Report on

GEN-2017-097 Modification Request Impact Study

Revision R1 January 26, 2023

Submitted to
Southwest Power Pool

SPP Southwest Power Pool

anedenconsulting.com

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Revision History

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
1/26/2023	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 GEN-2017-097, an active Generation Interconnection Request (GIR) with a Point of Interconnection (POI) at the Underwood 115 kV substation.

The GEN-2017-097 project interconnects in the Western Area Power Administration (WAPA) control area with a capacity of 128 MW as shown in Table ES-1 below. This Study has been requested to evaluate the modification of GEN-2017-097 to change the inverter configuration to 40 x Sungrow SG3600UD 3.2 MW for a total capacity of 128 MW. The inverters are rated at 3.6 MW, and use a Power Plant Controller (PPC) to limit the total power injected into the POI. The generating capability for GEN-2017-097 (144 MW) exceeds its Generator Interconnection Agreement (GIA) Interconnection Service amount, 128 MW, as listed in Appendix A of the GIA. As a result, the customer must ensure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA. In addition, the modification request included changes to the collection system, generator step-up transformer, generation interconnection line, main substation transformer, and reactive power devices. The existing and modified configurations for GEN-2017-097 are shown in Table ES-2.

Table ES-1: GEN-2017-097 Existing Configuration

Request	Point of Interconnection	Existing Generator Configuration	GIA Capacity (MW)
GEN-2017-097	Underwood 115 kV (NUNDRWD7 652485)	42 x Power Electronics FS3000CU15 3.048 MW	128

Table ES-2: GEN-2017-097 Modification Request

<table>
<tr><th>Facility</th><th colspan="2">DISIS-2017-002 Configuration</th><th>Modification Configuration</th></tr>
<tr><td>Point of Interconnection</td><td colspan="2">Underwood 115 kV (NUNDRWD7 652485)</td><td>Underwood 115 kV (NUNDRWD7 652485)</td></tr>
<tr><td>Configuration/Capacity</td><td colspan="2">42 x Power Electronics FS3000CU15 3.048 MW = 128 MW</td><td>40 x Sungrow SG3600UD 3.2 MW = 128 MW
Units are rated at 3.6 MW, PPC in place to limit POI to 128 MW</td></tr>
<tr><td>Generation Interconnection Line</td><td colspan="2">Length = 0.75 miles
R = 0.000900 pu
X = 0.005480 pu
B = 0.000770 pu
Rating MVA = 0 MVA</td><td>Length = 0.75 miles
R = 0.000987 pu
X = 0.005482 pu
B = 0.000774 pu
Rating MVA = 194 MVA</td></tr>
<tr><td>Main Substation Transformer[1]</td><td colspan="2">X = 9.368%, R = 0.375%,
Winding MVA = 100 MVA,
Rating MVA = 128 MVA</td><td>X = 9.035%, R = 0.143%,
Winding MVA = 96 MVA,
Rating MVA = 160 MVA</td></tr>
<tr><td>Equivalent GSU Transformer[1]</td><td>Gen 1 Equivalent Qty: 21
X = 7.99%, R = 0.399%,
Winding MVA = 70 MVA,
Rating MVA = 77 MVA</td><td>Gen 2 Equivalent Qty: 21
X = 7.99%, R = 0.399%,
Winding MVA = 70 MVA,
Rating MVA = 77 MVA</td><td>Gen 1 Equivalent Qty: 40
X = 5.798%, R = 0.85%,
Winding MVA = 144 MVA,
Rating MVA = 144 MVA</td></tr>
<tr><td>Equivalent Collector Line[2]</td><td>R = 0.008850 pu
X = 0.008610 pu
B = 0.005530 pu</td><td>R = 0.009970 pu
X = 0.010090 pu
B = 0.006590 pu</td><td>R = 0.002582 pu
X = 0.003705 pu
B = 0.024766 pu</td></tr>
<tr><td>Generator Dynamic Model[3] & Power Factor</td><td>21 x Power Electronics FS3000CU15 3.2 MVA (REGCA1)[3]
±0.99</td><td>21 x Power Electronics FS3000CU15 3.2 MVA (REGCA1)[3]
±0.99</td><td>40 x Sungrow SG3600UD 3.6 MVA (REGCAU1)[3]
±0.95</td></tr>
<tr><td>Reactive Power Devices</td><td colspan="2">N/A</td><td>1 x 8 MVAr 34.5 kV Capacitor Bank</td></tr>
</table>

1) X and R based on Winding MVA, 2) All pu are on 100 MVA Base, 3) DYR stability model name

SPP determined that power flow should not be performed based on the POI MW injection decrease of 0.63% compared to the DISIS-2017-002 power flow models (GEN-2017-097 dispatched to 100%). However, SPP determined that the change in inverter manufacturer from Power Electronics to Sungrow required short circuit and dynamic stability analyses.

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

Aneden performed the analyses using the modification request data based on the DISIS-2017-002 study models:

1. 2025 Summer Peak (25SP),
2. 2025 Winter Peak (25WP)

All analyses were performed using the Siemens PTI PSS/E[1] version 34 software and the results are summarized below.

The results of the charging current compensation analysis using the 25SP and 25WP models showed that the GEN-2017-097 project needed a 2.6 MVAr shunt reactor on the 34.5 kV bus of the project substation with the modifications in place, an increase from the 1.29 MVAr found in the DISIS-2017-001 study[2]. This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during reduced generation conditions. The information gathered from the charging current compensation analysis is provided as information to the Interconnection Customer and Transmission Owner (TO) and/or Transmission Operator. The applicable reactive power requirements will be further reviewed by the Transmission Owner and/or Transmission Operator.

The short circuit analysis was performed using the 25SP stability model modified for short circuit analysis. The results from the short circuit analysis with the updated topology showed that the maximum GEN-2017-097 contribution to three-phase fault currents in the immediate transmission systems at or near the GEN-2017-097 POI was no greater than 0.62 kA. All three-phase fault current levels within 5 buses of the POI with the GEN-2017-097 generator online were below 22 kA.

The dynamic stability analysis was performed using Siemens PTI PSS/E version 34.8 software for the two modified study models: 25SP and 25WP. 102 events were simulated, which included three-phase faults, three-phase faults on prior outage cases, and single-line-to-ground stuck breaker faults.

The results of the dynamic stability analysis showed that there were several existing base case issues found in the case with the GEN-2017-097 modification and in the original DISIS-2017-002 case. These issues were not attributed to the GEN-2017-097 modification request and are detailed in Appendix D.

There were no damping or voltage recovery violations attributed to the GEN-2017-097 modification request 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.

[1] Power System Simulator for Engineering
[2] DISIS-2017-001-2 Restudy of Stability and Short Circuit Analysis – June 16, 2022

The requested modification has been determined by SPP to not be a Material Modification. The requested modification does not have a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date. As the requested modification places the generating capability of the Interconnection Request at a higher amount than its Interconnection Service, the customer must install monitoring and control equipment as needed to ensure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA.

In accordance with FERC Order No. 827, the generating facility will be required to provide dynamic reactive power within the range of 0.95 leading to 0.95 lagging at the high-side of the generator substation.

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 GEN-2017-097. 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 Siemens PTI PSS/E version 34 software. The results of each analysis are presented in the following sections.

1.1 Power Flow Analysis

To determine whether power flow analysis is required, SPP evaluates the difference in the real power output at the POI between the DISIS-2017-002 power flow model configuration and the requested modification. Power flow analysis is performed if the difference in the real power may result in a significant impact on the results of the DISIS power flow analysis.

1.2 Stability Analysis, Short Circuit Analysis

To determine whether stability and short circuit analyses are required, SPP evaluates the difference between the stability model parameters and, if needed, the equivalent 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 project'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

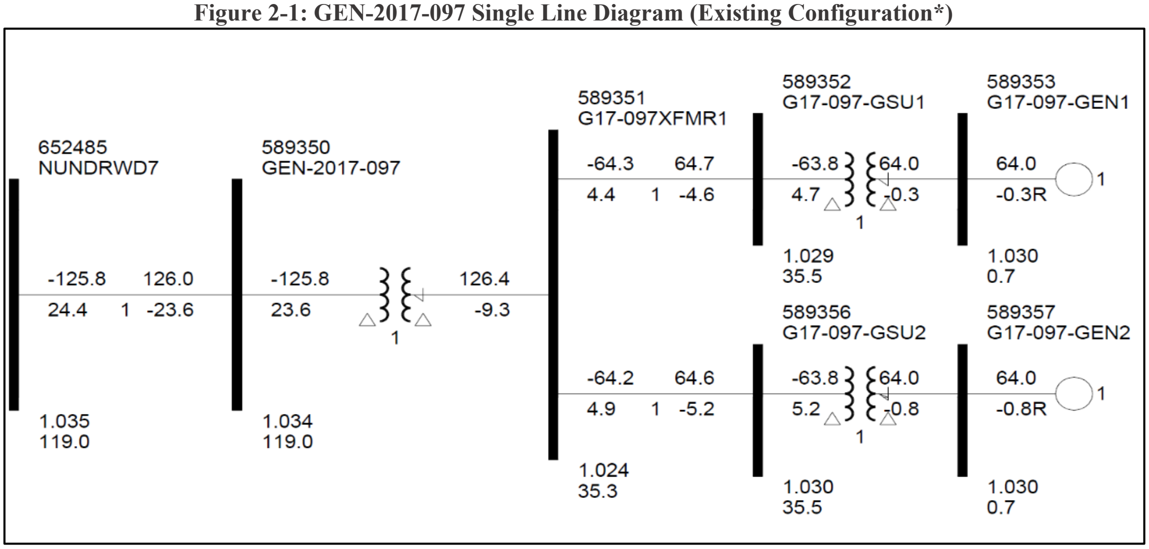
The GEN-2017-097 Interconnection Customer has requested a modification to its Interconnection Request (IR) with a Point of Interconnection (POI) at the Underwood 115 kV substation. At the time of report posting, GEN-2017-097 is an active Interconnection Request with a queue status of "IA FULLY EXECUTED/ON SCHEDULE." GEN-2017-097 is a solar plant with a maximum summer and winter queue capacity of 128 MW with Energy Resource Interconnection Service (ERIS).

