GEN-2016-043

Impact Restudy for Generator Modification

Published October 2019
By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
10/25/2019	SPP	Initial report issued.

CONTENTS

SUMMARY

The GEN-2016-043 Interconnection Customer has requested a modification to its 230 MW Interconnection Request. This system impact restudy was performed to determine the effects of changing turbines from 61 Vestas V136 3.6 MW and 3 Vestas V136 3.45 MW wind turbine generators (for a total of 229.95 MW) to 82 GE 127 2.8048 MW wind turbine generators (for a total of 229.99 MW). In addition, the modification request included changes to the collection system, generation interconnection line and the generator substation transformer. The point of interconnection (POI) for GEN-2016-043 remains at the Hoskins 345 kV Substation.

This study was performed by Aneden Consulting to determine whether the request for modification is considered Material. A short circuit analysis, a low-wind/no-wind condition analysis, and stability analysis was performed for this modification request. The study report follows this executive summary.

The generating facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VArs) in accordance with FERC Order 827. Additionally, the project will be required to install approximately 19.29 MVArs of reactor shunts on its substation 345 kV bus or provide an alternate means of reactive power compensation. This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during low-wind/no-wind conditions.

There were no other machine rotor angle damping or transient voltage recovery violations observed in the simulated fault events. Additionally, the project wind farm was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A. The requested modification is not considered Material.

It should be noted that this study analyzed the requested modification to change generator technology and layout. Powerflow analysis was not performed. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, 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.

A: CONSULTANT'S MATERIAL MODIFICATION STUDY REPORT

See next page for the Consultant's Material Modification Study report.

Submitted to
Southwest Power Pool

Report On

GEN-2016-043
Modification Request Impact Study

Revision R1

Date of Submittal
October 07, 2019

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Executive Summary

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to perform a Modification Request Impact Study (Study) for GEN-2016-043, an active generation interconnection request with a point of interconnection (POI) at the Hoskins 345 kV Substation.

The GEN-2016-043 project is proposed to interconnect in the Nebraska Public Power District (NPPD) control area with a capacity of 230 MW as shown in Table ES-1 below. This Study has been requested to evaluate the modification of GEN-2016-043 to change turbine configuration to a total of 82 x GE 127 2.805MW wind turbines for total capacity of 229.99 MW. In addition, the modification request included changes to the collection system, generation interconnection line and the generator substation transformer. The modification request changes are shown in Table ES-2 below.

Table ES-1: GEN-2016-043 Configuration

Request	Capacity (MW)	Existing Generator Configuration	Point of Interconnection
GEN-2016-043	230	61 x Vestas V136 3.6 MW + 3 x Vestas V136 3.45 MW	Hoskins 345 kV Substation (640226)

Table ES-2: GEN-2016-043 Modification Request

<table>
<tr><th>Facility</th><th colspan="2">Existing</th><th>Modification Request</th></tr>
<tr><td>Point of Interconnection</td><td colspan="2">Hoskins 345 kV Substation (640226)</td><td>Hoskins 345 kV Substation (640226)</td></tr>
<tr><td>Configuration/Capacity</td><td colspan="2">61 x Vestas V136 3.6MW + 3 x Vestas V136 3.45MW = 229.95 MW</td><td>82 x GE 127 2.8048 MW = 229.99 MW</td></tr>
<tr><td>Generation Interconnection Line</td><td colspan="2">Length = 3.7 miles
R = 0.000475 pu
X = 0.002031 pu
B = 0.018022 pu</td><td>Length = 0.67 miles
R = 0.000054 pu
X = 0.000343 pu
B = 0.005492 pu</td></tr>
<tr><td>Main Substation Transformer</td><td colspan="2">Z = 9%, Winding 161 MVA, Rating 269 MVA</td><td>Three winding Transformer:
Z12 = 9.5%, Z23 = 2.85%, Z13 = 14.25%, Rating 260 MVA</td></tr>
<tr><td>GSU Transformer</td><td>Gen 1 Equivalent Qty: 61:
Z = 8.97%, Rating 244 MVA</td><td>Gen 2 Equivalent Qty: 3:
Z = 8.97%, Winding 11.25 MVA, Rating 10.4 MVA</td><td>Gen Equivalent Qty: 82:
Z = 5.7%, Rating 266.5 MVA</td></tr>
<tr><td>Equivalent Collector Line</td><td colspan="2">R = 0.011520 pu
X = 0.014150 pu
B = 0.137810 pu</td><td>R = 0.006016 pu
X = 0.010184 pu
B = 0.185212 pu</td></tr>
<tr><td>Reactive Power Devices</td><td colspan="2">N/A</td><td>1 x 10 MVAR 34.5 kV Capacitor Bank</td></tr>
</table>

Aneden performed reactive power analysis, short circuit analysis, and dynamic stability analysis using the modification request data on the initial DISIS-2016-002-1 Group 9 study models. All analyses were performed using the PTI PSS/E version 33.7 software and the results are summarized below.

