GEN-2016-050

Limited Operation Interconnection System Impact Study

Posted May 2021

By Generator Interconnection

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
5/3/2021	Generator Interconnection	Initial Posting of GEN-2016-050 Limited Operation Study; power flow analysis performed by SPP staff and stability analysis performed by Siemens PTI

CONTENTS

EXECUTIVE SUMMARY

The GEN-2016-050 Interconnection Customer has requested, in accordance with GIA Article 5.9, operational studies be performed to determine the extent that the Generating Facility may operate under "Limited Operation" prior to the completion of the Previous Network Upgrades: SPP-NTC-200220 – (R-Plan) transmission circuits.

DISIS-2016-001-4, the latest restudy to evaluate this request, included both power flow analysis and stability analysis for Cluster Group 9. Power flow analysis identified that with all Base Case upgrades in-service, including the R-Plan transmission circuits, that there are no thermal or voltage constraints for which GEN-2016-050 met the criteria to require mitigation.

The DISIS-2016-001-4 stability analysis was performed with the all Base Case and other identified upgrades from the prior restudy DISIS-2016-001-1 in-service and identified additional upgrades. These upgrades include:

- SPP-NTC-200220[1] & SPP-NTC-200277 – (R-Plan)
    - Thedford 345 kV substation
    - Thedford 345/115/13.8 kV transformer circuit #1
    - Gentleman to Thedford 345 kV circuit #1
    - Holt County to Thedford 345 kV circuit #1
    - Holt County 345 kV station
- Gerald Gentleman Station to Keystone 345 kV circuit #2
- Keystone to Sidney (alternate upgrade for Keystone to Banner County 345 kV circuit with reduced route due to withdrawal of GEN-2016-034 from DISIS2016-001) 345 kV circuit #2
- Reroute the Laramie River Station to Stegall 345 kV line through the GEN-2016-023 Substation and equipment necessary to achieve a fault clearing within 5 cycles.

With the exception of the R-Plan, each of these identified upgrades were solely assigned to two other equally queued requests, GEN-2016-023 & GEN-2016-029, which are currently withdrawn. However, the entire R-Plan project remained identified for GEN-2016-050 as incorporated into the GIA.

To evaluate system conditions prior to the in-service date of any of the identified upgrades, except the Holt County 345 kV station without the transmission circuits, SPP staff performed power flow analysis and, at the direction of SPP, Siemens PTI performed stability analysis. The power flow analysis report is attached to this report in .xlsx format. The stability analysis report, without plots, is appended to this document. The Siemens PTI stability analysis report with result plots is available from SPP upon request.

[1] The former identification of "Cherry County" station has been updated to "Thedford" station

Power flow analysis identified that with all Base Case upgrades in-service, excluding the R-Plan transmission circuits, that there are no thermal or voltage constraints for which GEN-2016-050 met the criteria to require mitigation.

Stability analysis identified instability for several faults near Laramie River Station 345 kV and Gerald Gentleman Station 345 kV using typical fault clearing durations.

In coordination with the facility owners, Basin Electric Power Cooperative (BEPC) and Nebraska Public Power District (NPPD), SPP has identified that existing transmission facilities provide clearing of each studied fault event within the study identified stable durations. System stability is maintained for analysis with fault clearing durations adjusted from typical to actual equipment values.

The study performed indicates that the GEN-2016-050 generating facility may reliably operate under Limited Operation at up to the requested capacity of 250.7 MW under Energy Resource Interconnection Service prior to the completion of the R-Plan transmission circuits.

It should be noted that while this study analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, it is likely that the Customers may be required to reduce their generation output to **0 MW** 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.

Siemens PTI Report Number: R132-20

Limited Operation Impact Study Report for GEN-2016-050

Prepared for

Southwest Power Pool

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Revision History

Date	Rev.	Description
April 14, 2021	2	Revised report with additional requested analysis
March 1, 2021	1	Revised report with additional requested analysis
October 13, 2020	0	Initial draft for review

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Executive Summary

This report presents the results of a generator interconnection Limited Operation study for GEN-2016-050. The project is a 250.7 MW wind farm located in Webster and Franklin Counties, Nebraska. It is queued to SPP's DISIS-2016-001 study that analyzed the impact of interconnection of this and other queued generation projects on SPP's system.

The DISIS-2016-001-4 report concluded that the project's interconnection is contingent upon a previously allocated upgrade, the R-plan, which was included as a base case upgrade in DISIS-2016-001 studies as mitigation of constraints observed in the stability analysis in higher queued DISIS. This study aims to re-evaluate the network with topology changes to consider only existing facilities by removing unbuilt facilities associated with recent queue withdrawals and examine if the project's operation should remain contingent upon the completion of the R-plan or if that restriction may be removed.

The DISIS-2016-001-4 Cluster Group 9 stability package provided by SPP was adjusted by Siemens PTI and then used to perform this analysis. The simulations were performed for a total of six cases – 2017 Winter Peak, 2018 Summer Peak and 2026 Summer Peak with normal SPP GI study Group dispatch as well as the GGS stability interface dispatch to evaluate the Gerald Gentleman Station registered NERC flowgate #6006. No-fault runs were simulated to ensure a stable and damped response from the stability models.

A total of 14 severe faults were selected for this analysis on the basis of the stability results in the DISIS-2016-001-4 Cluster Group 9 report and the topology changes implemented by Siemens PTI. 67 additional faults were added for locations close to the point of interconnection. Standard screening clear times and fault admittances were utilized to study these events. Twenty-second simulations were run for these faults for each of the six cases. The majority of the screening faults simulated in DISIS-2016-001-4 show a stable response with the updated study models.

A few of the screening faults exhibit instability, primarily for the GGS stability interface dispatch, similar to the response described in the DISIS-2016-001-4 report. Actual study clearing times for several faults were received from BEPC and NPPD subsequent to the initial analysis which was performed with the generic screening clearing times and SLG fault value calculation methodology supplied by SPP. All of these events were re-simulated and the simulations showed a stable response with the BEPC and NPPD provided actual equipment fault clearing times for planning studies. The Interconnection of GEN-2016-050 is not contingent on the completion of the R-plan based on the results of this stability analysis.

Section

1

Introduction

Siemens PTI was retained by the GEN-2016-50 interconnection customer and provided direction by Southwest Power Pool to perform a generator interconnection system impact restudy for Limited Operation of GEN-2016-050. The project has been studied by SPP in a Definitive Interconnection System Impact Study, series 2016-001. The latest revision of this report, DISIS-2016-001-4 (Group 8 and 9 Restudy)[1], published on April 24, 2019 was used as a basis for this study.

This DISIS-2016-001-4 report analyzes the impact of adding new generation in Groups 8 and 9 totaling 2634.80MW to the SPP system. Based on the conclusions in the study report, the interconnection of GEN-2016-050 is contingent upon the completion of the R-plan. The R-plan, also referred to as a subset of SPP-NTC-200220, which includes the following major upgrades to the SPP system:

1. Building a new 222-mile, 345 kV line from Gentleman - Thedford - Holt Co[2].
2. Building new 345 kV substation at Thedford.
3. Terminal upgrades at Gentleman.

Note that the Holt County 345 kV substation is included in the Limited Operation study as a line sectionalizing station along the Grand Island to Grand Prairie 345 kV circuit to provide interconnection for higher queued request GEN-2015-023. The circuit from Holt County to Thedford 345 kV was not in-service.

This study re-evaluated the inclusion of the R-plan in the base case used for the stability analysis to determine if the R-plan is required for this project to interconnect and if any limit to the power output is needed to maintain system stability. This was accomplished by performing the stability analysis without the R-plan.

The stability package (MDWG16_DIS16014_G09.zip) provided by SPP was used for this study. The study was performed for 3 seasons similar to the DISIS-2016-001-4 report.

1. 2017 Winter Peak
2. 2018 Summer Peak
3. 2026 Summer Peak

[1] The report is available on SPP website at http://opsportal.spp.org/documents/studies/files/2016_Generation_Studies/DISIS-2016-001-4_Final_Rev2.pdf

[2] Note that in the DISIS report, the Thedford substation is given the name Cherry County consistent with NTC 200220 available on the SPP website at https://spp.org/document/19258/ntc%20200220%20-%20nebraska%20public%20power%20district.pdf

In addition to the normal Cluster Group 9 dispatch cases, the three seasons were also simulated for the GGS stability interface dispatches as a part of this study. The analysis was performed using PSS®E version 33.12.2 software. The methodology and results of the simulations are described in following sections.

