Underfrequency Load Shedding Program Assessment Report

Underfrequency Load Shedding Review Group

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WECC

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Executive Summary

The purpose of an Underfrequency Load Shedding (UFLS) plan is to protect the Bulk-Power System against major losses of generation. UFLS plans accomplish this through planned and controlled load tripping until load levels match remaining generation capacity. While some load is lost, shedding a small amount of load will prevent continued and uncontrolled loss of generation that, if allowed, could result in Interconnection-wide blackouts. Some argue that Underfrequency Load Shedding plans should be called Underfrequency *Load Saving* plans.

In conformance with PRC-006-WECC-CRT-1, WECC designated the Underfrequency Load Shedding Review Group (UFLS Review Group) to annually review the performance of the WECC Plan and to help WECC Members meet their compliance obligation to NERC Reliability Standard PRC-006-2.

This report is a summary of the activities and findings of the UFLS Review Group for the 2014/2015 study cycle. Also included is a section describing how all the UFLS-related WECC compliance processes fit together and how the existing WECC organizational structure inherently meets NERC compliance requirements.

Three island scenarios were simulated pursuant to the direction of the Planning Coordination Committee:

1) WECC island;

2) North island; and

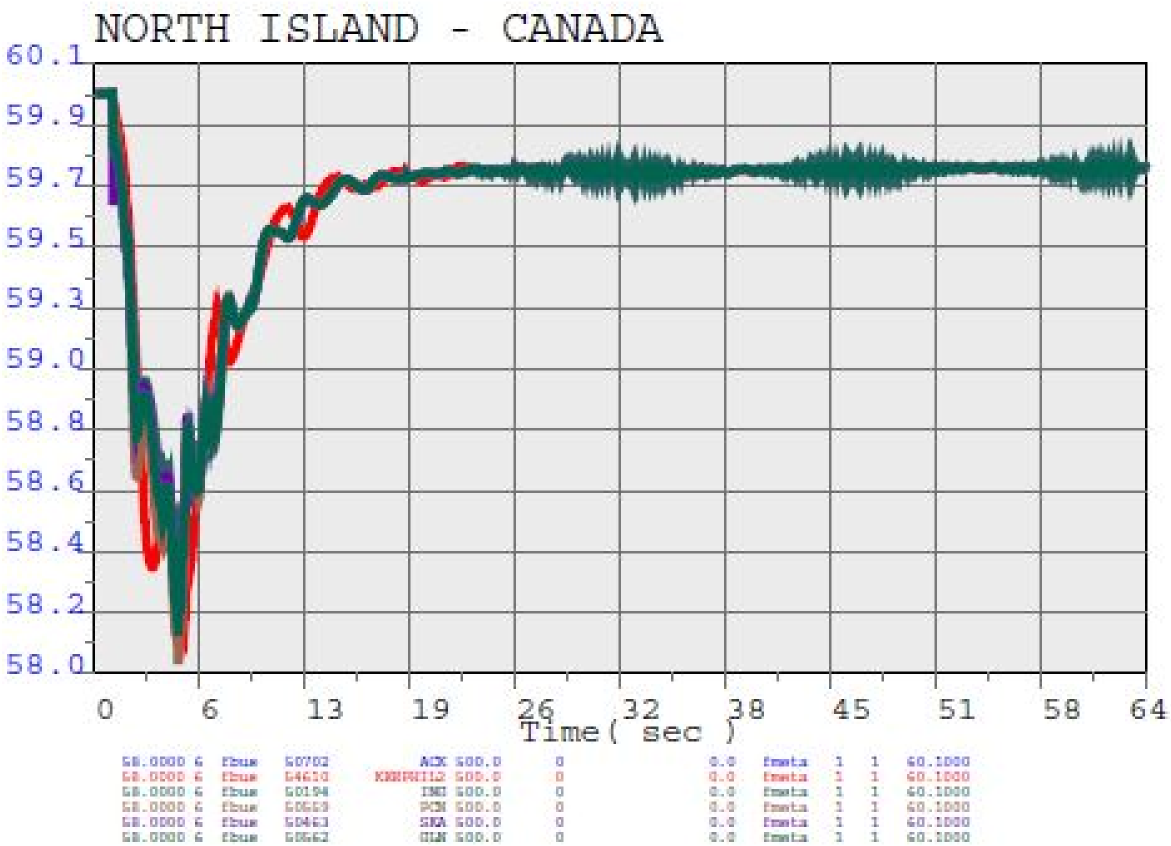
3) South island.

North and south island scenarios were studied because the WECC Region is designed to detach into a northern and southern island as a result of the WECC-1 Remedial Action Scheme (RAS).

Analysis showed that the WECC UFLS Plan continues to sufficiently arrest frequency decline following a 25 percent load and generation imbalance scenario. Frequency stabilized above 59.5 Hz in all simulations. Several imbalance scenarios in the southern island stabilized very close to 59.5 Hz. Ideally, per the WECC Plan design objectives, post-disturbance frequency would settle out above 60 Hz. No scenarios settled out above 60 Hz. This may have to be addressed in the future.

The worst performing frequency response was in the Canada Region for a WECC island 25 percent imbalance scenario, which can be seen in Figure 1.

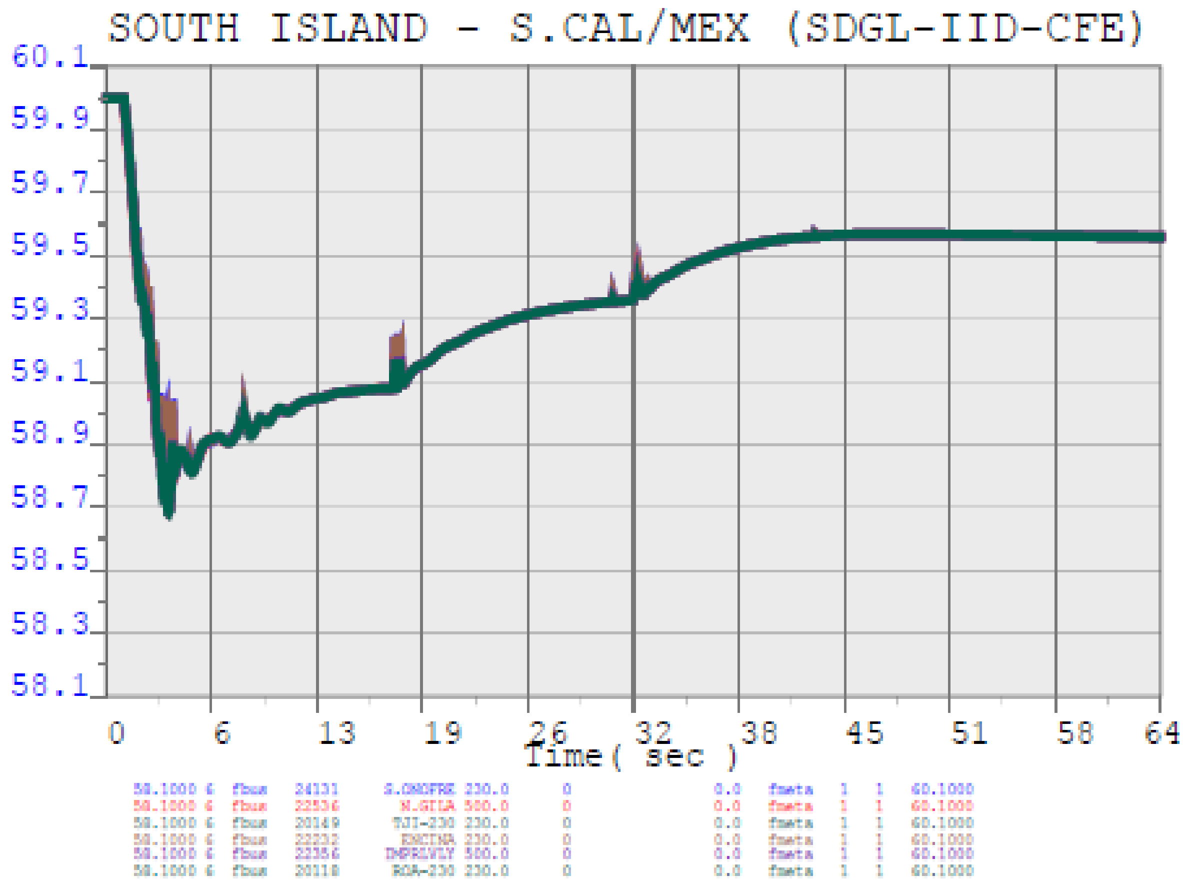
Figure 1: North Island - Canada Region frequency performance for a 25% generation loss scenario in the heavy summer case for the WECC island.



As shown in Figure 1, the worst (Keephil2 and PCN 500 kV) bus frequencies dipped to below 58.1 Hz before the decline was arrested by load shedding. Frequency stabilized near 59.8 Hz. The WECC Plan is designed to ensure frequency does not dip below 58 Hz during a transient. It is also designed to ensure frequency stabilizes above 59.5 Hz following a transient. While it appears that the two buses nearly dip below 58 Hz, they stay above that threshold; therefore resulting in both these criteria being met in the WECC island simulations.

Lesser-imbalance scenarios were also studied and, as expected, frequency did not decline as much in these scenarios. Lesser-imbalance scenarios did highlight the importance of the underfrequency stalling elements of the WECC Plan. Figure 2 shows a frequency plot of the California/Mexico Region following a 20 percent imbalance scenario in a south island simulation.

Figure 2: Southern California / Mexico Region frequency following a 20% loss of generation. South island scenario.



Note how frequency recovery nearly stabilizes around 59.1Hz at t = 18 seconds following the instantaneous load shedding. It is likely frequency would have remained unsatisfactorily low if not for the underfrequency stalling relays. The simulation shows two stages of underfrequency stalling activating. The first group trips at around t = 18 seconds and the second around t = 32 seconds. Frequency stabilizes above the desirable 59.5 Hz range primarily as a result of these relays.

The WECC UFLS Plan continues to be an adequate safety net for major losses of generation within the WECC Region. In some scenarios, the use of underfrequency stalling relays is critical to restoring frequency above 59.5 Hz.

Table of Contents

Figures

Tables

Introduction

The purpose of an Underfrequency Load Shedding (UFLS) plan is to protect the Bulk-Power System against major losses of generation. UFLS plans accomplish this through planned and controlled load tripping until load levels match remaining generation capacity. While some load is lost, shedding a small amount of load will prevent continued and uncontrolled loss of generation that, if allowed, could result in Interconnection-wide blackouts. Some argue that Underfrequency Load Shedding plans should be called Underfrequency Load Saving plans.

This report is a summary of the activities and findings of the Underfrequency Load Shedding Review Group (UFLS Review Group) for the 2014/2015 study cycle. Also included is a section describing how all the UFLS-related WECC compliance processes fit together and how the existing WECC organizational structure inherently meets NERC compliance requirements.

Background

The WECC Off-Nominal Frequency Load Shedding Plan (WECC Plan) was developed in response to three system-wide disturbances that occurred in 1996. The WECC Plan was formally approved in 1997 and updated in 2011. The primary objectives of the WECC Plan are to:

- Minimize the risk of total Western Interconnection system collapse.
- Protect generating equipment and transmission facilities against damage.
- Provide for effective load shedding within the Western Interconnection to arrest frequency decline.
- Improve overall system reliability.
- Match overall generation to overall load and, where islands are created or remain, match generation and load as required to meet island area needs.
- Coordinate load shedding with underfrequency protection of generating units.
- Coordinate load shedding with any other actions that can be expected to occur under conditions of frequency decline.
- Base load shedding on studies of system dynamic performance, using the latest state-of-the-art computer analytical techniques.
- Minimize the risk of further separation, loss of generation, or excessive load shedding accompanied by excessive over-frequency conditions.
- Incorporate automatic generator tripping or other remedial measures to prevent excessive high frequency that could result in uncontrolled generator tripping or equipment damage.
- Address load controlled by customer-owned relays where the load is counted toward meeting minimum load shedding requirements.

The design of the Coordinated Plan was based on the following performance criteria:

- Load/generation imbalances based on load of up to 25 percent should be accounted for.
- Potential system separation points should reflect historical system load conditions and transfer levels.
- This Coordinated Plan should conform to the 5 percent loss of life of turbine blades recommendations as determined by generator manufacturers.
- Sufficient load must be dropped by UFLS Entities to keep the system frequency within the continuous operating range of the generating units (59.5 Hz and 60.5 Hz).
- Minimum permissible dynamic frequency during a disturbance is 58 Hz. The maximum permissible dynamic frequency during a disturbance is 61.0 Hz.
- Load shedding blocks will be in a five-step sequence with a minimum separation between steps of 0.1 Hz.
- Underfrequency relays must have a maximum operating time of six cycles for the high speed trip.
- System average operating time of breakers used to trip load is to be no more than fourteen cycles.
- Post-disturbance frequency ideally will settle out above 60 Hz, as opposed to below 60 Hz.
- Implementation of the Coordinated Plan should not cause other adverse system conditions that result in generation tripping that would exacerbate the loss-of-generation event.

WECC has two documents associated with its UFLS program. The primary document is the *Western Electricity Coordinating Council Off-Nominal Frequency Load Shedding Plan, May 24, 2011* (WECC Plan). It is the comprehensive description of WECC's UFLS program and it contains the background, design objectives, methodology, and plan details. To support implementation of the WECC Plan, WECC also created the criterion *PRC-006-WECC-CRT-1*. Its purpose is to assure consistent application of the WECC Plan and coordinate requirements among all applicable entities.

To accommodate the performance differences across the WECC Region, the WECC Plan also includes two sub-area plans in addition to the primary plan. The primary plan and both sub-area plans are detailed in Section E, items 1a, 1b, and 1c of the WECC Plan. Entities can adopt one or a combination of the three plans based on where in the WECC Region their loads are located. Most entities will adopt a single plan, but some entities span multiple regions and thus appropriately implement multiple plans.

Underfrequency Load Shedding Review Group

In conformance with PRC-006-WECC-CRT-1, WECC designated the Underfrequency Load Shedding Review Group (UFLS Review Group) to annually review the performance of the WECC Plan and to help WECC Members meet their compliance obligation to NERC Reliability Standard PRC-006-2. The activities of the UFLS Review Group are overseen by the Joint Guidance Committee whose purpose is to coordinate matters of overlapping significance relevant to planning, operations, and market interface. The Joint Guidance Committee coordinates with the Planning Coordination Committee, among others.

By Charter (Appendix J), the responsibilities of the UFLS Review Group are to:

- Annually review the WECC Plan's consistency with the requirements of PRC-006.
- Conduct annual simulations of the Plan to assess consistency with the performance requirements of PRC-006.
- Review the submitted UFLS data for consistency and accuracy of modeling.
- Collaborate with all applicable entities to develop an annual report of the findings of the review and simulations.

PRC-006-2 Compliance

Reliability Standard PRC-006-2 is the NERC Standard associated with UFLS programs. Its stated purpose is to "establish design and documentation requirements for automatic UFLS programs to arrest declining frequency, assist recovery of frequency following underfrequency events and provide the last resort system preservation measures." PRC-006-2 includes a variance for the WECC Region.