The DISIS-2016-002-1 Group 9 study models used in this Study included the following upgrades in the 2017WP, 2018SP and 2026SP models:

1. Keystone to Red Willow 345kV circuit #1
2. Red Willow to Post Rock 345kV circuit #1
3. Reroute Laramie River Station (GEN-2016-110-Tap) to Stegall 345kV circuit #1 through the GEN-2016-023-Tap

Two previously identified models in the DISIS-2016-002 report published on August 20, 2018 were <u>not</u> included in the DISIS-2016-002-1 Group 9 models used in this Study:

1. Grand Prairie to Antelope 345kV circuit #1
2. Keystone 345 kV +/-100 MVAR SVC (offline in models)

A power factor analysis was not performed as there was no change in the point of interconnection for GEN-2016-043.

The results of the reactive power analysis, also known as the low-wind/no-wind condition analysis, performed using the three main models showed that the GEN-2016-043 project may require a 19.29 MVAr shunt reactor on the 345kV bus of the project substation (with the collection system capacitor bank offline). The shunt reactor is needed to reduce the reactive power transfer at the POI to approximately zero during low/no wind conditions while the generation interconnection project remains connected to the grid.

The results from short circuit analysis showed that the maximum change in the fault currents in the immediate systems at or near GEN-2016-043 was approximately 0.95 kA for the 2018SP and 2026SP models, and 0.95 kA for the 2018SP and 2026SP GGS models. All three-phase current levels with the GEN-2016-043 generator online were below 43 kA for the 2018SP and 2026SP models, and below 43 kA for the 2018SP and 2026SP GGS models.

The dynamic stability analysis was performed using the six models 2017 Winter Peak, 2018 Summer Peak, 2026 Summer Peak, 2017 Winter Peak GGS, 2018 Summer Peak GGS, and 2026 Summer Peak GGS. Up to 71 contingencies were simulated, which included three-phase faults, three phase faults on prior outage cases, and single-line-to-ground faults and stuck breakers faults.

The results of the dynamic stability analysis showed that there were no machine rotor angle damping or transient voltage recovery violations observed in the simulated fault events associated with this modification request study. Additionally, the project wind farm was found to stay connected during the other contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

The results of this Study show that the GEN-2016-043 Modification Request does not constitute a material modification.

1.0 Introduction

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to perform a Modification Request Impact Study (Study) for GEN-2016-043, an active generation interconnection request with point of interconnection (POI) at the Hoskins 345 kV Substation.

The GEN-2016-043 project is proposed to interconnect in the Nebraska Public Power District (NPPD) control area with a combined capacity of 230 MW as shown in Table 1-1 below. Details of the modification request is provided in Section 2.0 below.

Table 1-1: Existing GEN-2016-043 Configuration

Request	Capacity (MW)	Existing Generator Configuration	Point of Interconnection
GEN-2016-043	230	61 x Vestas V136 3.6MW + 3 x Vestas V136 3.45MW	Hoskins 345 kV Substation (640226)

1.1 Scope

The Study included reactive power analysis, short circuit analysis, and dynamic stability analysis. The methodology, assumptions, and results of the analyses are presented in the following five main sections:

1. Project and Modification Request
2. Reactive Power Analysis
3. Short Circuit Analysis
4. Dynamic Stability Analysis
5. Conclusions

Aneden performed the analyses using a set of modified study models developed using the modification request data and the six DISIS-2016-002-1 study models:

1. 2017 Winter Peak (2017WP),
2. 2018 Summer Peak (2018SP),
3. 2026 Summer Peak (2026SP),
4. 2017 GGS Winter Peak Case (2017WP_GGS),
5. 2018 GGS Summer Peak Case (2018SP_GGS), and
6. 2026 GGS Summer Peak Case (2026SP_GGS).

