GEN-2017-057

MODIFICATION REQUEST IMPACT STUDY

By SPP Generator Interconnection

Published on 04/16/2025

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
4/16/2025		Original Version	

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EXECUTIVE SUMMARY

1898 & Co., a part of Burns & McDonnell, was retained by the Southwest Power Pool (SPP) to perform a Modification Request Impact Study (Study) for GEN-2017-057, an active Generation Interconnection Request (GIR) with a Point of Interconnection (POI) at the Hosston Substation 69 kV bus in American Electric Power (AEP) control area.

The GEN-2017-057 project interconnects in the American Electric Power (AEP) control area with a capacity of 72.5 MW. This Study has been requested to evaluate the modification of GEN-2017-057 to change the solar inverters from Sungrow 3600UD-MV to Sungrow 4400UD-MW.

SPP determined that steady-state analysis was not required because the results of the previous DISIS analysis observed the maximum injection at the POI for GEN-2017-057. However, SPP determined that the change in inverters required short circuit and dynamic stability analysis.

The scope of this study included reactive power analysis, short circuit analysis, and dynamic stability analysis.

The detailed configuration is captured in Table 1 below.

Table 1: GEN-2017-057 Modification Request

Facility	Existing Configuration	Proposed Modified Configuration
Point of Interconnection	Hosston Substation 69 kV Bus	Hosston Substation 69 kV Bus
Configuration/Capacity	19 x Sungrow 3600UD-MV Inverters 3.6 MVA (Solar) = 72.5 MW	19 x Sungrow 4400UD-MV Inverters 4.4 MVA (Solar) = 72.5 MW
Generation Interconnection Line	Length = 1.5 miles	Length = 1.66 miles
	R = 0.005760 pu	R = 0.004079 pu
	X = 0.019810 pu	X = 0.023167 pu
	B = 0.000460 pu	B = 0.000510 pu
	Rating MVA = N/A MVA	Rating MVA = 104 MVA
Main Substation Transformer[1]	X = 3.4989% R = 0.0875% Voltage = 69/34.5 kV, Winding MVA = 80.0, Winding MVA Base= 48.00 MVA,	X = 9.0359% R = 0.2708% Voltage = 138/34.5 kV, Winding MVA = 80.0, Winding MVA Base= 48.00 MVA,
Equivalent GSU Transformer[1]	X = 5.7215%, R = 0.5721%, Voltage = 34.5/0.69 kV, Winding MVA = 75 MVA, Rating MVA = 87.5 MVA	X = 6.9653%, R = 0.6965%, Voltage = 34.5/0.60 kV, Winding MVA = 83.6 MVA, Rating MVA = 83.6 MVA
Equivalent Collector Line[2]	R = 0.003780 pu	R = 0.006830 pu
	X = 0.003900 pu	X = 0.008094 pu
	B = 0.006680 pu	B = 0.021950 pu

Generator Dynamic Model[3] & Power Factor	19 x Sungrow 3600UD-MV Inverters (Solar) (REGCAU1)[3] Leading: 0.95 Lagging: 0.95	19 x Sungrow 4400UD-MV Inverters (Solar) (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.

1898 & Co. performed the analyses using the study data provided for the SGF and the DISIS-2021-001 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 GEN-2017-057 project needed a 2.18 MVAr shunt reactor on the 34.5 kV bus of the project substation with the modifications in place. 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 stability model modified for short circuit analysis. The results from the short circuit analysis compared the 25SP model with the new inverters. The results from the short circuit analysis with the updated topology showed that the maximum GEN-2017-057 contribution to three-phase fault currents in the immediate transmission systems at or near the GEN-2017-057 POI was 6.4095 kA. The maximum three-phase fault current level within 5 buses of the POI with the new POI location was 17.5674 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 inverter change was about 3.97% and 0.229 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 25WP. 117 fault events were simulated, which included three-phase faults and single-line-to-ground stuck breaker faults.

The results of the dynamic stability analysis showed several existing base case issues that were found in both the original DISIS-2021-001 models and in the models with the GEN-2017-057

[1] Power System Simulator for Engineering

modification included. These issues were not attributed to the GEN-2017-057 modification request and are detailed in Appendix C.