The GEN-2017-097 project is currently in the DISIS-2017-001 cluster. Figure 2-1 shows the power flow model single line diagram for the existing GEN-2017-097 configuration using the DISIS-2017-002 stability models. The GEN-2017-097 project interconnects in the Western Area Power Administration (WAPA) control area with a capacity of 128 MW as shown in Table 2-1 below.

Table 2-1: GEN-2017-097 Existing Configuration

Request	Point of Interconnection	Existing Generator Configuration	GIA Capacity (MW)
GEN-2017-097	Underwood 115 kV (NUNDRWD7 652485)	42 x Power Electronics FS3000CU15 3.048 MW	128

Figure 2-1: GEN-2017-097 Single Line Diagram (Existing Configuration*)



*based on the DISIS-2017-002 stability models

This Study has been requested by the Interconnection Customer to evaluate the modification of GEN-2017-097 to an inverter configuration of 40 x Sungrow SG3600UD 3.2 MW for a total capacity of 128 MW. The inverters are rated at 3.6 MW, and use a Power Plant Controller (PPC) to limit the total power injected into the POI. The generating capability for GEN-2017-097 (144 MW) exceeds its Generator Interconnection Agreement (GIA) Interconnection Service amount, 128 MW, as listed in Appendix A of the GIA. As a result, the customer must ensure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA.

In addition, the modification request included changes to the collection system, generator step-up transformer, generation interconnection line, main substation transformer, and reactive power devices. Figure 2-2 shows the power flow model single line diagram for the GEN-2017-097 modification. The existing and modified configurations for GEN-2017-097 are shown in Table 2-2.

Figure 2-2: GEN-2017-097 Single Line Diagram (Modification Configuration)

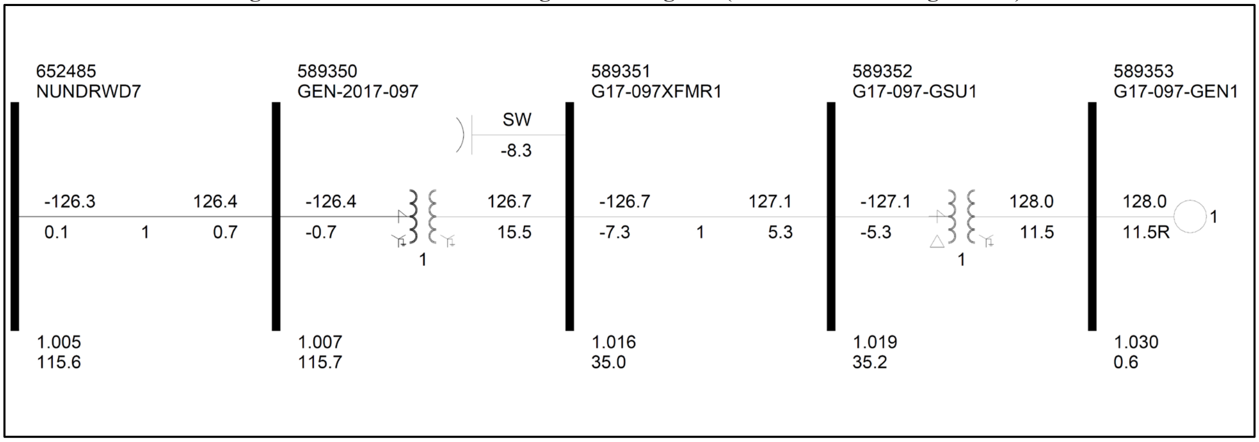


Table 2-2: GEN-2017-097 Modification Request

Facility	DISIS-2017-002 Configuration		Modification Configuration
Point of Interconnection	Underwood 115 kV (NUNDRWD7 652485)		Underwood 115 kV (NUNDRWD7 652485)
Configuration/Capacity	42 x Power Electronics FS3000CU15 3.048 MW = 128 MW		40 x Sungrow SG3600UD 3.2 MW = 128 MW Units are rated at 3.6 MW, PPC in place to limit POI to 128 MW
Generation Interconnection Line	Length = 0.75 miles R = 0.000900 pu X = 0.005480 pu B = 0.000770 pu Rating MVA = 0 MVA		Length = 0.75 miles R = 0.000987 pu X = 0.005482 pu B = 0.000774 pu Rating MVA = 194 MVA
Main Substation Transformer[1]	X = 9.368%, R = 0.375%, Winding MVA = 100 MVA, Rating MVA = 128 MVA		X = 9.035%, R = 0.143%, Winding MVA = 96 MVA, Rating MVA = 160 MVA
Equivalent GSU Transformer[1]	Gen 1 Equivalent Qty: 21 X = 7.99%, R = 0.399%, Winding MVA = 70 MVA, Rating MVA = 77 MVA	Gen 2 Equivalent Qty: 21 X = 7.99%, R = 0.399%, Winding MVA = 70 MVA, Rating MVA = 77 MVA	Gen 1 Equivalent Qty: 40 X = 5.798%, R = 0.85%, Winding MVA = 144 MVA, Rating MVA = 144 MVA
Equivalent Collector Line[2]	R = 0.008850 pu X = 0.008610 pu B = 0.005530 pu	R = 0.009970 pu X = 0.010090 pu B = 0.006590 pu	R = 0.002582 pu X = 0.003705 pu B = 0.024766 pu
Generator Dynamic Model[3] & Power Factor	21 x Power Electronics FS3000CU15 3.2 MVA (REGCA1)[3] ±0.99	21 x Power Electronics FS3000CU15 3.2 MVA (REGCA1)[3] ±0.99	40 x Sungrow SG3600UD 3.6 MVA (REGCAU1)[3] ±0.95
Reactive Power Devices	N/A		1 x 8 MVAr 34.5 kV Capacitor Bank

1) X and R based on Winding MVA, 2) All pu are on 100 MVA Base, 3) DYR stability model name

3.0 Existing vs Modification Comparison

To determine which analyses are required for the Study, 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 DISIS-2017-002 study models.

The methodology and results of the comparisons are described below. The analysis was completed using PSS/E version 34 software.

3.1 POI Injection Comparison

The real power injection at the POI was determined using PSS/E to compare the DISIS-2017-002 power flow model configuration to the requested modifications with the PPC in place for GEN-2017-097. The percentage change in the POI injection was then evaluated. If the MW percentage 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 (decrease of 0.63%) in the real power output at the POI between the studied DISIS-2017-002 power flow model configuration (GEN-2017-097[3] dispatched to 100%) and requested modification shown in Table 3-1.

Table 3-1: GEN-2017-097 POI Injection Comparison

Interconnection Request	Existing POI Injection (MW)	MRIS POI Injection (MW)	POI Injection Difference %
GEN-2017-097	127.1	126.3	-0.63%

3.2 Stability Model Parameters Comparison

SPP determined that short circuit and dynamic stability analyses were required because of the inverter change from Power Electronics to Sungrow. This is because the short circuit contribution and 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.

As short circuit and dynamic stability analyses were required, a turbine parameters comparison was not needed for the determination of the scope of the study.

3.3 Equivalent Impedance Comparison Calculation

As the inverter change 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.

[3] Note that the project was not dispatched to 100% in the starting models due the SPP fuel-based dispatch

4.0 Charging Current Compensation Analysis

The charging current compensation analysis was performed for GEN-2017-097 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

The GEN-2017-097 generators and capacitors were switched out of service while other system elements remained in-service. A shunt reactor was tested at the project'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).

Aneden performed the charging current compensation analysis using the modification request data based on the DISIS-2017-002 stability study models:

1. 2025 Summer Peak (25SP),
2. 2025 Winter Peak (25WP)

4.2 Results

The results from the analysis showed that the GEN-2017-097 project needed approximately 2.6 MVAr of compensation at its project substation to reduce the POI MVAr to zero. This is an increase from the 1.29 MVAr found in the DISIS-2017-001 study[4]. Figure 4-1 illustrates the shunt reactor size needed to reduce the POI MVAr to approximately zero with the updated topology. The final shunt reactor requirements for GEN-2017-097 are shown in Table 4-1.

