GEN-2024-GR3

Generator Replacement Study

By SPP Generator Interconnection

Published on 2/24/2024

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
02/24/2024		Original Version	

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EXECUTIVE SUMMARY

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (SPP tariff) Attachment V section 3.9 and SPP Business Practice 7800, Interconnection Customers can submit replacement requests for their Existing Generating Facilities. The Interconnection Customer of an Existing Generating Facility (EGF) with a Point of Interconnection (POI) at the Cunningham 230 kV Substation requested to be studied in the SPP Generator Replacement process.

GEN-2024-GR3, the Replacement Generating Facility (RGF), will connect to, the existing POI, the Cunningham 230 kV Substation in the Southwest Power Service (SPS) area.

The EGF has 196 MW of available replacement capacity, based on the EGF Generation Interconnection Agreement (GIA). This Study has been requested to evaluate the replacement configuration of 54 x 4.2 MVA PE FS4200M MW solar panels with a proportionally reduced dispatch of 196 MW as specified by the Interconnection Customer. This generating capacity for the RGF (198.936 MW), exceeds its requested Interconnection Service amount of 196 MW. As a result, 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.

The Generator Replacement Process consists of two parts: a Reliability Assessment Study and a Replacement Impact Study. The Reliability Assessment Study identifies any system impacts between the removal of the EGF from service and the commission date of the RGF and system adjustments to mitigate those issues. The Replacement Impact Study identifies whether the RGF is a Material Modification.

Reliability Assessment Study

See attached.

Replacement Impact Study

1898 & Co, a part of Burns & McDonnell, was retained by SPP to perform the Replacement Impact Study (Impact Study) for GEN-2024-GR3.

SPP determined that steady-state analysis was not required because the requested capacity of the RGF does not exceed the previously studied EGF output of 196 MW. In addition, the EGF was previously studied at maximum Interconnection Service under all necessary reliability conditions. However, SPP determined that short circuit and dynamic stability analyses were required as the dynamic model for the EGF and RGF are different (GENROU and REGCA1, respectively). The scope of this Impact Study included reactive power analysis, short circuit analysis, and dynamic stability analysis.

The results of the Impact Study showed that the requested replacement did not have a material adverse impact on the SPP transmission system. The requested generator replacement of the EGF with GEN-2024-GR3 was determined **not a Material Modification**.

As the requested replacement generating capacity is higher 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 requested Interconnection Service amount. The monitoring and control scheme may be reviewed by the Transmission Owner (TO) and documented in Appendix C of the RGF 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 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. Transfer of an existing resource designation from the EGF to the RGF can be achieved by submitting a transfer of designation request pursuant to Section 30.2.1 of the SPP tariff. If the customer would like to obtain new 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

Pursuant to SPP tariff Attachment V section 3.9 and SPP Business Practice 7800, Interconnection Customers can submit replacement requests for its Existing Generating Facilities. A Generator Replacement Impact Study is an interconnection study performed to evaluate the impacts of replacing existing generation with new generation. Two analyses covering different time frames are evaluated:

- Reliability Assessment Study – study performed to evaluate the performance of the Transmission System for the time period between the date that the Existing Generating Facility (EGF) ceases commercial operations and the Commercial Operation Date (COD) of the Replacement Generating Facility (RGF).
- Replacement Impact Study – study performed to evaluate if the RGF has a material adverse impact on the SPP Transmission System.

For any impacts to the system identified in the Reliability Assessment Study, non-transmission solutions such as redispatch, remedial action schemes, or reactive setting adjustments will be identified to mitigate issues originating after the removal of the EGF from service and before the commission of the RGF.

If the Replacement Impact Study identifies any materially adverse impact from operating the RGF when compared to the EGF, such impacts shall be deemed a Material Modification.

RELIABILITY ASSESSMENT STUDY

See attached.

REPLACEMENT IMPACT STUDY

1898 & Co, a part of Burns & McDonnell, was retained by SPP to perform the Replacement Impact Study (Impact Study) for GEN-2024-GR3. All analyses were performed using Siemens PTI PSS/E version 34 software.

STEADY STATE ANALYSIS

To determine whether steady state analysis is required, SPP evaluates if all required reliability conditions were previously studied. This is done by comparing the current DISIS steady-state requirements versus the steady-state analysis previously performed on the EGF. SPP determined that since the EGF was previously studied at maximum Interconnection Service under all necessary reliability conditions, no steady-state analysis for the RGF is required.

STABILITY AND SHORT CIRCUIT ANALYSES

To determine whether stability and short circuit analyses are required, SPP evaluates the difference between the stability models and corresponding parameters and, if needed, the collector system impedance between the existing configuration and the requested replacement. Dynamic stability analysis and short circuit analysis would be required if the differences listed above may result in a significant impact on the most recently performed DISIS stability analysis.

REACTIVE POWER ANALYSIS

A reactive power analysis was performed on the requested replacement configuration as it is a non-synchronous resource. The reactive power 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 (if any) are offline.

STUDY LIMITATIONS

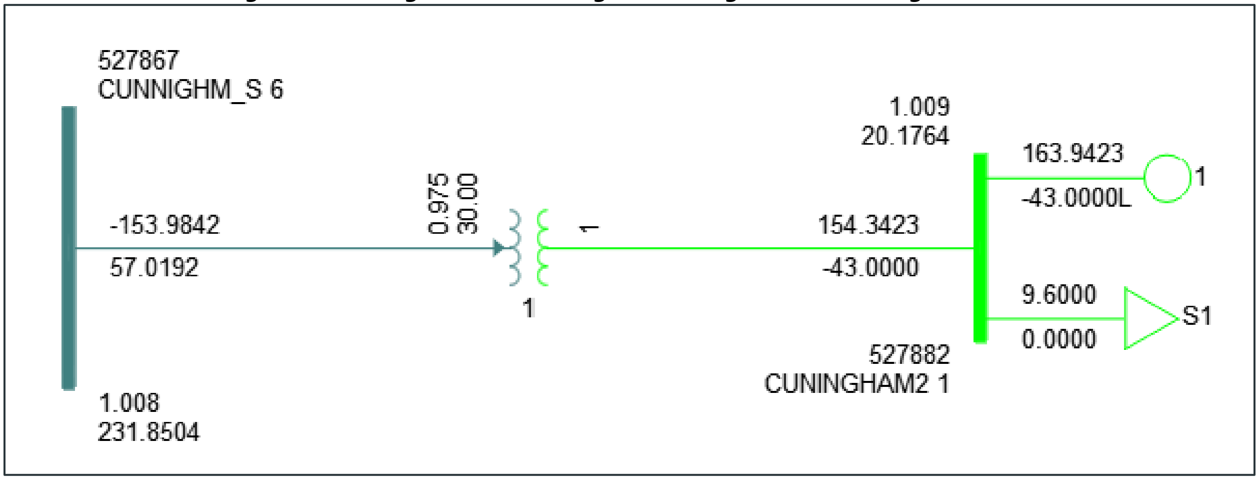
The assessments and conclusions provided in this report are based on assumptions and information provided to SPP/1898 & Co. by others. While the assumptions and information provided may be appropriate for the purposes of this report, SPP/1898 & Co. does not guarantee that those conditions assumed will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

PROJECT AND REPLACEMENT REQUEST

The GEN-2024-GR3 Interconnection Customer has requested a replacement to its EGF, a Natural gas generating facility with a POI at the Cunningham 230 kV Substation and a requested retirement date of September 15, 2026. The Interconnection Service available for replacement is 196 MW, based on the EGF Generation Interconnection Agreement (GIA). Of the Interconnection Service available, the RGF Interconnection Customer has requested 196 MW of Energy Resource Interconnection Service (ERIS). The requested RGF is a solar farm consisting of 54 x 4.2 MVA PE FS4200M solar inverters with a proportionally reduced dispatch of 196 MW as specified by the Interconnection Customer. This generating capacity for the RGF (198.936 MW), exceeds its requested Interconnection Service amount of 196 MW. As a result, 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. The RGF has a planned commercial operation date of April 1, 2027.

