GEN-2024-SR15

SURPLUS SERVICE IMPACT STUDY

By SPP Generator Interconnection

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REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
2/27/2025		Original Version	
3/28/2025		Updated EGF Modelling and Analysis	

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EXECUTIVE SUMMARY

1898 & Co., a part of Burns & McDonnell, was retained by the Southwest Power Pool (SPP) to conduct the Surplus Interconnection Service Impact Study (Study) for GEN-2024-SR15. The purpose of the Study is to evaluate the use of Surplus Interconnection Service made available by GEN-2017-239 at its existing Point of Interconnection (POI) at the Mahoney 230 kV substation in the Xcel/Southwestern Public Service (Xcel/SPS) control area.

GEN-2024-SR15, the proposed Surplus Generating Facility (SGF), will connect to the Mahoney 230 kV bus via the same bay connection. GEN-2017-239, the Existing Generating Facility (EGF), has an effective Generator Interconnection Agreement (GIA) with a POI capacity of 300 MW and is making 300 MW of Surplus Interconnection Service available. According to the SPP Open Access Transmission Tariff (SPP Tariff), the available Surplus Interconnection Service for the SGF is limited to the amount of Interconnection Service granted to the EGF at the same POI. Furthermore, Surplus Interconnection Service can only be accommodated without requiring Network Upgrades, except those specified in the SPP Tariff.

The proposed SGF configuration includes 112 x CAB1000/AC-3.2 690 VRMS Storage System Inverters, each rated at 3 MVA. While the SGF has a total generating capability of 315.06 MW, its injection at the POI must be limited to 300 MW. Combined generation from the SGF and EGF cannot exceed 300 MW at the POI. A Power Plant Controller (PPC) will be implemented as part of GEN-2024-SR15 to regulate and limit power injection as required. The dynamic model data for the GEN-2024-SR15 project is provided in Appendix A.

Information pertaining to the SGF and EGF configuration is shown in Table 1 below.

Table 1: EGF & SGF Configuration

Request	Interconnection Queue Capacity (MW)	Fuel Type	Point of Interconnection
GEN-2024-SR15 (SGF)	300	Battery Storage	Mahoney 230 kV (527011)
GEN-2017-239 (EGF)	300	Solar	Mahoney 230 kV (527011)

The detailed SGF configuration is captured in Table 2 below.

Table 2: SGF Interconnection Configuration

Facility	SGF Configuration	
Point of Interconnection	Mahoney 230 kV (527011)	
Configuration/Capacity	112 x CAB1000/AC-3.2 690 VRMS (Battery Storage) = 315.06 MW [dispatch] Units are rated at 3 MVA, PPC to limit GEN-2024-SR15 to 300 MW at the POI Total POI injection w/ GEN-2017-239 to 300 MW at the POI	
Generation Interconnection Line (Shared with the EGF and unchanged)	Length = 2 miles	
	R = 0.000291 pu	
	X = 0.002728 pu	
	B = 0.006241 pu	
	Rating MVA = 472 MVA	
Main Substation Transformer[1]	Gen 1: (56 Inverters) X12 = 9.499% R12 = 0.210%, X23 = 2.849% R23 = 0.063%, X13 = 14.247% R13 = 0.315%, Voltage = 230/34.5/13.8 kV (YN0yn0d1), Winding1-2 MVA = 166.7 MVA, Winding2-3 MVA = 166.7 MVA, Winding3-1 MVA = 55.6 MVA, Winding MVA Base= 100 MVA,	Gen 2: (56 Inverters) X12 = 9.499% R12 = 0.210%, X23 = 2.849% R23 = 0.063%, X13 = 14.247% R13 = 0.315%, Voltage = 230/34.5/13.8 kV (YN0yn0d1), Winding1-2 MVA = 166.7 MVA, Winding2-3 MVA = 166.7 MVA, Winding3-1 MVA = 55.6 MVA, Winding MVA Base= 100 MVA,
Equivalent GSU Transformer[1]	X2 = 5.703%, R2 = 0.733%, Voltage = 34.5/0.69 kV, Winding MVA = 168 MVA,r Rating MVA = 168 MVA	X2 = 5.703%, R2 = 0.733%, Voltage = 34.5/0.69 kV, Winding MVA = 168 MVA, Rating MVA = 168 MVA
Equivalent Collector Line[2]	R = 0.000161 pu	R = 0.000184 pu
	X = 0.000257 pu	X = 0.000295 pu
	B = 0.003080 pu	B = 0.003500 pu
Generator Dynamic Model[3] & Power Factor	112 x CAB1000/AC-3.2 690 VRMS (REGCAU1)[3] Leading: 0.95 Lagging: 0.95	112 x CAB1000/AC-3.2 690 VRMS (REGCAU1)[3] Leading: 0.95 Lagging: 0.95

1) X and R based on Winding MVA, 2) All pu are on 100 MVA Base, equivalent based on average derated MVA base provided by IC, 3) DYR stability model name.

The scope of this study included reactive power analysis, short circuit analysis, and dynamic stability analysis. SPP determined that steady-state analysis was not required because the addition of the SGF does not increase the maximum active power output of 300 MW. In addition, the EGF was previously studied at maximum Interconnection Service under all necessary reliability conditions.

