Interconnection System Impact Study Report
Request # GI-2014-5

50 MW Solar Photovoltaic Generating Facility
Missile Site 230 kV Station, Colorado

Public Service Company of Colorado
Transmission Planning
December 18, 2014

Executive Summary

Public Service Company of Colorado (PSCo) received an interconnection request for a 50 MW solar photovoltaic generating facility on May 13, 2014 that was assigned GI-2014-5 as the queue number. The proposed generating facility will be located on 545 acres of currently farmed land. The facility will connect to PSCo's Missile Site 345/230 kV Station with an approximately 0.5 mile 230 kV line. The primary point of interconnection (POI) requested for GI-2014-5 is the Missile Site 230 kV bus and the generating facility will interconnect to the POI using a new 230 kV, 0.5- mile long transmission line. The in-service date (ISD) requested for GI-2014-5 generating facility is December 31, 2016, and the request will be studied as both a Network Resource and Energy Resource♣.

This request was studied as a stand-alone generator interconnection that excluded any other new generation requests existing in the PSCo Generator Interconnection Request queue, except for the generator interconnection projects that are already planned to be in service by winter of 2016. The main purpose of this System Impact Study was to evaluate the potential impact on the interconnected transmission system of PSCo and its neighboring utilities (the affected parties) due to an additional 50 MW of generation injected into the Missile Site 230 kV bus. It should be noted that PSCo evaluated the capacity adequacy of the transmission system beyond the POI – the Interconnection Customer is responsible for ensuring that the 230 kV tie line to the POI is adequately rated for the proposed 50 MW generation.

There are no facilities belonging to other entities in the immediate vicinity of the interconnection and therefore there are no identified affected parties. The System Impact Study indicated that there were no adverse impacts to other systems.

♣ Energy Resource Interconnection Service allows Interconnection Customer to connect the Large Generating Facility to the Transmission System and be eligible to deliver the Large Generating Facility's output using the existing firm or non-firm capacity of the Transmission System on an "as available" basis. Energy Resource Interconnection Service does not in and of itself convey any right to deliver electricity to any specific customer or Point of Delivery.

Network Resource (NR)

At the primary POI at the Missile Site 230 kV substation, the proposed generation caused a 102.2% contingency loading of the 8-hour emergency rating of the Smoky Hill 230/345 kV transformers. The result of this loading is greatly affected by the modeling of maximum output of wind generation interconnected at Missile Site, and high output of wind generation at Pawnee for the study case. Since the output of the regional wind generation is unlikely to operate at maximum levels at the same time that the solar generation is at peak output, the contingency loading on the Smoky Hill transformers is not expected to go beyond the 8-hour emergency rating. Hence, the Network Resource Capability of the proposed generation is as follows:

NR = 50 MW (at Missile Site 230 kV POI, without PSCo upgrades)

Energy Resource (ER)

Since the output of the regional wind generation is unlikely to operate at maximum levels at the same time that the solar generation is at peak output, the contingency loading on the Smoky Hill transformers is not expected to go beyond the 8-hour emergency rating. Hence, the Energy Resource Capability of the proposed generation is as follows:

ER = 50 MW (at Missile Site 230 kV POI, without PSCo upgrades)

Short Circuit

The short circuit study results showed no new circuit breakers overdutied due to the proposed solar generation facility.

Cost Estimates

The cost for the transmission interconnection (in 2014 dollars):

Transmission Proposal
The total estimated cost of the recommended system improvements to interconnect the project is approximately **$1.115 million** and includes:

- $0.645 million for PSCo-Owned, Customer-Funded Interconnection Facilities
- $0.470 million for PSCo-Owned, PSCo-Funded Network Upgrades for Interconnection
- $0 million for PSCo Network Upgrades for Delivery to PSCo Loads

This work can be completed in 18 months following receipt of authorization to proceed.

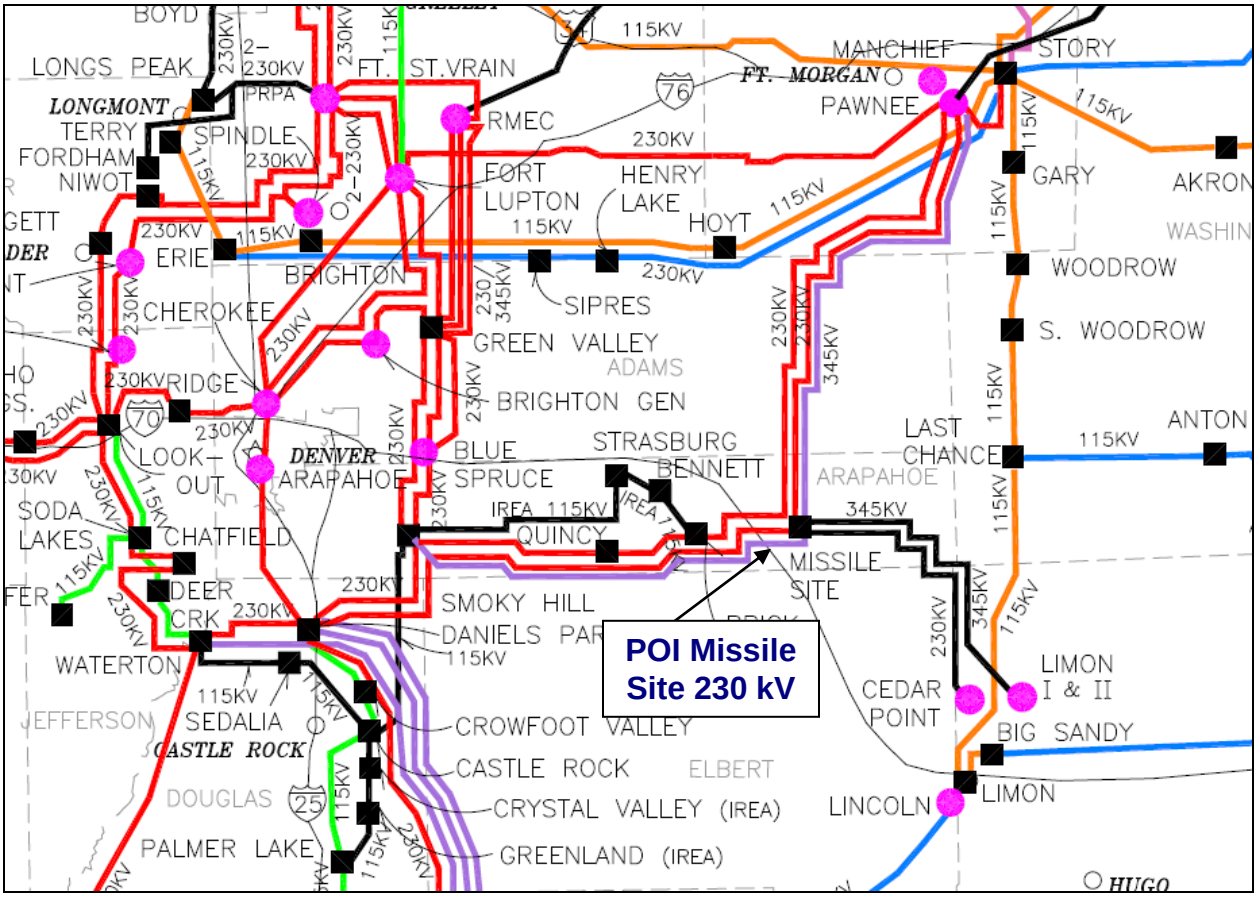


Figure 1 Missile Site, Pawnee, Daniels Park, and Surrounding Transmission System

Introduction

Public Service Company of Colorado (PSCo) received an interconnection request for a 50 MW solar photovoltaic generating facility on May 13, 2014 that was assigned GI-2014-5 as the queue number. The proposed generating facility will be located on 545 acres of currently farmed land approximately 0.5 miles away from PSCo's Missile Site 345/230 kV Station. The primary point of interconnection (POI) requested for GI-2014-5 is the Missile Site 230 kV bus and the generating facility will interconnect to the POI using a new 230 kV, 0.5- mile long transmission line. The in-service date (ISD) requested for GI-2014-5 generating facility is December 31, 2016.

Study Scope and Analysis

The System Impact Study evaluated the transmission impacts associated with the proposed solar generation facility. The study consists of power flow, short circuit, and transient stability analyses. The power flow analysis identified thermal and voltage limit violations resulting form the installation of the proposed generation and an identification

of network upgrades required to deliver the proposed generation to PSCo loads. The short circuit analysis identified any new circuit breakers overdutied due to the proposed generation and the short circuit levels at the primary POI. The transient stability analysis identified any dynamic stability problems associated with the new generation.

PSCo adheres to NERC & WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per unit of nominal, and steady-state power flows below the thermal ratings of all facilities. Operationally, PSCo attempts to maintain a transmission system voltage profile ranging from 1.02 per unit or higher at regulating (generation) buses to 1.0 per unit or higher at transmission load buses. Following a single contingency, transmission system steady state bus voltages must remain within 0.90 per unit to 1.10 per unit, and power flows within 100% of the facilities' continuous thermal ratings. Also, voltage deviations should not exceed 5%.

Transient stability criteria require that all generating machines remain in synchronism and all power swings should be well damped for single contingency events. Also, transient voltage performance should meet the following WECC Disturbance-Performance criteria:

- Following fault clearing for singe contingencies:
  - Voltage may not drop more than 25% of the pre-fault voltage at load buses, more than 30% at non-load buses, or more than 20% for more than 20 cycles at any bus.
  - Frequency man not drop below 59.6 Hz for 6 cycles or more at load buses.
- Following fault clearing for double contingencies:
  - Voltage may not drop more than 30% of the pre-fault voltage at any bus or more than 20% for more than 40 cycles at any bus.
  - Frequency may not drop below 59.0 Hz for 6 cycles or more at load buses.

The project was studied as a Network Resource and Energy Resource. Network Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission System: (1) in a manner comparable to that in which the Transmission Provider integrates its generation facilities to serve native load customers; or (2) in an TRO or ISO with market based congestion management, in the same manner as all other Network Resources. Network Resource Interconnection Service in and of itself does not convey transmission service.

Energy Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission

Provider's Transmission System on an as available bases. Energy Resource Interconnection Service in and of itself does not convey transmission service.

There are no facilities belonging to other entities in the immediate vicinity of the interconnection and the studies indicated that there were no adverse impacts to other systems.