The POI of the EGF and RGF is at the Cunningham 230 kV Substation in the Southwest Power Service (SPS) area, and the EGF and RGF are not expected to be operational simultaneously. Figure 1 and Figure 2 show the steady state model single-line diagram for the EGF and RGF configurations, respectively. Table 1 details the existing and replacement configurations for GEN-2024-GR3.

Figure 1: Existing Generation Single Line Diagram (EGF Configuration)*



*based on the DISIS-2018-002/2019-001-1 25SP stability models

Figure 2: GEN-2024-GR3 Single Line Diagram (RGF Configuration)

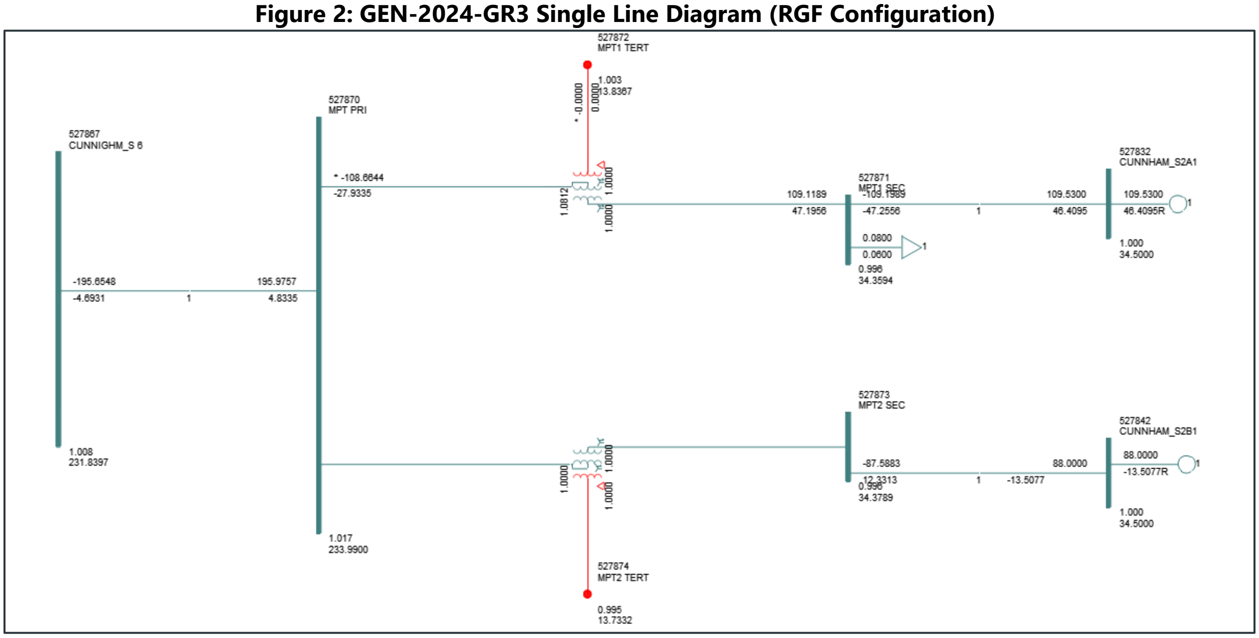


Table 1: EGF and RGF Configuration Details

Facility	Existing Generator Facility Configuration	Replacement Generator Facility Configuration	
Point of Interconnection	Cunningham 230kV Substation (527867)	Cunningham 230kV Substation (527867)	
Configuration/Capacity	Natural Gas Steam Turbine 180 MW (GENROU)4	54 x 4.2 MVA PE FS4200M (solar) = 198.936 MW [196 MW dispatch] PPC to limit GEN-2023-GR3 to 196 MW at the POI	
Generation Interconnection Line		Length = 7.00 miles R = 0.000864pu X = 0.007822 pu B = 0.026770 pu Rating A/B/C MVA = 723/723/361 MVA	
Main Substation Transformer[1]	X[2] = 5.558%, R[2] = 0.142%, Voltage = 230.0/19.0 kV, Taps Available = 5 Taps, ±5% Winding MVA = 100 MVA, Rating MVA = 241.0 MVA	**Gen 1: (30 Inverters)** X12 = 9.998% R12 = 0.209%, X23 = 2.999% R23 = 0.063%, X13 = 14.997% R13 = 0.314%, Taps Available = 16 Taps, ±10% Winding MVA = 75 MVA, Rating MVA = 125 MVA	**Gen 2: (24 Inverters)** X12 = 9.998% R12 = 0.209%, X23 = 2.999% R23 = 0.063%, X13 = 14.997% R13 = 0.314%, Voltage = 230/34.5/13.8 kV (Wye Grounded/Wye Grounded), Taps Available = 16 Taps, ±10% Winding MVA = 75 MVA, Rating MVA = 125 MVA
Generator Step Up Transformer		X2 = 8.871%, R2 = 0.715%, Voltage = 34.5/0.66 kV, Taps Available = 4 Taps, +2.5%; 2 Taps, -2.5% Winding MVA = 100 MVA, Rating MVA = 126.2 MVA	X2 = 8.871%, R2 = 0.715%, Voltage = 34.5/0.66 kV, Taps Available = 4 Taps, +2.5%; 2 Taps, -2.5% Winding MVA = 100 MVA, Rating MVA = 100.9 MVA
Equivalent Collector Line[3]		R = 0.002330 pu X = 0.003240 pu B = 0.013120 pu	R = 0.005210 pu X = 0.008290 pu B = 0.018380 pu
Generator Dynamic Model[4]	Natural Gas Steam Turbine 180 MW (GENROU)[4]	30 x 4.2 MVA PE FS4200M (REGCA1)[4]	24 x 4.2 MVA PE FS4200M (REGCA1)[4]
Power Factor	Leading: 0.84 Lagging: 0.84	Leading: 0.5[5] Lagging: 0.5[5]	Leading: 0.5[5] Lagging: 0.5[5]
1) X and R based on Winding MVA, 2) X and R based on System MVA, 3) All pu are on 100 MVA Base, 4) DYR stability model name, 5) From Appendix 3: Generator Interconnection Study Agreement.			

RELIABILITY ASSESSMENT STUDY

See attached at end of the report.

REPLACEMENT IMPACT STUDY

1898 & Co, a part of Burns & McDonnell, was retained by SPP to perform the Replacement Impact Study (Impact Study) for GEN-2024-GR3.

EXISTING VS. REPLACEMENT COMPARISON

To determine which analyses are required for the Impact Study, the differences between the existing configuration and the requested replacement were evaluated. SPP performed this comparison and the resulting analyses using a set of modified study models developed based on the replacement request data and the DISIS-2018-002/2019-001-1 study models.

STABILITY MODEL PARAMETERS COMPARISION

Because the dynamic model for the EGF and RGF are different (GENROU and REGCA1, respectively), SPP determined short-circuit and dynamic stability analyses were required. This is because the short-circuit contribution and stability responses of the existing configuration and the requested replacement's configuration may differ. The generator dynamic model for the RGF can be found in Appendix A.

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

EQUIVALENT IMPEDANCE COMPARISON CALCULATION

As the stability model 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.

REACTIVE POWER ANALYSIS

1898 & Co, a part of Burns & McDonnell, performed a reactive power analysis for GEN-2024-GR3 to determine the capacitive charging effects under 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.

METHODOLOGY AND CRITERIA

For this analysis, the nearby projects that share the gen-tie line were disconnected. The GEN-2024-GR3 generators 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).

