Submitted to
Southwest Power Pool

SPP Southwest Power Pool

Report On

GEN-2011-008
Modification Request Impact Study

Revision R1

Date of Submittal
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anedenconsulting.com

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Revision History

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
10/19/2020	Aneden Consulting	Initial Report Issued.

Executive Summary

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to perform a Modification Request Impact Study (Study) for Phase III of GEN-2011-008, an active generation interconnection request with a point of interconnection (POI) at the Clark County 345 kV substation.

The GEN-2011-008 project is interconnected in the Sunflower Electric Power Corporation (SUNC) control area with a capacity of 600 MW as shown in Table ES-1 below. This Study has been requested by the Interconnection Customer to evaluate the modification of GEN-2011-008 Phase III from the previously studied 100 x Vestas V110 2.0MW to a turbine configuration of 62 x GE 2.82 MW + 12 x Vestas V110 2.0 MW wind turbines for total capacity of 198.84 MW. In addition, the Phase III modification request included changes to the collection system, generator substation transformer, main substation transformer, generation interconnection line, and reactive power devices. The Phase I and Phase II collection systems, generator substation transformers, generation interconnection lines, main substation transformers, and reactive power devices were also updated with the latest project information in the modified cases to ensure accurate results. The Phase III modification request changes and updates are shown in Table ES-2, and the Phase I and Phase II updates are shown in Table ES-3 and Table ES-4 respectively.

Table ES-1: GEN-2011-008 Existing Configuration

Request	Capacity (MW)	Existing Generator Configuration	Point of Interconnection
GEN-2011-008	600	100 x Vestas V110 2.0 MW (Phase I) = 200 MW 100 x Vestas V110 2.0 MW (Phase II) = 200 MW 100 x Vestas V110 2.0 MW (Phase III) = 200 MW	Clark County 345 kV (539800)

Table ES-2: GEN-2011-008 Phase III Modification Request

Facility	Existing	Modification	
Point of Interconnection	Clark County 345 kV (539800)	Clark County 345 kV (539800)	
Configuration/Capacity	100 x Vestas V110 2.0 MW = 200 MW	62 x GE 2.82 MW + 12 x Vestas V110 2.0 MW = 198.84 MW	
Generation Interconnection Line	Length = 2.9 miles R = 0.000280 pu X = 0.001820 pu B = 0.019320 pu	Length = 9.72 miles R = 0.000447 pu X = 0.004775 pu B = 0.084946 pu	
Main Substation Transformer	X = 9%, R = 0.23%, Winding 127 MVA, Rating 212 MVA	X = 11.43%, R = 0.18%, Winding 134 MVA, Rating 222 MVA	
GSU Transformer	Gen 1 Equivalent Qty: 100 X = 7.76%, R = 0.8%, Rating 210 MVA	Gen 1 Equivalent Qty: 62: X = 6.26%, R = 0.73%, Rating 189.1 MVA	Gen 2 Equivalent Qty: 12: X = 9.76%, R = 0.895%, Rating 27.6 MVA
Equivalent Collector Line	R = 0.002220 pu X = 0.003540 pu B = 0.094010 pu	R = 0.004131 pu X = 0.006132 pu B = 0.104020 pu	
Reactive Power Devices	N/A	1 x 15 MVAR 34.5 kV Shunt Reactor 2 x 15 MVAR 34.5 kV Capacitor Bank	

Table ES-3: GEN-2011-008 Phase I Updates

<table>
<tr><th>Facility</th><th>Existing</th><th colspan="4">Updated</th></tr>
<tr><td>Point of Interconnection</td><td>Clark County 345 kV (539800)</td><td colspan="4">Clark County 345 kV (539800)</td></tr>
<tr><td>Configuration/Capacity</td><td>100 x Vestas V110 2.0 MW = 200 MW</td><td colspan="4">100 x Vestas V110 2.0 MW = 200 MW
(22 Mk10A + 78 Mk10C)</td></tr>
<tr><td>Generation Interconnection Line</td><td>Length = 6.9 miles
R = 0.000690 pu
X = 0.004410 pu
B = 0.046650 pu</td><td colspan="4">Length = 6.79 miles
R = 0.000239 pu
X = 0.003346 pu
B = 0.064551 pu</td></tr>
<tr><td>Main Substation Transformer</td><td>X = 9%, R = 0.23%, 127 MVA Base, Rating 212 MVA</td><td colspan="2">X = 9.97%, R = 0.235%, 67 MVA Base, Rating 112 MVA</td><td colspan="2">X = 10.09%, R = 0.235%, 67 MVA Base, Rating 112 MVA</td></tr>
<tr><td>GSU Transformer</td><td>Gen 1 Equivalent Qty: 100
X = 7.76%, R = 0.8%, Rating 210 MVA</td><td>Gen 1 Equivalent Qty: 15:
X = 9.76%, R = 0.895%, Rating 34.5 MVA</td><td>Gen 2 Equivalent Qty: 35:
X = 9.76%, R = 0.895%, Rating 80.5 MVA</td><td>Gen 3 Equivalent Qty: 7:
X = 9.76%, R = 0.895%, Rating 16.1 MVA</td><td>Gen 4 Equivalent Qty: 43:
X = 9.76%, R = 0.895%, Rating 98.9 MVA</td></tr>
<tr><td>Equivalent Collector Line</td><td>R = 0.002620 pu
X = 0.004180 pu
B = 0.096990 pu</td><td colspan="2">R = 0.006941 pu
X = 0.008870 pu
B = 0.044931 pu</td><td colspan="2">R = 0.007212 pu
X = 0.010086 pu
B = 0.045465 pu</td></tr>
<tr><td>Reactive Power Devices</td><td>N/A</td><td colspan="2">2 x 18 MVAR 34.5 kV Capacitor Bank</td><td colspan="2">1 x 15 MVAR 34.5 kV Shunt Reactor
2 x 18 MVAR 34.5 kV Capacitor Bank</td></tr>
</table>

Table ES-4: GEN-2011-008 Phase II Updates

<table>
<tr><th>Facility</th><th>Existing</th><th colspan="2">Updated</th></tr>
<tr><td>Point of Interconnection</td><td>Clark County 345 kV (539800)</td><td colspan="2">Clark County 345 kV (539800)</td></tr>
<tr><td>Configuration/Capacity</td><td>100 x Vestas V110 2.0 MW = 200 MW</td><td colspan="2">100 x Vestas V110 2.0 MW = 200 MW (Mk10C)</td></tr>
<tr><td>Generation Interconnection Line</td><td>Length = 6.7 miles
R = 0.000670 pu
X = 0.004300 pu
B = 0.045520 pu</td><td colspan="2">Length = 6.71 miles
R = 0.000309 pu
X = 0.003296 pu
B = 0.058641 pu</td></tr>
<tr><td>Main Substation Transformer</td><td>X = 9%, R = 0.23%, 127 MVA Base, Rating 212 MVA</td><td>X = 9.96%, R = 0.23%, 67 MVA Base, Rating 112 MVA</td><td>X = 9.96%, R = 0.23%, 67 MVA Base, Rating 112 MVA</td></tr>
<tr><td>GSU Transformer</td><td>Gen 1 Equivalent Qty: 100
X = 7.76%, R = 0.8%, Rating 210 MVA</td><td>Gen 1 Equivalent Qty: 49:
X = 9.76%, R = 0.895%, Rating 112.7 MVA</td><td>Gen 2 Equivalent Qty: 51:
X = 9.76%, R = 0.895%, Rating 117.3 MVA</td></tr>
<tr><td>Equivalent Collector Line</td><td>R = 0.002050 pu
X = 0.003280 pu
B = 0.084740 pu</td><td>R = 0.008161 pu
X = 0.011235 pu
B = 0.045635 pu</td><td>R = 0.005444 pu
X = 0.006968 pu
B = 0.041798 pu</td></tr>
<tr><td>Reactive Power Devices</td><td>N/A</td><td>2 x 18 MVAR 34.5 kV Capacitor Bank</td><td>1 x 15 MVAR 34.5 kV Shunt Reactor
2 x 18 MVAR 34.5 kV Capacitor Bank</td></tr>
</table>

SPP determined that power flow should not be performed based on the POI MW injection increase of 0.07%. However, SPP determined that the turbine change from Vestas to a combination of Vestas and GE turbines required short circuit and dynamic stability analyses.