The DISIS-2016-002-1 Group 9 study models used in this Study included the following upgrades:

1. Keystone to Red Willow 345kV circuit #1
2. Red Willow to Post Rock 345kV circuit #1
3. Reroute Laramie River Station (GEN-2016-110-Tap) to Stegall 345kV circuit #1 through the GEN-2016-023-Tap

Two previously identified models in the DISIS-2016-002 report published on August 20, 2018 were not included in the DISIS-2016-002-1 Group 9 models used in this Study:

1. Grand Prairie to Antelope 345kV circuit #1
2. Keystone 345 kV +/-100 MVAR SVC (offline in models)

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

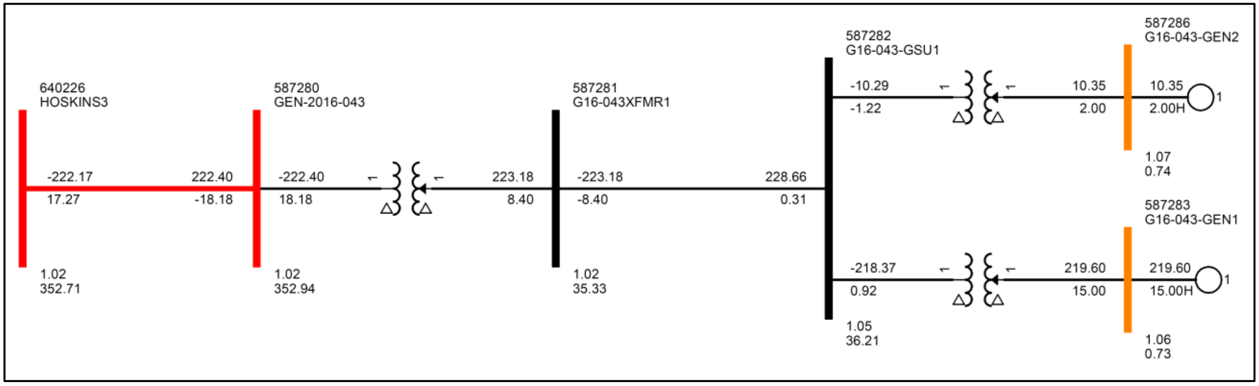
1.2 Study Limitations

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

2.0 Project and Modification Request

GEN-2016-043 was originally studied as part of Group 9 in the DISIS-2016-001 study cycle. Figure 2-1 shows the power flow model single line diagram for the existing GEN-2016-043 configuration.

Figure 2-1: GEN-2016-043 Single Line Diagram (Existing Configuration)



The GEN-2016-043 Modification Request included a turbine configuration change to a total of 82 x GE 127 2.8048MW wind turbines for a total capacity of 229.99 MW. In addition, the modification request also included changes to the collection system and the generator substation transformer. The major modification request changes are shown in Figure 2-2 and Table 2-1 below.

Figure 2-2: GEN-2016-043 Single Line Diagram (New Configuration)

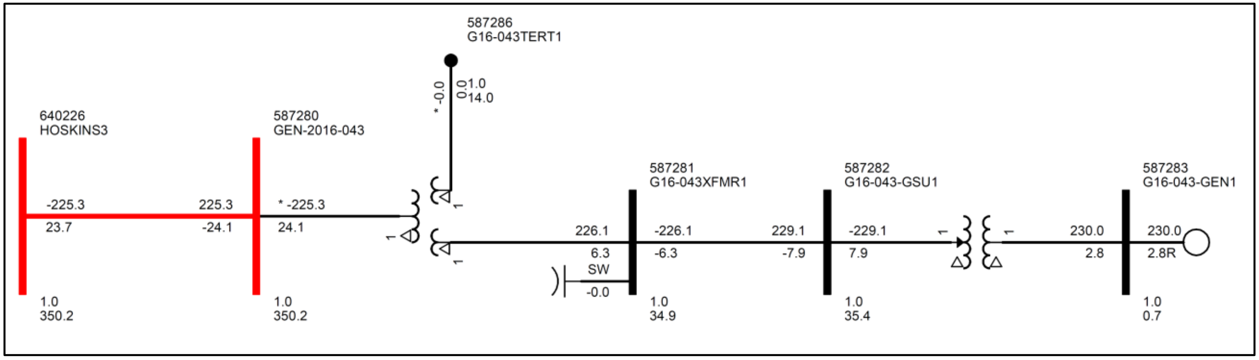


Table 2-1: GEN-2016-043 Modification Request

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</table>

3.0 Reactive Power Analysis

The reactive power analysis, also known as the low-wind/no-wind condition analysis, was performed for GEN-2016-043 to determine the reactive power contribution from the project's interconnection line and collector transformer and cables during low/no wind conditions while the project is still connected to the grid and to size shunt reactors that would reduce the project reactive power contribution at the POI to approximately zero.

3.1 Methodology and Criteria

For the GEN-2016-043 project, the generator was switched out of service while other collector system elements remained in-service. A shunt reactor was tested at the collection substation 345 kV bus to set the MVAr flow into the POI to approximately zero.