1898 & Co. performed the analyses using the study data provided for the SGF and the DISIS-2018-002/2019-001 study models:

- 2025 Summer Peak (25SP)
- 2025 Winter Peak (25W)

All analyses were performed using the Siemens PTI PSS/E[1] version 34 software and the results are summarized below.
The results of the reactive power analysis using the 25SP model showed that the SGF project needed a 0.49 MVAr shunt capacitor at the project substation to set the MVAr injection at the POI to zero. 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 reactive power analysis is provided as information to the Interconnection Customer and Transmission Owner (TO) and/or Transmission Operator (TOP). The applicable reactive power requirements will be further reviewed by the TO and/or TOP.

The short circuit analysis was performed using the 25SP Scenario 2 stability model modified for short circuit analysis. The results from the short circuit analysis compared the 25SP model with the EGF online and SGF not connected to the SGF study model (EGF and SGF online). The maximum contribution to three-phase fault currents in the immediate transmission systems due to the addition of the SGF was not greater than 0.681 kA. The maximum three-phase fault current level within 5 buses of the POI with the EGF and SGF generators online was 33.8 kA for the 25SP model. There were no buses with a maximum three-phase fault current over 40 kA. The maximum contribution to three-phase fault currents due to the addition of the SGF was about 4.15% and 0.669 kA. These buses are highlighted in Appendix B.

The dynamic stability analysis was performed using Siemens PTI PSS/E version 34 software for the two modified study models: 25SP and 25W, each with two dispatch scenarios. 53 fault events were simulated, which included three-phase faults and single-line-to-ground stuck breaker faults.

- Scenario 1: SGF at maximum assumed dispatch, 315.06 MW, and EGF disconnected.
- Scenario 2: The second scenario is selected based on a combination of SGF and EGF dispatch scenarios with the project dispatches varied by 10% increments of the total EGF capacity. The resulting selected worst-case scenario included a combination of the SGF dispatched to 126 MW and the EGF to 187.2 MW for a total POI injection of 300 MW.

There were no damping or voltage recovery violations attributed to the GEN-2024-SR15 surplus request observed during simulated faults. A few faults showed other generator tripping issues which were also observed in the base cases. For Scenario 2 the EGF (GEN-2017-239) and SGF were tripping for some of the winter simulations. This was due to the EGF generator's instantaneous high-voltage relay. To mitigate the trip, the voltage relay was switched off for the winter simulations. Additionally, the project was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

The results of the dynamic stability for Scenario 1 and Scenario 2 showed several existing base case issues that were found in both the original DISIS-2018-002/2019-001 model and the model

[1] Power System Simulator for Engineering

with Project included. Associated stability plots and existing DISIS base case issues are documented in Appendix C.

The results of the study showed that the Surplus Interconnection Service Request by GEN-2024-SR15 did not negatively impact the reliability of the Transmission System. There were no additional Interconnection Facilities or Network Upgrades identified by the analyses.

SPP has determined that GEN-2024-SR15 may utilize the requested 300 MW of Surplus Interconnection Service being made available by the EGF. The combined generation from both the SGF and the EGF may not exceed 300 MW at the POI.

The customer must install monitoring and control equipment as needed to ensure that the SGF does not exceed the granted surplus amount and to ensure that combination of the SGF and EGF power injected at the POI does not exceed the EGF's Interconnection Service amount. The monitoring and control scheme may be reviewed by the TO and documented in Appendix C of the SGF GIA.

In accordance with FERC Order No. 827, both SGF and EGF 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.

SCOPE OF STUDY

1898 & Co., a part of Burns & McDonnell, was retained by the Southwest Power Pool (SPP) to conduct the Surplus Service Impact Study (Study) for GEN-2024-SR15, the Surplus Generating Facility (SGF). The Study aims to assess the SGF's impact on transmission system reliability and to determine any necessary additional Interconnection Facilities, in accordance with the SPP Generator Interconnection Procedures (GIP) outlined in Attachment V, Section 3.3 of the SPP Open Access Transmission Tariff (SPP Tariff).

The availability of Surplus Interconnection Service for the SGF is constrained by the Interconnection Service previously granted to the existing interconnection customer for the Existing Generating Facility (EGF) at the same Point of Interconnection (POI). Surplus Interconnection Service is only permissible to the extent it does not require additional Network Upgrades beyond those stipulated in the SPP Tariff. The scope of the Study depends on the specifications of both the EGF and SGF.

The criteria sections below outline the analyses performed within the Study's scope. All analyses were performed using the Siemens PTI PSS/E version 34 software. The results of each analysis are presented in the following sections.

REACTIVE POWER ANALYSIS

SPP requires that a reactive power analysis be performed on the requested configuration if it is a non-synchronous resource. The reactive power analysis determines the added capacitive effect at the POI caused by the project’s collection system and transmission line’s capacitance. A shunt reactor size was determined for the SGF to offset the capacitive effect and maintain zero (0) MVAr injection at the POI while the plant’s generators and capacitors were offline.

SHORT CIRCUIT ANALYSIS

SPP requires that a short circuit analysis be performed to determine the maximum available fault current requiring interruption by protective equipment with both the SGF and EGF online, along with the amount of increase in maximum fault current due to the addition of the SGF. The analysis was performed on two scenarios, with the EGF in service and SGF offline, and the modified model with both EGF and SGF in service.

