1580T_230kV	-11.7104	0.996899	LEAD	24.54577	0.986587	LAG	11.68639	0.996912	LAG
10	FLT_10_YOAKUM6_YOAKUM3_230_115kV	-20.4295	0.990651	LEAD	3.41293	0.999735	LAG	1.85363	0.999922	LAG
11	FLT_11_TOLKWEST6_ROSEVELTN6_230kV	-18.7528	0.992105	LEAD	4.994177	0.999434	LAG	3.220461	0.999764	LAG
12	FLT_12_TOLKWEST6_PLANTX6_230kV	-17.3514	0.993229	LEAD	5.986191	0.999187	LAG	4.236259	0.999593	LAG
13	FLT_13_TOLK7_TOLKTAP6_345_230kV	-20.3527	0.99072	LEAD	2.554942	0.999852	LAG	1.877785	0.99992	LAG
14	FLT_14_TOLKWEST6_LAMBCNTY6_230kV	-16.012	0.994226	LEAD	10.8327	0.997345	LAG	6.91151	0.998916	LAG
15	FLT_15_TUCOINT7_BORDER7_345kV	-20.7488	0.99036	LEAD	3.221926	0.999764	LAG	1.425043	0.999954	LAG
16	FLT_16_BORDER7_WWRDEHV7_345kV	-21.1302	0.990008	LEAD	2.882341	0.999811	LAG	0.722355	0.999988	LAG
17	FLT_17_TUCOINT7_OKU7_345kV	-21.9178	0.989261	LEAD	2.458675	0.999863	LAG	1.044649	0.999975	LAG
18	FLT_29_HOBBSINT6_G1579&G1580T_230kV	-13.1535	0.996092	LEAD	23.04538	0.988148	LAG	10.02157	0.997726	LAG

Appendix E – Reduced Wind Generation Analysis Results

(One-line diagram moved to main body of report)

Appendix F – Short Circuit Analysis Results

Table F-1: GEN-2013-027 Short Circuit Analysis Results (2017SP)

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                             PSS®E ASCC SHORT CIRCUIT CURRENTS          THU, AUG 17 2017   8:43
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+)
562480 [G13-027-TAP 230.00] AMP     8842.8   -83.13
525531 [TOLK_WEST  6230.00] AMP    25294.5   -86.15
526935 [YOAKUM     6230.00] AMP    11670.9   -83.68
583840 [GEN-2013-027230.00] AMP     8401.7   -83.23
524909 [ROSEVELT_N 6230.00] AMP     8577.2   -82.08
525481 [PLANT_X    6230.00] AMP    21882.5   -85.22
525543 [TOLK_TAP   6230.00] AMP    25294.5   -86.15
525637 [LAMB_CNTY  6230.00] AMP     5315.1   -81.86
526460 [AMOCO_SS   6230.00] AMP     9102.1   -82.55
526934 [YOAKUM     3115.00] AMP    14679.4   -82.04
527010 [OXYBRU_TP  6230.00] AMP     9858.0   -83.56
527149 [MUSTANG    6230.00] AMP    10292.0   -84.21
560059 [G1579&G1580T230.00] AMP     8250.8   -83.57
524623 [DEAFSMITH  6230.00] AMP     7681.3   -80.79
524770 [PLSNT_HILL 6230.00] AMP     5969.0   -81.80
524908 [ROOSEVELT  3115.00] AMP    10053.3   -81.83
524915 [SW_4K33    6230.00] AMP     8577.2   -82.08
525461 [NEWHART    6230.00] AMP    10656.8   -81.87
525480 [PLANT_X    3115.00] AMP    20791.2   -84.02
525524 [TOLK_EAST  6230.00] AMP    25294.5   -86.15
525549 [TOLK       7345.00] AMP     6849.6   -87.53
525636 [LAMB_CNTY  3115.00] AMP     8474.2   -80.19
526435 [SUNDOWN    6230.00] AMP    10449.2   -82.64
526784 [AMOCOWASSON6230.00] AMP     9635.2   -83.83
526792 [PRENTICE   3115.00] AMP     5769.2   -75.67
526928 [PLAINS_INT 3115.00] AMP     9218.3   -78.07
527041 [ARCO_TP    3115.00] AMP    11998.5   -78.94
527146 [MUSTANG    3115.00] AMP    19877.1   -83.79
527151 [GS-MUSTANG 6230.00] AMP    10292.0   -84.21
527194 [LG-PLSHILL 3115.00] AMP     7200.0   -76.35
527276 [SEMINOLE   6230.00] AMP     6103.1   -82.34
527894 [HOBBS_INT  6230.00] AMP    14489.3   -86.70