3.2 Results

The results from the reactive power analysis showed that the GEN-2016-043 project required an approximately 19.29 MVAr shunt reactor at the project substation, to reduce the POI MVAr to zero. Figure 3-1 illustrates the shunt reactor size required to reduce the POI MVAr to approximately zero. Reactive compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

Figure 3-1: GEN-2016-043 Single Line Diagram (Shunt Reactor)

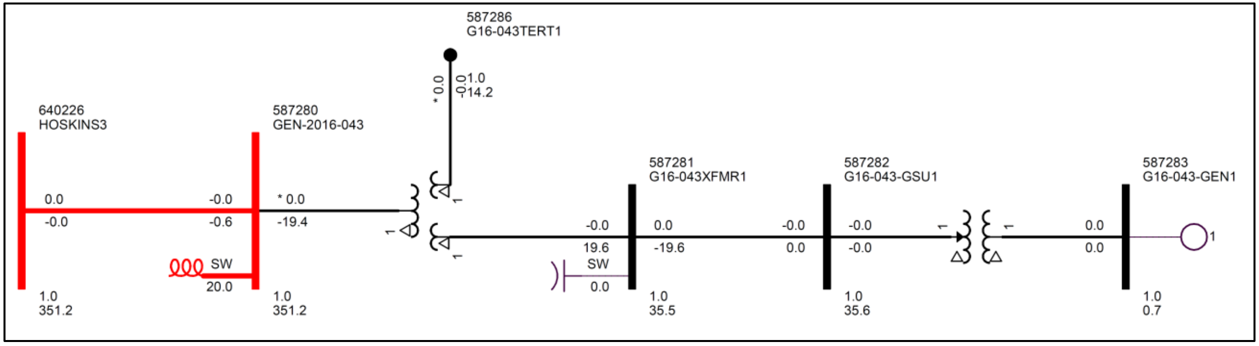

Table 3-1 shows the shunt reactor size determined for the three study models used in the assessment. Note that the 10 MVAR capacitor bank in the collections system was not dispatched.

Table 3-1: Shunt Reactor Size for Low Wind Study

Machine	POI Bus Number	POI Bus Name	Reactor Size (MVAr)		
			17WP	18SP	26SP
GEN-2016-043	640226	Hoskins 3	19.29	19.29	19.29

4.0 Short Circuit Analysis

A short-circuit study was performed using the 2018SP and 2026SP and the 2018SP GGS and 2026SP GGS models for GEN-2016-043. The detail results of the short-circuit analysis are provided in Appendix A.

4.1 Methodology

The short-circuit analysis included applying a 3-phase fault on buses up to 5 levels away from the 345 kV POI bus. The PSS/E "Automatic Sequence Fault Calculation (ASCC)" fault analysis module was used to calculate the fault current levels with and without the project online.

4.2 Results

The results of the short circuit analysis for the 2018SP and 2026SP models are summarized in Table 4-1 and Table 4-2 respectively. The maximum increase in fault current was about 8.2%, 0.95 kA. The maximum fault current calculated within 5 buses with GEN-2016-043 was less than 43 kA for the 2018SP and 2026SP models respectively.

Table 4-1: 2018SP Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
69	25.7	0.02	0.3%
115	36.4	0.45	2.6%
161	42.0	0.08	0.3%
230	20.2	0.28	2.9%
345	31.3	0.95	8.2%
Max	**42.0**	**0.95**	**8.2%**

Table 4-2: 2026SP Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
69	26.1	0.02	0.3%
115	36.7	0.45	2.5%
161	42.2	0.08	0.3%
230	19.8	0.28	2.8%
345	31.8	0.95	8.1%
Max	**42.2**	**0.95**	**8.1%**

The results of the short circuit analysis for the 2018SP and 2026SP GGS models are summarized in Table 4-3 and Table 4-4 respectively. The maximum increase in fault current was about 8.2%, 0.95 kA. The maximum fault current calculated within 5 buses with GEN-2016-043 was less than 43 kA for the 2018SP GGS and 2026SP GGS models.

Table 4-3: 2018SP GGS Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
69	25.6	0.02	0.3%
115	36.4	0.45	2.5%
161	41.9	0.08	0.3%
230	20.2	0.28	2.9%
345	31.3	0.94	8.2%
Max	**41.9**	**0.94**	**8.2%**

Table 4-4: 2026SP GGS Short Circuit Results

Voltage (kV)	Max. Current (kA)	Max kA Change	Max %Change
69	26.1	0.02	0.3%
115	36.7	0.45	2.5%
161	42.2	0.08	0.3%
230	19.8	0.28	2.8%
345	31.8	0.95	8.2%
Max	**42.2**	**0.95**	**8.2%**

5.0 Dynamic Stability Analysis

Aneden performed a dynamic stability analysis to identify the impact of the turbine configuration change and other modifications to the GEN-2016-043 project. The analysis was performed according to SPP's Disturbance Performance Requirements shown in Appendix B. The modification details are described in Section 2.0 above and the dynamic modeling data is provided in Appendix C. The simulation plots can be found in Appendix D.