1898 & Co, a part of Burns & McDonnell, performed the reactive power analysis using the replacement request data based on the DISIS-2018-002/2019-001-1 stability study 2025 Summer Peak (25SP) model.

RESULTS

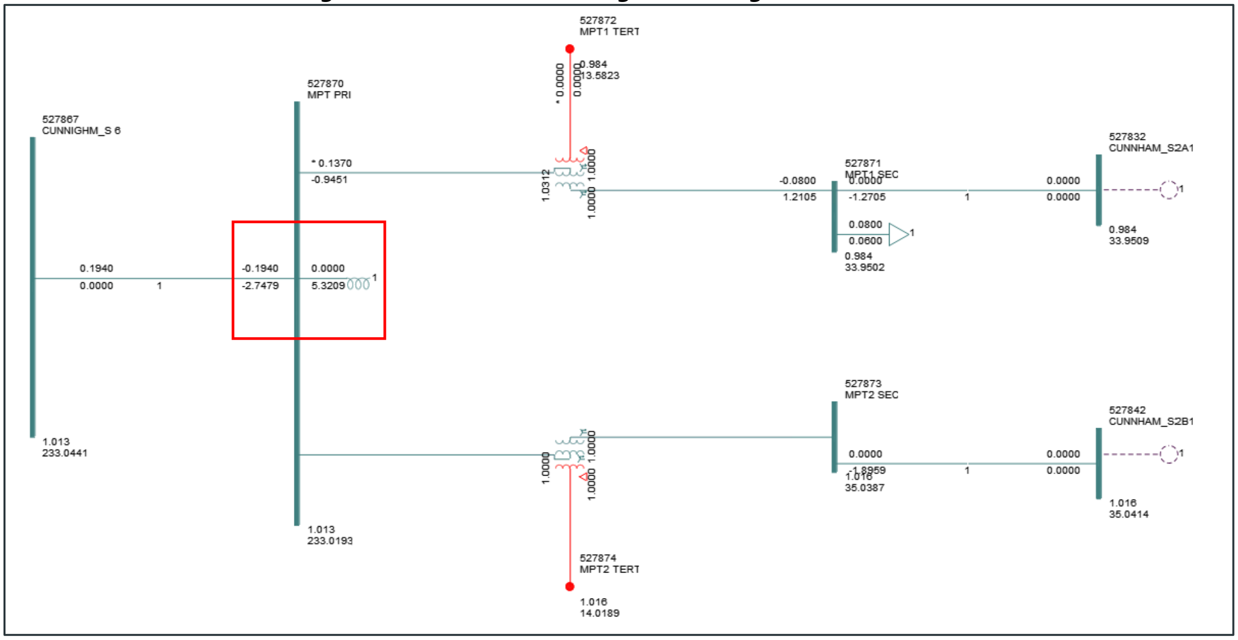
The results from the analysis showed that the GEN-2024-GR3 project needed approximately 5.19 MVAr of compensation at its collector substation, to reduce the POI MVAr to zero. Figure 3 illustrates the shunt reactor size needed to reduce the POI MVAr to approximately zero with the updated configuration. The final shunt reactor requirements for GEN-2024-GR3 are shown in Table 2.

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.

Table 2: Shunt Reactor Size for Reactive Power Analysis

Machine	POI Bus Number	POI Bus Name	Reactor Size (MVAr)
			25SP
GEN-2023-GR3	527867	CUNNIGHM_S 6	5.19

Figure 3: GEN-2024-GR3 Single Line Diagram (Shunt Size)



SHORT-CIRCUIT ANALYSIS

1898 & Co, a part of Burns & McDonnell, performed a short circuit study using the 25SP model to determine the maximum fault current requiring interruption by protective equipment with the RGF online for each bus in the relevant subsystem, and the amount of increase in maximum fault current due to the addition of the RGF. The detailed results of the short circuit analysis are provided in Appendix B.

METHODOLOGY

The short-circuit analysis included applying a three-phase fault on buses up to five 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 GEN-2024-GR3 RGF online.

SPP created a short circuit model using the 25SP stability study model by adjusting the GEN-2024-GR3 short-circuit parameters consistent with the replacement data. The adjusted parameters are shown in Table 3 below.

Table 3: GEN-2024-GR3 Short-Circuit Parameters*

Parameter	Value by Generator Bus#	Value by Generator Bus#
	527832	527842
Machine MVA Base	126.0	100.8
R (pu)	0.001	0.001
X'' (pu)	0.921	0.921

*pu values based on Machine MVA Base

RESULTS

The results of the short circuit analysis for the 25SP model are summarized in Table 4 and Table 5. The GEN-2024-GR3 POI bus (Cunningham 230 kV) fault current magnitude is provided in Table 4 showing a fault current of 15.96 kA with the RGF online. The addition of the RGF increased the POI bus fault current by -2.345 kA. Table 5 shows the maximum fault current magnitudes and fault current increases with the RGF project online.

The maximum fault current calculated within 5 buses of the POI was 33.78 kA for the 25SP model. There were several buses with a maximum three-phase fault current over 30 kA. These buses are highlighted in Appendix B. The maximum contribution to three-phase fault currents due to the addition of the RGF was about 1.07% and 0.040 kA.

Table 4: POI Short-Circuit Results

Case	GEN-OFF Current (kA)	GEN-ON Current (kA)	kA Change	%Change
25SP	18.300	15.955	-2.345	-13%

Table 5: 25SP Short-Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
69	9.940	0.040	1.07%
115	33.608	0.018	0.23%
138	0.000	0.000	0.00%
230	33.781	-0.008	-0.09%
345	16.729	0.000	0.00%
Max	**33.781**	**0.040**	**1.07%**

DYNAMIC STABILITY ANALYSIS

1898 & Co, a part of Burns & McDonnell, performed a dynamic stability analysis to identify the impact of the GEN-2024-GR3 project. The analysis was performed according to SPP's Disturbance Performance Requirements[1]. The replacement details are described in the Project and Replacement Request section and the dynamic modeling data is provided in Appendix A. The simulation plots can be found in Appendix C.

METHODOLOGY AND CRITERIA

The dynamic stability analysis was performed using models developed with the requested RGF configuration of 54 x 4.2 MVA PE FS4200M MW (REGCA1). This stability analysis was performed using PTI's PSS/E version 34.9.6 software.

The RGF project details were used to create modified stability models for this impact study based on the DISIS-2018-002/2019-001-1 stability study models:

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

The dynamic model data for the GEN-2024-GR3 project is provided in Appendix A. The modified power flow models and associated dynamics database were initialized (no-fault test) to confirm that there were no errors in the initial conditions of the system and the dynamic data.

The following system adjustments were made to address simulation issues:

- 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 RGF and other current and prior queued projects in Group 5[2]. In addition, voltages of five (5) buses away from the POI of the RGF were monitored and plotted. The machine rotor angle for synchronous machines and speed for asynchronous machines within the study areas including AEPW, OKGE, SPS, and WAPA were monitored. The voltages of all 100 kV and above buses within the study area were monitored as well.

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

[2] Based on the DISIS-2018-002/2019-001-1 Cluster Groups

FAULT DEFINITIONS

1898 & Co. developed fault events as required in order to study the RGF. The new set of faults were simulated using the modified 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. The simulated faults are listed and described in Appendix D. These contingencies were applied to the modified 25SP and 25WP models.

RESULTS

Table 6 shows the relevant results of the fault events simulated for each of the modified cases. The associated stability plots are also provided in Appendix C.

