Lucky Corridor
Mora Line Transmission Project

Non-Tariff
System Impact Study

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Main Analysis Prepared by:
Utility System Efficiencies, Inc. (USE)

Under Contract with:
Public Service Company of New Mexico

&

Gladstone Phase Shifter Sensitivity Prepared by:
Public Service Company of New Mexico (PNM)

PNM®

Foreword

This technical report is prepared for Lucky Corridor (Interconnection Customer) who submitted an Interconnection Application to Public Service Company of New Mexico (PNM). This study (except the Gladstone Phase Shifter Sensitivity) was performed by Utility System Efficiencies, Inc. (USE) pursuant to a consulting contract with PNM Transmission/Distribution Planning and Contracts Department.

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Table of Contents

Executive Summary 1
Power Transfers to the Four Corners Area 3
Introduction 6
Study Criteria 6
Power Flow Criteria 7
Transient Stability Criteria 7
Short Circuit Criteria 8
Power Flow Base Case Development 8
Generation Dispatch 9
Power Flow Case Attributes 10
List of Contingencies 11
Power Flow Analysis Results 13
Power Flow Results 13
Power Flow – Voltage Performance Results 15
Short-Circuit Analysis Results 18
Transient Stability Analysis Results 18
Transmission Interconnection Facilities 19

Appendix A - Power Flow Diagrams
Appendix B - Transient Stability Plots
Appendix C – Generator dynamic data
Appendix D – Short Circuit Results
Appendix E – Historical Walsenburg – Gladstone 230 kV line flow

List of Figures

Figure 1 - Mora Line Model illustration 1
Figure 2 — Breaker level one-line drawing of the existing system. 2
Figure 3 — Breaker level one-line drawing of the proposed MLTP 3

List of Tables

Table 1 — Transmission Interconnection Upgrades 5
Table 2 — Power Flow Disturbance/Performance Criteria 7
Table 3 — PNM Fault Clearing Times 8
Table 4 — Generation Dispatch 9
Table 5 — Power Flow Case Attributes – Base Scenario 10
Table 6 — Power Flow Contingencies 11
Table 7 — Transient Stability Contingencies 12
Table 8 – 2021 Heavy Winter Results 14
Table 9 – 2017 Light Spring Results With Gladstone PST at 107 MW 14
Table 10 — Light Spring Overloads with Gallegos Collector at 160 MW and Gladstone PST setting at 180 MW. 15
Table 11 – 2021 Heavy Winter Post-Contingency Voltage Results 16
Table 12 – 2017 Light Spring Post-Contingency Voltage Results 16
Table 13— Light Spring Gladstone PST 180 case 17

Executive Summary

On August 6, 2015, Lucky Corridor, LLC.("LCLLC") requested a non-tariff wires-to-wires interconnection of the Mora Line Transmission Project ("MLTP") to Public Service Company of New Mexico's (PNM) radial 115 kV transmission line serving the PNM Arriba distribution substation. LCLLC proposes to interconnect the MLTP at Tri-State Generation and Transmission Association's (TSGT) Gladstone and Springer 115 kV Switching Stations. The project parallels TSGT's existing 115 kV transmission line from Gladstone to Springer and will parallel portions of the existing TSGT 115 kV line from Springer to Storrie Lake.

Figure 1 below, shows the MLTP and proposed switching station additions for interconnection. The purpose of the project is to accommodate additional renewable resources in the region. Previous analysis has shown that up to 180 MW of additional generation can be accommodated with this project.

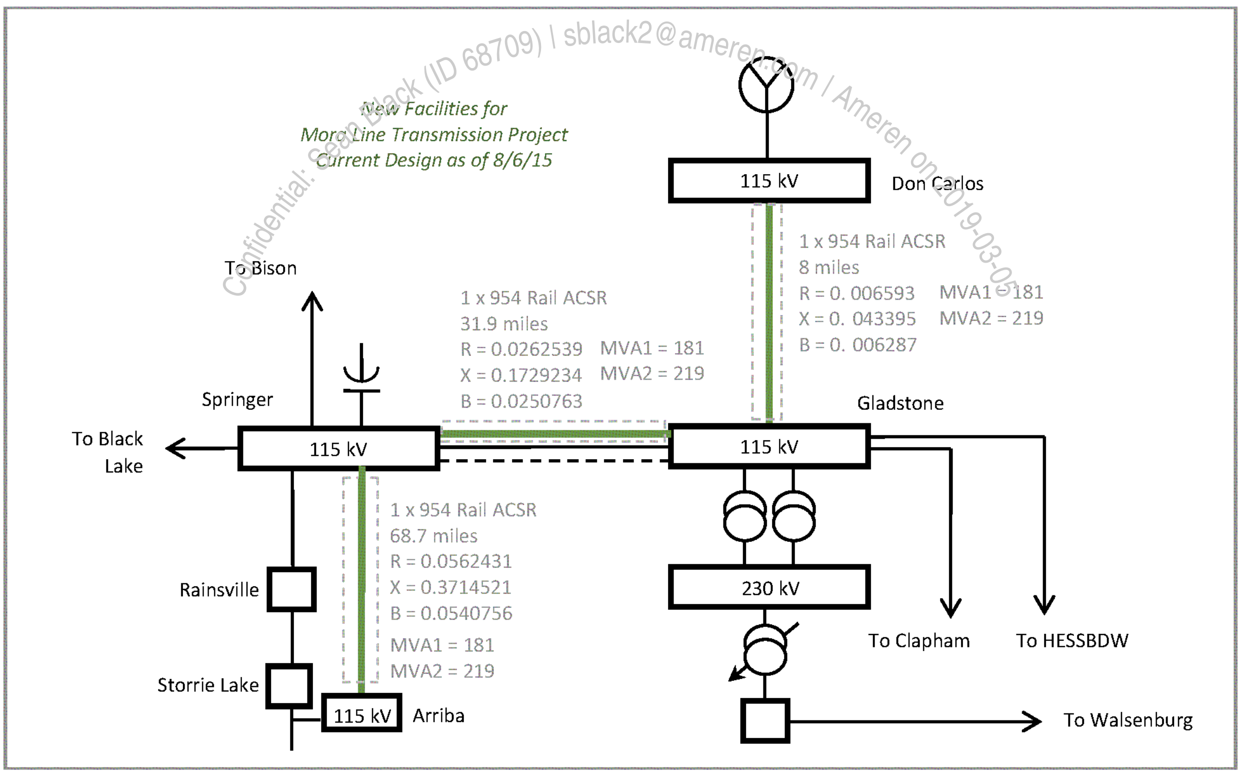

Figure 1 - Mora Line Model illustration

This analysis is limited to studying the ability to interconnect and inject power at the points of delivery to PNM's and TSGT's systems with an assumed delivery to Four Corners on an "as available" basis only using non-firm transmission capacity. Transmission service on either PNM's or TSGT's system requires a separate request for transmission service and will be analyzed in accordance with PNM's or TSGT's Open Access Transmission Tariff ("OATT"). Likewise, this study is not and does not substitute for a generation interconnection System Impact Study. Note that Interconnection Service in and of itself does not convey Transmission Service. This study provides a non-binding cost and construction schedule estimate for all identified system reinforcements required to interconnect the MLTP.

Figure 2 is a breaker level drawing of the existing transmission system.

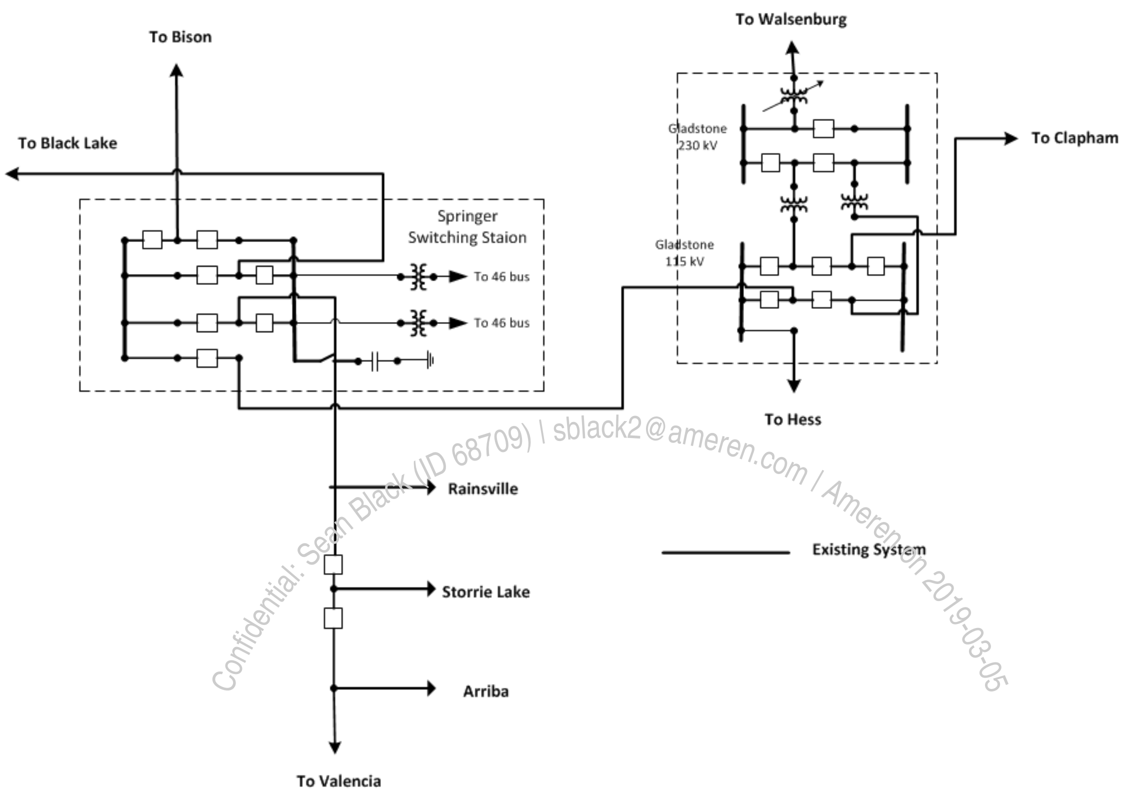

Figure 2 — Breaker level one-line drawing of the existing system.

Figure 3 represents an overlay of the proposed MLTP showing the proposed interconnection upgrades for interconnection. Due to space limitations, the existing shunt capacitor at Springer switching station will have to be moved to accommodate the MLTP. The circuit switcher that connects the capacitor today will be retired. It is assumed that when it is relocated it will be fitted with a synchronizing breaker.

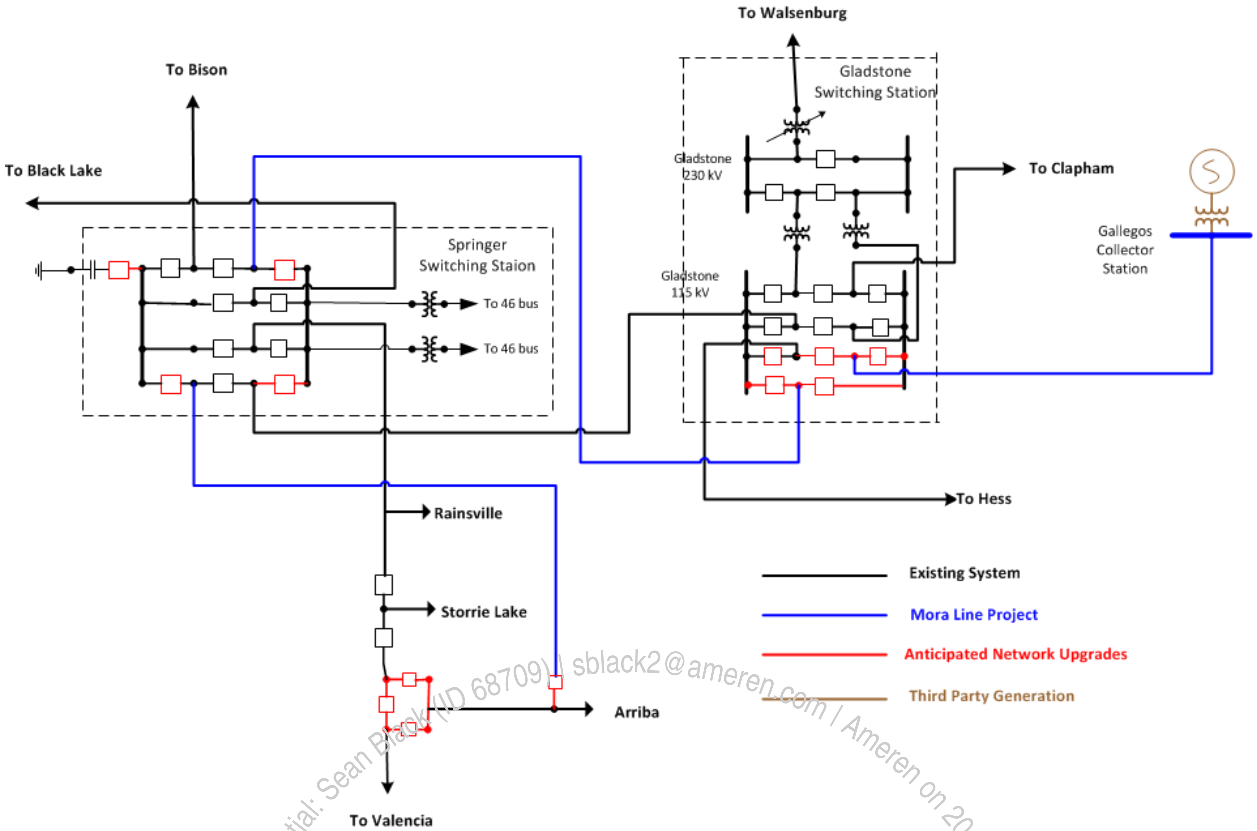

Figure 3 — Breaker level one-line drawing of the proposed MLTP

Power Transfers to the Four Corners Area

The project sponsors have expressed an interest in determining the interconnection facilities and system improvements needed to accept power at the points of interconnection to PNM's and TSGT's system and deliver up to 180 MW of power to Four Corners. Resources connected to the MLTP were offset by reducing generation beyond the Four Corners area to determine what transmission system improvements are required to deliver those resources. This analysis only determined the transmission interconnection upgrades are required for the PNM and TSGT transmission systems. The system improvements for transmission service beyond PNM's system at Four Corners will require separate requests be made with the associated transmission service providers.

The purpose of this study was to determine the system reinforcements required to safely and reliably interconnect the MLTP to the PNM and TSGT transmission systems. The final design and cost estimates of any system reinforcements required for interconnection will be undertaken in a separate facility study, should the customer decide to pursue their MLTP.

The findings of this System Impact Study are summarized as follows:

Steady-State Performance

The results of the powerflow analysis show that the amount of power that can be injected from the MTLP depends on the flow scheduled on the Gladstone Phase-Shifting-Transformer (PST). Historical flows on the Walsenburg-Gladstone line have ranged up to 180 MW with typical flows ranging in the 100 MW to 150 MW range[1]. The forecast schedules on the Walsenburg-Gladstone line are expected to be similar to what has been observed with historical flows.

This analysis showed that the 160 MW level could be accommodated without transmission system improvements when schedule flow on the Walsenburg-Gladstone 230 kV line was at or below 135 MW. The amount of power that could be accepted from the MLTP at Gladstone decreased to 83 MW with Gladstone PST schedules at 180 MW. The reduction of the Mora generation is approximately 1 MW for each MW increase in the Gladstone PST schedule. Details of this analysis are shown on page 13.

The analysis determined that the most limiting conditions for the MLTP were due to equipment limits and voltage criteria violations that occur in the 2017 light spring case. In order to support a Project schedule of 160 MW with a Gladstone PST schedule above 135 MW, transmission system improvements will be required to address several line overloads and voltage issues around Gladstone. The violations identified in this analysis include:

- Zia – Valencia 115 kV line overload
- Gladstone – Springer 115 kV (TSGT) line overload
- Gladstone – Springer 115 kV (MLTP) line overload
- Taos – Black Lake 115 kV (TSGT) line overload
- Automatic capacitor switching at Springer and Black Lake

This analysis has only identified the likely system impacts and does not address the specific transmission system improvements needed to mitigate these overloads. This will be determined at a later date through studies addressing transmission service requests on PNM's and Tri-State's systems. Specific details can be seen on pages 15 through 17.

Power factor at Gladstone Switching Station: PNM and Tri-State will require the MLTP to maintain unity power factor at the point of interconnection at the Gladstone Switching Station. Based upon the power flow analysis performed in this study, it is expected that the MLTP will have to provide up to 30 MVAr of reactive power being absorbed by the MLTP depending on the length of the line from Don Carlos (8 to 17 miles). This analysis only captures reactive compensation tied to the transmission system and does not include a specific wind collector system design at Don Carlos which will influence overall reactive compensation requirements. Ultimately the interconnection customer will have to verify that the project can meet or exceed PNM and Tri-State interconnection requirements.

[1] Historical flows on the Walsenburg – Gladstone 230 kV line pre and post PST have varied from150-200 MW as can be seen in Appendix E

Transient Stability Performance

The study results showed that the new Mora line did not cause any transient stability violations, for all single and double contingencies studied. This analysis only captured transient stability performance with an estimate of how Gallegos collector generation might perform given the plan of the MLTP. A subsequent System Impact Study will be performed when a Transmission Service Request is made which will verify acceptable system performance for the final design of the Gallegos collector system and wind turbines.

Short Circuit Analysis

A short circuit study was conducted to determine if the existing circuit breakers are sufficient to accommodate the MLTP. Based on these results, the existing circuit breakers are adequate. Please See Appendix E for detailed results.

Conclusion

Based on a potential generation injection level of 83 MW, the estimated costs and schedule for the MLTP interconnection upgrades are summarized below. (This estimate does not include costs for system improvements associated at higher output levels of MLTP.) PNM provided estimated costs and construction schedules for interconnection on PNM's at the Arabia substation. TSGT provided estimated costs and construction schedules for interconnection at the Springer and Gladstone stations. The Facility Study will provide a detail cost estimate and schedule. Both PNM and TSGT will develop their own Facility Study that will be incorporated into their wires-to-wires interconnection agreement with MLTP.

Table 1 — Transmission Interconnection Upgrades

Transmission Interconnection Upgrades	Cost	Construction time	Utility
Construct a new 3 breaker ring at the intersection of the Valencia – Storrie 115 kV line and Arriba Tap 115 kV transmission line.	8.25	18 months	PNM
Interconnect Arriba Station to MLTP via 1 115 kV breaker	1.0	6 months	PNM
Install new line positions, associated dead ends, 4-115kV circuit breakers, 5-115kV disconnects, CCVTs and metering to terminate MLTP at Springer Switching Station	2.74	24 months	TSGT
Install new line positions, associated dead ends, 5-115kV circuit breakers, 8-115kV disconnects, CCVTs and metering to terminate MLTP at Gladstone Switching Station	3.16	24 months	TSGT
Total	**15.2**	**24 months**	

Introduction

This non-tariff wires-to-wires interconnection study reviews the MLTP as requested by the customer. Previous analysis[2] identified the ability to accommodate up to 180 MW of MLTP power at Gladstone. The purpose of the analysis is to evaluate the impact and identify the facilities required to interconnect the MLTP.

This analysis is limited to studying the ability to interconnect and inject power at the points of delivery to PNM's and TSGT's systems with an assumed delivery to Four Corners on an "as available" basis only using non-firm transmission capacity. Transmission service on either PNM's or TSGT's system requires a separate request for transmission service and will be analyzed in accordance with PNM's or TSGT's Open Access Transmission Tariff ("OATT"). Likewise, this study is not and does not substitute for a generation interconnection System Impact Study. Note that Interconnection Service in and of itself does not convey Transmission Service. This study provides a non-binding cost and construction schedule estimate for all identified system reinforcements required to interconnect the MLTP.

This report details the results for the SIS which determines the physical and electrical impacts to PNM's and TSGT's transmission system from the MLTP. It then identifies the required interconnection upgrades and Customer obligations to accommodate the interconnection request. The results of this study are based on power flow (equipment and voltage performance), transient stability (dynamic simulation), and short circuit analysis.

This SIS also provides a non-binding cost and construction schedule estimate for all identified system reinforcements required for interconnection of MLTP.

Study Criteria

A system reliability evaluation consists of power flow analysis for identifying equipment overloads or voltages outside criteria (too high or low) under normal and contingency conditions. Transient stability analysis is performed to ensure all machines remain in synchronism, all voltage swings are damped within acceptable limits, and all oscillations show positive damping within 30-seconds after the start of the studied event. A short circuit analysis is performed to ensure all fault currents remain within acceptable circuit breaker and switch capabilities. Each evaluation is conducted for credible contingencies that the system might sustain, such as the loss of a single or double circuit line, a transformer, a generator or a combination of these facilities. This study was completed in accordance to NERC Standard FAC-002-2.

Performance of the transmission system is measured against the following planning criteria: the Western Electricity Coordinating Council (WECC) Reliability Criteria, and the North American Electric Reliability Council (NERC) Planning Standards. If system reliability problems resulting from the interconnection of a project are discovered, the study will identify the system facilities or operational measure that will be necessary to mitigate reliability criteria violations. Addition of these new facilities would maintain the reliability to the transmission network.

This SIS investigates whether the MLTP results in:

[2] Lucky Corridor, LLC Mora Line Transmission Project report. June 30, 2015

- Equipment overloads on transmission lines, transformers, series compensation or other devices
- Voltage criteria violations
- All machines do not remain synchronized to the transmission system
- Voltage swings exceed acceptable limits
- Positive damping does not occur within 30 seconds
- Fault duty increases that result in short circuit current that exceeds the interrupt rating of circuit breakers and switches

Power Flow Criteria

All power flow analysis is conducted with version 19.1_01 of General Electric's PSLF/PSDS/SCSC software. Traditional power flow analysis is used to evaluate equipment and voltage performance of the system under Category P0 (all elements in service), Category P1 (N-1) and Category P4 and P7 (N-2) conditions.[3]

The power flow performance criteria utilized to assess the impact of the MLTP throughout the SIS are shown in the table below. The criteria are WECC/NERC performance requirements[4] with applicable additions and/or exceptions for the New Mexico transmission system[5].

Table 2 — Power Flow Disturbance/Performance Criteria

AREA	CONDITION	LOADING LIMIT	VOLTAGE RANGE (p.u)	VOLTAGE DEVIATION	APPLICATION
EPEC (Area 11)	Normal ALIS (P0)	< Normal Rating	0.95 - 1.05	NA	BES facilities
	P1	< Emergency Rating	0.90 - 1.10	8%[5]	BES facilities
	P2-P7	< Emergency Rating	0.90 - 1.10	NA	BES facilities
PNM (Area 10)	Normal ALIS (P0)	< Normal Rating	0.95 - 1.05	NA	BES facilities
	P1	< Emergency Rating	0.90 - 1.10	8%	BES facilities
	P2-P7	< Emergency Rating	0.90 - 1.10	NA	BES facilities
Tri- State Zone (120-123)	Normal ALIS (P0)	< Normal Rating	0.95 - 1.05	NA	BES facilities
	P1	< Emergency Rating	0.90 - 1.10	8%	BES facilities
	P2-P7	< Emergency Rating	0.90 - 1.10	NA	BES facilities

1) Taiban Mesa 345, Guadalupe 345 kV and Jicarilla 345 kV voltages 0.950 and 1.10 pu under normal and contingency conditions
2) PNM will monitor 46 & 69 kV facilities
3) El Paso will monitor 69 kV facilities
4) Greenlee 345 kV is a 5% voltage Drop
5) Per 10/5/2016 - email - 7% voltage drop will be use for 345 kV buses
6) Per 10/5/2016 - email - EPE will modify its criteria in the 2017 FERC 715 filing

- All equipment loadings must be below their normal ratings under normal conditions.
- All line loadings must be below their emergency ratings for both single and double contingencies. All transformers and equipment with emergency rating should be below their emergency rating.

Transient Stability Criteria

The NERC/WECC transient stability performance requirements for transmission contingencies are as follows:

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[3] For TPL-004-0 see NERC website http://www.nerc.com
[4] For TPL-001-WECC-1-CR, TPL-002-WECC-1-CR, TPL-003-WECC-1-CR, TPL-004-WECC-1-CR see http://www.wecc.biz/Standards/WECC%20Criteria/Forms/AllItems.aspx
[5] For PNM exceptions to WECC criteria see http://www.oatioasis.com/PNM/PNMdocs/PNM_Study_Criteria_and_Guidelines_03-04-08.pdf

- All machines will remain in synchronism.
- All voltage swings are well damped.
- Following fault clearing, the voltage shall recover to 80% of the pre-contingency voltage within 20 seconds of the initiating event for all P1 through P7 events, for each applicable BES bus serving load.
- Following fault clearing and voltage recovery above 80%, voltage at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds, for all P1 through P7 events.
- All frequency dips are well damped.

Fault clearing times used in this SIS are shown in Table 3.

Table 3 — PNM Fault Clearing Times

Categories	Fault Type	Voltage (kV)	Clearing Time (near-far end breakers)
P1,P3,P6, P7	3 Phase Normally Cleared	345	4–4 Cycles
		230	4–4 Cycles
		115	4–4 Cycles
Categories	**Fault Type**	**Voltage (kV)**	**Clearing Time (normally opened breaker both near and far end—breaker opened due to stuck breaker both near and far end**
P2,P4,P5,P7	1 Phase Stuck Breaker	345	4-12 Cycles
		230	
		115	4-15 Cycles

Short Circuit Criteria

Breakers in excess of 92% are flagged for determination as to when the breaker should be considered for upgrading. Generally based on age and maintenance related issues those in excess 95% are to be scheduled for upgrade.

Power Flow Base Case Development

The following approved WECC cases were used to evaluate the proposed transmission project. A 2020 Heavy Summer case (2020HS2a), a 2021 Heavy Winter case (2021HW1a) and 2017 Light Spring case (2017 LSP) were used to model the base system as well as the post MLTP.

Case	Projects
2020HS2A	Base system
2020HS2A-post project	Base system with MLTP and associated generation
2021HW1A	Base system
2021HW1A-post project	Base system with MLTP and associated generation

2017LSP	Base System
2017LSP-post project	Base system with MLTP and associated generation

Details of the generation dispatch and resulting path/transmission element flows, and bus voltages of interest are discussed in the "Power Flow Case Attributes" section of this report.

Generation Dispatch

Generation dispatch (before the addition of MLTP) of existing and planned facilities for each case used in the analysis is itemized in the table below. It was assumed the associated generation for the MLTP would displace generation in California for modeling purposes.

Table 4 — Generation Dispatch

Unit	Nameplate Rating	2020 HS output	2020-2021 HW output	2017 LS output
Coal				
San Juan Unit 1	370	360	360	232.9
San Juan Unit 2 (retired)	0	0	0	0
San Juan Unit 3 (retired)	0	0	0	0
San Juan Unit 4 (Area Swing)	544	510	530	485/500
Four Corners Unit 1 (retired)	0	0	0	0
Four Corners Unit 2 (retired)	0	0	0	0
Four Corners Unit 3 (retired)	0	0	0	0
Escalante Generating Station	265	223	234	150
Comanche 1 & 2	725	671	689	490
Comanche 3	805	780	750	450
Natural Gas/Oil				
Reeves 1 (Natural Gas)	43	0	0	0
Reeves 2 (Natural Gas)	44	0	0	0
Reeves 3 (Natural Gas)	66	25	25	0
Rio Bravo (Natural Gas/Oil)	132	0	0	0
Luna Energy Facility (Natural Gas)	570	520	520	330
Lordsburg (Natural Gas)	80	0	0	0
Afton (Natural Gas)	235	235	0	0
Valencia Energy Facility (Natural Gas)	173	117	0	0
La Luz #1 (Natural Gas)	42.3	0	0	0
San Juan Gas Plant	87	81	81	81
Pyramid Generating Station (Natural	160	104	25	61
Black Hills CT (BACULITE)	400	375	250	183
Wind Resources				
Taiban Mesa Wind Project	200	10	100	100
Aragonne Mesa Wind Project	90	69	69.0	69
Red Mesa Wind Project	102	5	51	51
High Lonesome Mesa Wind Project	100	78	78	78
Solar Resources				
Ambrose Solar Project	9	9	0	0
Reeves Solar Project	3	2	0	0
Los Lunas Solar Project	7	5	0	0
Manzano Solar Project	8.9	6	0	0
Marquez Solar Project	10	7	0	0
Meadow Lake Solar	9	6	0	0
Prosperity Energy Storage (Studio)	.5	.5	0	0
Enchanted Mesa	9.8	6	0	0
VIA	10	7	0	0
Huning Solar	10	7	0	0
Las Vegas Solar	5.0	5	0	0
Walh North	10	7	0	0

South Valley	9.5	6	0	0
Santolina Solar	11	7	0	0
Santa Fe Solar	9.75	9.75	0	0
Cook Solar	5	5	0	0
Cimaron Solar	30	10.3	0	0
COMANCHE Solar	120	78	0	0

Power Flow Case Attributes

Table 5 provides an overview of the power flow cases after loading the project and the generation pattern into the study cases.