523959 [POTTER_CO  6230.00] AMP    20123.4   -84.70
524267 [BUSHLAND   6230.00] AMP     9606.8   -82.93
524622 [DEAFSMITH  3115.00] AMP    11922.6   -79.72
524768 [PLSNT_HILL 3115.00] AMP     9576.8   -80.71
524822 [CURRY      3115.00] AMP    10230.1   -79.53
524875 [OASIS      6230.00] AMP     7157.1   -81.92
524911 [ROSEVELT_S 6230.00] AMP     8577.2   -82.08
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524924 [PORTALES   3115.00] AMP     7114.7   -78.83
525019 [EMU&VLY_TP 3115.00] AMP     5083.7   -76.00
525056 [BC-EARTH   3115.00] AMP     8736.1   -76.58
525213 [SWISHER    6230.00] AMP     9977.4   -82.27
525446 [SPGLAKE_TP3 115.00] AMP    10505.2   -77.67
525454 [HALE_CNTY  3115.00] AMP    10060.2   -73.67
525460 [NEWHART    3115.00] AMP    14949.2   -81.55
525635 [LAMB_CNTY  269.000] AMP     5909.9   -85.13
525830 [TUCO_INT   6230.00] AMP    19165.6   -84.58
526020 [HOCKLEY    3115.00] AMP     5464.0   -76.21
526434 [SUNDOWN    3115.00] AMP    11198.3   -80.92
526525 [WOLFFORTH  6230.00] AMP    12729.9   -83.31
526736 [TERRY_CNTY 3115.00] AMP    10509.2   -77.12
526944 [LG-PLAINS  3115.00] AMP     7550.9   -77.18
527018 [BENNETT    3115.00] AMP    12082.1   -78.97
527047 [OXY_WILRD1 3115.00] AMP     9800.2   -77.87
527062 [SHELL_CO2  3115.00] AMP    14455.7   -80.20
527130 [DENVER_N   3115.00] AMP    18662.7   -82.33
527136 [DENVER_S   3115.00] AMP    18662.7   -82.33
527202 [SEAGRAVES  3115.00] AMP     8140.9   -76.70
527275 [SEMINOLE   3115.00] AMP    10367.3   -80.38
527656 [CROSSROADS 7345.00] AMP     5222.7   -86.02
527865 [CUNNINHAM  6230.00] AMP    14213.2   -86.69
527891 [HOBBS_INT  3115.00] AMP    28205.8   -85.96
528604 [ANDREWS    6230.00] AMP     5704.4   -83.99
528626 [LE-PLNSINT 269.000] AMP     4300.1   -82.89
523309 [MOORE_CNTY 6230.00] AMP     6685.6   -82.73
523869 [CHAN/TASCOS6230.00] AMP     3839.6   -82.07
523961 [POTTER_CO  7345.00] AMP     7410.1   -86.52
523979 [HARRNG_EST 6230.00] AMP    25818.6   -86.32
524010 [ROLLHILLS  6230.00] AMP    19166.6   -84.79
524266 [BUSHLAND   3115.00] AMP     9314.7   -83.80
524290 [WILDOR2_JUS6230.00] AMP     6590.0   -83.45
524502 [NORTON     3115.00] AMP     2715.0   -80.50
524567 [NE_HEREFORD3115.00] AMP     9537.9   -78.34
524597 [PANDAHFD   3115.00] AMP     8335.8   -74.65
524606 [HEREFORD   3115.00] AMP    10687.3   -78.73
524669 [DS-#20     3115.00] AMP     4764.9   -68.32
524734 [DS-#21     3115.00] AMP    10765.2   -78.36
524746 [CASTRO_CNTY3115.00] AMP    11600.5   -78.94
524764 [NORRIS_TP  3115.00] AMP    10204.7   -79.52
524773 [E_CLOVIS   3115.00] AMP     8244.0   -78.55
524776 [N_CLOVIS_TP3115.00] AMP     7015.1   -78.62
524821 [CURRY      269.000] AMP     4312.4   -85.63
524831 [FE-HOLLAND 3115.00] AMP     8485.1   -79.25
524838 [FE-CLOVIS2 3115.00] AMP     9716.0   -79.30
524874 [OASIS      3115.00] AMP     9361.3   -81.67
524885 [SN_JUAN_TAP6230.00] AMP     4609.0   -83.05
524923 [PORTALES   269.000] AMP     7050.4   -82.41
524935 [KILGORE    3115.00] AMP     5570.3   -77.66