Table 6: Stability Analysis Results

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_527793_EDDY_STH-527786_ATOKA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527793_EDDY_STH-527799_EDDY_NORTH_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527793_EDDY_STH-528178_PECOS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527798_EDDY_NTH-527564_ROSWLL_INT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527798_EDDY_NTH-527711_EAGLE_CREEK311500_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527798_EDDY_NTH-527793_EDDY_STH_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527798_EDDY_NTH-527799_EDDY_NORTH_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527799_EDDY_NORTH-527483_CHAVES_CNTY623000_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527799_EDDY_NORTH-527793_EDDY_STH_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527799_EDDY_NORTH-527798_EDDY_NTH_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527799_EDDY_NORTH-527802_EDDY_CNTY_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527799_EDDY_NORTH-528095_7-RIVERS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527799_EDDY_NORTH-599960_EPTNP-D6_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527802_EDDY_CNTY-527656_CROSSROADS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527802_EDDY_CNTY-527799_EDDY_NORTH_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527802_EDDY_CNTY-527965_KIOWA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527864_CUNNINHAM-527867_CUNNIGHM_S_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527864_CUNNINHAM-527891_HOBBS_INT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527864_CUNNINHAM-527891_HOBBS_INT_Ckt2	Pass	Pass	Stable	Pass	Pass	Stable
P1_527864_CUNNINHAM-528348_BUCKEYE_TP_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527864_CUNNINHAM-528355_MADDOX_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527864_CUNNINHAM-528394_QUAHADA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_527864_CUNNINHAM-528581_BYRD_TP_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527865_CUNNIGHM_N-527799_EDDY_NORTH_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527865_CUNNIGHM_N-527963_POTASH_JCT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527867_CUNNIGHM_S-527864_CUNNINHAM_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527867_CUNNIGHM_S-527865_CUNNIGHM_N_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527867_CUNNIGHM_S-527894_HOBBS_INT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527891_HOBBS_INT-527894_HOBBS_INT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527891_HOBBS_INT-528333_LE-WEST_SUB311500_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527891_HOBBS_INT-528355_MADDOX_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527891_HOBBS_INT-528413_TAYLOR_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527891_HOBBS_INT-528433_BENSING_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527894_HOBBS_INT-527028_INK_BASIN_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527894_HOBBS_INT-527891_HOBBS_INT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527894_HOBBS_INT-527896_HOBBS_INT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527894_HOBBS_INT-528604_ANDREWS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-526936_YOAKUM_345_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527656_CROSSROADS_CktBA	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527656_CROSSROADS_CktLX	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527894_HOBBS_INT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-527965_KIOWA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-528027_RDRUNNER_CktUC	Pass	Pass	Stable	Pass	Pass	Stable
P1_527896_HOBBS_INT-528027_RDRUNNER_CktXA	Pass	Pass	Stable	Pass	Pass	Stable
P1_527930_PCA-527929_PCA_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527930_PCA-527962_POTASH_JCT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527930_PCA-528160_CARLSBAD_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527930_PCA-528394_QUAHADA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527962_POTASH_JCT-527963_POTASH_JCT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527962_POTASH_JCT-527966_KIOWA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527963_POTASH_JCT-527962_POTASH_JCT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_527963_POTASH_JCT-528179_PECOS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_527965_KIOWA-528185_N_LOVING_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528027_RDRUNNER-528015_PHANTOM_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528179_PECOS-528095_7-RIVERS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528179_PECOS-528178_PECOS_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_528317_ENRON_TP-528392_PEARLE_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528348_BUCKEYE_TP-528627_LE-TXACO_TP311500_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_528355_MADDOX-528353_MADDOXG23_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528355_MADDOX-528392_PEARLE_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528355_MADDOX-528491_MONUMENT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528355_MADDOX-762442_G18-004-TAP_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528394_QUAHADA-527930_PCA_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528394_QUAHADA-528399_LEA_NATIONL311500_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528399_LEA_NATIONL311500-528317_ENRON_TP_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528491_MONUMENT-528498_W_HOBBS_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528581_BYRD_TP-527864_CUNNINHAM_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528581_BYRD_TP-528505_LEA_ROAD_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_528604_ANDREWS-528602_ANDREWS_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_528627_LE-TXACO_TP311500-528622_LE-SANANDRS269000_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_762442_G18-004-TAP-528449_W_BENDER_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527799_EDDY_NORTH	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527802_EDDY_CNTY	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527864_CUNNINHAM	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527865_CUNNIGHM_N	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527867_CUNNIGHM_S	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527891_HOBBS_INT	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527894_HOBBS_INT	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527896_HOBBS_INT	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527962_POTASH_JCT	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527963_POTASH_JCT	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-527965_KIOWA	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-528027_RDRUNNER	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-528355_MADDOX	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-528394_QUAHADA	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108434	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108435	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108436	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-526936_YOAKUM_345-ConID-108442	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527656_CROSSROADS-ConID-108421	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527802_EDDY_CNTY-ConID-108422	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527802_EDDY_CNTY-ConID-108423	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527802_EDDY_CNTY-ConID-108424	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527802_EDDY_CNTY-ConID-108440	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P4_CON-527965_KIOWA-ConID-108429	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-527965_KIOWA-ConID-108441	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-528027_RDRUNNER-ConID-108445	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-528027_RDRUNNER-ConID-108447	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-528185_N_LOVING-ConID-108430	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-528185_N_LOVING-ConID-108431	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-528185_N_LOVING-ConID-108432	Pass	Pass	Stable	Pass	Pass	Stable
P4_CON-528185_N_LOVING-ConID-108443	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-129	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-130	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-526936_YOAKUM_345-ConID-SPS-131	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527656_CROSSROADS-ConID-SPS-109	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527802_EDDY_CNTY-ConID-SPS-114	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527802_EDDY_CNTY-ConID-SPS-115	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527802_EDDY_CNTY-ConID-SPS-116	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527896_HOBBS_INT-ConID-SPS-119	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527965_KIOWA-ConID-SPS-120	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-527965_KIOWA-ConID-SPS-121	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-528027_RDRUNNER-ConID-SPS-126	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-528027_RDRUNNER-ConID-SPS-127	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-528027_RDRUNNER-ConID-SPS-128	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-528185_N_LOVING-ConID-SPS-122	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-528185_N_LOVING-ConID-SPS-123	Pass	Pass	Stable	Pass	Pass	Stable
P4_TO-528185_N_LOVING-ConID-SPS-124	Pass	Pass	Stable	Pass	Pass	Stable

There were no damping or voltage recovery violations attributed to the GEN-2024-GR3 replacement 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.

INSTALLED 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.

NECESSARY INTERCONNECTION FACILITIES

This study identified necessary Interconnection Facilities to accommodate GEN-2024-GR3 as shown in Table 7.

Table 7: Necessary Interconnection Facilities

Upgrade Name	Upgrade Description
Cunnigham_S 6 230 kV GEN-2024-GR3 Interconnection (TOIF) (AEP)	Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2024-GR3, into the POI at Cunnigham_S 6 230 kV.
Cunnigham_S 6 230 kV GEN-2024-GR3 Interconnection (Non-Shared NU) (AEP)	Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2024-GR3, into the POI at Cunnigham_S 6 230 kV.

Should the Interconnection Customer choose to move forward with this request, an Interconnection Facilities Study will be necessary to determine the full scope, cost, and time required to interconnect these upgrades. SPP will work with the TO(s) indicated for the Interconnection Facilities Study.

RESULTS

RELIABILITY ASSESSMENT STUDY

See attached.

REPLACEMENT IMPACT STUDY

In accordance with SPP tariff Attachment V, any material adverse impact from operating the RGF when compared to the EGF would be identified as a Material Modification. In the case that the Interconnection Customer chooses to move forward with the RGF, it must submit the RGF as a new Interconnection Request.

Because no material adverse impacts to the SPP Transmission System were identified, SPP determined the requested replacement is **not a Material Modification**. SPP determined that the requested replacement did not cause a materially adverse impact to the dynamic stability and short-circuit characteristics of the SPP system.