Table 5 — Power Flow Case Attributes – Base Scenario

Unit	2020 HS (MW)			2020-2021 HW (MW)			2017 LSP MW		
	Pre	Post	Sens: PST 180	Pre	Post	Sens: PST 180	Pre	Post	Sens: PST 180
Path 47: Southern New Mexico	76	76	76	365	366	366	428	429	429
Path 48: Northern New Mexico	1818	1640	1692	1723	1011	1614	349	211	257
Blackwater Converter	0	0	0	0	0	0	0	0	0
Arroyo Phase-Shifter	11	11	11	51	46	46	48	48	48
Walsenburg-Gladstone line	132	132	180	135	133	180	107	107	180
Don Carlos Generation	N/A	160	115	N/A	160	115	N/A	160	83

Several updates were made to all of the WECC seed cases:

- Add TSGT's planned 30 MVAR (2 x 15) shunt capacitors at Gladstone 115 kV.
- Modify the Gladstone PST and Arroyo PST transformer type in order to control/hold the flow to the current level for each case.
- Removed the San Juan Project which included:
  - Shiprock – Black Glade 230 kV line
  - Black Glade – Black Glade 230 PST
  - Black Glade – Coyote G 230 kV line
  - Coyote G – Iron Horse 230 kV line
  - Glade Tap – Black Glade S 115 kV line
  - Black Glade S – Black Glade W 115 kV line
  - Black Glade W - Black Glade WP 115 PST
  - Black Glade WP – Black Glade N 115 kV line
  - Black Glade N – El Paso Tap 115 kV line
- Update the following transformers connected to the San Juan 345 kV bus to a three-winding model:
  - 345/69 kV transformer
  - 345/230 kV transformer
- Update the Rio Puerco SVC model based on final design.
- Add Jicarilla shunt reactor
- Update the New San Juan gas generation

- Add Cabezon 345 kV and update topology
- Add Torreon 115 kV and update topology
- Open San Ysidro – Algodones 115 kV

In addition, the Los Alamos load (zone 133) was reduced in the 2020 HS and the 2021 HW cases.

- HS: Reduce Los Alamos load from 132.6 MW to 104 MW
  HW: Reduce Los Alamos load from 126.4 MW to 104 MW

List of Contingencies

The contingencies evaluated for power flow (equipment & voltage) in this SIS are listed below.

Table 6 — Power Flow Contingencies

NO.	CATEGORY	CONTINGENCY DESCRIPTION
Category P0 Contingences		
0	P0	All-lines-in service
Category P1 Contingencies		
1	P1	Ojo-Taos 345 kV Line
2	P1	San Juan-Jicarilla 345 kV
3	P1	Jicarilla-Ojo 345 kV
4	P1	San Juan-McKinley 345 kV Line 1
5	P1	San Juan-McKinley 345 kV Line 2
6	P1	San Juan-Shiprock 345 kV Line
7	P1	Cabezon -Rio Puerco 345 kV Line
8	P1	San Juan-Hesperus 345 kV Line
9	P1	San Juan-Four Corners 345 kV Line
10	P1	Four Corners-Rio Puerco 345 kV Line
11	P1	Rio Puerco-West Mesa 345 kV Line
12	P1	BA-Rio Puerco 345 kV Line 1
13	P1	BA-Norton 345 kV Line
14	P1	BA-Guadalupe 345 kV Line
15	P1	West Mesa-Sandia 345 kV Line
16	P1	Norton 345/115 kV Transformer
17	P1	Rio Puerco 345/115 kV Transformer
18	P1	BA 345/115 kV Transformer
19	P1	San Juan 345/230 kV Transformer
20	P1	West Mesa 345/115 kV Transformer 1
21	P1	Ojo 345/115 kV Transformer
22	P1	Taos 345/115 kV Transformer 1
23	P1	Gladstone-Walsenburg 230 kV Line
24	P1	Comanche-Walsenburg 230 kV Line, transfer trips Walsenburg-Gladstone 230 kV
25	P1	West Mesa-Ambrosia 230 kV Line
26	P1	Gladstone 230 kV PST
27	P1	Gladstone 230/115 kV Transformer 1
28	P1	Walsenburg 230/115 kV Transformer T2
29	P1	West Mesa 230/115 kV Transformer 1
30	P1	Bison-Cimarron 115 kV Line

NO.	CATEGORY	CONTINGENCY DESCRIPTION
31	P1	Taos-Springer 115 kV Line
32	P1	Clapham-Rosebud 115 kV Line
33	P1	Gladstone-Clapham 115 kV Line
34	P1	Gladstone-Hessbdw 115 kV Line
35	P1	Taos-Hernandez 115 kV Line
36	P1	Springer-Storrie Lake 115 kV Line
37	P1	Springer-Bison 115 kV Line
38	P1	Gladstone-Springer 115 kV Line 1
39	P1	Gladstone-Springer 115 kV Line 3 (PROJECT ELEMENT)
40	P1	York Canyon-Bison 115 kV Line
41	P1	Storrie Lake-Valencia-Arriba 115 kV Line (3-term outage)
42	P1	Springer - Arriba -Gal -Arriba Tap 115 kV Line (Post-MLTP – New breaker at Arriba Tap)
43	P1	Zia-Valencia 115 kV line (Zia-Eldorado-Colinas-Rowe Tap-Valencia)
44	P1	Norton-Hernandez 115 kV Line
45	P1	Ojo-Hernandez 115 kV Line
46	P1	Norton-Zia 115 kV line (NS)
47	P1	Norton-Zia-Algodones 3 terminal 115 kV line
48	P1	Zia-BA 115 kV line
49	P1	Bluewater-Ambrosia 115 kV line
50	P1	Zia1-Zia2 115 kV line
51	P1	Norton-ETA 115 kV line
52	P1	BA-STA Station 115 kV line
53	P1	Clapham 115/69 kV Transformer
54	P1	Gallegos Collector Generator (Post-MLTP)
55	P1	Gallegos Collector-Gladstone 115 kV Line (PROJECT ELEMENT)
56	P1	Comanche – Boone 230 kV (Gladstone PST Sensitivity)
57	P1	Comanche - CF&IFURN 230 kV (Gladstone PST Sensitivity)
58	P1	Comanche – MidwayPS 230 kV (Gladstone PST Sensitivity)
59	P1	Daniel Peak – Comanche 345 kV (Gladstone PST Sensitivity)
60	P1	Comanche 345/230 Transformer (Gladstone PST Sensitivity)
61	P1	Comanche 230/155 Transformer (Gladstone PST Sensitivity)
62	P1	Comanche Solar (Gladstone PST Sensitivity)
63	P1	Comanche Unit 1 (Gladstone PST Sensitivity)
64	P1	Comanche Unit 2 (Gladstone PST Sensitivity)
Category P4 & P7 Contingencies		
65	P4	Rio Puerco - BA 1&2 345 kV lines
66	P4	San Juan –Jicarilla & Jicarilla – Ojo 345 kV lines
67	P7	Springer-Gladstone #1 & #3 115 kV lines (Post-MLTP)
68	P7	Rio Puerco-West Mesa #1 &# 2 345 kV lines

The contingencies evaluated for transient stability in this SIS are listed below.

Table 7 — Transient Stability Contingencies

NO.	CATEGORY	CONTINGENCY DESCRIPTION	CLEARING TIME (CYCLES)
Category P0 Contingencies			

NO.	CATEGORY	CONTINGENCY DESCRIPTION		CLEARING TIME (CYCLES)
0	P0	No Disturbance run		n/a
Category P1 Contingencies				
1	P1	West Mesa – Arroyo 345 kV	3-phase fault near WEST MESA 345 kV	4
2	P1	Cabezon –Rio Puerco 345 kV	3-phase fault near RIO PUERCO 345 kV	4
3	P1	San Juan – Jicarilla 345 kV	3-phase fault SAN JUAN 115 kV	4
4	P1	Gladstone - Springer 115 kV #1	3-phase fault near GLADSTONE 115 kV	4
5	P1	BA – Norton 345 kV (WB)	3-phase fault near BA 345 kV	4
6	P1	Walsenburg – Gladstone 230 kV	3-phase fault near GLADSTONE 230 kV	4
7	P1	Valencia – Zia 115 kV	3-phase fault near VALENCIA 115 kV	4
8	P1	Taos - Springer 115 kV	3-phase fault near TAOS 115 kV	4
Category P4 & P7 Contingencies				
9	P4	BA – Rio Puerco 345 kV (two circuits)	3-phase fault near RIO PUERCO 345 kV Delayed clearing of line #2.	4, 12
10	P4	San Juan-Jicarilla & Jicarilla-Ojo	3-phase fault near JICARILLA 115 kV Delayed clearing of Jicarilla-Ojo line	4, 12
11	P7	Springer – Gladstone #1 & #3 (post-MLTP)	3-phase fault near GLADSTONE 115 kV	4

Power Flow Analysis Results

The study modeled the interconnection of the MLTP to PNM's radial 115 kV transmission line serving the PNM Arriba distribution substation, with additional 115 kV interconnections at TSGT's Gladstone and Springer 115 kV Switching Stations. A wind generator connected to MLTP at Don Carlos was modeled with up to 180 MW of generation dispatched in order to analyze the potential impacts of the MLTP. The line to Don Carlos was modeled using 17 miles distance but has been changed to 8 miles and this change will have no material impact to the study results.

Power Flow Results

Sixty eight (68) outages were simulated for each case modeling the 2020 Heavy Summer, 2021 Heavy Winter, and 2017 Light Spring timeframes. The post-project cases included the MLTP and up to 180 MW of generation at the Gallegos Collector for initial analysis.

Heavy Summer Analysis

Results using the 2020 Heavy summer cases did not identify performance criteria violations at a full 180 MW Gallegos Collector output for Gladstone PST schedules of 132 MW or less in a north to south direction.

Heavy Winter Analysis

Review of the thermal results identified one Gallegos Collector triggered overload at 180 MW of generation. Reducing the generation to 160 MW eliminated the overload. These results are tabulated in Table 8.

Table 8 – 2021 Heavy Winter Results

2021 HW					
#	Branch/Element	Contingency Description	Pre	Post 160 MW	Post 180 MW
1	Gladstone-Springer 115 kV (TSGT) Line	Gladstone-Springer 115 kV MLTP	n/a	93.7	103.2

Light Spring Analysis

Review of the power flow results identified six new overloads with the Gallegos Collector associated generation at 180 MW and the Gladstone PST schedule at 107 MW. Reducing the generation to 160 MW eliminated the overloads with a Gladstone PST schedule set to a 107 MW north to south schedule. These results are tabulated in Table 8.

Table 9 – 2017 Light Spring Results With Gladstone PST at 107 MW

2017 Light Spring					
#	Branch/Element	Contingency Description	Pre	Post 160 MW	Post 180 MW
1	Gladstone-Springer 115 kV (TSGT)	Gladstone-Springer 115 kV Line (MLTP)	n/a	94.1	104.4
2	Arriba Tap – Valencia 115 kV	Taos – Springer 115 kV Line	5.2	99.4	110.8
3	Valencia – Rowe Tap 115 kV		4.0	98.3	109.6
4	Rowe Tap – Colinas 115 kV		2.0	95.2	106.5
5	Colinas – Eldorado Tap 115kV		2.1	93.6	104.9
6	Eldorado Tap – Zia 115 kV		2.7	92.9	104.2

Sensitivity: Maximum Gladstone PST Schedule

Additional analysis for the summer, winter and light spring conditions was performed with the Gladstone PST at a 180 MW north to south schedule. Results show that the amount of power injected by the project needs to be reduced by approximately 1 MW for each 1 MW increase in the Gladstone PST schedule without system improvements to accommodate the higher flow levels. The most limiting conditions occur during the light spring season with the MLTP generation limited to 83 MW at a Gladstone PST flow of 180 MW. Table 10 shows MLTP caused overloads with the MLTP generation output at 160 MW and a Gladstone PST flow of 180 MW in the light spring case. The analysis is an indication of system impacts which will be explored further along with mitigations when Transmission Service Request related studies are performed.

Table 10 — Light Spring Overloads with Gallegos Collector at 160 MW and Gladstone PST setting at 180 MW.

#	Branch/Element	Contingency Description	Post – MLTP 160 MW Output
1	Arriba Tap – Valencia 115 kV	Taos – Springer 115 kV Line	145.8
2	Valencia – Rowe Tap 115 kV		144.6
3	Colinas – Rowe Tap 115 kV		141.5
4	Eldorado Tap – Colinas 115 kV		139.8
5	Zia – Eldorado Tap 115 kV		139.1
6	Gladstone-Springer 115 kV (TSGT)	Gladstone-Springer 115 kV (MLTP)	132.5
7	Gladstone-Springer 115 kV (MLTP)	Gladstone-Springer 115 kV (TSGT)	103.6
8	Black Lake – Cruzalta Tap	Line Valencia-Zia 115 kV	101.3
9	Taos – Cruzalta Tap		100.1

Power Flow Summary:
Based on the above findings, the MLTP could accommodate up to 83 MW of Gallegos Collector injections without additional system upgrades for a 180 MW Gladstone PST flow[6] in light loading conditions. The reduction on the MLTP generation will be approximately a 1 for 1 ratio for the increase of the Gladstone PST flow. These upgrades will be addressed when specific Transmission Service Requests are made to deliver Gallegos Collector generation.

Power Flow – Voltage Performance Results

The voltage analysis focused on PNM and TSGT in Areas 10 and 70, and on voltages 46 kV and above.

Heavy Summer Analysis

Results showed no MLTP-triggered voltage violations for the Heavy Summer case with 160 MW of generation at higher Gladstone PST flow of 132 MW.

Heavy Winter Analysis

The 2021 HW cases were adjusted to incorporate a 1.035 voltage set point at the Black Lake 115 kV bus, affecting the operation of the Black Lake capacitors. (The 2017 LSP case and the 2020 HS case had the Black Lake voltage set point at 1.038 and 1.035 respectively, whereas the 2021 HW seed case had a set point of 1.025. Increasing the HW set point to 1.035 brought it in line with the other two cases and the anticipated operation of the TSGT system.)

Results show MLTP triggered high voltages at the limit of the criteria for the P7 of Springer-Gladstone Circuits (TSGT and MLTP lines). Mitigation would be to open capacitors at Springer post contingency.

[6] Report: Methodology for Determining System Operating Limits of the Gladstone Phase Shifting Transformer

Table 11 – 2021 Heavy Winter Post-Contingency Voltage Results

2021 Heavy Winter, one TSGT Gladstone-Springer line					PU Voltage		
#	Bus	kV	Area	Contingency	WECC – CRT-3	Post 160 MW	Mitigation
1	ARRIBA	115	10	P7: Springer – Gladstone TSGT & MLTP 115 kV lines (Post-MLTP Contingency)	1.1	1.09	Turn off Springer SVD/cap
2	ARRIBA_T	115	10		1.1	1.09	
3	VALENCIA	115	10		1.1	1.09	
4	GALLINAT	115	10		1.1	1.09	
5	SPRINGER	69	10		1.1	1.12	
6	YORKCANY	69	10		1.1	1.12	

The above findings were based on Mora generation of 160 MW at a Gladstone PST schedule of 135 MW north to south.

Light Spring Analysis

The Black Lake and Springer SVDs are both on pre-contingency in the post-MLTP case.

Results showed high voltage violations in the post-MLTP case for the loss of both Springer-Gladstone Circuits (TSGT and MLTP lines). These voltages can be mitigated post-contingency by turning off the Springer capacitor and allowing the Springer 115/69 kV transformer taps to operate. Alternately, if the pre-contingency voltage at Springer is lowered to ~ 1.0 pu (turning off the Springer shunt capacitor) and the WECC-CRT-3 voltage limits are employed, the only potential voltage issues are at the Springer 69 kV bus and the York canyon 69 kV buses which could be adjusted with transformer taps, or by turning off the Black Lake SVD. If faster post-contingency operation is required, the MLTP could install a fast acting reactive source (~ 13 MVAr) at Springer 115 kV or replace/upgrade the existing Springer SVD with a faster-acting device.

Table 12 – 2017 Light Spring Post-Contingency Voltage Results

2017 Light Spring, one TSGT Gladstone-Springer line							
#	Bus	kV	Area	Contingency	WECC – CRT-3	Post 160 MW	Mitigation
1	ARRIBA	115	10	P7: Springer – Gladstone TSGT & MLTP 115 kV lines (Post-MLTP Contingency)	1.1	1.11	Turn off Springer SVD/cap and allow the Springer 115/69 kV transformer taps to operate
2	ARRIBA_T	115	10		1.1	1.11	
3	VALENCIA	115	10		1.1	1.11	
4	GALLINAT	115	10		1.1	1.11	
5	BLACKLAK	69	10			1.10	
6	BLACKLAK	115	10		1.1	1.10	
7	SPRINGER	69	10			1.15	
8	SPRINGER	115	10		1.1	1.13	
9	STORRIE	115	10		1.1	1.11	
10	YORKCANY	69	10			1.14	
11	YORKCANY	115	10		1.1	1.12	
12	RAINSVIL	115	10		1.1	1.12	

13	RAINSVILX	115	10		1.1	1.12	
14	BISON	115	10		1.1	1.12	
15	CIMARRON	115	10		1.1	1.12	

Sensitivity: Gladstone Phase Shifting transformer at 180 MW

The voltage performance with the Gladstone PST at 180 MW was the worst in the light spring case as seen below in Table 13. The required mitigation is automatic capacitor tripping post contingency at Springer and Black Lake. Gallegos Collector generation was dispatched at 160 MW for this analysis. This result was not verified in Stability and is only an indication of voltage remediation that will have to be revisited upon a Transmission Service Request (System Impact Study) analysis where the actual plan of service will be studied.

Table 13— Light Spring Gladstone PST 180 case

2017 Light Spring							
#	Bus	kV	Area	Contingency	WECC – CRT-3	Post 160 MW	Mitigation
1	ARRIBA	115	10	P7: Springer – Gladstone TSGT & MLTP 115 kV (Post-MLTP Contingency)	1.1	1.10	Automatically trip Springer and Black Lake capacitors allow the Springer 115/69 kV transformer taps to operate
2	ARRIBA_T	115	10		1.1	1.10	
	12ST_TAP	46	10			1.11	
	BACA	46	10			1.11	
3	VALENCIA	115	10		1.1	1.10	
	VALENCIA	46	10			1.11	
4	GALLINAT	115	10		1.1	1.10	
5	BLACKLAK	69	10			1.10	
6	BLACKLAK	115	10		1.1	1.09	
7	ROWE_TAP	115	10		1.1	1.08	
8	SPRINGER	69	10			1.17	
9	SPRINGER	115	10		1.1	1.11	
10	STORRIE	115	10		1.1	1.10	
11	YORKCANY	69	10			1.15	
12	YORKCANY	115	10		1.1	1.12	
13	RAINSVIL	115	10		1.1	1.11	
14	RAINSVILX	115	10		1.1	1.11	
17	BISON	115	10		1.1	1.11	
18	CIMARRON	115	10		1.1	1.11	

Other notable observations: The Walsenburg-Gladstone contingency in the post project heavy winter case results in the solution diverging due to voltage rising when the Remedial Action Scheme (RAS) sheds load. Not allowing the RAS to shed load in the heavy winter case mitigates the voltage rising which causes a no solution. In the heavy summer case, the Walsenburg – Gladstone contingency solves but has post contingency voltages in the range of 1.11 to 1.24 pu. Again this can be mitigated by eliminating the load shedding on the Walsenburg –Gladstone RAS. If the project moves forward further modification to the RAS will be necessary.

Short-Circuit Analysis Results

A short circuit study was conducted to determine if the existing circuit breakers are sufficient to accommodate the MLTP. Based on these results, the existing circuit breakers are adequate. See Appendix E for detailed information.

Transient Stability Analysis Results

The study results showed that the new Mora line did not cause any transient stability violations, for all single and double contingencies studied. This analysis only captured transient stability performance with an estimate of how Gallegos collector generation might perform given the plan of the MLTP. A subsequent System Impact Study will be performed when a Transmission Service Request is made which will verify acceptable system performance for the final design of the Gallegos collector system and wind turbines.

For the HW case, the P1 contingency of Gladstone – Springer 115 kV diverged in the pre-MLTP and post-MLTP case. Evaluating the solution of the dynamic simulation revealed there was in insufficient reactive support at Rosebud due to voltage collapse. This analysis was followed up by installing a Rosebud 115 kV shunt capacitor (30 Mvar), and it resolved the convergence issue. Note: The shunt capacitance requirements at Rosebud were not optimized during this study.

Other non-MLTP issues are noted below.

The Bravo Dome out-of-step relay protection (ooslen) opened the Clapham – Rosebud 115 kV line for the loss of the Gladstone – Springer 115 kV both pre and post-MLTP for each case, and subsequently on the loss of Gladstone – Springer TSGT & MLTP 115 kV for the HS and LSpr cases. It also operated for the loss of the Walsenburg – Gladstone 230 kV line in the HS case both pre and post-MLTP, and for the breaker failure scenario of the Jicarilla – San Juan and the Jicarilla - Ojo lines in the pre-MLTP case only. In all cases, its operation originates pre-MLTP.

An angle violation at TA-3-AL was seen both pre and post MLTP for the below contingencies in the HW case. HW is the only season with this unit on (or any unit at this bus). Netting the generator model at this bus resolved the problem. This issue was not triggered by the MLTP.

- P1: West Mesa – Arroyo PS 345 kV
- P1: Cabezon – Rio Puerco 345 kV
- P1: San Juan – Jicarilla 345 kV
- P1: BA-Norton 345 kV
- P4: BA-Rio Puerco #1 & #2 345 kV

Updates to the dynamic file and cases are noted below.

The following TSGT changes were made to the dynamic models (dyd) file.

- Update the old Clapham 50 MVAR SVC “vwscc” model with the “svcwsc” model
- Add the Bravo Dome out-of-step relay protection (Clapham-Rosebud 115 kV)
- Add the UVLS to drop Hilltop/Springfield loads (tlin1)

The following changes were made to the customer dynamic data (Gallegos Collector generation):

- The reference buses in the repc_a and lhvrt models referred to a 230 kV bus. This was updated to the 115 kV Gallegos Collector bus.
- The regc_a and reec_a models were modified to eliminate ringing at the generator buses and other nearby buses in the HW case for the following contingencies: Gladstone-Springer 115 kV, Walsenburg-Gladstone 230 kV, Valencia-Zia 115 kV, Taos-Springer 115kV, and Springer-Gladstone TSGT & MLTP 115 kV. See Appendix for details.

The power flow analysis modeled the Gallegos Collector generation at the Gallegos Collector 115 kV bus, but the dynamic data file (dyd) provided later had the generator at 0.69 kV. Thus for the transient stability analysis the generator modeling was updated to include two transformers: 115/34.5 kV and 34.5/0.69 kV. No collector system was modeled since no data was supplied for it. A fixed tap was added on the 34.5/0.69 kV transformer to keep the generator bus at a reasonable voltage.

Transmission Interconnection Facilities

The cost and schedule for the interconnection of the MLTP to the PNM and the TSGT facilities are summarized below. Theses estimated costs and construction schedules were developed by PNM and TSGT for their respective interconnection to MLTP. The Facility Study will provide a detail cost estimate and schedule. Both PNM and TSGT will develop their own Facility Study that will be incorporated into their wires-to-wires interconnection agreement with MLTP.