Section

2

Stability Model

2.1 PSS®E Model

GEN-2016-050 is a 250.7 MW wind facility comprised of 109 GE 2.3 MW wind turbine generators that interconnects at a new 345 kV substation that sectionalizes the Axtell and Post Rock 345 kV circuit within NPPD's transmission system Figure 2-1 shows the power flow model of the project as modeled in the stability package used for this study. The load flow and the dynamic model data is presented in Appendix A.

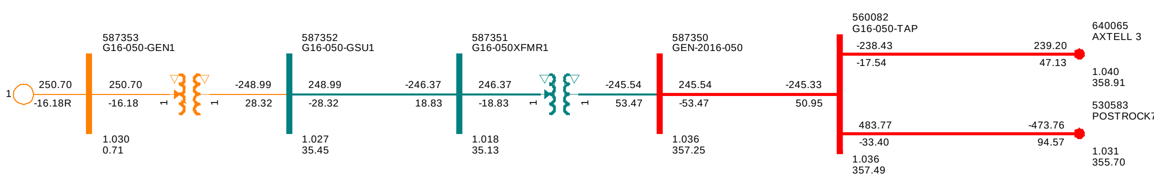

Figure 2-1. Power flow one-line diagram for GEN-2016-050

2.2 Model Updates

To reflect the developments since the DISIS-2016-001-4 study, changes were made by Siemens PTI to the stability models used for this study.

Previously queued units GEN-2016-023 and GEN-2016-029 have been turned off in the model since these projects have been withdrawn from the queue. Consequently, the GEN-2016-023 interconnection substation sectionalizing the Laramie to Sidney 345 kV circuit has also been removed from the cases. The existing configuration of the 345 kV Laramie to Sidney line was modeled in the case. With the withdrawal of these projects, it was concluded the upgrades allocated to these projects should also be removed. So, the second 345 kV line from Gentleman substation to Keystone was turned off to reflect this change. Additionally, the DISIS-2016-001 assigned Keystone to Banner County 345 kV circuit (DISIS-2016-001-1), Keystone to Sidney 345 kV circuit #2 (DISIS-2016-001-4) and reroute of Laramie to Stegall 345 kV through the GEN-2016-023 interconnection station (DISIS-2016-001-4) were confirmed to be removed from the cases. Furthermore, the stuck breaker, P4 planning event, involving the Gerald Gentleman Station shared breaker between the Sweetwater and Red Willow terminals was retained in the study scope as the DISIS-2016-001-4 identified reconfiguration is not currently assigned or completed.

To analyze whether the R-plan was required for the operation of GEN-2016-050, the simulations were performed without the R-plan upgrades in the system. This was accomplished by turning off the new substation at Thedford and the 345 kV line from Gentleman - Thedford - Holt Co.

The generation in the resulting models were then scaled to compensate for the removal of generation from GEN-2016-023 and GEN-2016-029 based on scaling subsystems defined by SPP. This exercise was repeated for the cases with GGS stability interface dispatch.

Section

3

Stability Simulations

The Siemens PTI updated PSSE models were used for stability simulations. The objective of the analysis was to observe the dynamic response of system with the revised topology. Bus voltages, previously queued generation and the project's response were monitored for all the stability runs.

A 20 second no-fault run was performed for all 6 cases. The project initialized without any initial condition suspects and shows a flat response. The results from these simulations are plotted in Appendix C.

The analysis investigated the faults shown to be unstable in the DISIS-2016-001-4 report. Several of those faults involved the lines connected to the new substation added to tap the Laramie to Sidney line for the addition of GEN-2016-023 and GEN-2016-029 and thus are no longer applicable. To replace those faults, FLT144-3PH and FLT145-3PH were added to the list to test the faults on the existing 345 kV line from Laramie to Sidney. Allowing for these topology changes, the remaining 12 faults exhibiting instability in the DISIS-2016-001-4 study were also chosen to be performed in this study. At the request of SPP, an additional 67 faults were simulated for locations close to the point of interconnection of GEN-2016-050 to assess the project's impact on the SPP system. The detailed descriptions for all the simulated faults can be found in Appendix B.

Table 3-1 provides the summary of the results from the stability analysis. The majority of the faults deemed unstable and requiring mitigation in the DISIS-2016-001-4 report are now stable with the updated topology and removal of withdrawn requests. The stable runs were compliant with the SPP's Voltage recovery criteria. This criteria includes ensuring that the transient voltage recovers above 0.7 p.u. within 2.5 seconds after the fault is cleared and does not swing above 1.2 p.u. at any point after the fault is cleared. Additionally, the simulations should have the steady-state voltages of 0.95 p.u. – 1.05 p.u. for pre-event voltages and 0.9 p.u. – 1.05 p.u. for post-event voltages.

Generator instability was observed for some of the faults during the analysis, primarily for the GGS stability interface dispatch. This generator instability (pole slipping) is seen in the voltage oscillations observed for these faults. Note that generator protection that is expected to trip the unstable unit(s) under these system conditions is not modeled in these simulations, so these oscillations persist in the simulations. This non-consequential generation loss would not be an acceptable system response for the planning events evaluated. These faults were investigated further to determine the impact of the project on these stability issues. The methodology and the results from these simulations are presented in Section 3.1.

Season -> Faults	17W	17W-GGS	18S	18S-GGS	26S	26S-GGS
FLT03-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT04-3PH	Unstable	Unstable	Unstable	Unstable	Unstable	Unstable
FLT57-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT58-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT59-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT60-SB	Stable	Unstable	Stable	Stable	Stable	Stable
FLT61-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT62-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT63-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT131-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT132-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT133-SB	Stable	Stable	Stable	Stable	Stable	Stable
FLT144-3PH	Stable	Unstable	Stable	Stable	Stable	Stable
FLT145-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1000-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1001-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1002-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1003-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1004-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1005-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1006-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1008-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1009-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1010-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1011-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1012-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1013-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1014-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1015-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1016-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1017-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1018-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1020-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1021-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1024-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1026-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1028-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1032-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1033-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1035-3PH	Stable	Unstable	Stable	Stable	Stable	Stable
FLT1036-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1037-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1038-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1039-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1040-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1041-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1042-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1043-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1044-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1047-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1051-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1052-3PH	Stable	Stable	Stable	Stable	Stable	Stable

Season -> Faults	17W	17W-GGS	18S	18S-GGS	26S	26S-GGS
FLT1053-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1054-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1055-3PH	Stable	Stable	Stable	Stable	Stable	Stable
FLT1060-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1061-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1064-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1067-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1068-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1069-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1070-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1071-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1072-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1073-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1074-SLG	Stable	Stable	Stable	Stable	Stable	Stable
FLT1075-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1076-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1077-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1078-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1079-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1080-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1081-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1082-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1083-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1084-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1085-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1086-PO3	Stable	Unstable	Stable	Unstable	Stable	Stable
FLT1087-PO3	Stable	Unstable	Stable	Stable	Stable	Stable
FLT1088-PO3	Stable	Stable	Stable	Stable	Stable	Stable
FLT1089-PO3	Stable	Stable	Stable	Stable	Stable	Stable

Table 3-1. Summarized results for Stability Analysis

3.1 Stability Response for Selected Faults

Actual clearing times for several faults were received from NPPD and BEPC subsequent to the initial analysis which was performed with the generic clearing times supplied by SPP. The faults listed in Table 3-2 were simulated with the actual clearing times as supplied by NPPD and BEPC. All of these simulations showed a stable response with these clearing times. The plots for these simulations can be found in Appendix E.