Power Flow Study Models

The GI-2014-5 System Study was performed using a 2017 heavy summer (2017HS) power flow base case for steady state power flow and short circuit analyses and using a a WECC 2019 heavy summer (2019HS) power flow base case with associated dynamic modeling data in GE PSLF format for the stability analyses. The analyses assumed two cases, the Benchmark case (Before GI-2014-5) and the Study case (After GI-2014-5). The 2017HS and 2019HS base case was updated to set the TOT-3 major path flow (north-south) between 700-800 MW and to dispatch the existing and planned wind generation interconnected at Pawnee and Missile Site stations at their maximum expected coincident output (based on 2012-13 winter operating data). The resulting Benchmark case was then used to create the Study case by adding GI-2014-5 at the Missile Site 230 kV bus and dispatching the generator at 50 MW rated output. The wind and solar generation dispatch used at Pawnee and Missile Site stations in the two cases is as follows:

- ✓ Peetz Logan (Pawnee 230kV) = 80% of rated capacity = 461 MW
- ✓ Limon I and Limon II (Missile Site 345kV) = 97% of rated capacity = 392 MW
- ✓ Cedar Point (Missile Site 230kV) = 96% of rated capacity = 240 MW
- ✓ Planned (2014) Limon III (Missile Site 345kV) = 97% of rated capacity = 196 MW
- ✓ Proposed GI-2014-5 (Missile Site 230kV) = 100% of rated capacity = 50 MW

The study also assumed generation dispatch changes in other areas of the PSCo system to accommodate wind and solar dispatch and to more accurately represent the generation available by 2017. The changes to the two cases are as follows:

- ✓ Manchief Units 1 and 2 (Pawnee 230kV) = 0% of rated capacity = 0 MW
- ✓ Arapahoe Unit 7 (Arapahoe 115kV) = 100% of rated capacity = 45 MW
- ✓ Ft. St. Vrain Units 2-5 (Ft. St. Vrain 230 kV) = 0% of rated capacity = 0 MW
- ✓ Valmont Unit 5 (Valmont 115 kV) = 0% of rated capacity = 0 MW
- ✓ Spruce Units 1-2 (Spruce 230 kV) = 93% of rated capacity = 260 MW

Power Flow Study Process

Contingency power flow studies were completed on the reference models and the models with the proposed new generation using PTI's PSSE Ver. 33.4.0 program. Results from each of the two cases were compared and new overloads or overloads that increased significantly in the new generation case were noted. Voltage criteria violations were also recorded. PSSE's ACCC activity was used to perform the load flow

contingency analysis. Powerflow areas 70 and 73 were used for contingency files (single branches and tielines). Monitored elements included branches in ties in powerflow zones 700, 703, 704, 705, 706, 710, 752, 753, 754, and 757.

Power Flow Results

Based on the results given in Table 1, it can be seen that the proposed generator interconnection results in both pre and post-contingency thermal overload on the Smoky Hill 230/345 kV auto-transformer remaining in-service after the forced outage of any one of the two identical Smoky Hill 230/345 kV auto-transformers, each rated at 560 MVA summer normal. The differential impact due to GI-2014-5 is a 2.7% increase in the post-contingency loading of the Smoky Hill auto-transformer – the power flow increases from 99.5% to 102.2% of the summer 8-hour emergency rating (644 MVA) of the auto-transformer.

No new violations of the voltage limit criteria (0.9 - 1.05 pu) or the voltage deviation criteria (< 5%) were caused in PSCo's interconnected transmission system due to the addition of GI-2014-5 generating facility.

N-1-1 and/or N-2 contingency analysis was not performed within this System Impact Study. However, the effect of N-1-1 and/or N-2 contingencies may be evaluated in the future to identify significant operational constraints and potential need for operating procedures for their mitigation.

Transient Stability Study Process

Transient stability analysis was completed on the reference models and the models with the proposed new generation using GE's PSLF Ver. 18.1_02 program. NERC Category B & C contingencies were considered as part of the analysis, including standard clearing and delayed clearing single events. Bus voltage, bus frequency, and generator angle were recorded and compared to the WECC allowable criteria. Also, any generators that went out of synchronism were recorded. WECC's ALLDYNS.p EPCL program was used to simulate the disturbances.

Transient Disturbances Studied

Eight transient stability disturbances were simulated for the benchmark and project cases, including the following:

A. NERC/WECC Category B Disturbances
(Three-phase, close-in faults at * with normal clearing of 6 cycles)

1. Missile Site* - Daniels Park 230 kV Line
2. Missile Site* - Pawnee 230 kV Line

3. Missile Site* - Smoky Hill 345 kV Line
4. Missile Site* - Pawnee 345 kV Line
5. Daniels Park* - Greenwood 230 kV Line
6. Pawnee* - Story 230 kV Line

B. NERC/WECC Category C Disturbances
(Single-line-to-ground, close-in faults at * with delayed clearing of 21 cycles)

7. Missile Site* - Daniels Park 230 kV Line
8. Missile Site* - Pawnee 230 kV Line

Transient Stability Study Results

The transient stability analysis for the GI-2014-5 System Impact Study simulated each of the eight disturbances listed for both of the two study cases. The results of each transient stability run were then analyzed to determine whether the voltage and frequency performed within the WECC criteria and whether generators continued in synchronism before or after the proposed generation was interconnected. As noted previously, a case was studied using the detailed model provided by the Interconnection Customer.

The GI-2014-5 transient stability analysis found no criteria violations in the pre-project and post-project cases for any of the studied outages. Therefore, this project is determined to cause no violations and to produce no adverse impacts for existing violations related to the transient behavior of the WECC system. The following results were obtained for every case and disturbance analyzed:

- ✓ No machines lost synchronism with the system
- ✓ No transient voltage drop violations were observed
- ✓ No transient frequency drop violations were observed

Transient stability plots showing surrounding bus voltages, bus frequencies, generator terminal voltages, generator relative angles, generator speeds, and generator power output for each of the disturbances run for each study scenario have been created and documented in Appendix A.

Network Resource (NR)

At the primary POI at the Missile Site 230 kV substation, the proposed generation caused a 102.2% contingency loading of the 8-hour emergency rating of the Smoky Hill 230/345 kV Transformer Nos. 1 and 2. 2.7% increase in contingency loading on the Smoky Hill 230/345 kV Transformer Nos. 1 and 2. The increased loading resulted in a loading equal to 102.2% of the 8-hour emergency rating of the transformers. The result of this loading is greatly affected by the modeling of maximum output of wind generation interconnected at Missile Site, and high output of wind generation at Pawnee for the

study case. Since the output of the regional wind generation is unlikely to operate at maximum levels at the same time that the solar generation is at peak output, the contingency loading on the Smoky Hill transformers is not expected to go beyond the 8-hour emergency rating. Hence, the Network Resource Capability of the proposed generation is as follows:

NR = 50 MW (at Missile Site 230 kV POI, without PSCo upgrades)

Energy Resource (ER)

Since the output of the regional wind generation is unlikely to operate at maximum levels at the same time that the solar generation is at peak output, the contingency loading on the Smoky Hill transformers is not expected to go beyond the 8-hour emergency rating. Hence, the Energy Resource Capability of the proposed generation is as follows:

ER = 50 MW (at Missile Site 230 kV POI, without PSCo upgrades)

Power Flow N-1 Contingency Analysis Results

Table 1 – Differentially Overloaded Facilities [1] for High Coincidence Wind/Solar Generation Dispatch at Pawnee and Missile Site

Pawnee 230kV = 461 MW (80%); Missile Site 345kV = 588 MW (97%); Missile Site 230kV = 240 MW (96%)

50 MW output of GI-2014-5 (100%)

					Branch N-1 Loading Before GI-2014-5		Branch N-1 Loading After GI-2014-5			
Monitored Facility (Line or Transformer)	Type	Owner	Summer Normal (Continuous) Facility Rating MVA	Summer 8-hour (2-hour) Emerg. Facility Rating MVA	N-1 Flow in MVA	N-1 Flow in % of 8-hour Rating	N-1 Flow in MVA	N-1 Flow in % of 8-hour Rating	Differential % Impact	N-1 Contingency Outage
Smoky Hill 230/345 kV # T4	Xfmr	PSCo	560	644 (700)	641	99.5%	658	102.2%	2.70%	Smoky Hill 230/345 kV # T5
Smoky Hill 230/345 kV # T5	Xfmr	PSCo	560	644 (700)	641	99.5%	658	102.2%	2.70%	Smoky Hill 230/345 kV # T4

[1] **Due to proposed 50 MW generation increase at Missile Site 230 kV Station**

Short Circuit Analysis

The short circuit study results show that no circuit breakers in the Missile Site 230kV switchyard will be over-dutied due to the proposed GI-2014-5 solar generation facility. The study assumed results from the prior GI-2012-5 feasibility study which found no over-dutied circuit breakers due to a 200 MW injection at Missile Site 230 kV switchyard.

Costs Estimates and Assumptions

GI-2014-5 (Feasibility / System Impact Study Report)
December 18, 2014

Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by Public Service Company of Colorado (PSCo) / Xcel Energy (Xcel) Engineering. The cost estimates are in 2014 dollars with escalation and contingency included. AFUDC is not included. Estimates are developed assuming typical construction costs for previous completed projects. These estimates include all applicable labor and overheads associated with the siting support, engineering, design, material/equipment procurement, construction, testing and commissioning of these new substation and transmission line facilities. This estimate does not include the cost for any other Customer owned equipment and associated design and engineering.

The estimated total cost for the required upgrades for is **$1,115,000.** Figure 2 below represents a conceptual one-line of the proposed interconnection into the 230 kV bus at the Missile Site Transmission Substation. These estimates do not include costs for any other Customer owned equipment and associated design and engineering. The following tables list the improvements required to accommodate the interconnection and the delivery of the Project generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon a more detailed and refined design.