The scope of this modification request study included a charging current compensation analysis, short circuit analysis, and dynamic stability analysis.

Aneden performed the analyses using the modification request data based on the DISIS-2016-002-2 Group 3 study models:

1. 2017 Winter Peak (2017WP),
2. 2018 Summer Peak (2018SP), and
3. 2026 Summer Peak (2026SP).

All analyses were performed using the PTI PSS/E version 33.7 software and the results are summarized below.

The results of the charging current compensation analysis performed using the 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak models showed that Phase III of the GEN-2011-008 project needed 18.96 MVAr of reactor shunts on the 34.5 kV bus of the Phase III project substation, an increase from the 11.34 MVAr found in the pre-modification case. Phase I and Phase II required 15.71 MVAr and 14.79 MVAr respectively with the updated topology, both increases from the existing model representation which required 14.38 MVAr for Phase I and 13.04 MVAr for Phase II. This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during low-wind or no-wind conditions. The information gathered from the charging current compensation analysis is provided as information to the customer and Transmission Owner. SPP does not require additional reactive requirements based on the results of this analysis.

The results from the short circuit analysis with the updated topology showed that the maximum Phase III GEN-2011-008 contribution to three-phase fault currents in the immediate systems at or near GEN-2011-008 was not greater than 0.69 kA for the 2018SP and 2026SP cases. All three-phase fault current levels within 5 buses of the POI with the Phase I, Phase II, and Phase II GEN-2011-008 generators online were below 42 kA for the 2018SP models and 2026SP models.

The dynamic stability analysis was performed using the three DISIS-2016-002-2 models 2017 Winter Peak, 2018 Summer Peak, 2026 Summer Peak. Up to 81 events were simulated, which included three-phase faults, three-phase faults on prior outage cases, and single-line-to-ground faults with stuck breakers faults.

The results of the dynamic stability analysis showed that there were no damping or voltage recovery violations observed during the simulated faults. Additionally, the project was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

The requested modification has been determined by SPP to not be a Material Modification. The requested modification does not have a material impact on the cost or timing of any Interconnection Request with a later Queue priority date.

In accordance with FERC Order #661A, a wind generating plant shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, measured at the Point of Interconnection as defined in this LGIA, if the Transmission Provider’s System Impact Study shows that such a requirement is necessary to ensure safety or reliability.

It is likely that the customer may be required to reduce its generation output to 0 MW in real-time, 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 or delivery rights. If the customer wishes to obtain deliverability to final customers, a separate request for transmission service must be requested on Southwest Power Pool’s OASIS by the customer.

1.0 Scope of Study

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to perform a Modification Request Impact Study (Study) for Phase III of GEN-2011-008. A Modification Request Impact Study is a generation interconnection study performed to evaluate the impacts of modifying the DISIS study assumptions. The determination of the required scope of the study is dependent upon the specific modification requested and how it may impact the results of the DISIS study. Impacting the DISIS results could potentially affect the cost or timing of any Interconnection Request with a later Queue priority date, deeming the requested modification a Material Modification. The criteria sections below include reasoning as to why an analysis was either included or excluded from the scope of study.

All analyses were performed using the PTI PSS/E version 33.7 software. The results of each analysis are presented in the following sections.

1.1 Power Flow

To determine whether power flow analysis is required, SPP evaluates the difference in the real power output at the POI between the existing configuration and the requested modification. Power flow analysis is included if the difference has a significant impact on the results of DISIS study.

1.2 Stability Analysis, Short Circuit Analysis

To determine whether stability and short circuit analyses are required, SPP evaluates the difference between the turbine parameters and, if needed, the collector system impedance between the existing configuration and the requested modification. Dynamic stability analysis and short circuit analysis would be required if the differences listed above were determined to have a significant impact on the most recently performed DISIS stability analysis.

1.3 Charging Current Compensation Analysis

SPP requires that a charging current compensation analysis be performed on the requested modification configuration as it is a non-synchronous resource. The charging current compensation analysis determines the capacitive effect at the POI caused by the project's collector system and transmission line's capacitance. A shunt reactor size is determined in order to offset the capacitive effect and maintain zero (0) MVAr flow at the POI while the plant's generators and capacitors are offline.

1.4 Study Limitations

The assessments and conclusions provided in this report are based on assumptions and information provided to Aneden by others. While the assumptions and information provided may be appropriate for the purposes of this report, Aneden does not guarantee that those conditions assumed will occur. In addition, Aneden did not independently verify the accuracy or completeness of the information provided. As such, the conclusions and results presented in this report may vary depending on the extent to which actual future conditions differ from the assumptions made or information used herein.

2.0 Project and Modification Request

The GEN-2011-008 Interconnection Customer has requested a modification to Phase III of its Interconnection Request (IR) with a point of interconnection (POI) at the Clark County 345 KV Substation. At the time of the posting of this report, GEN-2011-008 is an active IR with a queue status of "IA FULLY EXECUTED/COMMERCIAL OPERATION." GEN-2011-008 is a wind farm, has a maximum summer and winter queue capacity of 600 MW, and has Energy Resource Interconnection Service (ERIS).

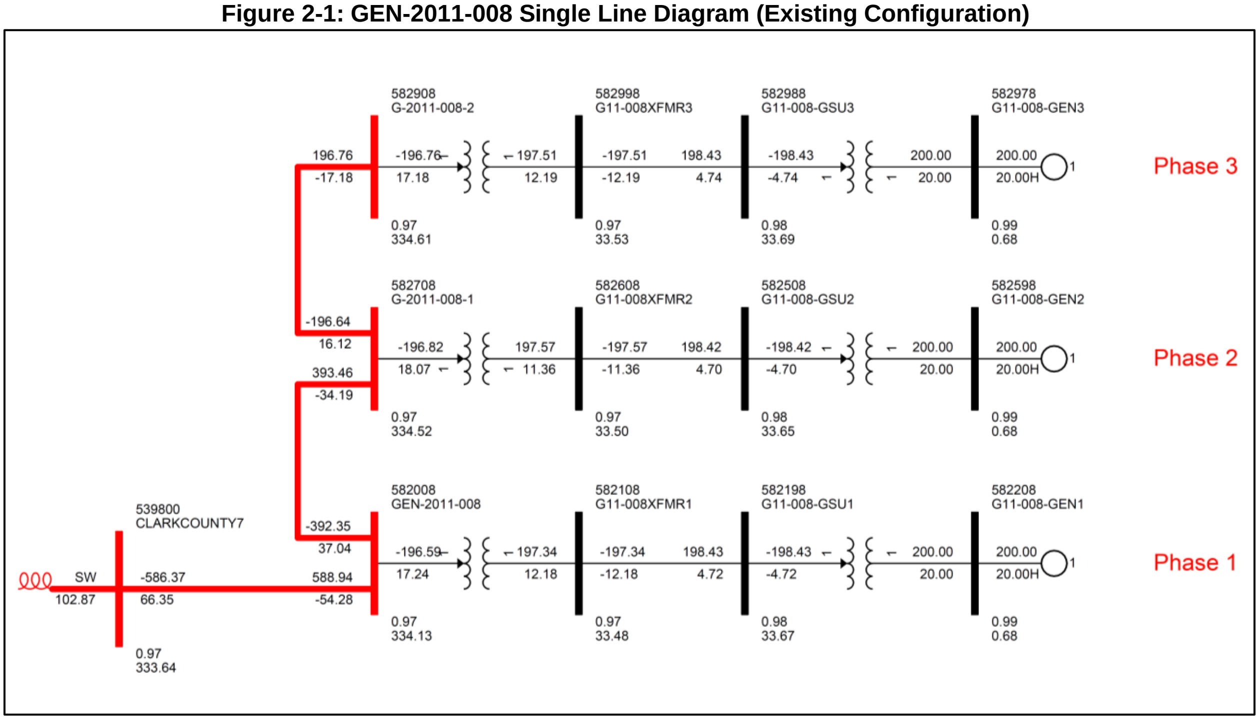
GEN-2011-008 was originally studied as part of Group 3 in the DISIS-2011-001 study. Figure 2-1 shows the power flow model single line diagram for the existing GEN-2011-008 configuration.