Season -> Faults	Clearing Time	17W	17W-GGS	18S	18S-GGS	26S	26S-GGS
FLT04-3PH	4.0	Stable	Stable	Stable	Stable	Stable	Stable
FLT144-3PH	4.0	Stable	Stable	Stable	Stable	Stable	Stable
FLT60-SB	13.5	Stable	Stable	Stable	Stable	Stable	Stable
FLT1035-3PH	4.5	Stable	Stable	Stable	Stable	Stable	Stable
FLT1086-PO3	4.5	Stable	Stable	Stable	Stable	Stable	Stable
FLT1087-PO3	4.5	Stable	Stable	Stable	Stable	Stable	Stable

Table 3-2. Summarized results for Stability Response for Selected Faults

3.2 Additional Stability Simulations

As seen in Table 3-1 the instability issues were mostly observed in the GGS stability interface dispatch cases. SPP requested additional simulations to assess the system's capability to withstand the severe faults. These faults were simulated using the generic screening clearing times and fault MVA assumptions defined by SPP. SPP also requested additional evaluations, for prior outage events that permit pre-event curtailment as a mitigation, to demonstrate the impact of the pre-disturbance flow on the GGS Flowgate #6006 on the stability of faults near Gentleman. The analysis is discussed in the text below for the faults where the instability was observed. The plots for these simulations are available in Appendix D.

3.2.1 Laramie fault events

Two of the faults, namely FLT04-3PH and FLT144-3PH, show generator instability for fault events on BEPC facilities. These simulations apply a 3-phase fault close to 345 kV Laramie Station followed by trip of the faulted line. Figure 3-1 compares the bus voltage at the 345 kV Laramie station for FLT 144-3PH for simulations with and without the GEN-2016-050 project. The plot shows sustained oscillations in the voltage due to the Laramie River unit losing synchronism with the SPP system for a 6 cycle fault (as noted above, the generator protection is not modeled). A critical clearing time analysis was performed. Figure 3-2 compares the rotor angle of the Laramie unit for the stable (clearing time of 5.75 cycles) and unstable simulation (clearing time of 6 cycles). The unit loses synchronism with 6 cycle fault clearing but stays in synchronism and exhibits acceptable damping for fault duration of 5.75 cycles. Figure 3-1 shows that the instability is not related to the operation of GEN-2016-050.

As noted in Section 3.1, the actual clearing time provided by BEPC for these events is 4 cycles which was also simulated and observed to result in a stable simulation for both FLT04-3PH and FLT144-3PH.

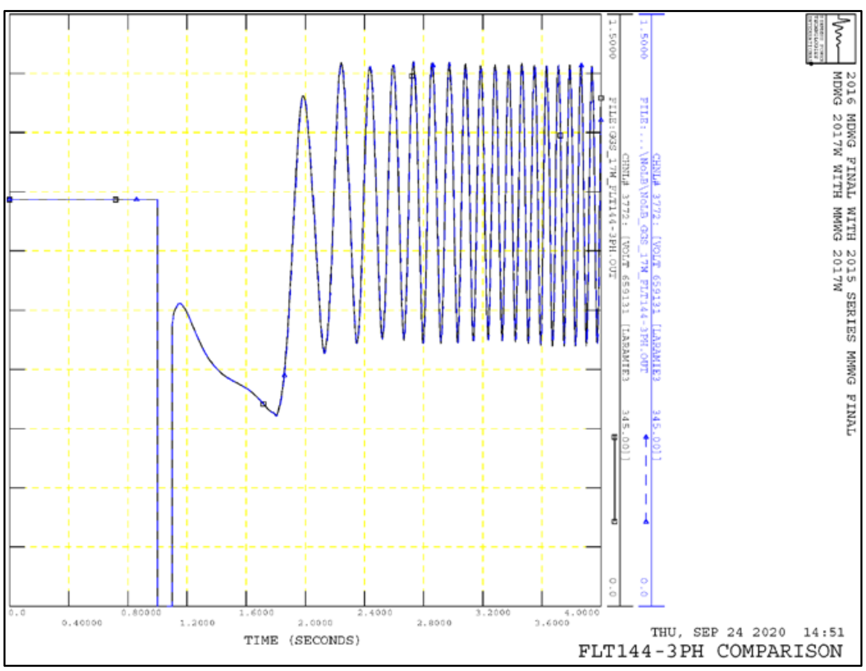

Figure 3-1. Flt 144-3PH with and without GEN-2016-050

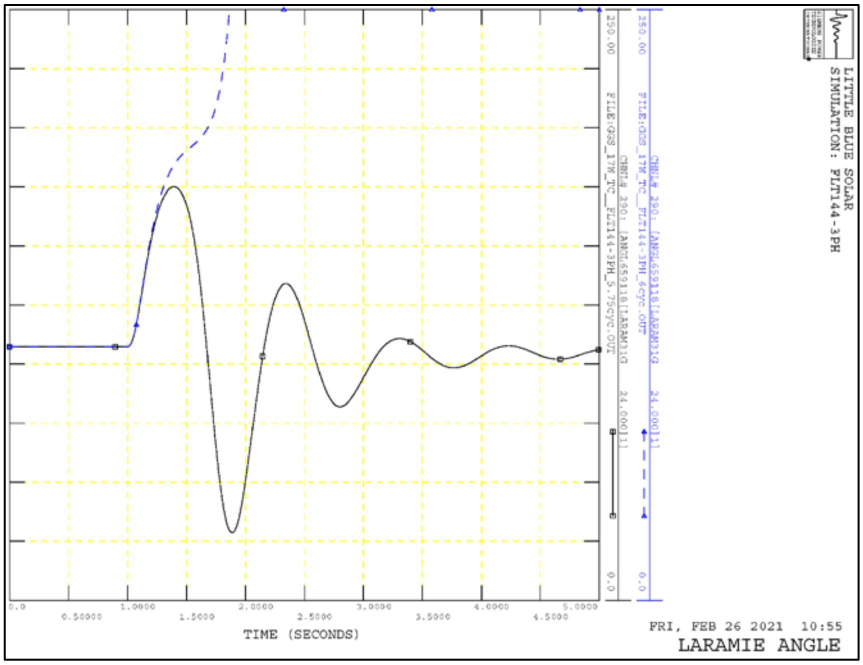

Figure 3-2. Flt 144-3PH with fault clearing times of 5.75 cycles (Stable) and 6 cycles (Unstable)

SPP requested the following simulations to investigate mitigation of FLT04-3PH and FLT144-3PH for the generic clearing time of 6 cycles:

1. Simulations were performed to find the critical clearing times for these faults for the unstable cases. The tables below show the clearing times for this fault for cases with the project on (TC) and with the project off (BC).

	BC		TC	
Case	**Normal**	**GGS**	**Normal**	**GGS**
17W	5.25 c	4.75 c	5.25 c	4.75 c
18S	5.25 c	5 c	5.25 c	5 c
26S	5.25 c	5 c	5.25 c	5 c

Table 3-3. Critical clearing times in cycles for FLT 04-3PH

	BC	TC
Case	**GGS**	**GGS**
17W	5.75 c	5.75 c

Table 3-4. Critical clearing times in cycles for FLT 144-3PH

2. These two faults were simulated with 6 cycle clearing with reduced generation from the Laramie unit. The Laramie unit was dispatched at its full power of 611 MW in the DISIS-2016-001-4 SPP provided cases. The unit was dispatched by Siemens PTI at successively reduced values (in 50 MW decrements) to assess the impact on

stability. It was observed that when the unit's output was reduced by 50 MW (to 561 MW), both FLT04-3PH and FLT144-3PH show a stable response with 6 cycle clearing, both with and without the project. This reduction is not an acceptable mitigation in the SPP system for these P1 planning events. However, the mitigation is not required since the system is stable for the BEPC provided actual clearing time of 4 cycles as described in Section 3.1

3. To test the impact of R-plan on the stability at Laramie, faults were also simulated with R-plan in service, both with and without the project. The R-plan did not resolve the stability issues at Laramie.

The analyses show that the project does not have any adverse impact on the stability of the systems for faults close to Laramie substation. The critical clearing time is the same with and without the project and the project also has no impact on the effectiveness of other measures such as generator power reduction or the R-plan. The critical clearing times for these faults are all longer than the actual clearing time of 4.0 cycles supplied by BEPC.