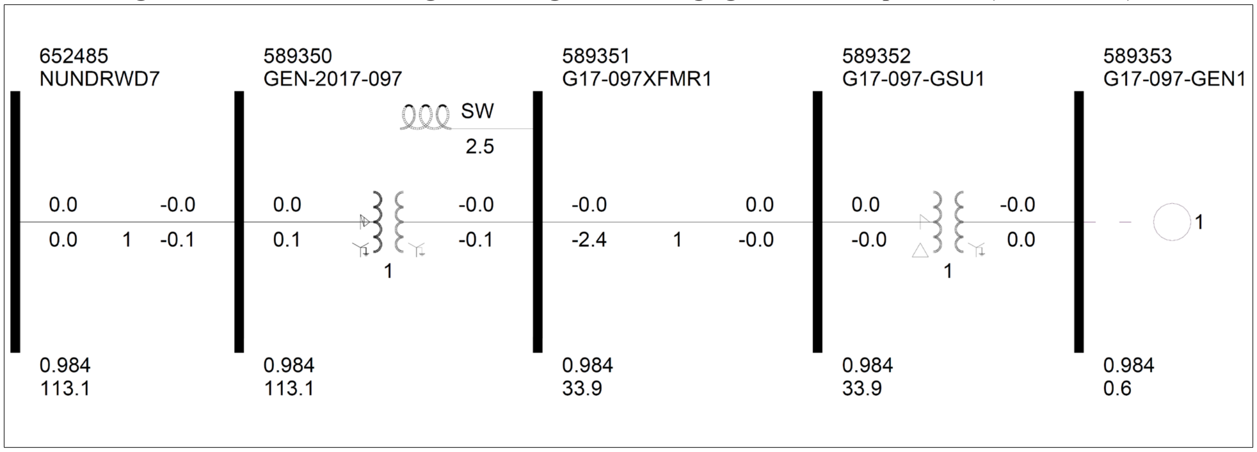
The information gathered from the charging current compensation analysis is provided as information to the Interconnection Customer and Transmission Owner (TO) and/or Transmission Operator. The applicable reactive power requirements will be further reviewed by the Transmission Owner and/or Transmission Operator.

Table 4-1: Shunt Reactor Size for Reduced Generation Study (Modification)

Machine	POI Bus Number	POI Bus Name	Reactor Size (MVAr)	
			25SP	25WP
GEN-2017-097	652485	NUNDRWD7 115 kV	2.6	2.6

[4] DISIS-2017-001-2 Restudy of Stability and Short Circuit Analysis – June 16, 2022

Figure 4-1: GEN-2017-097 Single Line Diagram w/ Charging Current Compensation (Modification)



5.0 Short Circuit Analysis

A short circuit study was performed using the 25SP model for GEN-2017-097. The detailed results of the short circuit analysis are provided in Appendix B.

5.1 Methodology

The short circuit analysis included applying a three-phase fault on buses up to 5 levels away from the 115 kV POI bus. The PSS/E "Automatic Sequence Fault Calculation (ASCC)" fault analysis module was used to calculate the fault current levels in the transmission system with and without GEN-2017-097 online.

Aneden created a short circuit model using the 25SP DISIS-2017-002 stability study model by adjusting the GEN-2017-097 short circuit parameters consistent with the modification data. The adjusted parameters are shown in Table 5-1 below.

Table 5-1: Short Circuit Model Parameters*

Parameter	Value by Generator Bus#
	589353
Machine MVA Base	144
R (pu)	0.0
X'' (pu)	0.9426

*pu values based on Machine MVA Base

5.2 Results

The results of the short circuit analysis for the 25SP model are summarized in Table 5-2 and Table 5-3. The GEN-2017-097 POI bus (NUNDRWD7 115 kV - 652485) fault current magnitudes are provided in Table 5-2 showing a maximum fault current of 7.46 kA with the GEN-2017-097 project online. Table 5-3 shows the maximum fault current magnitudes and fault current increases with the GEN-2017-097 project online.

The maximum fault current calculated within 5 buses of the GEN-2017-097 POI (including the POI bus) was less than 22 kA for the 25SP model. The maximum GEN-2017-097 contribution to three-phase fault current was about 9.1% and 0.62 kA.

Table 5-2: POI Short Circuit Results

Case	GEN-OFF Current (kA)	GEN-ON Current (kA)	Max kA Change	Max %Change
25SP	6.84	7.46	0.62	9.1%

Table 5-3: 25SP Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
69	4.4	0.08	2.2%
115	10.8	0.62	9.1%
230	21.2	0.28	7.1%
345	11.2	0.01	0.0%
Max	**21.2**	**0.62**	**9.1%**

6.0 Dynamic Stability Analysis

Aneden performed a dynamic stability analysis to identify the impact of the inverter configuration change and other modifications to GEN-2017-097. 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 existing base case issues and 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 GEN-2017-097 configuration of 40 x Sungrow SG3600UD 3.2 MW (REGCAU1). This stability analysis was performed using PTI's PSS/E version 34.8 software.

The modifications requested for the GEN-2017-097 project were used to create modified stability models for this impact study based on the DISIS-2017-002 stability study models:

1. 2025 Summer Peak (25SP),
2. 2025 Winter Peak (25WP)

The modified dynamic model data for the GEN-2017-097 project is provided in Appendix A. The modified power flow models and associated dynamic database were initialized (no-fault test) to confirm that there were no errors in the initial conditions of the system and the dynamic data.

The following system adjustments were made to address existing base case issues that are not attributed to the modification request:

1. The Fort Thompson (652807), Grand Prairie (652833), LO.LS-FT-BE3 (659424) and CC.LS-LO-BE3 (659428) 345 kV in-line reactors were switched off in the peak load scenarios to avoid unrealistic low voltage issues.
2. The voltage protection relays were disabled on buses 645065 & 645067 (Grand Prairie), 762241 (GEN-2017-175), 588593 & 588597 (GEN-2017-014), and 635332 (NEWHRVST).

During the fault simulations, the active power (PELEC), reactive power (QELEC), and terminal voltage (ETERM) were monitored for GEN-2017-097 and other current and prior queued projects in their cluster group[5]. In addition, voltages of five (5) buses away from the POI of GEN-2017-097 were monitored and plotted. The machine rotor angle for synchronous machines and speed for asynchronous machines within the study areas including 356 (AMMO), 600 (XEL), 608 (MP), 615 (GRE), 620 (OTP), 627 (ALTW), 635 (MEC), 652 (WAPA), 659 (BEPC-SPP), 661 (MDU), and 680 (DPC) 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-2017-097 and developed additional fault events 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 stuck breaker faults. Single-line-to-ground faults are approximated by applying a fault impedance to bring the faulted bus positive sequence voltage to 0.6 pu. The simulated faults are listed and described in Table 6-1 below. These contingencies were applied to the modified 25SP and 25WP models.