525018 [EMULESH&VLY3115.00] AMP     4718.2   -75.80
525028 [BAILEYCO   3115.00] AMP     4864.3   -75.99
525050 [BC-KELLEY  3115.00] AMP     8328.8   -76.40
525124 [HART_INDUST3115.00] AMP     7540.1   -76.43
525192 [KRESS_INT  3115.00] AMP    11023.2   -79.49
525212 [SWISHER    3115.00] AMP    10173.6   -81.31
525326 [COX        3115.00] AMP     5850.2   -71.99
525393 [SPRINGLAKE 3115.00] AMP     9343.6   -77.52
525414 [LAMTON     3115.00] AMP     7754.9   -75.23
525440 [LC-S_OLTON 3115.00] AMP     7393.0   -75.43
525453 [HALE_CNTY  269.000] AMP     6888.5   -82.63
525613 [W_LITTLFLD 269.000] AMP     2970.9   -73.96
525620 [LTFLD_S&CTY269.000] AMP     4177.3   -71.85
525650 [LC-LITTLFLD269.000] AMP     4939.3   -83.14
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525687 [LC-LUMSCHAP269.000] AMP     4618.8   -79.94
525828 [TUCO_INT   3115.00] AMP    18995.0   -82.75
525832 [TUCO_INT   7345.00] AMP    10079.1   -85.98
525840 [ANTELOPE_1 6230.00] AMP    19024.7   -84.59
526019 [HOCKLEY    269.000] AMP     5131.3   -81.73
526036 [LC-OPDYKE  3115.00] AMP     5764.7   -76.42
526161 [CARLISLE   6230.00] AMP    10295.2   -83.06
526269 [LUBBCK_STH 6230.00] AMP    16981.0   -85.25
526337 [JONES      6230.00] AMP    19159.6   -86.25
526352 [LEHMAN     3115.00] AMP     5961.0   -77.51
526424 [PACIFIC    3115.00] AMP     9502.5   -79.54
526445 [AMOCO_TP   3115.00] AMP    10560.7   -80.10
526491 [LG-CLAUENE 3115.00] AMP     8904.8   -77.06
526524 [WOLFFORTH  3115.00] AMP    11331.4   -81.75
526735 [TERRY_CNTY 269.000] AMP     6991.5   -84.14
527036 [SHELL_C2   3115.00] AMP    12005.5   -80.17
527046 [OXY_WILRD2 3115.00] AMP     9778.2   -77.86
527051 [ODC_TP     3115.00] AMP    12096.4   -78.97
527080 [EL_PASO    3115.00] AMP    14277.3   -80.02
527105 [SAN_ANDS_TP3115.00] AMP    15021.1   -80.13
527125 [DENVER_CTY 269.000] AMP     8386.1   -87.00
527201 [SEAGRAVES  269.000] AMP     5303.3   -83.35
527238 [ROZ        3115.00] AMP     8560.2   -79.16
527242 [AMERADA    3115.00] AMP     8649.8   -79.22
527262 [SULPHUR    3115.00] AMP     5546.5   -75.37
527286 [XTO_RUSSEL 3115.00] AMP     9605.2   -75.02
527322 [GAINES     3115.00] AMP     8071.6   -77.36
527340 [DOSS       3115.00] AMP     6757.6   -77.45
527800 [EDDY_SOUTH 6230.00] AMP     7095.7   -83.44
527802 [EDDY_CNTY  7345.00] AMP     4026.3   -84.90
527864 [CUNNINHAM  3115.00] AMP    24957.4   -84.27
527963 [POTASH_JCT 6230.00] AMP     6115.3   -82.69
528333 [LE-WEST_SUB3115.00] AMP     8426.7   -81.60
528355 [MADDOX     3115.00] AMP    24199.8   -85.05
528433 [NEW_NHOBBS 3115.00] AMP     7775.8   -73.82
528435 [MILLEN     3115.00] AMP    11035.1   -74.47
528602 [ANDREWS    3115.00] AMP     7719.9   -82.01
528740 [LE-PLANS_TP269.000] AMP     3573.3   -80.02
560050 [G15-031-TAP 230.00] AMP     8528.0   -82.19
560058 [G15-077-TAP 115.00] AMP     8041.0   -76.46
577103 [GEN-2008-022345.00] AMP     4960.1   -85.92
583340 [GEN-2012-020230.00] AMP     8643.8   -84.17
584260 [GEN-2014-047345.00] AMP     4249.5   -83.87
599955 [PNM-DC6     230.00] AMP     8577.2   -82.08