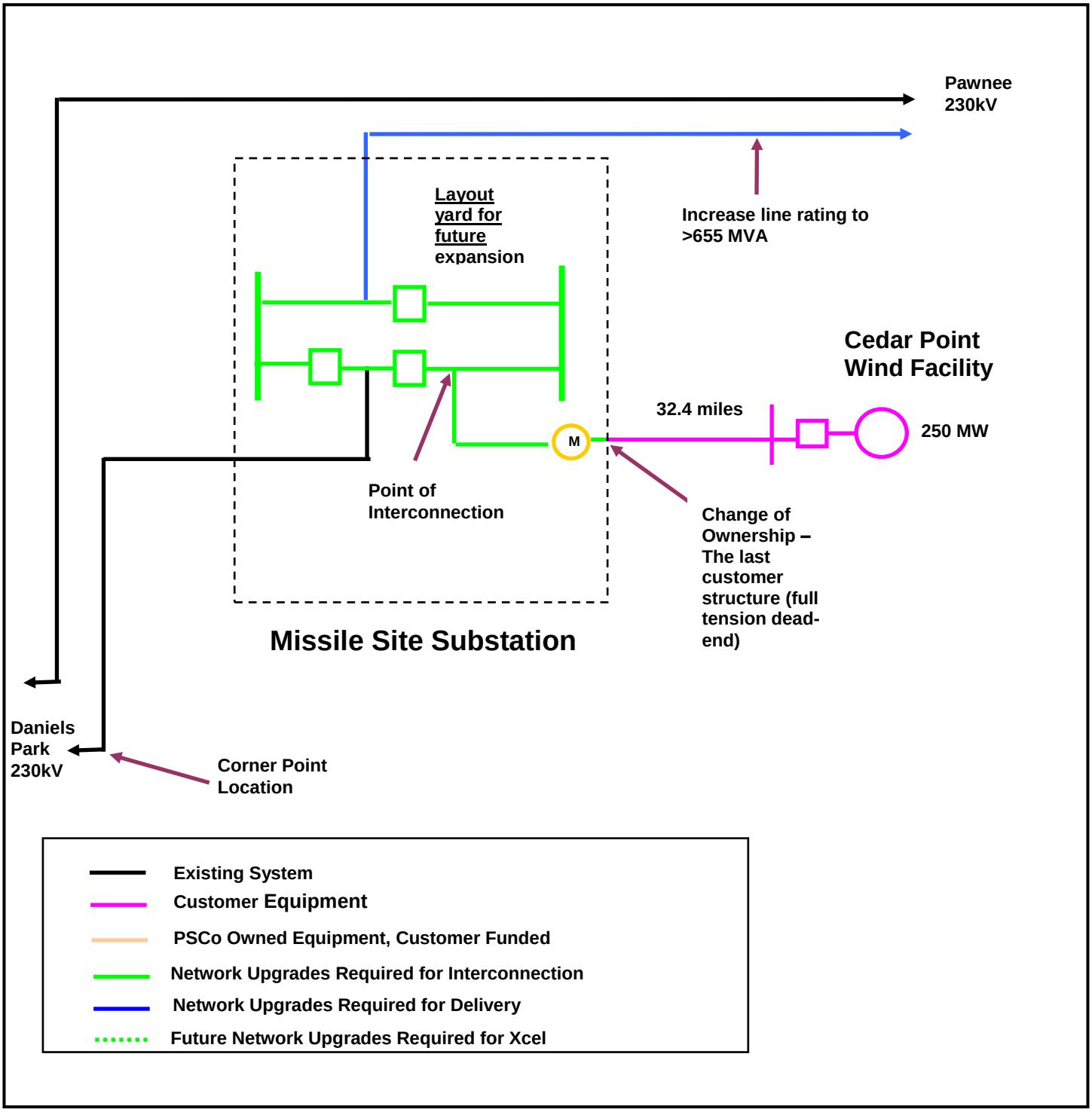


Figure 2: Conceptual one-line diagram

Table 2 – PSCo Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
Missile Site 230kV Transmission Substation	Interconnect Customer to tap at the Missile Site 230kV Transmission Substation (into the 230kV bus). The new equipment includes: • One 230kV gang switch • Three 230kV arresters • One set (of three) 230kV CT/PT metering units • AR15 communications equipment • Associated bus, wiring and equipment • Associated site development, grounding, foundations and structures • Associated transmission line communications, station controls, relaying and testing	**$0.465**
	Transmission line relocation and tap into substation. Structures, conductor, insulators, hardware and labor.	**$0.160**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	**$0.020**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$0.645**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 3: PSCo Owned; PSCo Funded Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
Missile Site 230kV Transmission Substation	Interconnect Customer to tap at Missile Site 230kV Transmission Substation (into the 230kV bus). The new equipment includes: • One 230kV circuit breaker • Two 230kV gang switches • Associated communications, supervisory and SCADA equipment • Associated line relaying, station controls and testing • Associated bus, miscellaneous electrical equipment, cabling and wiring • Associated foundations and structures • Associated road and site development, fencing and grounding	**$0.450**
	Siting and Land Rights support for substation land acquisition and construction.	**$0.020**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$0.470**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 4 – PSCo Network Upgrades for Delivery

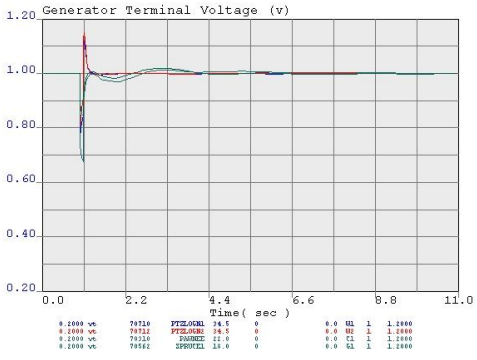
Element	Description	Cost Est. (Millions)
	N/A	

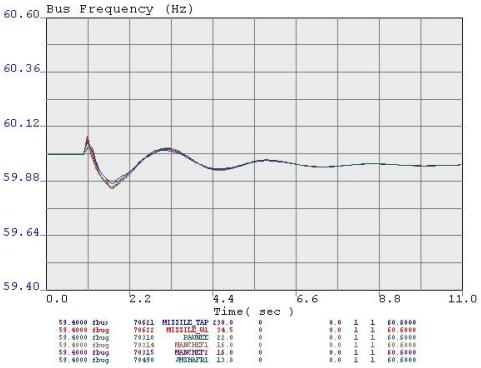
Cost Estimate Assumptions

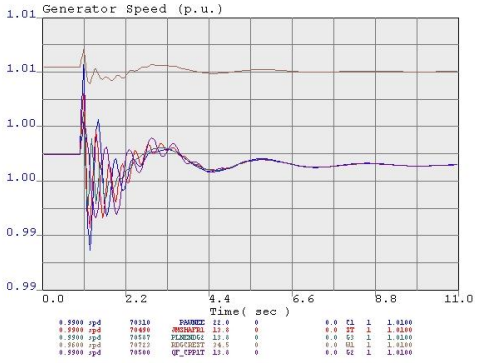
- Scoping level project cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo / Xcel Engineering.
- Estimates are based on 2014 dollars (appropriate contingency and escalation included).
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The Solar Generation Facility is not in PSCo's retail service territory. Therefore, no costs for retail load (distribution) facilities and metering required for station service are included in these estimates.
- PSCo / Xcel (or our Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- The estimated time to site, design, procure and construct the interconnection and network delivery facilities is approximately 18 months after authorization to proceed has been obtained.

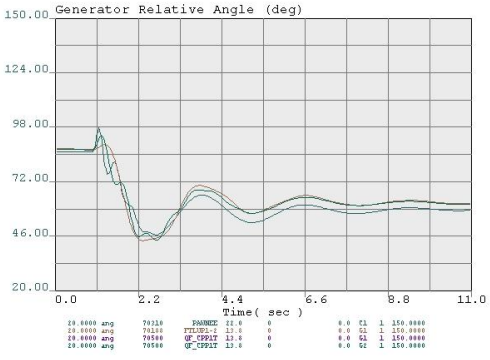
- A CPCN will not be required for the interconnection and network delivery facilities construction.
- The Customer will be required to design, procure and install a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer Substation. PSCo / Xcel will need indications, readings and data from the LFAGC RTU.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- No new substation land will need to be acquired.
- Breaker duty study determined that no breaker replacements are needed in neighboring substations.

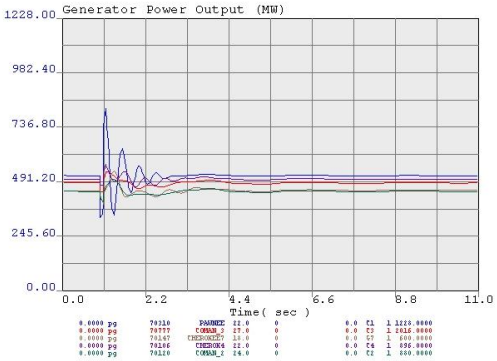
Appendix A
Transient Stability Plots











19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Missile 230 kV bus - clear in 6 cycles
Element removed: Missile Site - Daniels Park 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

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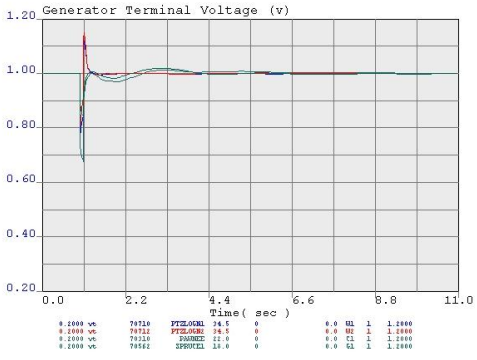

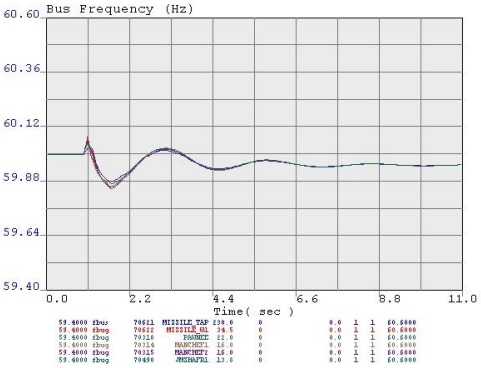

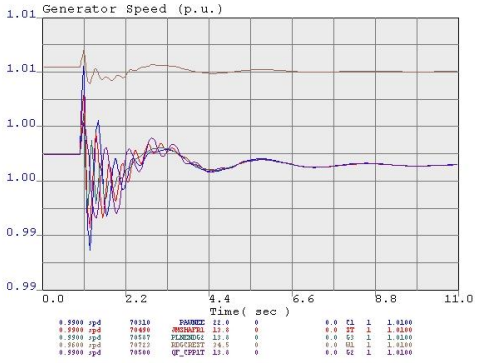

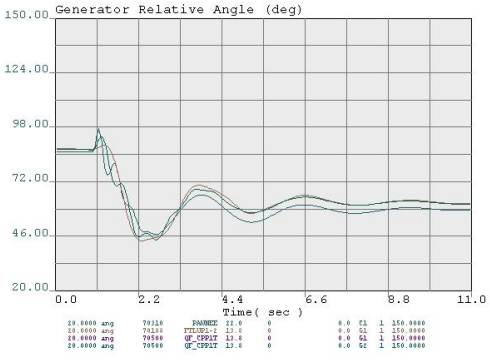

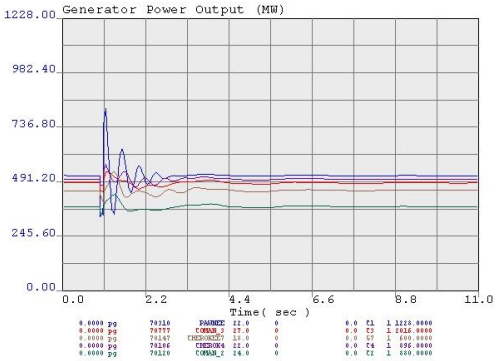

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30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Missile 230 kV bus - clear in 6 cycles
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ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