This determination implies that no new upgrades beyond those required for interconnection of the RGF are required, thus not resulting in a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date.

NEXT STEPS

As the requested replacement is determined to not be a Material Modification, pursuant to SPP tariff Attachment V section 3.9.3, the Interconnection Customer shall inform SPP within 30 Calendar Days after having received these study results of its election to proceed.

If the Interconnection Customer chooses to proceed with the studied replacement, SPP will initiate an Interconnection Facilities Study and subsequently tender a draft GIA. The Interconnection Customer shall withdraw any associated Attachment AB retirement requests of the EGF, if applicable, and complete the Attachment AE requirements for de-registration of the EGF and registration of the RGF, including transfer or termination of applicable existing transmission service. If the Interconnection Customer would like to obtain new deliverability to final customers, a separate request for transmission service must be requested on Southwest Power Pool's OASIS.

Failure by the Interconnection Customer to provide an election to proceed within 30 Calendar Days will result in withdrawal of the Interconnection Request pursuant to section 3.7 of SPP tariff Attachment V.

CUNNINGHAM 2

GENERATING FACILITY REPLACEMENT-RELIABILITY ASSESSMENT STUDY

By Aneden Consulting and SPP

Published on 5/22/2025

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
05/22/2025	Aneden Consulting & SPP Staff	Original Version	

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APPENDICES

EXECUTIVE SUMMARY

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (SPP Tariff) Attachment V Section 3, an Interconnection Customer submitted a Generating Facility Replacement (GFR) Interconnection Request to replace the SPS.CUNNGHAM2 (Cunningham 2) unit. Cunningham 2, the Existing Generating Facility (EGF), is a natural gas fueled combustion turbine with a Point of Interconnection (POI) at the Cunningham 230 kV Substation in the Southwestern Public Service Company (SPS) area. The Replacement Generating Facility (RGF), GEN-2024-GR3, is a 196 MW photovoltaic solar plant that will connect to the same POI.

Per the SPP Tariff Attachment V Section 3.9.2, Evaluation Process for Generating Facility Replacement Requests, the evaluation consists of two studies: a Reliability Assessment Study and a Replacement Impact Study.

This report provides the results of the Reliability Assessment Study. Results from the Replacement Impact Study are contained in a separate report.

Reliability Assessment Study

The Reliability Assessment Study is an engineering study that evaluates the impact of a proposed GFR on the reliability of Transmission System during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF. The SPP Business Practice 7800, Resource Retirement Study, describes the Reliability Assessment Study for GFR requests made pursuant to Attachment V.

In the Reliability Assessment Study screening process, SPP recommended that additional analysis would be needed due to a reasonable concern about meeting reliability requirements during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF. The Planning Screening Assessment identified that the conditions requiring a Planning Analysis were met as Cunningham 2 had been modeled as online and dispatched in the latest set of the approved Base Reliability powerflow models utilized in the 2024 TPL-001-4 assessment. The Operational Screening Assessment identified potential system reliability concerns if the Cunningham 2 resource is retired without mitigating actions in place. The resource is regularly committed in the SPP Market, between 250 and 350 times a year, with an average dispatch providing around 93 MW and 137 MVAR. Cunningham 2 is located near a major flowgate, SPSNMTIES, and provides support to the flowgate. Retirement of the Cunningham 2 resource may pose issues with maintaining System Operating Limits.

SPP held a teleconference with the Interconnection Customer and Transmission Owner to discuss the analysis to be performed. The developed scope included both a Planning Analysis and Analysis on Operational Models, each consisting of steady state and stability analyses. The Interconnection Customer identified that, if needed to address a reliability concern, the EGF may delay ceasing commercial operation from September 2026 up to March 2027 without impacting the Commercial Operation Date of the RGF in April 2027.

The results from the Planning Analysis showed that initial violations were found and resolved through model corrections from the ITP study and mitigations already provided through the 2024 TPL assessment. There were no remaining issues requiring mitigation identified with the retirement of Cunningham 2. These results are only valid for the requested period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. If this time period is shifted or extended beyond what was studied, additional analysis will be required.

The results from the Analysis on Operational Models showed that there are reliability concerns with the EGF ceasing commercial operation for the entire proposed period from September 2026 through the Commercial Operation Date of the RGF in April 2027. The transmission system was found not to respond reliably to system conditions with no availability to use the Cunnigham 2 as a mitigation. Delaying the date that the EGF ceases commercial operation to a planned date in late Q1 2027 improves these results. In addition, the amount of planned or maintenance outages taken during the replacement time period may be reduced to maintain system reliability.

Analysis on Operational Models showed that replacing Cunningham 2 with a solar resource, for periods without reliably forecasted or available fuel (e.g. wind and sunlight), will reduce or eliminate the necessary opportunities for planned maintenance outages for resources in the area. The Transmission Planner for this area is advised to consider these periods of reduced fuel along with resource maintenance requirements in its reliability plan.

SCOPE OF STUDY

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (SPP Tariff) Attachment V Section 3, an Interconnection Customer submitted a Generating Facility Replacement (GFR) Interconnection Request to replace the SPS.CUNNGHAM2 (Cunningham 2) unit. Cunningham 2, the Existing Generating Facility (EGF), is a natural gas fueled combustion turbine with a Point of Interconnection (POI) at the Cunningham 230 kV Substation in the Southwestern Public Service Company (SPS) area. The Replacement Generating Facility (RGF), GEN-2024-GR3, is a 196 MW photovoltaic solar plant that will connect to the same POI.

SPP Tariff Attachment V Section 3.9.2, Evaluation Process for Generating Facility Replacement Requests, evaluation consists of two studies: a Reliability Assessment Study and a Replacement Impact Study.

This report provides the results of the Reliability Assessment Study. Results from the Replacement Impact Study are contained in a separate report.

RELIABILITY ASSESSMENT STUDY

The Reliability Assessment Study is an engineering study that evaluates the impact of a proposed GFR on the reliability of Transmission System during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF. The SPP Business Practice 7800, Resource Retirement Study, describes the Reliability Assessment Study for GFR requests made pursuant to Attachment V. In the Reliability Assessment Study screening process, SPP recommended that additional analysis would be needed due to a reasonable concern about meeting reliability requirements during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF. The Planning Screening Assessment identified that the conditions requiring a Planning Analysis were met as Cunningham 2 had been modeled as online and dispatched in the latest set of the approved Base Reliability powerflow models utilized in the 2024 TPL-001-4 assessment. The Operational Screening Assessment identified potential system reliability concerns if the Cunningham 2 resource is retired without mitigating actions in place. The resource is regularly committed in the SPP Market, between 250 and 350 times a year, with an average dispatch providing around 93 MW and 137 MVAR. Cunningham 2 is located near a major flowgate, SPSNMTIES, and provides support to the flowgate. Retirement of the Cunningham 2 resource may pose issues with maintaining System Operating Limits.

SPP held a teleconference with the Interconnection Customer and Transmission Owner to discuss the analysis to be performed. The developed scope included both a Planning Analysis and Analysis on Operational Models, each consisting of steady state and stability analyses. The Interconnection Customer identified that, if needed to address a reliability concern, the EGF may delay ceasing commercial operation from September 2026 up to March 2027 without impacting the Commercial Operation Date of the RGF in April 2027.

STUDY LIMITATIONS

The assessments and conclusions provided in this report are based on assumptions and information provided to SPP/Aneden by others. While the assumptions and information provided may be appropriate for the purposes of this report, SPP/Aneden does not guarantee that those conditions assumed will occur. In addition, SPP/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.