The GEN-2011-008 project consists of three phases and is proposed to interconnect in the Sunflower Electric Power Corporation (SUNC) control area with a combined nameplate capacity of 600 MW as shown in Table 2-1 below.

Table 2-1: GEN-2011-008 Existing Configuration

Request	Capacity (MW)	Existing Generator Configuration	Point of Interconnection
GEN-2011-008	600	100 x Vestas V110 2.0 MW (Phase I) = 200 MW 100 x Vestas V110 2.0 MW (Phase II) = 200 MW 100 x Vestas V110 2.0 MW (Phase III) = 200 MW	Clark County 345 kV (539800)

Figure 2-1: GEN-2011-008 Single Line Diagram (Existing Configuration)



The GEN-2011-008 Phase III Modification Request included a turbine configuration change to a total of 62 x GE 2.82 MW + 12 x Vestas V110 2.0 MW wind turbines for total capacity of 198.84 MW. In addition, the Phase III modification request included changes to the collection system, generator substation transformer, main substation transformer, generation interconnection line, and reactive power devices. The Phase I and Phase II collection systems, generator substation transformers, generation interconnection lines, main substation transformers, and reactive power devices were also updated with the latest project information in the modified cases to ensure accurate results. The major Phase III modification request changes are shown in Figure 2-2 and Table 2-2 below. The Phase I and Phase II updates are shown in Table 2-3 and Table 2-4 respectively.

Figure 2-2: GEN-2011-008 Single Line Diagram (Modification Configuration)

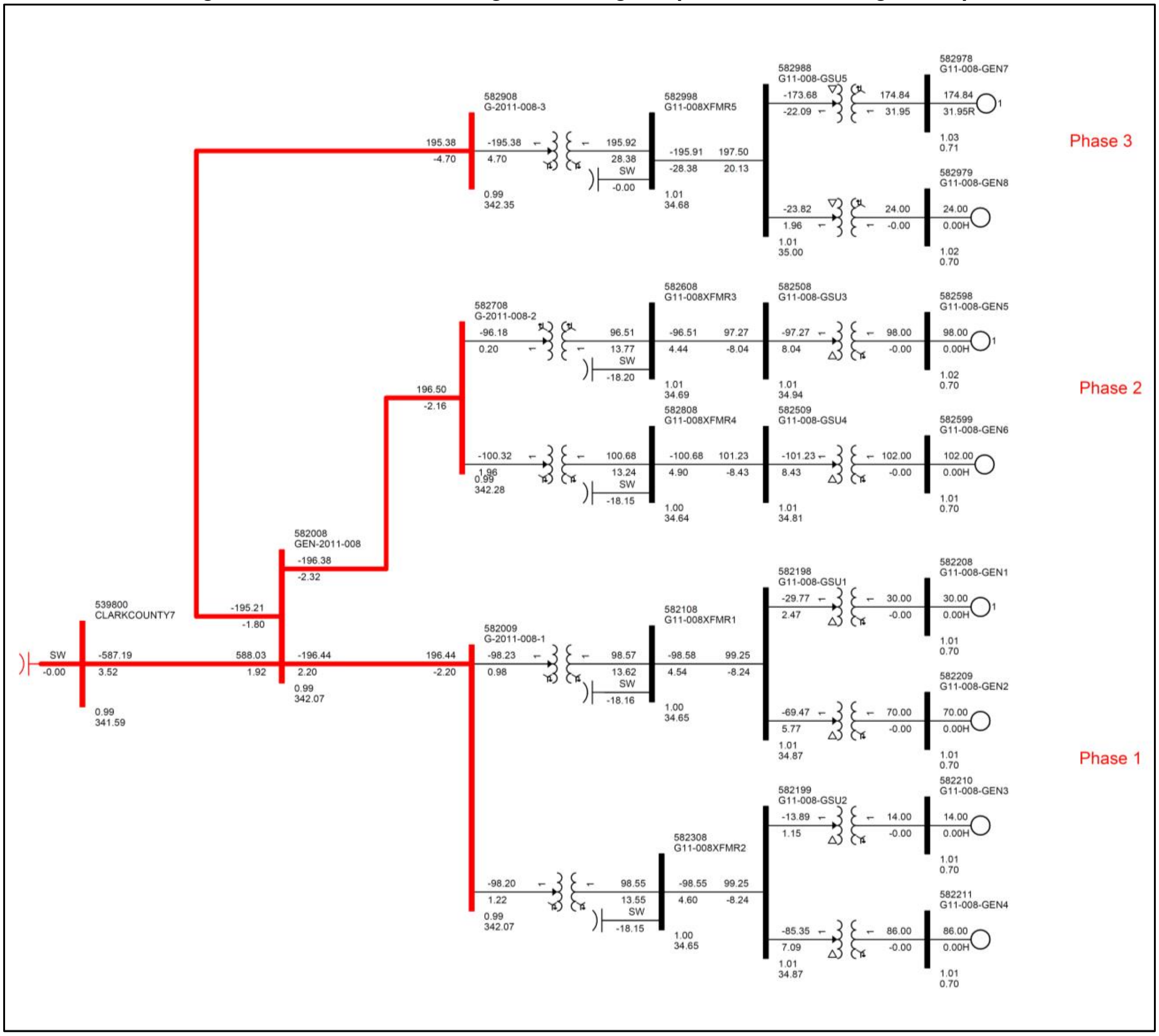


Table 2-2: GEN-2011-008 Phase III Modification Request

Facility	Existing	Modification	
Point of Interconnection	Clark County 345 kV (539800)	Clark County 345 kV (539800)	
Configuration/Capacity	100 x Vestas V110 2.0 MW = 200 MW	62 x GE 2.82 MW + 12 x Vestas V110 2.0 MW = 198.84 MW	
Generation Interconnection Line	Length = 2.9 miles R = 0.000280 pu X = 0.001820 pu B = 0.019320 pu	Length = 9.72 miles R = 0.000447 pu X = 0.004775 pu B = 0.084946 pu	
Main Substation Transformer	X = 9%, R = 0.23%, Winding 127 MVA, Rating 212 MVA	X = 11.43%, R = 0.18%, Winding 134 MVA, Rating 222 MVA	
GSU Transformer	Gen 1 Equivalent Qty: 100 X = 7.76%, R = 0.8%, Rating 210 MVA	Gen 1 Equivalent Qty: 62: X = 6.26%, R = 0.73%, Rating 189.1 MVA	Gen 2 Equivalent Qty: 12: X = 9.76%, R = 0.895%, Rating 27.6 MVA
Equivalent Collector Line	R = 0.002220 pu X = 0.003540 pu B = 0.094010 pu	R = 0.004131 pu X = 0.006132 pu B = 0.104020 pu	
Reactive Power Devices	N/A	1 x 15 MVAR 34.5 kV Shunt Reactor 2 x 15 MVAR 34.5 kV Capacitor Bank	