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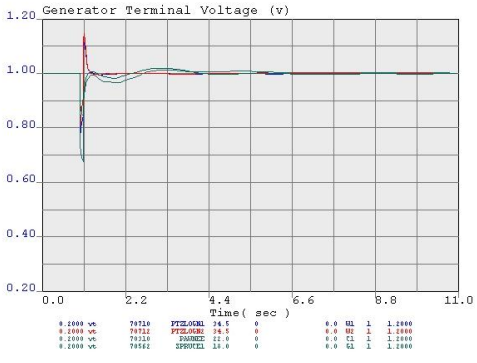

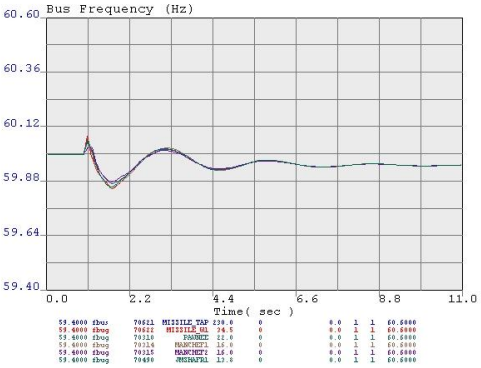

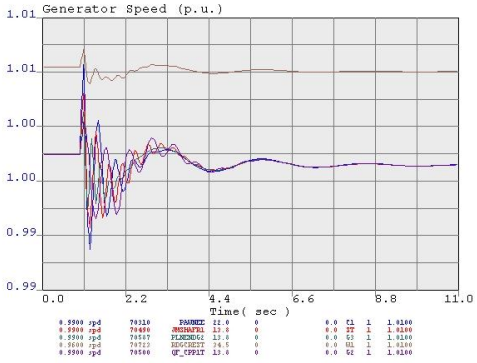

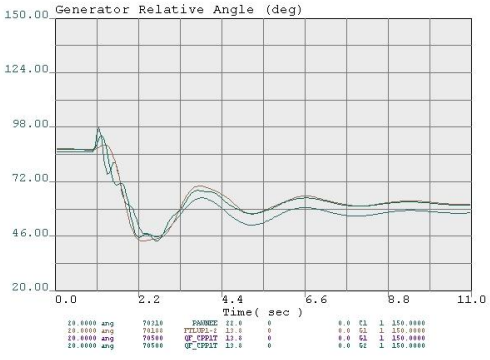

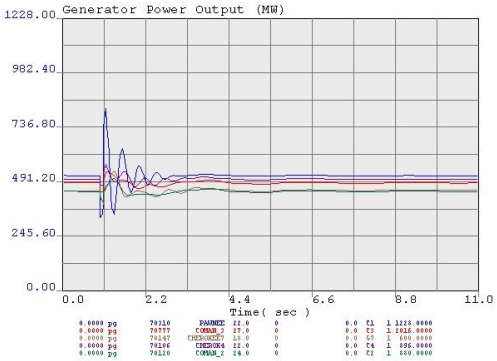

19hs21 BASE CASE
Benchmark case
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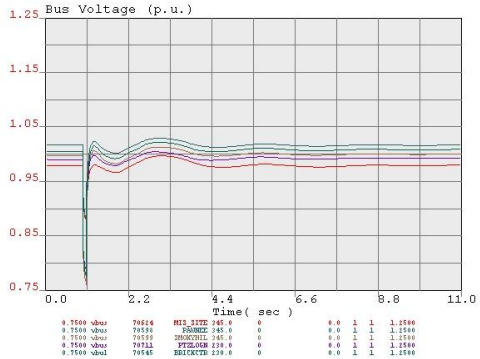
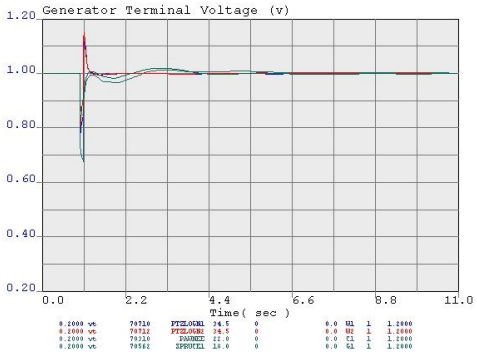
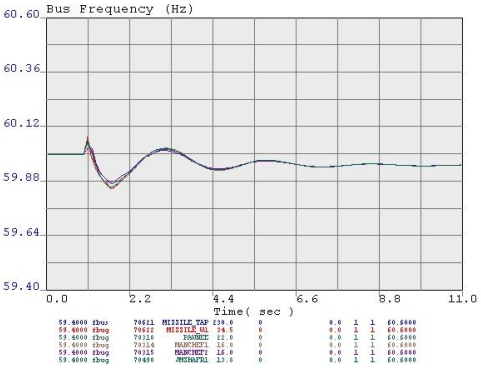
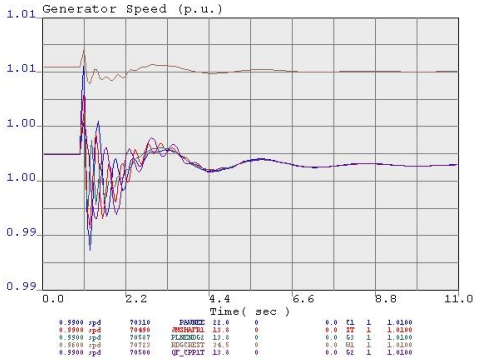
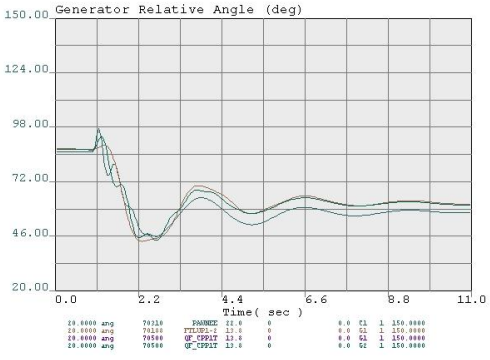
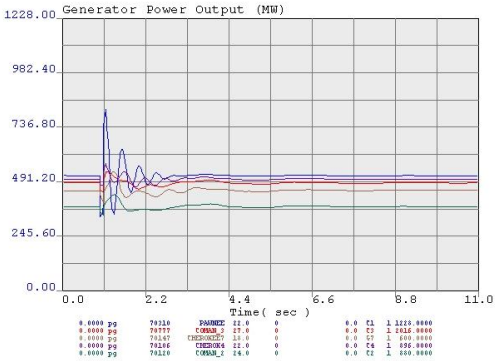








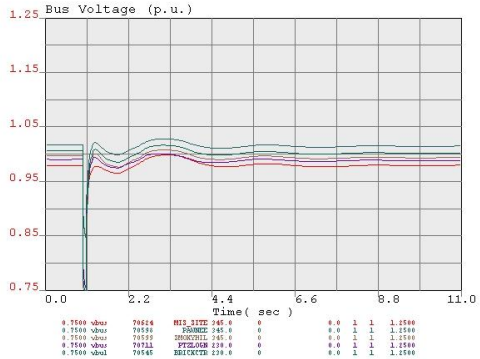


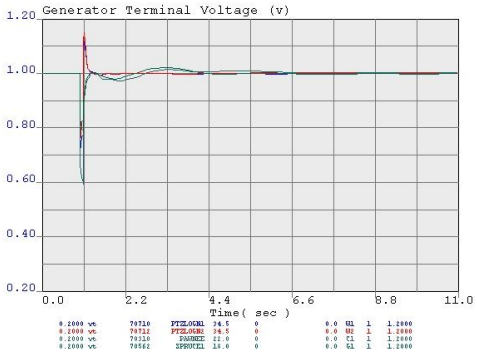


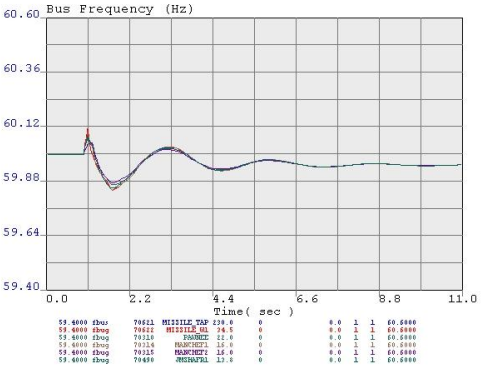
19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Missile 230 kV bus - clear in 6 cycles
Element removed: Missile Site - Pawnee 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

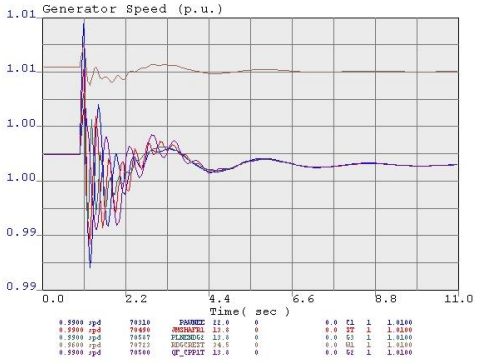
Page 1

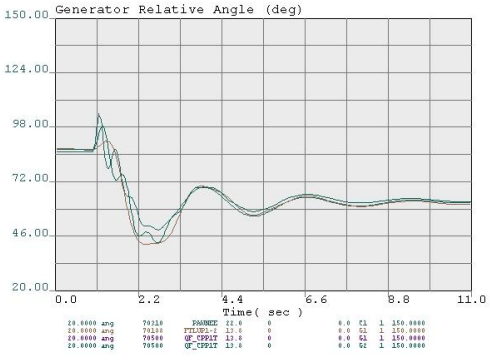
	2xMis-Pawn230.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:34:51 2014