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Table F-2: GEN-2013-027 Short Circuit Analysis Results (2025SP)

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                             PSS®E ASCC SHORT CIRCUIT CURRENTS          THU, AUG 17 2017   8:43
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
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                                         THREE PHASE FAULT
X--------- BUS ----------X                  /I+/    AN(I+)
562480 [G13-027-TAP 230.00] AMP     9007.4   -83.10
525531 [TOLK_WEST  6230.00] AMP    26092.0   -86.11
526935 [YOAKUM     6230.00] AMP    15294.9   -84.79
583840 [GEN-2013-027230.00] AMP     8549.5   -83.20
524909 [ROSEVELT_N 6230.00] AMP     8709.0   -82.04
525481 [PLANT_X    6230.00] AMP    23136.3   -85.29
525543 [TOLK_TAP   6230.00] AMP    26092.0   -86.11
525637 [LAMB_CNTY  6230.00] AMP     5529.7   -82.22
526460 [AMOCO_SS   6230.00] AMP     9522.2   -82.61
526934 [YOAKUM     3115.00] AMP    15965.7   -82.65
526936 [YOAKUM_345  345.00] AMP     8477.5   -86.28
527010 [OXYBRU_TP  6230.00] AMP    11988.4   -84.20
527149 [MUSTANG    6230.00] AMP    12048.0   -84.63
560059 [G1579&G1580T230.00] AMP     8951.1   -83.41
524623 [DEAFSMITH  6230.00] AMP     7765.4   -81.18
524770 [PLSNT_HILL 6230.00] AMP     6055.0   -81.77
524908 [ROOSEVELT  3115.00] AMP    10209.1   -81.75
524915 [SW_4K33    6230.00] AMP     8709.0   -82.04
525461 [NEWHART    6230.00] AMP    10763.7   -81.83
525480 [PLANT_X    3115.00] AMP    26550.5   -85.01
525524 [TOLK_EAST  6230.00] AMP    26092.0   -86.11
525549 [TOLK       7345.00] AMP     6932.9   -87.53
525636 [LAMB_CNTY  3115.00] AMP     9649.1   -80.29
525832 [TUCO_INT   7345.00] AMP    12275.3   -86.20
526435 [SUNDOWN    6230.00] AMP    10885.6   -82.68
526784 [AMOCOWASSON6230.00] AMP    11329.6   -84.27
526792 [PRENTICE   3115.00] AMP     5881.1   -75.63
526928 [PLAINS_INT 3115.00] AMP     9634.1   -78.15
527041 [ARCO_TP    3115.00] AMP    12556.5   -78.95
527146 [MUSTANG    3115.00] AMP    21048.0   -83.90
527151 [GS-MUSTANG 6230.00] AMP    12048.0   -84.63
527194 [LG-PLSHILL 3115.00] AMP     7392.4   -76.30
527276 [SEMINOLE   6230.00] AMP     6557.5   -82.40
527894 [HOBBS_INT  6230.00] AMP    18652.1   -86.99
527896 [HOBBS_INT  7345.00] AMP     8201.1   -86.76
511456 [O.K.U.-7    345.00] AMP     5100.7   -84.33
515458 [BORDER     7345.00] AMP     5055.5   -86.21
523959 [POTTER_CO  6230.00] AMP    20179.7   -84.69
524267 [BUSHLAND   6230.00] AMP     9628.8   -82.95
524622 [DEAFSMITH  3115.00] AMP    12155.4   -80.48
524768 [PLSNT_HILL 3115.00] AMP     9808.4   -80.59
524822 [CURRY      3115.00] AMP    10485.2   -79.47
524875 [OASIS      6230.00] AMP     7260.0   -81.88
524911 [ROSEVELT_S 6230.00] AMP     8709.0   -82.04
524924 [PORTALES   3115.00] AMP     7189.6   -78.74
525019 [EMU&VLY_TP 3115.00] AMP     6422.1   -77.12
525056 [BC-EARTH   3115.00] AMP     9135.5   -76.32
525213 [SWISHER    6230.00] AMP    10137.4   -82.24
525446 [SPGLAKE_TP3 115.00] AMP    11477.2   -77.38
525454 [HALE_CNTY  3115.00] AMP    10242.0   -73.51