WECC Planning Coordinators participate in jointly reviewing, assessing, and documenting the WECC Plan in accordance with NERC PRC-006-2 through their involvement in the Planning Coordination Committee and that committee's corresponding oversight of the UFLS Review Group.

Requirements PRC-006-2 E.B.1 and E.B.2 call for Planning Coordinators to participate in a joint regional review to select portions of the Bulk Electric System that may form islands, and further, to identify one or more of those islands as a basis for designing a Region-wide coordinated UFLS program. At the March 2014 Planning Coordination Committee meeting (Appendix K), the UFLS Review Group Chair presented 14 potential Bulk Electric System island configurations based on consideration of historical events, prior studies, and Special Protection Systems. It was proposed, and the Planning Coordination Committee approved, the following islands to be simulated by the UFLS Review Group during the 2014/2015 cycle:

1) WECC Island;
2) North Island; and
3) South Island.

The WECC Plan is coordinated across the WECC Region. To accommodate slight performance differences across WECC, the WECC Plan also includes two sub-area plans in addition to the primary plan. UFLS Entities must adopt one or a combination of the three plans based on where they reside. Requirement PRC-006-2 E.B.3 calls for Planning Coordinators to adopt a UFLS program that is "coordinated across the WECC region." Planning Coordinators who have adopted one or a combination of the three plans have adopted a UFLS program that is "coordinated across the WECC region" as required by PRC-006-2 E.B.3.

UFLS Entities within WECC maintain and annually update a UFLS database to ensure that sufficient information is available to model the UFLS program for use in event analysis and assessments of the UFLS program. The database is updated through a request to all UFLS Entities to compile and submit their respective UFLS plan data and dynamic files in the format defined in the data input form "Attachment B" of *PRC-006-WECC-CRT-1*. The update occurs once each calendar year and is completed by June 1st for Generator Owners and July 1st for the other UFLS Entities in accordance with *PRC-006-WECC-CRT-1*. The UFLS database submissions are reviewed by the UFLS Review Group to ensure the Master Dynamics File accurately reflects the submitted plan data. Inconsistencies are reported back to the UFLS Entities with a request to correct the errors in the Master Dynamics File through the company's respective MOD-032 processes. The Master Dynamics File contains data necessary to model the UFLS program for use in event analysis and assessments. Further, it is available to all Planning Coordinators within the WECC Region. The data input form also includes spreadsheets where UFLS Entities summarize their feeders and loads armed with UFLS relays, thereby demonstrating that they provide automatic tripping of load in accordance with the UFLS program design. By following this process, Planning Coordinators and UFLS Entities:

1. Maintain a UFLS database that contains data sufficient to model the UFLS program;
2. Share their UFLS database with other Planning Coordinators;
3. Provide data according to an established format and schedule; and
4. Demonstrate that they provide automatic tripping of loads as required by the UFLS program.

Thus, Planning Coordinators and UFLS Entities that follow this process can demonstrate compliance with PRC-006-2 requirements R6, R7, R8, and R9.

The UFLS Review Group reviewed the WECC Plan's consistency with the requirements of PRC-006-2. The primary plan and both sub-area plans are designed to arrest frequency decline before it reaches 58 Hz, recover frequency to 59.5 Hz or higher, and not exceed 61 Hz during a disturbance. Rather than fixed frequency ranges, PRC-006-2 defines operating curves for system frequency response. The curves are formulated in PRC-006-2 Attachment 1. While not identical in approach, the WECC Plan is consistent with the requirements of PRC-006. Specifically, the WECC Plan and two sub-area plans are generally designed to meet the performance objectives of PRC-006-2 E.B.3.1 and E.B.3.2.

Data Review

UFLS Entities provide updates to the UFLS database annually in accordance with PRC-006-WECC-CRT-1. The updates are managed through requests from WECC to UFLS Entities to compile their respective

Coordinated Plan data and dynamics files using the data input form Attachment B, which is part of PRC-006-WECC-CRT-1. The UFLS Review Group reviews and updates the Attachment B template prior to each data request to ensure that the UFLS database contains the data necessary to model the UFLS program once the Attachment B data input forms are completed by the UFLS Entities.

The UFLS Review Group made minor changes to the Attachment B data input form template in 2014. Aside from clarifying some of the instructions on the form, the primary change to Attachment B was the addition of a worksheet for Generator Owners to provide generator tripping characteristics in the form of the PSLF "*lhfrt*" model. Generator Owners were requested to provide this data for generating plants/facilities that met the criteria described in PRC-006-2 E.B.4.1 through E.B.4.6.

The UFLS Entities that responded to the 2014 data request are listed in Appendix L. The UFLS Review Group reviewed the UFLS data submissions for consistency and accuracy of modeling. UFLS Entities were notified of discrepancies between what was submitted on the Attachment B data input form and what was modeled in the Master Dynamics File (i.e., UFLS database). They were asked to correct their modeling data in the Master Dynamics File through the established processes as defined in the WECC Data Preparation Manual. The updated Master Dynamics File was used to model the UFLS program in the 2014/2015 assessment.

Post Event Assessments

There were no system frequency excursions below the initializing set points of the UFLS program this study cycle; therefore, no post-event assessments were performed.

General Methodology

GE Positive Sequence Load Flow (PSLF) Version 19.0, including the new Dynamic Composite Load Model (CMPLDW), was initially used for simulations. As will be described later, the CMPLDW model did not perform properly and required some modifications. The software vendor implemented changes to the model that fixed the issues and released a BETA version to the UFLS Review Group. Thus, the Review Group ended up using PSLF Version 19.0_01_BETA for simulations. UFLS Plan performance was simulated dynamically using the PSLF *alldyns.p* program.

WECC, northern, and southern island UFLS simulations were performed for heavy summer and heavy spring conditions. The 15hs4a.sav case was used for summer and the 15hsp1a.sav case was used for spring.

All UFLS relays were modeled in simulations to automatically reduce load during the simulations. The WECC Plan also includes some automatic load restoration (reclosing) to arrest frequency overshoot, which, if actuated, would operate within the duration of the simulation run for the assessment. The thresholds for frequency overshoot protection are 60.5 Hz, 60.7 Hz, and 60.9 Hz. Frequency was monitored during the simulations and if it exceeded any of these values, loads were simulated to be automatically restored. However, no frequency overshoot was observed.

Three island scenarios were simulated pursuant to the direction of the Planning Coordination Committee:

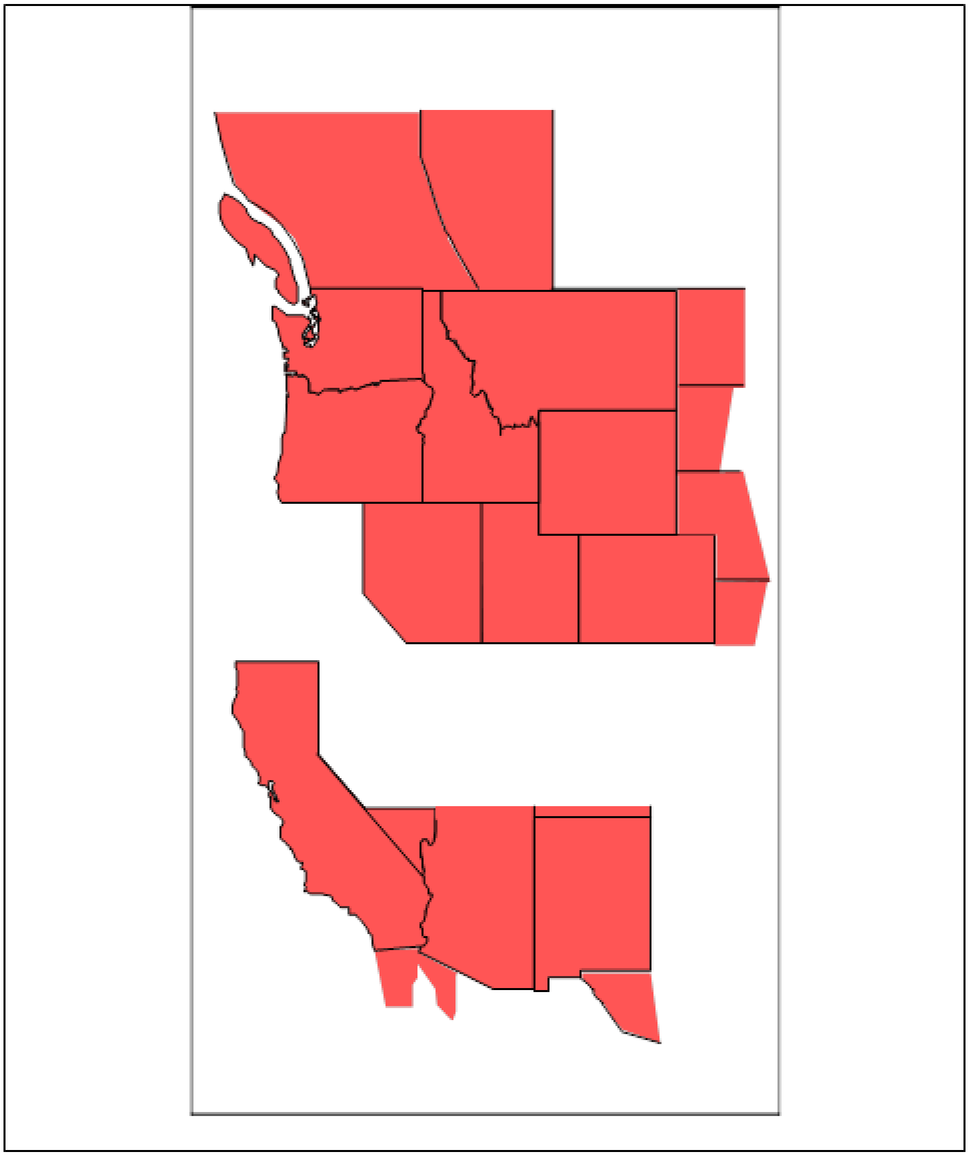
1) WECC island;

2) North island; and

3) South island.

A north and south island are studied because the WECC Region is designed to detach into a northern and southern island as a result of the WECC-1 Remedial Action Scheme (RAS). Depending on the region and the company referring to it, this scheme has many names including: NE/SE separation scheme, the COI RAS, PACI RAS, AC RAS, Four Corners Scheme, and Pacific Intertie Transfer Trip Scheme. WECC-1 is installed to prevent overload, low voltage, and instability in the connected system should one or more lines between John Day, Buckley, Marion in the north and Vincent in the south trip for whatever reason. In addition, selected 500-kV lines north of John Day, Buckley, and Marion have line loss logic to initiate WECC-1 for specific operating conditions. Figure 3 shows the separation cut-plane.

Figure 3: WECC-1 separation scheme.



The separation occurs between the following entities:

- BPA and PG&E on the COI at Malin and Round Mountain Substations;
- BPA and WASN at Captain Jack and Olinda Substations;
- PG&E and PACW at Cascade Substation;
- PG&E and NVEN (SPP) at NVE's California, Truckee, and North Truckee Substations;
- NVEN (SPP) and SCE at NVE's Silver Peak Substation;
- NVEN (SPP) and NVES (NEVP) at NVE's Robinson Summit Substation;

- PACE and APS at Four Corners and between PACE and NVES (NEVP) at Red Butte and Harry Allen.
- Tri-State and PNM at the Gladstone Substation.

To complete the separation between the northern and southern islands, WACRSP and WARM trips:

- Glen Canyon-Sigurd 230-kV line
- Shiprock-Lost Canyon 230-kV line
- Glade-Durango 115-kV line
- San Juan-Hesperus 345-kV line

Both island simulations were performed with WECC already islanded as an initial condition to the dynamic run. These simulations represent a scenario in which WECC has separated and been rebalanced through operator action. The NE/SE separation scheme was implemented in the power flow base cases and system adjustments were made so that a flat start was achieved in the dynamic simulations. Thus, the dynamic simulations began with an already stable WECC island scenario.

WECC was separated into a northern and southern island by opening the following transmission elements in accordance with WECC-1 RAS:

- Malin - Round Mountain 500 kV
- Captain Jack - Olinda 500 kV
- Summit/Drum - Cascade
- Silver Peak
- Robinson Summit
- Pinto - Four corners and Red Butte - Harry Allen
- Walsenburg - Gladstone
- Glen Canyon – Sigurd
- Shiprock - Lost Canyon
- Glade – Durango
- San Juan – Hesperus

Flows across the north/south cut-plane were reduced prior to simulating a WECC island. To minimize north-to-south flow prior to the separation, the following re-dispatch was simulated in the 2015 heavy summer case to assist numerical stability of the model:

- Raise LADWP generation 600 MW
- Raise Arizona generation 1800 MW
- Lower B.C. Hydro generation 2400 MW

- Lower Northwest generation 3000 MW
- Raise PG&E generation 3000 MW

Table 1 shows the 2015 heavy summer case load and generation summary by area, after the NE/SE separation scheme was simulated.

Table 1: 2015 heavy summer case load and generation summary, following simulation of the NE/SE separation scheme

Area Number	Area Name	Generation in South Island (MW)	Load in South Island (MW)	Generation in North Island (MW)	Load in North Island (MW)
40	NORTHWEST (2)			25,967	26,321
50	B.C.HYDRO			8,823	8,080
52	FORTISBC			1,013	761
54	ALBERTA			10,206	10,322
60	IDAHO			2,407	3,700
62	MONTANA			3,047	1,939
63	WAPA UGP			70	(37)
64	SIERRA			2,364	2,207
65	PACE			10,412	9,189
70	PSCOLORADO			7,432	7,906
73	WAPA R.M.	458	35	6,352	5,189
10	NEW MEXICO	3,213	2,780		
11	EL PASO	1,177	1,850		
14	ARIZONA	27,137	19,309		
18	NEVADA	5,627	6,063		
20	MEXICO-CFE	2,416	2,411		
21	IMPERIALCA	1,655	1,059		
22	SANDIEGO	3,426	5,175		
24	SOCALIF	15,692	22,833		
26	LADWP (1)(3)(4)(5)	9,037	6,598	1,900	1,898
30	PG AND E	25,469	22,918		
Total:		**95,306**	**91,030**	**79,993**	**77,474**

(1) includes 1840 MW generation in South Island from CELILO/SYLMAR DC tie
(2) includes 2000 MW load in North Island from CELILO/SYLMAR DC tie
(3) includes 1692.8 MW load in North Island from INTERMT/ADELANT DC tie
(4) includes 1636 MW generation in South Island from INTERMT/ADELANT DC tie
(5) includes 1900 MW generation in North Island from INTERMT generation (area 26 generation in North Island)

Similarly, the following re-dispatch was simulated in the 2015 heavy spring case prior to simulating the separation to assist numerical stability of the model:

- Raise LADWP generation 400 MW
- Raise Arizona generation 1200 MW

- Lower B.C. Hydro generation 1600 MW
- Lower Northwest generation 3650 MW
- Raise PG&E generation 3650 MW

Table 2: 2015 heavy spring case load and generation summary, following simulation of the NE/SE separation scheme

Area Number	Area Name	Generation in South Island (MW)	Load in South Island (MW)	Generation in North Island (MW)	Load in North Island (MW)
40	NORTHWEST (2)			26,328	25,034
50	B.C.HYDRO			6,663	8,437
52	FORTISBC			724	751
54	ALBERTA			10,195	10,331
60	IDAHO			2,105	2,784
62	MONTANA			3,177	1,509
63	WAPA UGP			53	(73)
64	SIERRA			1,761	1,753
65	PACE			8,294	7,084
70	PSCOLORADO			4,967	5,396
73	WAPA R.M.	430	40	4,149	3,501
10	NEW MEXICO	2,727	2,278		
11	EL PASO	963	1,628		
14	ARIZONA	23,190	15,903		
18	NEVADA	3,269	4,078		
20	MEXICO-CFE	2,041	2,013		
21	IMPERIALCA	1,126	758		
22	SANDIEGO	1,464	3,315		
24	SOCALIF	9,218	15,136		
26	LADWP (1)(3)(4)(5)	5,473	2,935	2,001	1,805
30	PG AND E	23,348	21,576		1
Total:		73,249	69,661	70,416	68,313

(1) includes 1801.2 MW generation in South Island from CELILO/SYLMAR DC tie
(2) includes 1954 MW load in North Island from CELILO/SYLMAR DC tie
(3) includes 1730.4 MW load in North Island from INTERMT/ADELANT DC tie
(4) includes 1671.6 MW generation in South Island from INTERMT/ADELANT DC tie
(5) includes 1864.4 MW generation in North Island from INTERMT generation (area 26 generation in North Island)

Note the Sylmar and Intermountain DC ties were kept in-service for all scenarios. Their post-separation flows are indicated on the tables.