[5] Based on the DISIS-2017-002 Cluster Groups

Table 6-1: Fault Definitions

Fault ID	Planning Event	Fault Descriptions
FLT01-3PH	P1	3 phase fault on the PHILIP_T-BE4 (659188) to NUNDRWD4 (652484) 230 kV line CKT 1, near PHILIP_T-BE4. a. Apply fault at the PHILIP_T-BE4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT05-3PH	P1	3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-3PH	P1	3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-3PH	P1	3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to Wall 7 (652492) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-3PH	P1	3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT09-3PH	P1	3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-3PH	P1	3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT13-3PH	P1	3 phase fault on the NUNDRWD-LXN3 (652884) to MAURINE4 (652497) 230 kV line CKT 1, near NUNDRWD-LXN3. a. Apply fault at the NUNDRWD-LXN3 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT15-3PH	P1	3 phase fault on the PHILIP_T-BE4 (659188) to OAHE 4 (652519) 230 kV line CKT 1, near PHILIP_T-BE4. a. Apply fault at the PHILIP_T-BE4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT16-3PH	P1	3 phase fault on the WAYSIDE4 (640404) to STEGALL-LNX3 (652873) 230 kV line CKT 1, near WAYSIDE4. a. Apply fault at the WAYSIDE4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT18-3PH	P1	3 phase fault on the RAPIDCY7 (652490) to DRYCREEK-BE7 (659377) 115 kV line CKT 1, near RAPIDCY7. a. Apply fault at the RAPIDCY7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT19-3PH	P1	3 phase fault on the RAPIDCY7 (652490) to ELKCRK 7 (652473) to NEWELL 7 (652483) 115 kV line CKT 1, near RAPIDCY7. a. Apply fault at the RAPIDCY7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT21-3PH	P1	3 phase fault on the PHILIP9 (652487) to WANBLEE 7 (652579) to MARTIN 7 (652479) 115 kV line CKT 1, WANBLEE 7 (652579) to MARTIN 7 (652479) 115 kV line CKT 2, near PHILIP9. a. Apply fault at the PHILIP9 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT23-3PH	P1	3 phase fault on the OAHE 4 (652519) to G16-094-TAP (587764) 230 kV line CKT 1, near OAHE 4. a. Apply fault at the OAHE 4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT24-3PH	P1	3 phase fault on the OAHE 4 (652519) to FTTHOMP4 (652507) 230 kV line CKT 1, near OAHE 4. a. Apply fault at the OAHE 4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT25-3PH	P1	3 phase fault on the OAHE 4 (652519) to SULLYBT-ER4 (655487) 230 kV line CKT 1, near OAHE 4. a. Apply fault at the OAHE 4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT27-3PH	P1	3 phase fault on the MA KV1A 3 230 kV (652497) / 115 kV (652480) /13.8 kV (652247) transformer CKT 1, near MAURINE4 230 kV. a. Apply fault at the MAURINE4 230 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT29-3PH	P1	3 phase fault on the STEGALL-LNX3 (652873) to STEGALL4 (652573) 230 kV line CKT Z, near STEGALL-LNX3. a. Apply fault at the STEGALL-LNX3 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT31-3PH	P1	3 phase fault on the DRYCREEK-BE4 (659376) to RCDC.E_BE4 (659271) 230 kV line CKT Z, near DRYCREEK-BE4. a. Apply fault at the DRYCREEK-BE4 230 kV bus. b. Clear fault after 7 cycles by tripping the faulted line. **Block DCLINE MRO_46_RPCTY** c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 7 cycles, then trip the line in (b) and remove fault.
FLT32-3PH	P1	3 phase fault on the KV1A DRY 230 kV (659376) / 115 kV (659377) /13.8 kV (659378) transformer CKT 1, near DRYCREEK-BE4 230 kV. a. Apply fault at the DRYCREEK-BE4 230 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT70-3PH	P1	3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT15-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the PHILIP_T-BE4 (659188) to OAHE 4 (652519) 230 kV line CKT 1, near PHILIP_T-BE4. a. Apply fault at the PHILIP_T-BE4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT70-PO2	P6	**PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to PHILIP 7 (652487) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT09-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT07-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to PHILIP 7 (652487) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT09-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT05-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT09-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT9001-3PH	P1	3 phase fault on the ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near ELSWRTH7. a. Apply fault at the ELSWRTH7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9002-3PH	P1	3 phase fault on the WICKSVL7 (652493) to WALL 7 (652492) 115 kV line CKT 1, near WICKSVL7. a. Apply fault at the WICKSVL7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9003-3PH	P1	3 phase fault on the WALL 7 (652492) to PHILIP 7 (652487)115 kV line CKT 1, near WALL 7. a. Apply fault at the WALL 7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9004-3PH	P1	3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9005-3PH	P1	3 phase fault on the PHILIP_T-BE4 (659188) to GEN-2017-014 (588590) 230 kV line CKT 1, near PHILIP_T-BE4. a. Apply fault at the PHILIP_T-BE4 230 kV bus. b. Clear fault after 7 cycles by tripping the faulted line. **Trip generator G17-014-GEN2 (588597)** **Trip generator G17-014-GEN1 (588593)** c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 7 cycles, then trip the line in (b) and remove fault.
FLT9006-3PH	P1	3 phase fault on the OA NO.5 230 kV (652519)/ 115 kV (652520) / 13.8 kV (652589) transformer CKT 1, near OAHE 4 230 kV. a. Apply fault at the OAHE 4 230 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT9007-3PH	P1	3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9008-3PH	P1	3 phase fault on the OA NO.2 230 kV (652519)/ 13.8 kV (652556) transformer CKT 1, near OAHE 4 230 kV. a. Apply fault at the OAHE 4 230 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer. **Trip generators on bus OAHE2-3G (652556)**
FLT9009-3PH	P1	3 phase fault on the PHILIP_T-BE4 (659188) to PHILIP_-BE4 (659192) 230 kV line CKT 1, near PHILIP_T-BE4. a. Apply fault at the PHILIP_T-BE4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT9010-3PH	P1	3 phase fault on the WAYSIDE T1 230 kV (640404) / 115 kV (640405) /13.8 kV (640406) transformer CKT 1, near WAYSIDE4 230 kV. a. Apply fault at the WAYSIDE4 230 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT9011-3PH	P1	3 phase fault on the MAURINE4 (652497) to BISON___-GE4 (659351) 230 kV line CKT 1, near MAURINE4. a. Apply fault at the MAURINE4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9012-3PH	P1	3 phase fault on the PL KV1A 230 kV (659192) / 115 kV (652487) /13.2 kV (659193) transformer CKT 1, near PHILIP_-BE4 230 kV. a. Apply fault at the PHILIP_-BE4 230 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT05-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-PO1	P6	PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1; 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to PHILIP 7 (652487) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT09-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT9004-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9007-PO1	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT05-PO2	P6	**PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO2	P6	**PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-PO2	P6	PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1; 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to PHILIP 7 (652487) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO2	P6	**PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO2	P6	**PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9004-PO2	P6	**PRIOR OUTAGE of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 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 of the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT70-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9004-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9007-PO3	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT05-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT08-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT70-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9004-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9007-PO4	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT70-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT9004-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9007-PO5	P6	**PRIOR OUTAGE of the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT05-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to PHILIP 7 (652487) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT09-PO6	P6	**PRIOR OUTAGE of NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT70-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT9004-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9007-PO6	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT05-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to PHILIP 7 (652487) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT09-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT70-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT9007-PO7	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z;** 3 phase fault on the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT05-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT06-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to ELSWRTH7 (652477) to RAPIDCY7 (652490) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT07-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD7 (652485) to WICKSVL7 (652493) to Wall 7 (652492) 115 kV line CKT 1, near NUNDRWD7. a. Apply fault at the NUNDRWD7 115 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT08-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT09-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1, near NUNDRWD4 115 kV. a. Apply fault at the NUNDRWD4 115 kV bus. b. Clear fault after 7 cycles and trip the faulted transformer.
FLT12-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT70-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.

Table 6-1 Continued

Fault ID	Planning Event	Fault Descriptions
FLT9004-PO8	P6	**PRIOR OUTAGE of the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1;** 3 phase fault on the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z, near NUNDRWD4. a. Apply fault at the NUNDRWD4 230 kV bus. b. Clear fault after 7 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 7 cycles, then trip the line in (b) and remove fault.
FLT1001-SB	P4	**Stuck Breaker on at NUNDRWD4 (652484) at 230kV bus** a. Apply single-phase fault at NUNDRWD4 (652484) on the 230kV bus. b. After 16 cycles, trip the following elements c. Trip the NUNDRWD4 (652484) to WAYSIDE4 (640404) 230 kV line CKT 1. d. Trip the NUNDRWD4 (652484) to DRYCREEK-BE4 (659376) 230 kV line CKT 1. e. Trip the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1.
FLT1002-SB	P4	**Stuck Breaker on at NUNDRWD4 (652484) at 230kV bus** a. Apply single-phase fault at NUNDRWD4 (652484) on the 230kV bus. b. After 16 cycles, trip the following elements c. Trip the NUNDRWD4 (652484) to NUNDRWD-LXN3 (652884) 230 kV line CKT Z. d. Trip the NUNDRWD4 (652484) to PHILIP_T-BE4 (659188) 230 kV line CKT 1. e. Trip the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1.
FLT1003-SB	P4	**Stuck Breaker on at NUNDRWD7 (652485) at 115kV bus** a. Apply single-phase fault at NUNDRWD7 (652485) on the 230kV bus. b. After 16 cycles, trip the following elements c. Trip the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652267) transformer CKT 1. d. Trip the NUNDRWD7 (652485) to ELSWRTH7 (652477) 115 kV line CKT 1. e. Trip the NUNDRWD7 (652485) to WICKSVL7 (652493) 115 kV line CKT 1.
FLT1004-SB	P4	**Stuck Breaker on at NUNDRWD7 (652485) at 115kV bus** a. Apply single-phase fault at NUNDRWD7 (652485) on the 230kV bus. b. After 16 cycles, trip the following elements c. Trip the NU KV2A 230 kV (652484)/ 115 kV (652485) / 13.8 kV (652266) transformer CKT 1. d. Trip the NUNDRWD7 (652485) to RUSHMORE-RM7 (655763) 115 kV line CKT 1.

6.3 Results

Table 6-2 shows the relevant results of the fault events simulated for each of the modified cases. Existing DISIS base case issues are documented separately in Appendix D. The associated stability plots are also provided in Appendix D.

Table 6-2: GEN-2017-097 Dynamic Stability Results

Fault ID	25SP			25WP		
	Volt Violation	Volt Recovery	Stable	Volt Violation	Volt Recovery	Stable
FLT01-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT13-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT15-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT16-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT18-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT19-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT21-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT23-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT24-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT25-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT27-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT29-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT31-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT32-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9005-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9008-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9011-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9012-3PH	Pass	Pass	Stable	Pass	Pass	Stable

Table 6-2 continued

Fault ID	25SP			25WP		
	Volt Violation	Volt Recovery	Stable	Volt Violation	Volt Recovery	Stable
FLT1001-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT1002-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT1003-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT1004-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT15-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO4	Pass	Pass	Stable	Pass	Pass	Stable

Table 6-2 continued

Fault ID	25SP			25WP		
	Volt Violation	Volt Recovery	Stable	Volt Violation	Volt Recovery	Stable
FLT05-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO8	Pass	Pass	Stable	Pass	Pass	Stable

The results of the dynamic stability analysis showed that there were several existing base case issues found in the original DISIS-2017-002 case and the case with the GEN-2017-097 modification. These issues were not attributed to the GEN-2017-097 modification request and detailed in Appendix D.

There were no damping or voltage recovery violations attributed to the GEN-2017-097 modification request 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 Modified Capacity Exceeds GIA Capacity

Under FERC Order 845, Interconnection Customers are allowed to request Interconnection Service that is lower than the full generating capacity of their planned generating facilities. The Interconnection Customers must install acceptable control and protection devices that prevent the injection above their requested Interconnection Service amount measured at the POI.