Table 2-3: GEN-2011-008 Phase I Updates

Facility	Existing	Updated			
Point of Interconnection	Clark County 345 kV (539800)	Clark County 345 kV (539800)			
Configuration/Capacity	100 x Vestas V110 2.0 MW = 200 MW	100 x Vestas V110 2.0 MW = 200 MW (22 Mk10A + 78 Mk10C)			
Generation Interconnection Line	Length = 6.9 miles R = 0.000690 pu X = 0.004410 pu B = 0.046650 pu	Length = 6.79 miles R = 0.000239 pu X = 0.003346 pu B = 0.064551 pu			
Main Substation Transformer	X = 9%, R = 0.23%, 127 MVA Base, Rating 212 MVA	X = 9.97%, R = 0.235%, 67 MVA Base, Rating 112 MVA		X = 10.09%, R = 0.235%, 67 MVA Base, Rating 112 MVA	
GSU Transformer	Gen 1 Equivalent Qty: 100 X = 7.76%, R = 0.8%, Rating 210 MVA	Gen 1 Equivalent Qty: 15: X = 9.76%, R = 0.895%, Rating 34.5 MVA	Gen 2 Equivalent Qty: 35: X = 9.76%, R = 0.895%, Rating 80.5 MVA	Gen 3 Equivalent Qty: 7: X = 9.76%, R = 0.895%, Rating 16.1 MVA	Gen 4 Equivalent Qty: 43: X = 9.76%, R = 0.895%, Rating 98.9 MVA
Equivalent Collector Line	R = 0.002620 pu X = 0.004180 pu B = 0.096990 pu	R = 0.006941 pu X = 0.008870 pu B = 0.044931 pu		R = 0.007212 pu X = 0.010086 pu B = 0.045465 pu	
Reactive Power Devices	N/A	2 x 18 MVAR 34.5 kV Capacitor Bank		1 x 15 MVAR 34.5 kV Shunt Reactor 2 x 18 MVAR 34.5 kV Capacitor Bank	

Table 2-4: GEN-2011-008 Phase II Updates

Facility	Existing	Updated	
Point of Interconnection	Clark County 345 kV (539800)	Clark County 345 kV (539800)	
Configuration/Capacity	100 x Vestas V110 2.0 MW = 200 MW	100 x Vestas V110 2.0 MW = 200 MW (Mk10C)	
Generation Interconnection Line	Length = 6.7 miles R = 0.000670 pu X = 0.004300 pu B = 0.045520 pu	Length = 6.71 miles R = 0.000309 pu X = 0.003296 pu B = 0.058641 pu	
Main Substation Transformer	X = 9%, R = 0.23%, 127 MVA Base, Rating 212 MVA	X = 9.96%, R = 0.23%, 67 MVA Base, Rating 112 MVA	X = 9.96%, R = 0.23%, 67 MVA Base, Rating 112 MVA
GSU Transformer	Gen 1 Equivalent Qty: 100 X = 7.76%, R = 0.8%, Rating 210 MVA	Gen 1 Equivalent Qty: 49: X = 9.76%, R = 0.895%, Rating 112.7 MVA	Gen 2 Equivalent Qty: 51: X = 9.76%, R = 0.895%, Rating 117.3 MVA
Equivalent Collector Line	R = 0.002050 pu X = 0.003280 pu B = 0.084740 pu	R = 0.008161 pu X = 0.011235 pu B = 0.045635 pu	R = 0.005444 pu X = 0.006968 pu B = 0.041798 pu
Reactive Power Devices	N/A	2 x 18 MVAR 34.5 kV Capacitor Bank	1 x 15 MVAR 34.5 kV Shunt Reactor 2 x 18 MVAR 34.5 kV Capacitor Bank

3.0 Existing vs Modification Comparison

To determine which analysis is required, the differences between the existing configuration and the requested modification were evaluated.

Aneden performed this comparison and the resulting analyses using a set of modified study models developed based on the modification request data and the three DISIS-2016-002-2 Group 3 study models:

1. 2017 Winter Peak (2017WP),
2. 2018 Summer Peak (2018SP), and
3. 2026 Summer Peak (2026SP).

The methodology and results of the comparisons are described below. The analysis was completed using PSS/E version 33.7 software.

3.1 POI Injection Comparison

The real power injection at the POI was determined using PSS/E for both the existing configuration and the requested modification with updates for GEN-2011-008. The percentage change in the POI injection before and after the modification request was then compared. If the MW difference was determined to be significant, power flow analysis would be performed to assess the impact of the modification request.

SPP determined that power flow analysis was not required due to the insignificant change (increase of 0.07%) in the real power output at the POI between the existing configuration and requested modification shown in Table 3-1.

Table 3-1: GEN-2011-008 POI Injection Comparison

Interconnection Request	Existing POI Injection from Project (MW)	MRIS POI Injection from Project (MW)	POI Injection Difference from Project %
GEN-2011-008	586.37	586.79	0.07%

3.2 Turbine Parameters Comparison

The turbine models from the existing configuration and the requested modification were compared to determine if the change in modeling parameters was significant.

For the turbine collection, the turbine changes were from Vestas turbines to a combination of GE and Vestas turbines. SPP determined that short circuit analysis and dynamic stability analysis were required due to the change in turbines as the stability responses of the existing configuration and the requested modification's configuration may differ. The generator dynamic model for the modification can be found in Appendix A.

3.3 Equivalent Impedance Comparison Calculation

As the turbine comparison determined that short circuit and dynamic stability analyses were required, an equivalent impedance comparison was not needed for the determination of the scope of the study.

4.0 Charging Current Compensation Analysis

The charging current compensation analysis was performed for GEN-2011-008 to determine the capacitive charging effects during reduced generation conditions (unsuitable wind speeds, unsuitable solar irradiance, insufficient state of charge, idle conditions, curtailment, etc.) at the generation site and to size shunt reactors that would reduce the project reactive power contribution to the POI to approximately zero.

4.1 Methodology and Criteria

For the GEN-2011-008 project, Phase I, II, and III were analyzed. A reactor size was determined for each phase of the project sequentially, starting with Phase I while the radially connected Phase II and Phase III were disconnected. For the project being studied, the generators and capacitors (if any) were switched out of service while other collector system elements remained in-service. A shunt reactor was tested at the phase's collection substation 34.5 kV bus to set the MVAr flow into the POI to approximately zero. The size of the shunt reactor is equivalent to the charging current value at unity voltage and the compensation provided is proportional to the voltage effects on the charging current (i.e. for voltages above unity, reactive compensation is greater than the size of the reactor).

4.2 Results

The results from the analysis showed that the GEN-2011-008 Phase III project needed an approximately 18.96 MVAr shunt reactor at the project substation, to reduce the POI MVAr to zero for Phase III. This is an increase from the existing model representation which required 11.34 MVAr. Phase I and Phase II required 15.71 MVAr and 14.79 MVAr respectively, both increases from the existing model representation which required 14.38 MVAr for Phase I and 13.04 MVAr for Phase II. Figure 4-1 illustrates the shunt reactor sizes needed to reduce the POI MVAr to approximately zero in the existing model. Figure 4-2 illustrates the shunt reactor sizes needed to reduce the POI MVAr to approximately zero with the updated topology. The final shunt reactor requirements for GEN-2011-008 is shown in Table 4-1.

The information gathered from the charging current compensation analysis is provided as information to the customer and Transmission Owner. SPP does not require additional reactive requirements based on the results of this analysis.