For the WECC island scenario, no changes were made to the base case generation and load levels. Table 1 and Table 2 show these levels for both the summer and spring cases.

Table 3: 2015 heavy summer case load and generation summary for WECC

Area Number	Area Name	Generation in WECC Island (MW)	Load in WECC Island (MW)
10	NEW MEXICO	3,153	2,780
11	EL PASO	1,177	1,850
14	ARIZONA	25,611	19,309
18	NEVADA	5,627	6,063
20	MEXICO-CFE	2,416	2,411
21	IMPERIALCA	1,655	1,059
22	SANDIEGO	3,426	5,175
24	SOCALIF	15,692	22,833
26	LADWP	4,983	6,598
30	PG AND E	22,907	22,918
40	NORTHWEST	28,967	24,321
50	B.C.HYDRO	11,223	8,080
52	FORTISBC	1,013	761
54	ALBERTA	10,206	10,322
60	IDAHO	2,407	3,700
62	MONTANA	3,047	1,939
63	WAPA UGP	70	(37)
64	SIERRA	2,364	2,207
65	PACE	10,546	9,189
70	PSCOLORADO	7,432	7,906
73	WAPA R.M.	6,352	5,189
Total:		**170,274**	**164,571**

Table 4: 2015 heavy spring case load and generation summary for WECC

Area Number	Area Name	Generation in WECC Island (MW)	Load in WECC Island (MW)
10	NEW MEXICO	2,668	2,278
11	EL PASO	963	1,628
14	ARIZONA	22,231	15,903
18	NEVADA	3,269	4,078
20	MEXICO-CFE	2,041	2,013
21	IMPERIALCA	1,126	758
22	SANDIEGO	1,464	3,315
24	SOCALIF	9,218	15,136
26	LADWP (1)(3)(4)(5)	3,621	4,740
30	PG AND E	20,279	21,577
40	NORTHWEST (2)	29,979	23,080
50	B.C.HYDRO	8,263	8,437
52	FORTISBC	724	751
54	ALBERTA	10,195	10,331
60	IDAHO	2,105	2,784
62	MONTANA	3,177	1,509
63	WAPA UGP	53	(73)
64	SIERRA	1,761	1,753
65	PACE	8,029	7,084
70	PSCOLORADO	4,967	5,396
73	WAPA R.M.	4,579	3,541
Total:		**140,709**	**136,020**

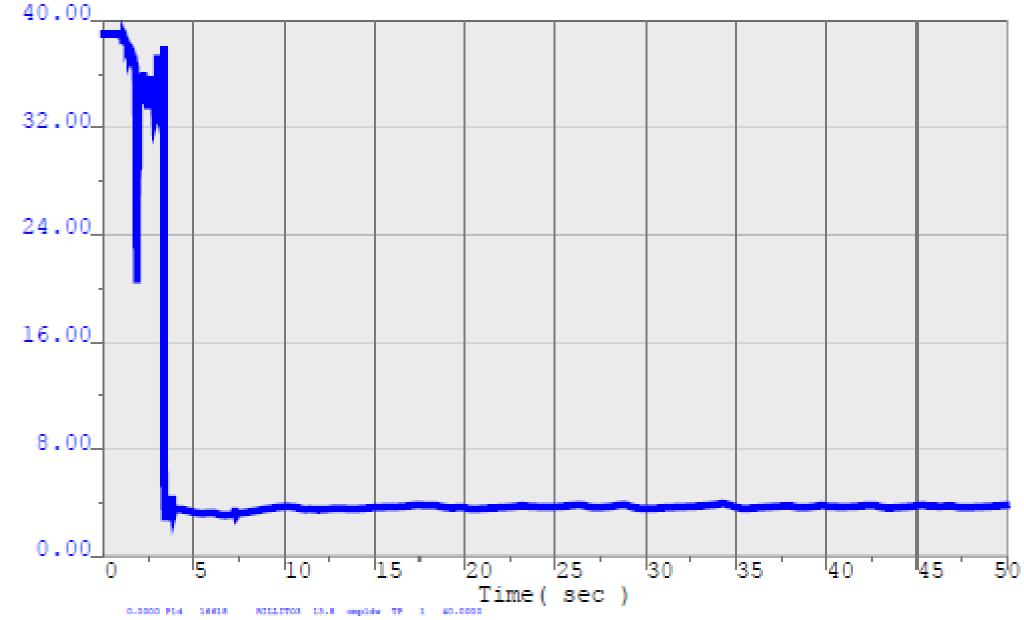
Imbalances of 5, 10, 15, 20, and 25 percent were simulated in each scenario. Specific scenarios are discussed in more detail in subsections that follow. The simulated generation loss was based on the load magnitude.

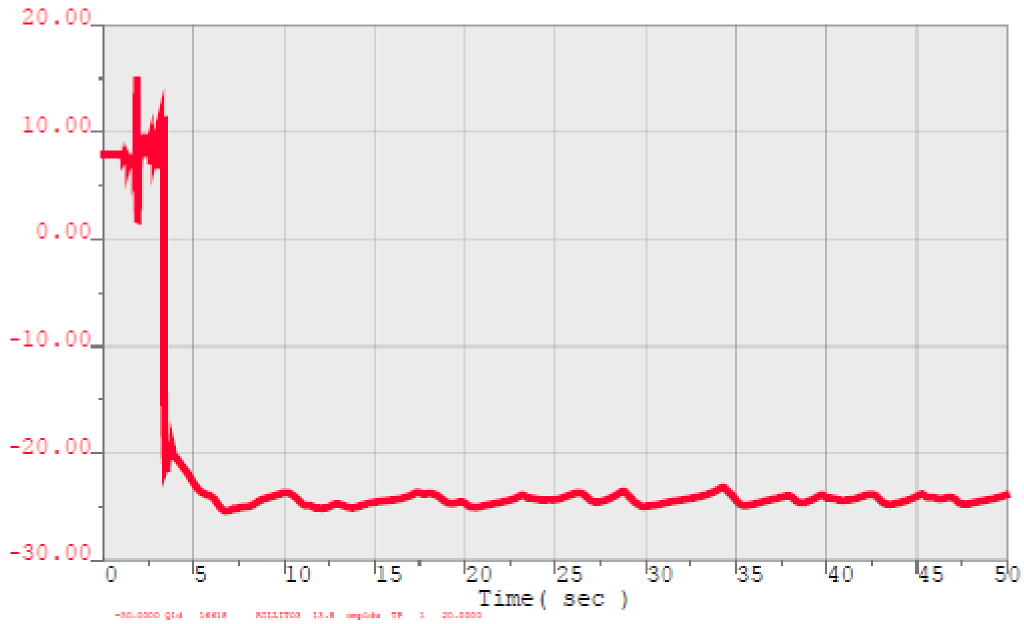
All buses were monitored for voltage and frequency. V/Hz was monitored on all generator buses. The frequency of representative Bulk Power buses were plotted to show general UFLS Plan performance.

Composite Load Model

Initial simulations using GE PSLF Version 19.0 with CMPLDW model showed that the CMPLDW did not perform properly during a load shedding event. Figure 4 shows how a CMPLDW model performed for the RILLITO3 bus during a 25 percent loss of generation simulation in the southern island analysis as an example of the problem.

Figure 4: GE PSLF Version 19.0 CMPLDW model performance during a load shedding event for the RILLITO3 load bus. Top graph is MW (blue); bottom graph is MVAR (red). This performance is incorrect.





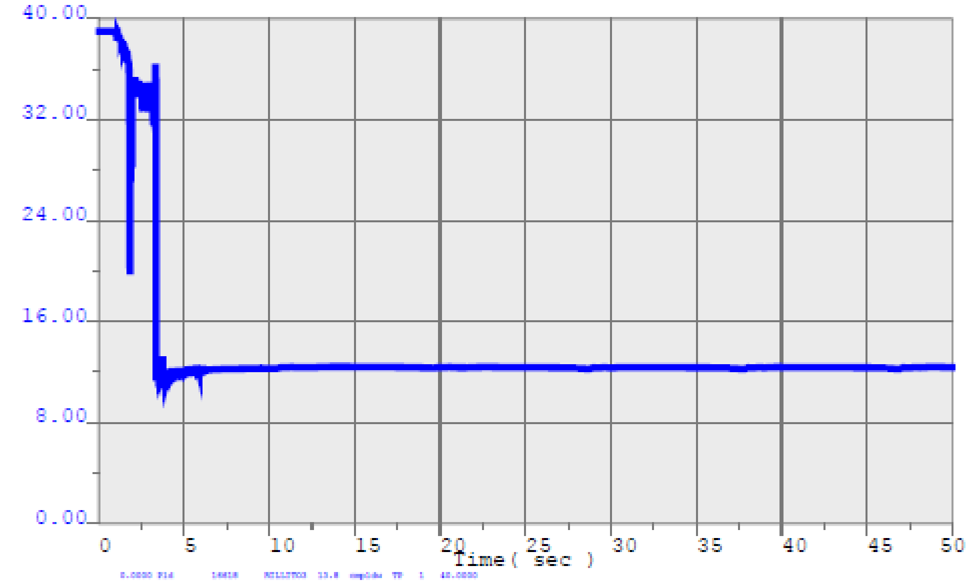
The RILLITO3 load was 39 MW and 7.9 MVAR (lagging) prior to the UFLS event. RILLITO3 has an associated UFLS relay model that is supposed to reduce its load by 65.9 percent if frequency falls below 58.7 Hz. The RILLITO3 load level should have reduced to 13.3 MW and 2.69 MVAR (lagging) at about 3 seconds during the simulation. Instead, the real power went from 39 MW to approximately 4 MW.

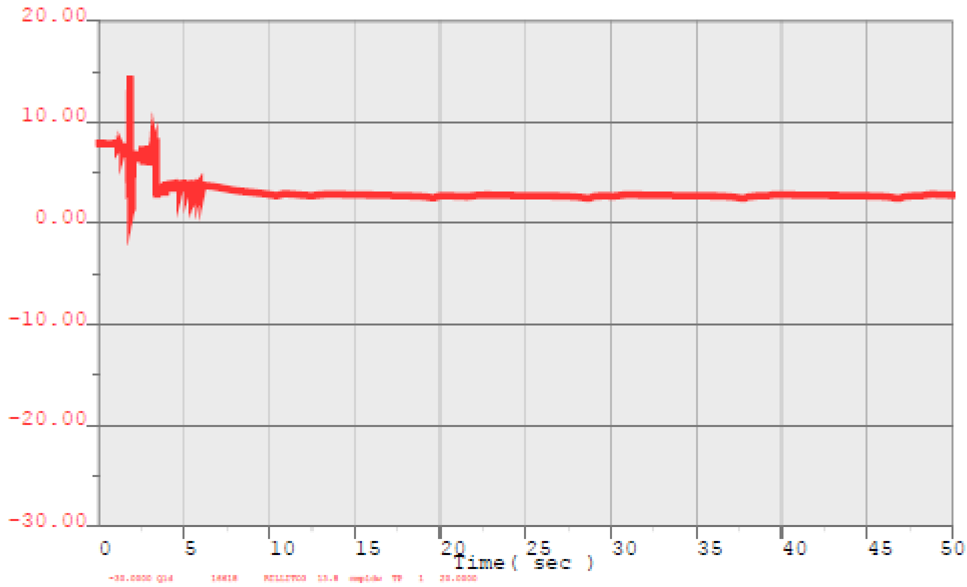
Worse, the reactive power went from 7.9 MVAR (lagging) to -25 MVAR (leading). Rather than a 65.9 percent reduction in VARs, the CMPLDW model simulated a more than 400 percent swing in VARs. The RILLITO3 performance is representative of how most other CMPLDW models performed. This resulted in exceptionally high voltages throughout the case. This occurred for loads that were partially reduced by the relay model. Load shedding that involved 100 percent of the load did not exhibit this behavior.

The UFLS Review Group brought this issue to the attention of GE and worked to modify the software to fix this issue. GE fixed the problem and released a beta version of PSLF to the Review Group so it could continue the simulations. The fix was included in the next WECC update to PSLF, version 19.01.

Figure 5 shows the RILLITO3 load bus model performance using updated software.

Figure 5: PSLF Version 19.0_01_BETA CMPLDW model performance during a load shedding event for the RILLITO3 load bus. Top graph is MW (blue); bottom graph is MVAR (red). This performance is correct.





As can be seen, the real power level reduced to around 12 MW and the reactive power reduced to about 2.5 MVAR (lagging), which are the expected values.

Study: WECC Island

WECC Island: Approach

Load/generation imbalance scenarios were based on the overall base case load levels for the entirety of WECC. As shown in previous tables, the total WECC load was 164,571 MW in the summer case and 136,020 MW in the spring. Five imbalance scenarios were studied. Table 5 shows the minimum amount of generation to be tripped to accomplish each load/generation imbalance target. Groups of generators were selected and taken out of service so that the aggregate loss of generation was close to the imbalance scenario targets. The imbalance scenario targets were based on connected load rather than connected generation. This approach is consistent with the original WECC Plan design methodology.