As such, Interconnection Customers are allowed to increase the generating capacity of a generating facility without increasing its Interconnection Service amount stated in its GIA. This is allowable as long as they install the proper control and protection devices, and the requested modification is not determined to be a Material Modification.

7.1 Results

The modified generating capability of GEN-2017-097 (144 MW) exceeds the GIA Interconnection Service amount, 128 MW, as listed in Appendix A of the GIA. The GEN-2017-097 inverters are rated at 3.6 MW, and use a Power Plant Controller (PPC) to limit the total power injected into the POI.

The customer must install monitoring and control equipment as needed to ensure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA.

8.0 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. Material Modification shall mean (1) modification to an Interconnection Request in the queue that has a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date; or (2) planned modification to an Existing Generating Facility that is undergoing evaluation for a Generating Facility Modification or Generating Facility Replacement, and has a material adverse impact on the Transmission System with respect to: i) steady-state thermal or voltage limits, ii) dynamic system stability and response, or iii) short-circuit capability limit; compared to the impacts of the Existing Generating Facility prior to the modification or replacement.

8.1 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 did not negatively impact the prior study dynamic stability and short circuit results, and the modifications to the project were not significant enough to change the previously studied power flow conclusions.

This determination implies that any network upgrades already required by GEN-2017-097 would not be negatively impacted and that no new upgrades are required due to the requested modification, thus not resulting in a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date.

9.0 Conclusions

The Interconnection Customer for GEN-2017-097 requested a Modification Request Impact Study to assess the impact of the inverter and facility change to 40 x Sungrow SG3600UD 3.2 MW for a total capacity of 128 MW. The inverters are rated at 3.6 MW, and use a Power Plant Controller (PPC) to limit the total power injected into the POI. The generating capability for GEN-2017-097 (144 MW) exceeds its Generator Interconnection Agreement (GIA) Interconnection Service amount, 128 MW, as listed in Appendix A of the GIA. As a result, the customer must ensure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA.

In addition, the modification request included changes to the collection system, generator step-up transformer, generation interconnection line, main substation transformer, and reactive power devices.

SPP determined that power flow should not be performed based on the POI MW injection decrease of 0.63% compared to the DISIS-2017-002 power flow models (GEN-2017-097 dispatched to 100%). However, SPP determined that the change in inverter manufacturer from Power Electronics to Sungrow required short circuit and dynamic stability analyses.

All analyses were performed using the Siemens PTI PSS/E version 34 software and the results are summarized below.

The results of the charging current compensation analysis using the 25SP and 25WP models showed that the GEN-2017-097 project needed a 2.6 MVAr shunt reactor on the 34.5 kV bus of the project substation with the modifications in place, an increase from the 1.29 MVAr found in the DISIS-2017-001 study[6]. This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during reduced generation conditions. The information gathered from the charging current compensation analysis is provided as information to the Interconnection Customer and Transmission Owner (TO) and/or Transmission Operator. The applicable reactive power requirements will be further reviewed by the Transmission Owner and/or Transmission Operator.

The short circuit analysis was performed using the 25SP stability model modified for short circuit analysis. The results from the short circuit analysis with the updated topology showed that the maximum GEN-2017-097 contribution to three-phase fault currents in the immediate transmission systems at or near the GEN-2017-097 POI was no greater than 0.62 kA. All three-phase fault current levels within 5 buses of the POI with the GEN-2017-097 generator online were below 22 kA.

The dynamic stability analysis was performed using Siemens PTI PSS/E version 34.8 software for the two modified study models: 25SP and 25WP. 102 events were simulated, which included three-phase faults, three-phase faults on prior outage cases, and single-line-to-ground stuck breaker faults.

The results of the dynamic stability analysis showed that there were several existing base case issues found in the case with the GEN-2017-097 modification and in the original DISIS-2017-002 case. These issues were not attributed to the GEN-2017-097 modification request and are detailed in Appendix D.
There were no damping or voltage recovery violations attributed to the GEN-2017-097 modification request observed during the simulated faults. Additionally, the project was found to stay connected during the

[6] DISIS-2017-001-2 Restudy of Stability and Short Circuit Analysis – June 16, 2022

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 adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date. As the requested modification places the generating capability of the Interconnection Request at a higher amount than its Interconnection Service, the customer must install monitoring and control equipment as needed to ensure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA.

In accordance with FERC Order No. 827, the generating facility will be required to provide dynamic reactive power within the range of 0.95 leading to 0.95 lagging at the high-side of the generator substation.

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.

Appendices

GEN-2017-097
Modification Request Impact Study

Date of

Submittal

January 26, 2023

anedenconsulting.com

Appendix A

GEN-2017-097 Generator Dynamic Model

```
  // *************** GEN-2017-097 100% **************
//
// POI at Underwood 115 kV Sub
//
//
// SG 3.6 MVA X 40, POI 128MW

589353 'USRMDL' 1 'REGCAU1' 101 1 1 14 3 4
 0
 0.02000     10.0000     0.90000     0.50000     1.10000
 1.10000     0.90000     0.03000    -1.00000     0.01000
 0.00000     999.000    -999.000     1.00000/


589353 'USRMDL' 1 'REECAU1' 102 0 6 45 6 9
 0        0        1        0        0        0
 0.90000     1.10000     0.01000    -0.10000     0.10000
 2.00000     1.00000    -1.00000     1.00000     0.01000
 0.00000     0.00000     0.01000     0.60000    -0.60000
 1.10000     0.90000     0.30000     5.00000     0.50000
 0.00000     0.00000     0.01000     99.0000    -99.0000
 1.00000     0.00000     1.00000     0.01000     0.05000
 1.00000     0.49000     1.00000     0.50000     1.00000
 1.20000     1.00000     0.05000     1.00000     0.49000
 1.00000     0.50000     1.00000     1.20000     1.00000/


589353 'USRMDL' 1 'REPCAU1' 107 0 7 27 7 9
 589350      589350      652485      '1'     1     1     1
 0.05000     0.50000     3.00000     0.00000     0.05000
 0.70000     0.00000     0.00000     0.00000     0.05000
-0.05000     0.00000     0.00000     0.60000    -0.60000
 0.50000     0.25000     0.25000    -0.00060     0.00060
 999.000    -999.000     1.00000     0.00000     0.50000
 20.0000     20.0000/


58935301 'VTGTPAT'  589353   589353   1   0.50   999   3.00   0.0 /
58935302 'VTGTPAT'  589353   589353   1   0.88   999   1.10   0.0 /
58935303 'VTGTPAT'  589353   589353   1   0.00   1.1   2.00   0.0 /
58935304 'VTGTPAT'  589353   589353   1   0.00   1.2   0.16   0.0 /
58935305 'FRQTPAT'  589353   589353   1   58.5   999   300.0  0.0 /
58935306 'FRQTPAT'  589353   589353   1   56.5   999   0.16   0.0 /
58935307 'FRQTPAT'  589353   589353   1   0.00   62.0  0.16   0.0 /
58935308 'FRQTPAT'  589353   589353   1   0.00   61.2  300.0  0.0 /
```