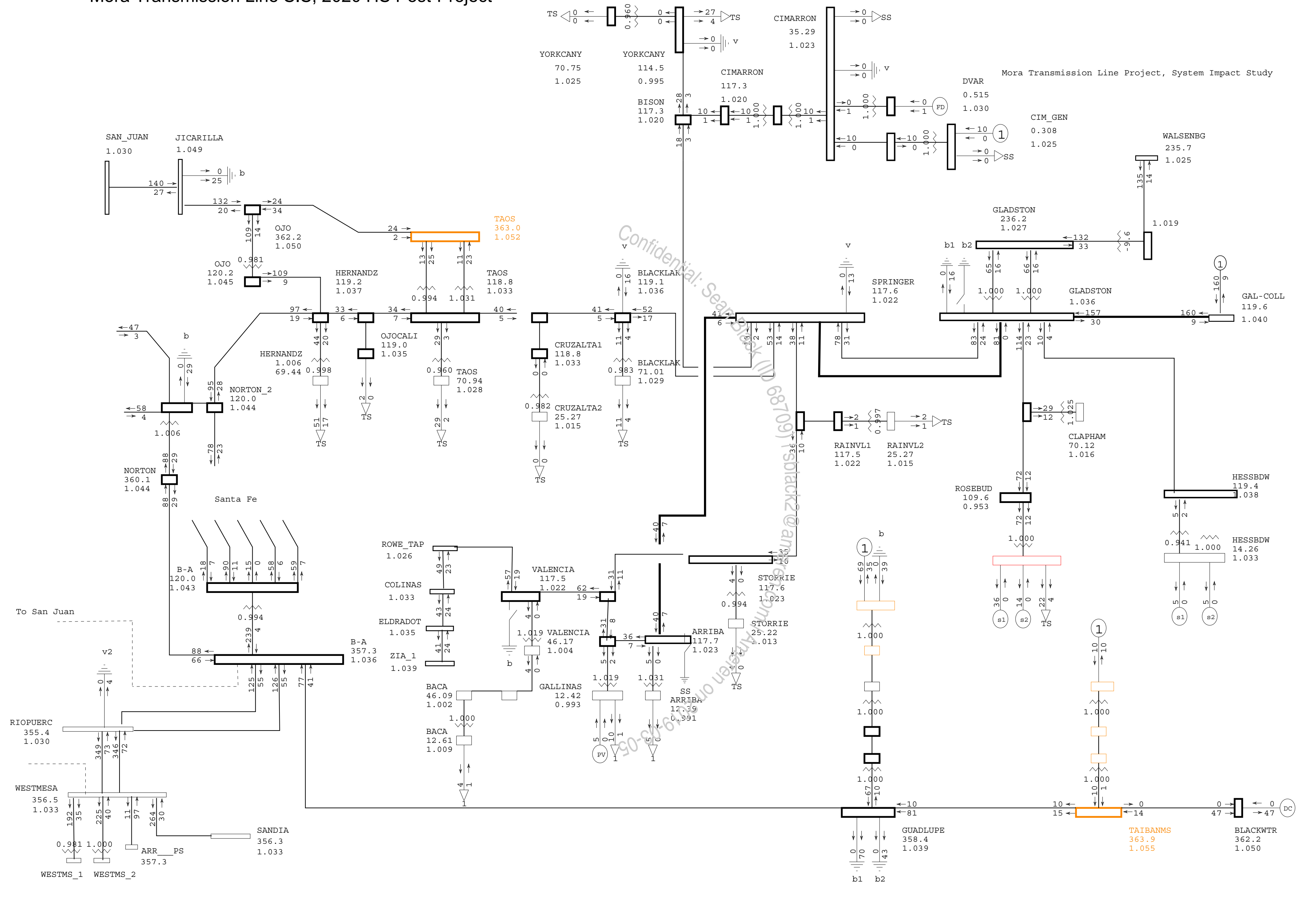
Transmission Interconnection Facilities	Cost	Construction time	Utility
Construct a new 3 breaker ring at the intersection of the Valencia – Storrie 115 kV line and Arriba Tap 115 kV transmission line.	8.25	18 months	PNM
Interconnect Arriba Station to MLTP via 1 115 kV breaker	1.0	6 months	PNM
Install new line positions, associated dead ends, 4-115kV circuit breakers, 5-115kV disconnects, CCVTs and metering to terminate MLTP at Springer Switching Station	2.74	24 months	TSGT
Install new line positions, associated dead ends, 5-115kV circuit breakers, 8-115kV disconnects, CCVTs and metering to terminate MLTP at Gladstone Switching Station	3.16	24 months	TSGT
Total	**15.2**	**24 months**	

Appendix A – Power Flow Plots

Diagrams for the following post-Project cases are provided:

1. 20 Heavy Summer
2. 21 Heavy Winter
3. 17 Light Spring

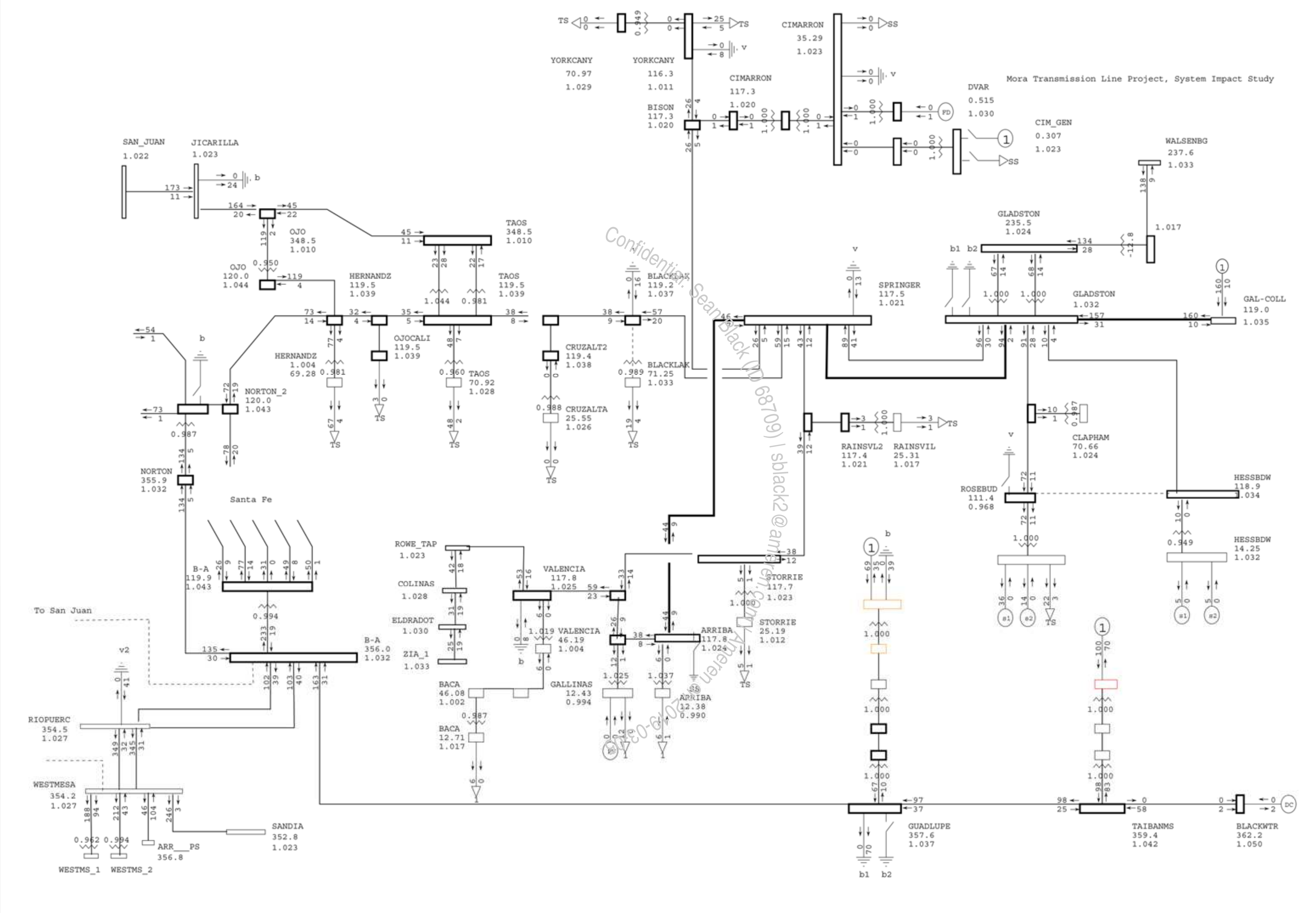
Mora Transmission Line SIS, 2020 HS Post-Project



General Electric International, Inc. PSLF Program Wed Sep 14 16:12:35 2016 02_20hs2a_post_160MW_pf.sav

2020 HS Case, Mora TL SIS Post-project. 160 MW. Offset gen at Navajo.	WECC 2020 HEAVY SUMMER 2 PLANNING CASE 9/23/14	MW/MVAR PNM_MoraSIS_post_r3b.drw Rating = 1

Mora Transmission Line SIS, 2021 HW Post-Project



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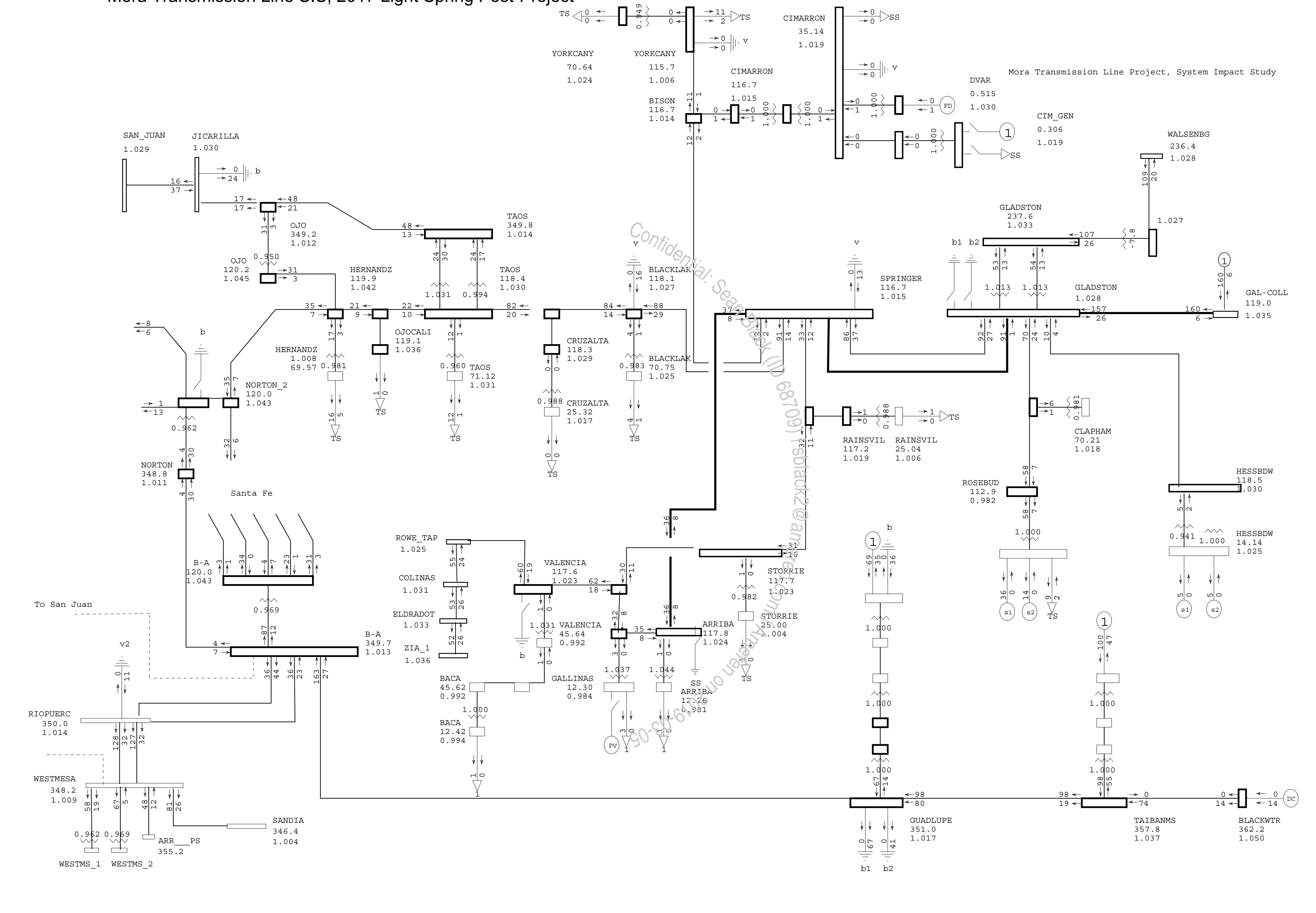
Mora Transmission Line SIS, 2017 Light Spring Post-Project



General Electric International, Inc. PSLF Program Wed Sep 14 16:14:45 2016 06_17lsp_post_160MW_pf.sav

GE	2017 LSP Case, Mora TL SIS Post-project. 160 MW. Offset gen at Navajo.	WECC 2017 LSP1-S PLANNING CASE 11/6/14	MW/MVAR PNM_MoraSIS_post_r3b.drw Rating = 1

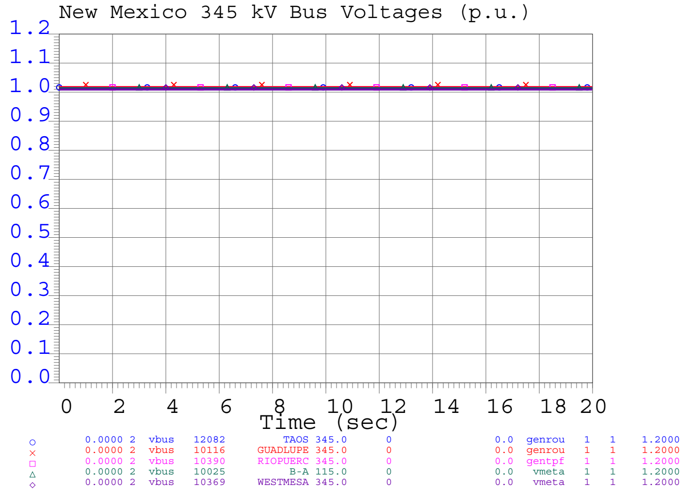
Appendix B – Transient Stability Plots

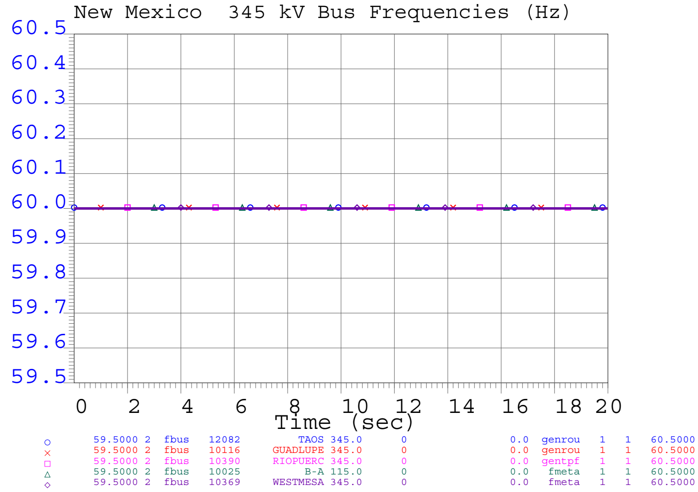
This appendix provides a sample of the transient stability plots run as part of this study. Additional plots may be provided on request.

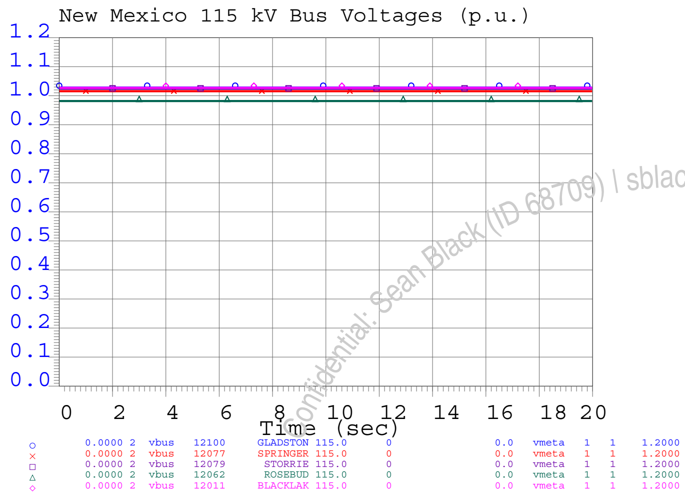
The plots represent the post-project case with generation dispatched at 160 MW. Plots for the following contingencies are provided:

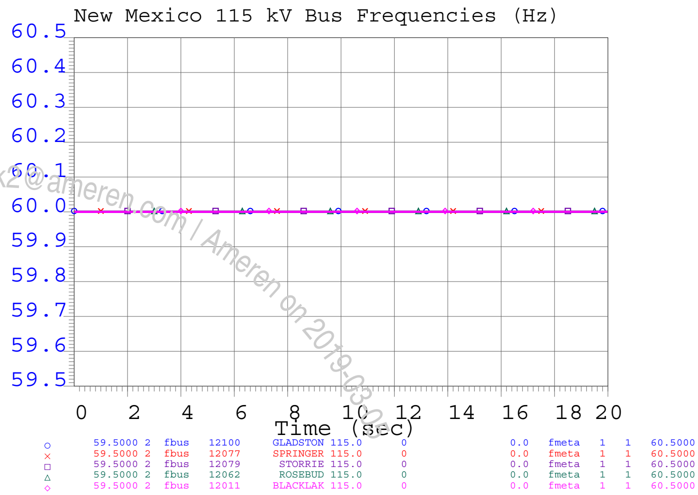
NO.	CONTINGENCY DESCRIPTION		CLEARING TIME (CYCLES)	SEASON
All Lines in Service				
1	FLAT RUN			17 LSp
P1 Contingencies				
2	Cabezon –Rio Puerco 345 kV	3-phase fault near RIO PUERCO 345 kV	4	17 LSp
3	Gladstone - Springer 115 kV #1	3-phase fault near GLADSTONE 115 kV	4	17 LSp
4	Walsenburg – Gladstone 230 kV	3-phase fault near GLADSTONE 230 kV	4	17 LSp
5	Valencia – Zia 115 kV	3-phase fault near VALENCIA 115 kV	4	21 HW
6	Taos - Springer 115 kV	3-phase fault near TAOS 115 kV	4	21 HW
P4 Contingencies				
7	San Juan-Jicarilla & Jicarilla-Ojo	3-phase fault near JICARILLA 115 kV Delayed clearing of Jicarilla-Ojo line	4, 12	21 HW
P7 Contingencies				
8	Springer – Gladstone #1 & #3 (post-Project)	3-phase fault near GLADSTONE 115 kV	4	21 HW

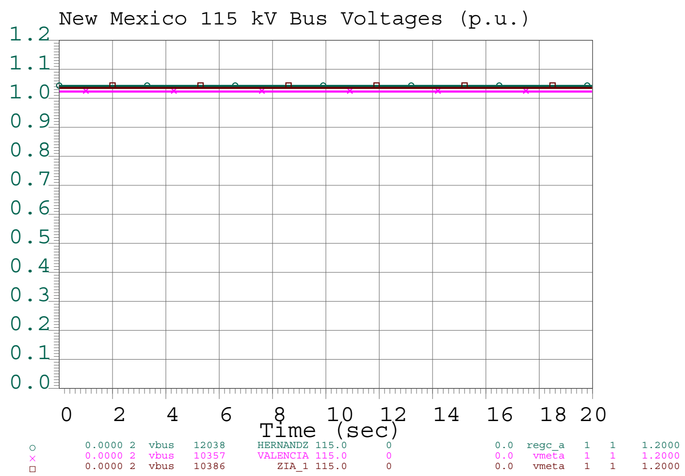
MORA
Transient Stability Plots

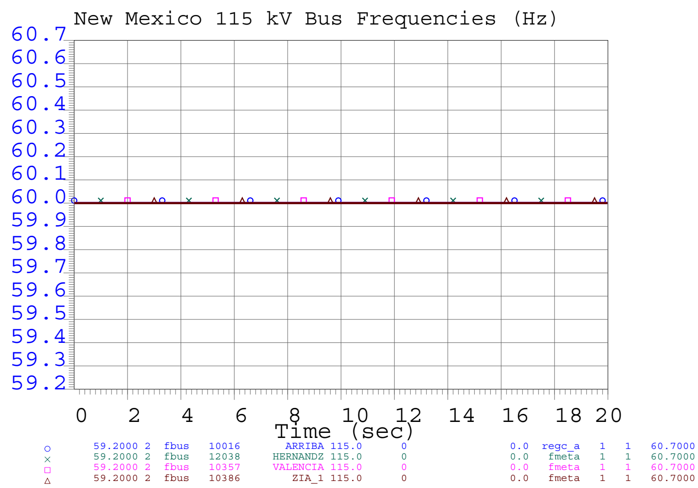












2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
1 01_N-0_FLAT_RUN

C:\!USE\dynamics\000001-01_N-0_FLAT_RUN-06_17lsp_post_160MW_ts.chf

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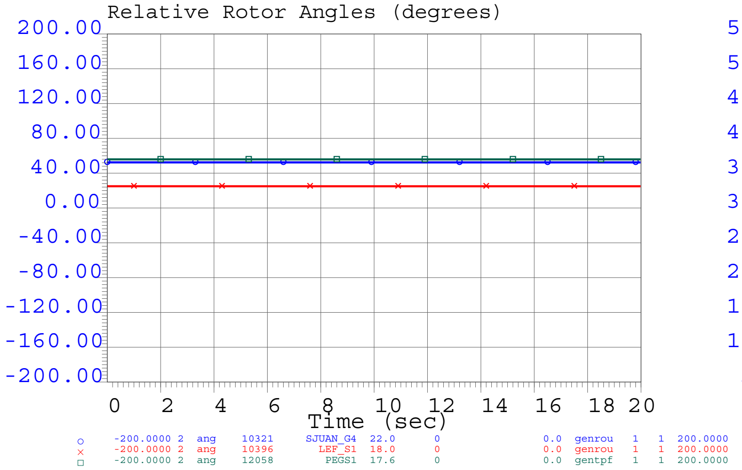
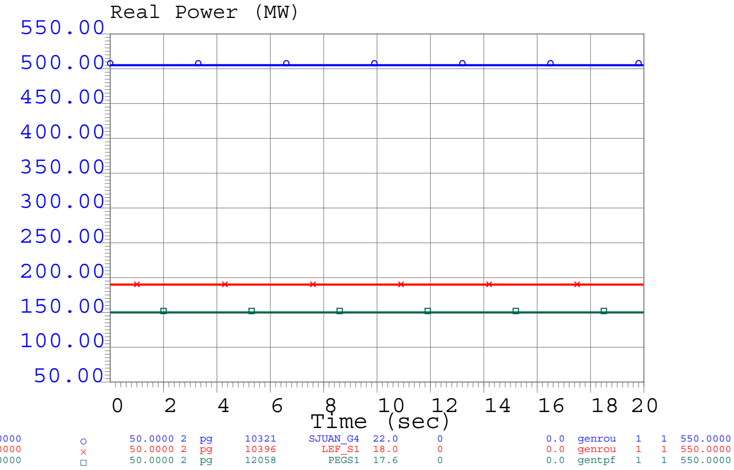
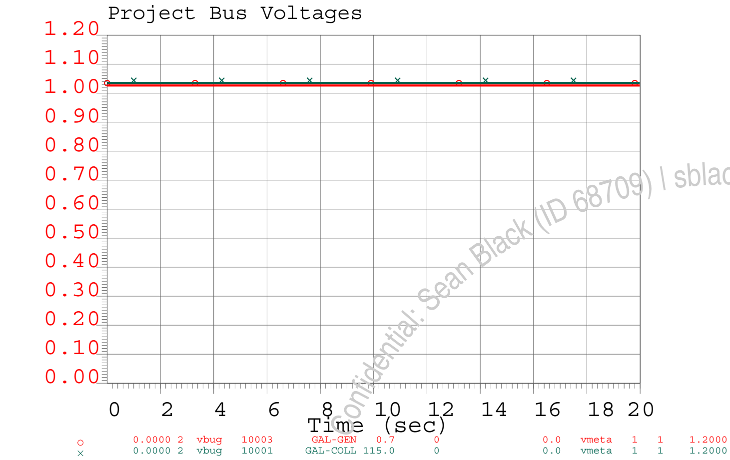
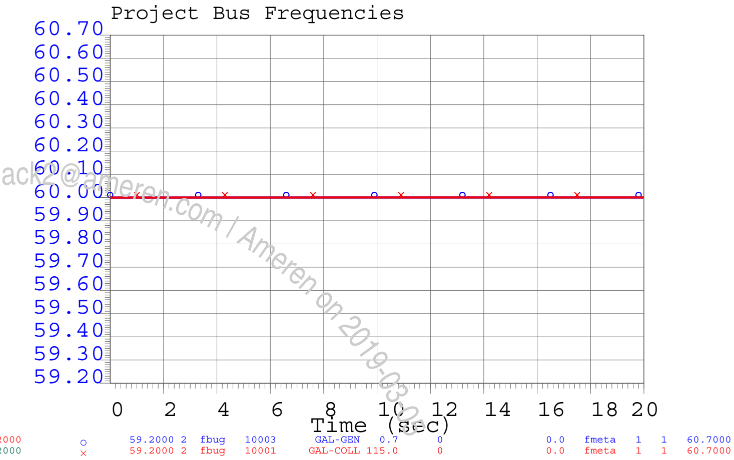
Wed Sep 14 18:27:06 2016

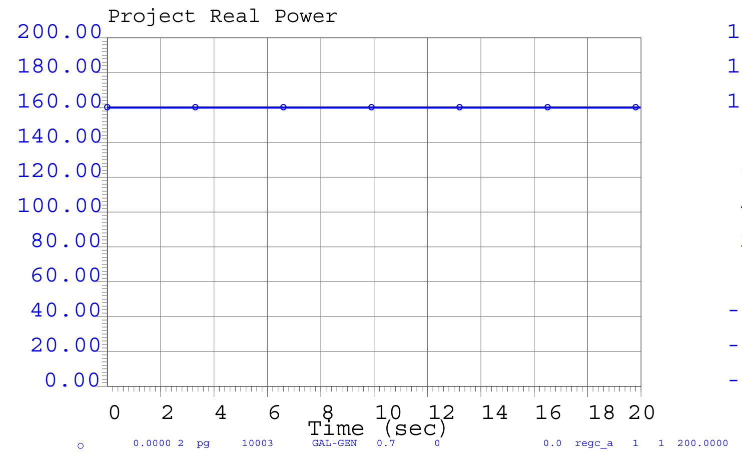
MORA
Transient Stability Plots

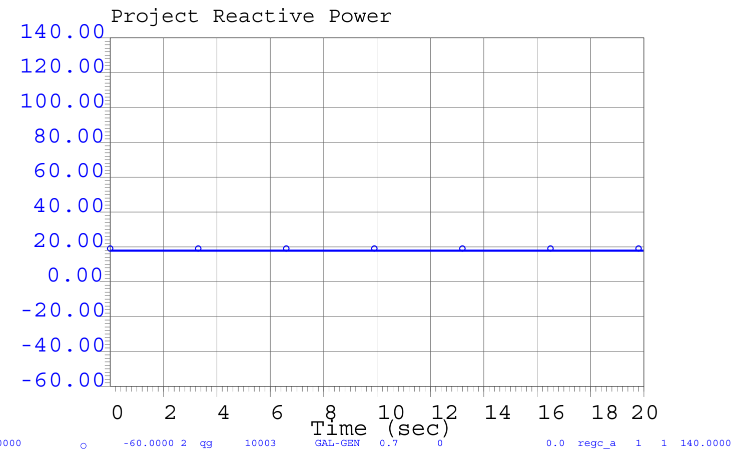












2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
1 01_N-0_FLAT_RUN

C:\!USE\dynamics\000001-01_N-0_FLAT_RUN-06_17lsp_post_160MW_ts.chf

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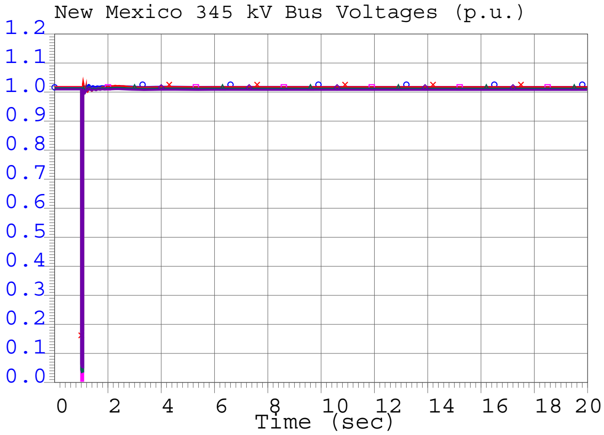
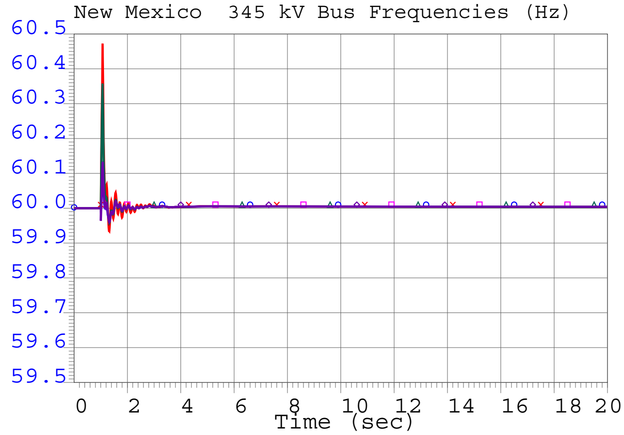
Wed Sep 14 18:27:06 2016

MORA
Transient Stability Plots

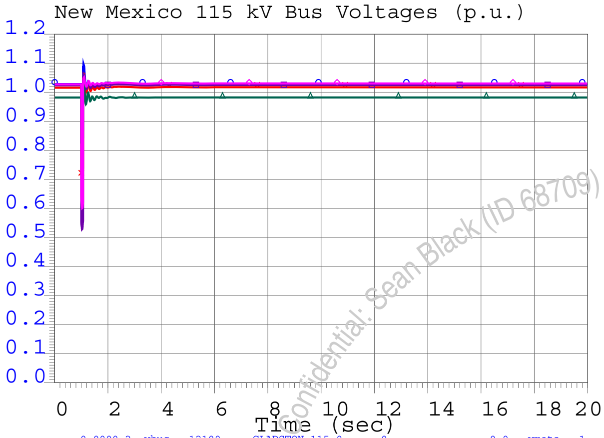
New Mexico 345 kV Bus Voltages (p.u.)