Table 5: WECC island imbalance scenario targets

Imbalance Scenario (%)	Imbalance Target: Heavy Summer (MW)	Imbalance Target: Heavy Spring (MW)
5%	8,229	6,801
10%	16,457	13,602
15%	24,686	20,403
20%	32,914	27,204
25%	41,143	34,005

The criteria for selecting which generators to trip were arbitrary. Nevertheless, an attempt was made to minimize the number of units being tripped, thereby reducing the number of concurrent contingencies required for such an event. Larger units were selected with some smaller units to keep the total loss near the imbalance targets.

Units that showed a propensity for going unstable were tripped as well, with the conservative assumption that these units would self-protect during an event anyway. Several generator units exhibited instability, likely because of improper governor or exciter models. This was indicated by unrealistic VAR outputs or local frequency. A list of models that failed within the first 20 seconds of the simulations is in Appendix O.

A small number of *tlin1* models were also found to be incorrect, which caused the simulations to crash. These are also included in Appendix O.

Table 6 and Table 7 show summaries of the amount of generation tripped, by area, for each imbalance scenario.

Table 6: Total generation tripped, by area, for WECC island 2015 heavy summer simulations

Area Number	Area Name	Total Generation in South Island	Gen Loss: 5% Imbalance	Gen Loss: 10% Imbalance	Gen Loss: 15% Imbalance	Gen Loss: 20% Imbalance	Gen Loss: 25% Imbalance
10	NEW MEXICO	3,153	-	-	492	1,036	1,036
11	EL PASO	1,177	-	-	-	-	-
14	ARIZONA	25,611	2,849	3,654	5,311	6,415	8,639
18	NEVADA	5,627	-	-	-	-	-
20	MEXICO-CFE	2,416	-	-	-	-	-
21	IMPERIALCA	1,655	96	96	96	96	96
22	SANDIEGO	3,426	96	96	96	386	114
24	SOCALIF	15,692	520	520	1,465	1,457	2,867
26	LADWP	4,983	43	43	993	2,023	2,023
30	PG AND E	22,907	792	3,191	3,191	4,022	4,053
40	NORTHWEST	28,967	1,522	3,871	3,871	4,542	4,595
50	B.C.HYDRO	11,223	842	842	1,742	2,903	5,963
52	FORTISBC	1,013	-	-	-	-	-
54	ALBERTA	10,206	393	393	393	1,180	1,651
60	IDAHO	2,407	33	33	33	58	58
62	MONTANA	3,047	-	-	805	843	1,643
63	WAPA UGP	70	-	-	-	-	-
64	SIERRA	2,364	-	-	-	-	-
65	PACE	10,546	1,043	2,152	3,147	4,343	6,479
70	PSCOLORADO	7,432	147	1,285	1,285	1,952	505
73	WAPA R.M.	6,352	-	396	1,857	1,890	1,890
	Total Gen MW:	170,274	8,375	16,572	24,777	33,147	41,613
	Units tripped:	N/A	41	51	66	122	140

Table 7: Total generation tripped, by area, for WECC island 2015 heavy spring simulations.

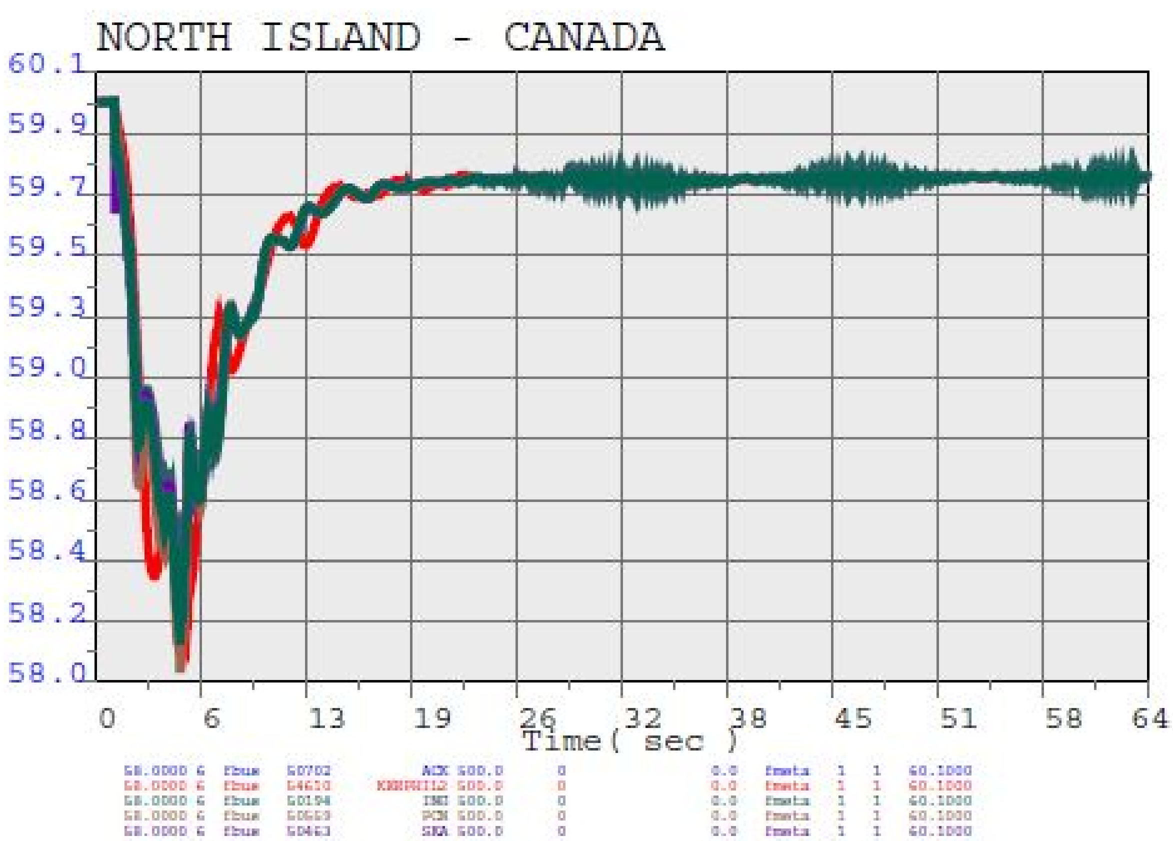
Area Number	Area Name	Total Generation in WECC Island	Gen Loss: 5% Imbalance	Gen Loss: 10% Imbalance	Gen Loss: 15% Imbalance	Gen Loss: 20% Imbalance	Gen Loss: 25% Imbalance
10	NEW MEXICO	2,668	-	-	-	1,061	1,061
11	EL PASO	963	-	-	-	-	-
14	ARIZONA	22,231	4,132	4,132	5,991	6,442	6,682
18	NEVADA	3,269	-	-	-	-	328
20	MEXICO-CFE	2,041	-	-	-	-	-
21	IMPERIALCA	1,126	-	-	-	-	96
22	SANDIEGO	1,464	-	-	-	-	-
24	SOCALIF	9,218	-	-	-	520	1,205
26	LADWP (1)(3)(4)(5)	3,621	-	-	1,850	925	962
30	PG AND E	20,279	1,211	1,210	2,410	2,884	5,005
40	NORTHWEST (2)	29,979	92	5,113	6,508	5,310	5,406
50	B.C.HYDRO	8,263	876	876	876	1,764	2,044
52	FORTISBC	724	-	-	-	-	-
54	ALBERTA	10,195	-	-	-	943	1,245
60	IDAHO	2,105	-	-	-	95	242
62	MONTANA	3,177	27	27	1,627	1,627	1,694
63	WAPA UGP	53	-	-	-	-	-
64	SIERRA	1,761	-	-	-	-	500
65	PACE	8,029	582	1,682	582	3,777	4,277
70	PSCOLORADO	4,967	-	600	600	600	1,450
73	WAPA R.M.	4,579	-	-	-	1,332	1,876
	Total Gen MW:	140,709	6,919	13,640	20,444	27,280	34,072
	Units tripped:	N/A	25	35	43	75	126

Dynamic simulations were conducted using GE PSLF Version 19.0_01_BETA. As discussed earlier, a beta version was used due to improper CMPLDW model performance in the commercially available 18.0 version. Simulations were conducted for each imbalance scenario and were run for 65 seconds to ensure UFLS relays used to correct for underfrequency stalling were considered. EPCL tool "alldyns-GE.p" was used to orchestrate the simulations.

WECC Island: Results

All simulations in the WECC island met all performance requirements of the WECC Plan and NERC Standard PRC-006-2.The worst frequency performance occurred in the North Island – Canada Region under a 25 percent imbalance scenario in the 2015 heavy summer base case, which can be seen in Figure 6 .

Figure 6: North Island - Canada region frequency performance for a 25% generation loss scenario in the heavy summer case for the WECC island.



As shown in Figure 6, the worst (Keephil2 and PCN 500 kV) bus frequencies dipped to below 58.1 Hz before the decline was arrested by load shedding. Frequency stabilized near 59.8 Hz. The WECC Plan is designed to ensure frequency does not dip below 58 Hz during a transient. It is also designed to ensure frequency stabilizes above 59.5 Hz following a transient. While it appears that the two bus voltages nearly dip below 58 Hz, they stay above that threshold, resulting in both these criteria being met in the WECC island simulations.

No frequency overshoot issues were observed in any of the simulations. Also, no overvoltage issues were found that required additional automatic switching of capacitor banks, transmission lines, or reactors to control over-voltages as a result of UFLS.

Ideally, post-disturbance frequency would settle out above 60 Hz, as opposed to below 60 Hz. While all imbalance scenarios resulted in frequency stabilized above the minimum 59.5 Hz, none settled out above 60 Hz. The 10 percent imbalance scenario stabilized at the lowest steady state point, which was at 59.8 Hz.

All frequency plots for the WECC island are included in Appendix B.

Table 8 and Table 9 summarize the load shedding, by area, for the various imbalance scenarios.

Table 8: Load shedding summary, by area, for 2015 heavy summer WECC island simulations

Area Number	Area Name	Total Load in South Island	Load Shed: 5% Imbalance	Load Shed: 10% Imbalance	Load Shed: 15% Imbalance	Load Shed: 20% Imbalance	Load Shed: 25% Imbalance
10	NEW MEXICO	2,780		167	205	427	568
11	EL PASO	1,850		97	201	284	378
14	ARIZONA	19,309		1084	1863	2339	4066
18	NEVADA	6,063		395	549	1337	1587
20	MEXICO-CFE	2,411		130	331	331	611
21	IMPERIALCA	1,059		9	15	24	36
22	SANDIEGO	5,175		297	297	594	1206
24	SOCALIF	22,833			1225	2646	4059
26	LADWP	6,598		367	367	721	1009
30	PG AND E	22,918		380	1518	2558	3804
40	NORTHWEST	24,321		2070	3439	5059	5929
50	B.C.HYDRO	8,080	58	849	1446	1752	1825
52	FORTISBC	761		22	79	112	112
54	ALBERTA	10,322		294	518	707	1387
60	IDAHO	3,700			320	595	612
62	MONTANA	1,939	30	30	185	274	345
63	WAPA UGP	(37)					
64	SIERRA	2,207		190	561	626	704
65	PACE	9,189			428	976	1381
70	PSCOLORADO	7,906		73	470	1365	1617
73	WAPA R.M.	5,189		182	323	756	913
	Total Load MW:	164,571	88	6,636	14,340	23,483	32,149
	Total Load %:	100.0%	0.1%	4.0%	8.7%	14.3%	19.5%

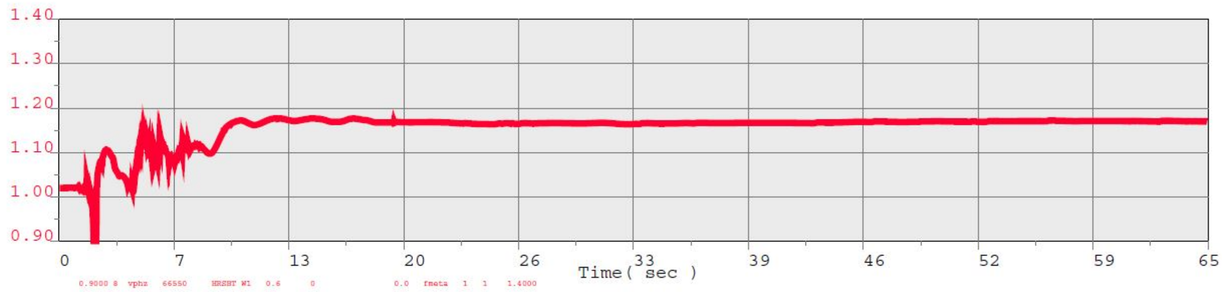
Table 9: Load shedding summary, by area, for 2015 heavy spring WECC island simulations

Area Number	Area Name	Total Load in WECC Island	Load Shed: 5% Imbalance	Load Shed: 10% Imbalance	Load Shed: 15% Imbalance	Load Shed: 20% Imbalance	Load Shed: 25% Imbalance
10	NEW MEXICO	2,278		129	299	366	527
11	EL PASO	1,628		87	257	276	402
14	ARIZONA	15,903		532	1224	2016	2999
18	NEVADA	4,078		269	383	876	1030
20	MEXICO-CFE	2,013		82	287	388	502
21	IMPERIALCA	758		6	14	16	25
22	SANDIEGO	3,315		189	189	395	624
24	SOCALIF	15,136			1129	1686	2231
26	LADWP (1)(3)(4)(5)	4,740		264	264	510	706
30	PG AND E	21,577		222	1115	2601	3181
40	NORTHWEST (2)	23,080	17	1781	4189	6342	6199
50	B.C.HYDRO	8,437	53	209	1060	1963	2006
52	FORTISBC	751			22	122	122
54	ALBERTA	10,331				927	1118
60	IDAHO	2,784			264	431	574
62	MONTANA	1,509	21	14	122	183	240
63	WAPA UGP	(73)					
64	SIERRA	1,753		182	516	609	688
65	PACE	7,084		11	602	1011	1295
70	PSCOLORADO	5,396		51	345	887	1277
73	WAPA R.M.	3,541		8	186	507	752
	Total Load MW:	136,020	91	4,037	12,467	22,112	26,498
	Total Load %:	100.0%	0.1%	3.0%	9.2%	16.3%	19.5%

Volts per Hz (V/Hz) was analyzed under the 25 percent imbalance scenarios in both the summer and spring base cases to evaluate the WECC Plan's conformance with PRC-006-2 E.B.3.3. It was monitored on all generator buses in WECC using the *vfmetr* recorder. As its name suggests, the *vfmetr* computes the ratio of per-unit bus voltage to per-unit bus frequency. It also includes provisions for V/Hz thresholds and associated time limits. Every bus that exceeded either 1.18 per unit (pu) V/Hz for longer than 2 seconds or 1.1 pu V/Hz for longer than 45 seconds was investigated. There were 19 generator buses whose sizes met the criteria set forth in E.B.3.3.1 – E.B.3.3.3, that violated either the 1.18 or 1.1 V/Hz criteria in the heavy summer case. For the heavy spring case, there were nine generator buses that met the size criteria and violated either the 1.18 or 1.1 V/Hz criteria, four of which were the same buses from the summer case.