There were no damping or voltage recovery violations attributed to the GEN-2017-057 modification request observed during simulated faults. A few faults showed other generator tripping issues which were also observed in the base cases. 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.

Based on the results of the study, SPP determined that the requested modification is **not a Material Modification**. The requested modification does not have a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date or negatively impact the reliability of the Transmission System. There were no additional Interconnection Facilities or Network Upgrades identified by the analyses.

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 a Modification Request Impact Study (Study) for GEN-2017-057. A Modification Request Impact Study is a generation interconnection study performed to evaluate the impacts of modifying the DISIS study assumptions. The determination of the required scope of the study is dependent upon the specific modification requested and how it may impact the results of the DISIS study. Impacting the DISIS results could potentially affect the cost or timing of any Interconnection Request with a later Queue priority date, deeming the requested modification a Material Modification. The criteria sections below include reasoning as to why an analysis was either included or excluded from the scope of study.

All analyses were performed using the Siemens PTI PSS/E version 34 software. The results of each analysis are presented in the following sections.

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 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 & STABILITY ANALYSIS

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

STEADY-STATE ANALYSIS

Steady-state analysis is performed if SPP deems it necessary based on the nature of the requested change. SPP determined that steady-state analysis was not required because the results of the previous DISIS analysis observed the maximum injection at the POI for GEN-2017-057.

STUDY LIMITATIONS

The assessments and conclusions provided in this report are based on assumptions and information provided to1898 & Co., a part of Burns & McDonnell, 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 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 MODIFICATION REQUEST

The GEN-2017-057 Interconnection Customer requested a modification to its Generation Interconnection Request (GIR) with a Point of Interconnection (POI) at the Hosston substation 69 kV bus in the American Electric Power (AEP) control area.

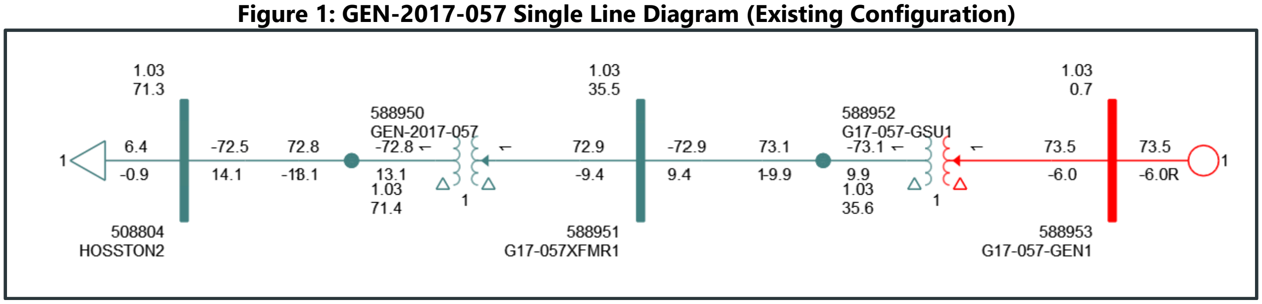
At the time of report posting, GEN-2017-057 is an active Interconnection Request with a queue status of "IA FULLY EXECUTED/ON SCHEDULE." GEN-2017-057 is a solar facility with a maximum summer and winter queue capacity of 72.5 MW with Energy Resource Interconnection Service (ERIS).

The GEN-2017-057 project is currently in the DISIS-2018-001 cluster. Figure 2-1 shows the power flow model single line diagram for the existing modeled GEN-2017-057 configuration using the DISIS-2021-001 25SP stability model.

This Study has been requested to evaluate the modification of GEN-2017-057 to change the inverter technology from (19) Sungrow 3600UD-MV inverters to (19) Sungrow 4400UD-MV inverters. In addition, modification request included changes to the gen-tie line, collector feeder configuration, substation main-power transformer, and generator step-up. The injection amount must be limited to 72.5 MW at the POI as listed in Appendix A of the GIA. As a result, the customer must make sure that the amount of power injected at the POI does not exceed the Interconnection Service amount listed in its GIA.

Figure 1 shows the power flow model single line diagram for the GEN-2017-057 facility. The existing configuration from the DISIS-2021-001 models and modified configuration for GEN-2017-057 are shown in Table 2 below.