Appendix B

Short Circuit Results

Table B-1: 25SP Short Circuit Results

BUS NUMBER	BUS NAME	Voltage (kV)	AREA	ZONE	3 Phase Fault Current (kA)		Difference (ON - OFF)		Distance from GEN POI Bus	Greater Than 40 kA
					GenON	GenOFF	Change	%	652485	
652485	NUNDRWD7	115	652	1603	7.463	6.840	0.623	9.11%	0	FALSE
589350	GEN-2017-097	115	652	1603	6.975	N/A	N/A	N/A	1	FALSE
652477	ELSWRTH7	115	652	1603	4.379	4.182	0.197	4.71%	1	FALSE
652484	NUNDRWD4	230	652	1603	4.260	3.977	0.283	7.12%	1	FALSE
652493	WICKSVL7	115	652	1603	4.501	4.316	0.185	4.29%	1	FALSE
655763	RUSHMORE-RM7	115	652	1676	5.051	4.805	0.246	5.12%	1	FALSE
640404	WAYSIDE4	230	652	686	2.813	2.768	0.045	1.63%	2	FALSE
652490	RAPIDCY7	115	652	1603	5.421	5.159	0.262	5.08%	2	FALSE
652492	WALL 7	115	652	1603	3.686	3.606	0.080	2.22%	2	FALSE
652884	NUNDRWD-LNX3	230	652	1603	4.251	3.969	0.282	7.11%	2	FALSE
655764	RUSHMORE-RM8	69	652	1676	3.232	3.166	0.066	2.08%	2	FALSE
659188	PHILIP_T-BE4	230	652	1628	5.474	5.371	0.103	1.92%	2	FALSE
659376	DRYCREEK-BE4	230	652	1628	3.149	2.988	0.161	5.39%	2	FALSE
588590	GEN-2017-014	230	652	1603	5.474	5.371	0.103	1.92%	3	FALSE
640405	WAYSIDE7	115	640	686	3.968	3.932	0.036	0.92%	3	FALSE
652473	ELKCRK 7	115	652	1628	4.101	3.977	0.124	3.12%	3	FALSE
652487	PHILIP 7	115	652	1603	6.053	5.971	0.082	1.37%	3	FALSE
652497	MAURINE4	230	652	1603	3.100	3.039	0.061	2.01%	3	FALSE
652519	OAHE 4	230	652	1604	13.253	13.221	0.032	0.24%	3	FALSE
652873	STEGALL-LNX3	230	652	1603	4.970	4.953	0.017	0.34%	3	FALSE
655762	RAPIDCTY-RM8	69	652	1676	3.635	3.558	0.077	2.16%	3	FALSE
659192	PHILIP__-BE4	230	652	1628	4.128	4.064	0.064	1.57%	3	FALSE
659271	RCDC.E__-BE4	230	652	1628	3.141	2.980	0.161	5.40%	3	FALSE
659377	DRYCREEK-BE7	115	652	1628	5.052	4.829	0.223	4.62%	3	FALSE
587764	G16-094-TAP	230	652	1604	9.183	9.177	0.006	0.07%	4	FALSE
640109	CHADRON7	115	640	686	3.549	3.529	0.020	0.57%	4	FALSE
652268	PHILIP 8	69	652	1603	2.465	2.454	0.011	0.45%	4	FALSE
652480	MAURINE7	115	652	1603	4.866	4.802	0.064	1.33%	4	FALSE
652481	MIDLAND7	115	652	1603	3.408	3.392	0.016	0.47%	4	FALSE
652483	NEWELL 7	115	652	1603	3.886	3.830	0.056	1.46%	4	FALSE
652507	FTTHOMP4	230	652	1604	21.248	21.232	0.016	0.08%	4	FALSE
652520	OAHE 7	115	652	1603	10.796	10.774	0.022	0.20%	4	FALSE
652573	STEGALL4	230	652	1603	4.984	4.968	0.016	0.32%	4	FALSE
652579	WANBLEE 7	115	652	1603	2.963	2.952	0.011	0.37%	4	FALSE
655487	SULLYBT-ER4	230	652	1632	6.097	6.091	0.006	0.10%	4	FALSE
659268	RCDC.DUM-BE4	230	652	1628	5.758	6.289	-0.531	-8.44%	4	FALSE
659351	BISON___-GE4	230	652	1682	2.853	2.825	0.028	0.99%	4	FALSE
587760	GEN-2016-094	230	652	1604	9.021	9.015	0.006	0.07%	5	FALSE
589324	G17-094-TAP	230	652	1604	10.901	10.899	0.002	0.02%	5	FALSE
640147	CRAWFRD7	115	640	686	2.464	2.456	0.008	0.33%	5	FALSE
640334	RUSHVIL7	115	640	686	2.058	2.051	0.007	0.34%	5	FALSE
640396	VICTRYH4	230	640	686	3.463	3.454	0.009	0.26%	5	FALSE
652243	FAITH 7	115	652	1603	2.468	2.454	0.014	0.57%	5	FALSE
652248	MAURINE8	69	652	1603	2.782	2.767	0.015	0.54%	5	FALSE
652263	MIDLAND8	69	652	1603	2.093	2.088	0.005	0.24%	5	FALSE
652265	NEWELL 8	69	652	1603	2.839	2.819	0.020	0.71%	5	FALSE
652276	FTTHOMP8	69	652	1604	4.402	4.402	0.000	0.00%	5	FALSE
652476	EAGLEBT7	115	652	1603	1.942	1.937	0.005	0.26%	5	FALSE
652479	MARTIN 7	115	652	1603	3.064	3.054	0.010	0.33%	5	FALSE
652491	SULPHUR	115	652	1603	4.845	4.785	0.060	1.25%	5	FALSE
652506	FTTHOMP3	345	652	1604	11.166	11.161	0.005	0.04%	5	FALSE
652509	FTRANDL4	230	652	1604	12.327	12.324	0.003	0.02%	5	FALSE
652540	BIGBND14	230	652	1604	12.261	12.256	0.005	0.04%	5	FALSE
652541	BIGBND24	230	652	1604	12.174	12.169	0.005	0.04%	5	FALSE
652600	ASH TAP	115	652	1603	8.220	8.205	0.015	0.18%	5	FALSE
652606	LETCHER4	230	652	1604	4.709	4.708	0.001	0.02%	5	FALSE
652607	WESSINGTON 4	230	652	1604	5.649	5.648	0.001	0.02%	5	FALSE
653311	DUNLAP 7	115	640	1612	2.386	2.378	0.008	0.34%	5	FALSE
655475	LAKPLAT-ER4	230	652	1632	5.602	5.601	0.001	0.02%	5	FALSE
655488	SULLYBT-ER8	69	652	1632	2.348	2.347	0.001	0.04%	5	FALSE
655510	SB.LS-WK-ER4	230	652	1632	6.097	6.091	0.006	0.10%	5	FALSE
658174	IRVSIMM7	115	652	1624	7.778	7.762	0.016	0.21%	5	FALSE
659206	STEGALL_-MB4	230	652	698	5.211	5.195	0.016	0.31%	5	FALSE
659350	BISON___-GE7	115	652	1682	1.390	1.386	0.004	0.29%	5	FALSE
659352	BISON___-GE8	69	652	1682	2.048	2.042	0.006	0.29%	5	FALSE
659829	DH_CS_EA-TS4	230	652	1630	4.984	4.968	0.016	0.32%	5	FALSE
661047	HETINGR4	230	652	1636	3.363	3.346	0.017	0.51%	5	FALSE

Appendix C

SPP Disturbance Performance Requirements

Southwest Power Pool Disturbance Performance Requirements

Revision 3.0

July 21, 2016

Revision History

Version Number	Author	Change Description	Comments
1.0 (1/13/2013)	Transient Stability Task Force	First draft	TWG approval of Rotor Angle Damping
1.1 (7/31/2013)	Transmission Working Group	Approval of entire document	Approval of both Rotor Angle Damping and Transient Voltage requirements and addressed items regarding SPPR figure.
2.0 (12/15/2015)	Transmission Working Group	Revision to Transient Voltage Requirements	Addition of 2.5 seconds delay of looking at voltage being above 0.7 p.u.
3.0 (7/21/2016)	Dynamic Load Task Force	Revision to Rotor Angle Damping Requirements	Edited verbiage to clarify rotor angle requirements.

Southwest Power Pool
Disturbance Performance Requirements

OVERVIEW

These Disturbance Performance Requirements ("Requirements") shall be applicable to the Bulk Electric System within the Southwest Power Pool Planning Area. Utilization of these Requirements applies to all registered entities within the Southwest Power Pool Planning Area. These Requirements shall not be applicable to facilities that are not part of Bulk Electric System. More stringent Requirements are at the sole discretion of each Transmission Planner.

Transient and dynamic stability assessments are generally performed to assure adequate avoidance of loss of generator synchronism and prevention of system voltage collapse within the first 20 seconds after a system disturbance. These Requirements provide a basis for evaluating the system response during the initial transient period following a disturbance on the Bulk Electric System by establishing minimum requirements for machine rotor angle damping and transient voltage recovery.

ROTOR ANGLE DAMPING REQUIREMENT

Machine Rotor Angles shall exhibit well damped angular oscillations following a disturbance on the Bulk Electric System for all NERC TPL-001-4 P1 through P7 events.

Machines with rotor angle deviations greater than or equal to 16 degrees (measured as absolute maximum peak to absolute minimum peak) shall be evaluated against SPPR1 or SPPR5 requirements below. Machines with rotor angle deviations less than 16 degrees which do not exhibit convergence shall be evaluated on an individual basis. Rotor angle deviations will be calculated relative to the system swing machine.

Well damped angular oscillations shall meet one of the following two requirements when calculated directly from the rotor angle:

1. Successive Positive Peak Ratio One (SPPR1) must be less than or equal to 0.95 where SPPR1 is calculated as follows:

$$\text{SPPR1} = \frac{\text{Peak Rotor Angle of } 2^{nd} \text{ Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of } 1^{st} \text{ Positive Peak minus Minimum Value}} \leq 0.95$$

   -or- Damping Factor % = (1 – SPPR1) x 100% $\geq$ 5%

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

   Damping Ratio $\geq$ 0.0081633

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

$$\text{SPPR5} = \frac{\text{Peak Rotor Angle of } 6^{th} \text{ Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of } 1^{st} \text{ Positive Peak minus Minimum Value}} \leq 0.774$$

   -or- Damping Factor % = (1 – SPPR5) x 100% $\geq$ 22.6%

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

   Damping Ratio $\geq$ 0.0081633

Qualitatively, these Requirements are shown in Figure 1 & 2 below.