Each V/Hz violation was further investigated to determine if it was caused by insufficiencies in the UFLS Plan or problems with the model. All V/Hz violations were found to be caused by incorrect exciter or SVD model performance and not caused by deficiencies in the UFLS program. The WECC Plan was found to comply with PRC-006-2 E.B.3.3. Figure 7 is one example of incorrect exciter model performance.

Figure 7: V/Hz measured on bus 66550.



Bus number 66550 is associated with the HRSBT W1 0.6-kV generator, which has a 100-MW rating. The generator was receiving 13.3 MVARs at the conclusion of the simulation. This falls within the reactive power range of the unit (-49.7 MVAR to 33.7 MVAR), so that was not the issue. However, an SVD at a nearby bus (65670) was outputting significant VARs while holding its bus voltage to 1.231 pu, which in turn caused the voltage at HRSBT W1 to be very high as well. The issue was deemed to be caused by an improper SVD model and/or the solution engine logic rather than UFLS Plan shortfalls.

Appendix C includes plots and explanations for all generator buses that were investigated. The UFLS Review Group will notify the respective generator owners of their unit's model performance. Some models are more appropriate for simulations less than 15 seconds due to numerical instability. The issues noted in this study are not meant to imply that there are actual issues with the associated generator exciter models.

Study: Northern Island

Northern Island: Approach

Load/generation imbalance scenarios were based on the post-separation load levels in the northern island. As shown in the previous tables, the northern island load was 77,474 MW in the summer case and 68,313 MW in the spring. Five imbalance scenarios were studied. Table 10 shows the minimum amount of generation to be tripped to accomplish each load/generation imbalance target. Groups of generators were selected and taken out of service so that the aggregate loss of generation was close to the imbalance scenario targets. The imbalance scenario targets were based on connected load rather than connected generation. This approach is consistent with the original WECC Plan design methodology.

Table 10: Imbalance scenario targets

Imbalance Scenario (%)	Imbalance Target: Heavy Summer (MW)	Imbalance Target: Heavy Spring (MW)
5%	3,873.72	3,415.63
10%	7,747.44	6,831.26
15%	11,621.16	10,246.89
20%	15,494.88	13,662.52
25%	19,368.60	17,078.15

The criteria for selecting which generators to trip were arbitrary. Nevertheless, an attempt was made to minimize the number of units being tripped, thereby reducing the number of concurrent contingencies required for such an event. Larger units were selected with some smaller units to keep the total loss near the imbalance targets.

Units that showed a propensity for going unstable were tripped as well, with the conservative assumption that these units would self-protect during an event anyway. Several generator units exhibited instability, likely because of either improper governor or exciter models. This was indicated by unrealistic VAR outputs or local frequency. A list of models that failed within the first 20 seconds of the simulations is in Appendix O.

A small number of *tlin1* models were also found to be incorrect, which caused the simulations to crash. These are also included in Appendix O.

Table 11 and Table 12 show summaries of the amount of generation tripped, by area, for each imbalance scenario.

Table 11: Total generation tripped, by area, for 2015 heavy summer northern island simulations

Area Number	Area Name	Total Generation in North Island	Gen Loss: 5% Imbalance	Gen Loss: 10% Imbalance	Gen Loss: 15% Imbalance	Gen Loss: 20% Imbalance	Gen Loss: 25% Imbalance
26	LADWP (1)(3)(4)(5)	1,900	1,900	1,900	1,983	1,033	1,983
40	NORTHWEST (2)	25,967	2,184	2,385	4,514	5,023	5,023
50	B.C.HYDRO	8,823	-	-	-	668	1,061
52	FORTISBC	1,013	-	-	-	-	-
54	ALBERTA	10,206	-	-	-	471	2,057
60	IDAHO	2,407	-	-	30	78	78
62	MONTANA	3,047	-	1,605	1,605	800	800
63	WAPA UGP	70	-	-	-	-	-
64	SIERRA	2,364	-	-	-	515	515
65	PACE	10,412	-	1,109	1,947	4,698	5,119
70	PSCOLORADO	7,432	13	793	793	518	518
73	WAPA R.M.	6,352	-	-	831	1,733	2,549
	Total Gen MW:	79,993	4,097	7,792	11,703	15,538	19,704
	Units Tripped:	N/A	10	15	36	65	82

Table 12: Total generation tripped, by area, for 2015 heavy spring northern island simulations

Area Number	Area Name	Total Generation in North Island	Gen Loss: 5% Imbalance	Gen Loss: 10% Imbalance	Gen Loss: 15% Imbalance	Gen Loss: 20% Imbalance	Gen Loss: 25% Imbalance
26	LADWP (1)(3)(4)(5)	2,001	1,864	1,864	1,864	1,864	1,983
40	NORTHWEST (2)	26,328	1,097	2,345	4,135	5,711	5,023
50	B.C.HYDRO	6,663	-	-	-	-	668
52	FORTISBC	724	-	-	-	-	-
54	ALBERTA	10,195	-	-	-	475	852
60	IDAHO	2,105	-	-	-	-	58
62	MONTANA	3,177	-	1,694	1,694	1,694	800
63	WAPA UGP	53	-	-	-	-	-
64	SIERRA	1,761	-	-	-	-	515
65	PACE	8,294	-	847	2,322	3,372	5,119
70	PSCOLORADO	4,967	600	400	600	600	518
73	WAPA R.M.	4,149	-	-	-	-	1,733
	Total Gen MW:	70,416	3,561	7,150	10,615	13,716	17,270
	Units Tripped:	N/A	7	22	28	35	75

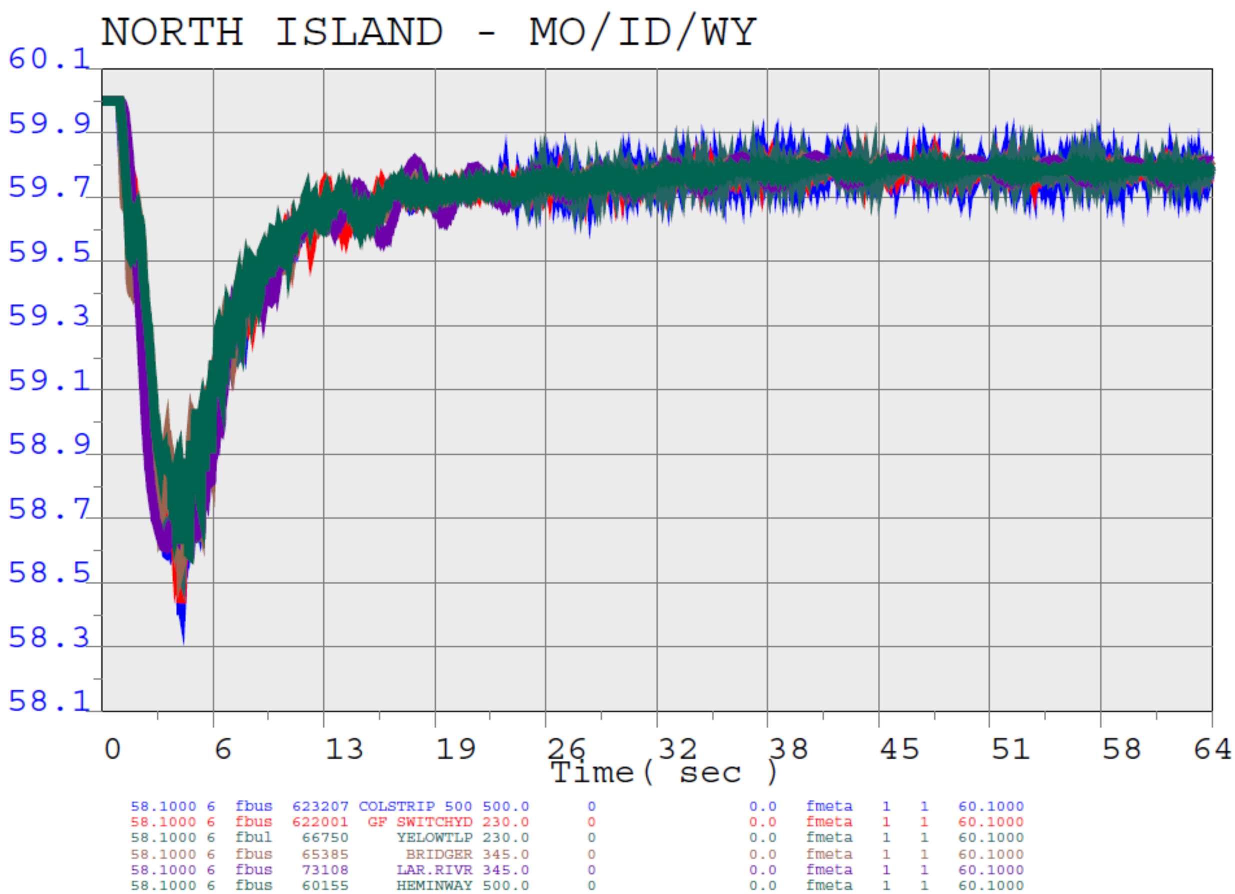
Dynamic simulations were conducted using GE PSLF Version 19.0_01_BETA. As discussed earlier, a beta version was used due to improper CMPLDW model performance in the commercially available 18.0 version. Simulations were conducted for each imbalance scenario and were run for 65 seconds to ensure UFLS relays used to correct for underfrequency stalling were considered. EPCL tool *alldyns-GE.p* was used to orchestrate the simulations.

Northern Island: Results

All simulations in the northern island met all performance requirements of the WECC Plan and NERC Standard PRC-006-2.

The worst frequency performance occurred in the Montana/Idaho/Wyoming Region under a 25 percent imbalance scenario in the 2015 heavy summer base case. This is shown in Figure 8.

Figure 8: MO/ID/WY Region frequency performance for a 25% generation loss scenario in the northern island in the heavy summer case.



As shown on Figure 8, the worst (Colstrip 500 kV) bus frequency dipped to 58.3 Hz before the decline was arrested by load shedding. Frequency stabilized near 59.8 Hz. The WECC Plan is designed to ensure frequency does not dip below 58 Hz during a transient. It is also designed to ensure frequency stabilizes above 59.5 Hz following a transient. As shown on Figure 8, both these criteria were met in the northern island simulations.

Ideally, post-disturbance frequency would settle out above 60 Hz, as opposed to below 60 Hz. While all imbalance scenarios resulted in frequency stabilized above the minimum 59.5 Hz, none settled out above 60 Hz. Several imbalance scenarios stabilized around 59.65 Hz.

No frequency overshoot issues were observed in any of the northern island simulations. Also, no overvoltage issues were found that required additional automatic switching of capacitor banks, transmission lines, or reactors to control over-voltages as a result of UFLS.

All frequency plots for the northern island are included in Appendix E.

Table 13 and Table 14 summarize the load shedding, by area, for the various imbalance scenarios.

Table 13: Load shedding summary, by area, for 2015 heavy summer northern island simulations

Area Number	Area Name	Total Load in North Island	Load Shed: 5% Imbalance	Load Shed: 10% Imbalance	Load Shed: 15% Imbalance	Load Shed: 20% Imbalance	Load Shed: 25% Imbalance
26	LADWP (1)(3)(4)(5)	1,898	-	-	-	-	-
40	NORTHWEST (2)	26,321	-	1,111	2,498	4,084	4,898
50	B.C.HYDRO	8,080	48	152	1,054	1,258	1,570
52	FORTISBC	761	-	-	41	79	79
54	ALBERTA	10,322	-	187	620	911	1,128
60	IDAHO	3,700	-	-	229	412	594
62	MONTANA	1,939	30	30	103	185	262
63	WAPA UGP	(37)	-	-	-	-	-
64	SIERRA	2,207	-	190	415	567	577
65	PACE	9,189	-	-	388	421	967
70	PSCOLORADO	7,906	-	52	423	503	891
73	WAPA R.M.	5,189	-	11	185	326	510
	Total Load MW:	77,474	79	1,733	5,954	8,747	11,478
	Total Load %:	100.0%	0.1%	2.2%	7.7%	11.3%	14.8%

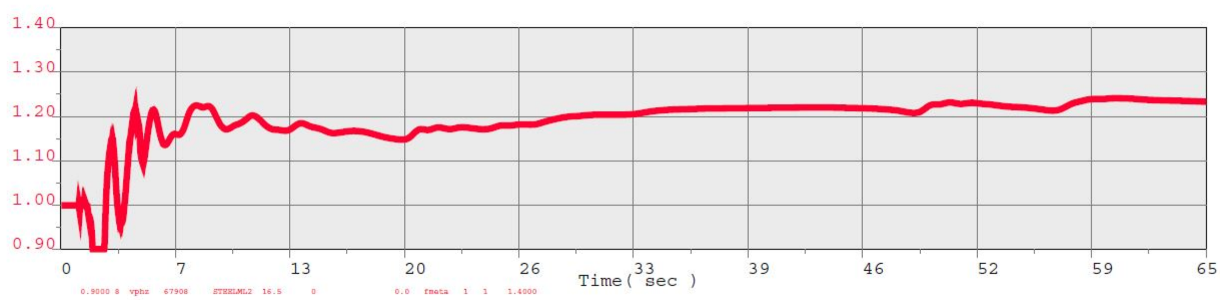
Table 14: Load shedding summary, by area, for 2015 heavy spring northern island simulations

Area Number	Area Name	Total Load in North Island	Load Shed: 5% Imbalance	Load Shed: 10% Imbalance	Load Shed: 15% Imbalance	Load Shed: 20% Imbalance	Load Shed: 25% Imbalance
26	LADWP (1)(3)(4)(5)	1,805	-	-	-	-	-
30	PG AND E	1	-	-	-	-	-
40	NORTHWEST (2)	25,034	-	1,499	3,036	4,908	5,268
50	B.C.HYDRO	8,437	53	154	1,048	1,564	1,986
52	FORTISBC	751	-	-	22	91	122
54	ALBERTA	10,331	-	1	-	306	456
60	IDAHO	2,784	-	-	151	431	431
62	MONTANA	1,509	21	-	74	111	210
63	WAPA UGP	(73)	-	-	-	-	-
64	SIERRA	1,753	-	182	434	609	609
65	PACE	7,084	-	11	275	834	1,011
70	PSCOLORADO	5,396	-	51	332	641	597
73	WAPA R.M.	3,501	-	8	136	346	475
	Total Load MW:	68,313	74	1,905	5,508	9,841	11,164
	Total Load %:	100.0%	0.1%	2.8%	8.1%	14.4%	16.3%

Volts per Hz (V/Hz) was analyzed under the 25 percent imbalance scenarios in both the summer and spring base cases to evaluate the WECC Plan’s conformance with PRC-006-2 E.B.3.3. It was monitored on all buses in the northern island using the *vfmetr* recorder. The *vfmetr* computes the ratio of per-unit bus voltage to per-unit bus frequency as its name suggests. It also includes provisions for V/Hz thresholds and associated time limits. Every bus that exceeded either 1.18 pu V/Hz for longer than 2 seconds or 1.1 pu V/Hz for longer than 45 seconds was investigated. There were 13 generator buses whose sizes met the criteria set forth in E.B.3.3.1 – E.B.3.3.3, that violated either the 1.18 or 1.1 V/Hz criteria in the heavy summer case. Six generator buses were also found to violate the criteria in the heavy spring case, three of which were also found in the heavy summer case. No associated generator step-up transformer high-side buses were found to violate criteria.