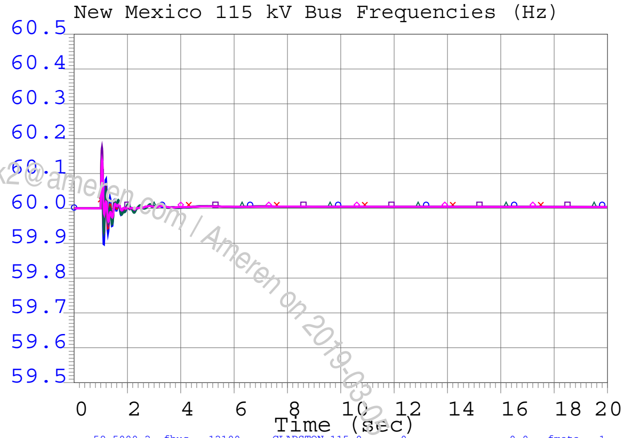
New Mexico 345 kV Bus Frequencies (Hz)



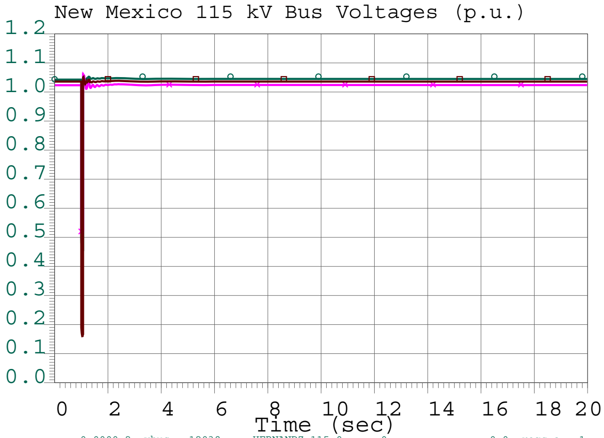
New Mexico 115 kV Bus Voltages (p.u.)



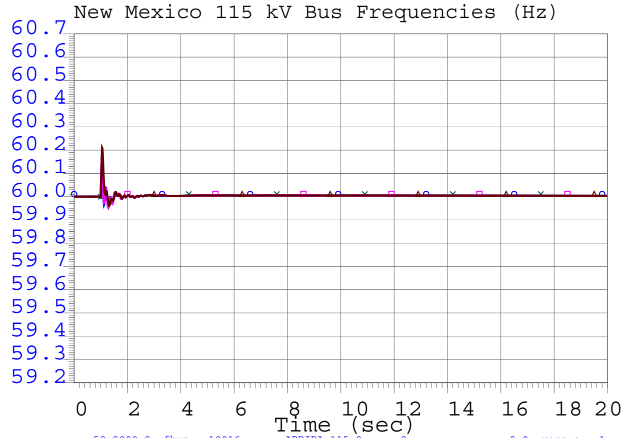
New Mexico 115 kV Bus Frequencies (Hz)



New Mexico 115 kV Bus Voltages (p.u.)



New Mexico 115 kV Bus Frequencies (Hz)

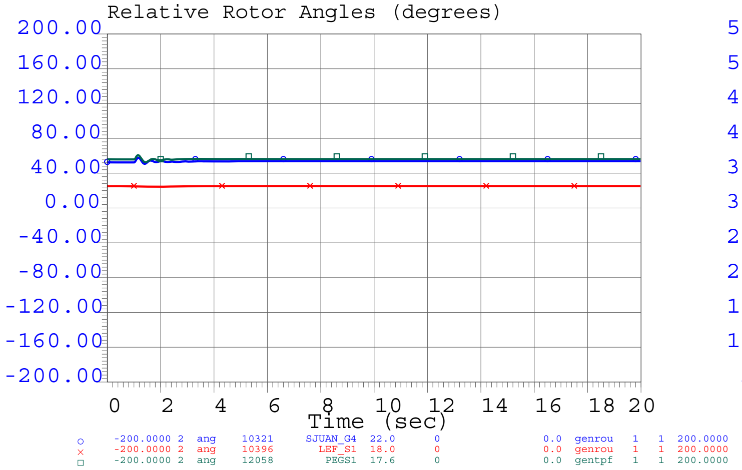


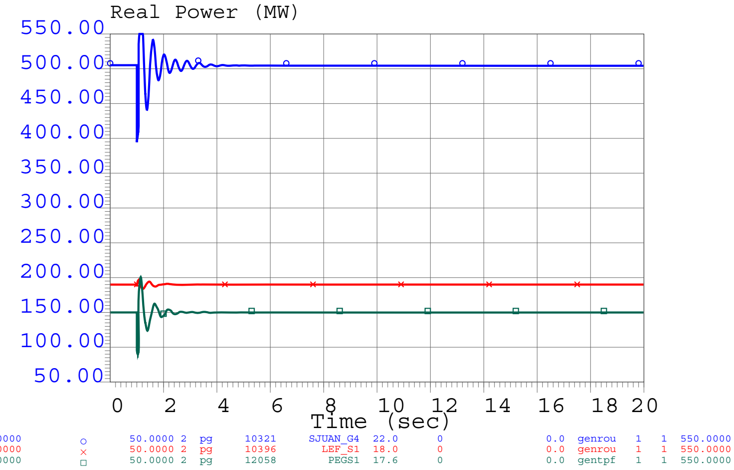
2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
3 03_Cab-RioPuerc_345_4c

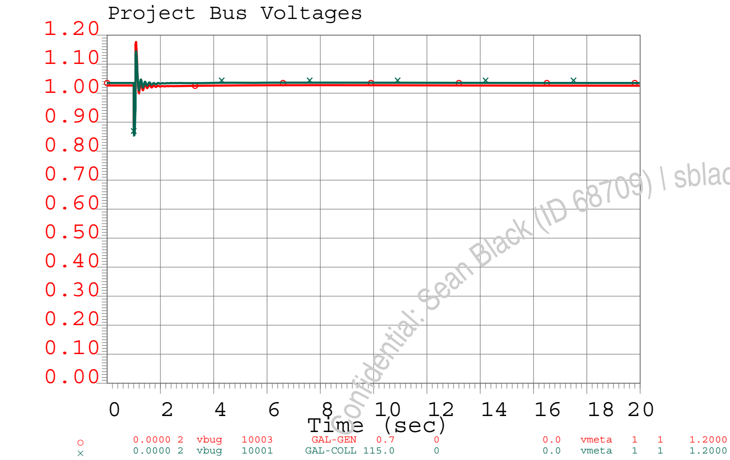
C:\!USE\dynamics\000003-03_Cab-RioPuerc_345_4c-06_17lsp_post_160MW_ts.chf

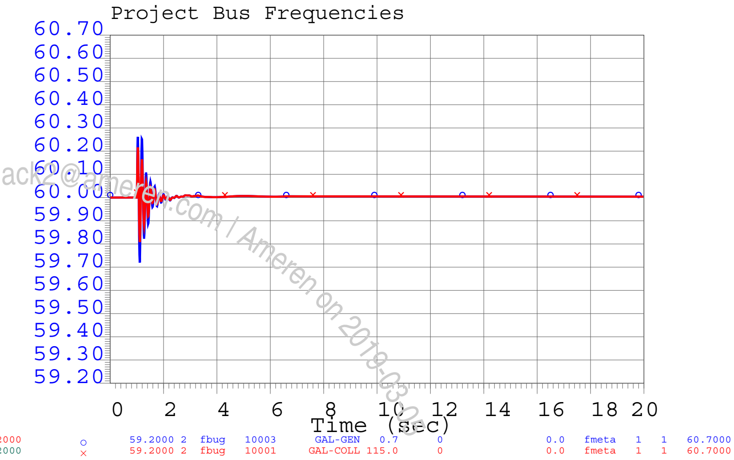
Wed Sep 14 18:27:06 2016

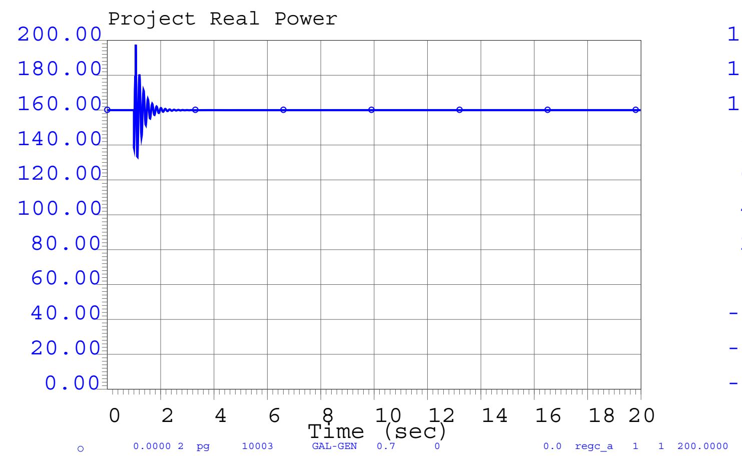
MORA
Transient Stability Plots

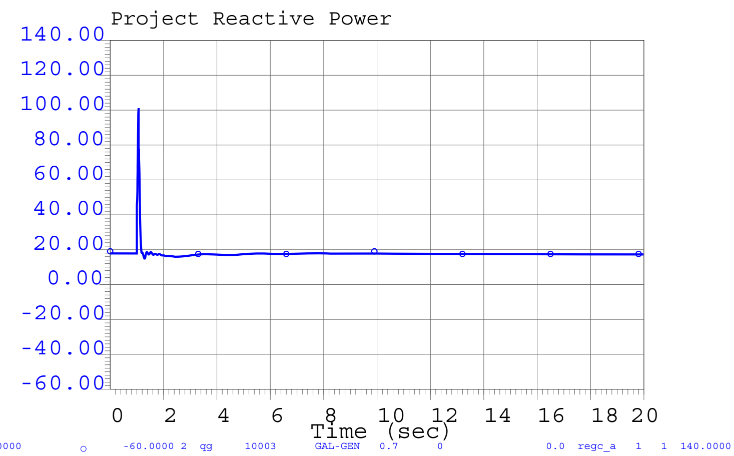












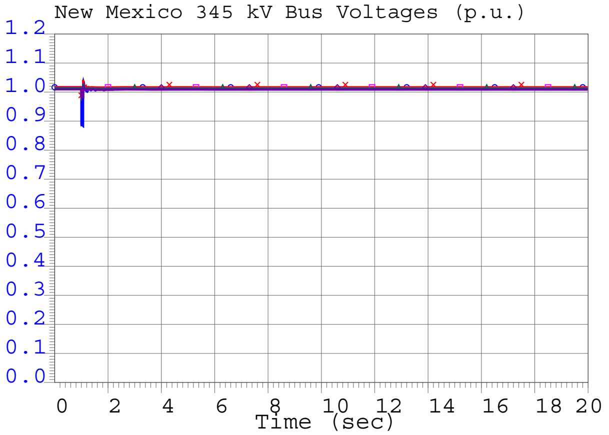
2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
3 03_Cab-RioPuerc_345_4c

C:\!USE\dynamics\000003-03_Cab-RioPuerc_345_4c-06_17lsp_post_160MW_ts.chf

Wed Sep 14 18:27:06 2016

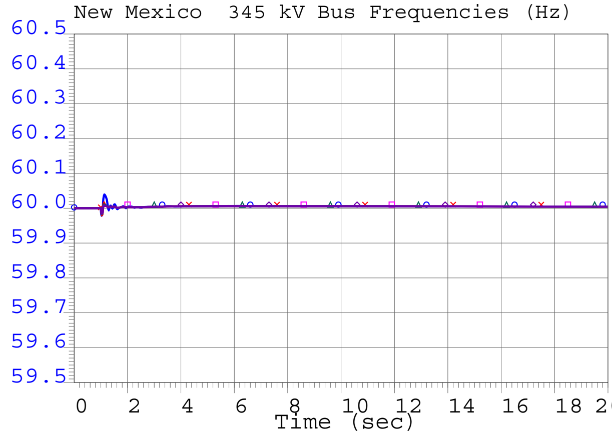
MORA
Transient Stability Plots

New Mexico 345 kV Bus Voltages (p.u.)



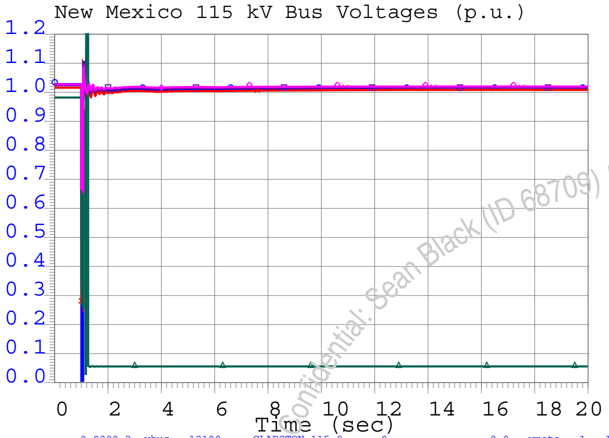
○	0.0000	2	vbus	12082	TAOS 345.0	0	0.0	genrou	1	1	1.2000
×	0.0000	2	vbus	10116	GUADLUPE 345.0	0	0.0	genrou	1	1	1.2000
□	0.0000	2	vbus	10390	RIOPUERC 345.0	0	0.0	gentpf	1	1	1.2000
△	0.0000	2	vbus	10025	B-A 115.0	0	0.0	vmeta	1	1	1.2000
◇	0.0000	2	vbus	10369	WESTMESA 345.0	0	0.0	vmeta	1	1	1.2000

New Mexico 345 kV Bus Frequencies (Hz)



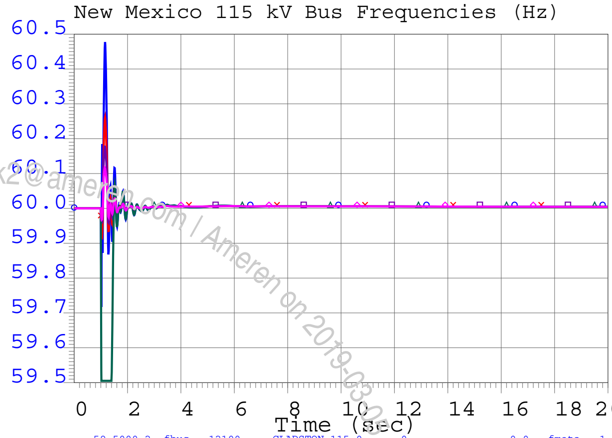
○	59.5000	2	fbus	12082	TAOS 345.0	0	0.0	genrou	1	1	60.5000
×	59.5000	2	fbus	10116	GUADLUPE 345.0	0	0.0	genrou	1	1	60.5000
□	59.5000	2	fbus	10390	RIOPUERC 345.0	0	0.0	gentpf	1	1	60.5000
△	59.5000	2	fbus	10025	B-A 115.0	0	0.0	fmeta	1	1	60.5000
◇	59.5000	2	fbus	10369	WESTMESA 345.0	0	0.0	fmeta	1	1	60.5000

New Mexico 115 kV Bus Voltages (p.u.)



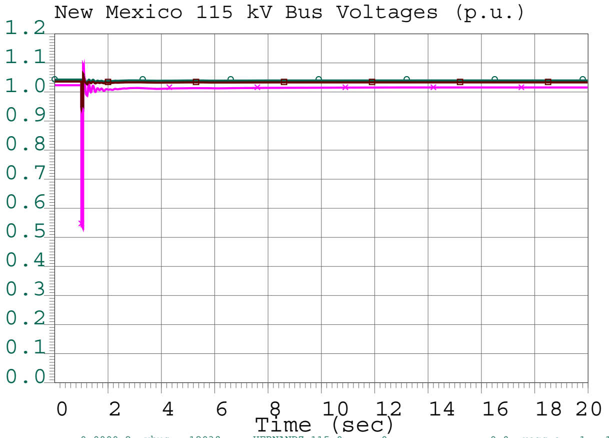
○	0.0000	2	vbus	12100	GLADSTON 115.0	0	0.0	vmeta	1	1	1.2000
×	0.0000	2	vbus	12077	SPRINGER 115.0	0	0.0	vmeta	1	1	1.2000
□	0.0000	2	vbus	12079	STORRIE 115.0	0	0.0	vmeta	1	1	1.2000
△	0.0000	2	vbus	12062	ROSEBUD 115.0	0	0.0	vmeta	1	1	1.2000
◇	0.0000	2	vbus	12011	BLACKLAK 115.0	0	0.0	vmeta	1	1	1.2000

New Mexico 115 kV Bus Frequencies (Hz)



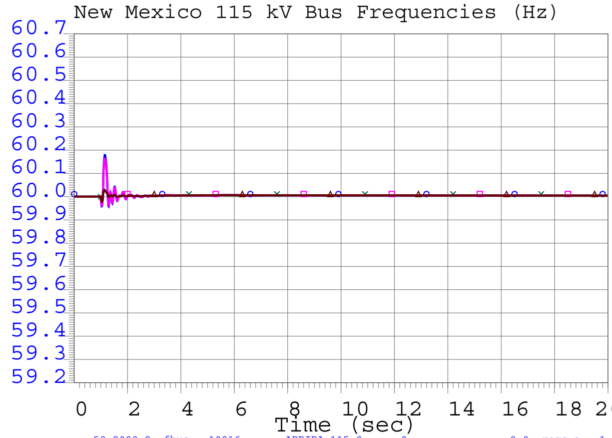
○	59.5000	2	fbus	12100	GLADSTON 115.0	0	0.0	fmeta	1	1	60.5000
×	59.5000	2	fbus	12077	SPRINGER 115.0	0	0.0	fmeta	1	1	60.5000
□	59.5000	2	fbus	12079	STORRIE 115.0	0	0.0	fmeta	1	1	60.5000
△	59.5000	2	fbus	12062	ROSEBUD 115.0	0	0.0	fmeta	1	1	60.5000
◇	59.5000	2	fbus	12011	BLACKLAK 115.0	0	0.0	fmeta	1	1	60.5000

New Mexico 115 kV Bus Voltages (p.u.)



○	0.0000	2	vbus	12038	HERNANDZ 115.0	0	0.0	regc_a	1	1	1.2000
×	0.0000	2	vbus	10357	VALENCIA 115.0	0	0.0	vmeta	1	1	1.2000
□	0.0000	2	vbus	10386	ZIA_1 115.0	0	0.0	vmeta	1	1	1.2000

New Mexico 115 kV Bus Frequencies (Hz)



○	59.2000	2	fbus	10016	ARRIBA 115.0	0	0.0	regc_a	1	1	60.7000
×	59.2000	2	fbus	12038	HERNANDZ 115.0	0	0.0	fmeta	1	1	60.7000
□	59.2000	2	fbus	10357	VALENCIA 115.0	0	0.0	fmeta	1	1	60.7000
△	59.2000	2	fbus	10386	ZIA_1 115.0	0	0.0	fmeta	1	1	60.7000

2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
5 05_GLAD-SPR_4c

C:\!USE\dynamics\000005-05_GLAD-SPR_4c-06_17lsp_post_160MW_ts.chf

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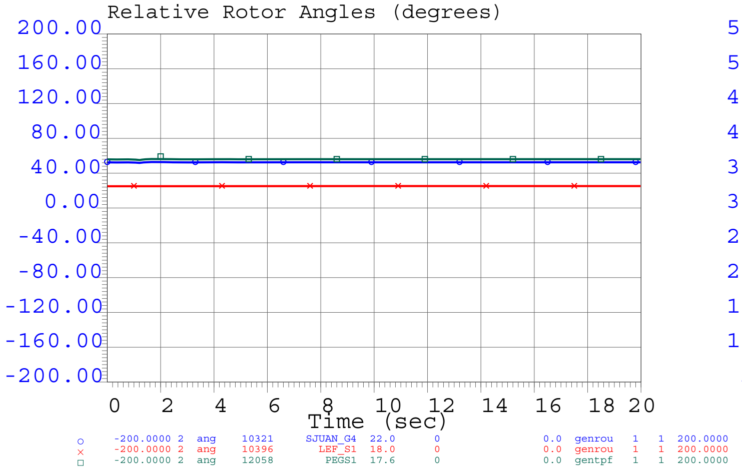
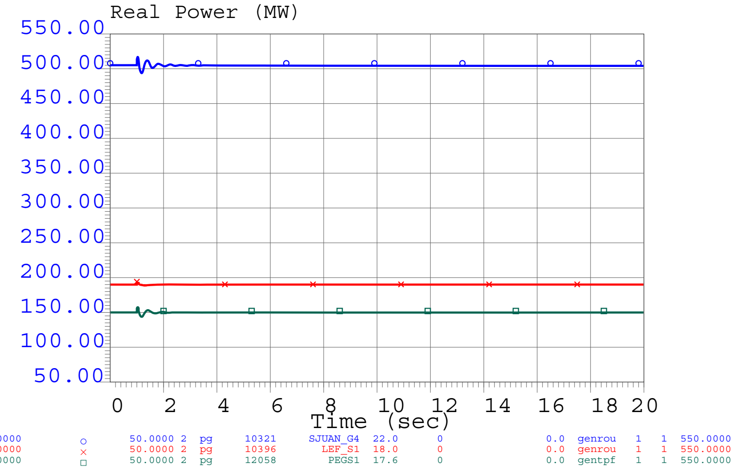
Wed Sep 14 18:27:05 2016

MORA
Transient Stability Plots

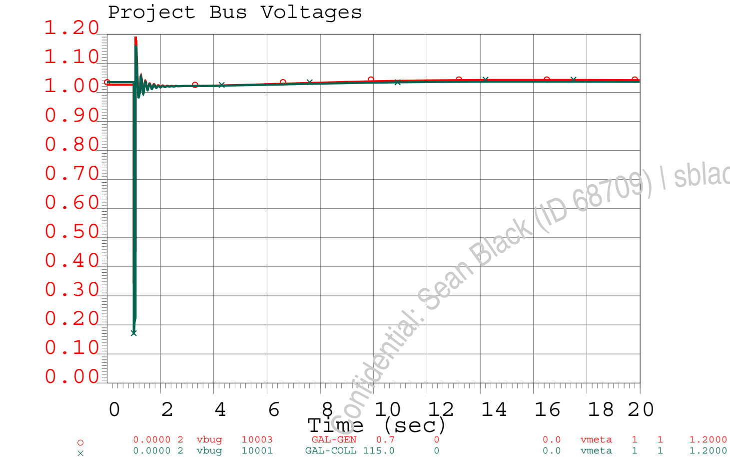
Relative Rotor Angles (degrees)



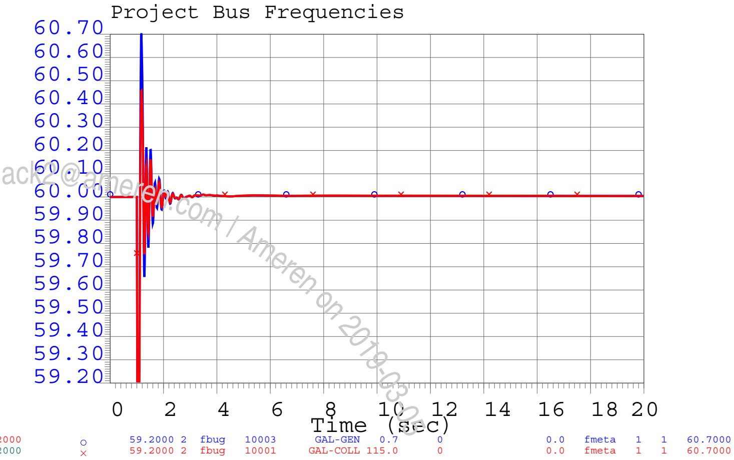
Real Power (MW)



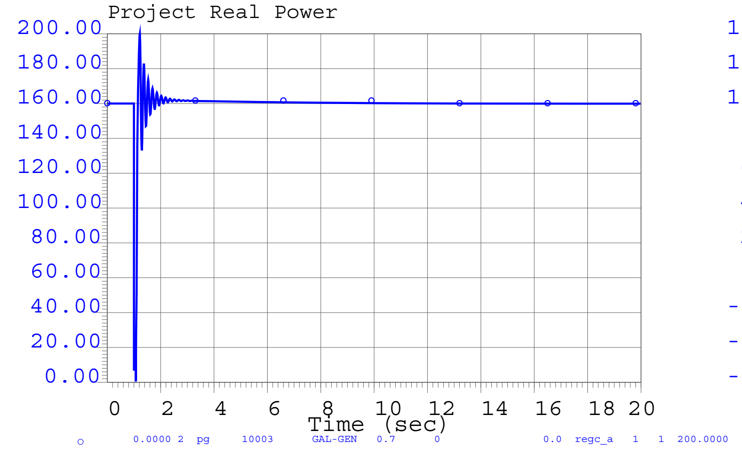
Project Bus Voltages



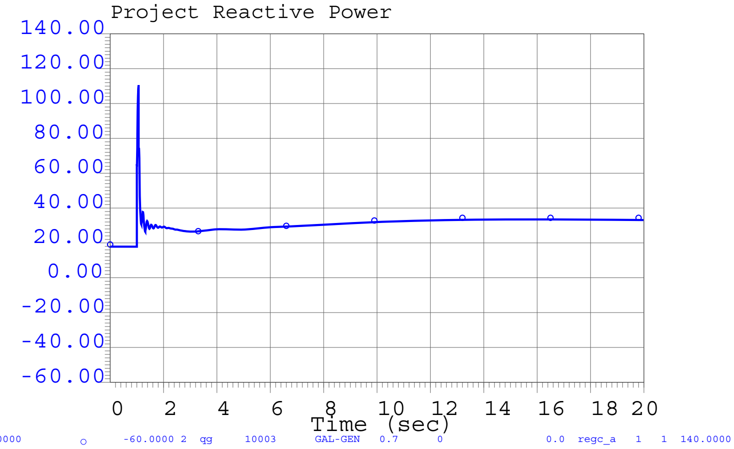
Project Bus Frequencies



Project Real Power



Project Reactive Power



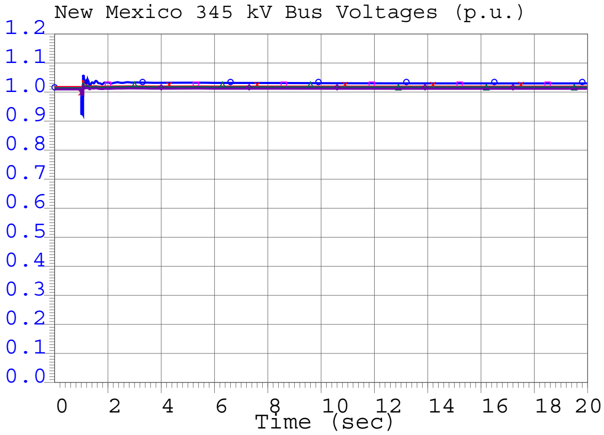
2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
5 05_GLAD-SPR_4c

C:\!USE\dynamics\000005-05_GLAD-SPR_4c-06_17lsp_post_160MW_ts.chf .

Wed Sep 14 18:27:05 2016

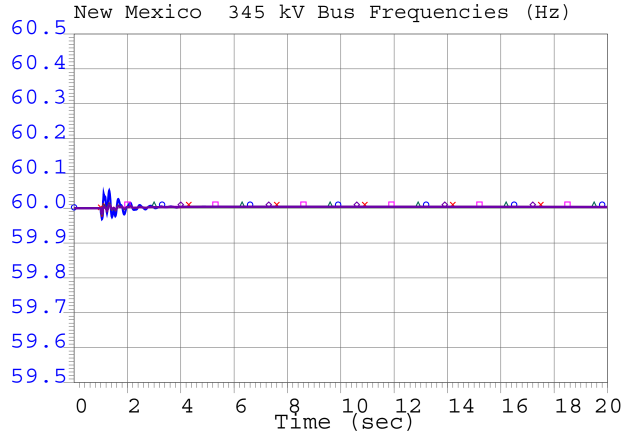
MORA
Transient Stability Plots

New Mexico 345 kV Bus Voltages (p.u.)