5.1 Methodology and Criteria

The dynamic stability analysis was performed using models developed with the requested 82 x GE 127 2.8048 MW turbines configuration for the GEN-2016-043 generating facilities. This stability analysis was performed using PTI's PSS/E version 33.7 software.

The stability models were developed using the models from DISIS-2016-002-1 for Group 9. The modifications requested to project GEN-2016-043 were used to create modified stability models for this impact study.

The modified dynamics model data for GEN-2016-043 is provided in Appendix C. The modified power flow models and associated dynamics database were initialized (no-fault test) to confirm that there were no errors in the initial conditions of the system and the dynamic data.

During the fault simulations, the active power (PELEC), reactive power (QELEC), and terminal voltage (ETERM) were monitored for GEN-2016-043 and other equally and prior queued projects in Group 9. In addition, voltages of five (5) buses away from the POI of GEN-2016-043 were monitored and plotted. The machine rotor angle for synchronous machines and speed for asynchronous machines within this study area including 534 (SUNC), 536 (WERE), 540 (GMO), 541 (KCPL), 635 (MEC), 640 (NPPD), 645 (OPPD), 650 (LES), 652 (WAPA), were monitored. In addition, the voltages of all 100 kV and above buses within the study area were monitored.

5.2 Fault Definitions

Aneden simulated the faults previously simulated for GEN-2016-043 and selected additional fault events for GEN-2016-043 as required. The new set of faults were simulated using the modified study models. The fault events included three-phase faults, three-phase faults on prior outage cases, and single-line-to-ground faults with stuck breakers. The simulated faults are listed and described in Table 5-1 below. These contingencies were applied to the modified 2017 Winter Peak, 2018 Summer Peak, and the 2026 Summer Peak models (including the GGS models).

Table 5-1: Fault Definitions

Fault ID	Fault Descriptions
FLT89-3PH	3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT90-3PH	3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT91-3PH	3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT92-3PH	3 phase fault on the Hoskins 345/230/13.8kV (640226)(640227)(643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT93-3PH	3 phase fault on the Hoskins 345/115/13.8kV (640226)(640228)(640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT94-3PH	3 phase fault on the Raun (635200) to Sioux City (652564) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT96-3PH	3 phase fault on the Raun (635200) to S3451 (645451) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT98-3PH	3 phase fault on the Raun 345/161kV (635200) (635201) transformer, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT100-3PH	3 phase fault on the Shell Creek (640342) to Columbus (640125) 345kV line circuit 1, near Shell Creek. a. Apply fault at the Shell Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT101-3PH	3 phase fault on the Shell Creek 345/230/13.8kV (640342) (640343) (643136) transformer, near Shell Creek. a. Apply fault at the Shell Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT102-3PH	3 phase fault on the Antelope 345/115/13.8kV (640520) (640521) (640524) transformer, near Antelope. a. Apply fault at the Antelope 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT103-3PH	3 phase fault on the Hoskins 230/115/13.8kV (640227) (640228) (643083) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT104-3PH	3 phase fault on the Hoskins (640227) to G10-051-Tap (560347) 230kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

Table 5-1 continued

Fault ID	Fault Descriptions
FLT105-3PH	3 phase fault on the Hoskins (640228) to Norfolk (640298) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
FLT106-3PH	3 phase fault on the Hoskins (640228) to Belden (640080) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
FLT107-3PH	3 phase fault on the Hoskins (640228) to Norfolk North (640296) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
FLT108-3PH	3 phase fault on the Hoskins (640228) to Stanton West (640363) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
FLT109-SB	**Hoskins 345 kV (640226) Stuck Breaker Scenario 1** a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) – Shell Creek (640342) 345kV d. Hoskins 345/230/13.8kV (640226) (640227) (643082) transformer
FLT110-SB	**Hoskins 345 kV (640226) Stuck Breaker Scenario 2** a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) – Shell Creek (640342) 345kV d. Hoskins (640226) – Antelope (640520) 345kV
FLT111-SB	**Hoskins 345 kV (640226) Stuck Breaker Scenario 3** a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins 345/230/13.8kV (640226) (640227) (643082) transformer d. Hoskins 345/115/13.8kV (640226) (640228) (640231) transformer
FLT1001-SB	**Stuck Breaker at Antelope 3 (640520)** a. Apply single phase fault at faulted bus. b. Clear fault after 16 cycles and trip the following elements c. Antelope 3 345kV bus
FLT1002-SB	**Stuck Breaker at Shell Creek (640342)** a. Apply single phase fault at faulted bus. b. Clear fault after 16 cycles and trip the following elements c. Shell Creek 345kV bus
FLT1003-SB	**Stuck Breaker at Hoskins 7 (640228)** a. Apply single phase fault at faulted bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins 7 115kV bus
FLT1004-SB	**Stuck Breaker at Hoskins 4 (640227)** a. Apply single phase fault at faulted bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins 4 230kV bus