Each V/Hz violation was further investigated to determine if they were caused by insufficiencies in the UFLS Plan or problems with the model. All V/Hz violations were found to be caused by incorrect exciter or SVD model performance and not caused by deficiencies in the UFLS program. The WECC Plan was found to comply with PRC-006-2 E.B.3.3. Figure 9 is one example of incorrect exciter model performance.

Figure 9: V/Hz measured on bus number 67908.



Bus number 67908 is associated with the STEELML2 16.5-kV generator, which has a 256-MW rating. The generator was absorbing 137.6 MVARs at the conclusion of the simulation. This significantly exceeds the Qmin rating in the model, thus the model should not have allowed this. Also, an SVD at a nearby bus (65260) is outputting significant VARs holding its bus voltage to 1.302 pu, which in turn caused the voltage at STEELML2 to be very high. The issue was deemed to be caused by an improper model and/or the solution engine logic rather than UFLS Plan shortfalls. Appendix F includes plots and explanations for all generator buses that were investigated. The UFLS Review Group will notify the respective generator owners of their unit's model performance. Some models are more appropriate for simulations less than 15 seconds due to numerical instability. The issues noted in this study are not meant to imply that there are actual issues with the associated generator exciter models.

Study: Southern Island

Southern Island: Approach

Load/generation imbalance scenarios were based on the post-separation load levels in the southern island. As shown in the previous tables, the southern island load was 95,306 MW in the summer case and 73,249 MW in the spring. Five imbalance scenarios were studied. Table 15 below shows the minimum amount of generation to be tripped to accomplish each load/generation imbalance target. Groups of generators were selected and taken out of service so that the aggregate loss of generation was close to the imbalance scenario targets. The imbalance scenario targets were based on connected load rather than connected generation. This approach is consistent with the original WECC Plan design methodology.

Table 15: Imbalance scenario targets

Imbalance Scenario (%)	Imbalance Target: Heavy Summer (MW)	Imbalance Target: Heavy Spring (MW)
5%	4,551	3,483
10%	9,103	6,966
15%	13,654	10,449
20%	18,206	13,932
25%	22,757	17,415

The criteria for selecting which generators to trip were arbitrary. Nevertheless, an attempt was made to minimize the number of units being tripped, thereby reducing the number of concurrent contingencies required for such an event. Larger units were selected with some smaller units to keep the total loss near the imbalance targets.

Units that showed a propensity for going unstable were tripped as well, with the conservative assumption that these units would self-protect during an event anyway. Several generator units exhibited instability, likely because of either improper governor or exciter models. This was indicated by unrealistic VAR outputs or local frequency. A list of models that failed within the first 20 seconds of the simulations is in Appendix O.

A small number of *tlin1* models were also found to be incorrect, which caused the simulations to crash. These are also included in Appendix O.

Table 16 and Table 17 below show summaries of the amount of generation tripped, by area, for each imbalance scenario.

Table 16: Total generation tripped, by area, for 2015 heavy summer simulations

Area Number	Area Name	Total Generation in South Island	Gen Loss: 5% Imbalance	Gen Loss: 10% Imbalance	Gen Loss: 15% Imbalance	Gen Loss: 20% Imbalance	Gen Loss: 25% Imbalance
10	NEW MEXICO	3,213	1,036	544	1,036	492	1,746
11	EL PASO	1,177	-	-	-	-	-
14	ARIZONA	27,137	1,473	5,031	7,086	9,500	10,764
18	NEVADA	5,627	-	-	-	-	328
20	MEXICO-CFE	2,416	-	-	-	-	-
21	IMPERIALCA	1,655	96	96	96	96	96
22	SANDIEGO	3,426	-	-	-	-	880
24	SOCALIF	15,692	990	520	1,935	3,515	3,115
26	LADWP (1) (4)	9,037	43	993	993	993	1,323
30	PG AND E	25,469	619	1,819	2,901	3,705	4,715
73	WAPA R.M.	458	458	458	-	458	458
	Total Gen MW:	95,306	4,714	9,460	14,047	18,759	23,425
	Units tripped:	N/A	17	20	29	40	53

Table 17: Total generation tripped, by area, for 2015 heavy spring simulations

Area Number	Area Name	Total Generation in South Island	Gen Loss: 5% Imbalance	Gen Loss: 10% Imbalance	Gen Loss: 15% Imbalance	Gen Loss: 20% Imbalance	Gen Loss: 25% Imbalance
10	NEW MEXICO	2,727	544	-	1,061	517	1,061
11	EL PASO	963	-	-	-	-	-
14	ARIZONA	23,190	1,379	3,560	4,034	7,870	9,753
18	NEVADA	3,269	-	-	-	-	-
20	MEXICO-CFE	2,041	-	-	-	-	-
21	IMPERIALCA	1,126	96	96	96	96	96
22	SANDIEGO	1,464	-	-	-	-	-
24	SOCALIF	9,218	990	520	1,935	2,715	2,405
26	LADWP (1) (4)	5,473	37	969	969	969	969
30	PG AND E	23,348	620	1,843	2,926	2,130	3,789
73	WAPA R.M.	430	-	430	-	430	430
Tripped Gen (MW):		73,249	3,666	7,418	11,020	14,727	18,502
Number Units tripped:			14	19	28	33	41

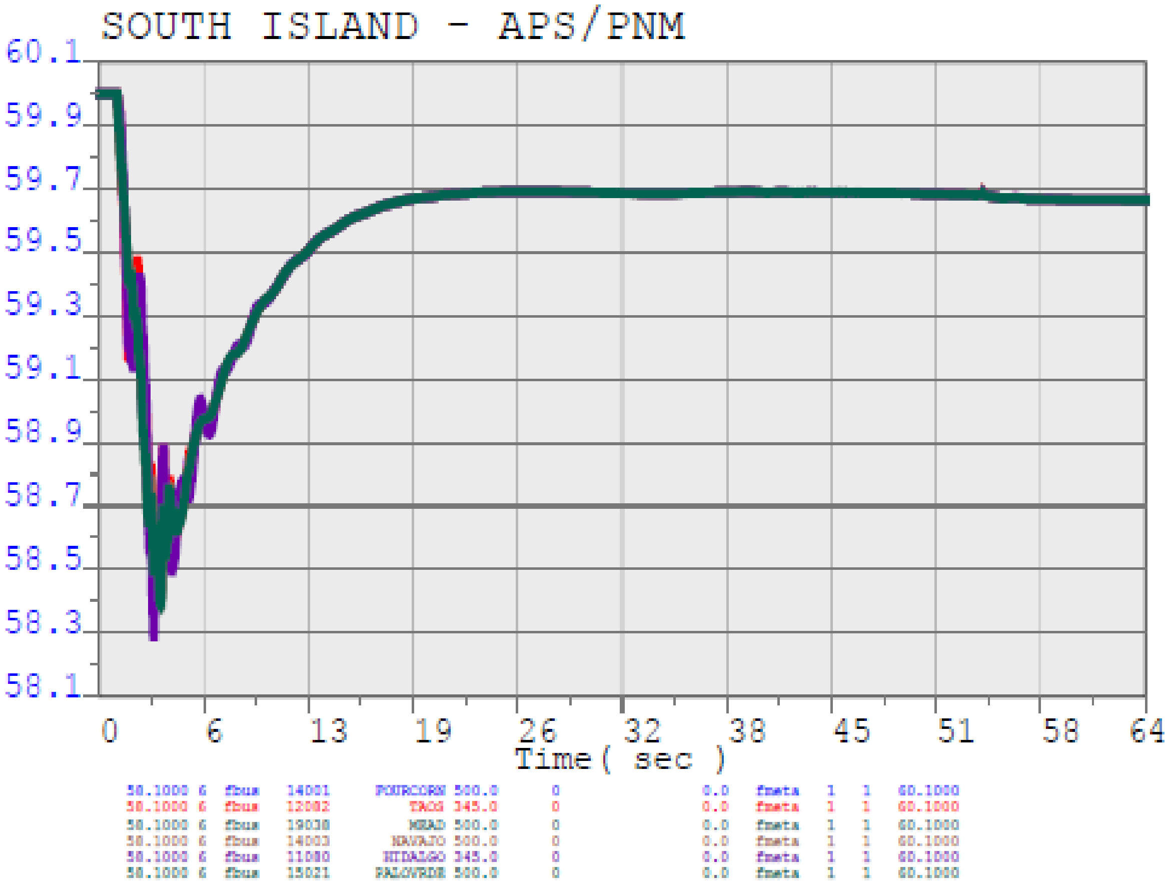
Dynamic simulations were conducted using GE PSLF Version 19.0_01_BETA. As discussed earlier, a beta version was used due to improper CMPLDW model performance in the commercially available 18.0 version. Simulations were conducted for each imbalance scenario and were run for 65 seconds to ensure UFLS relays used to correct for underfrequency stalling were considered. EPCL tool *alldyns-GE.p* was used to orchestrate the simulations.

Southern Island: Results

All simulations in the southern island met all performance requirements of the WECC Plan and NERC Standard PRC-006-2.

The worst frequency performance occurred in the Arizona/New Mexico Region under a 25 percent imbalance scenario in the 2015 heavy spring base case. This is shown in Figure 10.

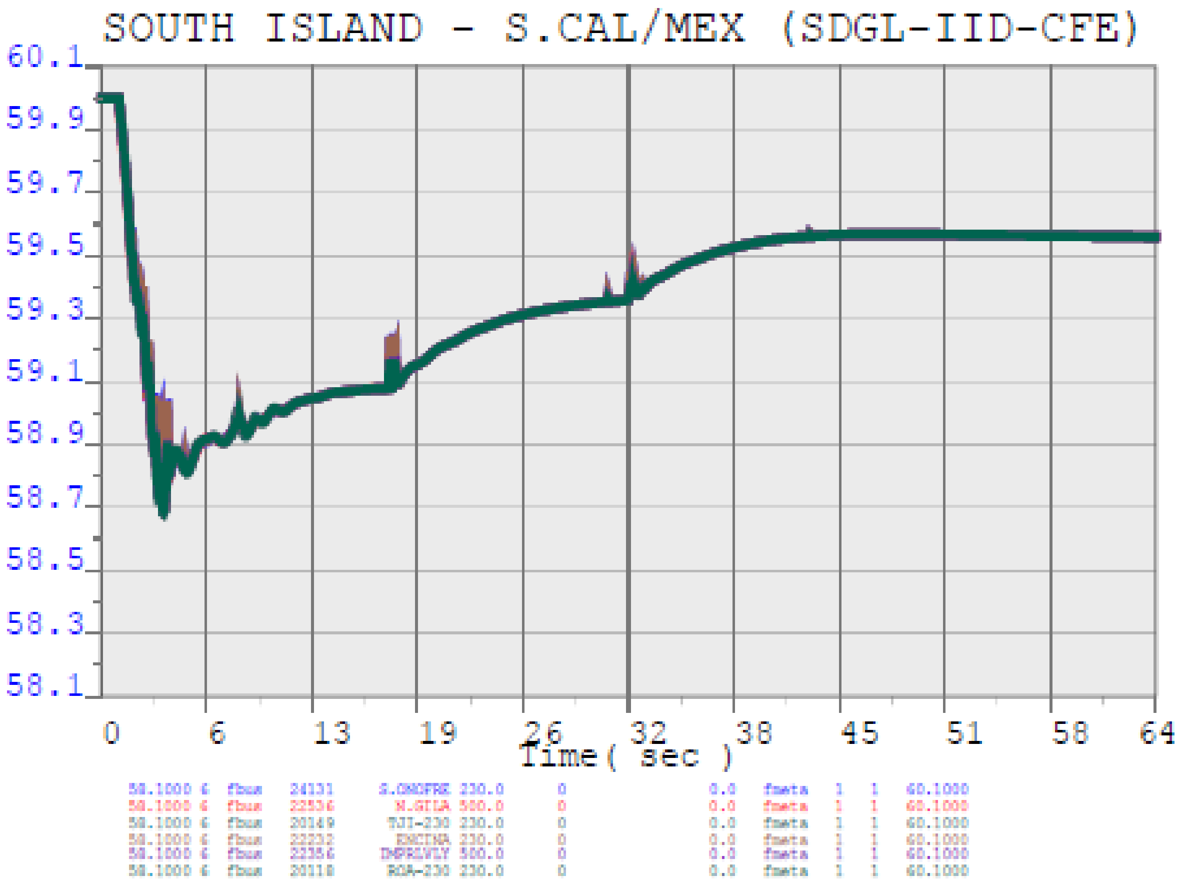
Figure 10: APS/PNM Region frequency performance for a 25% generation loss scenario in the southern island in the heavy spring case.



As shown on Figure 10, the worst (Hidalgo 345 kV) bus frequency dipped to 58.3 Hz before the decline was arrested by load shedding. Frequency stabilized near 59.7 Hz. The WECC Plan is designed to ensure frequency does not dip below 58 Hz during, a transient. It is also designed to ensure frequency stabilizes above 59.5 Hz following a transient. As shown on Figure 10, both these criteria were met in the southern island simulations.

Frequency did not decline as much in the reduced imbalance scenarios, as expected. They did highlight the importance of the underfrequency stalling elements of the WECC Plan. Figure 11 below shows a frequency plot of the California/Mexico Region following a 20 percent imbalance simulation.

Figure 11: Southern California / Mexico Region frequency following a 20% loss of generation.



Note how frequency recovery nearly stabilizes around 59.1Hz at t = 18 seconds following the instantaneous load shedding. It is likely frequency would have remained unsatisfactorily low if not for the underfrequency stalling relays. The simulation shows two stages of underfrequency stalling relays activating. The first group trips at around t = 18 seconds and the second around t = 32 seconds. Frequency stabilizes above the desirable 59.5 Hz range primarily as a result of these relays.

Ideally, post-disturbance frequency would settle out above 60 Hz, as opposed to below 60 Hz. While all imbalance scenarios resulted in frequency stabilized above the minimum 59.5 Hz, none settled out above 60 Hz. Several imbalance scenarios stabilized around the minimum 59.5 Hz.

No frequency overshoot issues were observed in any of the southern island simulations. Also, no overvoltage issues were found that required additional automatic switching of capacitor banks, transmission lines, or reactors to control over-voltages as a result of UFLS.

All frequency plots for the southern island are included in Appendix H.

Table 18 and Table 19 below summarize the load shedding, by area, for the various imbalance scenarios.