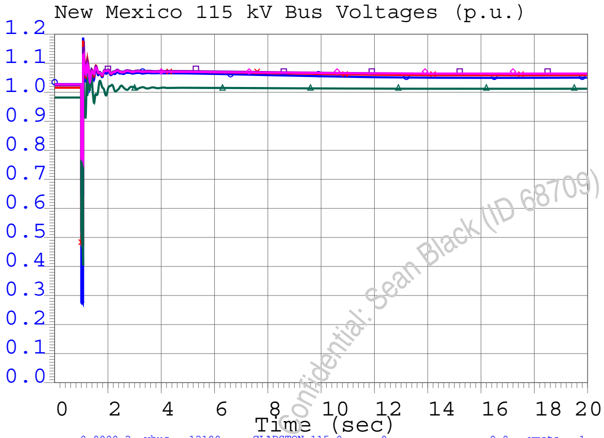
○	0.0000	2	vbus	12082	TAOS 345.0	0	0.0	genrou	1	1	1.2000
×	0.0000	2	vbus	10116	GUADLUPE 345.0	0	0.0	genrou	1	1	1.2000
□	0.0000	2	vbus	10390	RIOPUERC 345.0	0	0.0	gentpf	1	1	1.2000
△	0.0000	2	vbus	10025	B-A 115.0	0	0.0	vmeta	1	1	1.2000
◇	0.0000	2	vbus	10369	WESTMESA 345.0	0	0.0	vmeta	1	1	1.2000

New Mexico 345 kV Bus Frequencies (Hz)



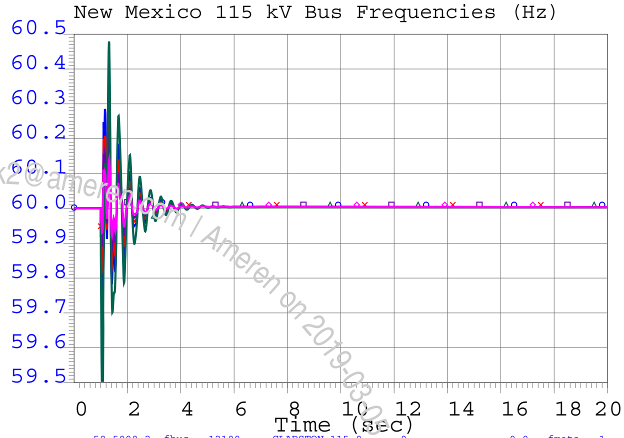
○	59.5000	2	fbus	12082	TAOS 345.0	0	0.0	genrou	1	1	60.5000
×	59.5000	2	fbus	10116	GUADLUPE 345.0	0	0.0	genrou	1	1	60.5000
□	59.5000	2	fbus	10390	RIOPUERC 345.0	0	0.0	gentpf	1	1	60.5000
△	59.5000	2	fbus	10025	B-A 115.0	0	0.0	fmeta	1	1	60.5000
◇	59.5000	2	fbus	10369	WESTMESA 345.0	0	0.0	fmeta	1	1	60.5000

New Mexico 115 kV Bus Voltages (p.u.)



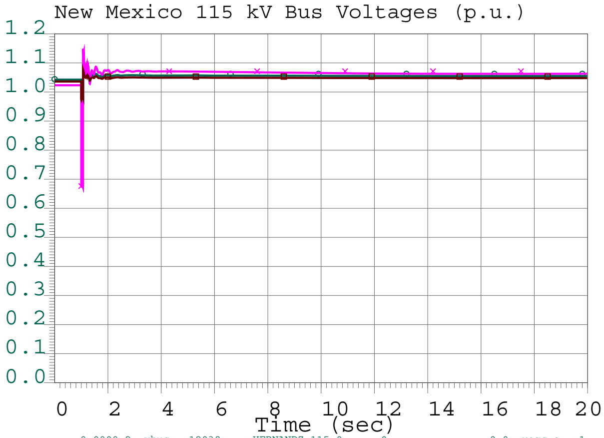
○	0.0000	2	vbus	12100	GLADSTON 115.0	0	0.0	vmeta	1	1	1.2000
×	0.0000	2	vbus	12077	SPRINGER 115.0	0	0.0	vmeta	1	1	1.2000
□	0.0000	2	vbus	12079	STORRIE 115.0	0	0.0	vmeta	1	1	1.2000
△	0.0000	2	vbus	12062	ROSEBUD 115.0	0	0.0	vmeta	1	1	1.2000
◇	0.0000	2	vbus	12011	BLACKLAK 115.0	0	0.0	vmeta	1	1	1.2000

New Mexico 115 kV Bus Frequencies (Hz)



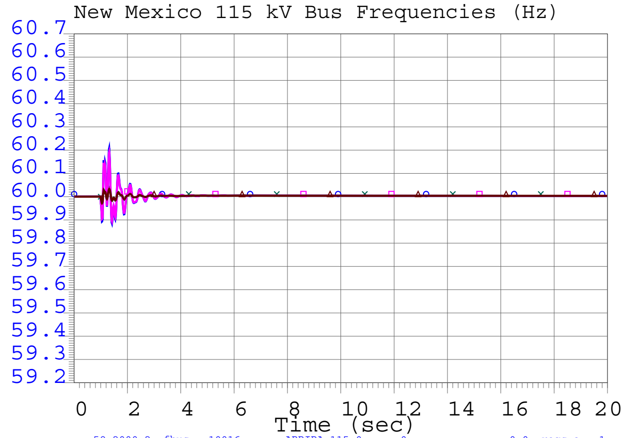
○	59.5000	2	fbus	12100	GLADSTON 115.0	0	0.0	fmeta	1	1	60.5000
×	59.5000	2	fbus	12077	SPRINGER 115.0	0	0.0	fmeta	1	1	60.5000
□	59.5000	2	fbus	12079	STORRIE 115.0	0	0.0	fmeta	1	1	60.5000
△	59.5000	2	fbus	12062	ROSEBUD 115.0	0	0.0	fmeta	1	1	60.5000
◇	59.5000	2	fbus	12011	BLACKLAK 115.0	0	0.0	fmeta	1	1	60.5000

New Mexico 115 kV Bus Voltages (p.u.)



○	0.0000	2	vbus	12038	HERNANDZ 115.0	0	0.0	regc_a	1	1	1.2000
×	0.0000	2	vbus	10357	VALENCIA 115.0	0	0.0	vmeta	1	1	1.2000
□	0.0000	2	vbus	10386	ZIA_1 115.0	0	0.0	vmeta	1	1	1.2000

New Mexico 115 kV Bus Frequencies (Hz)



○	59.2000	2	fbus	10016	ARRIBA 115.0	0	0.0	regc_a	1	1	60.7000
×	59.2000	2	fbus	12038	HERNANDZ 115.0	0	0.0	fmeta	1	1	60.7000
□	59.2000	2	fbus	10357	VALENCIA 115.0	0	0.0	fmeta	1	1	60.7000
△	59.2000	2	fbus	10386	ZIA_1 115.0	0	0.0	fmeta	1	1	60.7000

2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
7 07_WALS-GLAD_4c

C:\!USE\dynamics\000007-07_WALS-GLAD_4c-06_17lsp_post_160MW_ts.chf

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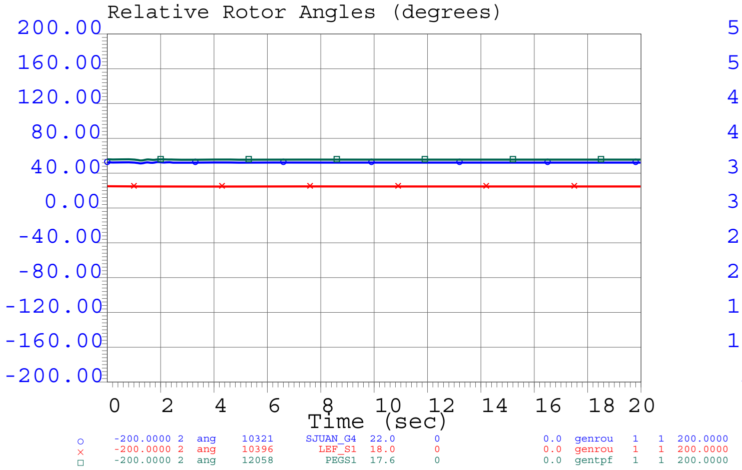
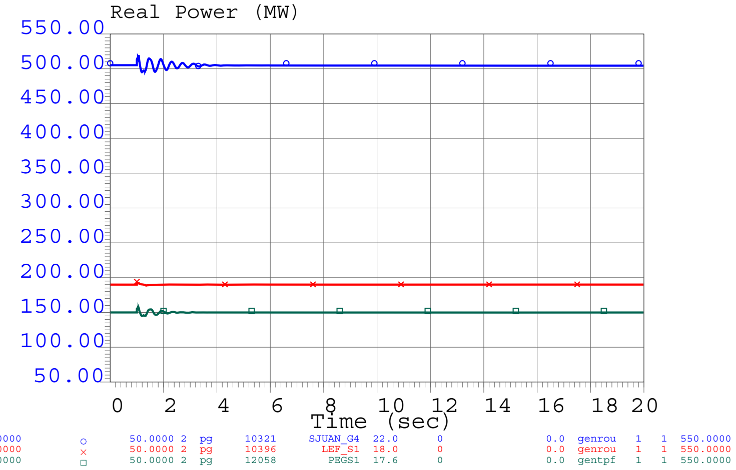
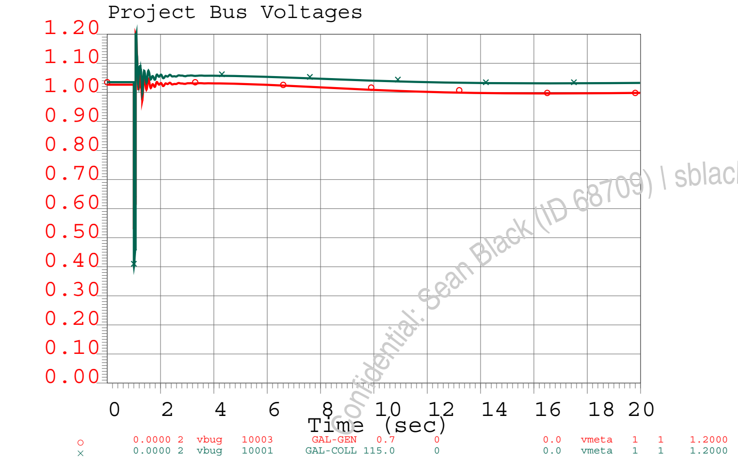
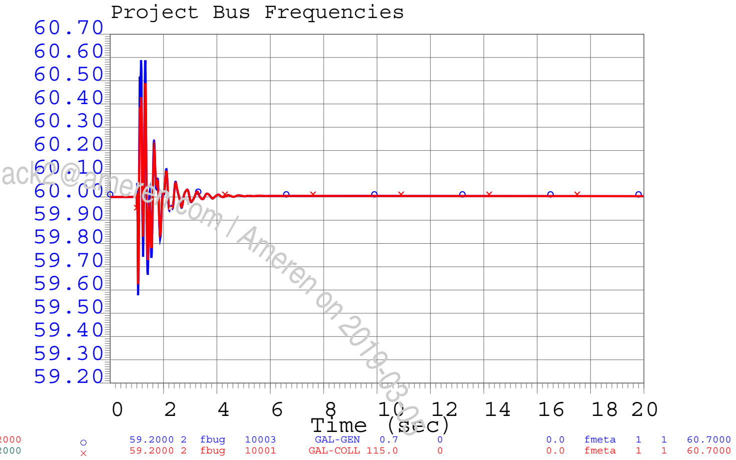
Wed Sep 14 18:27:06 2016

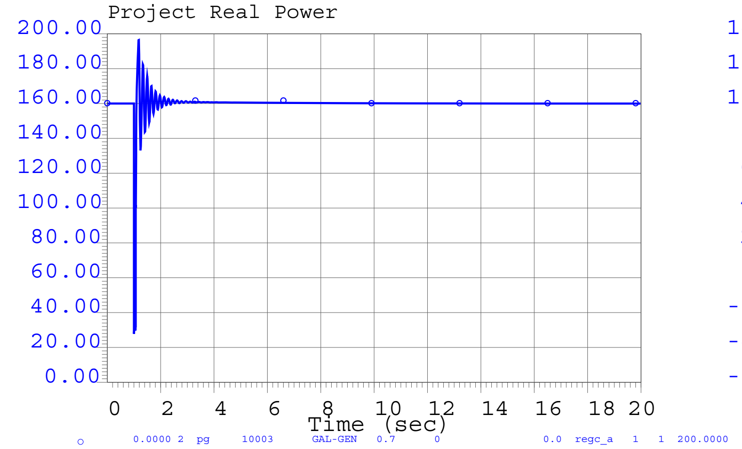
MORA
Transient Stability Plots

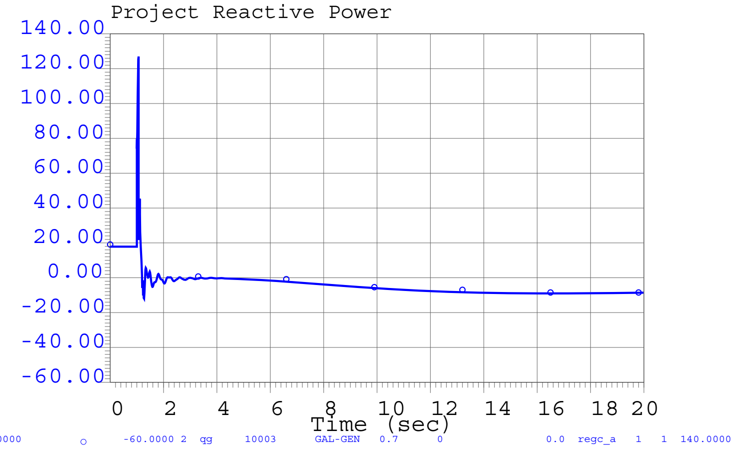












2017 LSP Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
7 07_WALS-GLAD_4c

C:\!USE\dynamics\000007-07_WALS-GLAD_4c-06_17lsp_post_160MW_ts.chf

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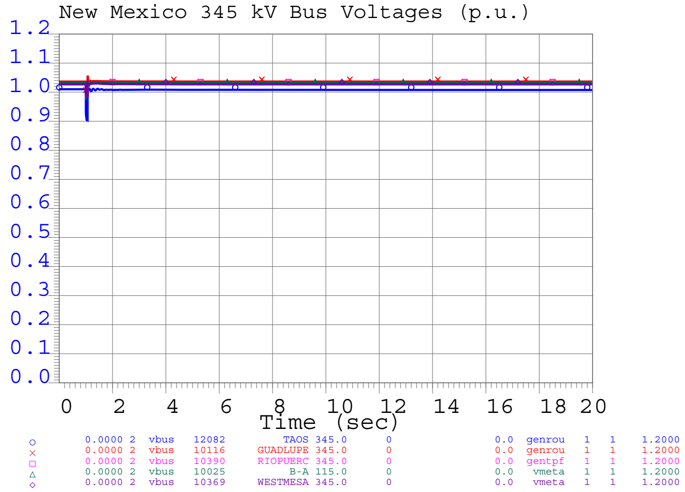
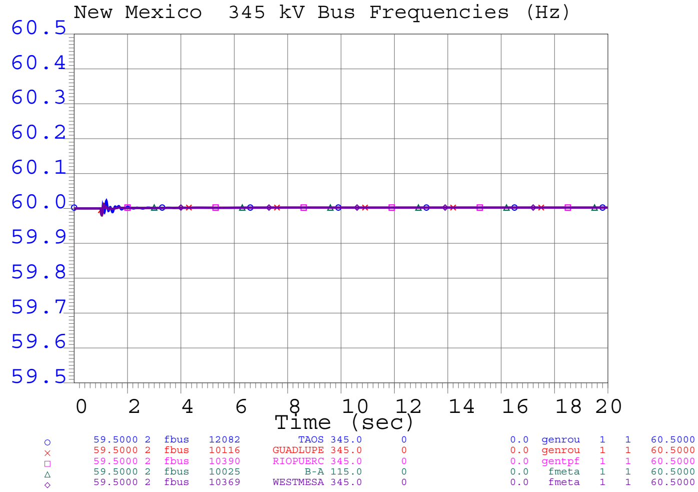
Wed Sep 14 18:27:06 2016

MORA
Transient Stability Plots

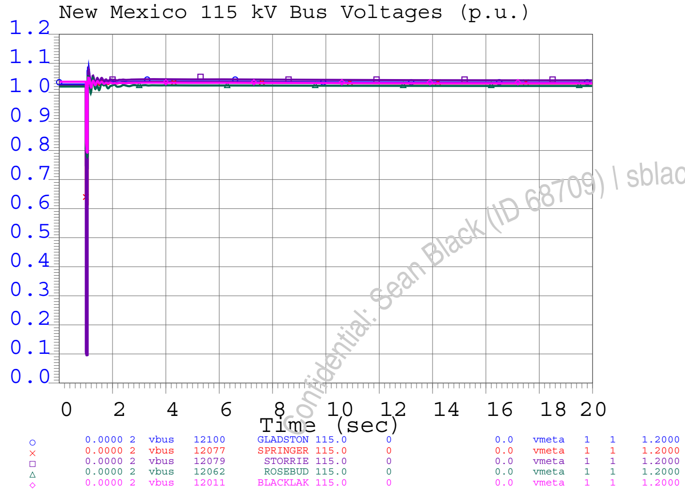
New Mexico 345 kV Bus Voltages (p.u.)



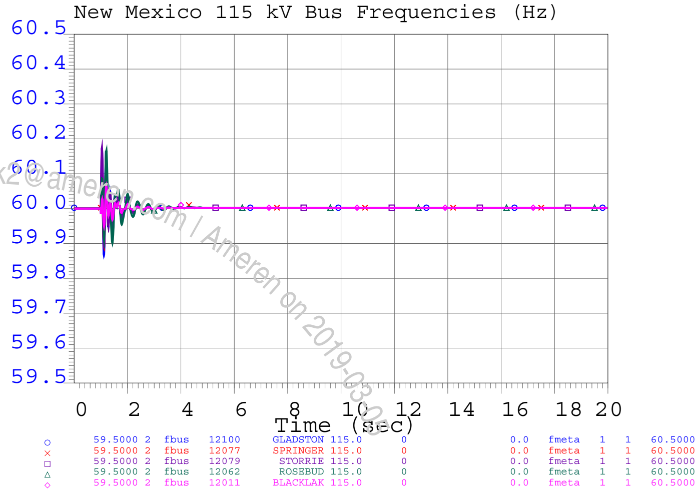
New Mexico 345 kV Bus Frequencies (Hz)



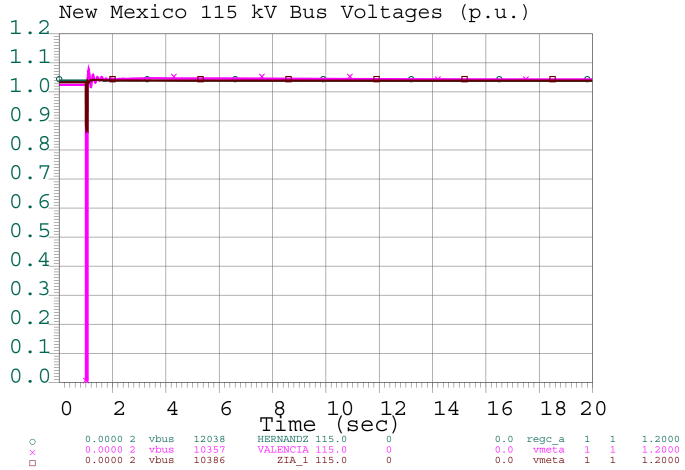
New Mexico 115 kV Bus Voltages (p.u.)



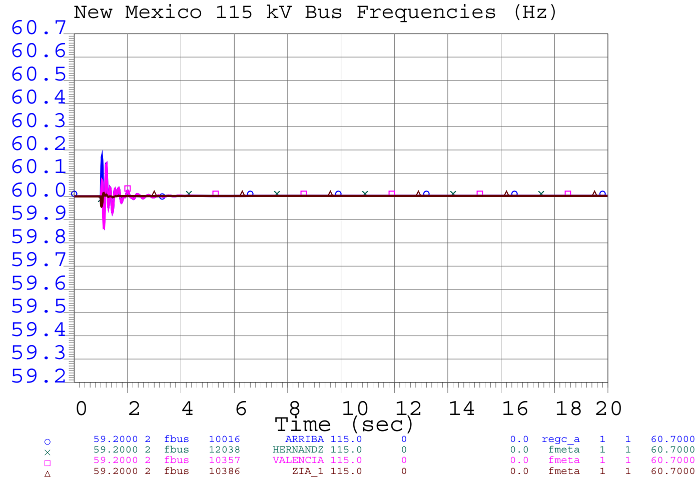
New Mexico 115 kV Bus Frequencies (Hz)



New Mexico 115 kV Bus Voltages (p.u.)



New Mexico 115 kV Bus Frequencies (Hz)

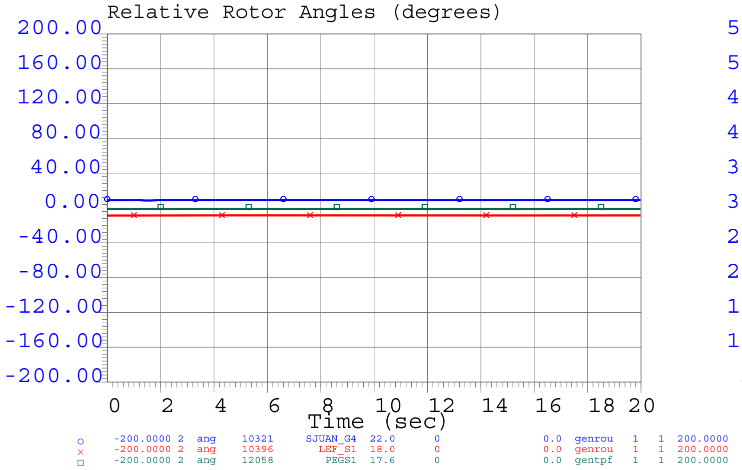


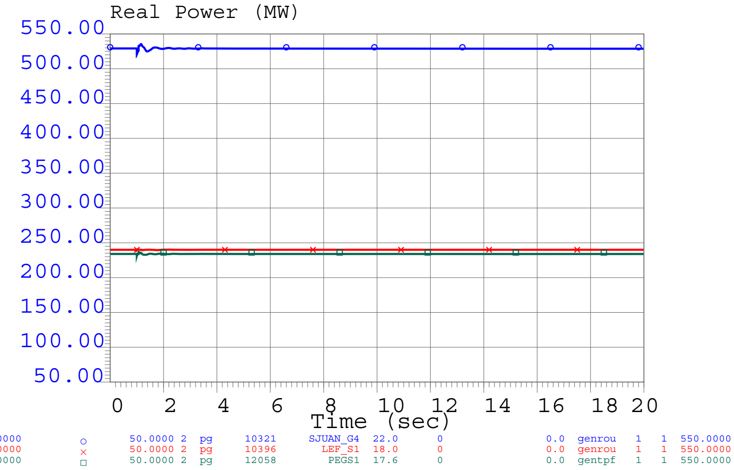
2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
8 08b_VAL-ZIA_4c

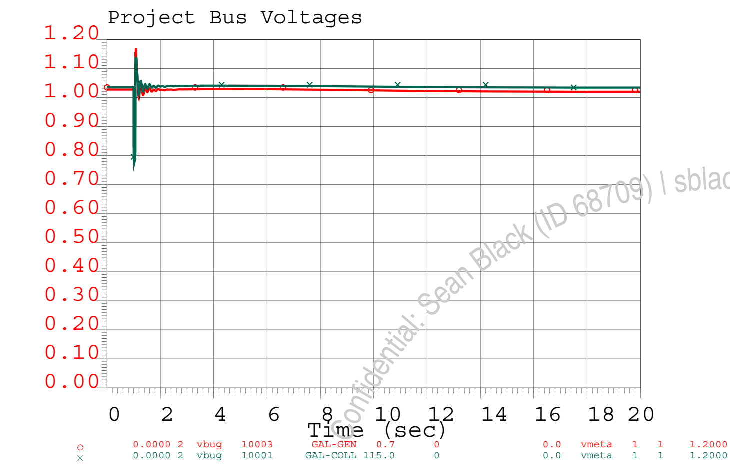
C:\!USE\dynamics\000008-08b_VAL-ZIA_4c-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

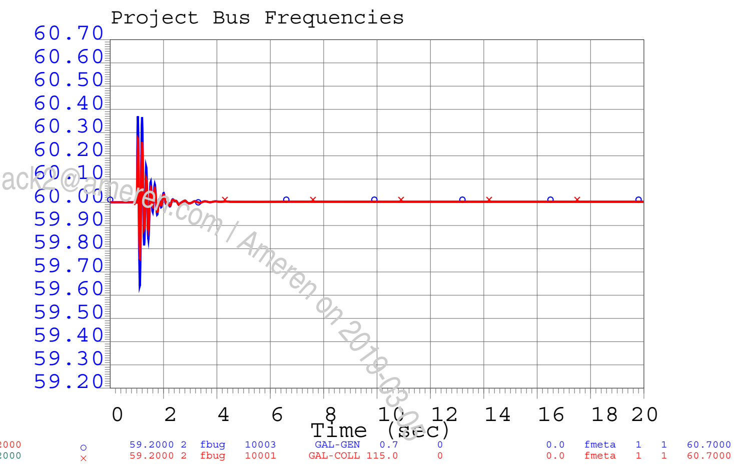
Wed Sep 14 18:55:18 2016

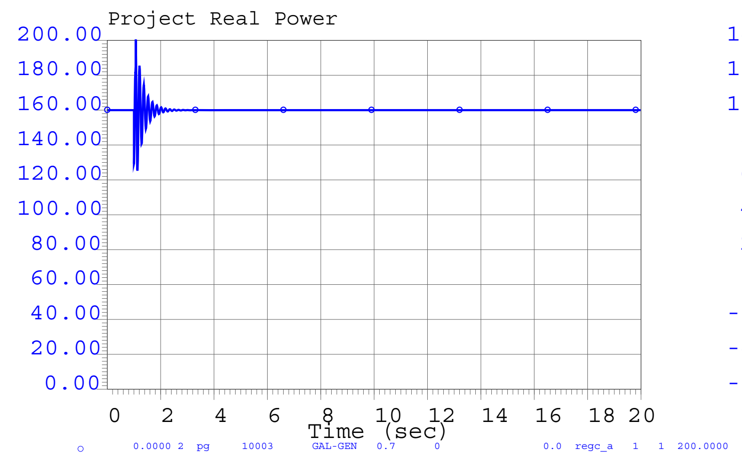
MORA
Transient Stability Plots

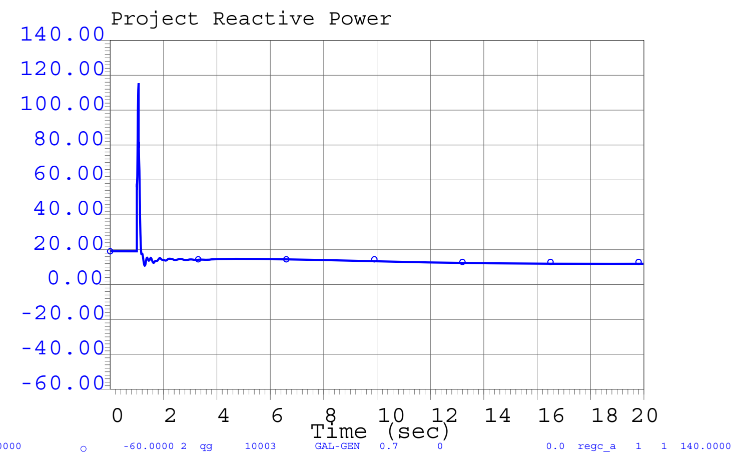










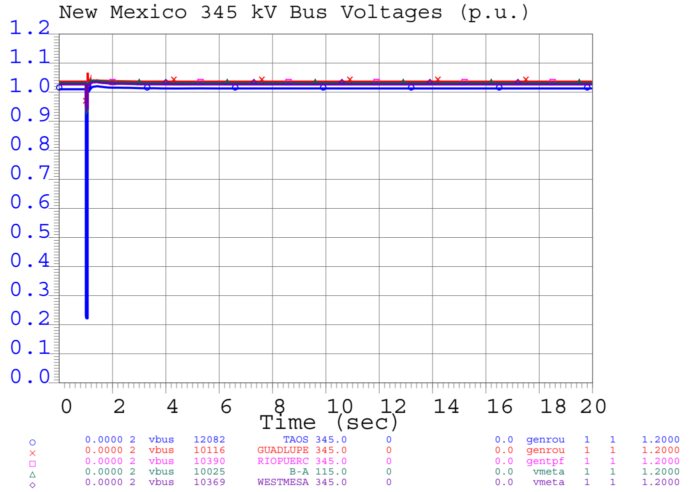


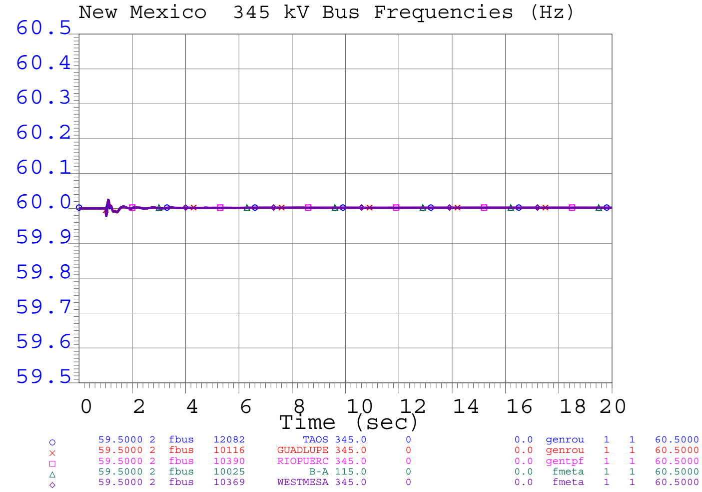
2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
8 08b_VAL-ZIA_4c