RELIABILITY PLANNING ANALYSIS

In the Reliability Assessment Study screening process, SPP recommended that additional analysis would be needed due to a reasonable concern about meeting reliability requirements during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF. The Planning Screening Assessment identified that the conditions requiring a Planning Analysis were met as Cunningham 2 had been modeled as online and dispatched in the latest set of the approved Base Reliability powerflow models utilized in the 2024 TPL-001-4 assessment.

SPP held a teleconference with the Interconnection Customer and Transmission Owner to discuss the analysis to be performed. The developed scope included both a Planning Analysis and Analysis on Operational Models, each consisting of steady state and stability analyses.

In coordination with SPP, Aneden was retained to perform the Planning Analysis scope for the Interconnection Customer requested period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. If this time period is shifted or extended beyond what was studied, additional analysis will be required.

PLANNING ANALYSIS

The Planning Analysis consisted of steady state and stability analyses to determine whether system constraints exist with the removal of the EGF. The planning analysis was performed using the 2024 ITP Base Reliability models.

MODEL UPDATES

BASE CASE

The following 2024 TPL models were used as base cases for the steady state analysis:

- 2025 Light Load

The following 2024 TPL models were used as base cases for the stability analysis:

- 2025 Light Load

The 2025 Light Load model was selected based on the period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. The base cases have the EGF dispatched according to the TPL models, and change cases were created where the EGF was removed from the base cases and compensated for using generation within the SPS area to represent the retirement of the EGF. The performance of both sets of cases were then compared to determine the impact of removing the EGF from service to the SPP transmission system.

IMPACT ANALYSIS

STEADY STATE POWERFLOW ANALYSIS

Steady state analysis compared the power flows and voltages between the base cases and the change cases using PowerGEM TARA software and determined the impacts of removing the EGF from service.

The following assumptions were made for the steady state analysis:

- Monitored Elements
  - SPP facilities 69 kV and above
  - First-tier companies 100 kV and above
- Contingencies
  - P1, P2, P3, P4, P5, P6 and P7 events[1] within 5 buses of the EGF's POI for all models
- Impact Criteria
  - The system performance in the base and study cases were evaluated based on the SPP Planning Criteria[2] (Section 5.4.2).
  - Any new voltage violations or thermal violations were identified as new impacts
- Adjustments
  - Solution settings changes and alterations of solution parameters were needed to solve some non-convergence issues. This was required in both the base and change cases.

The results of the steady state analysis showed that there was a high voltage at the Andrews 230 kV bus. This was resolved by adjusting the capacitor bank on the NA_ENRICH 115 kV bus to produce 0 MVAR.

In addition, existing thermal overloads were worsened slightly with the retirement of the EGF. The worst loading for each line is shown below in Table 1.

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[1] NERC TPL-001 Standard Table 1
[2] SPP Planning Criteria Revision 4.4, March 29, 2024

Table 1: Worst Planning Analysis Thermal Overloads

Monitored Facility	Rating (MVA)	Worst Loading (Base Case) (%)	Worst Loading (Study Case) (%)	Increase (%)
527864 CUNNINHAM 3 115 527891 HOBBS_INT 3 115 1	174	116.34	116.56	0.22
527864 CUNNINHAM 3 115 527891 HOBBS_INT 3 115 2	174	103.25	103.55	0.3
528013 PHANTOM 3 115 528228 WOOD_DRAW 3 115 1	175	125.68	127.17	1.49
528018 RED_BLUFF 3 115 528025 RDRUNNER 3 115 1	175	116.53	118.83	2.3
528020 BOPCO_PKRLK3 115 528235 WOLFCAMP_TP3 115 1	175	138.33	141.04	2.71
528526 TEAGUE 3 115 528547 S_JAL 3 115 1	154	105.21	107.3	2.09
528540 WHITTEN 3 115 528547 S_JAL 3 115 1	154	112.91	114.78	1.87

These potential violations were resolved through system adjustments and model corrections identified in the 2024 ITP/TPL analysis.

As these overloads were present in the base case and resolved by previously identified corrections they are not considered impacts from the EGF retirement. Overall, there were no thermal or voltage impacts identified in the change cases due to the EGF retirement. As no impacts were observed in the study area for the studied time period, removing the EGF from service was determined to meet reliability requirements of applicable NERC Reliability Standards, SPP Planning Criteria, and local planning criteria.

TRANSIENT STABILITY ANALYSIS

Transient stability analysis was performed and simulated using PSS/E for both the 2025 Light Load base and change cases. The contingencies were developed during the 2024 Planning Assessment for the SPS Transmission Planning area and included P1-P7 Planning and Extreme Events for a total of 164 events.

The simulations were performed for 20 seconds, and the following parameters were monitored according to the SPP Disturbance Performance Requirements[3]:

- Rotor angle stability within the SPP Planning Coordinator (PC) Area
- Oscillation damping within the SPP PC Area
- Transient voltage stability within 10 buses of the fault bus

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

Aneden compared the post processed results from the base and change cases to determine the impact on the SPP Bulk Electric System (BES).

The results of the transient stability analysis showed that there were no new rotor angle stability, oscillation damping, or transient voltage stability violations identified in the change cases as compared to the base cases due to the EGF retirement. As no new impacts were observed in the study area, removing the EGF from service was determined to meet reliability requirements of applicable NERC Reliability Standards, SPP Planning Criteria, local planning criteria, and the SPP Disturbance Performance Requirements.

SUMMARY

The results from the Planning Analysis showed that no issues requiring mitigation were identified. These results are only valid for the requested period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. If this time period is shifted or extended beyond what was studied, additional analysis will be required.

ANALYSIS ON OPERATIONAL MODELS

In the Reliability Assessment Study screening process, SPP recommended that additional analysis would be needed due to a reasonable concern about meeting reliability requirements during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF. The Operational Screening Assessment identified potential system reliability concerns if the Cunningham 2 resource is retired without mitigating actions in place. The resource is regularly committed in the SPP Market, between 250 and 350 times a year, with an average dispatch providing around 93 MW and 137 MVAR. Cunningham 2 is located near a major flowgate, SPSNMTIES, and provides support to the flowgate. Retirement of the Cunningham 2 resource may pose issues with maintaining System Operating Limits.

SPP held a teleconference with the Interconnection Customer and Transmission Owner to discuss the analysis to be performed. The developed scope included both a Planning Analysis and Analysis on Operational Models, each consisting of steady state and stability analyses. The Interconnection Customer identified that, if needed to address a reliability concern, the EGF may delay ceasing commercial operation from September 2026 up to March 2027 without impacting the Commercial Operation Date of the RGF in April 2027.

SPP staff performed the Analysis on Operational Models scope for the Interconnection Customer requested period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. Additionally, analysis was performed beyond this timeframe to replicate the system conditions causing SPP's concerns in the Operational Screening Process and to evaluate the ability of the transmission system to respond to system conditions with no availability to use the EGF as a mitigation. The evaluated timeframe included the Interconnection Customer indicated accommodation to delay, if necessary for reliability, the date that the EGF ceases commercial operation from September 2026 up to March 2027.

OPERATIONAL MODELS

STUDY CASES

Based on the study scope described above SPP developed a total of six different operational models (cases) replicating the system conditions causing SPP's concerns in the Operational Screening Assessment. The case description and associated snapshot from the SPP EMS model are shown in Table 2 below.

Table 2: Operational Models Powerflow Cases

Case	Time and Date
Year Highest Net Load	8/19/2024 6:00 PM
Non-Summer Highest Net Load	9/19/2024 2:40 PM
Spring Highest Net Load	4/28/2024 7:50 PM
Year Highest SPSNMTIES Flow	8/12/2024 7:40 PM
Non-Summer Highest SPSNMTIES Flow	10/24/2024 5:20 PM
Spring Highest SPSNMTIES Flow	3/3/2024 6:25 PM

Each case represents the peak conditions across three different timeframes for both Highest Net Load across the SPS area and the highest flow across SPSNMTIES flowgate.