Figure 1: GEN-2017-057 Single Line Diagram (Existing Configuration)



*based on the DISIS-2021-001 25SP stability models

Table 2: GEN-2017-057 Modification Request

Facility	Existing Configuration	Proposed Modified Configuration
Point of Interconnection	Hosston Substation 69 kV Bus	Hosston Substation 69 kV Bus
Configuration/Capacity	19 x Sungrow 3600UD-MV Inverters 3.6 MVA (Solar) = 72.5 MW	19 x Sungrow 4400UD-MV Inverters 4.4 MVA (Solar) = 72.5 MW
Generation Interconnection Line	Length = 1.5 miles	Length = 1.66 miles
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	Rating MVA = N/A MVA	Rating MVA = 104 MVA
Main Substation Transformer[1]	X = 3.4989% R = 0.0875% Voltage = 69/34.5 kV, Winding MVA = 80.0, Winding MVA Base= 48.00 MVA,	X = 9.0359% R = 0.2708% Voltage = 138/34.5 kV, Winding MVA = 80.0, Winding MVA Base= 48.00 MVA,
Equivalent GSU Transformer[1]	X = 5.7215%, R = 0.5721%, Voltage = 34.5/0.69 kV, Winding MVA = 75 MVA, Rating MVA = 87.5 MVA	X = 6.9653%, R = 0.6965%, Voltage = 34.5/0.60 kV, Winding MVA = 83.6 MVA, Rating MVA = 83.6 MVA
Equivalent Collector Line[2]	R = 0.003780 pu	R = 0.006830 pu
	X = 0.003900 pu	X = 0.008094 pu
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Generator Dynamic Model[3] & Power Factor	19 x Sungrow 3600UD-MV Inverters (Solar) (REGCAU1)[3] Leading: 0.95 Lagging: 0.95	19 x Sungrow 4400UD-MV Inverters (Solar) (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.

EXISTING VS MODIFICATION COMPARISON

To determine which analyses are required for the Study, the differences between the existing configuration from the DISIS-2021-001 models and the requested modification were evaluated. 1898 & Co. performed this comparison and the resulting analyses using a set of modified study models developed based on the modification request data and the DISIS-2021-001 study models. The analysis was completed using PSS/E version 34 software.

The methodology and results of the comparisons are described below.

STABILITY MODEL PARAMETER COMPARISON

SPP determined that short circuit and dynamic stability analyses were required because of the inverter change from Sungrow 3600UD-MV to Sungrow 4400UD-MV. This is because the short circuit contribution and stability responses of the existing configuration and the requested modification may differ. The generator dynamic model for the modification can be found in Appendix A.

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

EQUIVALENT IMPEDANCE COMPARISON CALCULATION

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

REACTIVE POWER ANALYSIS

The reactive power analysis was performed for GEN-2017-057 to determine the capacitive charging effects during reduced generation conditions (unsuitable wind speeds, unsuitable solar irradiance, insufficient state of charge, idle conditions, curtailment, etc.) at the generation site and to size shunt reactors that would reduce the project reactive power contribution to the POI to approximately zero.

METHODOLOGY AND CRITERIA

GEN-2017-057 generator was 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 reduce 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).

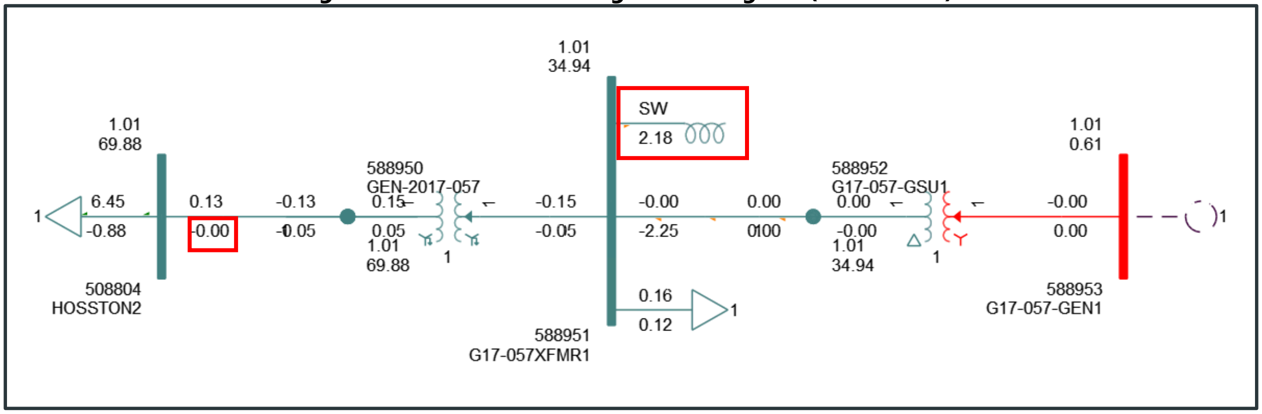
1898 & Co. performed the reactive power analysis using the modification request data based on the 25SP DISIS 2021-001 stability study model.