525460 [NEWHART    3115.00] AMP    15076.2   -81.48
525608 [NEW_AMHERST3115.00] AMP     5308.3   -80.60
525614 [W_LITLFLDTP3115.00] AMP     8225.5   -77.65
525635 [LAMB_CNTY  269.000] AMP     6225.5   -85.43
525830 [TUCO_INT   6230.00] AMP    22220.0   -85.13
526020 [HOCKLEY    3115.00] AMP     5611.0   -76.05
526434 [SUNDOWN    3115.00] AMP    11455.4   -80.87
526525 [WOLFFORTH  6230.00] AMP    13451.1   -83.45
526736 [TERRY_CNTY 3115.00] AMP    10747.0   -77.04
526944 [LG-PLAINS  3115.00] AMP     7801.4   -77.19
527018 [BENNETT    3115.00] AMP    12643.0   -78.98
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527047 [OXY_WILRD1 3115.00] AMP    10169.3   -77.84
527062 [SHELL_CO2  3115.00] AMP    15155.9   -80.19
527130 [DENVER_N   3115.00] AMP    19687.4   -82.34
527136 [DENVER_S   3115.00] AMP    19687.4   -82.34
527202 [SEAGRAVES  3115.00] AMP     8362.8   -76.63
527275 [SEMINOLE   3115.00] AMP    10827.6   -80.42
527656 [CROSSROADS 7345.00] AMP     5294.8   -86.02
527865 [CUNNINHAM  6230.00] AMP    17020.5   -86.67
527891 [HOBBS_INT  3115.00] AMP    32425.5   -85.85
527965 [KIOWA      7345.00] AMP     5518.0   -84.90
528611 [GAINESGENTP6230.00] AMP     9822.3   -85.44
528626 [LE-PLNSINT 269.000] AMP     4349.8   -82.82
511468 [L.E.S.-7    345.00] AMP    12244.9   -84.70
515375 [WWRDEHV7    345.00] AMP    18268.8   -86.03
523309 [MOORE_CNTY 6230.00] AMP     6692.2   -82.73
523869 [CHAN/TASCOS6230.00] AMP     3841.5   -82.07
523961 [POTTER_CO  7345.00] AMP     7424.0   -86.52
523979 [HARRNG_EST 6230.00] AMP    25904.0   -86.36
524010 [ROLLHILLS  6230.00] AMP    19215.9   -84.80
524266 [BUSHLAND   3115.00] AMP     9323.5   -83.80
524290 [WILDOR2_JUS6230.00] AMP     6599.8   -83.46
524502 [NORTON     3115.00] AMP     3310.9   -81.49
524567 [NE_HEREFORD3115.00] AMP     9687.9   -78.92
524597 [PANDAHFD   3115.00] AMP     9054.6   -80.09
524606 [HEREFORD   3115.00] AMP    10872.8   -79.38
524669 [DS-#20     3115.00] AMP     4804.7   -68.23
524734 [DS-#21     3115.00] AMP    10876.9   -78.29
524746 [CASTRO_CNTY3115.00] AMP    11734.2   -78.85
524764 [NORRIS_TP  3115.00] AMP    10458.2   -79.45
524773 [E_CLOVIS   3115.00] AMP     8408.9   -78.44
524776 [N_CLOVIS_TP3115.00] AMP     7124.9   -78.50
524821 [CURRY      269.000] AMP     4339.1   -85.66
524831 [FE-HOLLAND 3115.00] AMP     8661.0   -79.14
524838 [FE-CLOVIS2 3115.00] AMP     9945.4   -79.23
524874 [OASIS      3115.00] AMP     9489.6   -81.59
524885 [SN_JUAN_TAP6230.00] AMP     4655.9   -83.00
524923 [PORTALES   269.000] AMP     7094.6   -82.38
524935 [KILGORE    3115.00] AMP     5905.7   -77.79
524977 [MARKET_ST  3115.00] AMP     5477.7   -77.42
525018 [EMULESH&VLY3115.00] AMP     5850.2   -76.77
525028 [BAILEYCO   3115.00] AMP     6363.0   -77.42
525050 [BC-KELLEY  3115.00] AMP     8582.7   -76.19
525124 [HART_INDUST3115.00] AMP     7600.4   -76.33
525192 [KRESS_INT  3115.00] AMP    11120.0   -79.42
525212 [SWISHER    3115.00] AMP    10254.1   -81.26
525326 [COX        3115.00] AMP     5891.5   -71.89