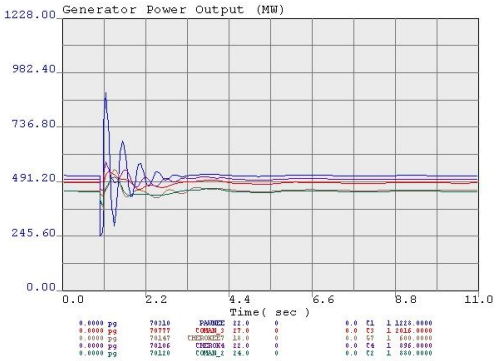




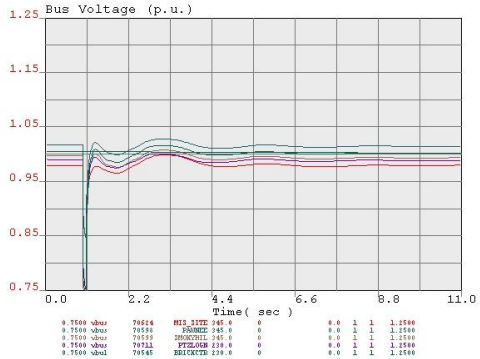


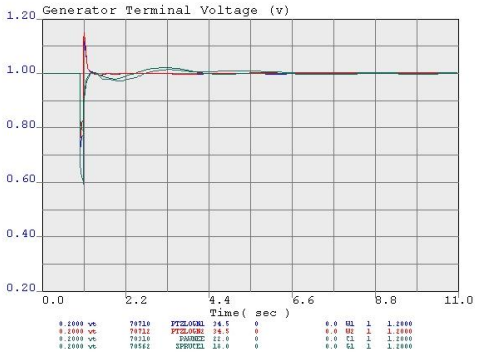


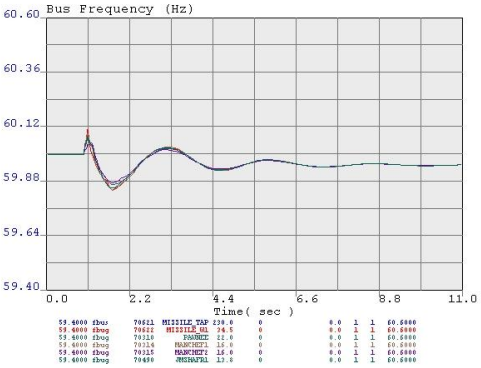


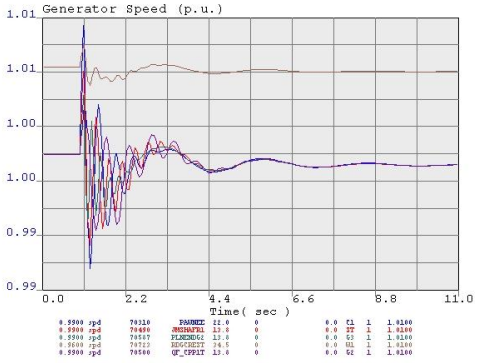


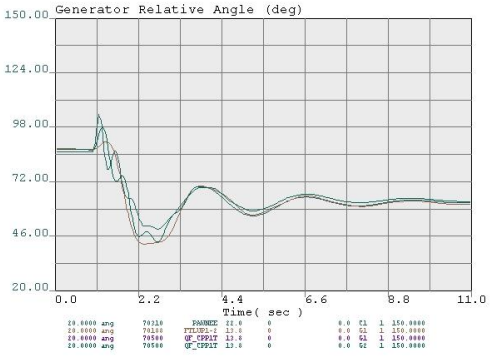
19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Missile 345 kV bus - clear in 6 cycles
Element removed: Missile Site - Smoky Hill 345 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

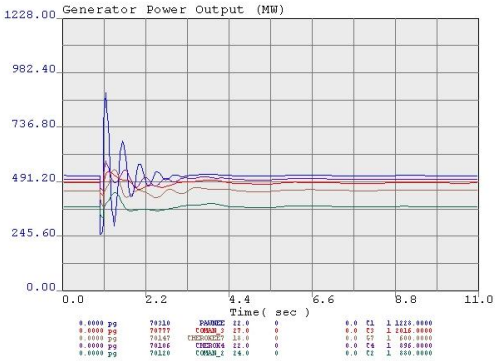








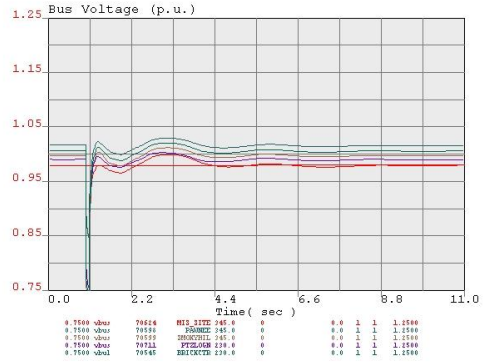


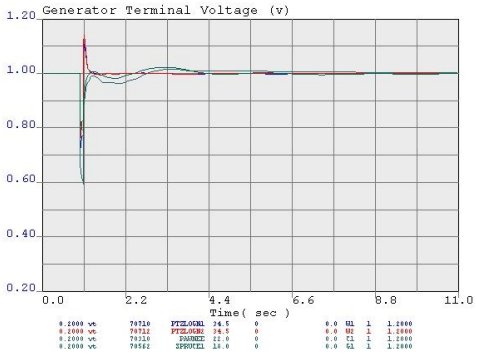


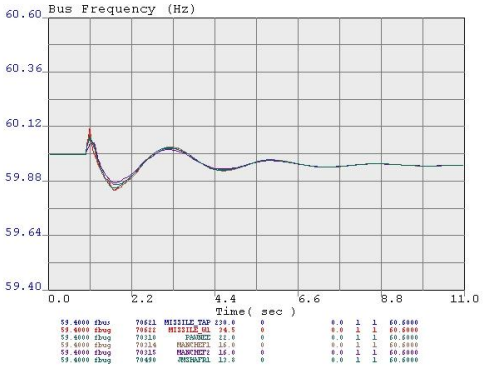
19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Missile 345 kV bus - clear in 6 cycles
Element removed: Missile Site - Smoky Hill 345 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

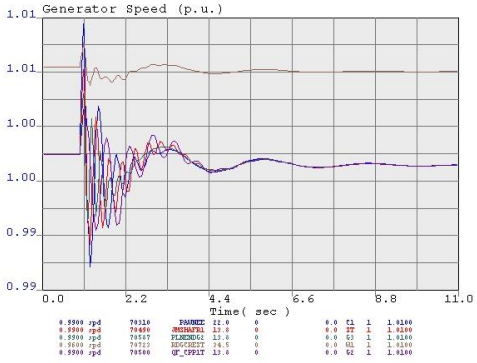
Page 1

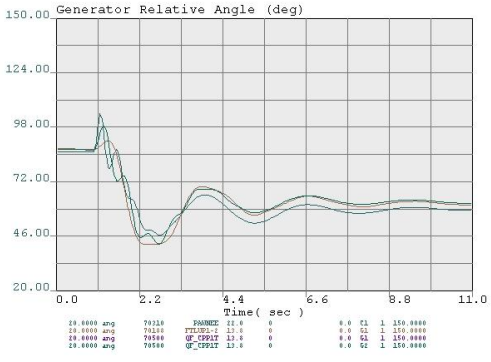
	3xMis-Smok345.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:35:52 2014

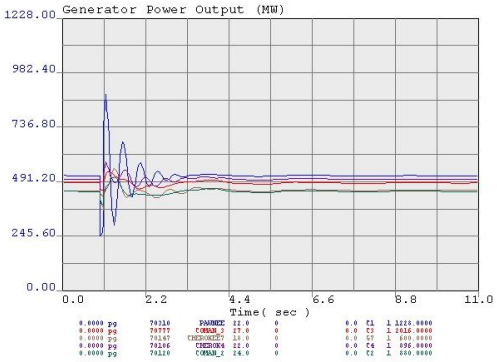








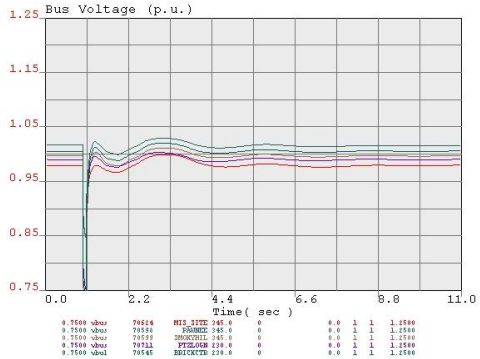


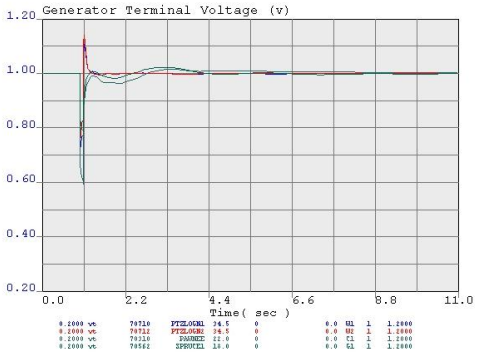


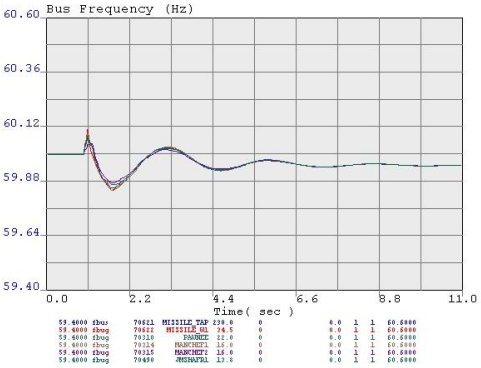
19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Missile 345 kV bus - clear in 6 cycles
Element removed: Missile Site - Pawnee 345 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