RESULTS

The results from the analysis showed that the GEN-2017-057 project needed approximately 2.18 MVAr of compensation at its collector substation to reduce the MVAr injection at the POI to zero. The MVAr injection at the POI with the GEN-2017-057 unit offline remained at zero. Figure 2 illustrates the GEN-2017-057 facility offline with zero MVAr at the POI.

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.

Figure 2: GEN-2017-057 Single Line Diagram (Shunt Sizes)



SHORT CIRCUIT ANALYSIS

1898 & CO. performed a short circuit study using the 25SP model for GEN-2017-057 to determine the maximum fault current requiring interruption by protective equipment for each bus in the relevant subsystem. 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 69 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, comparing the fault current levels between the existing configuration versus the modified configuration.

1898 & Co. created a short circuit model using the 25SP DISIS-2021-001 stability study model by adjusting the GEN-2017-003 short circuit parameters consistent with the submitted data. The adjusted parameters used in the short circuit analysis are shown in Table 3 below. No other changes were made to the model.

Table 3: Short Circuit Model Parameters*

Parameter	Value by Generator Bus#
	588953 (PV)
Machine MVA Base	83.60
R (pu)	0.000
X'' (pu)	0.800

*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-2017-057 POI bus (HOSSTON2 69 kV) fault current magnitudes for the comparison cases are provided in Table 5 showing a fault current of 6.4095 kA with the GEN-2017-057 project existing inverter configuration and 6.2997 kA with the GEN-2017-057 proposed modified inverter configuration. Table 6 shows the maximum fault current magnitudes and fault current increases with the GEN-2017-057 comparison cases.

The maximum fault current calculated within 5 buses of the POI was 17.5674 kA for the 25SP model. The maximum GEN-2017-057 contribution to three-phase fault currents was about 3.06% and -0.1765 kA.

Table 4: POI Short Circuit Comparison Results

Case	Existing Configuration (kA)	Proposed Modified Configuration (kA)	kA Change	%Change
25SP	6.4095	6.2997	0.1098	1.713%

Table 5: 25SP Short Circuit Comparison Results

Voltage (kV)	Max. Current (Existing & Proposed Inverter Modification) (kA)	Max kA Change	Max %Change
69	10.1217	-0.1765	-3.060%
115	N/A	N/A	N/A
138	17.5674	-0.0135	-0.077%
230	N/A	N/A	N/A
345	N/A	N/A	N/A
Max	**17.5674**	**-0.1765**	**-3.060%**

DYNAMIC STABILITY ANALYSIS

1898 & Co. performed a dynamic stability analysis to identify the impact of the modifications to GEN-2017-057. The analysis was performed according to SPP's Disturbance Performance Requirements. The modification details are described in Section 2.0 above and the dynamic modeling data is provided in Appendix A. The existing base case issues and simulation plots can be found in Appendix C.

METHODOLOGY AND CRITERIA

The dynamic stability analysis was performed using models developed with the requested GEN-2017-057 inverter change from (19) Sungrow 3600UD-MV to (19) Sungrow 4400UD-MV. This stability analysis was performed using Siemens PTI's PSS/E version 34.9.6 software.