STABILITY ANALYSIS

SPP requires that a dynamic stability analysis be performed to determine whether the SGF, EGF, and the transmission system will remain stable and within applicable criteria. Dynamic stability analysis was performed on two dispatch scenarios, the first where the SGF was online at 100% of the assumed dispatch with the EGF offline and disconnected, and the second which is determined to be the worst-case scenario based on a dispatch test described in the Stability Methodology and Criteria section. The stability analyses will identify any additional Interconnection Facilities and Network Upgrades necessary.

STEADY-STATE ANALYSIS

The steady-state (thermal/voltage) analyses may be performed as necessary to ensure that all required reliability conditions are studied. If the EGF was not studied under off-peak conditions, off-peak steady state analyses shall be performed to the required level necessary to demonstrate reliable operation of the Surplus Interconnection Service. If the original system impact study is not available for the Interconnection Service, both off-peak and peak analysis may need to be performed for the EGF associated with the request.

SPP determined that steady-state analysis was not required because the addition of the SGF does not increase the maximum active power output of 300 MW. In addition, the EGF was previously studied at maximum Interconnection Service under all necessary reliability conditions.

NECESSARY INTERCONENCTION FACILITIES & NETWORK UPGRADES

The SPP Tariff[2] states that the reactive power, short circuit/fault duty, stability, and steady-state analyses (where applicable) for the Surplus Interconnection Service will identify any additional Interconnection Facilities necessary. In addition, the analyses will determine if any Network Upgrades are required for mitigation. The Surplus Interconnection Service is only available up to the amount that can be accommodated without requiring additional Network Upgrades unless (a) those additional Network Upgrades are either (1) located at the Point of Interconnection substation and at the same voltage level as the Generating Facility with an effective GIA, or (2) are System Protection Facilities; and (b) there are no material adverse impacts on the cost or timing of any Interconnection Requests pending at the time the Surplus Interconnection Service request is submitted.

STUDY LIMITATIONS

The assessments and conclusions provided in this report are based on assumptions and information provided to 1898 & Co. by others. While the assumptions and information provided may be appropriate for the purposes of this report, 1898 & Co. does not guarantee that those conditions assumed will occur. In addition, 1898 & Co. did not independently verify the accuracy

[2] SPP Open Access Transmission Tariff Section 3.3.4.1

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.

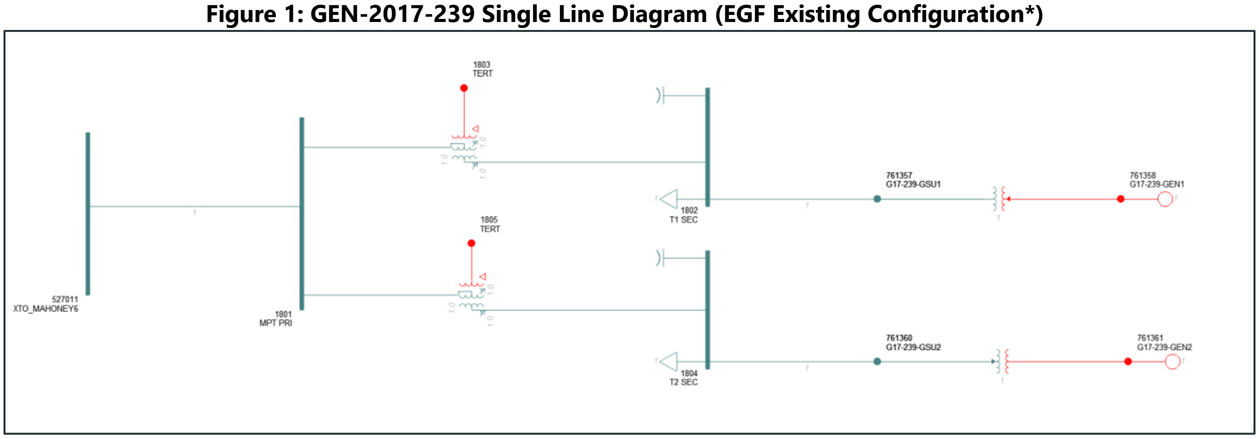
SURPLUS INTERCONNECTION SERVICE REQUEST

The Interconnection Customer has requested a Surplus Interconnection Service Impact Study (Study) for GEN-2024-SR15 to evaluate the Surplus Interconnection Service being made available by GEN-2017-239 at its existing Point of Interconnection (POI) at the Mahoney 230 kV substation in the Xcel/Southwestern Public Service (Xcel/SPS) control area.

GEN-2024-SR15, the proposed Surplus Generating Facility (SGF), will connect to the Mahoney 230 kV POI bus via a separate bay connection. GEN-2017-239 (EGF) has a nameplate capacity of 323.214 MW and is making 300 MW of Surplus Interconnection Service available at its POI. Per the SPP Tariff the amount of Surplus Interconnection Service available to the SGF is limited by the amount of Interconnection Service granted to the EGF at the same POI. In addition, the Surplus Interconnection Service is only available up to the amount that can be accommodated without requiring additional Network Upgrades except those specified in the SPP Tariff.

At the time of the posting of this report, the EGF is an active existing generator at the same POI at Mahoney 230 kV substation. GEN-2017-239 is a solar generation plant, has a maximum summer and winter queue capacity of 300 MW, and has Energy Resource Interconnection Service (ERIS). The EGF was originally studied in the DISIS-2017-002 cluster study. Figure 1 shows the power flow model single line diagram for the EGF configuration.