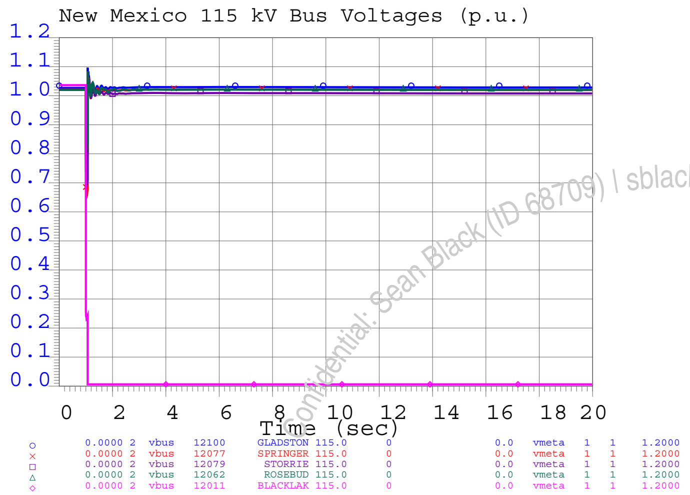
C:\!USE\dynamics\000008-08b_VAL-ZIA_4c-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

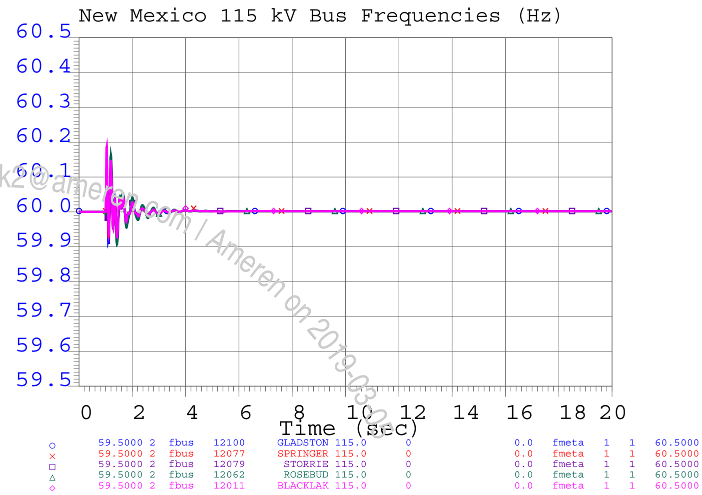
Wed Sep 14 18:55:18 2016

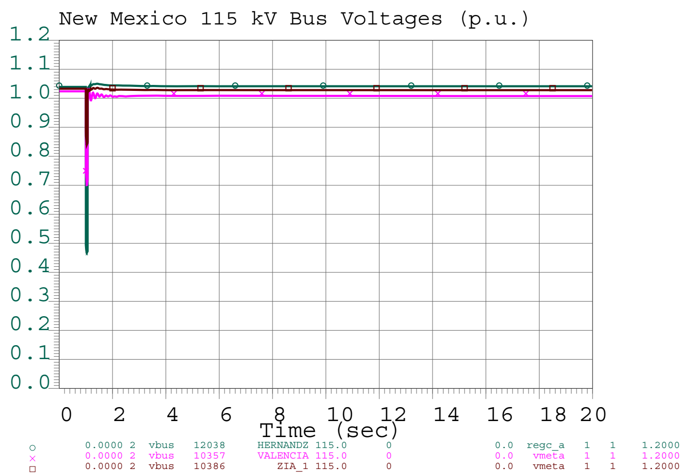
MORA
Transient Stability Plots

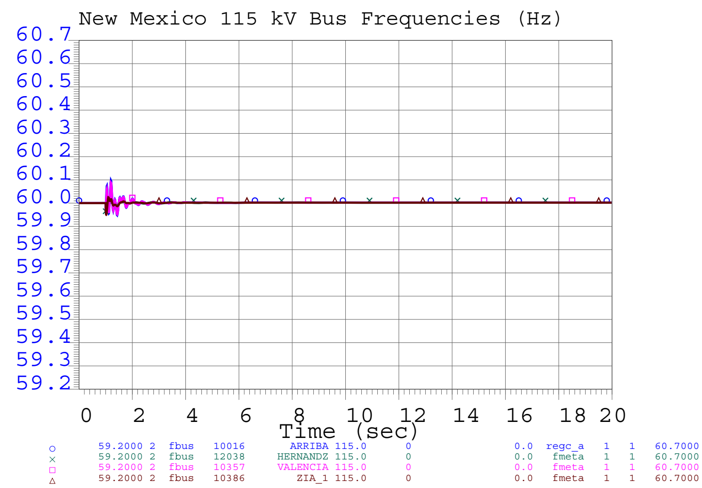










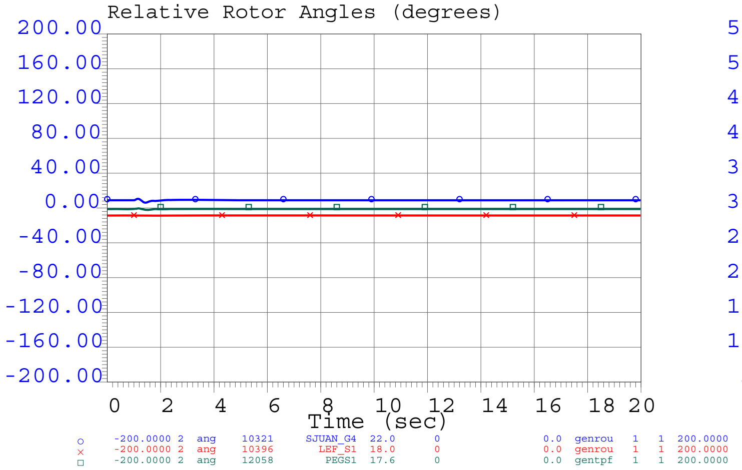


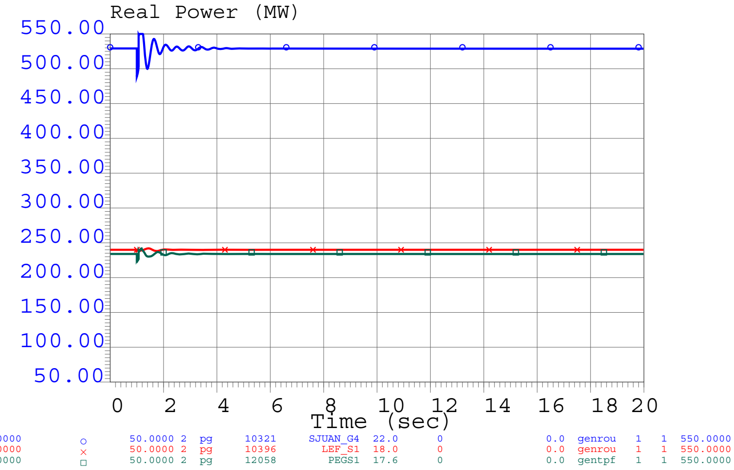
2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
9 09a_TAOS-SPR_4c

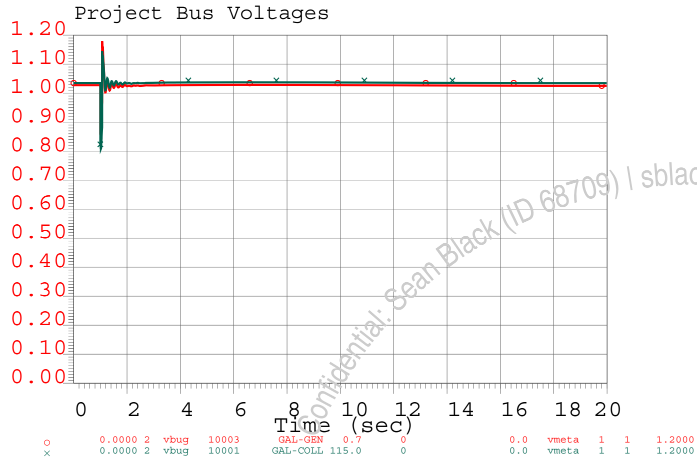
C:\!USE\dynamics\000009-09a_TAOS-SPR_4c-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

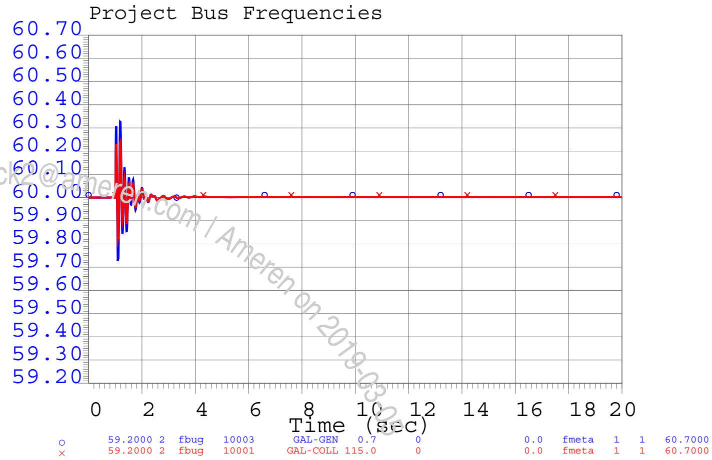
Wed Sep 14 18:55:17 2016

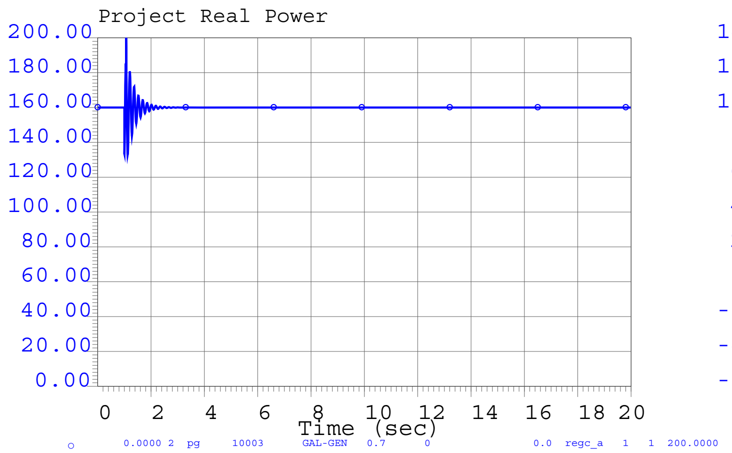
MORA
Transient Stability Plots

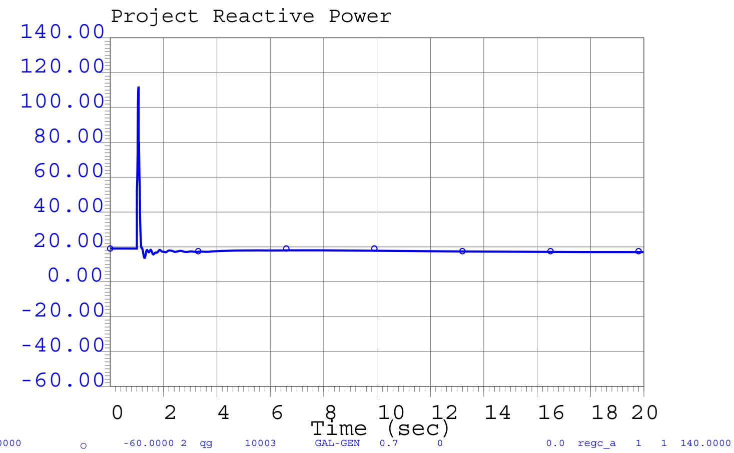












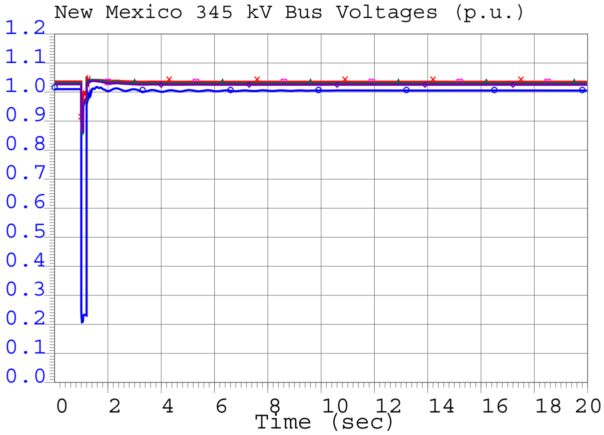
2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
9 09a_TAOS-SPR_4c

C:\!USE\dynamics\000009-09a_TAOS-SPR_4c-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

Wed Sep 14 18:55:17 2016

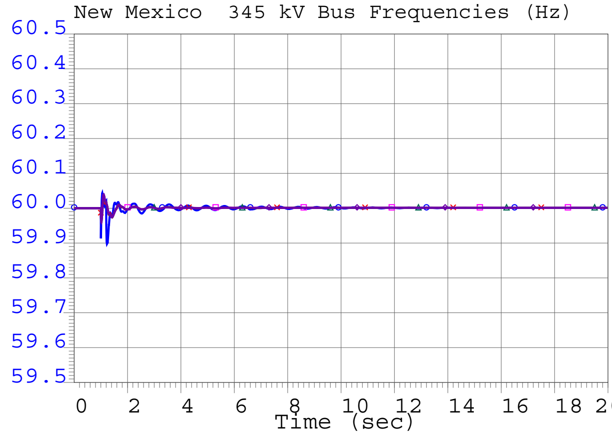
MORA
Transient Stability Plots

New Mexico 345 kV Bus Voltages (p.u.)



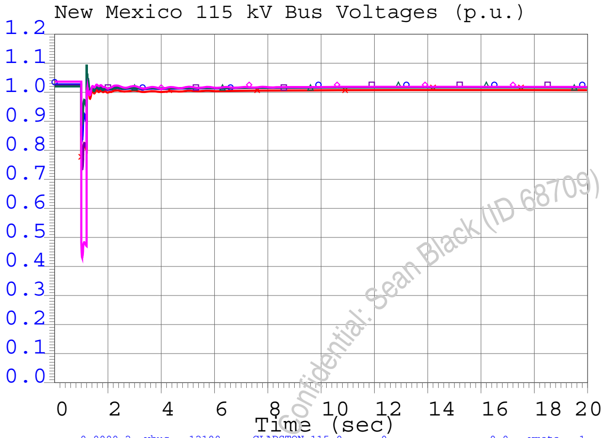
○	0.0000	2	vbus	12082	TAOS 345.0	0	0.0	genrou	1	1	1.2000
×	0.0000	2	vbus	10116	GUADLUPE 345.0	0	0.0	genrou	1	1	1.2000
□	0.0000	2	vbus	10390	RIOPUERC 345.0	0	0.0	gentpf	1	1	1.2000
△	0.0000	2	vbus	10025	B-A 115.0	0	0.0	vmeta	1	1	1.2000
◇	0.0000	2	vbus	10369	WESTMESA 345.0	0	0.0	vmeta	1	1	1.2000

New Mexico 345 kV Bus Frequencies (Hz)



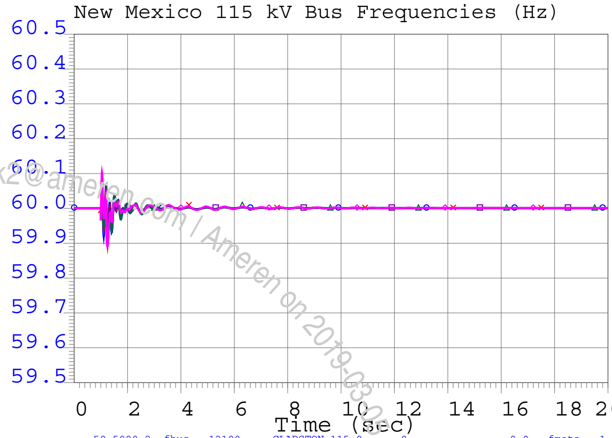
○	59.5000	2	fbus	12082	TAOS 345.0	0	0.0	genrou	1	1	60.5000
×	59.5000	2	fbus	10116	GUADLUPE 345.0	0	0.0	genrou	1	1	60.5000
□	59.5000	2	fbus	10390	RIOPUERC 345.0	0	0.0	gentpf	1	1	60.5000
△	59.5000	2	fbus	10025	B-A 115.0	0	0.0	fmeta	1	1	60.5000
◇	59.5000	2	fbus	10369	WESTMESA 345.0	0	0.0	fmeta	1	1	60.5000

New Mexico 115 kV Bus Voltages (p.u.)



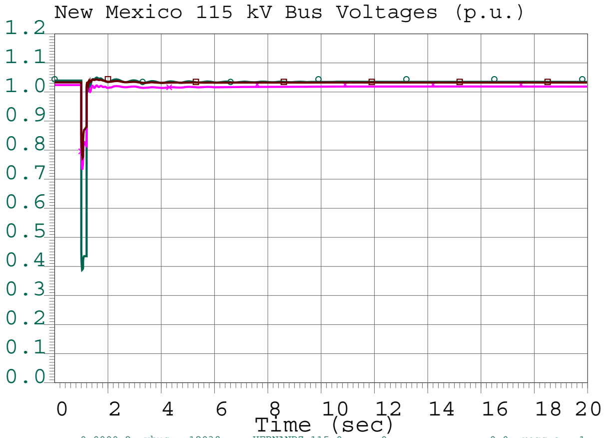
○	0.0000	2	vbus	12100	GLADSTON 115.0	0	0.0	vmeta	1	1	1.2000
×	0.0000	2	vbus	12077	SPRINGER 115.0	0	0.0	vmeta	1	1	1.2000
□	0.0000	2	vbus	12079	STORRIE 115.0	0	0.0	vmeta	1	1	1.2000
△	0.0000	2	vbus	12062	ROSEBUD 115.0	0	0.0	vmeta	1	1	1.2000
◇	0.0000	2	vbus	12011	BLACKLAK 115.0	0	0.0	vmeta	1	1	1.2000

New Mexico 115 kV Bus Frequencies (Hz)



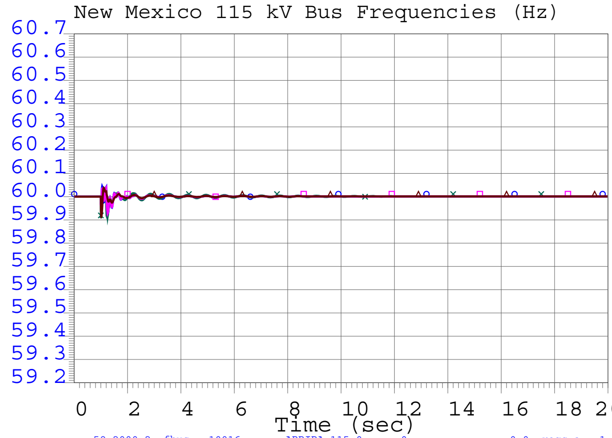
○	59.5000	2	fbus	12100	GLADSTON 115.0	0	0.0	fmeta	1	1	60.5000
×	59.5000	2	fbus	12077	SPRINGER 115.0	0	0.0	fmeta	1	1	60.5000
□	59.5000	2	fbus	12079	STORRIE 115.0	0	0.0	fmeta	1	1	60.5000
△	59.5000	2	fbus	12062	ROSEBUD 115.0	0	0.0	fmeta	1	1	60.5000
◇	59.5000	2	fbus	12011	BLACKLAK 115.0	0	0.0	fmeta	1	1	60.5000

New Mexico 115 kV Bus Voltages (p.u.)



○	0.0000	2	vbus	12038	HERNANDZ 115.0	0	0.0	regc_a	1	1	1.2000
×	0.0000	2	vbus	10357	VALENCIA 115.0	0	0.0	vmeta	1	1	1.2000
□	0.0000	2	vbus	10386	ZIA_1 115.0	0	0.0	vmeta	1	1	1.2000

New Mexico 115 kV Bus Frequencies (Hz)



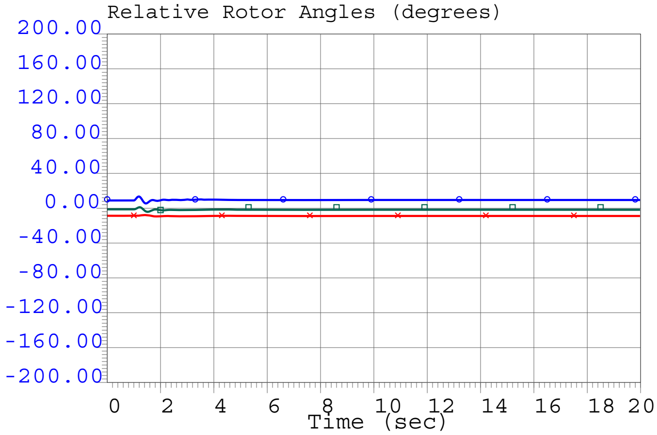
○	59.2000	2	fbus	10016	ARRIBA 115.0	0	0.0	regc_a	1	1	60.7000
×	59.2000	2	fbus	12038	HERNANDZ 115.0	0	0.0	fmeta	1	1	60.7000
□	59.2000	2	fbus	10357	VALENCIA 115.0	0	0.0	fmeta	1	1	60.7000
△	59.2000	2	fbus	10386	ZIA_1 115.0	0	0.0	fmeta	1	1	60.7000

2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
11 12_P4_JIC-SJ and JIC-OJO

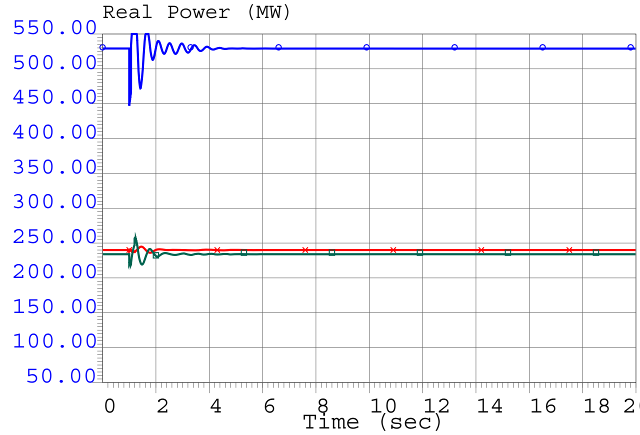
C:\!USE\dynamics\000011-12_P4_JIC-SJ_and_JIC-OJO-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

Wed Sep 14 18:55:18 2016

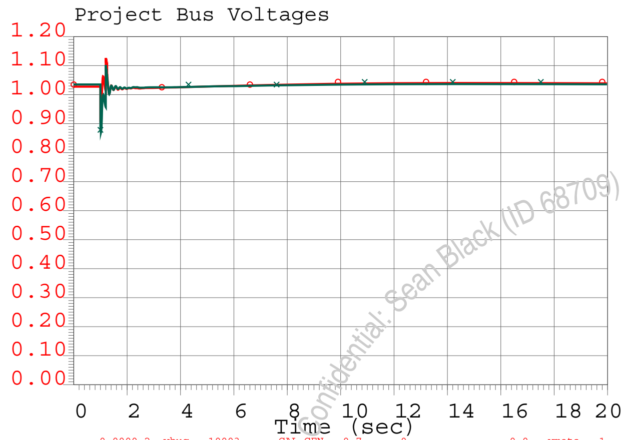
MORA
Transient Stability Plots



○ -200.0000 2 ang 10321 SJUAN_G4 22.0 0 0.0 genrou 1 1 200.0000
× -200.0000 2 ang 10396 LEF_S1 18.0 0 0.0 genrou 1 1 200.0000
□ -200.0000 2 ang 12058 PEGS1 17.6 0 0.0 gentpf 1 1 200.0000



○ 50.0000 2 pg 10321 SJUAN_G4 22.0 0 0.0 genrou 1 1 550.0000
× 50.0000 2 pg 10396 LEF_S1 18.0 0 0.0 genrou 1 1 550.0000
□ 50.0000 2 pg 12058 PEGS1 17.6 0 0.0 gentpf 1 1 550.0000



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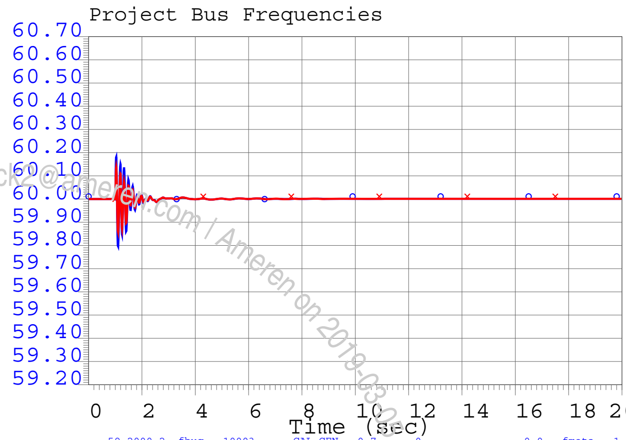
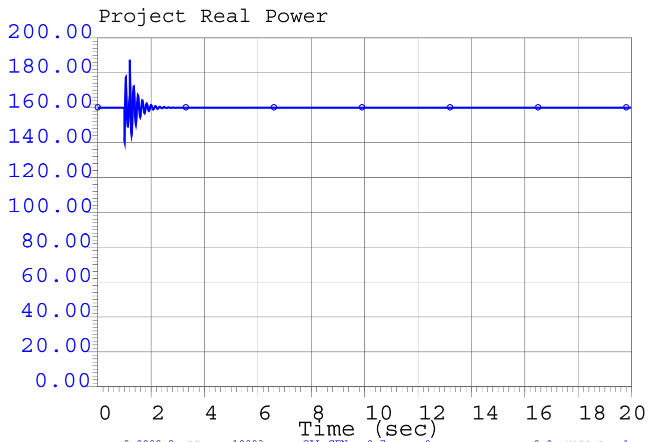
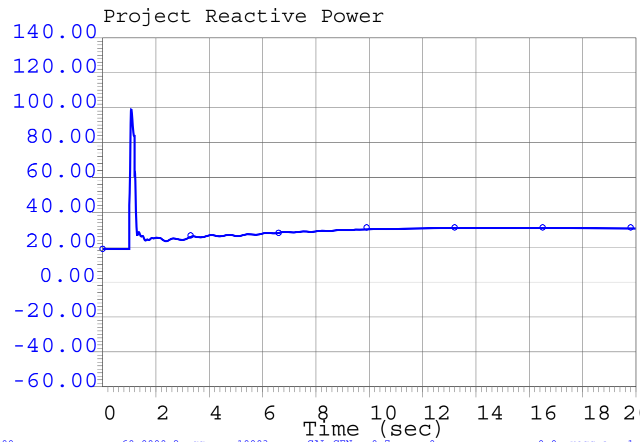
× 0.0000 2 vbug 10001 GAL-COLL 115.0 0 0.0 vmeta 1 1 1.2000