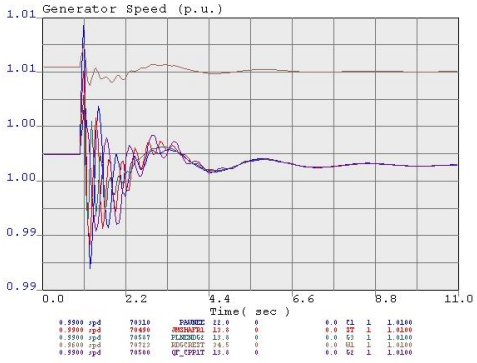
Page 1

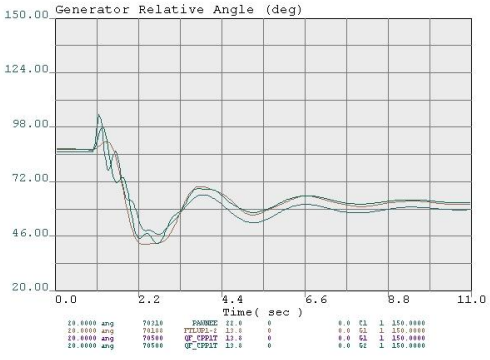
	4Mis-Pawn345.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:37:06 2014

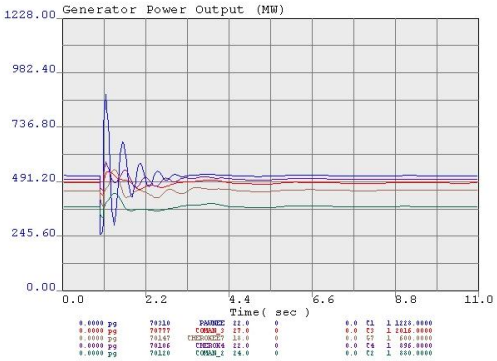








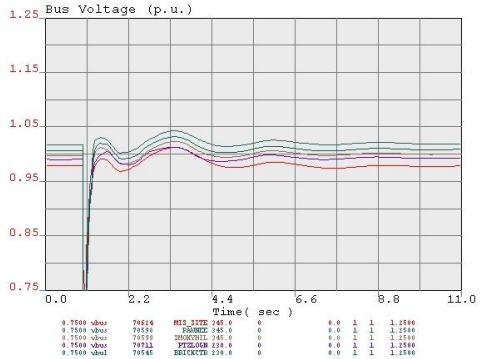


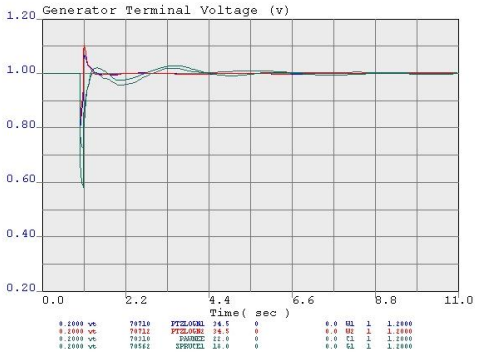


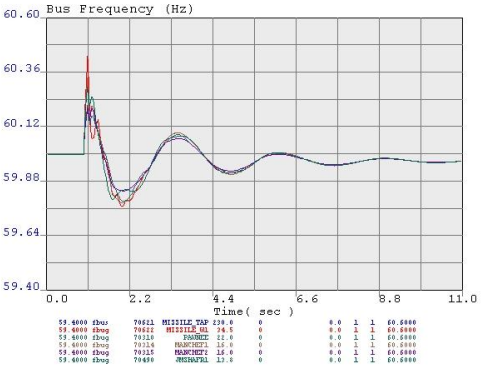
19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Missile 345 kV bus - clear in 6 cycles
Element removed: Missile Site - Pawnee 345 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

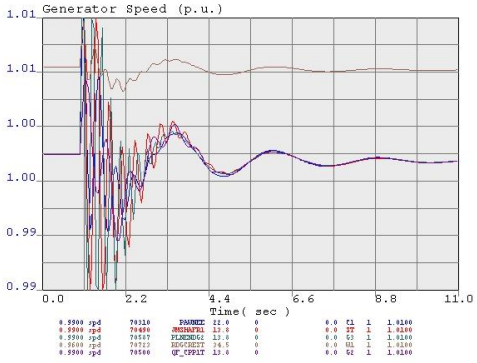
Page 1

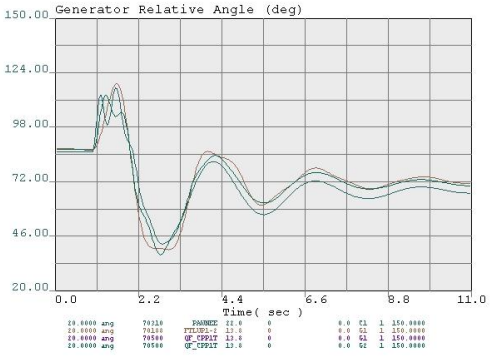
	4xMis-Pawn345.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:37:29 2014

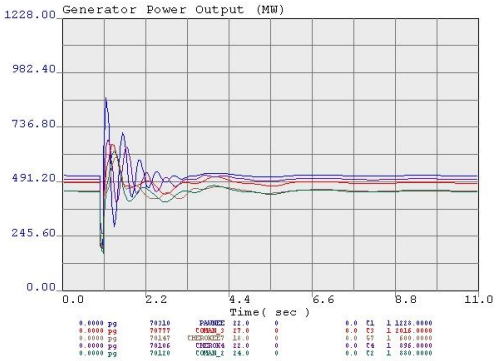








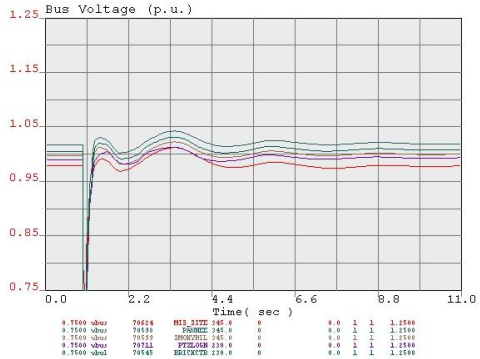


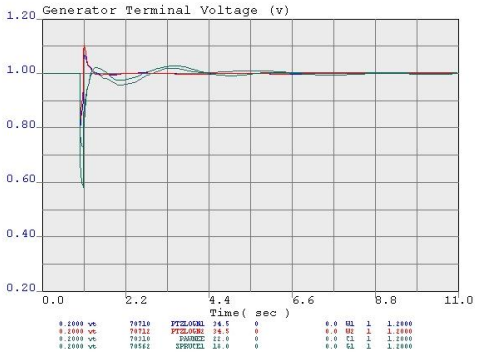


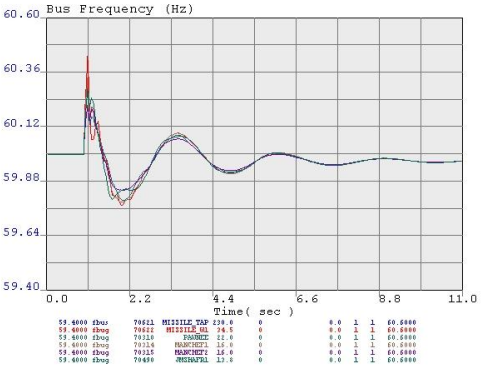
19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Daniels Park 230 kV bus - clear in 6 cycles
Element removed: Daniels Park - Greenwood 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

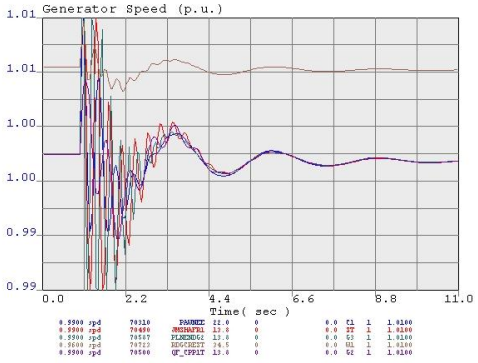
Page 1

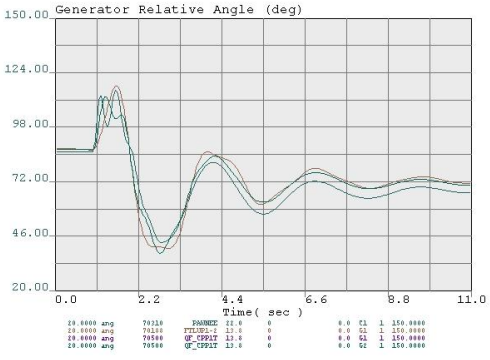
	5Dan-Gree230.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:37:59 2014

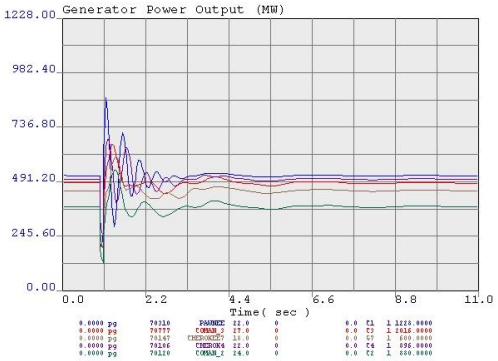








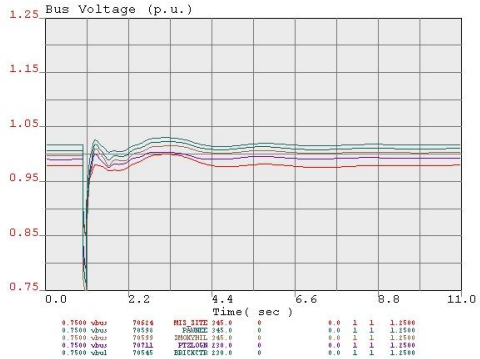


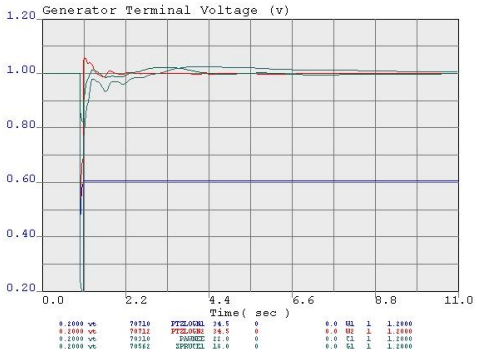


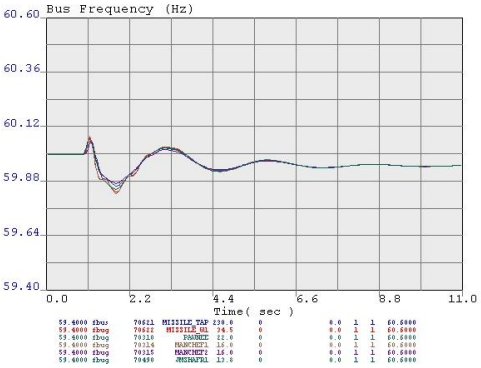
19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Daniels Park 230 kV bus - clear in 6 cycles
Element removed: Daniels Park - Greenwood 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