Figure 1: GEN-2017-239 Single Line Diagram (EGF Existing Configuration*)



*based on the DISIS-2018-002/2019-001 25SP stability models

The proposed SGF configuration consists of 112 x CAB1000/AC-3.2 690 VRMS Storage System Inverters, each rated at 3 MVA. While the SGF has a total generating capability of 315.06 MW, its injection at the POI must be limited to 300 MW. Combined generation from the SGF and EGF cannot exceed 300 MW at the POI. A Power Plant Controller (PPC) will be implemented as part of GEN-2024-SR15 to regulate and limit power injection as required.

The SGF and EGF information is shown in Table 3 below, and the proposed SGF configuration is captured in Figure 2 and detailed in Table 4 .

Table 3: EGF & SGF Configuration

Request	Interconnection Queue Capacity (MW)	Fuel Type	Point of Interconnection
GEN-2024-SR15 (SGF-BESS 1 & 2)	300	Battery Storage	Mahoney 230 kV
GEN-2017-239 (EGF-PV 1 & 2)	300	Solar	Mahoney 230 kV

Figure 2: GEN-2017-239 & GEN-2024-SR14 Single Line Diagram (EGF & SGF Configuration)

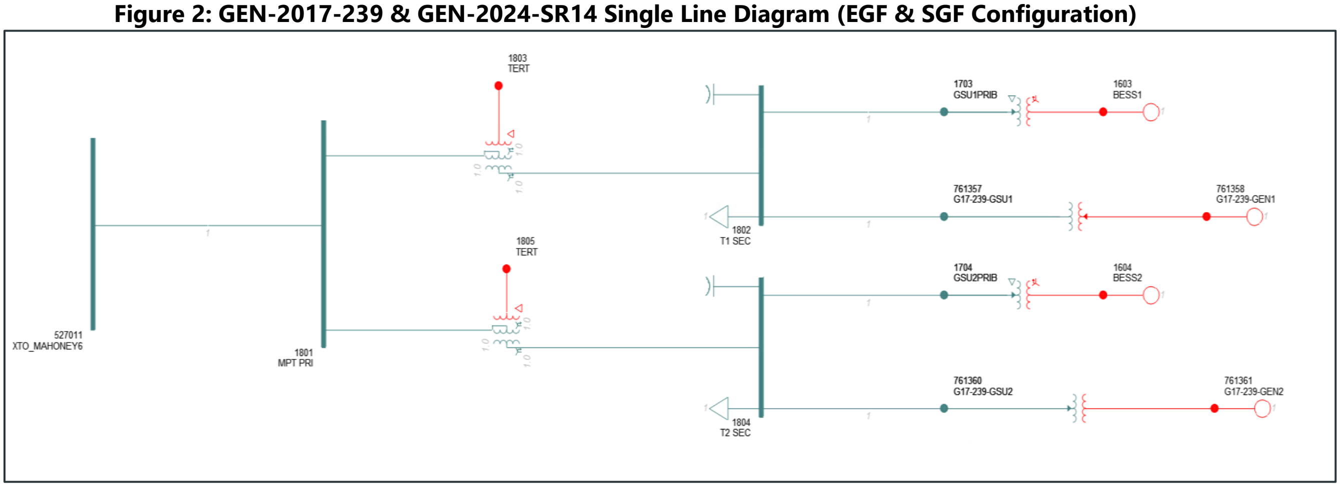


Table 4: SGF Interconnection Configuration

Facility	SGF Configuration	
Point of Interconnection	Mahoney 230 kV (527011)	
Configuration/Capacity	112 x CAB1000/AC-3.2 690 VRMS (Battery Storage) = 315.06 MW [dispatch] Units are rated at 3 MVA, PPC to limit GEN-2024-SR15 to 300 MW at the POI Total POI injection w/ GEN-2017-239 to 300 MW at the POI	
Generation Interconnection Line (Shared with the EGF and unchanged)	Length = 2 miles	
	R = 0.000291 pu	
	X = 0.002728 pu	
	B = 0.006241 pu	
	Rating MVA = 472 MVA	
Main Substation Transformer[1]	Gen 1: (56 Inverters) X12 = 9.499% R12 = 0.210%, X23 = 2.849% R23 = 0.063%, X13 = 14.247% R13 = 0.315%, Voltage = 230/34.5/13.8 kV (YN0yn0d1), Winding1-2 MVA = 166.7 MVA, Winding2-3 MVA = 166.7 MVA, Winding3-1 MVA = 55.6 MVA, Winding MVA Base= 100 MVA,	Gen 2: (56 Inverters) X12 = 9.499% R12 = 0.210%, X23 = 2.849% R23 = 0.063%, X13 = 14.247% R13 = 0.315%, Voltage = 230/34.5/13.8 kV (YN0yn0d1), Winding1-2 MVA = 166.7 MVA, Winding2-3 MVA = 166.7 MVA, Winding3-1 MVA = 55.6 MVA, Winding MVA Base= 100 MVA,
Equivalent GSU Transformer[1]	X2 = 5.703%, R2 = 0.733%, Voltage = 34.5/0.69 kV, Winding MVA = 168 MVA, Rating MVA = 168 MVA	X2 = 5.703%, R2 = 0.733%, Voltage = 34.5/0.69 kV, Winding MVA = 168 MVA, Rating MVA = 168 MVA
Equivalent Collector Line[2]	R = 0.000161 pu	R = 0.000184 pu
	X = 0.000257 pu	X = 0.000295 pu
	B = 0.003080 pu	B = 0.003500 pu
Generator Dynamic Model[3] & Power Factor	112 x CAB1000/AC-3.2 690 VRMS (REGCAU1)[3] Leading: 0.95 Lagging: 0.95	112 x CAB1000/AC-3.2 690 VRMS (REGCAU1)[3] Leading: 0.95 Lagging: 0.95