Table 18: Load shedding summary, by area, for 2015 heavy summer southern island simulations

Area Number	Area Name	Total Load in South Island	Load Shed: 5% Imbalance	Load Shed: 10% Imbalance	Load Shed: 15% Imbalance	Load Shed: 20% Imbalance	Load Shed: 25% Imbalance
10	NEW MEXICO	2,780	167	181	221	442	613
11	EL PASO	1,850	65	97	201	378	452
14	ARIZONA	19,309	1071	1095	2118	3356	4698
18	NEVADA	6,063	395	395	783	1337	1650
20	MEXICO-CFE	2,411	130	163	364	450	622
21	IMPERIALCA	1,059	9	11	19	31	44
22	SANDIEGO	5,175	297	297	392	893	1137
24	SOCALIF	22,833	0	0	1792	2995	5498
26	LADWP (1) (4)	6,598	367	367	367	872	1439
30	PG AND E	22,918	380	662	2818	3082	4657
73	WAPA R.M.	35					
	Total Load MW:	91,030	2,881	3,268	9,074	13,837	20,811
	Total Load %:	100.0%	3.2%	3.6%	10.0%	15.2%	22.9%

Table 19: Load shedding summary, by area, for 2015 heavy spring southern island simulations

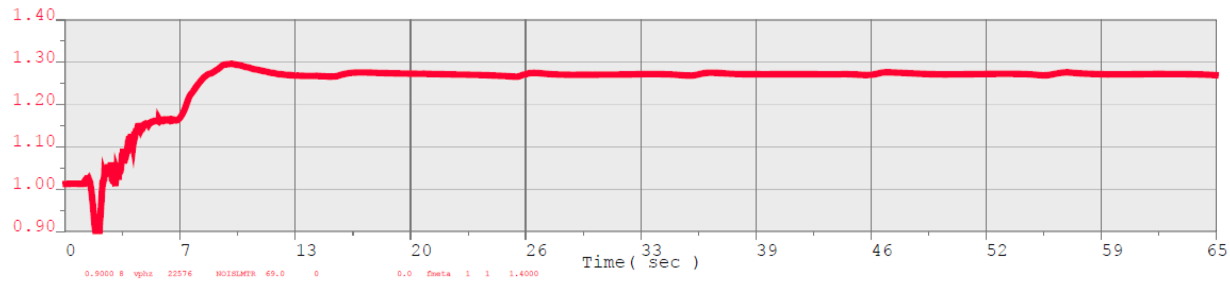
Area Number	Area Name	Total Load in South Island	Load Shed: 5% Imbalance	Load Shed: 10% Imbalance	Load Shed: 15% Imbalance	Load Shed: 20% Imbalance	Load Shed: 25% Imbalance
10	NEW MEXICO	2,278	129	141	271	344	515
11	EL PASO	1,628	62	181	265	307	429
14	ARIZONA	15,903	514	1,148	1,987	2,187	3,815
18	NEVADA	4,078	269	371	485	1,040	1,052
20	MEXICO-CFE	2,013	82	207	316	417	527
21	IMPERIALCA	758	6	9	16	19	30
22	SANDIEGO	3,315	189	189	251	562	852
24	SOCALIF	15,136	0	771	1,904	2,216	2,836
26	LADWP (1) (4)	2,935	264	264	510	510	706
30	PG AND E	21,576	222	1,212	2,438	2,611	4,133
73	WAPA R.M.	40					
	Total Load (MW):	69,661	1,738	4,492	8,444	10,213	14,897
	Total Load %:		2.5%	6.4%	12.1%	14.7%	21.4%

Volts per Hz (V/Hz) was analyzed under the 25 percent imbalance scenarios in both the summer and spring base cases to evaluate the WECC Plan's conformance with PRC-006-2 E.B.3.3. It was monitored on all buses in the southern island using the *vfmetr* recorder. The *vfmetr* computes the ratio of per-unit bus voltage to per-unit bus frequency as its name suggests. It also includes provisions for V/Hz thresholds and associated time limits. Every bus that exceeded either 1.18 pu V/Hz for longer than 2 seconds or 1.1 pu V/Hz for longer than 45 seconds was investigated. There were ten generator buses whose sizes met the criteria set forth in E.B.3.3.1 – E.B.3.3.3, that violated either the 1.18 or 1.1 V/Hz criteria in the heavy summer case. Four of those generator buses were also found to violate the criteria in the heavy spring case. No associated generator step-up transformer high-side buses were found to violate criteria.

Each V/Hz violation was further investigated to determine if it was caused by insufficiencies in the UFLS Plan or problems with the model. All V/Hz violations were found to be caused by incorrect exciter or SVD model performance and not caused by deficiencies in the UFLS program.

The WECC Plan was found to comply with PRC-006-2 E.B.3.3. Figure 12 below is one example of incorrect exciter model performance.

Figure 12: V/Hz measured on bus number 22576.



Bus number 22576 is associated with the NOISLMTR 69-kV generator, which has a 42.7-MW rating. The generator was generating 186 MVARs at the conclusion of the simulation. This significantly exceeds the Qmax rating in the model, thus the model should not have allowed this. The issue was deemed to be caused by an improper model and or the solution engine logic rather than UFLS Plan shortfalls. Appendix I includes plots and explanations for all generator buses that were investigated. The UFLS Review Group will notify the respective generator owners of their unit's model performance. Some models are more appropriate for simulations less than 15 seconds due to numerical instability. The issues noted in this study are not meant to imply that there are actual issues with the associated generator exciter models.

Conclusions

The WECC UFLS Plan continues to sufficiently arrest frequency decline following a 25 percent load and generation imbalance scenario. For the 2014/2015 study cycle, the WECC Planning Coordinators identified three islands to serve as the basis to evaluate the UFLS program: 1) the WECC island; 2) the northern island; and 3) the southern island. Dynamic simulations were conducted for each island and the WECC Plan demonstrated proper performance in accordance with PRC-006 E.B.3.

Frequency stabilized above 59.5 Hz in all simulations. Several imbalance scenarios in the southern island stabilized very close to 59.5 Hz. Ideally, per the WECC Plan design objectives, post-disturbance frequency would settle out above 60 Hz. No scenarios settled out above 60 Hz. This may have to be addressed in the future.

The composite load model was used in UFLS Plan simulations for the first time. Issues were discovered with its response to conditions where only a portion of a given load was shed. The software vendor was notified and with the UFLS Review Group's support, those characteristics of the composite load model were fixed and implemented in PSLF version 19.01.

Several other dynamic models were found to perform suspiciously. The UFLS Review Group's general approach to this was to correct, ignore, or turn off the suspect models so that the results of the greater study were not clouded. The UFLS Review Group did not attempt to correct all the models in the WECC base case as this was beyond the Review Group's scope. A list of the suspect models is included in Appendix O.

The manner in which existing WECC processes are compliant with the applicable requirements of PRC-006 was described. See the section "PRC-006-2 Compliance" for details. In essence, Planning Coordinators oversee the activities of the UFLS Review Group through the WECC Planning Coordination Committee and can demonstrate compliance with PRC-006. Also, UFLS Entities that respond to the annual UFLS data requests contribute to maintaining a shared UFLS database and provide their UFLS data according to an established format and schedule. A list of the entities that responded to the 2014 data request is included in Appendix L.

This concludes the efforts of the UFLS Review Group for the 2014/2015 study cycle. As was stated in the Introduction, the purpose of an Underfrequency Load Shedding plan is to protect the Bulk-Power System against major losses of generation. While the Bulk Power System continues to evolve to have less inertia, and newer more advanced technologies, the WECC UFLS Plan continues to be a steadfast safety net.

Disclaimer

WECC receives data used in its analyses from a wide variety of sources. WECC strives to source its data from reliable entities and undertakes reasonable efforts to validate the accuracy of the data used. WECC believes the data contained herein and used in its analyses is accurate and reliable. However, WECC disclaims any and all representations, guarantees, warranties, and liability for the information contained herein and any use thereof. Persons who use and rely on the information contained herein do so at their own risk.

Appendix A: WECC Island Simulations: Generator Loss Summary

5% Gen loss units: 2015 Heavy Summer - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
37581	SPRINGCR	13.8	1	82	30	1
37581	SPRINGCR	13.8	2	82	30	1
60417	HIGHMESA	0.6	1	10	60	1
45124	COPCO 1	69	1	7.5	40	1
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
43407	PELTON	13.8	1	90	40	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
65191	BONANZA	24	1	488	65	1
61811	MINIDOKA	2.4	6	2	60	1
61811	MINIDOKA	2.4	7	4	60	1
61812	MINIDOKA	4.16	8	8	60	1
61812	MINIDOKA	4.16	9	9	60	1
54424	KEEP#2GN	19	2A	392.8	54	1
50496	GMS 13G2	13.8	2	260	50	1
50497	GMS 13G3	13.8	3	260	50	1
50513	PCN 13G1	13.8	1	160	50	1
50514	PCN 13G2	13.8	2	160	50	1
31832	SLY.CR.	6.6	1	9.5	30	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
22704	SAMPSON	12.5	1	0.7	22	1
22576	NOISLMTR	69	1	42.7	22	1
22660	POINTLMA	69	1	16.7	22	1
22660	POINTLMA	69	2	1.6	22	1
51143	VLG .6G1	0.6	1	1	50	1
51143	VLG .6G1	0.6	2	1	50	1
22172	DIVISION	69	1	34.4	22	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
65386	BRIDGER1	22	1	555	65	1
70105	CHEROK3	20	C3	146.6	70	1
	5% Imbalance =	8,228.56	**MW total =**	8374.7	**# units =**	41

10% Gen loss units: 2015 Heavy Summer - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
37581	SPRINGCR	13.8	1	82	30	1
37581	SPRINGCR	13.8	2	82	30	1
60417	HIGHMESA	0.6	1	10	60	1
45124	COPCO 1	69	1	7.5	40	1
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
43407	PELTON	13.8	1	90	40	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
65191	BONANZA	24	1	488	65	1
61811	MINIDOKA	2.4	6	2	60	1
61811	MINIDOKA	2.4	7	4	60	1
61812	MINIDOKA	4.16	8	8	60	1
61812	MINIDOKA	4.16	9	9	60	1
54424	KEEP#2GN	19	2A	392.8	54	1
50496	GMS 13G2	13.8	2	260	50	1
50497	GMS 13G3	13.8	3	260	50	1
50513	PCN 13G1	13.8	1	160	50	1
50514	PCN 13G2	13.8	2	160	50	1
31832	SLY.CR.	6.6	1	9.5	30	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
22704	SAMPSON	12.5	1	0.7	22	1
22576	NOISLMTR	69	1	42.7	22	1
22660	POINTLMA	69	1	16.7	22	1
22660	POINTLMA	69	2	1.6	22	1
51143	VLG .6G1	0.6	1	1	50	1
51143	VLG .6G1	0.6	2	1	50	1
22172	DIVISION	69	1	34.4	22	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
15981	NAVAJO 1	26	1	805	14	1

70777	COMAN_3	27	C3	780	70	1
40293	COULEE20	15	1	600	40	1
40295	COULEE21	15	1	598	40	1
65386	BRIDGER1	22	1	555	65	1
65388	BRIDGER3	22	1	555	65	1
65387	BRIDGER2	22	1	554	65	1
70310	PAWNEE	22	C1	505	70	1
73129	MBPP-1	24	1	396.2	73	1
	10% MW =	16,457.11	**MW total =**	16571.5	**# units =**	51

15% Gen loss units: 2015 Heavy Summer -WECC Island

BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
37581	SPRINGCR	13.8	1	82	30	1
37581	SPRINGCR	13.8	2	82	30	1
60417	HIGHMESA	0.6	1	10	60	1
45124	COPCO 1	69	1	7.5	40	1
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
43407	PELTON	13.8	1	90	40	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
65191	BONANZA	24	1	488	65	1
61811	MINIDOKA	2.4	6	2	60	1
61811	MINIDOKA	2.4	7	4	60	1
61812	MINIDOKA	4.16	8	8	60	1
61812	MINIDOKA	4.16	9	9	60	1
54424	KEEP#2GN	19	2A	392.8	54	1
50496	GMS 13G2	13.8	2	260	50	1
50497	GMS 13G3	13.8	3	260	50	1
50513	PCN 13G1	13.8	1	160	50	1
50514	PCN 13G2	13.8	2	160	50	1
31832	SLY.CR.	6.6	1	9.5	30	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
22704	SAMPSON	12.5	1	0.7	22	1
22576	NOISLMTR	69	1	42.7	22	1

22660	POINTLMA	69	1	16.7	22	1
22660	POINTLMA	69	2	1.6	22	1
51143	VLG .6G1	0.6	1	1	50	1
51143	VLG .6G1	0.6	2	1	50	1
22172	DIVISION	69	1	34.4	22	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
15981	NAVAJO 1	26	1	805	14	1
70777	COMAN_3	27	C3	780	70	1
40293	COULEE20	15	1	600	40	1
40295	COULEE21	15	1	598	40	1
65386	BRIDGER1	22	1	555	65	1
65388	BRIDGER3	22	1	555	65	1
65387	BRIDGER2	22	1	554	65	1
70310	PAWNEE	22	C1	505	70	1
73130	MBPP-2	24	1	500	73	1
26039	INTERM1G	26	1	950	26	1
15982	NAVAJO 2	26	1	804.5	14	1
623504	COLSTRIP GN4	26	1	805	62	1
65500	EHUNTR 3	22	1	500	65	1
65795	HUNTN G1	22	1	495	65	1
10321	SJUAN_G4	22	1	492.2	10	1
79017	CRAIG 3	22	1	479	73	1
24005	ALAMT5 G	20	5	475	24	1
72500	SPR GEN3	21	1	458	73	1
50637	MCA 16G1	16	1	450	50	1
50638	MCA 16G2	16	2	450	50	1
14914	FCNGN4CC	22	H	433	14	1
15971	CORONAD1	22	1	420	14	1
76404	DRYFORK	19	1	420	73	1
24123	REDON7 G	20	7	470	24	1
	15% MW =	24,685.67	**MW total =**	24777	**# units =**	66

20% Gen loss units: 2015 Heavy Summer - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
60032	TUANAGEN	0.69	1	25	60	1
73341	NSS2	13.8	2	93	73	1
79162	CRYSTAL	12.5	1	17	73	1
65021	MAGCORP	13.8	1	10.5	65	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1

37581	SPRINGCR	13.8	1	82	30	1
37581	SPRINGCR	13.8	2	82	30	1
60417	HIGHMESA	0.6	1	10	60	1
45124	COPCO 1	69	1	7.5	40	1
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
43407	PELTON	13.8	1	36.8	40	1
43407	PELTON	13.8	1	26.6	40	1
43407	PELTON	13.8	1	26.6	40	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
65191	BONANZA	24	1	488	65	1
61811	MINIDOKA	2.4	6	2	60	1
61811	MINIDOKA	2.4	7	4	60	1
61812	MINIDOKA	4.16	8	8	60	1
61812	MINIDOKA	4.16	9	9	60	1
54424	KEEP#2GN	19	2A	392.8	54	1
50496	GMS 13G2	13.8	2	260	50	1
50497	GMS 13G3	13.8	3	260	50	1
50513	PCN 13G1	13.8	1	160	50	1
50514	PCN 13G2	13.8	2	160	50	1
31832	SLY.CR.	6.6	1	9.5	30	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
22704	SAMPSON	12.5	1	0.7	22	1
22576	NOISLMTR	69	1	42.7	22	1
22660	POINTLMA	69	1	16.7	22	1
22660	POINTLMA	69	2	1.6	22	1
51143	VLG .6G1	0.6	1	1	50	1
51143	VLG .6G1	0.6	2	1	50	1
22172	DIVISION	69	1	34.4	22	1
80594	FKR G1-3	13.8	2	13.2	50	1
80594	FKR G1-3	13.8	1	13.2	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1