Table 5-1 continued

Fault ID	Fault Descriptions
FLT1005-SB	**Stuck Breaker at Raun 3 (635200)** a. Apply single phase fault at faulted bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) to Raun (635200) 345kV line circuit 1 d. Raun (635200) to S3451 (645451) 345kV line circuit 1
FLT9001-3PH	3 phase fault on the Columbus (640125) to NW68HOLDRG3 (650114) 345 kV line circuit 1, near Columbus. a. Apply fault at the Columbus 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT9002-3PH	3 phase fault on the Shell Creek (640343) to Columbus (640133) 230 kV line circuit 1, near Shell Creek. a. Apply fault at the Shell Creek 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT9003-3PH	3 phase fault on the Columbus (640133) to E.Col.4 (640126) 230 kV line circuit 1, near Columbus. a. Apply fault at the Columbus 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT9004-3PH	3 phase fault on the Columbus (640133) to Columbus W4 (640131) 230 kV line circuit 1, near Columbus. a. Apply fault at the Columbus 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT9005-3PH	3 phase fault on the Columbus (640133) to Meadow Grove (640540) 230 kV line circuit 1, near Columbus. a. Apply fault at the Columbus 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT9006-3PH	3 phase fault on the G10-051-TAP (560347) to Twin (640386) 230 kV line circuit 1, near G10-051-TAP. a. Apply fault at the G10-051-TAP 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT9007-3PH	3 phase fault on the Twin (640386) to Sioux City (652565) 230 kV line circuit 1, near Twin. a. Apply fault at the Twin 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT9008-3PH	3 phase fault on SIOUXCY3 345 kV (652564) to SIOUXCY4 230kV (652565) to SIOUXC29 13.8 kV (652305) XFMR, near SIOUXCY3 345 kV. a. Apply fault at the SIOUXCY3 345 kV bus. b. Clear fault after 6 cycles and trip the faulted transformer.
FLT9009-3PH	3 phase fault on SIOUXCY3 345 kV (652564) to SIOUXCY4 230kV (652565) to SIOUXC19 13.8 kV (652304) XFMR, near SIOUXCY3 345 kV. a. Apply fault at the SIOUXCY3 345 kV bus. b. Clear fault after 6 cycles and trip the faulted transformer.
FLT9010-3PH	3 phase fault on the Sioux City (652564) to Sioux City LNX3 (652864) 345 kV line circuit Z, near Sioux City. a. Apply fault at the Sioux City 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.

Table 5-1 continued

Fault ID	Fault Descriptions
FLT9011-3PH	3 phase fault on the Raun (635200) to J506 POI (65400) 345 kV line circuit 1, near Raun. a. Apply fault at the Raun 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9012-3PH	3 phase fault on the J506 POI (65400) to Highland (635400) 345 kV line circuit 1, near J506 POI. a. Apply fault at the J506 POI 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9013-3PH	3 phase fault on the Highland (635400) to OBrien (635368) 345 kV line circuit 1, near Highland. a. Apply fault at the Highland 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9014-3PH	3 phase fault on the J506 POI (65400) to A345 (15010) 345 kV line circuit 1, near J506 POI. a. Apply fault at the J506 POI 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. Trip the generator. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9015-3PH	3 phase fault on the Raun (635200) to J412 POI (55201) 345 kV line circuit 1, near Raun. a. Apply fault at the Raun 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9016-3PH	3 phase fault on the J412 POI (55201) to IDA CO 3 (635206) 345 kV line circuit 1, near J412 POI. a. Apply fault at the J412 POI 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9017-3PH	3 phase fault on the IDA CO 3 (635206) to J535 POI (66201) 345 kV line circuit 1, near IDA CO 3. a. Apply fault at the IDA CO 3 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9018-3PH	3 phase fault on the J535 POI (66201) to Lehigh (636010) 345 kV line circuit 1, near J535 POI. a. Apply fault at the J535 POI 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9019-3PH	3 phase fault on the J535 POI (66201) to J535 (66202) 345 kV line circuit 1, near J535 POI. a. Apply fault at the J535 POI 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. Trip the generator. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 6 cycles, then trip the line in (b) and remove fault.
FLT9020-3PH	3 phase fault on Columbus E3 345 kV (640125) to Columbus E7 115 kV (640127) to Columbus T9 13.8 kV (640129) XFMR, near Columbus E3 345 kV. a. Apply fault at the Columbus E3 345 kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT9021-3PH	3 phase fault on the Hoskins4 (640227) to Hoskins T89 (640230) 230/34.5 kV transformer near Hoskins4. a. Apply fault at the Hoskins4 230/34.5 kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