1.0) X and R based on Winding MVA, 2) All pu are on 100 MVA Base, equivalent based on average derated MVA base provided by IC, 3) DYR stability model name.

REACTIVE POWER ANALYSIS

The reactive power analysis was performed using the 25SP model to determine the capacitive charging effects due to the SGF 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 set the project reactive power contribution to the POI to approximately zero.

METHODOLOGY AND CRITERIA

To determine the shunt reactor size required to compensate for the current charging attributed to the SGF collection system, all SGF components were switched offline and the EGF generator was switched offline while its other collector system elements remained in-service. A shunt reactor was tested at the project's collection substation 34.5 kV bus to set the MVAr injection at the POI to zero. All SGF components except for the generator were then switched online and an additional shunt reactor was tested at the project's collection substation 34.5 kV bus to set the MVAr injection at the POI to 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).

RESULTS

The results from the analysis showed that the EGF needed an approximately 0.27 MVAr shunt reactor at the EGF substation, and the SGF needed an approximately 0.49 MVAr shunt capacitor at the SGF substation. For both the EGF and SGF, a 0.23 MVAr shunt capacitor is needed to set the MVAr injection at the POI to zero. The final shunt reactor requirements are shown in Table 5. Figure 3 illustrates the shunt reactor size needed to set the POI MVAr to approximately zero with the EGF alone, and Figure 4 illustrates the shunt reactor size needed to set the POI MVAr to approximately zero with the EGF and SGF online.

Table 5: Shunt Reactor Size for Reactive Power Analysis

Machine	POI Bus Number	POI Bus Name	Shunt Size (MVAr)
			25SP
GEN-2017-239 (EGF)	527011	Mahoney 230 kV	-0.269
GEN-2024-SR15 (SGF)	527011	Mahoney 230 kV	+0.495*
GEN-2017-239 (EGF) & GEN-2024-SR15 (SGF)	527011	Mahoney 230 kV	+0.226

*The SGF collection system has a capacitive characteristic due to high GSU transformer's magnetizing B value.

Figure 3: EGF Single Line Diagram (Shunt Sizes)

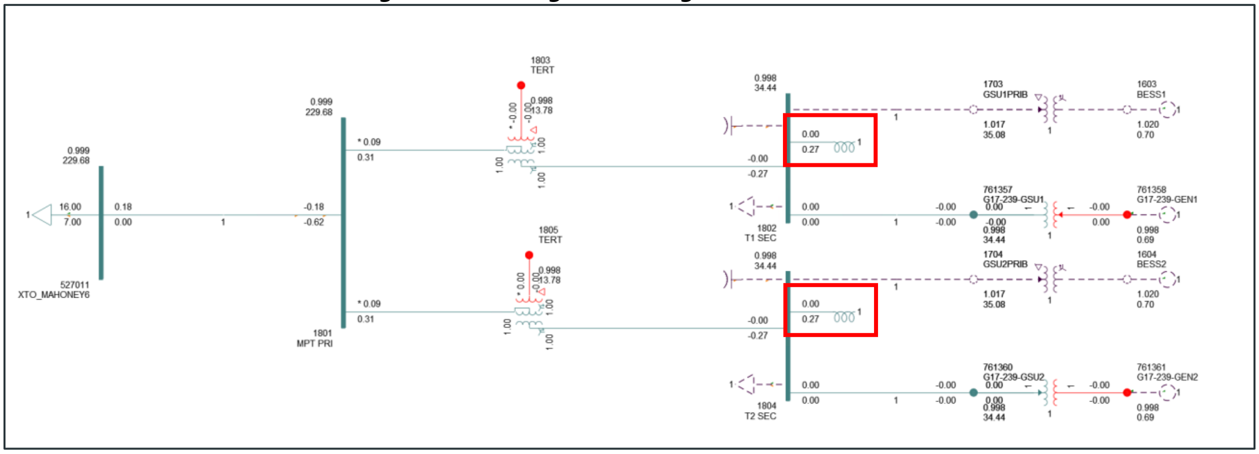
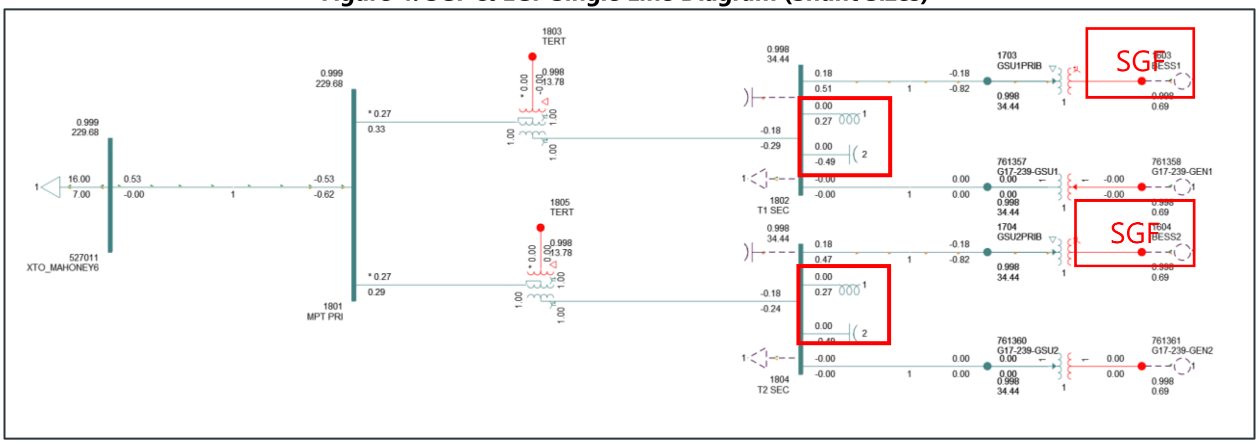