Table 4-1: Shunt Reactor Size for Low Wind Study (Modification)

Machine	POI Bus Number	POI Bus Name	Reactor Size (MVAr)		
			17WP	18SP	26SP
GEN-2011-008 Phase I	539800	Clark County 345 kV	15.71	15.71	15.71
GEN-2011-008 Phase II	539800	Clark County 345 kV	14.79	14.79	14.79
GEN-2011-008 Phase III	539800	Clark County 345 kV	18.96	18.96	18.96

Figure 4-1: GEN-2011-008 Single Line Diagram (Existing Shunt Reactor)

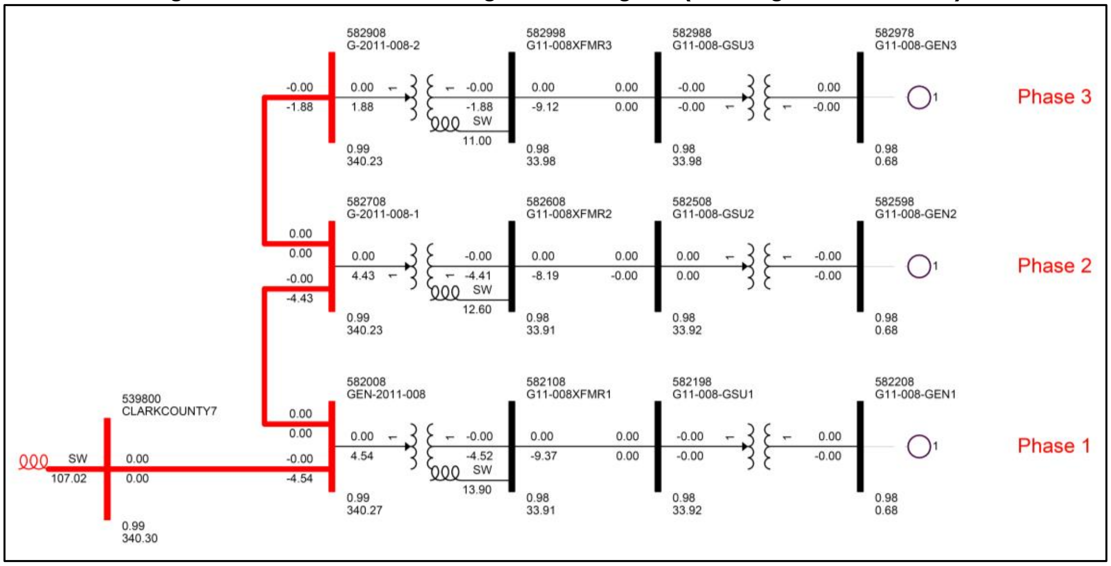
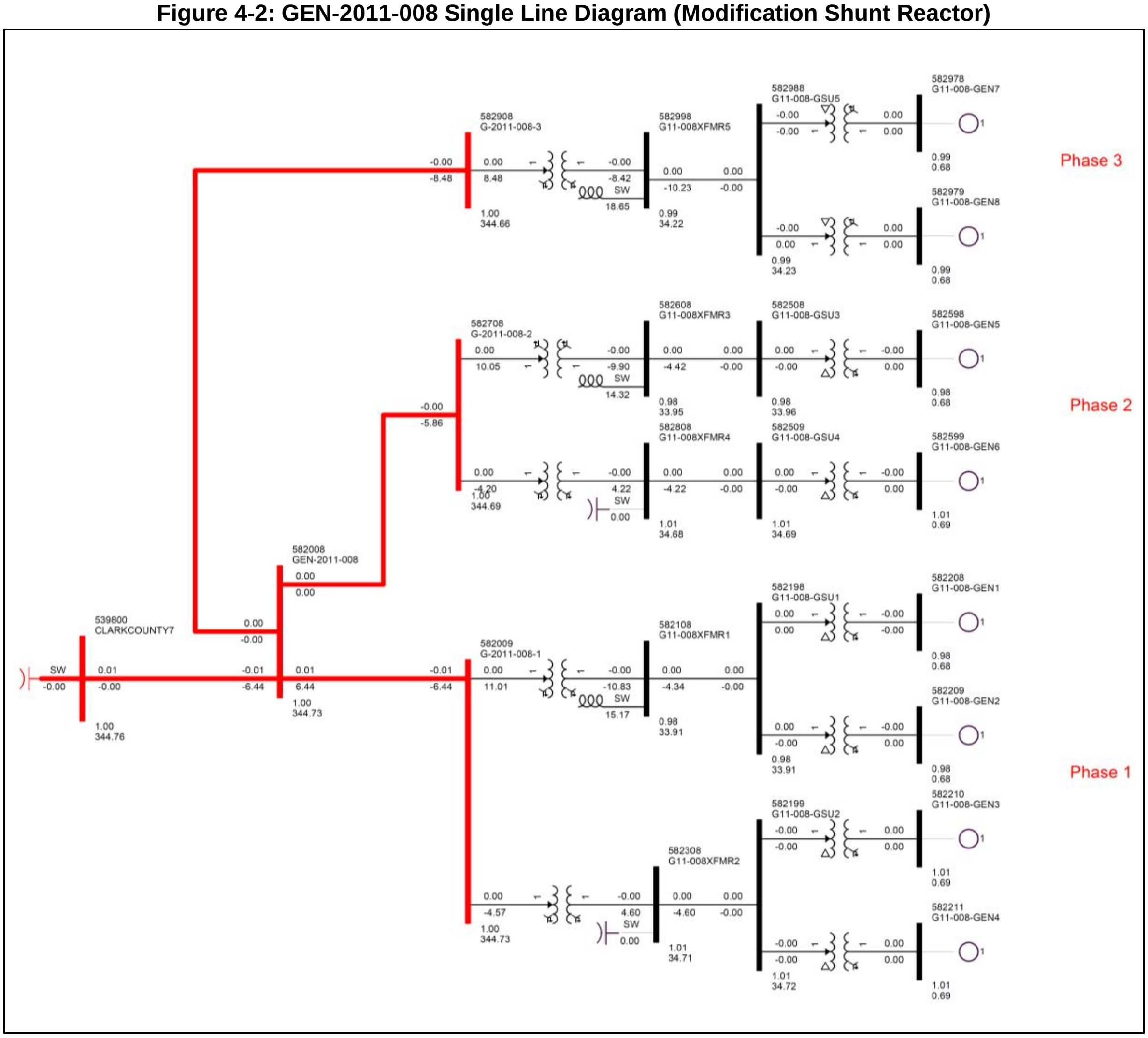


Figure 4-2: GEN-2011-008 Single Line Diagram (Modification Shunt Reactor)



5.0 Short Circuit Analysis

A short circuit study was performed using the 2018SP and 2026SP models for Phase III of GEN-2011-008 with the updated topology for Phase I, Phase II and Phase III. The detailed results of the short circuit analysis are provided in Appendix B.

5.1 Methodology

The short circuit analysis included applying a 3-phase fault on buses up to 5 levels away from the 345 kV POI bus. The PSS/E "Automatic Sequence Fault Calculation (ASCC)" fault analysis module was used to calculate the fault current levels with and without Phase III of GEN-2011-008 online. Phase I and Phase II were left online through the analysis.

5.2 Results

The results of the short circuit analysis for the 2018SP and 2026SP models are summarized in Table 5-1 through Table 5-3 respectively. The GEN-2011-008 POI bus fault current magnitudes are provided in Table 5-1 showing a maximum fault current of 12.82 kA with Phase III online.

The maximum fault current calculated within 5 buses of the GEN-2011-008 POI was less than 42 kA for the 2018SP and 2026SP models respectively. The maximum GEN-2011-008 Phase III contribution to three-phase fault current was about 6.8% and 0.69 kA.

Table 5-1: POI Short Circuit Results

Case	GEN-OFF Current (kA)	GEN-ON Current (kA)	Max kA Change	Max %Change
2018SP	12.17	12.81	0.64	5.2%
2026SP	12.19	12.82	0.64	5.2%

Table 5-2: 2018SP Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
115	21.9	0.03	0.2%
138	41.1	0.02	0.1%
230	12.4	0.10	0.8%
345	31.9	0.69	6.8%
Max	**41.1**	**0.69**	**6.8%**

Table 5-3: 2026SP Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
115	22.6	0.03	0.2%
138	41.3	0.02	0.1%
230	12.4	0.10	0.8%
345	31.9	0.69	6.8%
Max	**41.3**	**0.69**	**6.8%**

6.0 Dynamic Stability Analysis

Aneden performed a dynamic stability analysis to identify the impact of the turbine configuration change and other modifications to Phase III of the GEN-2011-008 project. The analysis was performed according to SPP's Disturbance Performance Requirements shown in Appendix C. The modification details are described in Section 2.0 above and the dynamic modeling data is provided in Appendix A. The simulation plots can be found in Appendix D.