Table 5-1 continued

Fault ID	Fault Descriptions
FLT9022-3PH	3 phase fault on Raun 3 345 kV (635200) to Raun 5 161 kV (635201) to Raun XT9 13.8 kV (635205) XFMR, near Raun 3 345 kV. a. Apply fault at the Raun 3 345 kV bus. b. Clear fault after 6 cycles and trip the faulted transformer.
FLT9023-3PH	3 phase fault on the Raun 3 (635200) to Neal 3G (635213) 345/22 kV transformer, near Raun 3. a. Apply fault at the Raun 3 345/22 kV bus. b. Clear fault after 6 cycles by tripping the faulted line, remove generator.
FLT9024-3PH	3 phase fault on the Raun 3 (635200) to Neal 4G (635214) 345/24 kV transformer, near Raun 3. a. Apply fault at the Raun 3 345/24 kV bus. b. Clear fault after 6 cycles by tripping the faulted line, remove generator.
FLT9025-3PH	3 phase fault on the G10-051-TAP (560347) to G10-051&1127 (580011) 230 kV line circuit 1, near G10-051-TAP. a. Apply fault at the G10-051-TAP 230 kV bus. b. Clear fault after 6 cycles by tripping the faulted line. Trip generators.
FLT9026-3PH	3 phase fault on the J412 POI (55201) to J412 T1 (55202) 345/34.5 kV transformer, near J412 POI. a. Apply fault at the J412 POI 345 kV bus. b. Clear fault after 6 cycles by tripping the faulted line, remove generator.
FLT91-PO2	**Prior Outage of Hoskins (640226) to Antelope (640520) 345 kV Circuit 1;** 3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT91-PO3	**Prior Outage of Hoskins 345/230/13.8 kV (640226) (640227) (643082) Transformer;** 3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT91-PO4	**Prior Outage of Hoskins 345/115/13.8kV (640226) (640228) (640231) Transformer;** 3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT91-PO5	**Prior Outage of Hoskins (640226) to Shell Creek (640342) 345kV Circuit 1;** 3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT89-PO1	**Prior Outage of Hoskins (640226) to Raun (635200) 345kV Circuit 1;** 3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT89-PO3	**Prior Outage of Hoskins 345/230/13.8 kV (640226) (640227) (643082) Transformer;** 3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Table 5-1 continued

Fault ID	Fault Descriptions
FLT89-PO4	**Prior Outage of Hoskins 345/115/13.8kV (640226) (640228) (640231) Transformer;** 3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT89-PO5	**Prior Outage of Hoskins (640226) to Shell Creek (640342) 345kV Circuit 1;** 3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT92-PO1	**Prior Outage of Hoskins (640226) to Raun (635200) 345kV Circuit 1;** 3 phase fault on the Hoskins 345/230/13.8kV (640226) (640227) (643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT92-PO2	**Prior Outage of Hoskins (640226) to Antelope (640520) 345 kV Circuit 1;** 3 phase fault on the Hoskins 345/230/13.8kV (640226) (640227) (643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT92-PO4	**Prior Outage of Hoskins 345/115/13.8kV (640226)(640228)(640231) Transformer;** 3 phase fault on the Hoskins 345/230/13.8kV (640226)(640227)(643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT92-PO5	**Prior Outage of Hoskins (640226) to Shell Creek (640342) 345kV Circuit 1;** 3 phase fault on the Hoskins 345/230/13.8kV (640226) (640227) (643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT93-PO1	**Prior Outage of Hoskins (640226) to Raun (635200) 345kV Circuit 1;** 3 phase fault on the Hoskins 345/115/13.8kV (640226) (640228) (640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT93-PO2	**Prior Outage of Hoskins (640226) to Antelope (640520) 345 kV Circuit 1;** 3 phase fault on the Hoskins 345/115/13.8kV (640226) (640228) (640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT93-PO3	**Prior Outage of Hoskins 345/230/13.8 kV (640226) (640227) (643082) Transformer;** 3 phase fault on the Hoskins 345/115/13.8kV (640226) (640228) (640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT93-PO5	**Prior Outage of Hoskins (640226) to Shell Creek (640342) 345kV Circuit 1;** 3 phase fault on the Hoskins 345/115/13.8kV (640226) (640228) (640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT90-PO1	**Prior Outage of Hoskins (640226) to Raun (635200) 345kV Circuit 1;** 3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT90-PO2	**Prior Outage of Hoskins (640226) to Antelope (640520) 345 kV Circuit 1;** **3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins.** **a. Apply fault at the Hoskins 345kV bus.** **b. Clear fault after 5 cycles by tripping the faulted line.**