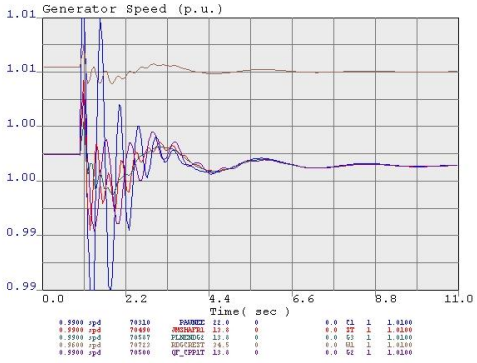
Page 1

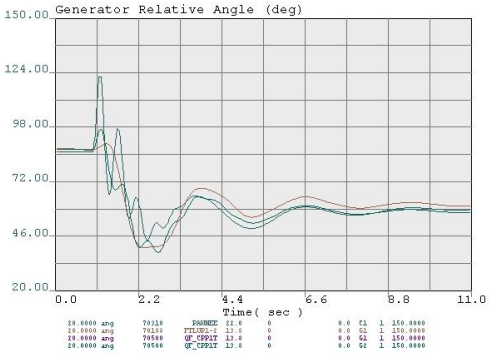
	5xDan-Gree230.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:38:25 2014

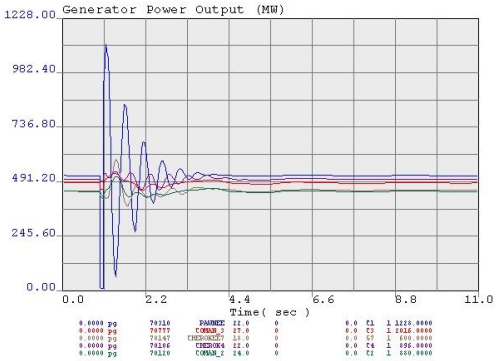












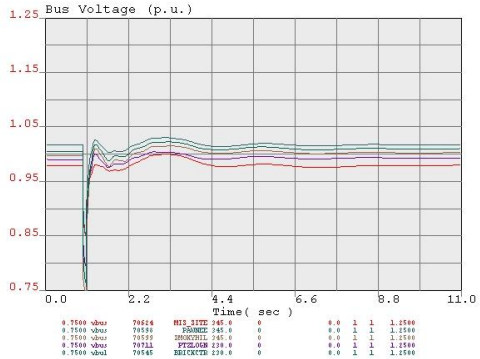
19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Pawnee 230 kV bus - clear in 6 cycles
Element removed: Pawnee - Story 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

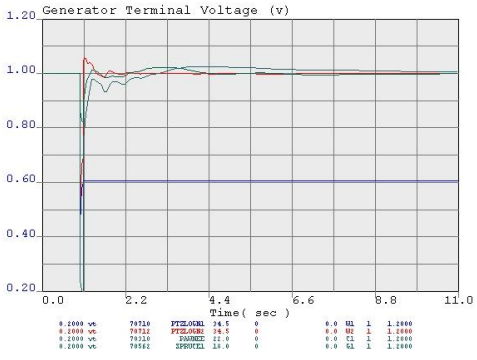
Page 1

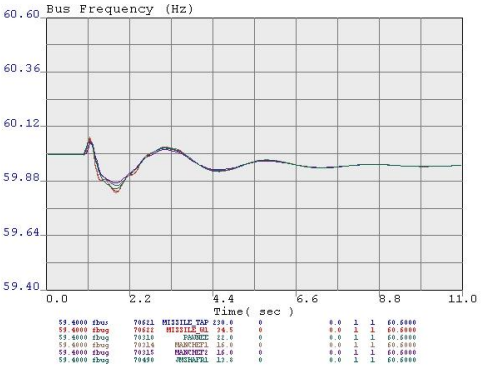
6Pawn-Sty230.chf

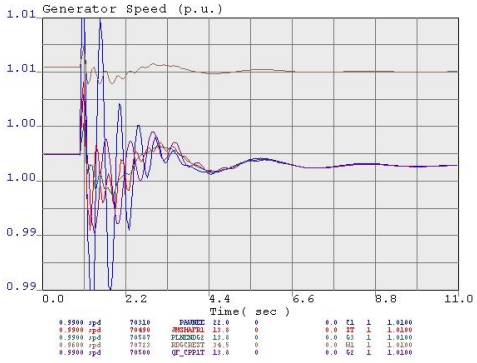
C:\1-GE\GI-2014-5\plots

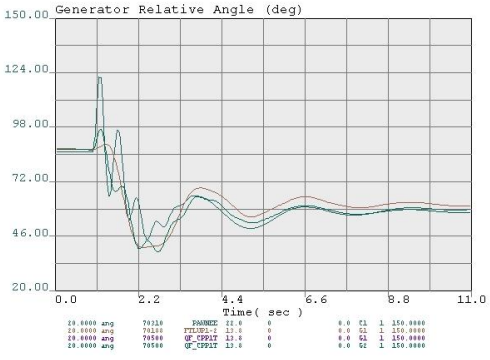
Wed Jul 02 10:38:48 2014

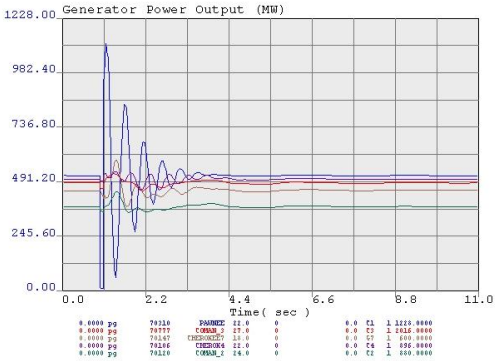








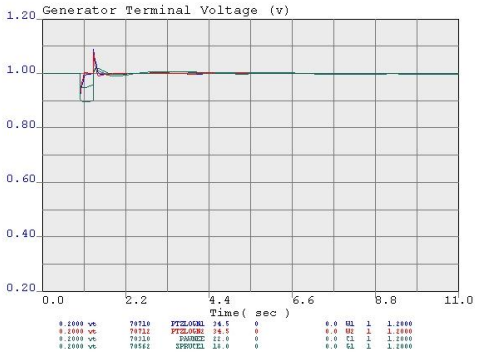


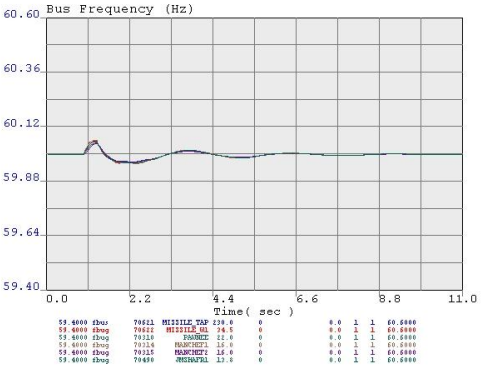


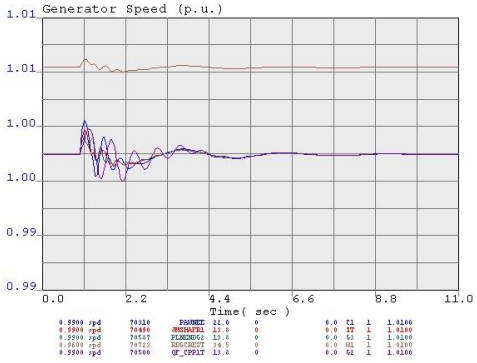
19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Pawnee 230 kV bus - clear in 6 cycles
Element removed: Pawnee - Story 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

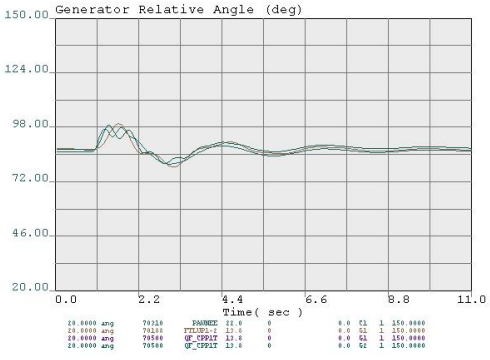
Page 1

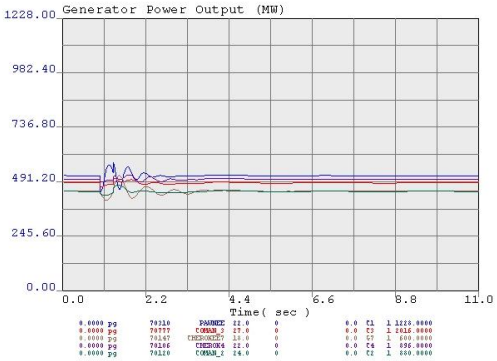
	6xPawn-Sty230.chf	C:\1-GE\GI-2014-5\plots Wed Jul 02 10:39:10 2014