○ 59.2000 2 fbug 10003 GAL-GEN 0.7 0 0.0 fmeta 1 1 60.7000
× 59.2000 2 fbug 10001 GAL-COLL 115.0 0 0.0 fmeta 1 1 60.7000



○ 0.0000 2 pg 10003 GAL-GEN 0.7 0 0.0 regc_a 1 1 200.0000



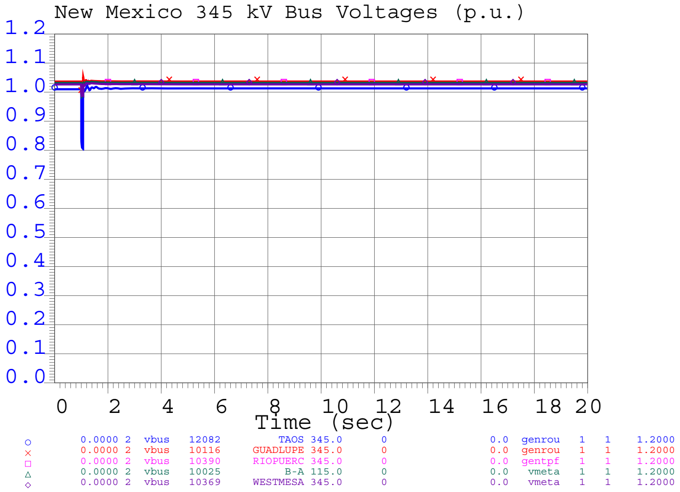
○ -60.0000 2 qg 10003 GAL-GEN 0.7 0 0.0 regc_a 1 1 140.0000

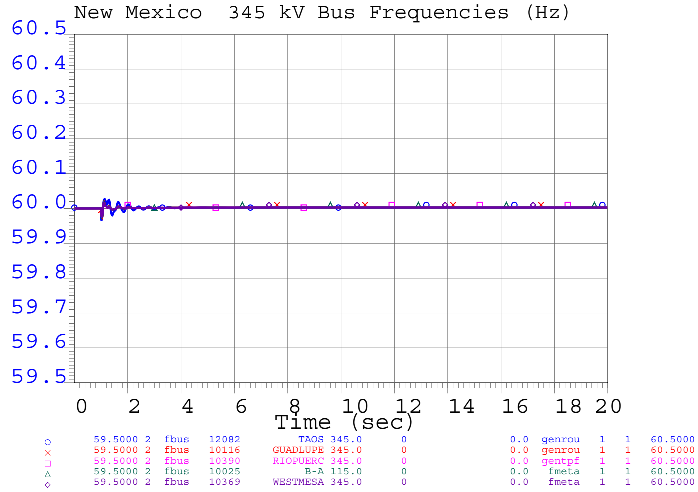
2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
11 12_P4_JIC-SJ and JIC-OJO

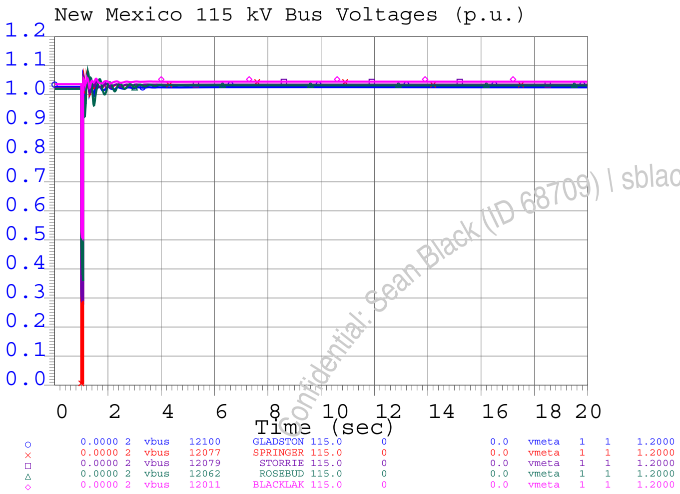
C:\!USE\dynamics\000011-12_P4_JIC-SJ_and_JIC-OJO-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

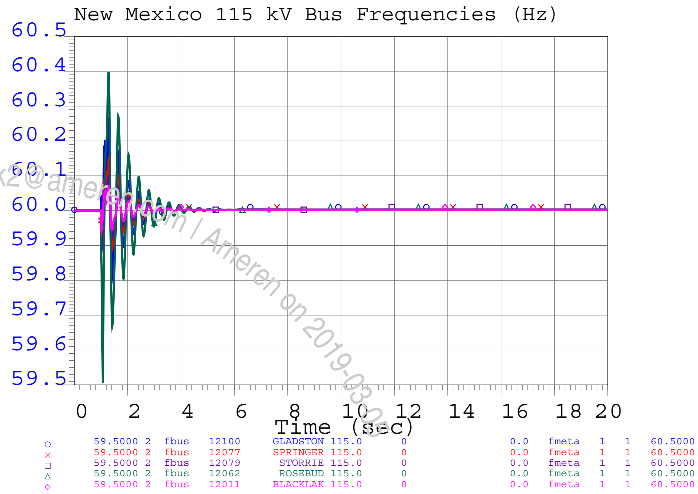
Wed Sep 14 18:55:18 2016

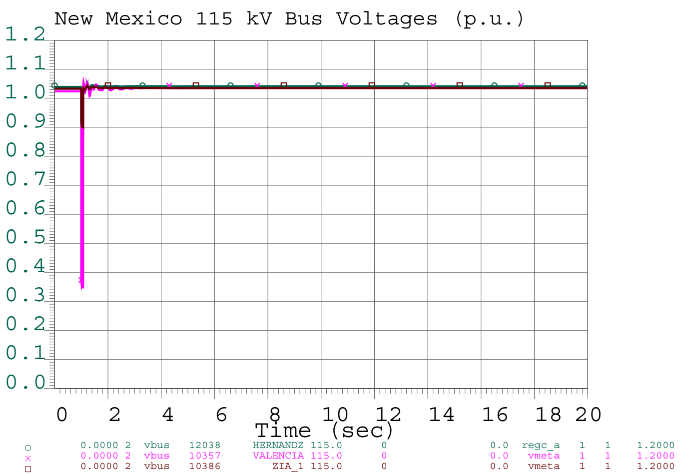
MORA
Transient Stability Plots

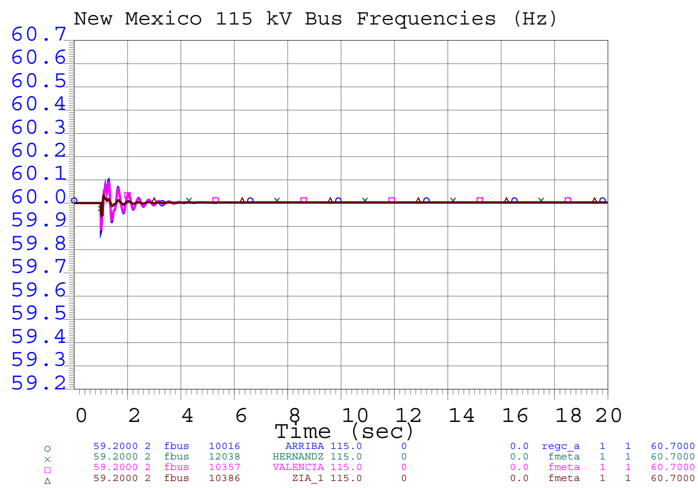










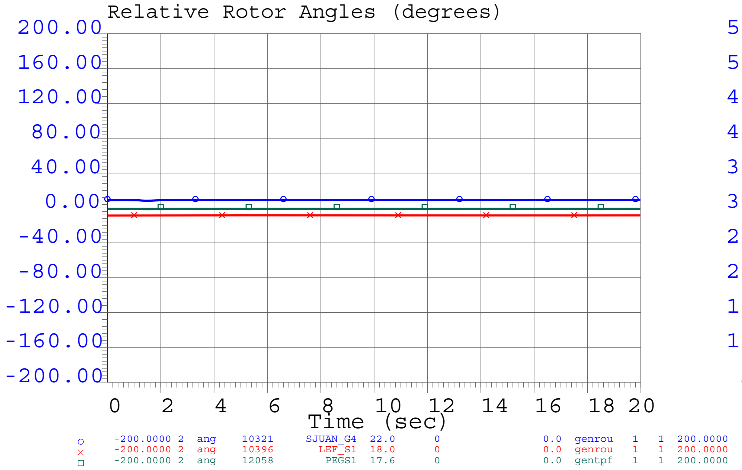


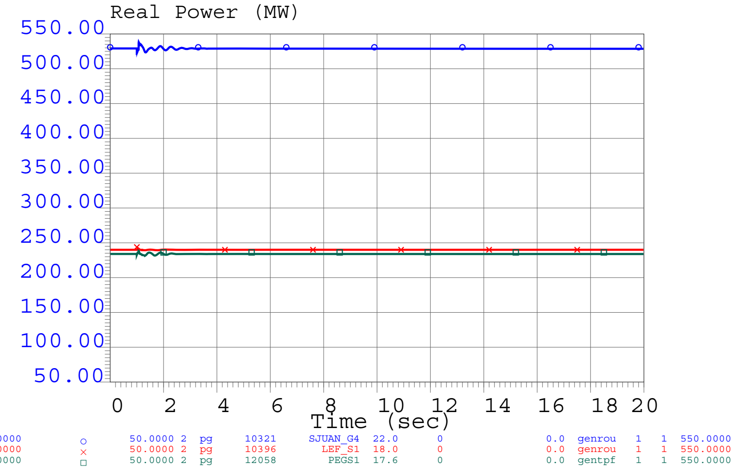
2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
12 11_P7_SPR-GLAD_1_3

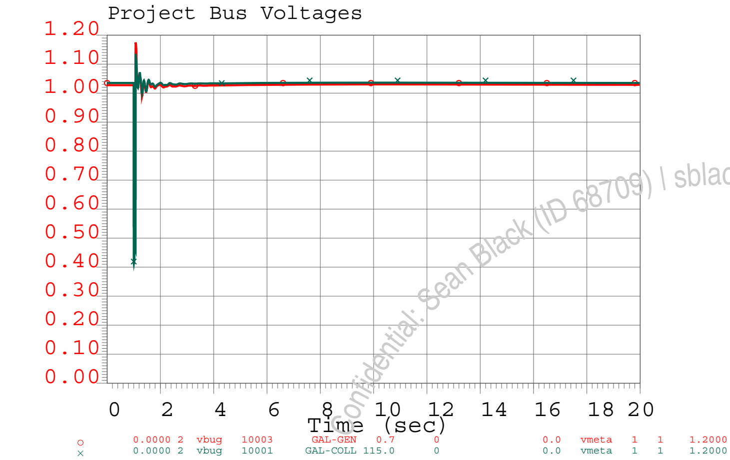
C:\!USE\dynamics\000012-11_P7_SPR-GLAD_1_3-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

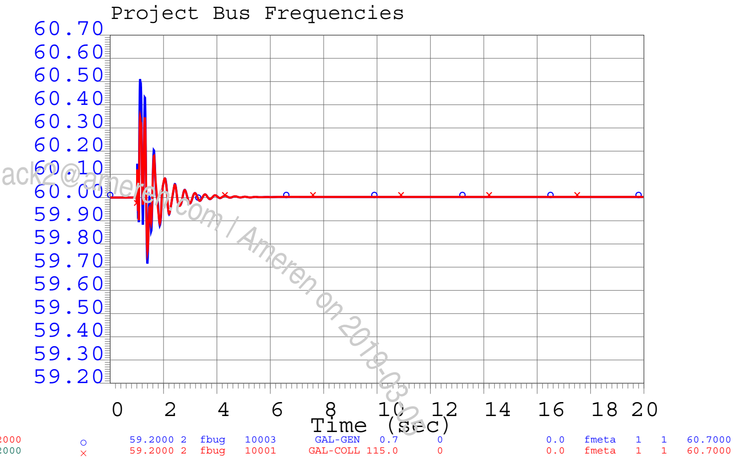
Wed Sep 14 18:55:18 2016

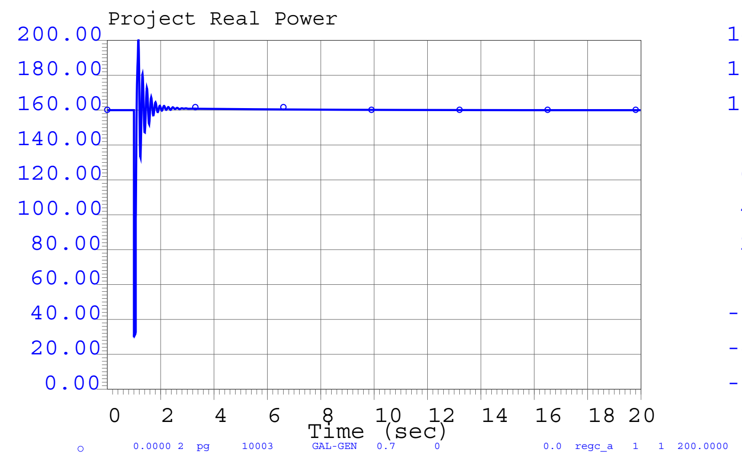
MORA
Transient Stability Plots

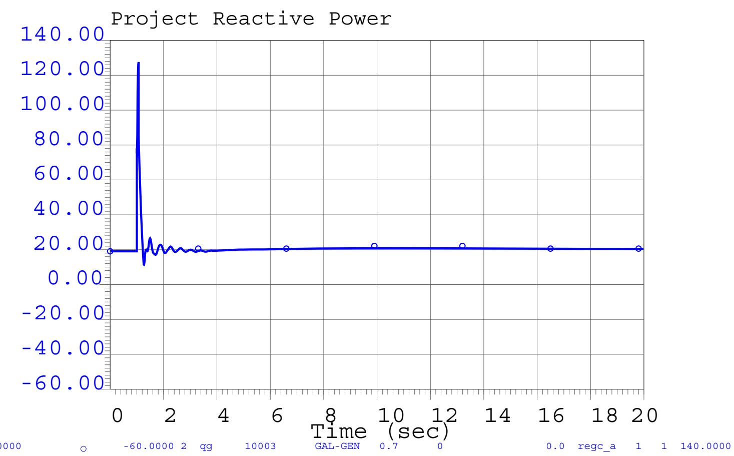












2021 HW Case, Mora TL SIS
Post-project. 160 MW. Offset gen at Navajo.
12 11_P7_SPR-GLAD_1_3

C:\!USE\dynamics\000012-11_P7_SPR-GLAD_1_3-04a_21hw1a_post_160MW_Blklk-1035_ts.chf

Wed Sep 14 18:55:18 2016

Appendix C – Dynamic Data

In order to study the Mora Transmission Line Project, generation models were needed for the associated generation. This appendix documents the dynamic models used. The regc_a and reec_a models were updated from the original data provided to eliminate ringing as noted in the main report.

- regc_a
- reec_a
- wtgq_a
- wtgt_a
- wtga_a
- wtgp_a
- repc_a
- lhvrt

regc_a: Generator/converter model

Variable	Original Data	Project Data	PSLF Default
MVA Base		**199.33**	
Lvplsw	1	1	1
Rrpwr	10	10	10
Brkpt	0.9	0.9	0.9
Zerox	0.5	0.5	0.5
Lvpl1	1.22	1.22	1.22
Vtmax	1.2	1.2	1.2
Lvpnt1	0.8	0.8	0.8
Lvpnt0	0.4	0.4	0.4
Qmin	-1.3	-1.3	-1.3
Accel	0.7	0.7	0.7
Tg	0.02	0.02	0.02
Tfltr	0.02	0.02	0.02
Iqrmax	999	99	99
Iqrmin	-999	-99	-99
Xe	0	0.8	0

reec_a: Renewable energy electrical control model

Variable	Original Data	Project Data	PSLF Default
mvab	0	0	
Vdip	0	-99	-99
Vup	2	99	99
Trv	0.02	0	0
dbd1	0	-0.05	-0.05
dbd2	0	0.05	0.05
kqv	0	0	0
iqh1	1	1.05	1.05
iql1	-1	-1.05	-1.05

vref0	1.03	1.03	0
iqfrz	0	0.15	0.15
thld	0	0	0
thld2	0	0	0
Tp	0.02	0.05	0.05
qmax	0.436	0.436	0.436
qmin	-0.436	-0.436	-0.436
vmax	1.1	1.1	1.1
vmin	0.9	0.9	0.9
Kqp	0	0	0
Kqi	0.41	0.1	0.5
Kvp	0	0	0
Kvi	40	40	40
vref1	0	0	0
Tiq	0.02	0.02	0.02
dpmax	0.45	99	99
dpmin	-0.45	-99	-99
pmax	1.12	1	1.12
pmin	0.04	0	0.04
Imax	1.7	1.82	1.82
tpord	0.02	0.02	0.02
pfflag	0	0	0
vflag	1	1	1
qflag	1	1	1
pflag	0	0	0
pqflag	0	0	0
vq1	0	-1	-1
iq1	0	1.45	1.45
vq2	0.4	2	2
iq2	1.1	1.45	1.45
vq3	0.8	0	0
iq3	1.1	0	0
vq4	2	0	0
iq4	1.1	0	0
vp1	0	-1	-1
ip1	0	1.1	1.1
vp2	0.4	2	2
ip2	1.1	1.1	1.1
vp3	0.8	0	0
ip3	1.1	0	0
vp4	2	0	0
ip4	1.1	0	0

wtgq_a: WTG Torque controller

Variable	Original/Project Data
mvab	0
kip	0.6
kpp	3
tp	0.05
twref	60

temax	1.2
temin	0.08
p1	0.2
spd1	0.69
p2	0.4
spd2	0.78
p3	0.6
spd3	0.98
p4	0.74
spd4	1.2
tflag	1

wtgt_a: Drive train model

Variable	Original/Project Data
mvab	0
ht	3.22
hg	0.62
dshaft	1.5
kshaft	0
wo	1.2

wtga_a: Simple aerodynamic model

Variable	Original/Project Data
mvab	0
ka	0.01
theta0	0

wtgp_a: WTG Pitch controller

Variable	Original/Project Data
Mvab	0
kiw	25
kpw	150
kic	30
kpc	3
kcc	0
tpi	0.3
pimax	27
pimin	0
piratmx	10
piratmn	-10

repc_a: Power Plant Controller

Variable	Original/Project Data
Mvab	0
tfltr	0.02

kp	2
ki	1
tft	0
tfv	0.15
refflg	1
vfrz	0.7
rc	0
xc	0
kc	0
vcmpflg	0
emax	0.1
emin	-0.1
dbd	0
qmax	0.44
qmin	-0.44
kpg	0
kig	0
tp	0.02
fdbd1	0
fdbd2	0
Femax	1
Femin	0
Pmax	1
Pmin	0.08
Tlag	1
ddn	0.99
dup	0.99
frqflg	0
outflag	0
Puflag	0

lhvrt: Low/High Voltage Ride Through generator protection

Variable	Original/Project Data
vref	1
dvtrp1	-0.6
dvtrp2	-0.4
dvtrp3	-0.25
dvtrp4	-0.15
dvtrp5	-0.1
dvtrp6	0.101
dvtrp7	0.15
dvtrp8	0.175
dvtrp9	0.2
dvtrp10	0.3
dttrp1	1
dttrp2	1.7
dttrp3	2.2
dttrp4	10
dttrp5	600

dttrp6	1
dttrp7	0.5
dttrp8	0.2
dttrp9	0.1
dttrp10	0.01
alarm	0

Appendix D – Short Circuit Analysis

Pre- Project Short Circuit – Analysis

Without Lucky Corridor Project

-- ASPEN OneLiner(Tm) --
VERSION 14.4

DATE AND TIME: Sun Dec 18 20:58:19 2016

OLR FILE NAME: D:\BREAKER-TPL-FAC002\2016TPL-BASE LATE-VERDE -LUCKY.OLR

STUDY DATE: None

NAME OF THIS FILE: D:\BREAKER-TPL-FAC002\REPORTS\LuckyCorridor OUT.TXT


```
BASE MVA = 100.
THIS FILE HAS:   444 BUSES
                  67 GENERATORS
                   0 LOADS
                  43 SHUNTS
                 326 LINES
                 101 2-WINDING TRANSFORMERS
                  54 3-WINDING TRANSFORMERS
                   2 PHASE SHIFTERS
                  16 SWITCHES
                   4 SERIES CAPCITORS. 0 BYPASSED
                   3 SERIES REACTORS. 3 BYPASSED
                   8 MUTUAL COUPLING PAIRS
```

FILE COMMENTS:..   2013 Q4 modified as belo
w..

Added Britton sw sta on AW line, Snow Vista on PW line and Scenic on CE line
Added annotated comment for OOS facilities
Added Lajara 115kv line to Algodones and associate 69kV TRIS loop
Added El Cerro, Manzano and Palace Taps on AT line

____________________ 2014 Q1 MODIFICATIONS_____________________________________
____
Added Jicarilla station on OJ 345kV line
Added Ojo 300MVA auto ISD 2014 (OOS)
Added Freeport Mining Facilites-MD1 area
Revised HLM transformer Z

xxxxxxxxxxxxxxxxxxxxxxxxxxx 2014 Q2 MODIFICATIONS xxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxx
Added Richmond Station, tied to Prager, North and Sandia, via PN, EB-CG-HW line
 sections. Left OOS
Removed Bus Tie Reactor at WM1-2, replaced with switch N.C.