3.2.2 Gerald Gentleman Station fault events

Fault FLT60-SB simulates a screening duration of a 16 cycle stuck breaker single line to ground (SLG) of -j5000 MVA fault at the Gentleman station. Figure 3-3 shows a comparison of the voltage at the 345 kV Gentleman station for FLT60-SB (the black curve is with GEN-2016-050 on line and the blue curve without GEN-2016-050 The instability is observed with the screening fault duration and MVA with GEN-2016-050 either on-line and off-line. There is a slight improvement in the observed instability with GEN-2016-050 on-line but not enough to remedy the observed instability. The plot again shows sustained oscillations in the voltage, in this case due to the Gentleman and Laramie units losing synchronism with the SPP system and proceeding to slip poles for the remainder of the simulation. As noted above, the model does not include the protection that is expected to detect this instability and trip these units under these system conditions. This non-consequential generation loss would not be an acceptable system response for the planning events evaluated.

As noted in Section 3.1, the actual clearing time provided by NPPD for this event is 13.5 cycles which was also simulated and observed to result in a stable simulation for this fault.

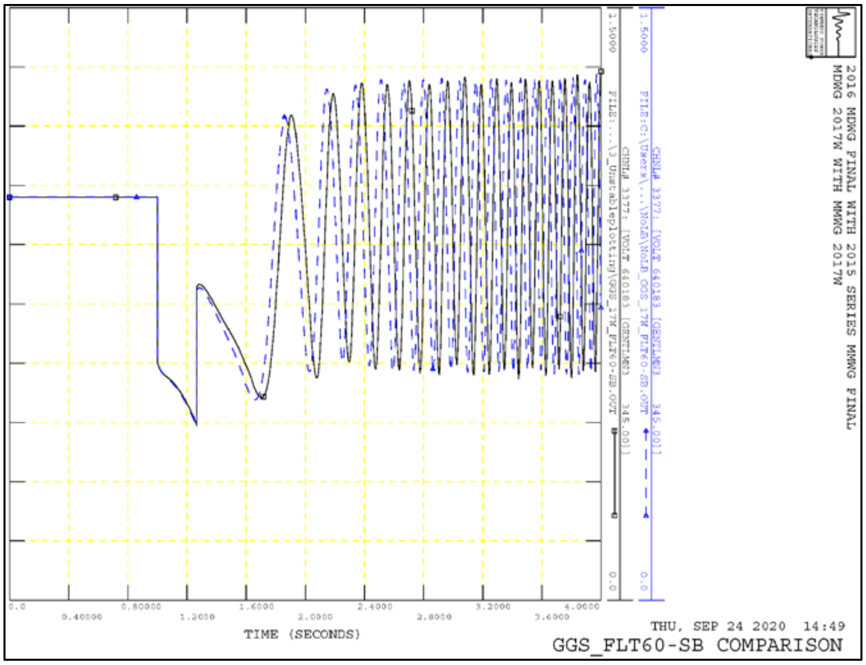

Figure 3-3. Flt 60-SB with and without GEN-2016-050

SPP requested Siemens PTI to investigate mitigations of Fault 60-SB including critical clearing time with the screening values, fault MVA magnitude and X/R ratio with various clearing time, and GGS flowgate reduction with the screening values for fault duration and magnitude.

As noted in Section 3.1, the actual clearing time provided by NPPD for this planning event is 13.5 cycles and a fault MVA of 1328 – j3529 (X/R = 2.66, |3771| MVA,). which was also simulated and observed to result in a stable simulation for FLT60-SB.

1. Simulations were performed to find the critical clearing times for the fault. The table below shows the clearing times for this fault with the SPP screening fault MVA of -j5000 MVA (as used in the simulations of Section 3.0) for cases with the project on (TC) and off (BC). These values indicate that interconnection of the GEN-2016-050 request provides an improvement to the system stability for the fault MVA value evaluated.

	BC	**TC**
Case	**GGS**	**GGS**
17W	13 c	13.75 c

Table 3-5. Critical clearing times in cycles for FLT 60-SB

2. SPP requested simulations to investigate the impact of the fault MVA magnitude and X/R ratio on the critical clearing time. The highest possible stable fault MVA was calculated for fault durations of 13 cycles and 16 cycles for various fault X/R ratios and a mid-point duration for an X/R ratio of 1/0. Faults were simulated by successively reducing the fault MVA to identify the highest 50 MVA increment for

which the system showed a stable response post fault. The table below provides the results of the analyses.

It can be seen that the system is stable for higher fault MVAs for cases where the project is online. This indicates that the project has no detrimental impact on the stability of the system for Fault 60-SB and may have a small beneficial impact that would require identification of the GEN-2016-050 contribution to the fault MVA to identify the impact.

Cycle	X/R	Fault MVA (BC)	Fault MVA (TC)
13	1/0	-j5000 (|5000|)	-j5200 (|5200|)
13	2.66/1	2744.7- j7301.1 (|7800|)	2815.2 - j7488.3 (|8000|)
13	1/1	8131.7 - j8131.7 (|11500|)	8414.6 - j8414.6 (|11900|)
13	0/1	1800 (|1800|)	1850 (|1850|)
14.5	1/0	-j4600 (|4600|)	
15	1/0		-j4700 (|4700|)
16	1/0	-j4300 (|4300|)	-j4500 (|4500|)
16	2.66/1	2340.1 - j6224.7 (|6650|)	2428.1- j6458.7 (|6900|)
16	1/1	7141.8 - j7141.8 (|10100|)	7389.3 - j7389.3 (|10450|)
16	0/1	1450 (|1450|)	1500 (|1500|)

Table 3-6. Critical Fault MVAs for BC and TC cases

SPP requested that an interpolation be performed to visualize the variation in critical fault MVA with increase in the fault clearing times. Figure 3-4 compares the variation in fault MVAs with an X/R ratio of 1/0 for the fault with and without the project.

Figure 3-4 shows that the project has no detrimental impact on the stability of the system for this fault and may actually have a small beneficial impact, demonstrated by a small increase in the critical clearing time or the magnitude of the fault MVA resulting in stable operation for a given clearing time. Determination of the comprehensive impacts from GEN-2016-050 would require identification of the GEN-2016-050 contribution to the fault MVA compared to the increased value.

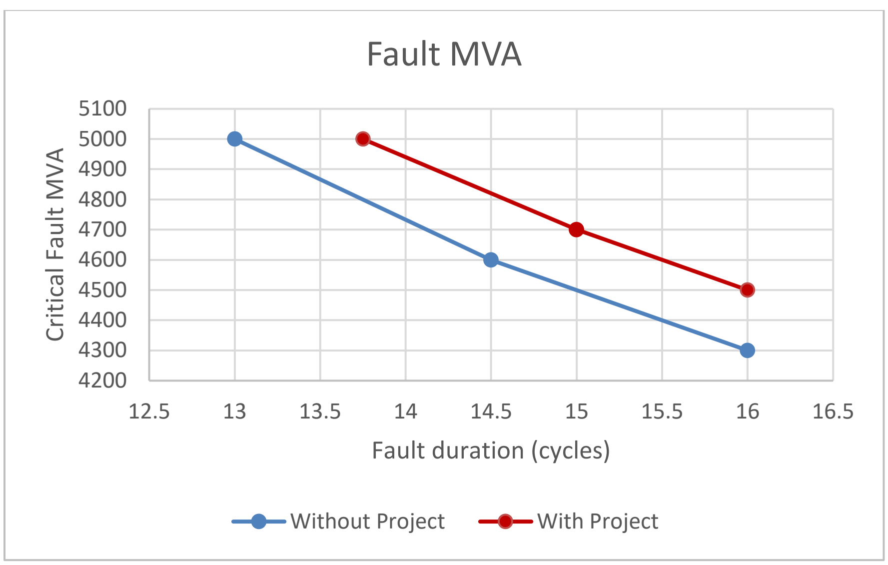

Figure 3-4. Comparison of highest Fault MVAs for stable operation

3. SPP also requested analysis to demonstrate the impact of reduction in the flow on the SPP flowgate #6006 on the stability of fault FLT60-SB.

   The #6006 flowgate definition[3] consists of following 230 kV and 345 kV lines in the SPP region. In accordance with the NPPD FERC form 715 filing, the GGS flowgate limit is 1,850 MW for evaluation of service requests in planning studies. The current SPP OASIS posted Interconnection Reliability Operating Limit (IROL) for this flowgate is 1700 MW. Per NERC definition, an IROL is a system operating limit that, if exceeded, could lead to system instability, uncontrolled separation, or cascading that adversely impact the reliability of the Bulk Electric System.