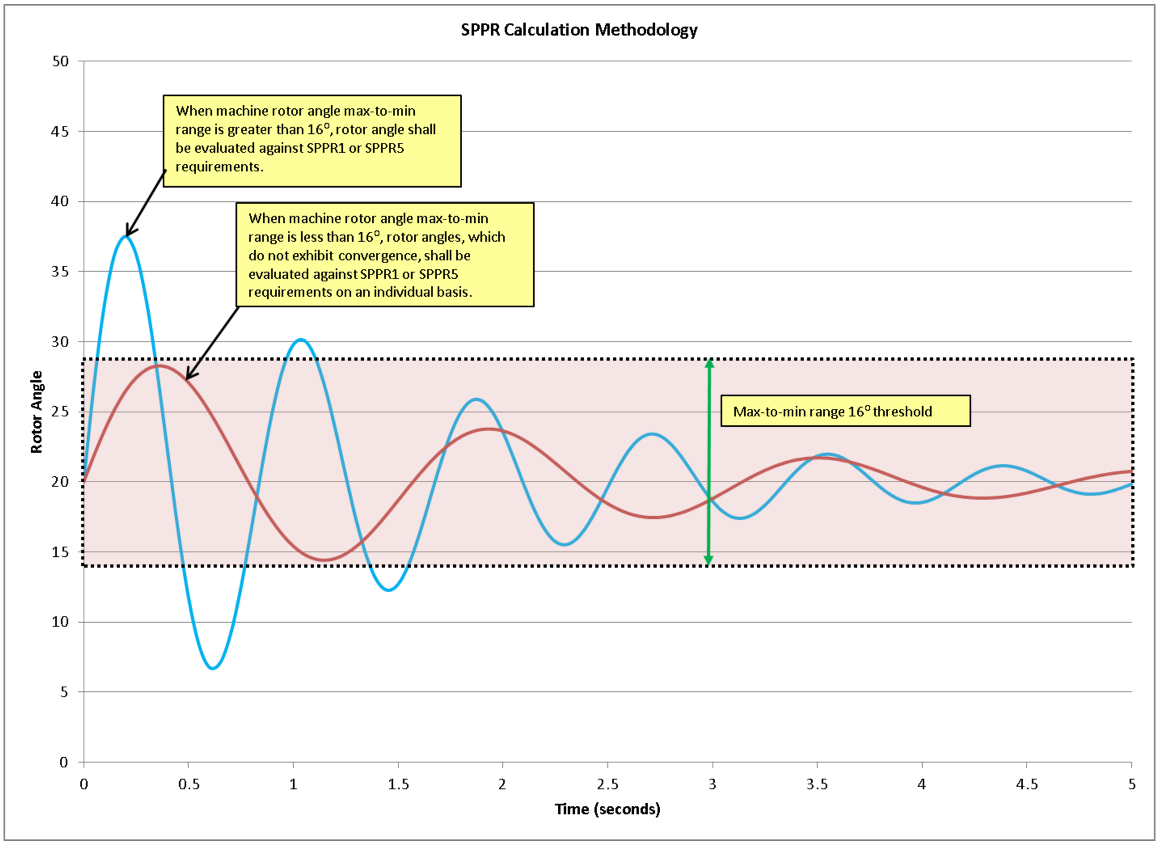


Figure 1. Applicability of 16 Degree Threshold

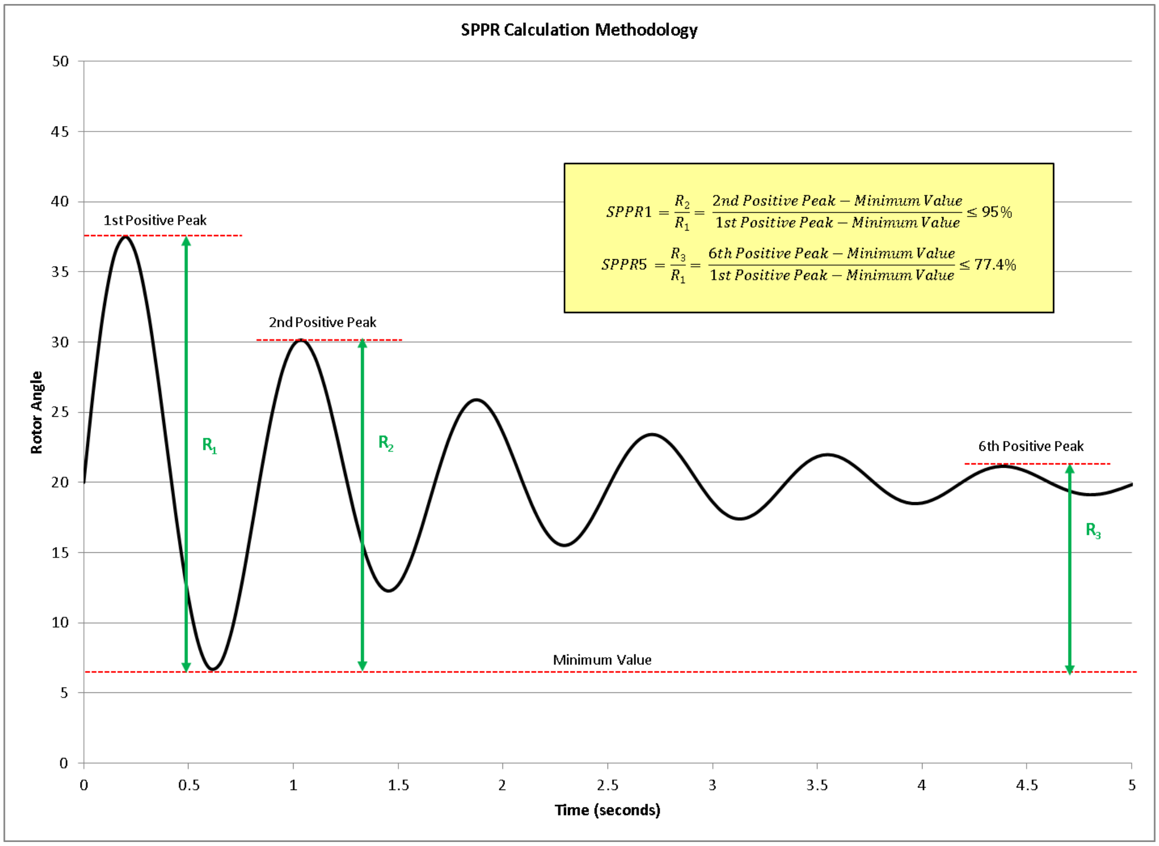


Figure 2. SPPR1 and SPPR5 Calculations

TRANSIENT VOLTAGE RECOVERY REQUIREMENT

Bus voltages on the Bulk Electric System shall recover above 0.70 per unit, 2.5 seconds after the fault is cleared. Bus voltages shall not swing above 1.20 per unit after the fault is cleared, unless affected transmission system elements are designed to handle the rise above 1.2 per unit.

Qualitatively, this Requirement is shown in Figure 3 below.

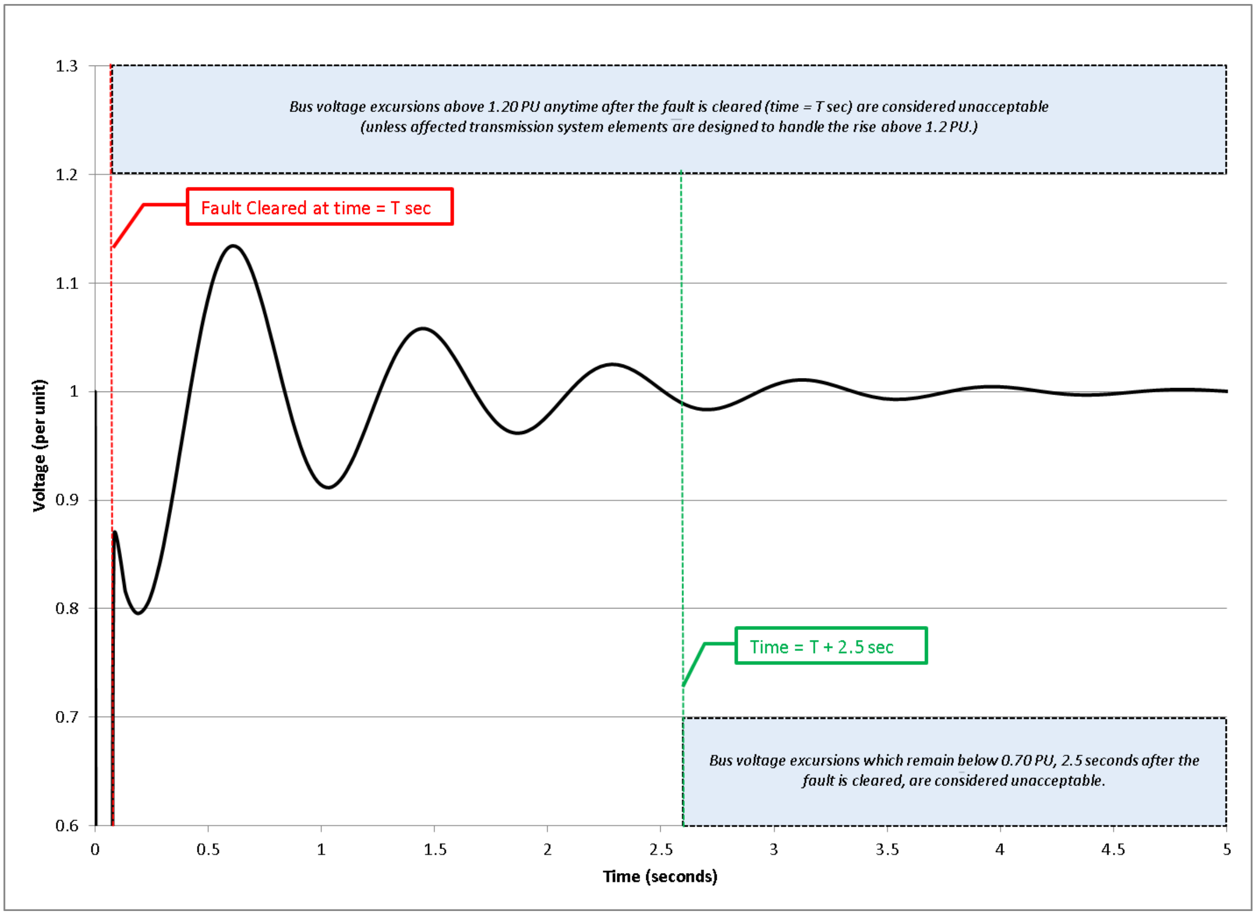


Figure 3. Transient Voltage Recovery Requirement

Appendix D

GEN-2017-097

Dynamic Stability Results with Existing Base Case Issues & Simulation Plots

Table D-1: GEN-2017-097 Dynamic Stability Results w/ Existing DISIS Base Case Issues