Figure 4: SGF & EGF Single Line Diagram (Shunt Sizes)



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

SHORT CIRCUIT ANALYSIS

A short circuit study was performed to determine the maximum available fault current requiring interruption by protective equipment with both the SGF and EGF online for each bus in the relevant subsystem, and the amount of increase in maximum fault current due to the addition of the SGF. The detailed results of the short circuit analysis are provided in Appendix B.

METHODOLOGY

The short circuit analysis included applying a 3-phase fault on buses up to 5 levels away from the 230 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 the SGF online. The first scenario was studied with both the SGF and EGF in service. In the second scenario the SGF was disconnected while the EGF was online to determine the impact of the SGF.

1898 & Co. created a short circuit model using the 25SP DISIS-2018-002/2019-001 stability study model by adjusting the SGF short circuit parameters consistent with the submitted data. The adjusted parameters used in the short circuit analysis are shown in Table 6 below. No other changes were made to the model.

Table 6: Short Circuit Model Parameters*

Parameter	Value by Generator Bus#	Value by Generator Bus#	Value by Generator Bus#	Value by Generator Bus#
	1601 (PV GEN 1)	1602 (PV GEN 2)	1603 (BESS GEN 1)	1604 (BESS GEN 2)
R (pu)	0.000	0.000	0.000	0.000
X'' (pu)	0.800	0.800	0.634	0.634

*pu values based on Machine MVA Base

RESULTS

The results of the short circuit analysis compared the 25SP model with the EGF online and SGF not connected to the stability in Scenario 1. In Scenario 2 both the EGF and SGF were online. The GEN-2024-SR15 POI bus fault current magnitudes for the comparison cases are provided in Table 7 showing a fault current of 16.788 kA with the EGF and SGF online. The addition of the SGF configuration increased the POI bus fault current by 0.669 kA. Table 8 shows the maximum fault current magnitudes and fault current increases with the SGF project online.

The maximum fault current calculated within 5 buses of the POI was 33.8 kA for the 25SP model. There were no buses with a maximum three-phase fault current over 40 kA. The maximum contribution to three-phase fault currents due to the addition of the SGF was about 4.15% and 0.669 kA. These buses are highlighted in Appendix B.

Table 7: POI Short Circuit Comparison Results

Case	EGF Only Current (kA)	SGF & EGF Current (kA)	kA Change	%Change
25SP	16.119	16.788	0.669	4.151%

Table 8: 25SP Short Circuit Comparison Results

Voltage (kV)	Max. Current (EGF & SGF) (kA)	Max kA Change	Max %Change
69	8.870	0.010	0.111%
115	33.648	0.137	0.549%
138	0.000	0.000	0.000%
230	33.807	0.669	4.151%
345	16.740	0.066	0.639%
Max	**33.807**	**0.669**	**4.151%**

DYNAMIC STABILITY ANALYSIS

The dynamic stability analysis was performed in accordance with SPP's Disturbance Performance Requirements[3] to identify the impact of the SGF project. The dynamic model data for the GEN-2024-SR15 project is provided in Appendix A, and existing base case issues and simulation plots can be found in Appendix C.

METHODOLOGY AND CRITERIA

The dynamic stability analysis was performed using models developed with the requested 112 x CAB1000/AC-3.2 690 VRMS inverters operating at 2.813 MW each to model the SGF generating facility. This stability analysis was performed using Siemens PTI's PSS/E version 34.9.6 software.

The Project details were used to create modified stability models for this impact study based on the DISIS-2018-002/2019-001 stability study models:

- 2025 Summer Peak (25SP),
- 2025 Winter Peak (25W)

In Scenario 1 the SGF is at 100% of the assumed dispatch (SGF = 315.06 MW) to inject 300 MW at the POI while the EGF generator was offline and disconnected. To determine the appropriate EGF/SGF dispatch combination for Scenario 2, dispatch models were created in 10% increments of the total EGF capacity and simulated with a POI fault. The dispatch scenarios tested are shown in Table 10Table 1. The nearby synchronous machine angle deviation and POI bus voltage deviation results were used to select the worst-case dispatch combination with both the EGF and SGF online for this impact study. The worst-case scenario selected is bolded in Table 9.