Flowgate	ElementType	From_Name	To_Name	Voltage
GGS	Monitored	G_GENT1	N_PLT1	230
GGS	Monitored	G_GENT1	N_PLT1	230
GGS	Monitored	G_GENT1	N_PLT1	230
GGS	Monitored	G_GENT1	REDWLO1	345
GGS	Monitored	G_GENT1	SWEETW4	345
GGS	Monitored	G_GENT1	SWEETW4	345

Table 3-7. Definition for GGS Flowgate 6006

   The flow on the interface was calculated for the models for 17 WP case (2017 winter peak) as follows:

   - DISIS-2016-001-4 – 1929.61 MW, 1929.7 MVA.
   - Limited Operation study cases:
     - Project ON – 1823.7 MW, 1824.2 MVA
     - Project OFF – 1831.4 MW, 1832.1 MVA

   The above values show that the interface was stressed beyond the 1,850 MW flowgate limit in the 17 WP cases in DISIS-2016-001-4 with inclusion of the withdrawn requests GEN-2016-023 & GEN-2016-029 which required network upgrades to achieve system stability. The 1,850 MW limit is not exceeded in the cases used for this Limited Operation study for GEN-2016-050.

   To reduce the flow on the flowgate, the generation at the Laramie unit was selected as a proxy of all units behind this interface that could be reduced as this unit is included in the interface dispatch and is most physically distant from the flowgate. Fault 60-SB was simulated with successively reduced dispatch (in 50 MW decrements) at the Laramie unit to find the highest stable MW value on the GGS Flowgate #6006 interface. The simulations show that the Laramie unit has to be reduced to 461 MW and 511 MW for the system to ride through the fault for BC and TC cases respectively. The flow on the flowgate for these cases is 1734 MW (BC) and 1759 MW (TC). This reduction is not acceptable mitigation in the SPP system for this P4 planning event. However, as noted in Section 3.1, the actual clearing time (13.5 cycles) and fault MVA (1328 – j3529, |3771| MVA) provided by NPPD for this event were also simulated and observed to result in a stable simulation.

[3] The definition can be found at:
http://www.oasis.oati.com/SWPP/SWPPdocs/Permanent_Flowgates.xls

Similar instability issues were observed for GGS sensitivity dispatch in 3 PH faults close to the Gentlemen Station. This includes FLT1035-3PH (17W-GGS), FLT1086-PO3 (17W-GGS and 18S-GGS) and FLT1087-PO3 (17W-GGS). These faults are originally modeled as 3 phase, 5 cycle faults with reclosing assumed at 20 cycles after the initial fault clearing. However, reclosing is generally not performed on 345 kV equipment close to a thermal generating station. Therefore, in consultation with SPP, these faults were re-modeled without reclosing. NPPD also later confirmed that reclosing is not applied. The table below provides the critical clearing times for these faults without reclosing:

Event	CCT (cycles)
1035-3PH	5.5 c
1086-PO3	5.25 c
1087-PO3	5.5 c

Table 3-8. Critical clearing times for P1 and P6 events near GGS

As noted in Section 3.1, the actual clearing time provided by NPPD is 4.5 cycles which was also simulated and observed to result in a stable simulation for FLT1035-3PH, FLT1086-PO3, and FLT1087-PO3 without system adjustment of curtailment following the prior outage for the P6 planning events.

An additional analysis was performed to mitigate FLT1086-PO3 with a clearing time of 6 cycles by reducing the dispatch at Laramie (in 50MW decrements) and thereby reducing the flow on the GGS flowgate. It was observed that the Laramie unit had to be dispatched at 361 MW for the fault to be stable with 6 cycle clearing. As the actual clearing time duration provided by NPPD results in a stable system response, a system adjustment for prior outage events that permit pre-event curtailment as a mitigation was not found necessary for the studied system conditions. This reduction would not be acceptable mitigation in the SPP system for this P1 planning event but may be acceptable mitigation for the P6 planning events.

Conclusion

The above analysis shows that the stability issues related to the Gentleman and Laramie generation seen in the DISIS-2016-001-4 and this Limited Operation study do not require the R-plan as mitigation prior to the interconnection of the GEN-2016-050 project.

Appendix

A

Modeling data

Power Flow Model

```
1,   100.00, 33, 0, 1, 60.00     / PSS(R)E-33.12   THU, SEP 24 2020  15:10
2016 MDWG FINAL WITH 2015 SERIES MMWG FINAL
MDWG 2017W WITH MMWG 2017W
587350,'GEN-2016-050', 345.0000,1, 640, 686, 640,1.03550,  52.5544,1.10000,0.90000,1.10000,0.90000
587351,'G16-050XFMR1',  34.5000,1, 640, 686, 640,1.01815,  60.4674,1.10000,0.90000,1.10000,0.90000
587352,'G16-050-GSU1',  34.5000,1, 640, 686, 640,1.02743,  61.3832,1.10000,0.90000,1.10000,0.90000
587353,'G16-050-GEN1',   0.6900,2, 640, 686, 640,1.03000,  64.1791,1.10000,0.90000,1.10000,0.90000
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0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA
0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA
587353,'1 ',   250.700,   -16.182,    82.401,   -82.401,1.03000,     0,   259.965, 0.00000E+0,
8.00000E-1, 0.00000E+0, 0.00000E+0,1.00000,1,  100.0,   250.700,     0.000, 640,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
530583,560082,'1 ', 4.58280E-3, 4.80548E-2,   0.95647, 1793.00, 1793.00,    0.00,  0.00000, -
0.55000,  0.00000,  0.00000,1,2, 104.29, 640,0.3847, 849,0.6153
560082,587350,'1 ', 3.59000E-4, 3.07500E-3,   0.04030,    0.00,    0.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,2,   6.50, 640,1.0000
560082,640065,'1 ', 1.44720E-3, 1.51752E-2,   0.30204, 1793.00, 1793.00,    0.00,  0.00000,
0.00000,  0.00000, -0.50000,1,2,  32.94, 640,0.3847, 849,0.6153
587351,587352,'1 ', 4.43300E-3, 6.33000E-3,   0.12650,    0.00,    0.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,2,   0.00, 640,1.0000
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0,1.0000,   0,1.0000,   0,1.0000,'            '
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1.00000,   0.000
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100.00,1.06591,  53.1499
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1.00000,   0.000, -30.000,    88.70,    88.70,   110.90, 0,      0, 1.10000, 0.90000, 1.10000,
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0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
Q
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Dynamic Model

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587353 'USRMDL' 1  'GEWTG2'  1 1 4 18 3 5
        0  109      0            0
        2.3000      0.80000      0.50000      0.9000      1.2200      1.2000
        2.0000      0.40000      0.80000      10.000      0.2000E-01  0.0000
        0.0000      0.50000      0.16700      0.9000      0.9250      0.0000      /
 587353 'USRMDL' 1  'GEWTE2'  4 0 12 67 18 9
        587353      0            0            1           0           0
        0           0            0            1           0           0
        0.1500      2.000        1.0000       0.0000      0.0000      0.5000E-01  3.0000
        0.6000      1.1200       0.4000E-01   0.4360      -0.4360     1.1000      0.20000E-
01
        0.4500      -0.450       60.000       0.1000      0.90000
        1.1000      40.000       0.5000       1.4500      0.5000E-01
        0.5000E-01  1.0000       0.1500       0.9600      0.99600
        1.0040      1.0400       1.0000       1.0000      1.00000
        0.4000      1.0000       0.2000       1.0000      0.25000
        -1.000      14.000       25.000       3.0000      -0.9000
        8.0000      0.2000       10.000       1.0000      1.7000
        1.22        1.2500       5.0000       0.0000      0.0000
        0.000       0.2500E-02   1.0000       5.5000      0.10000
        -1.000      0.1000       0.0000       0.1000      -0.1000
        0.7000      0.1200       -0.120       /
 587353 'USRMDL' 1  'GEWTT1'        5    0    1    5    4    3   0
        3.2200      0.0000       0.0000       1.8800      1.5000      /
 587353  'USRMDL'  '1'  'GEWGD1'  505  0  1  6  0  4
          0       9999.0  5.0000  30.000  9999.0  9999.0         30.000/
 587353  'USRMDL'  '1'  'GEWTA2'  505  0  0  9  1  4
          20.000  0.0000  27.000  -4.0000  0.0000  1.2250        56.500  104.00  1200.0/
 587353  'USRMDL'  '1'  'GEWTP2'  505  0  1  10  3  3
          0       0.30000  150.00  25.000  3.0000  30.000        -4.0000  27.000  -10.000
10.000  1.0000/
 58735300  'USRMSC'  'GEWPLT2'  512  0  2  0  0  17  587353  '1'/
 58735301  'VTGTPAT'  587353  587353  '1'  0.40  5.0000  1.00  0.08/
 58735302  'VTGTPAT'  587353  587353  '1'  0.60  5.0000  1.70  0.08/
 58735303  'VTGTPAT'  587353  587353  '1'  0.70  5.0000  2.50  0.08/
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 58735307  'VTGTPAT'  587353  587353  '1'  0.00  1.1200  300.00  0.08/
 58735308  'VTGTPAT'  587353  587353  '1'  0.00  1.1500  30.00  0.08/
 58735309  'VTGTPAT'  587353  587353  '1'  0.00  1.2000  2.00  0.08/
 58735310  'VTGTPAT'  587353  587353  '1'  0.00  1.2500  0.50  0.08/
 58735311  'VTGTPAT'  587353  587353  '1'  0.00  1.3800  0.30  0.08/
 58735312  'VTGTPAT'  587353  587353  '1'  0.00  1.5000  0.03  0.08/
 58735313  'VTGTPAT'  587353  587353  '1'  0.00  1.6000  0.01  0.08/
```