Fault ID	25SP			25WP		
	Volt Violation	Volt Recovery	Stable	Volt Violation	Volt Recovery	Stable
FLT01-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT13-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT15-3PH	Pass	Pass	Stable (1)	Pass	Pass	Stable (1)
FLT16-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT18-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT19-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT21-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT23-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT24-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT25-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT27-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT29-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT31-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT32-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9002-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9005-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9008-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9011-3PH	Pass	Pass	Stable	Pass	Pass	Stable
FLT9012-3PH	Pass	Pass	Stable	Pass	Pass	Stable

Table D-1 Continued

Fault ID	25SP			25WP		
	Volt Violation	Volt Recovery	Stable	Volt Violation	Volt Recovery	Stable
FLT1001-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT1002-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT1003-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT1004-SB	Pass	Pass	Stable	Pass	Pass	Stable
FLT15-PO1	Pass	Pass	Unstable (1)	Pass	Pass	Unstable (1)
FLT05-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO1	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO2	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO3	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO4	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO4	Pass	Pass	Stable	Pass	Pass	Stable

Table D-1 Continued

Fault ID	25SP			25WP		
	Volt Violation	Volt Recovery	Stable	Volt Violation	Volt Recovery	Stable
FLT05-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO5	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO6	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-PO7	Pass	Pass	Stable	Pass	Pass	Stable
FLT05-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT06-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT07-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT08-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT09-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT12-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT70-PO8	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-PO8	Pass	Pass	Stable	Pass	Pass	Stable

(1) GEN-2017-014 (588593 & 588597) active & reactive power high frequency oscillations were in both the pre and post modification models.

The results of the stability analysis showed that active and reactive power high frequency oscillations were observed for GEN-2017-014 (588593 & 588597) with the prior outage of the NUNDRWD4 to PHILIP_T-BE4 230 kV line and subsequent loss of the PHILIP_T-BE4 to OAHE 4 230 kV line. This issue was observed for fault FLT15-PO1 in the DISIS-2017-002 case without and with the GEN-2017-097 modification as shown in Figure D-1 and Figure D-2 respectively. Therefore, these oscillations were not attributed to the GEN-2017-097 modification request.

Figure D-1: FLT15-PO1 GEN-2017-014 Oscillations (25SP DISIS Case)

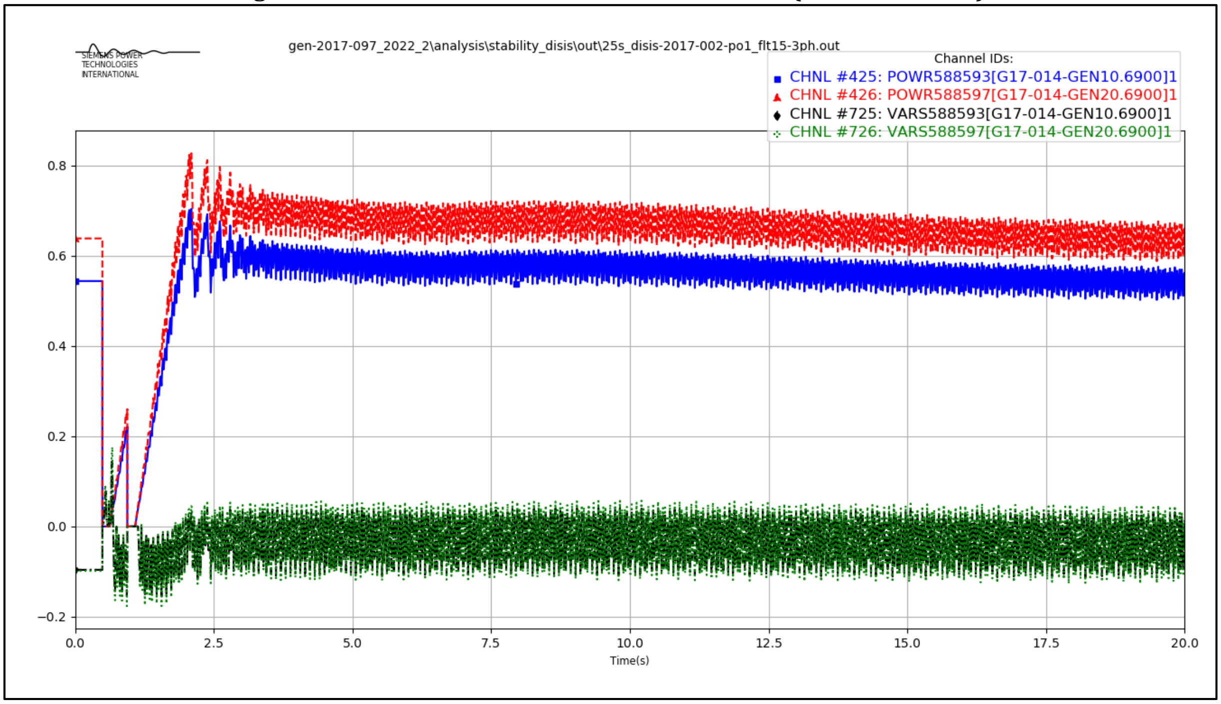
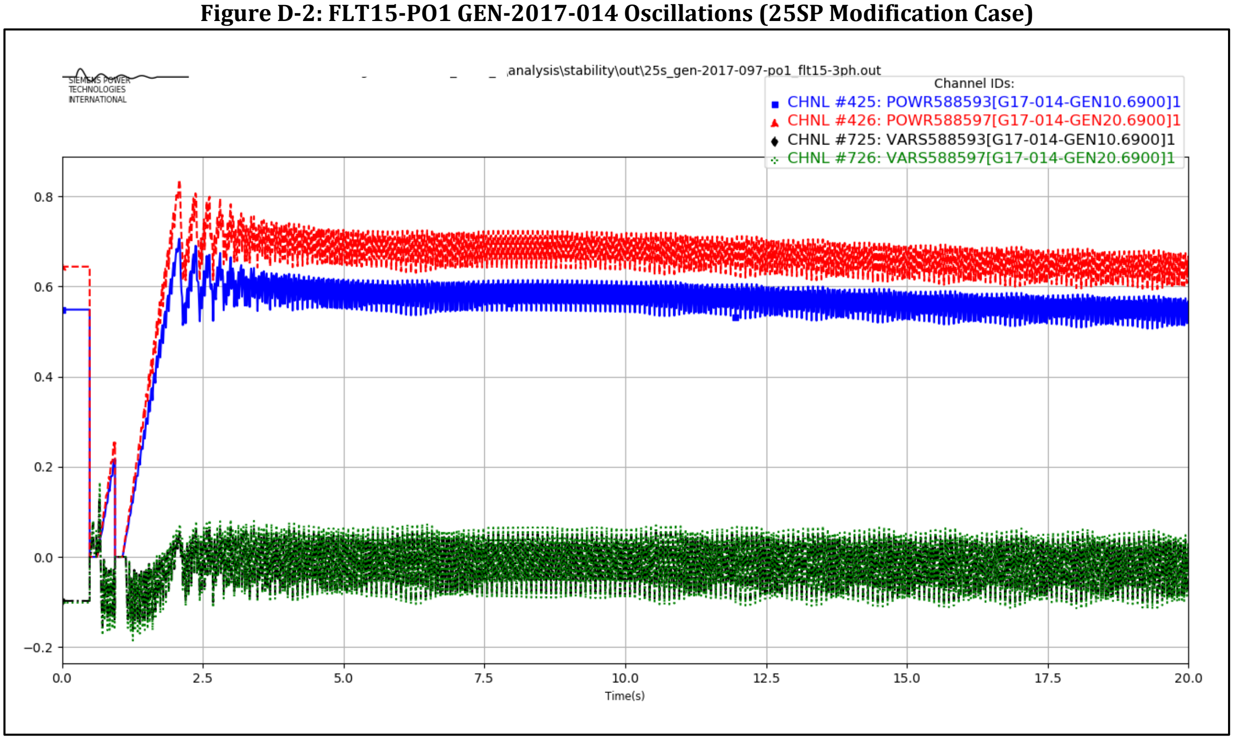


Figure D-2: FLT15-PO1 GEN-2017-014 Oscillations (25SP Modification Case)



2025 Summer Peak Plots

Including Prior Outage Plots

GEN-2017-097_25SP_Plots.pdf

2025 Winter Peak Plots

Including Prior Outage Plots

GEN-2017-097_25WP_Plots.pdf