- The yearly cases evaluate the system impacts independent of the replacement timeframe
- The non-Summer cases correlate to the original replacement timeframe of September 2026 to April 2027
- The Spring cases correlate to the alternate replacement timeframe of March 2027 to April 2027

The Cunningham 2 resource is located in the Southern SPS area that consists of the following zones within the SPP EMS model:

- SPS SPS
- SPS – HOBB
- SPS – LEA
- SPS – PECO

*Note that the Milo and Roosevelt Wind resources are modeled in these zones but excluded from the Southern SPS Area for this study.

The Southern SPS zones have the following general characteristics in the selected powerflows, shown in Table 3 below. The SPSNMTIES flowgate represents imports into the Southern SPS area.

Table 3: Operational Model Southern SPS Area Characteristics

Case	Load	SPSNMTIES
	MW	MW
Year Highest Net Load	2132	1039
Non-Summer Highest Net Load	1974	1306
Spring Highest Net Load	1643	1038
Year Highest SPSNMTIES Flow	2097	1320
Non-Summer Highest SPSNMTIES Flow	2061	1150
Spring Highest SPSNMTIES Flow	1823	1107

The Southern SPS area is transmission constrained requiring commitment and dispatch of local resources to reliably serve the entirety of its load. The SPSNMTIES flowgate limit had a calculated normal range between 600 MW and 1400 MW over the last year. The limit varies based on system conditions including the energization of lines and resources in the region. Each of the selected cases had an elevated flow near the upper end of the limits seen over the last year.

The selected cases had a various blend of essential elements online or offline that impacted the Southern SPS area. The state of these elements can be found in Table 4 below.

Table 4: Operational Model Powerflow Case Element Characteristics

Unit	Year Highest Net Load	Non-Summer Highest Net Load	Spring Highest Net Load	Year Highest SPSNMTIES Flow	Non-Summer Highest SPSNMTIES Flow	Spring Highest SPSNMTIES Flow
Cunningham 2	In	In	In	In	In	Out
Cunningham 3	In	Out	Out	Out	Out	In
Cunningham 4	In	Out	Out	In	Out	In
Hobbs Plant	Out	Out	In	Out	Out	In
Maddox Plant	In	In	In	In	In	In
Mustang Combined Cycle	In	In	In	In	In	In
Antelope Plant	In	Out	Out	In	In	Out
Tuco Elk	Out	Out	Out	In	In	Out
OKU – LES 345 kV	In	In	Out	In	In	Out

Each case had a unique distribution of resources within the Southern SPS area. A summary of the dispatch characteristics of these resources can be seen in

Table 5 below while a detailed list can be found in Appendix A: Powerflow Case Dispatches.

Table 5: Operational Model Powerflow Dispatch Characteristics

Case	Solar Dispatch	Wind Dispatch	Conventional Dispatch	Conventional Unused Capacity				Cunningham 2 Dispatch
					Online	Outaged	Recall	
Year Highest Net Load	169 MW	3 MW	688 MW	685 MW	72 MW	613 MW	0 MW	173 MW
Non-Summer Highest Net Load	39 MW	17 MW	369 MW	1003 MW	170 MW	833 MW	0 MW	141 MW
Spring Highest Net Load	8 MW	5 MW	586 MW	786 MW	267 MW	300 MW	220 MW	148 MW
Year Highest SPSNMTIES Flow	14 MW	27 MW	552 MW	821 MW	99 MW	613 MW	109 MW	174 MW
Non-Summer Highest SPSNMTIES Flow	172 MW	2 MW	461 MW	915 MW	82 MW	722 MW	111 MW	170 MW
Spring Highest SPSNMTIES Flow	3 MW	28 MW	537 MW	836 MW	541 MW	295 MW	0 MW	0 MW
Max Capacity	**220 MW**	**57 MW**	**1373 MW**					**184 MW**

Resources are summarized by fuel type with Conventional being composed of Gas and Coal resources. The dispatch of renewable resources in each case varies and in most of the cases is well below the aggregate rated capacity. Notably, the Spring Highest Net Load case experienced renewable resources producing 5% of their rated max capacity. Nearby solar resources, including the RGF for Cunningham 2, are expected to show a similar dispatch profile. This demonstrates that the EGF ceasing commercial operation will have an adverse impact on the necessary opportunities for planned maintenance outages for resources in the Southern SPS area.

Under these system conditions and the transmission limitations to import power into the Southern SPS area, commitment and dispatch of Conventional resources was necessary for system reliability in the Southern SPS area. Each case had Conventional Unused Capacity which comprised of Online, Outaged and Recall.

- Online refers to the headroom on synchronized conventional generating resources in each case
- Outaged refers to the capacity of generating resources that were unavailable to the system
- Recall refers to the amount of capacity that is available to be synchronized and available to the system after some time

Cunningham 2 was dispatched at a high level in five of the six cases. The Year Highest Net Load did not have adequate Online nor Recall capacity to offset the dispatch of Cunningham 2. Southern SPS area resource outages would not have been reliability taken with Cunningham 2 retired. The Non-Summer Highest Net Load, Non-Summer Highest SPSNMTIES Flow and Year Highest SPSNMTIES Flow cases had a slight margin of Online and Recall capacity to offset the dispatch of Cunningham 2. Of the six cases only the Spring Highest Net Load and Spring Highest SPSNMTIES Flow cases have enough Online and Recall capacity to offset the dispatch of Cunningham 2. These characteristics demonstrate that outside of the Spring timeframe, resource outages within the Southern SPS area may not have been reliability taken with no availability to use the Cunningham 2 resource as a mitigation.

MODEL UPDATES

Operational models were updated to replicate the system conditions causing SPP's concerns in the Operational Screening Assessment though each of the following steps:

Step 1: Basecase (P0, P1)– contingencies are run on the unmodified powerflows. This is used to determine violations present in the snapshot in each case.

Step 2: Retirement (P0, P1)– contingencies are run on the modified powerflows with the study resource removed from operation with resources external to SPS dispatched to maintain balance. This scenario is used to determine violations following the resource's retirement. Changes in violations are used to assess the impact of retirement.

Step 3: Retirement Plus (P3, P6) - contingencies are run on the modified powerflows with the study resource removed as well as an additional online generating unit/plant or in use major transmission element. This scenario is used to assess the resilience of the study area following the resource retirement.

Step 4: (as needed): Retirement with Mitigation (P0, P1, P3, P6)– contingencies are run on the modified powerflows with the study resource removed and mitigation included. This scenario is used to verify the adequacy of the identified mitigation.

The impact analysis process is performed across both steady state and stability analyses.

IMPACT ANALYSIS

The scope for the Analysis on Operational Models included the following charact across both steady state (ACCC) and stability (TSAT) analyses:

- Monitored Elements
  - All elements in SPS
- Contingencies
  - P1 events for all elements in SPS for the ACCC Study
  - P3 events for selected resources in SPS for the ACCC Study
  - P6 events for selected transmission lines in SPS for the ACCC Study
  - Selected events from ACCC Study for Transient Stability Study
- Analysis Criteria
  - System Intact
    - Loading within Normal Rating
    - Bus voltages within 0.95 – 1.05 pu
  - Post-contingency
    - Loading within Emergency Rating
    - Bus voltages within 0.90 – 1.05 pu
  - Transient Security
    - SPP Disturbance Performance Requirements

STEADY STATE POWERFLOW ANALYSIS

Contingency analysis was performed on cases from each step using the ACCC function in PSSE version 33. Per the PSSE version 33 User Manual, the ACCC calculates the full AC power flow solutions for a specific set of contingency cases, the results of which are stored in reports. The reports contain a list of non-converged contingencies, violations, loadings and available capacity.