Appendix

B

Fault Descriptions

Fault	Description
FLT03-3PH	3 phase fault on the Stegall (659135) to Laramie (659131) 345kV line circuit 1, near Stegall. a. Apply fault at the Stegall 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT04-3PH	3 phase fault on the Laramie (659131) to Stegall (659135) 345kV line circuit 1, near Laramie. a. Apply fault at the Laramie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT57-SB	**Gentleman 345 kV Stuck Breaker Scenario 1** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1. d. Trip Gentleman (640183) to Keystone (640252) 345kV line circuit 1.
FLT58-SB	**Gentleman 230 kV Stuck Breaker Scenario 2** a. Apply single phase fault at the Gentleman (640184) 230kV bus. b. Wait 16 cycles and remove fault. c. Trip Gentleman (640183) to Sweetwater (640374) 345kV line circuit 1. d. Trip Gentleman 345/230/13.8kV (640183/640184/640185) Transformer.
FLT59-SB	**Gentleman 345 kV Stuck Breaker Scenario 3** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1. d. Trip Gentleman 345/230/13.8kV (640183/640184/643066) Transformer.
FLT60-SB	**Gentleman 345 kV Stuck Breaker Scenario 4** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1. d. Trip Red Willow (640325) to Gentleman (640183) 345kV line circuit 1.

Fault	Description
FLT61-SB	**Gentleman 345 kV Stuck Breaker Scenario 5** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Red Willow (640325) to Gentleman (640183) 345kV line circuit 1. d. Trip Gentleman 345/230/13.8kV (640183/640184/640185) Transformer.
FLT62-SB	**Gentleman 345 kV Stuck Breaker Scenario 6** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Red Willow (640325) to Gentleman (640183) 345kV line circuit 1. d. Trip Gentleman 345/230/13.8kV (640183/640184/643066) Transformer.
FLT63-SB	**Gentleman 345 kV Stuck Breaker Scenario 7** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Red Willow (640325) to Gentleman (640183) 345kV line circuit 1. d. Trip Keystone (640252) to Gentleman (640183) 345kV line circuit 1.
FLT131-SB	**Gentleman 345 kV Stuck Breaker Scenario 8** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 13.5 cycles and remove fault. c. Trip Red Willow (640325) to Gentleman (640183) 345kV line circuit 1. d. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 2.
FLT132-SB	**Gentleman 345 kV Stuck Breaker Scenario 9** a. Apply single phase fault at the Gentleman (640183) 345kV bus. b. Wait 13.5 cycles and remove fault. c. Trip Keystone (640252) to Gentleman (640183) 345kV line circuit 1. d. Trip Gentleman 345/230/13.8kV (640183/640184/643066) Transformer.
FLT133-SB	**Gentleman 230 kV Stuck Breaker Scenario 8** a. Apply single phase fault at the Gentleman (640184) 230kV bus. b. Wait 13.5 cycles and remove fault. c. Trip North Platte (640286) to Gentleman (640184) 230kV line circuit 1. d. Trip North Platte (640286) to Gentleman (640184) 230kV line circuit 2.
FLT144-3PH	3 phase fault on the Sidney (659133) to Laramie (659131) 345kV line circuit 1, near Laramie. a. Apply fault at the Laramie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