--2015 FUT MODIFICATIONS --

Bussed 345kV line into Rio Puerco
Adder PR line Progress-Rio Puerco 115kV

PREFAULT VOLTAGE PROFILE: FLAT BUS VOLTAGES. PREFAULT V=1 PU
GENERATOR IMPEDANCE: SUBTRANSIENT
IGNORE PHASE SHIFT   [ ]
IGNORE LOADS   [ ]

```
IGNORE TRANSMISSION LINE G+jB                             [ ]
IGNORE SHUNTS WITH + SEQ IMPEDANCE                        [ ]
IGNORE TRANSFORMER LINE SHUNTS                            [ ]
MOV ITERATION                                             [X]
GENERATOR CURRENT LIMIT                                   [ ]
SIMULATE VOLTAGE CONTROLLED CURRENT SOURCES               [ ]
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PAGE    2                                                                        Bus Fault on:          0 ZIA 1        115. kV 3LG


==================================================================================================================================
  1. Bus Fault on:           0 ZIA 1        115. kV 3LG
                                                            FAULT CURRENT (PU @ DEG)
                   + SEQ              - SEQ              0 SEQ             A PHASE            B PHASE            C PHASE
                19.065@ -80.4       0.000@   0.0       0.000@   0.0      19.065@ -80.4      19.065@ 159.6      19.065@  39.6
                                                            THEVENIN IMPEDANCE (PU)
             0.00872+j0.05172   0.00872+j 0.0516   0.00811+j0.05434

                   SHORT CIRCUIT MVA= 1906.5         X/R RATIO= 5.92949     R0/X1= 0.15686    X0/X1= 1.0507
----------------------------------------------------------------------------------------------------------------------------------
BUS      0 ZIA 1          115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                     + SEQ            - SEQ            0 SEQ            A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)          >      0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (PU) TO     >
     0 ANZ TP        115.  1L     7.825@ 100.2     0.000@   0.0     0.000@   0.0     7.825@ 100.2     7.825@ -19.8     7.825@-139.8
    66 VALENCIA      115.  1L     0.838@ 105.0     0.000@   0.0     0.000@   0.0     0.838@ 105.0     0.838@ -15.0     0.838@-135.0
     7 B-A           115.  1L     3.519@ 102.8     0.000@   0.0     0.000@   0.0     3.519@ 102.8     3.519@ -17.2     3.519@-137.2
     0 ZIA 2          46.   X     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
     0 Z3TERT        13.8   X
                   AUTO NEUTRAL CURRENT =        0.0 @ -177.5 A
    73 ZIA 2         115.   S     6.902@  96.6     0.000@   0.0     0.000@   0.0     6.902@  96.6     6.902@ -23.4     6.902@-143.4
   190 ZIA XFMR 1     7.2  1T     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
   191 ZIA XFMR 2     7.2  1T     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0

CURRENT TO FAULT (PU)      >    19.065@ -80.4     0.000@   0.0     0.000@   0.0    19.065@ -80.4    19.065@ 159.6    19.065@  39.6
THEVENIN IMPEDANCE (PU)    >   0.05245@  80.4   0.05233@  80.4   0.05495@  81.5
----------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):                PHASE A           PHASE B           PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                                   0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                                   0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                                   0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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2. Bus Fault on: 0 ZIA 1 115. kV 1LG Type=A

FAULT CURRENT (PU @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
6.261@ -80.8	6.261@ -80.8	6.261@ -80.8	18.783@ -80.8	0.000@ 0.0	0.000@ 0.0

THEVENIN IMPEDANCE (PU)

+ SEQ	- SEQ	0 SEQ
0.00872+j0.05172	0.00872+j 0.0516	0.00811+j0.05434

SHORT CIRCUIT MVA= 1878.3 X/R RATIO= 6.16942 R0/X1= 0.15686 X0/X1= 1.0507

BUS 0 ZIA 1 115.KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.000@ 0.0 PU)

				+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G)			>	44.592@ 0.2	21.753@ 179.6	22.841@-179.3	0.000@ 0.0	67.265@-120.6	66.523@ 121.0
BRANCH CURRENT (PU) TO			>						
0 ANZ TP	115.	1L		2.570@ 99.8	2.570@ 99.8	1.747@ 102.2	6.885@ 100.4	0.828@ -85.3	0.828@ -85.3
66 VALENCIA	115.	1L		0.275@ 104.6	0.275@ 104.6	0.227@ 105.6	0.777@ 104.9	0.048@ -79.5	0.048@ -80.4
7 B-A	115.	1L		1.156@ 102.4	1.156@ 102.4	0.478@ 108.0	2.787@ 103.4	0.682@ -81.6	0.682@ -81.5
0 ZIA 2	46.	X		0.000@ 0.0	0.000@ 0.0	0.984@ 90.7	0.984@ 90.7	0.984@ 90.7	0.984@ 90.7
0 Z3TERT	13.8	X							
AUTO NEUTRAL CURRENT = 1482.1 @ 90.7 A									
73 ZIA 2	115.	S		2.267@ 96.2	2.267@ 96.2	1.790@ 102.5	6.316@ 98.0	0.526@-105.8	0.526@-105.7
190 ZIA XFMR 1	7.2	1T		0.000@ 0.0	0.000@ 0.0	0.570@ 91.1	0.569@ 91.1	0.570@ 91.1	0.570@ 91.1
191 ZIA XFMR 2	7.2	1T		0.000@ 0.0	0.000@ 0.0	0.500@ 91.2	0.499@ 91.2	0.500@ 91.2	0.500@ 91.2
CURRENT TO FAULT (PU)			>	6.261@ -80.8	6.261@ -80.8	6.261@ -80.8	18.783@ -80.8	0.000@ 0.0	0.000@ 0.0
THEVENIN IMPEDANCE (PU)			>	0.05245@ 80.4	0.05233@ 80.4	0.05495@ 81.5			

EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):	PHASE A	PHASE B	PHASE C
CAP FW 345.000kV - RIO_PUERCO 345.000kV	0.000 + j-0.027	0.000 + j-0.027	0.000 + j-0.027
CAP WW 345.000kV - RIO_PUERCO 345.000kV	0.000 + j-0.027	0.000 + j-0.027	0.000 + j-0.027
OJO 345.000kV - OJO CAP 345.000kV	0.000 + j-0.037	0.000 + j-0.037	0.000 + j-0.037

3. Bus Fault on: 66 VALENCIA 115. kV 3LG

FAULT CURRENT (PU @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
3.783@ -73.9	0.000@ 0.0	0.000@ 0.0	3.783@ -73.9	3.783@ 166.1	3.783@ 46.1

THEVENIN IMPEDANCE (PU)

+ SEQ	- SEQ	0 SEQ
0.07308+j0.25401	0.0731+j0.25392	0.03684+j0.29683

SHORT CIRCUIT MVA= 378.3 X/R RATIO= 3.47574 R0/X1= 0.14504 X0/X1= 1.16859

BUS 66 VALENCIA 115.KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.000@ 0.0 PU)

		+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G)	>	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (PU) TO	>						
0 ZIA 1 115. 1L		2.308@ 107.8	0.000@ 0.0	0.000@ 0.0	2.308@ 107.8	2.308@ -12.2	2.308@-132.2
120 STORIE LAKE 115. 1L		1.479@ 103.3	0.000@ 0.0	0.000@ 0.0	1.479@ 103.3	1.479@ -16.7	1.479@-136.7
174 XFMR VALENCI 13.8 1T		0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
CURRENT TO FAULT (PU)	>	3.783@ -73.9	0.000@ 0.0	0.000@ 0.0	3.783@ -73.9	3.783@ 166.1	3.783@ 46.1
THEVENIN IMPEDANCE (PU)	>	0.26431@ 73.9	0.26424@ 73.9	0.29911@ 82.9			

EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):

	PHASE A	PHASE B	PHASE C
CAP FW 345.000kV - RIO_PUERCO 345.000kV	0.000 + j-0.027	0.000 + j-0.027	0.000 + j-0.027
CAP WW 345.000kV - RIO_PUERCO 345.000kV	0.000 + j-0.027	0.000 + j-0.027	0.000 + j-0.027
OJO 345.000kV - OJO CAP 345.000kV	0.000 + j-0.037	0.000 + j-0.037	0.000 + j-0.037

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  4. Bus Fault on:          66 VALENCIA     115. kV 1LG Type=A
                                                            FAULT CURRENT (PU @ DEG)
                 + SEQ              - SEQ              0 SEQ              A PHASE            B PHASE            C PHASE
               1.212@ -77.2       1.212@ -77.2       1.212@ -77.2       3.635@ -77.2       0.000@   0.0       0.000@   0.0
                                                            THEVENIN IMPEDANCE (PU)
           0.07308+j0.25401    0.0731+j0.25392   0.03684+j0.29683

                   SHORT CIRCUIT MVA= 363.5          X/R RATIO= 4.39707     R0/X1= 0.14504    X0/X1= 1.16859
-------------------------------------------------------------------------------------------------------------------------------------
BUS     66 VALENCIA       115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                     + SEQ            - SEQ            0 SEQ            A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)          >     45.182@   1.5    21.257@ 176.8    24.063@-174.3     0.000@   0.0    70.877@-120.4    64.756@ 123.7
BRANCH CURRENT (PU) TO     >
     0 ZIA 1         115.  1L     0.739@ 104.6     0.739@ 104.6     0.306@ 114.2     1.781@ 106.2     0.440@ -82.1     0.440@ -82.1
   120 STORIE LAKE   115.  1L     0.474@ 100.1     0.473@ 100.1     0.373@ 103.8     1.320@ 101.1     0.104@ -93.3     0.104@ -93.4
   174 XFMR VALENCI  13.8  1T     0.000@   0.0     0.000@   0.0     0.542@  95.7     0.542@  95.7     0.542@  95.7     0.542@  95.7

CURRENT TO FAULT (PU)      >      1.212@ -77.2     1.212@ -77.2     1.212@ -77.2     3.635@ -77.2     0.000@   0.0     0.000@   0.0
THEVENIN IMPEDANCE (PU)    >    0.26431@  73.9   0.26424@  73.9   0.29911@  82.9
-------------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):              PHASE A          PHASE B          PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                               0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                               0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                               0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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  5. Bus Fault on:         120 STORIE LAKE  115. kV 3LG
                                                            FAULT CURRENT (PU @ DEG)
                   + SEQ              - SEQ              0 SEQ             A PHASE            B PHASE            C PHASE
                 3.668@ -74.2       0.000@   0.0       0.000@   0.0       3.668@ -74.2       3.668@ 165.8       3.668@  45.8
                                                            THEVENIN IMPEDANCE (PU)
             0.07401+j0.26237   0.07403+j0.26229   0.04866+j0.33513

                   SHORT CIRCUIT MVA= 366.8          X/R RATIO= 3.54528     R0/X1= 0.18547    X0/X1= 1.2773
----------------------------------------------------------------------------------------------------------------------------------
BUS    120 STORIE LAKE    115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                     + SEQ             - SEQ             0 SEQ             A PHASE           B PHASE           C PHASE
VOLTAGE (KV, L-G)          >      0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0

SHUNT CURRENTS (PU)        >
  TO SHUNT                        0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (PU) TO     >
    66 VALENCIA      115.  1L     2.080@ 107.9     0.000@   0.0     0.000@   0.0     2.080@ 107.9     2.080@ -12.1     2.080@-132.1
   118 SPRINGER      115.  1L     1.592@ 102.9     0.000@   0.0     0.000@   0.0     1.592@ 102.9     1.592@ -17.1     1.592@-137.1

CURRENT TO FAULT (PU)      >      3.668@ -74.2     0.000@   0.0     0.000@   0.0     3.668@ -74.2     3.668@ 165.8     3.668@  45.8
THEVENIN IMPEDANCE (PU)    >    0.27261@  74.2   0.27254@  74.2   0.33864@  81.7
----------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):                PHASE A           PHASE B           PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                                 0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                                 0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                                 0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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  6. Bus Fault on:        120 STORIE LAKE  115. kV 1LG Type=A
                                                           FAULT CURRENT (PU @ DEG)
                 + SEQ              - SEQ              0 SEQ             A PHASE            B PHASE            C PHASE
               1.134@ -77.1       1.134@ -77.1       1.134@ -77.1       3.401@ -77.1       0.000@   0.0       0.000@   0.0
                                                           THEVENIN IMPEDANCE (PU)
           0.07401+j0.26237   0.07403+j0.26229   0.04866+j0.33513

                   SHORT CIRCUIT MVA= 340.1          X/R RATIO= 4.3711     R0/X1= 0.18547    X0/X1= 1.2773
----------------------------------------------------------------------------------------------------------------------------------
BUS    120 STORIE LAKE    115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                      + SEQ            - SEQ             0 SEQ            A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)           >     45.911@   1.3    20.516@ 177.1    25.492@-175.4     0.000@   0.0    71.572@-122.2    66.432@ 125.0

SHUNT CURRENTS (PU)         >
  TO SHUNT                         0.000@   0.0     0.000@   0.0     0.235@  94.6     0.235@  94.6     0.235@  94.6     0.235@  94.6
BRANCH CURRENT (PU) TO      >
    66 VALENCIA      115.  1L      0.643@ 105.1     0.643@ 105.1     0.674@ 104.3     1.959@ 104.8     0.032@  88.4     0.032@  88.2
   118 SPRINGER      115.  1L      0.492@ 100.0     0.492@ 100.0     0.228@ 107.3     1.211@ 101.4     0.267@ -86.1     0.267@ -86.2

CURRENT TO FAULT (PU)       >      1.134@ -77.1     1.134@ -77.1     1.134@ -77.1     3.401@ -77.1     0.000@   0.0     0.000@   0.0
THEVENIN IMPEDANCE (PU)     >    0.27261@  74.2   0.27254@  74.2   0.33864@  81.7
----------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):              PHASE A           PHASE B           PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                                 0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                                 0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                                 0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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Post Project (Mora Line Project) Short Circuit – Analysis

Lucky Corridor Project In Service

-- ASPEN OneLiner(Tm) --
VERSION 14.4

```
DATE AND TIME:    Sun Dec 18 20:53:56 2016

OLR FILE NAME: D:\BREAKER-TPL-FAC002\2016TPL-BASE LATE-VERDE -LUCKY.OLR

STUDY DATE: None

NAME OF THIS FILE: D:\BREAKER-TPL-FAC002\REPORTS\LuckyCorridor In.TXT

BASE MVA = 100.
THIS FILE HAS:   444 BUSES
                  67 GENERATORS
                   0 LOADS
                  43 SHUNTS
                 326 LINES
                 101 2-WINDING TRANSFORMERS
                  54 3-WINDING TRANSFORMERS
                   2 PHASE SHIFTERS
                  16 SWITCHES
                   4 SERIES CAPCITORS. 0 BYPASSED
                   3 SERIES REACTORS. 3 BYPASSED
                   8 MUTUAL COUPLING PAIRS

FILE COMMENTS:...................................................    2013 Q4 modified as belo
w...................................................................

Added Britton sw sta on AW line, Snow Vista on PW line and Scenic on CE line
Added annotated comment for OOS facilities
Added Lajara 115kv line to Algodones and associate 69kV TRIS loop
Added El Cerro, Manzano and Palace Taps on AT line

____________________ 2014 Q1 MODIFICATIONS_____________________________________
_________
Added Jicarilla station on OJ 345kV line
Added Ojo 300MVA auto ISD 2014 (OOS)
Added Freeport Mining Facilites-MD1 area
Revised HLM transformer Z

xxxxxxxxxxxxxxxxxxxxxxxxxxx  2014 Q2  MODIFICATIONS xxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxx
Added Richmond Station, tied to Prager, North and Sandia, via PN, EB-CG-HW line
 sections.  Left OOS
Removed Bus Tie Reactor at WM1-2, replaced with switch N.C.

------------------------------------------------------2015 FUT MODIFICATIONS --
---------------------------------------------------------------------------
Bussed 345kV line into Rio Puerco
Adder PR line Progress-Rio Puerco 115kV


PREFAULT VOLTAGE PROFILE: FLAT BUS VOLTAGES. PREFAULT V=1 PU
GENERATOR IMPEDANCE: SUBTRANSIENT
IGNORE PHASE SHIFT                                          [ ]
IGNORE LOADS                                                [ ]
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IGNORE TRANSMISSION LINE G+jB                               [ ]
IGNORE SHUNTS WITH + SEQ IMPEDANCE                          [ ]
IGNORE TRANSFORMER LINE SHUNTS                              [ ]
MOV ITERATION                                               [X]
GENERATOR CURRENT LIMIT                                     [ ]
SIMULATE VOLTAGE CONTROLLED CURRENT SOURCES                 [ ]
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=====================================================================================================================================
  1. Bus Fault on:           0 ZIA 1        115. kV 3LG
                                                             FAULT CURRENT (PU @ DEG)
                   + SEQ                - SEQ                0 SEQ              A PHASE              B PHASE              C PHASE
                19.427@ -80.3        0.000@   0.0        0.000@   0.0      19.427@ -80.3      19.427@ 159.7      19.427@  39.7
                                                             THEVENIN IMPEDANCE (PU)
             0.00864+j0.05074   0.00864+j0.05062   0.00814+j0.05427

                   SHORT CIRCUIT MVA= 1942.7         X/R RATIO= 5.86994     R0/X1= 0.16038    X0/X1= 1.06954
-------------------------------------------------------------------------------------------------------------------------------------
BUS      0 ZIA 1          115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                       + SEQ             - SEQ             0 SEQ            A PHASE           B PHASE           C PHASE
VOLTAGE (KV, L-G)          >      0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (PU) TO     >
     0 ANZ TP        115.  1L     7.834@ 100.2     0.000@   0.0     0.000@   0.0     7.834@ 100.2     7.834@ -19.8     7.834@-139.8
    66 VALENCIA      115.  1L     1.183@ 104.8     0.000@   0.0     0.000@   0.0     1.183@ 104.8     1.183@ -15.2     1.183@-135.2
     7 B-A           115.  1L     3.521@ 102.8     0.000@   0.0     0.000@   0.0     3.521@ 102.8     3.521@ -17.2     3.521@-137.2
     0 ZIA 2          46.   X     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
     0 Z3TERT        13.8   X
                   AUTO NEUTRAL CURRENT =        0.0 @  112.6 A
    73 ZIA 2         115.   S     6.910@  96.6     0.000@   0.0     0.000@   0.0     6.910@  96.6     6.910@ -23.4     6.910@-143.4
   190 ZIA XFMR 1     7.2  1T     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
   191 ZIA XFMR 2     7.2  1T     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0

CURRENT TO FAULT (PU)      >     19.427@ -80.3     0.000@   0.0     0.000@   0.0    19.427@ -80.3    19.427@ 159.7    19.427@  39.7
THEVENIN IMPEDANCE (PU)    >    0.05148@  80.3   0.05136@  80.3   0.05488@  81.5
-------------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):              PHASE A           PHASE B           PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                              0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                              0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                              0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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  2. Bus Fault on:           0 ZIA 1        115. kV 1LG Type=A
                                                            FAULT CURRENT (PU @ DEG)
                   + SEQ              - SEQ              0 SEQ            A PHASE            B PHASE            C PHASE
                 6.341@ -80.7       6.341@ -80.7       6.341@ -80.7      19.023@ -80.7       0.000@   0.0       0.000@   0.0
                                                            THEVENIN IMPEDANCE (PU)
             0.00864+j0.05074   0.00864+j0.05062   0.00814+j0.05427

                   SHORT CIRCUIT MVA= 1902.3         X/R RATIO= 6.12178     R0/X1= 0.16038    X0/X1= 1.06954
-------------------------------------------------------------------------------------------------------------------------------------
BUS      0 ZIA 1          115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                    + SEQ            - SEQ            0 SEQ            A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)          >     44.724@   0.2    21.622@ 179.6    23.105@-179.3     0.000@   0.0    67.490@-120.9    66.708@ 121.3
BRANCH CURRENT (PU) TO     >
     0 ANZ TP        115.  1L     2.557@  99.8     2.557@  99.8     1.767@ 102.3     6.880@ 100.5     0.795@ -85.7     0.795@ -85.7
    66 VALENCIA      115.  1L     0.386@ 104.4     0.385@ 104.4     0.238@ 106.4     1.009@ 104.9     0.148@ -78.6     0.148@ -79.0
     7 B-A           115.  1L     1.149@ 102.4     1.149@ 102.4     0.483@ 108.1     2.780@ 103.4     0.670@ -81.7     0.670@ -81.7
     0 ZIA 2          46.   X     0.000@   0.0     0.000@   0.0     0.995@  90.7     0.995@  90.7     0.995@  90.7     0.995@  90.7
     0 Z3TERT        13.8   X
                   AUTO NEUTRAL CURRENT =     1499.2 @   90.7 A
    73 ZIA 2         115.   S     2.256@  96.2     2.256@  96.2     1.811@ 102.6     6.314@  98.0     0.498@-107.5     0.498@-107.4
   190 ZIA XFMR 1     7.2  1T     0.000@   0.0     0.000@   0.0     0.576@  91.2     0.576@  91.2     0.576@  91.2     0.576@  91.2
   191 ZIA XFMR 2     7.2  1T     0.000@   0.0     0.000@   0.0     0.505@  91.3     0.505@  91.3     0.505@  91.3     0.505@  91.3

CURRENT TO FAULT (PU)      >      6.341@ -80.7     6.341@ -80.7     6.341@ -80.7    19.023@ -80.7     0.000@   0.0     0.000@   0.0
THEVENIN IMPEDANCE (PU)    >    0.05148@  80.3   0.05136@  80.3   0.05488@  81.5
-------------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):             PHASE A          PHASE B          PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                              0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                              0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                              0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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  3. Bus Fault on:          66 VALENCIA     115. kV 3LG
                                                            FAULT CURRENT (PU @ DEG)
                   + SEQ              - SEQ              0 SEQ             A PHASE            B PHASE            C PHASE
                 4.809@ -75.6       0.000@   0.0       0.000@   0.0       4.809@ -75.6       4.809@ 164.4       4.809@  44.4
                                                            THEVENIN IMPEDANCE (PU)
             0.05154+j0.20146   0.05157+j 0.2014   0.03606+j0.26389

                   SHORT CIRCUIT MVA= 480.9          X/R RATIO= 3.90861     R0/X1= 0.17898    X0/X1= 1.30988
-------------------------------------------------------------------------------------------------------------------------------------------
BUS     66 VALENCIA       115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                   + SEQ            - SEQ            0 SEQ            A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)          >      0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0
BRANCH CURRENT (PU) TO     >
     0 ZIA 1         115.  1L     2.302@ 107.8     0.000@   0.0     0.000@   0.0     2.302@ 107.8     2.302@ -12.2     2.302@-132.2
   120 STORIE LAKE   115.  1L     2.515@ 101.2     0.000@   0.0     0.000@   0.0     2.515@ 101.2     2.515@ -18.8     2.515@-138.8
   174 XFMR VALENCI  13.8  1T     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0     0.000@   0.0

CURRENT TO FAULT (PU)      >      4.809@ -75.6     0.000@   0.0     0.000@   0.0     4.809@ -75.6     4.809@ 164.4     4.809@  44.4
THEVENIN IMPEDANCE (PU)    >    0.20795@  75.6    0.2079@  75.6   0.26634@  82.2
-------------------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):             PHASE A          PHASE B          PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                              0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                              0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                              0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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  4. Bus Fault on:          66 VALENCIA     115. kV 1LG Type=A
                                                            FAULT CURRENT (PU @ DEG)
                 + SEQ              - SEQ              0 SEQ            A PHASE            B PHASE            C PHASE
               1.468@ -78.2       1.468@ -78.2       1.468@ -78.2       4.405@ -78.2       0.000@   0.0       0.000@   0.0
                                                            THEVENIN IMPEDANCE (PU)
           0.05154+j0.20146   0.05157+j 0.2014   0.03606+j0.26389

                   SHORT CIRCUIT MVA= 440.5          X/R RATIO= 4.79094     R0/X1= 0.17898    X0/X1= 1.30988
------------------------------------------------------------------------------------------------------------------------------------------
BUS     66 VALENCIA       115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                     + SEQ             - SEQ             0 SEQ             A PHASE           B PHASE           C PHASE
VOLTAGE (KV, L-G)          >     46.154@   1.1    20.266@ 177.4    25.963@-176.0     0.000@   0.0    71.664@-122.8    67.149@ 125.3
BRANCH CURRENT (PU) TO     >
     0 ZIA 1         115.  1L     0.703@ 105.3     0.703@ 105.3     0.331@ 112.5     1.734@ 106.6     0.377@ -81.1     0.377@ -81.0
   120 STORIE LAKE   115.  1L     0.768@  98.6     0.768@  98.6     0.564@ 103.6     2.098@ 100.0     0.212@ -94.8     0.212@ -94.9
   174 XFMR VALENCI  13.8  1T     0.000@   0.0     0.000@   0.0     0.585@  94.0     0.585@  94.0     0.585@  94.0     0.585@  94.0

CURRENT TO FAULT (PU)      >      1.468@ -78.2     1.468@ -78.2     1.468@ -78.2     4.405@ -78.2     0.000@   0.0     0.000@   0.0
THEVENIN IMPEDANCE (PU)    >    0.20795@  75.6    0.2079@  75.6   0.26634@  82.2
------------------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):              PHASE A           PHASE B           PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                                0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                                0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                                0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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5. Bus Fault on: 120 STORIE LAKE 115. kV 3LG

FAULT CURRENT (PU @ DEG)

+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
4.914@ -76.6	0.000@ 0.0	0.000@ 0.0	4.914@ -76.6	4.914@ 163.4	4.914@ 43.4

THEVENIN IMPEDANCE (PU)

+ SEQ	- SEQ	0 SEQ
0.04725+j0.19794	0.04728+j0.19788	0.04131+j0.27833

SHORT CIRCUIT MVA= 491.4 X/R RATIO= 4.18958 R0/X1= 0.2087 X0/X1= 1.40617

BUS 120 STORIE LAKE 115.KV AREA 1 ZONE 1 TIER 0 (PREFAULT V=1.000@ 0.0 PU)

		+ SEQ	- SEQ	0 SEQ	A PHASE	B PHASE	C PHASE
VOLTAGE (KV, L-G)	>	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
SHUNT CURRENTS (PU)	>						
TO SHUNT		0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0	0.000@ 0.0
BRANCH CURRENT (PU) TO	>						
118 SPRINGER 115. 2L		1.501@ 96.6	0.000@ 0.0	0.000@ 0.0	1.501@ 96.6	1.501@ -23.4	1.501@-143.4
66 VALENCIA 115. 1L		2.073@ 108.0	0.000@ 0.0	0.000@ 0.0	2.073@ 108.0	2.073@ -12.0	2.073@-132.0
118 SPRINGER 115. 1L		1.357@ 104.0	0.000@ 0.0	0.000@ 0.0	1.357@ 104.0	1.357@ -16.0	1.357@-136.0
CURRENT TO FAULT (PU)	>	4.914@ -76.6	0.000@ 0.0	0.000@ 0.0	4.914@ -76.6	4.914@ 163.4	4.914@ 43.4
THEVENIN IMPEDANCE (PU)	>	0.2035@ 76.6	0.20345@ 76.6	0.28138@ 81.6			

EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):

	PHASE A	PHASE B	PHASE C
CAP FW 345.000kV - RIO_PUERCO 345.000kV	0.000 + j-0.027	0.000 + j-0.027	0.000 + j-0.027
CAP WW 345.000kV - RIO_PUERCO 345.000kV	0.000 + j-0.027	0.000 + j-0.027	0.000 + j-0.027
OJO 345.000kV - OJO CAP 345.000kV	0.000 + j-0.037	0.000 + j-0.037	0.000 + j-0.037

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  6. Bus Fault on:        120 STORIE LAKE  115. kV 1LG Type=A
                                                           FAULT CURRENT (PU @ DEG)
                     + SEQ              - SEQ              0 SEQ              A PHASE            B PHASE            C PHASE
                  1.454@ -78.6       1.454@ -78.6       1.454@ -78.6       4.362@ -78.6       0.000@   0.0       0.000@   0.0
                                                           THEVENIN IMPEDANCE (PU)
              0.04725+j0.19794   0.04728+j0.19788   0.04131+j0.27833

                   SHORT CIRCUIT MVA= 436.2          X/R RATIO= 4.96318     R0/X1= 0.2087    X0/X1= 1.40617
----------------------------------------------------------------------------------------------------------------------------------
BUS    120 STORIE LAKE    115.KV  AREA   1  ZONE   1   TIER   0       (PREFAULT V=1.000@   0.0 PU)
                                      + SEQ           - SEQ            0 SEQ           A PHASE          B PHASE          C PHASE
VOLTAGE (KV, L-G)          >     46.766@   0.9    19.643@ 178.0    27.166@-177.1     0.000@   0.0    72.165@-124.3    68.738@ 126.3

SHUNT CURRENTS (PU)        >
  TO SHUNT                        0.000@   0.0     0.000@   0.0     0.251@  92.9     0.251@  92.9     0.251@  92.9     0.251@  92.9
BRANCH CURRENT (PU) TO     >
   118 SPRINGER      115.  2L     0.444@  94.6     0.444@  94.6     0.269@ 101.7     1.156@  96.2     0.181@ -95.9     0.181@ -95.9
    66 VALENCIA      115.  1L     0.613@ 105.9     0.613@ 105.9     0.718@ 102.6     1.944@ 104.7     0.112@  84.0     0.112@  83.9
   118 SPRINGER      115.  1L     0.402@ 102.0     0.402@ 102.0     0.221@ 106.7     1.023@ 103.0     0.183@ -83.7     0.183@ -83.8

CURRENT TO FAULT (PU)      >      1.454@ -78.6     1.454@ -78.6     1.454@ -78.6     4.362@ -78.6     0.000@   0.0     0.000@   0.0
THEVENIN IMPEDANCE (PU)    >     0.2035@  76.6   0.20345@  76.6   0.28138@  81.6
----------------------------------------------------------------------------------------------------------------------------------
EQUIVALENT IMPEDANCE OF MOV-PROTECTED SERIES CAPACITORS THAT FIRED (PU):                  PHASE A           PHASE B           PHASE C
         CAP FW 345.000kV -    RIO_PUERCO 345.000kV                                  0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
         CAP WW 345.000kV -    RIO_PUERCO 345.000kV                                  0.000 + j-0.027  0.000 + j-0.027  0.000 + j-0.027
            OJO 345.000kV -       OJO CAP 345.000kV                                  0.000 + j-0.037  0.000 + j-0.037  0.000 + j-0.037
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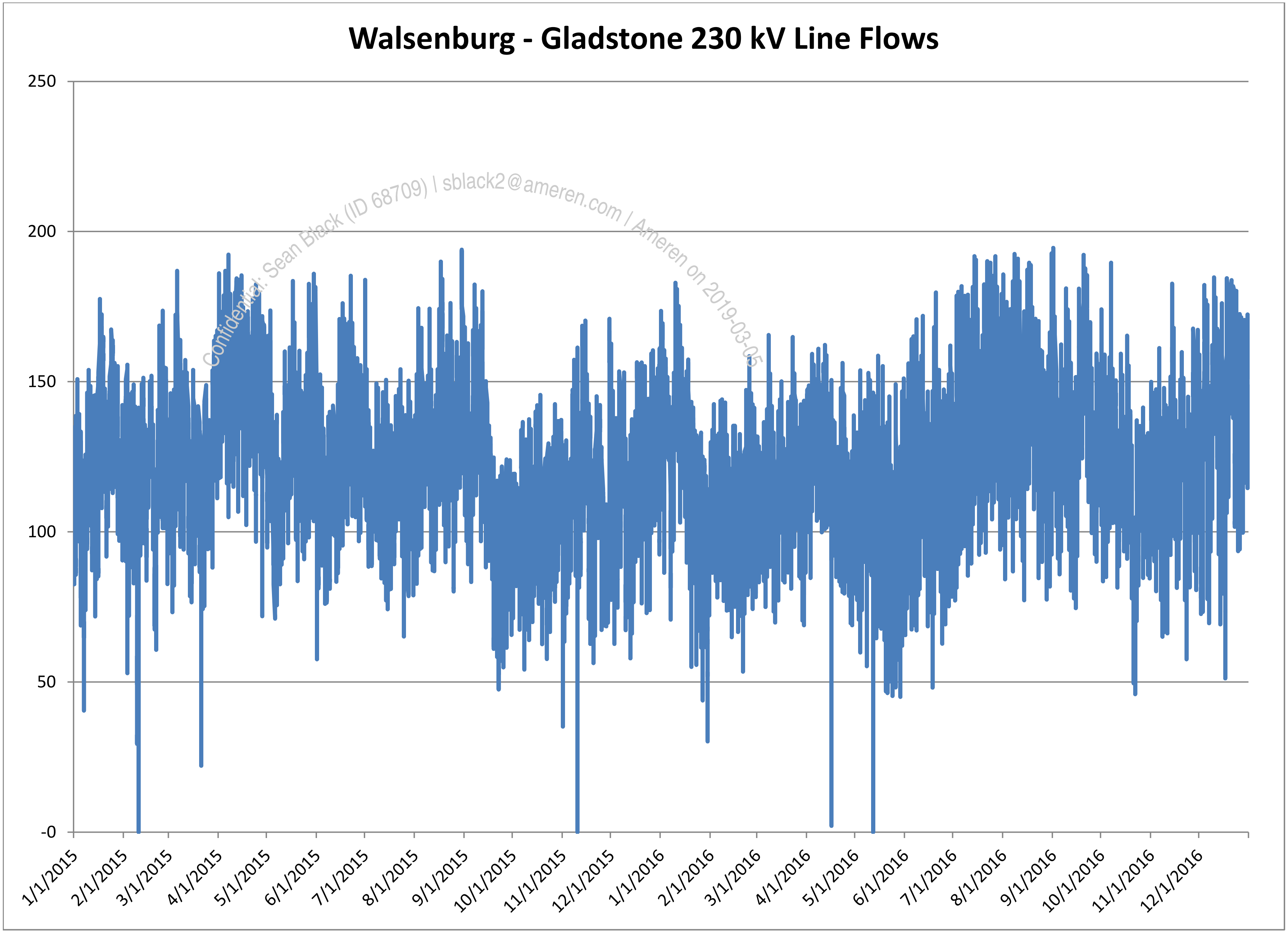
Appendix E – Historical Walsenburg – Gladstone 230 kV flows


Walsenburg - Gladstone 230 kV Line Flows
250
200
150
100
50
-0
1/1/2015
2/1/2015
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
11/1/2015
12/1/2015
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016