Table 9: Dispatch tests for Scenario 2

Dispatch Scenarios			
GEN-2017-239 EGF (MW)	GEN-2024-SR15 SGF (MW)	EGF+SGF (MW)	POI (MW)
281.7	31.5	313.2	300.0
250.4	63	313.4	300.0
218.75	94.5	313.25	300.0
187.2	**126**	**313.2**	**300.0**
156.7	156.7	313.4	300.0
124.7	189	313.7	300.0
93.4	220.5	313.9	300.0

[3] SPP Disturbance Performance Requirements: https://www.spp.org/documents/28859/spp%20disturbance%20performance%20requirements%20(twg%20approved).pdf

Dispatch Scenarios			
GEN-2017-239 EGF (MW)	GEN-2024-SR15 SGF (MW)	EGF+SGF (MW)	POI (MW)
62.2	252	314.2	300.0
31.1	283.5	314.6	300.0

The study scenarios are shown in Table 11.

Table 10: Study Scenarios (Generator Dispatch MW)

Scenario	XCEL/SPS EGF (MW)	GEN-2024-SR15 SGF (MW)	EGF + SGF (MW)
1	0 (Offline)	315.06	315.06
2	187.20	126.00	313.20

The 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 surplus request:

- The PSSE dynamic simulation iterations and acceleration factor were adjusted as needed to resolve PSSE dynamic simulation crashes.

During the fault simulations, the active power (PELEC), reactive power (QELEC), and terminal voltage (ETERM) were monitored for the EGF and SGF and other current and prior queued projects in Group 5[4]. In addition, voltages of five (5) buses away from the POI of the SGF were monitored and plotted.

FAULT DEFINITIONS

1898 & Co. developed fault events as required for the Study for simulation on the study models. The fault events included three-phase faults 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. 47 faults were simulated for the Study. The fault definitions can be found in Appendix D.

SCENARIO 1 RESULTS

Table 11 shows the relevant results of the fault events simulated for each of the modified models in Scenario 1.

[4] Based on the DISIS-2018-002/2019-001 Cluster Groups

Table 11: Scenario 1 Dynamic Stability Results (EGF = 0 MW, SGF = 315.06 MW)

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_525832_TUCO_INT-560022_CRAWFISH_DR_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_525832_TUCO_INT-560022_CRAWFISH_DR_Ckt2.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526934_YOAKUM-526935_YOAKUM_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-525586_NEEDMORE_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-526435_SUNDOWN_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-526934_YOAKUM_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-526936_YOAKUM_345_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-527028_INK_BASIN_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526936_YOAKUM_345-525832_TUCO_INT_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526936_YOAKUM_345-526935_YOAKUM_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526936_YOAKUM_345-527896_HOBBS_INT_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527009_BRU_SUB-526935_YOAKUM_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527011_XTO_MAHONEY623000-527009_BRU_SUB_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527011_XTO_MAHONEY623000-527149_MUSTANG_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527146_MUSTANG-527130_DENVER_N_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527146_MUSTANG-527149_MUSTANG_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-526935_YOAKUM_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-527011_XTO_MAHONEY623000_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-527146_MUSTANG_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-527276_SEMINOLE_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527276_SEMINOLE-527275_SEMINOLE_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527894_HOBBS_INT_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527965_KIOWA_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-525824_TUCO_TR1-ConID-108437.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-525824_TUCO_TR1-ConID-108438.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-525845_ELK_2-ConID-108439.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526435_SUNDOWN-ConID-85244.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108434.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108435.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108436.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108442.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527896_HOBBS_INT-ConID-108429.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527896_HOBBS_INT-ConID-108441.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-526934_YOAKUM.idv	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P4_HOL-526935_YOAKUM.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-526936_YOAKUM_345.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527146_MUSTANG.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527149_MUSTANG.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527896_HOBBS_INT.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526935_YOAKUM-ConID-SPS-137.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-129.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-130.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-131.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527146_MUSTANG-ConID-SPS-133.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527896_HOBBS_INT-ConID-SPS-119.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-515458_BORDER-ConID-118552.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-525832_TUCO_INT-ConID-SPS-132.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-525832_TUCO_INT-ConID-SPS-138.idv	Pass	Pass	Stable	Pass	Pass	Stable

There were no damping or voltage recovery violations attributed to the GEN-2024-SR15 surplus request observed during the simulated faults. A few faults showed generator tripping issues which were also observed in the base cases. Plots for these can be seen in Appendix C. The list of tripped generators is listed in Appendix E. 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.

Associated stability plots and existing DISIS base case issues are documented in Appendix C.

SCENARIO 2 RESULTS

Table 12 shows the relevant results of the fault events simulated for each of the modified models in Scenario 2.