6.1 Methodology and Criteria

The dynamic stability analysis was performed using models developed with the requested 62 x GE 2.82 MW (GEWTG2) + 12 x Vestas V110 2.0 MW (VC20045709) turbine configuration for Phase III of the GEN-2011-008 generating facilities. Phase I was composed of 100 x Vestas V110 2.0 MW (22 VS20045709 & 78 VC20045709). Phase II was composed of 100 x Vestas V110 2.0 MW (VC20045709). This stability analysis was performed using PTI's PSS/E version 33.7 software.

The stability models were developed using the models from DISIS-2016-002-2 for Group 3. SPP provided configuration and dynamic model updates for the Gray County Wind farm in the baseline models. The modifications requested for Phase III of the GEN-2011-008 project as well as configuration updates for Phase I and Phase II were used to create modified stability models for this impact study.

The modified dynamics model data for Phase I, Phase II and Phase III of the DISIS-2016-001 Group 3 request, GEN-2011-008, is provided in Appendix A. The modified 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.

During the fault simulations, the active power (PELEC), reactive power (QELEC), and terminal voltage (ETERM) were monitored for GEN-2011-008 and other equally and prior queued projects in Group 3. In addition, voltages of five (5) buses away from the POI of GEN-2011-008 were monitored and plotted. The machine rotor angle for synchronous machines and speed for asynchronous machines within this study area including 520 (AEPW), 524 (OKGE), 525 (WFEC), 526 (SPS), 531 (MIDW), 534 (SUNC), 536 (WERE), 640 (NPPD), 645 (OPPD), 650 (LES), and 652 (WAPA) were monitored. In addition, the voltages of all 100 kV and above buses within the study area were monitored.

6.2 Fault Definitions

Aneden simulated the faults previously simulated for GEN-2011-008 and selected additional fault events for GEN-2011-008 as required. The new set of faults were simulated using the modified study models. The fault events included three-phase faults, three-phase faults on prior outage cases, and single-line-to-ground faults with stuck breakers. The simulated faults are listed and described in Table 6-1 below. These contingencies were applied to the modified 2017 Winter Peak, 2018 Summer Peak, and the 2026 Summer Peak models.

Table 6-1: Fault Definitions

Fault ID	Planning Event	Fault Descriptions
FLT01-3PH	P1	3 phase fault on the Thistle 345KV (539801) to Woodward 345KV (515375) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT02-3PH	P1	3 phase fault on the Thistle 345KV (539801) to Woodward 345KV (515375) CKT 1 and 2, near Thistle. a. Apply fault at the Thistle 345KV bus. b. Clear fault after 5 cycles by tripping the faulted lines (CKT 1 and 2). c. Wait 20 cycles, and then re-close the lines in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the lines in (b) and remove fault.
FLT07-3PH	P1	3 phase fault on the Thistle 345KV (539801) to Thistle 138kV (539804) to Thistle 13.8kV (539802) XMFR CKT 1, near Thistle 345kV. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT08-3PH	P1	3 phase fault on the Spearville (531469) to G13-010 Tap 345KV (562334) 345KV CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT09-3PH	P1	3 phase fault on the Post Rock 345KV (530583) to Post Rock 230kV (530584) to Post Rock 13.8kV (530673) XMFR CKT 1, near Post Rock 345kV. a. Apply fault at the Post Rock 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT10-3PH	P1	3 phase fault on the Spearville 345KV (531469) to Buckner 345KV (531501) CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT12-3PH	P1	3 phase fault on the Spearville 345KV (531469) to Ironwood 345KV (539803) CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT13-3PH	P1	3 phase fault on the Spearville 345KV (531469) to Spearville 230kV (539695) to Spearville 13.8kV (531468) XMFR CKT 1, near Spearville 345kV. a. Apply fault at the Spearville 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT14-3PH	P1	3 phase fault on the Spearville 345KV (531469) to Spearville 115kv (539759) to Spearville 13.8kV (539960) XMFR CKT 1, near Spearville 345kV. a. Apply fault at the Spearville 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT15-3PH	P1	3 phase fault on the Buckner 345KV (531501) to Holcomb 345KV (531449) CKT 1, near Buckner. a. Apply fault at the Buckner 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	P1	3 phase fault on the GEN 2013-010-TAP 345KV (562334) to Post Rock 345KV (530583) CKT 1, near GEN 2013-010-TAP a. Apply fault at the GEN 2013-010-TAP 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.

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT37-3PH	P1	3 phase fault on the Buckner 345KV (531501) to CIMRRN 345KV (531502) CKT 1, near Buckner. a. Apply fault at the Buckner 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. Trip the generator Cimarron WTG1 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.
FLT38-3PH	P1	3 phase fault on the Buckner 345KV (531501) to CIMWD2 7 345KV (531504) CKT 1, near Buckner. a. Apply fault at the Buckner 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator Cimaron-WTG1 (531605)** 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.
FLT40-3PH	P1	3 phase fault on the Ironwood 345KV (539803) to Ironwood 34.5kv (539807) to Ironwood 13.8kV (539808) XMFR CKT 1, near Ironwood 345kV. a. Apply fault at the Ironwood 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer. **Trip generator IronWD-WTG1 (599030)** **Trip generator IronWD-WTG1 (599033)**
FLT22-PO1	P6	**Prior outage the Spearville (531469) to Buckner (531501) 345kV line (solve network for steady state solution)** 3 phase fault on the GEN 2013-010-TAP 345KV (562334) to Post Rock 345KV (530583) CKT 1, near GEN 2013-010-TAP a. Apply fault at the GEN 2013-010-TAP 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.
FLT01-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1 (solve network for steady state solution)** 3 phase fault on the Thistle 345KV (539801) to Woodward 345KV (515375) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT25-SB	P4	**Spearville 345kV Stuck Breaker** a. Apply single phase fault at the Spearville (531469) 345kV bus. b. Wait 16 cycles, and then trip Spearville (531469) – Ironwood (539803) 345kV CKT 1 and remove fault.
FLT29-SB	P4	**Stuck Breaker on Spearville – Buckner 345 kV line** a. Apply single-phase fault at Spearville (531469) 345kV bus on the Spearville – Buckner 345kV line. b. After 16 cycles, trip the Ironwood (539803) – Spearville (531469) 345 kV line. c. Trip the Spearville (531469) – Buckner (531501) line, and remove the fault.
FLT9001-3PH	P1	3 phase fault on the Clark County 345KV (539800) to Ironwood2 345KV (560002) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9002-3PH	P1	3 phase fault on the Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9003-3PH	P1	3 phase fault on the Clark County 345KV (539800) to G16-046-TAP 345KV (560080) CKT 1, near Clark County. a. Apply fault at the Clark County 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.