Table 5-1 continued

Fault ID	Fault Descriptions
FLT90-PO3	**Prior Outage of Hoskins 345/230/13.8 kV (640226) (640227) (643082) Transformer;** 3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT90-PO4	**Prior Outage of Hoskins 345/115/13.8kV (640226) (640228) (640231) Transformer;** 3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

5.3 Results

Table 5-2 shows the results of the fault events simulated for each of the models. The associated stability plots are provided in Appendix D. The results of the dynamic stability analysis showed that there were no machine rotor angle damping or transient voltage recovery violations observed in the simulated fault events associated with this modification request study. Additionally, the project wind farm was found to stay connected during the other contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

Table 5-2: GEN-2016-043 Dynamic Stability Results

Fault ID	17W & 17W_GGS			18S & 18S_GGS			26S & 26S_GGS		
	Volt. Recovery	Volt. Violation	Stable	Volt. Recovery	Volt. Violation	Stable	Volt. Recovery	Volt. Violation	Stable
FLT89-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT90-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT91-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT92-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT93-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT94-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT96-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT98-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT100-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT101-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT102-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT103-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT104-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT105-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT106-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT107-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT108-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT109-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT110-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT111-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1001-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1002-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1003-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1004-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT1005-SB	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9001-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable

Table 5-2 continued

Fault ID	17W & 17W_GGS			18S & 18S_GGS			26S & 26S_GGS		
	Volt. Recovery	Volt. Violation	Stable	Volt. Recovery	Volt. Violation	Stable	Volt. Recovery	Volt. Violation	Stable
FLT9002-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9003-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9004-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9005-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9006-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9007-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9008-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9009-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9010-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9011-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9012-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9013-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9014-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9015-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9016-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9017-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9018-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9019-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9020-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9021-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9022-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9023-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9024-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9025-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT9026-3PH	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT91-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT91-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT91-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT91-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT89-PO1	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT89-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT89-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT89-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT92-PO1	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT92-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT92-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT92-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT93-PO1	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT93-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT93-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT93-PO5	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT90-PO1	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT90-PO2	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT90-PO3	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable
FLT90-PO4	Pass	Pass	Stable	Pass	Pass	Stable	Pass	Pass	Stable

6.0 Conclusions

The Interconnection Customer for GEN-2016-043 requested a Modification Request Impact Study to assess the impact of the turbine and facility changes to a configuration with a total of 82 x GE 127 2.8048 MW wind turbines for total capacity of approximately 230 MW. In addition, the modification request included changes to the collection system, generation interconnection line and the generator substation transformer.

The DISIS-2016-002-1 Group 9 study models used in this Study included the following upgrades in the 2017WP, 2018SP and 2026SP models:

1. Keystone to Red Willow 345kV circuit #1
2. Red Willow to Post Rock 345kV circuit #1
3. Reroute Laramie River Station (GEN-2016-110-Tap) to Stegall 345kV circuit #1 through the GEN-2016-023-Tap

Two previously identified models in the DISIS-2016-002-1 report published on August 20, 2018 were not included in the DISIS-2016-002-1 Group 9 used in this Study:

3. Grand Prairie to Antelope 345kV circuit #1
4. Keystone 345 kV +/-100 MVAR SVC (offline in models)

A power factor analysis was not performed as there was no change in the point of interconnection for GEN-2016-043.

The results of the reactive power analysis, also known as the low-wind/no-wind condition analysis, performed using all three models showed that the combined GEN-2016-043 project may require a 19.29 MVAr shunt reactor on the 345kV bus of the project substation. The shunt reactor is needed to reduce the reactive power transfer at the POI to approximately zero during low/no wind conditions while the generation interconnection project remains connected to the grid.

The results from short circuit analysis showed that the maximum change in the fault currents in the immediate systems at or near GEN-2016-043 was approximately 0.95 kA for the 2018SP and 2026SP cases, and 0.95 kA for the 2018SP and 2026SP GGS cases. All three-phase current levels with the GEN-2016-043 generator online were below 43 kA for the 2018SP models and 2026SP, and below 43 kA for the 2018SP and 2026SP GGS models.

The results of the dynamic stability analysis showed that there were no machine rotor angle damping or transient voltage recovery violations observed in the simulated fault events associated with this modification request study. Additionally, the project wind farm was found to stay connected during the other contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

The results of this Study show that the GEN-2016-043 Modification Request does not constitute a material modification.