Table 12: Scenario 2 Dynamic Stability Results (EGF = 187.2 MW, SGF = 126 MW)

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_525832_TUCO_INT-560022_CRAWFISH_DR_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_525832_TUCO_INT-560022_CRAWFISH_DR_Ckt2.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526934_YOAKUM-526935_YOAKUM_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-525586_NEEDMORE_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-526435_SUNDOWN_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_526935_YOAKUM-526934_YOAKUM_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-526936_YOAKUM_345_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526935_YOAKUM-527028_INK_BASIN_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526936_YOAKUM_345-525832_TUCO_INT_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526936_YOAKUM_345-526935_YOAKUM_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_526936_YOAKUM_345-527896_HOBBS_INT_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527009_BRU_SUB-526935_YOAKUM_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527011_XTO_MAHONEY623000-527009_BRU_SUB_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527011_XTO_MAHONEY623000-527149_MUSTANG_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527146_MUSTANG-527130_DENVER_N_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527146_MUSTANG-527149_MUSTANG_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-526935_YOAKUM_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-527011_XTO_MAHONEY623000_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-527146_MUSTANG_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527149_MUSTANG-527276_SEMINOLE_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527276_SEMINOLE-527275_SEMINOLE_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527894_HOBBS_INT_3Winding.idv	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527965_KIOWA_Ckt1.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-525824_TUCO_TR1-ConID-108437.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-525824_TUCO_TR1-ConID-108438.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-525845_ELK_2-ConID-108439.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526435_SUNDOWN-ConID-85244.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108434.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108435.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108436.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108442.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527896_HOBBS_INT-ConID-108429.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527896_HOBBS_INT-ConID-108441.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-526934_YOAKUM.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-526935_YOAKUM.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-526936_YOAKUM_345.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527146_MUSTANG.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527149_MUSTANG.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527896_HOBBS_INT.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526935_YOAKUM-ConID-SPS-137.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-129.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-130.idv	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-131.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527146_MUSTANG-ConID-SPS-133.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527896_HOBBS_INT-ConID-SPS-119.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-515458_BORDER-ConID-118552.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-525832_TUCO_INT-ConID-SPS-132.idv	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-525832_TUCO_INT-ConID-SPS-138.idv	Pass	Pass	Stable	Pass	Pass	Stable

There were no damping or voltage recovery violations attributed to the GEN-2024-SR15 surplus request observed during the simulated faults. A few faults showed generator tripping issues which were also observed in the base cases. Plots for these can be seen in Appendix C. The list of tripped generators is listed in Appendix E. The EGF (GEN-2017-239) and SGF were tripping for some of the winter fault simulations. This was due to the EGF generator's instantaneous high-voltage relay. To mitigate the trip, the voltage relay was switched off for the winter simulations. 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.

Associated stability plots and existing DISIS base case issues are documented in Appendix C.

NECESSARY INTERCONNECTION FACILITIES

This study identified the impact of the Surplus Interconnection Service request GEN-2024-SR15 on the transmission system reliability and any additional Interconnection Facilities or Network Upgrades necessary. The Surplus Interconnection Service is only available up to the amount that can be accommodated without requiring additional Network Upgrades unless (a) those additional Network Upgrades are either (1) located at the Point of Interconnection substation and at the same voltage level as the Generating Facility with an effective GIA, or (2) are System Protection Facilities; and (b) there are no material adverse impacts on the cost or timing of any Interconnection Requests pending at the time the Surplus Interconnection Service request is submitted.

INTERCONNECTION FACILITIES

This study did not identify any additional Interconnection Facilities required by the addition of the SGF.

NETWORK UPGRADES

This study did not identify any Network Upgrades required by the addition of the SGF. SPP will reach out to the TO and/or TOP to determine if there are any additional Network Upgrades that are either (1) located at the Point of Interconnection substation and at the same voltage level as the Generating Facility with an effective GIA, or (2) are System Protection Facilities.

SURPLUS INTERCONNECTION SERVICE DETERMINATION AND REQUIREMENTS

In accordance with Attachment V of the SPP Tariff, SPP shall evaluate the request for Surplus Interconnection Service and inform the Interconnection Customer in writing of whether the Surplus Interconnection Service can be utilized without negatively impacting the reliability of the Transmission System and without any additional Network Upgrades necessary except those specified in the SPP Tariff.

SURPLUS SERVICE DETERMINATION

SPP determined the request for Surplus Interconnection Service does not negatively impact the reliability of the Transmission System and no required Network Upgrades or Interconnection Facilities were identified.

1898 & Co. evaluated the impact of the requested Surplus Interconnection Service on the prior study results and determined that the requested SGF resulted in similar dynamic stability and short circuit analyses therefore the prior study steady-state results should not be negatively impacted.

SPP has determined that GEN-2024-SR15 may utilize the requested 300 MW of Surplus Interconnection Service being made available by GEN-2017-239.

SURPLUS SERVICE REQUIREMENTS

The amount of Surplus Interconnection Service available to be used is limited by the amount of Interconnection Service granted to the existing interconnection customer at the same POI. The combined generation from both the SGF and the EGF may not exceed 300 MW at the POI, which is the total Interconnection Service amount currently granted to the EGF.

The customer must install monitoring and control equipment as needed to ensure that the SGF does not exceed the granted surplus amount and to ensure that a combination of the SGF and EGF power injected at the POI does not exceed the EGF's Interconnection Service amount. The monitoring and control scheme may be reviewed by the TO and documented in Appendix C of the SGF GIA.

SPP will reach out to the TO and/or TOP to determine if there are any additional Network Upgrades that are either (1) located at the Point of Interconnection substation and at the same voltage level as the Generating Facility with an effective GIA, or (2) are System Protection Facilities.