525393 [SPRINGLAKE 3115.00] AMP    10104.7   -77.25
525414 [LAMTON     3115.00] AMP     7936.2   -75.05
525440 [LC-S_OLTON 3115.00] AMP     7644.3   -75.21
525453 [HALE_CNTY  269.000] AMP     6939.8   -82.63
525594 [SUDANRURAL 3115.00] AMP     4771.7   -80.29
525607 [NEW_AMHERST269.000] AMP     3221.7   -85.76
525615 [W_LITTLFLD 3115.00] AMP     7690.4   -76.65
525620 [LTFLD_S&CTY269.000] AMP     4331.9   -71.57
525650 [LC-LITTLFLD269.000] AMP     5158.5   -83.30
525687 [LC-LUMSCHAP269.000] AMP     4810.4   -79.95
525828 [TUCO_INT   3115.00] AMP    19868.4   -83.04
525840 [ANTELOPE_1 6230.00] AMP    22049.7   -85.14
526019 [HOCKLEY    269.000] AMP     5208.7   -81.72
526036 [LC-OPDYKE  3115.00] AMP     5895.8   -76.27
526161 [CARLISLE   6230.00] AMP    13248.8   -83.80
526269 [LUBBCK_STH 6230.00] AMP    18797.0   -85.28
526337 [JONES      6230.00] AMP    20791.8   -86.16
526352 [LEHMAN     3115.00] AMP     6038.6   -77.45
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526424 [PACIFIC    3115.00] AMP     9684.7   -79.47
526445 [AMOCO_TP   3115.00] AMP    10788.7   -80.04
526491 [LG-CLAUENE 3115.00] AMP     9068.8   -76.98
526524 [WOLFFORTH  3115.00] AMP    11595.6   -81.87
526735 [TERRY_CNTY 269.000] AMP     7053.8   -84.17
527036 [SHELL_C2   3115.00] AMP    12399.1   -80.06
527046 [OXY_WILRD2 3115.00] AMP    10145.6   -77.83
527051 [ODC_TP     3115.00] AMP    12657.9   -78.99
527080 [EL_PASO    3115.00] AMP    14946.1   -79.99
527105 [SAN_ANDS_TP3115.00] AMP    15701.5   -80.05
527125 [DENVER_CTY 269.000] AMP     8505.0   -87.07
527201 [SEAGRAVES  269.000] AMP     5358.8   -83.39
527238 [ROZ        3115.00] AMP     8871.6   -79.15
527242 [AMERADA    3115.00] AMP     8967.9   -79.21
527262 [SULPHUR    3115.00] AMP     5632.7   -75.30
527286 [XTO_RUSSEL 3115.00] AMP     9850.9   -74.72
527322 [GAINES     3115.00] AMP     8298.6   -77.23
527340 [DOSS       3115.00] AMP     6934.3   -77.37
527800 [EDDY_SOUTH 6230.00] AMP     7678.2   -83.31
527802 [EDDY_CNTY  7345.00] AMP     4208.1   -84.95
527864 [CUNNINHAM  3115.00] AMP    29286.6   -84.51
527962 [POTASH_JCT 3115.00] AMP    14128.8   -83.23
527963 [POTASH_JCT 6230.00] AMP     6852.0   -84.05
528027 [RDRUNNER   7345.00] AMP     3763.4   -84.17
528185 [N_LOVING   7345.00] AMP     4392.3   -84.47
528333 [LE-WEST_SUB3115.00] AMP     8738.0   -81.19
528355 [MADDOX     3115.00] AMP    27408.5   -84.99
528433 [NEW_NHOBBS 3115.00] AMP     7972.9   -73.45
528435 [MILLEN     3115.00] AMP    11569.2   -73.87
528604 [ANDREWS    6230.00] AMP     6912.6   -84.42
528610 [GAINES_GEN 6230.00] AMP     8510.8   -85.63
528740 [LE-PLANS_TP269.000] AMP     3610.0   -79.84
560050 [G15-031-TAP 230.00] AMP     8630.0   -82.17
560058 [G15-077-TAP 115.00] AMP     8175.9   -76.38
577103 [GEN-2008-022345.00] AMP     5022.4   -85.91
583090 [G1149&G1504 345.00] AMP     4623.2   -86.07
583340 [GEN-2012-020230.00] AMP     9103.3   -84.27
584260 [GEN-2014-047345.00] AMP     4297.1   -83.84
599955 [PNM-DC6     230.00] AMP     8709.0   -82.04
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