Fault	Description
FLT145-3PH	3 phase fault on the Sidney (659133) to Laramie (659131) 345kV line circuit 1, near Laramie. a. Apply fault at the Sidney 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
FLT1000-3PH	3 phase fault on the POSTROCK7 (530583) to SPERVIL7 (531469) 345kV line Circuit 1 near POSTROCK7 a. Apply fault at the POSTROCK7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1001-3PH	3 phase fault on the POSTROCK7 (530583) to G16-050-TAP (560082) 345kV line Circuit 1 near G16-050-TAP a. Apply fault at the G16-050-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1002-3PH	3 phase fault on the G16-050-TAP (560082) to AXTELL 3 (640065) 345kV line Circuit 1 near G16-050-TAP a. Apply fault at the G16-050-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1003-3PH	3 phase fault on the AXTELL 3 (640065) to PAULINE3 (640312) 345kV line Circuit 1 near AXTELL 3 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1004-3PH	3 phase fault on the AXTELL 3 (640065) to SWEET W3 (640374) 345kV line Circuit 1 near AXTELL 3 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1005-3PH	3 phase fault on the KNOLL 6 (530558) to POSTROCK6 (530584) 230kV line Circuit 1 near POSTROCK6 a. Apply fault at the POSTROCK6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1006-3PH	3 phase fault on the S HAYS6 (530582) to POSTROCK6 (530584) 230kV line Circuit 1 near POSTROCK6 a. Apply fault at the POSTROCK6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1008-3PH	3 phase fault on the SPERVIL7 (531469) to BUCKNER7 (531501) 345kV line Circuit 1 near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1009-3PH	3 phase fault on the SPERVIL7 (531469) to IRONWOOD7 (539803) 345kV line Circuit 1 near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1010-3PH	3 phase fault on the SPERVIL7 (531469) to IRONWOOD2 7 (560002) to CLARKCOUNTY7 (539800) 345kV line Circuits 1 near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1011-3PH	3 phase fault on the G15-088-TAP (560062) to PAULINE3 (640312) 345kV line Circuit 1 near PAULINE3 a. Apply fault at the PAULINE3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1012-3PH	3 phase fault on the AXTELL 7 (640066) to HOLDREG7 (640224) 115kV line Circuit 1 near AXTELL 7 a. Apply fault at the AXTELL 7 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1013-3PH	3 phase fault on the AXTELL 7 (640066) to KEARNEY7 (640250) 115kV line Circuit 1 near AXTELL 7 a. Apply fault at the AXTELL 7 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1014-3PH	3 phase fault on the AXTELL 7 (640066) to MINDEN 7 (640275) 115kV line Circuit 1 near AXTELL 7 a. Apply fault at the AXTELL 7 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1015-3PH	3 phase fault on the GENTLMN3 (640183) to SWEET W3 (640374) 345kV line Circuit 1 near SWEET W3 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1016-3PH	3 phase fault on the GENTLMN3 (640183) to SWEET W3 (640374) 345kV line Circuit 2 near SWEET W3 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1017-3PH	3 phase fault on the SWEET W3 (640374) to GR ISLD3 (653571) 345kV line Circuit 1 near SWEET W3 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1018-3PH	3 phase fault on the SMOKYHL6 (530592) to SUMMIT 6 (532973) 230kV line Circuit 1 near SMOKYHL6 a. Apply fault at the SMOKYHL6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1020-3PH	3 phase fault on the S HAYS6 (530582) to GRTBEND6 (539679) 230kV line Circuit 1 near S HAYS6 a. Apply fault at the S HAYS6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1021-3PH	3 phase fault on the HOLCOMB7 (531449) to BUCKNER7 (531501) 345kV line Circuit 1 near BUCKNER7 a. Apply fault at the BUCKNER7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1024-3PH	3 phase fault on the GRTBEND6 (539679) to SPEARVL6 (539695) 230kV line Circuit 1 near SPEARVL6 a. Apply fault at the SPEARVL6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1026-3PH	3 phase fault on the SPRVL 3 (539759) to NFTDODG3 (539771) 115kV line Circuit 1 near SPRVL 3 a. Apply fault at the SPRVL 3 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1028-3PH	3 phase fault on the G16-046-TAP (560080) to CLARKCOUNTY7 (539800) 345kV line Circuit 1 near G16-046-TAP a. Apply fault at the G16-046-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1032-3PH	3 phase fault on the G15-088-TAP (560062) to MOORE 3 (640277) 345kV line Circuit 1 near G15-088-TAP a. Apply fault at the G15-088-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1033-3PH	3 phase fault on the GENTLMN3 (640183) to KEYSTON3 (640252) 345kV line Circuit 1 near GENTLMN3 a. Apply fault at the GENTLMN3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1035-3PH	3 phase fault on the GENTLMN3 (640183) to REDWILO3 (640325) 345kV line Circuit 1 near GENTLMN3 a. Apply fault at the GENTLMN3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1036-3PH	3 phase fault on the MCCOOL 3 (640271) to GR ISLD3 (653571) 345kV line Circuit 1 near GR ISLD3 a. Apply fault at the GR ISLD3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1037-3PH	3 phase fault on the FTTHOMP3 (652506) to FTTHOM2-LNX3 (652807) to GRPRAR2-LNX3 (652833) to GR PRAIRIE 3 (652532) 345kV line near FTTHOMP3 a. Apply fault at the FTTHOMP3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1038-3PH	3 phase fault on the POSTROCK7 345kV (530583) to POSTROCK6 345kV (530584) POSTROCK1 230kV (530673) transformer 1, near POSTROCK7 a. Apply fault at the POSTROCK7 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1039-3PH	3 phase fault on the AXTELL 7 345kV (640066) to AXTELL 3 115kV (640065) AXTELL 9 345kV (640067) transformer 1, near AXTELL 3 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1040-3PH	3 phase fault on the SPEARVL6 345kV (539695) to SPERVIL7 230kV (531469) SPERTER1 345kV (531468) transformer 1, near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1041-3PH	3 phase fault on the SPRVL 3 345kV (539759) to SPERVIL7 115kV (531469) SPRVL-T 345kV (539960) transformer 1, near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1042-3PH	3 phase fault on the PAULINE7 345kV (640313) to PAULINE3 115kV (640312) PAULINE9 345kV (640315) transformer 1, near PAULINE3 a. Apply fault at the PAULINE3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1043-3PH	3 phase fault on the KNOLL 6 230kV (530558) to KNOLL 3 230kV (530561) KNLL1 1 115kV (530629) transformer 1, near KNOLL 6 a. Apply fault at the KNOLL 6 230kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1044-3PH	3 phase fault on the S HAYS6 230kV (530582) to S HAYS 3 230kV (530553) SHYS1 1 115kV (530632) transformer 1, near S HAYS6 a. Apply fault at the S HAYS6 230kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1047-3PH	3 phase fault on the SPEARVL3 230kV (539694) to SPEARVL6 115kV (539695) SPERVLTT 230kV (539935) transformer 1, near SPEARVL6 a. Apply fault at the SPEARVL6 230kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1051-3PH	3 phase fault on the GENTLMN4 345kV (640184) to GENTLMN3 230kV (640183) G.GENT19 345kV (640185) transformer 1, near GENTLMN3 a. Apply fault at the GENTLMN3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1052-3PH	3 phase fault on the GENTLMN4 345kV (640184) to GENTLMN3 230kV (640183) GENTLEMANT29 345kV (643066) transformer 2, near GENTLMN3 a. Apply fault at the GENTLMN3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.

Fault	Description
FLT1053-3PH	3 phase fault on the GR ISLD4 345kV (640200) to GR ISLD3 230kV (653571) GR ISLD T6 9 345kV (643071) transformer 3, near GR ISLD3 a. Apply fault at the GR ISLD3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1054-3PH	3 phase fault on the GR ISLD3 345kV (653571) to GR ISLD4 345kV (640200) GR ISL19 230kV (653314) transformer 1, near GR ISLD3 a. Apply fault at the GR ISLD3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1055-3PH	3 phase fault on the GR ISLD3 345kV (653571) to GR ISLD4 345kV (640200) GR ISL29 230kV (653316) transformer 2, near GR ISLD3 a. Apply fault at the GR ISLD3 345kV bus. b. Clear fault after 5 cycles and trip the faulted transformer.
FLT1060-PO3	3 phase fault on the AXTELL 3 (640065) to PAULINE3 (640312) 345kV line Circuit 1 near AXTELL 3 with a prior outage of the AXTELL3 (640065) - AXTELL 7 (640066) - AXTELL 9 (640067) transformer a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1061-PO3	3 phase fault on the AXTELL 3 (640065) to SWEET W3 (640374) 345kV line Circuit 1 near AXTELL 3 with a prior outage of the AXTELL3 (640065) - AXTELL 7 (640066) - AXTELL 9 (640067) transformer a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1064-PO3	3 phase fault on the AXTELL 3 (640065) to SWEET W3 (640374) 345kV line Circuit 1 near AXTELL 3 with a prior outage of the AXTELL 3 (640065) to PAULINE3 (640312) 345 kV line a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1067-SLG	SLG Fault event at SWEET W3 (640374) 345kV bus a. Apply single phase fault at SWEET W3 (640374) 345kV bus b. Wait 16 cycles and remove fault c. Trip SWEET W3 (640374) to GR ISLD3 (653571) 345kV line Circuit 1 d. Trip GENTLMN3 (640183) to SWEET W3 (640374) 345kV line Circuit 1
FLT1068-SLG	SLG Fault event at MOORE 3 (640277) 345kV bus a. Apply single phase fault at MOORE 3 (640277) 345kV bus b. Wait 16 cycles and remove fault c. Trip G15-088-TAP (560062) to MOORE 3 (640277) 345kV line Circuit 1 d. Trip MOORE 3 (640277) to NW68HOLDRG3 (650114) 345kV line Circuit 1