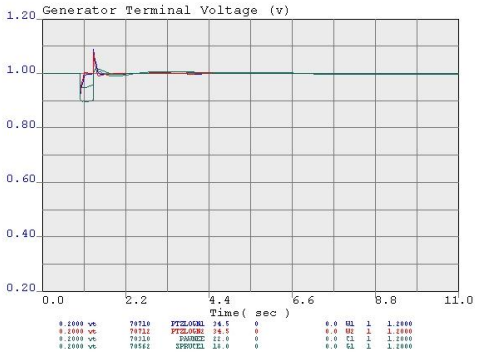


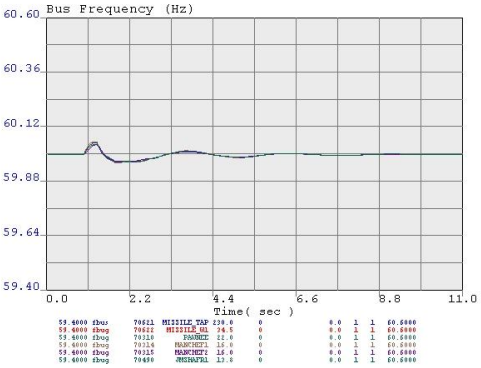


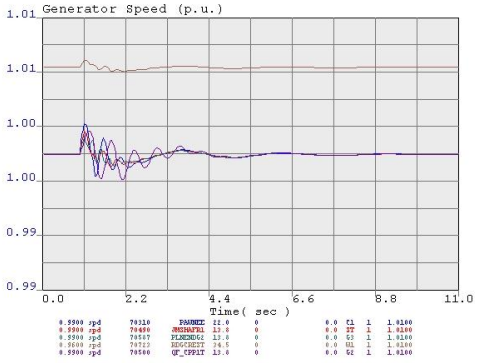
19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Missile 230 kV bus, breaker failure - clear in 21 cycles
Element removed: Missile Site - Daniels Park 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

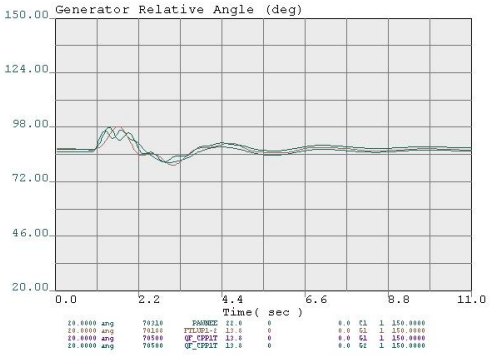
Page 1

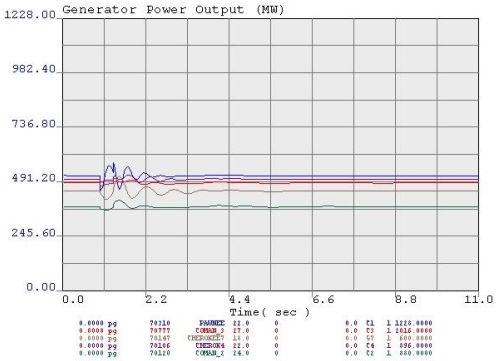
	7Mis-Dan230C.chf	C:\1-GE\GI-2014-5\plots Mon Jul 28 12:49:59 2014







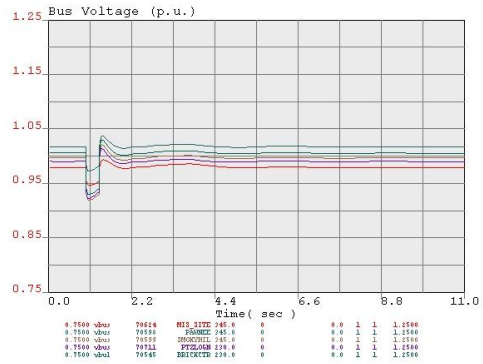


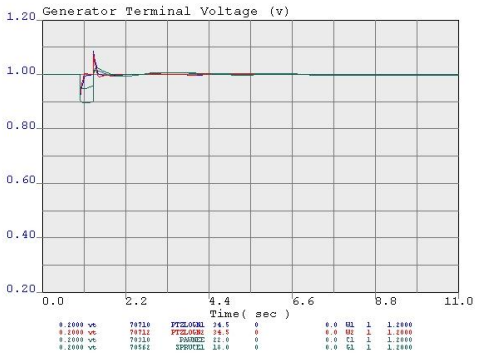


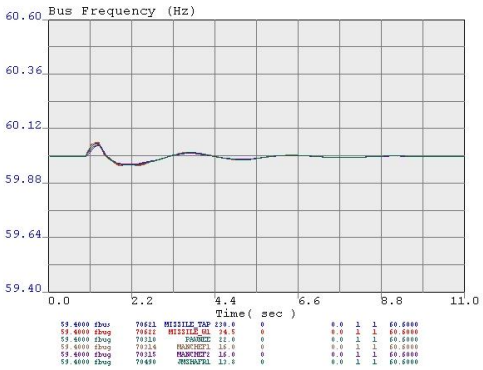
19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
GI-2014-5 stability analysis
Fault on Missile 230 kV bus, breaker failure - clear in 21 cycles
Element removed: Missile Site - Daniels Park 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

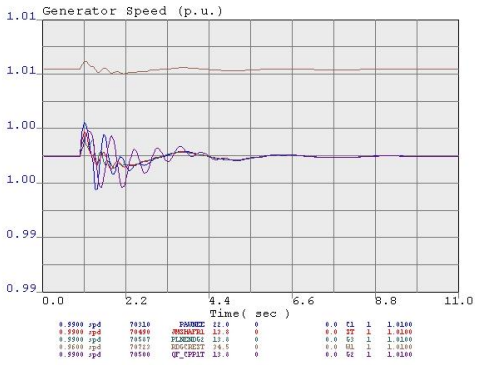
Page 1

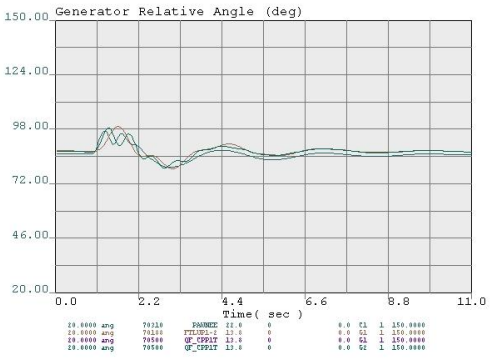
	7xMis-Dan230C.chf	C:\1-GE\GI-2014-5\plots Mon Jul 28 12:50:58 2014

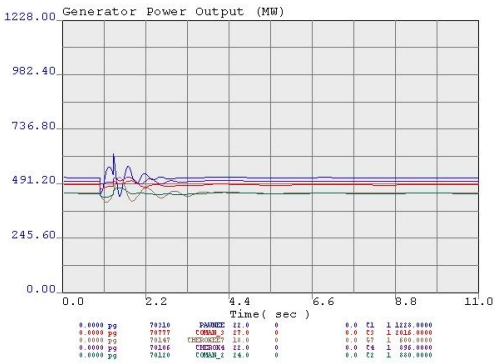












19hs21 BASE CASE
Benchmark case
GI-2014-5 stability analysis
Fault on Missile 230 kV bus, breaker failure - clear in 21 cycles
Element removed: Missile Site - Pawnee 230 kV
ALL COMMENTS FROM TSS AND OC REVIEW ARE INCLUDED.

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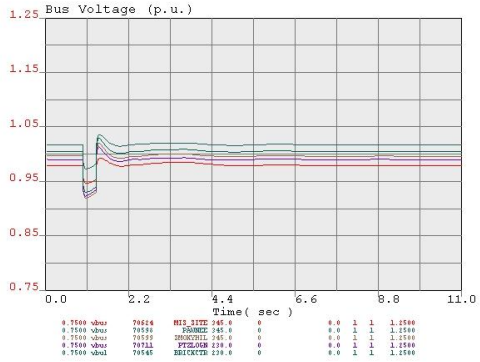
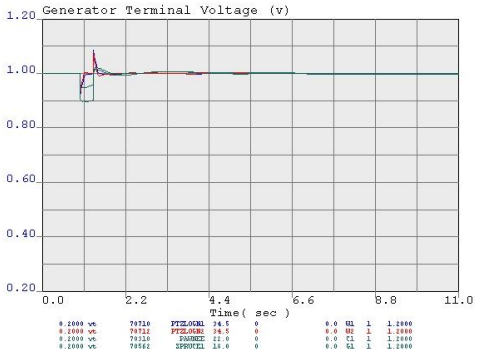
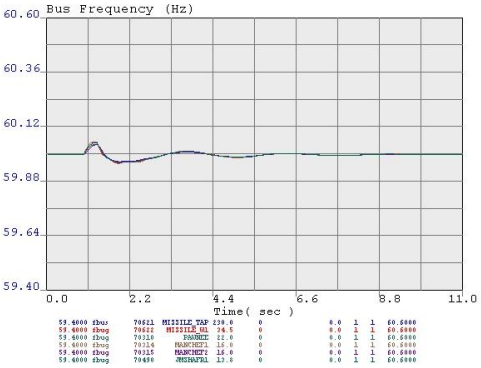
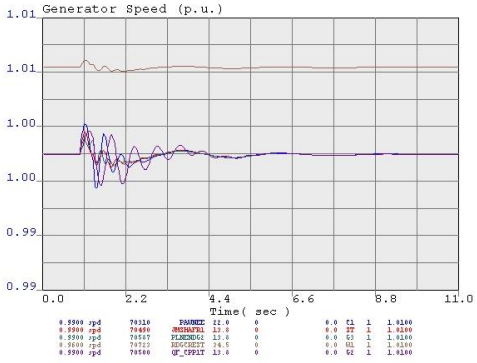
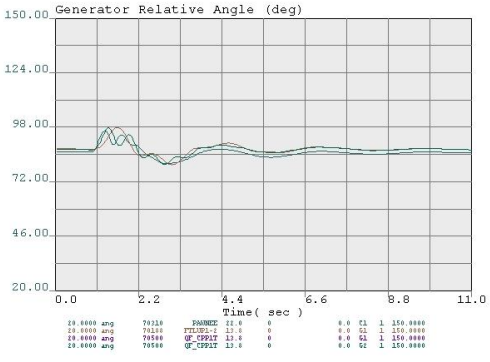
	8Mis-Pawn230C.chf	C:\1-GE\GI-2014-5\plots Mon Jul 28 12:51:57 2014

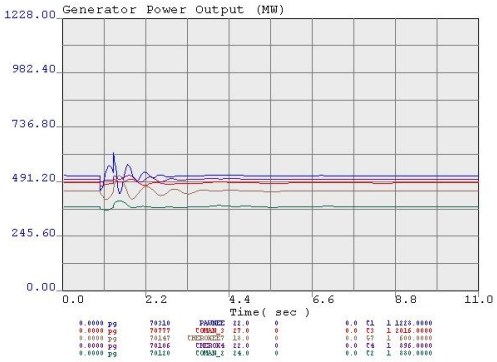












19hs21_GI-2014-5 BASE CASE
30MW solar PV generation at Missile Site 230 kV bus
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	8xMis-Pawn230C.chf	C:\1-GE\GI-2014-5\plots Mon Jul 28 12:55:44 2014