The modifications requested for GEN-2017-057 project were used to create modified stability models for this impact study based on the DISIS-2021-001 stability study models:

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

The dynamic model data for the GEN-2017-057 project is provided in Appendix A. 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 modification 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 GEN-2017-057 and other current and prior queued projects in Group 4[2]. In addition, voltages of five (5) buses away from the POI of the GEN-2017-057 were monitored and plotted.

[2] Based on the DISIS-2021-001 Cluster Groups

FAULT DEFINITIONS

1898 & Co. developed fault events as required to study the modification. 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 p.u.. 117 faults were simulated for the Study and are listed and described in Appendix E. These contingencies were applied to the modified 25SP and 25 WP models.

RESULTS

Error! Reference source not found. shows the relevant results of the fault events simulated for each of the modified models. Existing DISIS base case issues are documented separately in Appendix C. The associated stability plots are also provided in Appendix C.

Table 6: GEN-2017-057 Dynamic Stability Results

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_507711_ARSHILL4-507710_ARSHILL2_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_507711_ARSHILL4-507742_MCWILLI4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507711_ARSHILL4-508806_LIEBERM4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507711_ARSHILL4-508808_LONGWD_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507731_FTHUMBG4-507711_ARSHILL4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507731_FTHUMBG4-507730_FTHUMBG2_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_507731_FTHUMBG4-507751_RDPOINT4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507731_FTHUMBG4-507755_S_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507745_NMARKET2-507710_ARSHILL2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507745_NMARKET2-508805_LIEBERM2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507750_RDPOINT2-507751_RDPOINT4_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_507751_RDPOINT4-507782_PROBSON4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507751_RDPOINT4-508811_NBENTON4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507782_PROBSON4-507751_RDPOINT4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507782_PROBSON4-507765_WALLAKE4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507782_PROBSON4-507792_WOODCHUCK4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_507782_PROBSON4-507792_WOODCHUCK4_Ckt2	Pass	Pass	Stable	Pass	Pass	Stable
P1_508055_BLOOMBG2-508058_IPC_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508055_BLOOMBG2-508089_WATLANT2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508055_BLOOMBG2-508804_HOSSTON2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_508058_IPC-508086_TEXARK_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508059_IPC-508075_REDSPRG4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508078_SETEXAR4-508054_BANN_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508078_SETEXAR4-508086_TEXARK_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508078_SETEXAR4-508105_MANDEVILTP4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508086_TEXARK-508058_IPC_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508086_TEXARK-508078_SETEXAR4_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508086_TEXARK-508081_SUGHLET2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508086_TEXARK-508083_TAYLOR_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508089_WATLANT2-508055_BLOOMBG2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508089_WATLANT2-508090_WATLANT4_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508089_WATLANT2-508291_HUGHES_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508090_WATLANT4-508089_WATLANT2_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508090_WATLANT4-508106_CASSTP4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508090_WATLANT4-508840_WILKES_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508106_CASSTP4-508059_IPC_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508106_CASSTP4-509668_ROACH_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508291_HUGHES-508089_WATLANT2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508291_HUGHES-508293_JENKNST2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508291_HUGHES-508296_LSSOUTH2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508556_MARSHAL2-508553_LONGVHT2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508556_MARSHAL2-508576_MARAUTO2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508556_MARSHAL2-508842_WOODLWN2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508556_MARSHAL2-509055_BLOCKRT2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508557_MARSHL-4-508562_PIRKEY_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508557_MARSHL-4-508576_MARAUTO2_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508557_MARSHL-4-508835_JEFFRSN4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508576_MARAUTO2-508557_MARSHL-4_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508803_GILLIAM2-508815_SUPEROR2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508804_HOSSTON2-508055_BLOOMBG2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508804_HOSSTON2-508803_GILLIAM2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508804_HOSSTON2-508815_SUPEROR2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508804_HOSSTON2-508818_MOTT_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508805_LIEBERM2-507745_NMARKET2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508805_LIEBERM2-508806_LIEBERM4_3Winding	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_508806_LIEBERM4-508808_LONGWD_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508808_LONGWD-507711_ARSHILL4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508808_LONGWD-507727_FLOURNY4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508808_LONGWD-508566_SABMINT4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508808_LONGWD-508809_LONGWD_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508809_LONGWD-337376_7SAREPTA%_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508809_LONGWD-507760_SW_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508809_LONGWD-508808_LONGWD_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508809_LONGWD-508841_WILKES_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508811_NBENTON4-507751_RDPOINT4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508811_NBENTON4-508818_MOTT_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508811_NBENTON4-588404_G16-167-TAP_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508815_SUPEROR2-508804_HOSSTON2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508815_SUPEROR2-508805_LIEBERM2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508815_SUPEROR2-508842_WOODLWN2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508818_MOTT-508804_HOSSTON2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508818_MOTT-508811_NBENTON4_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508836_KARNCKT2-508825_MVPIPET2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508836_KARNCKT2-508842_WOODLWN2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-508064_MUNZCTY4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-508297_LSSOUTH4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-508355_WELSHRE4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-508835_JEFFRSN4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-508841_WILKES_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-509407_WILKE1-1_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-509407_WILKE1-1_Ckt2	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-509408_WILKE2-1_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508840_WILKES-509408_WILKE2-1_Ckt2	Pass	Pass	Stable	Pass	Pass	Stable
P1_508841_WILKES-508072_NWTXARK7_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508841_WILKES-508359_WELSH_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508841_WILKES-508840_WILKES_3Winding	Pass	Pass	Stable	Pass	Pass	Stable
P1_508841_WILKES-509409_WILKE3-1_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508841_WILKES-509409_WILKE3-1_Ckt2	Pass	Pass	Stable	Pass	Pass	Stable
P1_508842_WOODLWN2-508556_MARSHAL2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_508842_WOODLWN2-508815_SUPEROR2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable

Fault ID	25SP			25WP		
	Voltage Violation	Voltage Recovery	Stable	Voltage Violation	Voltage Recovery	Stable
P1_508842_WOODLWN2-508836_KARNCKT2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_509668_ROACH-508106_CASSTP4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_509668_ROACH-509645_DUGLASV2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_509668_ROACH-509647_DARENCT2_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P1_588404_G16-167-TAP-508806_LIEBERM4_Ckt1	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-507731_FTHUMBG4	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-507745_NMARKET2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-507750_RDPOINT2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-507751_RDPOINT4	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-507782_PROBSON4	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508055_BLOOMBG2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508059_IPC	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508086_TEXARK	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508291_HUGHES	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508556_MARSHAL2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508576_MARAUTO2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508804_HOSSTON2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508805_LIEBERM2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508806_LIEBERM4	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508808_LONGWD	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508809_LONGWD	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508811_NBENTON4	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508815_SUPEROR2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508836_KARNCKT2	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508840_WILKES	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-508841_WILKES	Pass	Pass	Stable	Pass	Pass	Stable
P4_HOL-509668_ROACH	Pass	Pass	Stable	Pass	Pass	Stable

There were no damping or voltage recovery violations attributed to the GEN-2017-057 modification 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 are listed in Appendix D. 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.

MATERIAL MODIFICATION DETERMINATION

In accordance with Attachment V of SPP's Open Access Transmission Tariff, for modifications other than those specifically permitted by Attachment V, SPP shall evaluate the proposed modifications prior to making them and inform the Interconnection Customer in writing of whether the modifications would constitute a Material Modification. Material Modification shall mean (1) modification to an Interconnection Request in the queue that has a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date; or (2) planned modification to an Existing Generating Facility that is undergoing evaluation for a Generating Facility Modification or Generating Facility Replacement, and has a material adverse impact on the Transmission System with respect to: i) steady-state thermal or voltage limits, ii) dynamic system stability and response, or iii) short-circuit capability limit; compared to the impacts of the Existing Generating Facility prior to the modification or replacement.

RESULTS

SPP determined the requested modification is not a Material Modification based on the results of this Modification Request Impact Study. 1898 & Co. evaluated the impact of the requested modification on the prior study results. 1898 & Co. determined that the requested modification did not negatively impact the prior study dynamic stability and short circuit results, and the modifications to the project were not significant enough to change the previously studied steady-state conclusions.

This determination implies that any network upgrades already required by GEN-2017-057 would not be negatively impacted and that no new upgrades are required due to the requested modification, thus not resulting in a material adverse impact on the cost or timing of any other Interconnection Request with a later Queue priority date.