Fault	Description
FLT1069-SLG	SLG Fault event at MOORE 3 (640277) 345kV bus a. Apply single phase fault at MOORE 3 (640277) 345kV bus b. Wait 16 cycles and remove fault c. Trip G15-088-TAP (560062) to MOORE 3 (640277) 345kV line Circuit 1 d. Trip SHELDON7 (640278) to MOORE 3 (640277) to MOORE 9 ()640280 115/345/13.8kV Transformer Circuit 1
FLT1070-SLG	SLG Fault event at AXTELL 3 (640065) 345kV bus a. Apply single phase fault at AXTELL 3 (640065) 345kV bus b. Wait 16 cycles and remove fault c. Trip AXTELL 3 (640065) to PAULINE3 (640312) 345kV line Circuit 1 d. Trip AXTELL 3 (640065) to SWEET W3 (640374) 345kV line Circuit 1
FLT1071-SLG	SLG Fault event at AXTELL 3 (640065) 345kV bus a. Apply single phase fault at AXTELL 3 (640065) 345kV bus b. Wait 16 cycles and remove fault c. Trip AXTELL 3 (640065) to PAULINE3 (640312) 345kV line Circuit 1 d. Trip G16-050-TAP (560082) to AXTELL 3 (640065)345kV line Circuit 1
FLT1072-SLG	SLG Fault event at POSTROCK7 (530583) 345kV bus a. Apply single phase fault at POSTROCK7 (530583) 345kV bus b. Wait 16 cycles and remove fault c. Trip POSTROCK7 (530583) 345kV bus
FLT1073-SLG	SLG Fault event at CLARKCOUNTY7 (539800) 345kV bus a. Apply single phase fault at CLARKCOUNTY7 (539800) 345kV bus b. Wait 16 cycles and remove fault c. Trip CLARKCOUNTY7 (539800) to IRONWOOD2 (560002) 345kV line Circuit 1 d. Trip CLARKCOUNTY7 (539800) to G16-005-TAP (560072) 345kV line Circuit 1 e. Trip THISTLE7 (539801) to G16-005-TAP (560072) 345kV line Circuit 1
FLT1074-SLG	SLG Fault event at 531449 (HOLCOMB7) 345kV bus a. Apply single phase fault at 531449 (HOLCOMB7) 345kV bus b. Wait 16 cycles and remove fault c. Trip HOLCOMB7 (531449) to BUCKNER7 (531449) 345kV line Circuit 1 d. Trip FINNEY (523853) to HOLCOMB7 (531449) 345kV line Circuit 1
FLT1075-PO3	3 phase fault on the SPERVIL7 (531469) to POSTROCK7 (530583) 345kV line Circuit 1 near SPERVIL7 with a prior outage of AXTELL 3 (640065) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1076-PO3	3 phase fault on the HOLCOMB7 (531449) to BUCKNER7 (531501) 345kV line Circuit 1 near BUCKNER7 with a prior outage of AXTELL 3 (640065) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the BUCKNER7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1077-PO3	3 phase fault on the KNOLL 6 (530558) to POSTROCK6 (530584) 230kV line Circuit 1 near POSTROCK6 with a prior outage of AXTELL 3 (640065) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the POSTROCK6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1078-PO3	3 phase fault on the S HAYS6 (530582) to GRTBEND6 (539679) 230kV line Circuit 1 near S HAYS6 with a prior outage of AXTELL 3 (640065) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the S HAYS6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1079-PO3	3 phase fault on the AXTELL 3 (640065) to SWEET W3 (640374) 345kV line Circuit 1 near AXTELL 3 with prior outage of POSTROCK7 (530583) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1080-PO3	3 phase fault on the AXTELL 3 (640065) to PAULINE3 (640312) 345kV line Circuit 1 near AXTELL 3 with a prior outage of POSTROCK7 (530583) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1081-PO3	3 phase fault on the G15-088-TAP (560062) to MOORE 3 (640277) 345kV line Circuit 1 near G15-088-TAP with a prior outage of POSTROCK7 (530583) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the G15-088-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1082-PO3	3 phase fault on the KNOLL 6 (530558) to POSTROCK6 (530584) 230kV line Circuit 1 near POSTROCK6 with a prior outage of POSTROCK7 (530583) - SPERVIL7 (531469) Circuit 1 a. Apply fault at the POSTROCK6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1083-PO3	3 phase fault on the S HAYS6 (530582) to GRTBEND6 (539679) 230kV line Circuit 1 near S HAYS6 with a prior outage of POSTROCK7 (530583) - SPERVIL7 (531469) Circuit 1 a. Apply fault at the S HAYS6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1084-PO3	3 phase fault on the THISTLE7 (539801) to G16-005-TAP (560072) 345kV line Circuit 1 near THISTLE7 with a prior outage of CLARKCOUNTY7 (539800) - G16-005-TAP (560072) Circuit 1 a. Apply fault at the THISTLE7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1085-PO3	3 phase fault on the G15-088-TAP (560062) to MOORE 3 345kV line Circuit 1 near G15-088-TAP with a prior outage of SWEET W3 (640374) - GR ISLD3 (653571) Circuit 1 a. Apply fault at the G15-088-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1086-PO3	3 phase fault on the GENTLMN3 (640183) to REDWILO3 (640325) 345kV line Circuit 1 near GENTLMN3 with a prior outage of AXTELL 3 (640065) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the GENTLMN3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1087-PO3	3 phase fault on the GENTLMN3 (640183) to REDWILO3 (640325) 345kV line Circuit 1 near GENTLMN3 with a prior outage of POSTROCK7 (530583) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the GENTLMN3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1088-PO3	3 phase fault on the GENTLMN3 (640183) to SWEET W3 (640374) 345kV line Circuit 1 near SWEET W3 with a prior outage of POSTROCK7 (530583) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1089-PO3	3 phase fault on the SWEET W3 (640374) to GR ISLD3 (653571) 345kV line Circuit 1 near SWEET W3 with a prior outage of POSTROCK7 (530583) - G16-050-TAP (560082) Circuit 1 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1000-3PH	3 phase fault on the POSTROCK7 (530583) to SPERVIL7 (531469) 345kV line Circuit 1 near POSTROCK7 a. Apply fault at the POSTROCK7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1001-3PH	3 phase fault on the POSTROCK7 (530583) to G16-050-TAP (560082) 345kV line Circuit 1 near G16-050-TAP a. Apply fault at the G16-050-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1002-3PH	3 phase fault on the G16-050-TAP (560082) to AXTELL 3 (640065) 345kV line Circuit 1 near G16-050-TAP a. Apply fault at the G16-050-TAP 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1003-3PH	3 phase fault on the AXTELL 3 (640065) to PAULINE3 (640312) 345kV line Circuit 1 near AXTELL 3 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1004-3PH	3 phase fault on the AXTELL 3 (640065) to SWEET W3 (640374) 345kV line Circuit 1 near AXTELL 3 a. Apply fault at the AXTELL 3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1005-3PH	3 phase fault on the KNOLL 6 (530558) to POSTROCK6 (530584) 230kV line Circuit 1 near POSTROCK6 a. Apply fault at the POSTROCK6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1006-3PH	3 phase fault on the S HAYS6 (530582) to POSTROCK6 (530584) 230kV line Circuit 1 near POSTROCK6 a. Apply fault at the POSTROCK6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1008-3PH	3 phase fault on the SPERVIL7 (531469) to BUCKNER7 (531501) 345kV line Circuit 1 near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1009-3PH	3 phase fault on the SPERVIL7 (531469) to IRONWOOD7 (539803) 345kV line Circuit 1 near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1010-3PH	3 phase fault on the SPERVIL7 (531469) to IRONWOOD2 7 (560002) to CLARKCOUNTY7 (539800) 345kV line Circuits 1 near SPERVIL7 a. Apply fault at the SPERVIL7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1011-3PH	3 phase fault on the G15-088-TAP (560062) to PAULINE3 (640312) 345kV line Circuit 1 near PAULINE3 a. Apply fault at the PAULINE3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1012-3PH	3 phase fault on the AXTELL 7 (640066) to HOLDREG7 (640224) 115kV line Circuit 1 near AXTELL 7 a. Apply fault at the AXTELL 7 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1013-3PH	3 phase fault on the AXTELL 7 (640066) to KEARNEY7 (640250) 115kV line Circuit 1 near AXTELL 7 a. Apply fault at the AXTELL 7 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1014-3PH	3 phase fault on the AXTELL 7 (640066) to MINDEN 7 (640275) 115kV line Circuit 1 near AXTELL 7 a. Apply fault at the AXTELL 7 115kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1015-3PH	3 phase fault on the GENTLMN3 (640183) to SWEET W3 (640374) 345kV line Circuit 1 near SWEET W3 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1016-3PH	3 phase fault on the GENTLMN3 (640183) to SWEET W3 (640374) 345kV line Circuit 2 near SWEET W3 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1017-3PH	3 phase fault on the SWEET W3 (640374) to GR ISLD3 (653571) 345kV line Circuit 1 near SWEET W3 a. Apply fault at the SWEET W3 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1018-3PH	3 phase fault on the SMOKYHL6 (530592) to SUMMIT 6 (532973) 230kV line Circuit 1 near SMOKYHL6 a. Apply fault at the SMOKYHL6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1020-3PH	3 phase fault on the S HAYS6 (530582) to GRTBEND6 (539679) 230kV line Circuit 1 near S HAYS6 a. Apply fault at the S HAYS6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Fault	Description
FLT1021-3PH	3 phase fault on the HOLCOMB7 (531449) to BUCKNER7 (531501) 345kV line Circuit 1 near BUCKNER7 a. Apply fault at the BUCKNER7 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT1024-3PH	3 phase fault on the GRTBEND6 (539679) to SPEARVL6 (539695) 230kV line Circuit 1 near SPEARVL6 a. Apply fault at the SPEARVL6 230kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Appendix

C

Plots for Simulations of Table 3-1

(Available upon request from SPP)

Appendix

D

Plots for Section 3.2

(Available upon request from SPP)

Appendix

E

Plots for Section 3.1 (Table 3-2)

(Available upon request from SPP)

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