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT9004-3PH	P1	3 phase fault on the Clark County 345KV (539800) to GEN-2012-024 345KV (583370) CKT 1, near Clark County. a. Apply fault at the Clark County 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator G12-024-GEN1 (583373)** 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.
FLT9005-3PH	P1	3 phase fault on the G16-005-TAP 345KV (560072) to GEN-2016-005 (587040) 345KV CKT 1, near G16-005-TAP. a. Apply fault at the G16-005-TAP 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator G16-005-GEN1 (587044)** 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.
FLT9006-3PH	P1	3 phase fault on the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 1, near G16-005-TAP. a. Apply fault at the G16-005-TAP 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.
FLT9007-3PH	P1	3 phase fault on the Thistle 345KV (539801) to Buffalo7 345KV (532782) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT9008-3PH	P1	3 phase fault on the G16-046-TAP 345KV (560080) to GEN-2016-046 345KV (587310) CKT 1, near G16-046-TAP. a. Apply fault at the G16-046-TAP 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator G16-046-GEN1 (587313)** 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.
FLT9009-3PH	P1	3 phase fault on the G16-046-TAP 345KV (560080) to Ironwood7 345KV (539803) CKT 1, near G16-046-TAP. a. Apply fault at the G16-046-TAP 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.
FLT9010-3PH	P1	3 phase fault on the Ironwood2 345KV (560002) to Spervil7 345kV (531469) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 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.
FLT9011-3PH	P1	3 phase fault on the Ironwood2 345KV (560002) to GEN-2011-016 345kV (582016) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator G11-016-GEN1 (582316)** 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.
FLT9012-3PH	P1	3 phase fault on the Ironwood7 345KV (539803) to GEN-2008-124 345kV (579480) CKT 1, near Ironwood7. a. Apply fault at the Ironwood7 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator G08-124-GEN1 (579483)** **Trip generator G08-124-GEN2 (579486)** 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 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT9013-3PH	P1	3 phase fault on the GEN 2013-010-TAP 345KV (562334) to GEN-2013-010 345KV (583600) CKT 1, near GEN 2013-010-TAP a. Apply fault at the GEN 2013-010-TAP 345KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator G13-010-GEN1 (583603)** 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.
FLT9014-3PH	P1	3 phase fault on the Post Rock 345KV (530583) to G16-050-TAP 345kV (560082) CKT 1, near Post Rock a. Apply fault at the Post Rock 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.
FLT9015-3PH	P1	3 phase fault on the Spearvl6 230KV (539695) to Grtbend6 230KV (539679) CKT 1, near Spearvl6. a. Apply fault at the Spearvl6 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.
FLT9016-3PH	P1	3 phase fault on the Spearvl6 230KV (539695) to Sprvill-Ehvb 230KV (599161) CKT 1, near Spearvl6. a. Apply fault at the Spearvl6 230KV bus. b. Clear fault after 5 cycles by tripping the faulted line. **Trip generator Sprvill-WTG1 (599164)** 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.
FLT9017-3PH	P1	3 phase fault on the Spearvl6 230KV (539695) to Gpewind1 34.5kV (539752) to Spwind-T1 13.8kV (539743) XMFR CKT 1, near Spearvl6 230kV. a. Apply fault at the Spearvl6 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer. **Trip generator GPW_G1 (599020)**
FLT9018-3PH	P1	3 phase fault on the Spearvl6 230KV (539695) to Spearvl3 115kV (539694) to SpervlTT 13.8kV (539935) XMFR CKT 1, near Spearvl6 230kV. a. Apply fault at the Spearvl6 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT07-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Thistle 138kV (539804) to Thistle 13.8kV (539802) XMFR CKT 1, near Thistle 345kV. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT9001-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1** 3 phase fault on the Clark County (539800) to Ironwood2 345KV (560002) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9002-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1** 3 phase fault on the Clark County (539800) to G16-005-TAP 345KV (560072) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9006-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1** 3 phase fault on the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 1, near G16-005-TAP. a. Apply fault at the G16-005-TAP 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.

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT9007-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Buffalo7 345KV (532782) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT9010-PO2	P6	**Prior outage Spearville (531469) to Ironwood (539803) 345kV CKT 1** 3 phase fault on the Ironwood2 345KV (560002) to Spervil7 345kV (531469) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 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.
FLT01-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Woodward 345KV (515375) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT07-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Thistle 138kV (539804) to Thistle 13.8kV (539802) XMFR CKT 1, near Thistle 345kV. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT12-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the Ironwood2 345KV (560002) to Spervil7 345kV (531469) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 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.
FLT9002-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the Clark County (539800) to G16-005-TAP 345KV (560072) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9003-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the Clark County (539800) to G16-046-TAP 345KV (560080) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9006-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 1, near G16-005-TAP. a. Apply fault at the G16-005-TAP 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.
FLT9007-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Buffalo7 345KV (532782) CKT 1, near Thistle. a. Apply fault at the Thistle 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.

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT9009-PO3	P6	**Prior outage Ironwood2 (560002) to Spervil7 (531469) 345kV CKT 1** 3 phase fault on the G16-046-TAP 345KV (560080) to Ironwood7 345KV (539803) CKT 1, near G16-046-TAP. a. Apply fault at the G16-046-TAP 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.
FLT01-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Woodward 345KV (515375) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT07-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Thistle 138kV (539804) to Thistle 13.8kV (539802) XMFR CKT 1, near Thistle 345kV. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT12-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the Ironwood2 345KV (560002) to Spervil7 345kV (531469) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 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.
FLT9002-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the Clark County (539800) to G16-005-TAP 345KV (560072) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9003-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the Clark County (539800) to G16-046-TAP 345KV (560080) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9006-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 1, near G16-005-TAP. a. Apply fault at the G16-005-TAP 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.
FLT9007-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the Thistle 345KV (539801) to Buffalo7 345KV (532782) CKT 1, near Thistle. a. Apply fault at the Thistle 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.
FLT9009-PO4	P6	**Prior outage Clark County (539800) to Ironwood2 (560002) 345KV CKT 1** 3 phase fault on the G16-046-TAP 345KV (560080) to Ironwood7 345KV (539803) CKT 1, near G16-046-TAP. a. Apply fault at the G16-046-TAP 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.

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT08-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Spearville (531469) to G13-010 Tap 345KV (562334) 345KV CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT10-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Spearville 345KV (531469) to Buckner 345KV (531501) CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT12-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Spearville 345KV (531469) to Ironwood 345KV (539803) CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT13-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Spearville 345KV (531469) to Spearville 230kV (539695) to Spearville 13.8kV (531468) XMFR CKT 1, near Spearville 345kV. a. Apply fault at the Spearville 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT14-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Spearville 345KV (531469) to Spearville 115kv (539759) to Spearville 13.8kV (539960) XMFR CKT 1, near Spearville 345kV. a. Apply fault at the Spearville 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT9002-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Clark County (539800) to G16-005-TAP 345KV (560072) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9001-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Clark County (539800) to Ironwood2 345KV (560002) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9003-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Clark County (539800) to G16-046-TAP 345KV (560080) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9009-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the G16-046-TAP 345KV (560080) to Ironwood7 345KV (539803) CKT 1, near G16-046-TAP. a. Apply fault at the G16-046-TAP 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.

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT9010-PO5	P6	**Prior outage Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 2** 3 phase fault on the Ironwood2 345KV (560002) to Spervil7 345kV (531469) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 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.
FLT12-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the Spearville 345KV (531469) to Ironwood 345KV (539803) CKT 1, near Spearville. a. Apply fault at the Spearville 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.
FLT9001-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the Clark County 345KV (539800) to Ironwood2 345KV (560002) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9002-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the Clark County 345KV (539800) to G16-005-TAP 345KV (560072) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9003-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the Clark County 345KV (539800) to G16-046-TAP 345KV (560080) CKT 1, near Clark County. a. Apply fault at the Clark County 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.
FLT9006-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 1, near G16-005-TAP. a. Apply fault at the G16-005-TAP 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.
FLT9009-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the G16-046-TAP 345KV (560080) to Ironwood7 345KV (539803) CKT 1, near G16-046-TAP. a. Apply fault at the G16-046-TAP 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.
FLT9010-PO6	P6	**Prior outage the G16-005-TAP 345KV (560072) to Thistle 345KV (539801) CKT 2** 3 phase fault on the Ironwood2 345KV (560002) to Spervil7 345kV (531469) CKT 1, near Ironwood2. a. Apply fault at the Ironwood2 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.
FLT1001-SB	P4	**Stuck Breaker at Thistle7 (539801)** a. Apply single phase fault at Thistle7 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Thistle7 (539801) to Buffalo7 (532782) 345kV CKT 2 line d. Thistle7 345kV (539801) to Thistle4 138kV (539804) to Thistle1 13.8kV (539802) transformer

Table 6-1 continued

Fault ID	Planning Event	Fault Descriptions
FLT1002-SB	P4	**Stuck Breaker at Thistle7 (539801)** a. Apply single phase fault at Thistle7 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Thistle7 (539801) to Buffalo7 (532782) 345kV CKT 1 line d. Thistle7 (539801) to G16-005-TAP (560072) 345kV CKT 2 line
FLT1003-SB	P4	**Stuck Breaker at Thistle7 (539801)** a. Apply single phase fault at Thistle7 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Thistle7 (539801) to WWRDEHV7 (515375) 345kV CKT 2 line d. Thistle7 (539801) to G16-005-TAP (560072) 345kV CKT 1 line
FLT1004-SB	P4	**Stuck Breaker at G16-046 Tap (560080)** a. Apply single phase fault at G16-046 Tap 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. G16-046 Tap 345kV Bus
FLT1005-SB	P4	**Stuck Breaker at Ironwood2 (560002)** a. Apply single phase fault at Ironwood2 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Ironwood2 345kV Bus
FLT1006-SB	P4	**Stuck Breaker at Ironwood (539803)** a. Apply single phase fault at Ironwood 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Ironwood 345kV Bus
FLT1007-SB	P4	**Stuck Breaker at Clark County (539800)** a. Apply single phase fault at Clark County 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Clarke County (539800) to G15-005-TAP (560072) 345kV CKT 2 line d. Clarke County (539800) to G16-046-TAP (560080) 345kV CKT 1 line

6.3 Results

Table 6-2 shows the results of the fault events simulated for each of the three modified cases. The associated stability plots are provided in Appendix D.