ACCC results included several criteria violations (voltage and thermal) resultant from the removal of the Cunningham 2 resource, comparing Step 2 to Step 1. To resolve these issues, a preliminary mitigation plan, Step 4, was developed for commitment and dispatch of resources in the Southern SPS area. As a demonstration of feasibility the Hobbs Plant, found offline in several of the cases, was placed in service (in cases found offline) and dispatch increased to offset the output of Cunningham 2. This mitigation resolved the criteria violations observed though this specific action may not be available. SPP, Transmission Owner, and Generator Owners may need to develop a mitigation plan to ensure resources in the Southern SPS area remain adequately available. The analysis results are found in Appendix B: Comparison Results.

The violations observed correspond with increased loading on the SPSNORTH_STH and SPSNMTIES flowgates. These violations were a result of increased flows into the SPS Southern area due to resources external to SPS being dispatched to offset the removal of the Cunningham 2 resource. The mitigation resolves the violations resultant from the retirement of Cunningham 2. However, there were voltage violations observed in the Spring Highest SPSNMTIES flow case with the Cunningham 2 resource offline. These violations were not resultant from the removal of the Cunnigham 2 resource and may be mitigated by actions of the transmission operator.

To further evaluate the system conditions causing SPP's concerns in the Operational Screening Assessment, the following Step 3 scenarios were considered which included an additional transmission facility outage:

- Cunningham 3 (in the cases where Cunningham 3 was online)
- Mustang Combined Cycle
- Hobbs Plant
- Crossroads Eddy County 345 kV line
- Hobbs Yoakum 345 kV line
- Tuco Border 345 kV line

Each of these cases produced an increase in non-converged contingencies and criteria violations (thermal and voltage). The preliminary mitigation plan, dispatching Hobbs, provided partial relief of these violations but additional mitigation would be required. These results demonstrate a degradation of the transmission system's ability to respond to system conditions with no availability to use the Cunningham 2 resource as a mitigation. Following the date that the EGF ceases commercial operations, resource and/or transmission outages in the SPS Southern area may increase the risk, both amount and duration, for interruption of service to load as necessary to maintain system reliability.

It should be noted that the specific mitigation implemented in the analysis may not have been available during the period represented in some of the selected cases. Alternate resources within the Southern SPS area, when available for dispatch, would provide a similar constraint relief. Resources outside of the Southern SPS area, on the other side of the SPSNMTIES, would not provide sufficient relief to observed constraints.

Renewable resources located in the Southern SPS area may generally provide similar constraint relief. However, there are periods when Cunningham 2 was the only available resource for commitment, particularly when nearby renewable resources did not have sufficient fuel to meet system demands. Requests for planned outages in the area may be further restricted following the retirement of Cunningham 2 gas unit.

TRANSIENT STABILITY ANALYSIS

Time domain analysis was performed on cases from each step using the Basecase Analysis function in TSAT version 24.0. Per the TSAT User Manual, Basecase Analysis is used to perform the transient security assessment at one system operation condition for all critical contingencies specified. Contingency events evaluated are based on the contingencies that had a major impact on violations because of Cunningham 2's retirement found in the Steady State Powerflow Analysis. The contingencies evaluated in TSAT can be found in Appendix C: TSAT Contingencies.

The TSAT security violation results found no changes to system stability violations resultant from the Cunningham 2 resource retirement. Note that security criteria violations were found in Step 1 of the impact analysis with Cunningham 2 online. These violations were predominately in the High Net Load cases where a large amount of power was flowing into SPS. The violations were local in nature and a result of that power flowing into an isolated load area being cut off by a contingency along major transmission lines.

SUMMARY

The operational models (cases) replicating the system conditions causing SPP's concerns in the Operational Screening Assessment demonstrate that outside of the Spring timeframe resource outages within the Southern SPS area may not have been reliability taken with no availability to use the Cunningham 2 resource as a mitigation.

Steady State Powerflow Analysis results demonstrate that adequate levels of generation capacity within the Southern SPS area is necessary to meet applicable reliability requirements of NERC Reliability Standards, SPP Planning Criteria, local planning criteria, and the SPP Disturbance Performance Requirements.

The preliminary mitigation plan, dispatching Hobbs, provided partial relief of observed violations but additional mitigation would be required. These results demonstrate a degradation of the transmission system's ability to respond to system conditions with no availability to use the Cunningham 2 resource as a mitigation. Following the date that the EGF ceases commercial operations, resource and/or transmission outages in the SPS Southern area may increase the risk, both amount and duration, for interruption of service to load as necessary to maintain system reliability.

Transient Stability Analysis did not observe any issues with meeting applicable reliability requirements of NERC Reliability Standards, SPP Planning Criteria, local planning criteria, and the SPP Disturbance Performance Requirements.

The results from the Analysis on Operational Models showed that there are reliability concerns with the EGF ceasing commercial operation for the entire proposed period from September 2026 through the Commercial Operation Date of the RGF in April 2027. The transmission system was found not to respond reliably to system conditions with no availability to use the Cunnigham 2 as a mitigation. Delaying the date that the EGF ceases commercial operation to late Q1 2027 improves these results. In addition, the amount of planned or maintenance outages taken during the replacement time period may be reduced to maintain system reliability.

Analysis on Operational Models showed that replacing Cunningham 2 with a solar resource, for periods without reliably forecasted or available fuel (e.g. wind and sunlight), will reduce or eliminate the necessary opportunities for planned maintenance outages for resources in the area. The Transmission Planner for this area is advised to consider these periods of reduced fuel along with resource maintenance requirements in its reliability plan.

CONCLUSION

The Reliability Assessment Study is an engineering study that evaluates the impact of a proposed GFR on the reliability of Transmission System during the time period between the date that the EGF ceases commercial operations and the Commercial Operation Date of the RGF.

Based on the findings of the Planning Analysis, initial violations were found and resolved through model corrections from the ITP study and mitigations already provided through the 2024 TPL assessment. There were no remaining issues requiring mitigation identified with the retirement of Cunningham 2. These Planning Analysis results are only valid for the requested period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. If this time period is shifted or extended beyond what was studied, additional analysis will be required.

SPP staff performed the Analysis on Operational Models scope for the Interconnection Customer requested period of time between the EGF's requested retirement date of September 15, 2026, and the RGF's planned commercial operation date of April 01, 2027. Based on the findings of the Analysis on Operational Models, the date that the EGF ceases commercial operation should be delayed to late Q1 2027. In addition, the amount of planned or maintenance outages taken during the replacement time period may be reduced to maintain system reliability.

To maintain system reliability, SPS is willing to delay the planned retirement date of the EGF (Cunningham 2) from the proposed date of September 15, 2026 to late Q1 of 2027.

Analysis on Operational Models also showed that replacing Cunningham 2 with a solar resource, for periods without reliably forecasted or available fuel (e.g. wind and sunlight), will reduce or eliminate the necessary opportunities for planned maintenance outages for resources in the Southern SPS area. The Transmission Planner for this area is advised to consider these periods of reduced fuel along with resource maintenance requirements in its reliability plan.

Per Section 3.9.3 of Attachment V, Interconnection Customer requesting Generating Facility Replacement shall inform Transmission Provider within thirty (30) Calendar Days after having received results of the Replacement Impact Study and Reliability Assessment Study of its election to proceed and Transmission Provider will initiate an Interconnection Facilities Study or tender a draft GIA. Failure by the Interconnection Customer to provide an election to proceed within thirty (30) Calendar Days will result in withdrawal of the Interconnection Request pursuant to Section 3.7.

Consistent with the above and in accordance with Section 3 of the SPP Business Practices 7800, upon completion of the study, the Interconnection Customer may submit its retirement notice in accordance with the SPP Market Protocols and developed mitigation plans