Table 6-2: GEN-2011-008 Phase III Dynamic Stability Results

Fault ID	2017WP			2018SP			2026SP		
	Volt. Recovery	Volt. Violation	Stable	Volt. Recovery	Volt. Violation	Stable	Volt. Recovery	Volt. Violation	Stable
FLT01-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT02-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT10-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT13-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT14-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT15-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT22-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT37-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable

Table 6-2 continued

Fault ID	17WP			18SP			26SP		
	Voltage Recovery	Voltage Violation	Stable	Voltage Recovery	Voltage Violation	Stable	Voltage Recovery	Voltage Violation	Stable
FLT38-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT40-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9005-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9008-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9011-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9012-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9013-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9014-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9015-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9016-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9017-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9018-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT25-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT29-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1001-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1002-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1003-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1004-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1005-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1006-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1007-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT22-PO1	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT01-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-PO2	Pass	Pass	Stable*	Pass	Pass	Stable	Pass	Pass	Stable
FLT01-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable

Table 6-2 continued

Fault ID	17WP			18SP			26SP		
	Voltage Recovery	Voltage Violation	Stable	Voltage Recovery	Voltage Violation	Stable	Voltage Recovery	Voltage Violation	Stable
FLT9009-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT01-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT10-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT13-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT14-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-PO6	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable*
FLT9002-PO6	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable*
FLT9003-PO6	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable*
FLT9006-PO6	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-PO6	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-PO6	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable

***RELAY SLNOS1 # 1 tripped 523853 [FINNEY 7 345.00] TO 531449 [HOLCOMB7 345.00] CKT 1 during the fault**

During a few prior outage conditions, the SLNOS1 #1 relay tripped the Finney to Holcomb 345 kV Circuit 1 line during the fault. This happened in both the pre and post modification cases, so it was not attributed to this MRIS study.

In addition, after the prior outage of Clark County to G16-005-TAP 345KV Circuit 2 line (PO5) or the G16-005-TAP to Thistle 345KV Circuit 2 line (PO6), there were steady state low voltage violations. The following system adjustments were made to mitigate this issue:

1. Turn off Summit 14.4kV shunt reactor (-27.2MVAR)
2. Turn on Circle 115kV capbank (45MVAR)
3. Turn on WMCPHER3 115kV capbank (45MVAR)
4. Turn on JOHNCR 3 115kV capbank (24MVAR)
5. Turn on NORTHVW3 115kV capbank (45MVAR)
6. Turn on 3 VANBU3 115kV capbank (30MVAR)
7. Adjust HEIZER 230/115kV TF tap ratio and disable automatic voltage regulator
8. Adjust GRTBNDTT 230/115kV TF tap ratio and disable automatic voltage regulator
9. Adjust Ironwood wind farm MPT ratio to allow generator to generate more reactive power

10. Adjust GEN-2016-046 wind farm MPT ratio to allow generator to generate more reactive power
11. Adjust GEN-2011-016 wind farm MPT ratio to allow generator to generate more reactive power
12. Adjust Cimarron wind farm MPT ratio to allow generator to generate more reactive power
13. Adjust Spearville wind farm MPT ratio to allow generator to generate more reactive power

There were no damping or voltage recovery violations observed during the simulated faults. Additionally, the project was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

7.0 Material Modification Determination

In accordance with Attachment V of SPP's Open Access Transmission Tariff, for modifications other than those specifically permitted by Attachment V, SPP shall evaluate the proposed modifications prior to making them and inform the Interconnection Customer in writing of whether the modifications would constitute a Material Modification. A Material Modification shall mean those modifications that have a material impact on the cost or timing of any Interconnection Request with a later Queue priority date.

7.1 Results

SPP determined the requested modification is not a Material Modification based on the results of this Modification Request Impact Study performed by Aneden. Aneden evaluated the impact of the requested modification on the prior study results. Aneden determined that the requested modification resulted in similar dynamic stability and short circuit analyses and that the prior study power flow results are not negatively impacted.

This determination implies that any network upgrades already required by GEN-2011-008 would not be negatively impacted and that no new upgrades are required due to the requested modification, thus not resulting in a material impact on the cost or timing of any Interconnection Request with a later Queue priority date.

8.0 Conclusions

The Interconnection Customer for GEN-2011-008 requested a Modification Request Impact Study to assess the impact of the Phase III turbine and facility changes to a configuration with a total of 62 x GE 2.82 MW + 12 x Vestas V110 2.0 MW wind turbines for total capacity of 198.84 MW. In addition, the Phase III modification request included changes to the collection system, generator substation transformer, main substation transformer, generation interconnection line, and reactive power devices. The Phase I and Phase II collection systems, generator substation transformers, generation interconnection lines, main substation transformers, and reactive power devices were also updated with the latest project information in the modified cases to ensure accurate results.

SPP determined that power flow should not be performed based on the POI MW injection increase of 0.07%. However, SPP determined that the turbine change from Vestas to a combination of Vestas and GE turbines required short circuit and dynamic stability analyses.

The scope of this modification request study included a charging current compensation analysis, short circuit analysis, and dynamic stability analysis.

The results of the charging current compensation analysis performed using the 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak models showed that Phase III of the GEN-2011-008 project needed 18.96 MVAr of reactor shunts on the 34.5 kV bus of the Phase III project substation, an increase from the 11.34 MVAr found in the pre-modification case. Phase I and Phase II required 15.71 MVAr and 14.79 MVAr respectively with the updated topology, both increased from the existing model representation which required 14.38 MVAr for Phase I and 13.04 MVAr for Phase II. This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during low-wind or no-wind conditions. The information gathered from the charging current compensation analysis is provided as information to the customer and Transmission Owner. SPP does not require additional reactive requirements based on the results of this analysis.

The results from the short circuit analysis with the updated topology showed that the maximum Phase III GEN-2011-008 contribution to three-phase fault currents in the immediate systems at or near GEN-2011-008 was not greater than 0.69 kA for the 2018SP and 2026SP cases. All three-phase fault current levels within 5 buses of the POI with the Phase I, Phase II, and Phase II GEN-2011-008 generators online were below 42 kA for the 2018SP models and 2026SP models.

The dynamic stability analysis was performed using the three DISIS-2016-002-2 models 2017 Winter Peak, 2018 Summer Peak, 2026 Summer Peak. Up to 81 events were simulated, which included three-phase faults, three-phase faults on prior outage cases, and single-line-to-ground faults with stuck breakers faults.

The results of the dynamic stability analysis showed that there were no damping or voltage recovery violations observed during the simulated faults. Additionally, the project was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

The requested modification has been determined by SPP to not be a Material Modification. The requested modification does not have a material impact on the cost or timing of any Interconnection Request with a later Queue priority date.

It is likely that the customer may be required to reduce its generation output to 0 MW in real-time, 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 or delivery rights. If the customer wishes to obtain deliverability to final customers, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the customer.