50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
65430	DAVEJON1	13.8	1	104	65	1
65435	DAVEJON2	13.8	1	104	65	1
65440	DAVEJON3	13.8	1	228	65	1
65445	DAVEJON4	22	1	338	65	1
31906	COLEMAN	6.6	1	10	30	1
31465	WHEELBR1	9.1	2	16	30	1
31465	WHEELBR1	9.1	3	16	30	1
31465	WHEELBR1	9.1	1	16	30	1
40361	DWOR 1	13.8	1	91.7	40	1
56405	CONKLIN2	13.8	1	71.1	54	1
57405	CONKLIN4	13.8	2	71.6	54	1
65953	MATHNTON	138	1	0	65	
57249	LNGLKCG1	13.8	G1	78.3	54	1
56249	LNGLKCG2	13.8	G2	78.3	54	1
65625	GEMST G1	13.8	1	10	65	1
57264	HORUP7	13.8	G1	70.7	54	1
623541	MONTANA ONE	13.8	1	38	62	1
50918	AKO 25G1	25.2	1	3.5	50	1
50642	WHN 4G	4.33	1	1.6	50	1
24026	CIMGEN	13.8	D1	25.3	24	1
50294	VIT 12C1	12.7	1	0	50	
50295	VIT 12C2	12.7	2	0	50	
50296	VIT 12C3	12.6	3	0	50	
50297	VIT 12C4	12.6	4	0	50	
27117	WTGCP	0.69	1	40	26	1
27119	WTGGE	0.57	GE	20	26	1
27123	WTGGE2	0.57	1	20	26	1
24140	SIMPSON	13.8	D1	37	24	1
50502	GMS 13G8	13.8	8	280	50	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
15981	NAVAJO 1	26	1	805	14	1
40293	COULEE20	15	1	600	40	1
40295	COULEE21	15	1	598	40	1
65386	BRIDGER1	22	1	555	65	1
65388	BRIDGER3	22	1	555	65	1
65387	BRIDGER2	22	1	554	65	1
70310	PAWNEE	22	C1	505	70	1
26039	INTERM1G	26	1	950	26	1
26040	INTERM2G	26	2	950	26	1
15982	NAVAJO 2	26	1	804.5	14	1

623504	COLSTRIP GN4	26	1	805	62	1
65500	EHUNTR 3	22	1	500	65	1
65795	HUNTN G1	22	1	495	65	1
10321	SJUAN_G4	22	1	492.2	10	1
24005	ALAMT5 G	20	5	475	24	1
72500	SPR GEN3	21	1	458	73	1
50637	MCA 16G1	16	1	450	50	1
50638	MCA 16G2	16	2	450	50	1
14914	FCNGN4CC	22	H	433	14	1
15971	CORONAD1	22	1	420	14	1
76404	DRYFORK	19	1	420	73	1
54490	GENES 39	22	3	417.4	54	1
70105	CHEROK3	20	C3	146.6	70	1
79015	CRAIG 1	22	1	451	73	1
34600	HELMS 1	18	1	404	30	1
29041	IEEC-G1	19.5	1	400	24	1
15983	NAVAJO 3	26	1	805	14	1
43047	BOARD F	24	1	580	40	1
66730	WYODAK 1	22	1	380	65	1
10320	SJUAN_G3	22	1	544	10	1
70106	CHEROK4	22	C4	360	70	1
70120	COMAN_2	24	C2	360	70	1
34604	HELMS 3	18	1	369	30	1
70350	RAWHIDE	24	C1	300	70	1
14902	CHOLLA3	22	1	299	14	1
22240	ENCINA 4	22	1	290	22	1
70409	ST.VRAIN	22	G1	280	70	1
79016	CRAIG 2	22	1	451	73	1
	20% MW =	32,914.22	**MW total =**	33146.6	**# units =**	91

25% Gen loss units: 2015 Heavy Summer - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
60032	TUANAGEN	0.69	1	25	60	1
73341	NSS2	13.8	2	93	73	1
79162	CRYSTAL	12.5	1	17	73	1
65021	MAGCORP	13.8	1	10.5	65	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
37581	SPRINGCR	13.8	1	82	30	1
37581	SPRINGCR	13.8	2	82	30	1
60417	HIGHMESA	0.6	1	10	60	1
45124	COPCO 1	69	1	7.5	40	1
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1

32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
43407	PELTON	13.8	1	36.8	40	1
43407	PELTON	13.8	1	26.6	40	1
43407	PELTON	13.8	1	26.6	40	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
65191	BONANZA	24	1	488	65	1
61811	MINIDOKA	2.4	6	2	60	1
61811	MINIDOKA	2.4	7	4	60	1
61812	MINIDOKA	4.16	8	8	60	1
61812	MINIDOKA	4.16	9	9	60	1
54424	KEEP#2GN	19	2A	392.8	54	1
50496	GMS 13G2	13.8	2	260	50	1
50497	GMS 13G3	13.8	3	260	50	1
50513	PCN 13G1	13.8	1	160	50	1
50514	PCN 13G2	13.8	2	160	50	1
31832	SLY.CR.	6.6	1	9.5	30	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
22576	NOISLMTR	69	1	42.7	22	1
22660	POINTLMA	69	1	16.7	22	1
22660	POINTLMA	69	2	1.6	22	1
51143	VLG .6G1	0.6	1	1	50	1
51143	VLG .6G1	0.6	2	1	50	1
22172	DIVISION	69	1	34.4	22	1
80594	FKR G1-3	13.8	2	13.2	50	1
80594	FKR G1-3	13.8	1	13.2	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1
50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
65430	DAVEJON1	13.8	1	104	65	1
65435	DAVEJON2	13.8	1	104	65	1
65440	DAVEJON3	13.8	1	228	65	1
65445	DAVEJON4	22	1	338	65	1
31906	COLEMAN	6.6	1	10	30	1

31465	WHEELBR1	9.1	2	16	30	1
31465	WHEELBR1	9.1	3	16	30	1
31465	WHEELBR1	9.1	1	16	30	1
40361	DWOR 1	13.8	1	91.7	40	1
56405	CONKLIN2	13.8	1	71.1	54	1
57405	CONKLIN4	13.8	2	71.6	54	1
65953	MATHNTON	138	1	0	65	
57249	LNGLKCG1	13.8	G1	78.3	54	1
56249	LNGLKCG2	13.8	G2	78.3	54	1
65625	GEMST G1	13.8	1	10	65	1
57264	HORUP7	13.8	G1	70.7	54	1
623541	MONTANA ONE	13.8	1	38	62	1
50918	AKO 25G1	25.2	1	3.5	50	1
50642	WHN 4G	4.33	1	1.6	50	1
24026	CIMGEN	13.8	D1	25.3	24	1
50294	VIT 12C1	12.7	1	0	50	
50295	VIT 12C2	12.7	2	0	50	
50296	VIT 12C3	12.6	3	0	50	
50297	VIT 12C4	12.6	4	0	50	
27117	WTGCP	0.69	1	40	26	1
27119	WTGGE	0.57	GE	20	26	1
27123	WTGGE2	0.57	1	20	26	1
24140	SIMPSON	13.8	D1	37	24	1
50502	GMS 13G8	13.8	8	280	50	1
50501	GMS 13G7	13.8	7	280	50	1
42014	ENSERCHL	13.8	L	53	40	1
22082	BR GEN1	0.21	1	19	22	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
26039	INTERM1G	26	1	950	26	1
26040	INTERM2G	26	2	950	26	1
15981	NAVAJO 1	26	1	805	14	1
15983	NAVAJO 3	26	1	805	14	1
623504	COLSTRIP GN4	26	1	805	62	1
15982	NAVAJO 2	26	1	804.5	14	1
623503	COLSTRIP GN3	26	1	800.3	62	1
40293	COULEE20	15	1	600	40	1
40295	COULEE21	15	1	598	40	1
43047	BOARD F	24	1	580	40	1
65386	BRIDGER1	22	1	555	65	1
65388	BRIDGER3	22	1	555	65	1
65387	BRIDGER2	22	1	554	65	1
65389	BRIDGER4	22	1	554	65	1

10320	SJUAN_G3	22	1	544	10	1
70310	PAWNEE	22	C1	505	70	1
65500	EHUNTR 3	22	1	500	65	1
51032	REV 16G5	16	5	500	50	1
65795	HUNTN G1	22	1	495	65	1
10321	SJUAN_G4	22	1	492.2	10	1
65800	HUNTN G2	22	1	485	65	1
50644	REV 13G1	16	1	480	50	1
24005	ALAMT5 G	20	5	475	24	1
65490	EHUNTR 1	24	1	474	65	1
65495	EHUNTR 2	24	1	474	65	1
54403	KEEP#3GN	22	3	471	54	1
24161	ALAMT6 G	20	6	470	24	1
24123	REDON7 G	20	7	470	24	1
24124	REDON8 G	20	8	470	24	1
72500	SPR GEN3	21	1	458	73	1
79015	CRAIG 1	22	1	451	73	1
79016	CRAIG 2	22	1	451	73	1
50637	MCA 16G1	16	1	450	50	1
50638	MCA 16G2	16	2	450	50	1
50639	MCA 16G3	16	3	450	50	1
50640	MCA 16G4	16	4	450	50	1
50647	REV 13G4	16	4	450	50	1
51125	MCA 16G5	16	5	449.7	50	1
14914	FCNGN4CC	22	H	433	14	1
14915	FCNGN5CC	22	H	433	14	1
16519	SPR GEN4	21	1	430	14	1
15971	CORONAD1	22	1	420	14	1
76404	DRYFORK	19	1	420	73	1
16500	SPR GEN1	19	1	419	14	1
16501	SPR GEN2	19	1	419	14	1
54490	GENES 39	22	3	417.4	54	1
14903	CHOLLA4	22	1	412	14	1
15972	CORONAD2	22	1	410	14	1
34600	HELMS 1	18	1	404	30	1
29042	IEEC-G2	19.5	2	400	24	1
38951	TBC_POT2	180.5	1	400	30	1
65391	CURRNTC1	18	1	142	65	1
65392	CURRNTC2	18	1	142	65	1
65393	CURRNTS1	18	1	245	65	1
	25% MW =	41,142.78	**MW total =**	41613.3	**# units =**	140

5% Gen loss units: 2015 Heavy Spring - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
31906	COLEMAN	6.6	1	11	30	1
80416	DSQ 7G	6.9	1	0.4	50	1
80594	FKR G1-3	13.8	1	13.1	50	1
80594	FKR G1-3	13.8	2	13.1	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1
50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
65021	MAGCORP	13.8	1	10.5	65	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
40361	DWOR 1	13.8	1	91.7	40	1
50641	KLY 12C1	12.5	1	0	50	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
65386	BRIDGER1	22	1	550	65	1
	5% Imbalance =	6,800.99	**MW total =**	6919.4	**# units =**	25

10% Gen loss units: 2015 Heavy Spring - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
31906	COLEMAN	6.6	1	11	30	1
80416	DSQ 7G	6.9	1	0.4	50	1
80594	FKR G1-3	13.8	1	13.1	50	1
80594	FKR G1-3	13.8	2	13.1	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1
50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
65021	MAGCORP	13.8	2	10.5	65	1

65021	MAGCORP	13.8	3	10.5	65	1
65021	MAGCORP	13.8	1	10.5	65	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
40361	DWOR 1	13.8	1	91.7	40	1
50641	KLY 12C1	12.5	1	0	50	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
40296	COULEE22	15	1	648	40	1
40291	COULEE19	15	1	600	40	1
40293	COULEE20	15	1	600	40	1
70777	COMAN_3	27	C3	600	70	1
40295	COULEE21	15	1	598	40	1
65386	BRIDGER1	22	1	550	65	1
65387	BRIDGER2	22	1	550	65	1
65388	BRIDGER3	22	1	550	65	1
	10% MW =	13,601.98	**MW total =**	13639.6	**# units =**	35

15% Gen loss units: 2015 Heavy Spring - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
31906	COLEMAN	6.6	1	11	30	1
80416	DSQ 7G	6.9	1	0.4	50	1
80594	FKR G1-3	13.8	1	13.1	50	1
80594	FKR G1-3	13.8	2	13.1	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1
50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
65021	MAGCORP	13.8	1	10.5	65	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1

40361	DWOR 1	13.8	1	91.7	40	1
50641	KLY 12C1	12.5	1	0	50	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
26039	INTERM1G	26	1	925	26	1
26040	INTERM2G	26	2	925	26	1
15981	NAVAJO 1	26	1	805	14	1
623504	COLSTRIP GN4	26	1	805	62	1
15982	NAVAJO 2	26	1	804	14	1
623503	COLSTRIP GN3	26	1	794.5	62	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
40297	COULEE23	15	1	697.7	40	1
40298	COULEE24	15	1	697.7	40	1
40296	COULEE22	15	1	648	40	1
40291	COULEE19	15	1	600	40	1
40293	COULEE20	15	1	600	40	1
70777	COMAN_3	27	C3	600	70	1
40295	COULEE21	15	1	598	40	1
65386	BRIDGER1	22	1	550	65	1
19313	GRIFFTH3	18	3	250	14	1
	15% MW =	20,402.97	**MW total =**	20443.5	**# units =**	43

20% Gen loss units: 2015 Heavy Spring - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
31906	COLEMAN	6.6	1	11	30	1
80416	DSQ 7G	6.9	1	0.4	50	1
80594	FKR G1-3	13.8	1	13.1	50	1
80594	FKR G1-3	13.8	2	13.1	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1
50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
65021	MAGCORP	13.8	1	10.5	65	1

29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
40361	DWOR 1	13.8	1	91.7	40	1
50641	KLY 12C1	12.5	1	0	50	1
31460	0105-WD	115	FW	5.5	30	1
31465	WHEELBR1	9.1	3	16.6	30	1
31465	WHEELBR1	9.1	1	16.6	30	1
31465	WHEELBR1	9.1	2	16.6	30	1
31824	VOLTA1-2	9.11	1	7	30	1
31824	VOLTA1-2	9.11	2	0.7	30	1
31826	SOUTH G	4.16	1	7	30	1
60036	BLISS 1	13.8	1	24	60	1
60037	BLISS 2	13.8	1	16	60	1
60201	L SAMN 1	13.8	1	16	60	1
60202	L SAMN 2	13.8	1	16	60	1
60246	MILNER	13.8	1	14	60	1
60246	MILNER	13.8	2	9	60	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
26039	INTERM1G	26	1	925	26	1
15981	NAVAJO 1	26	1	805	14	1
15983	NAVAJO 3	26	1	805	14	1
623504	COLSTRIP GN4	26	1	805	62	1
15982	NAVAJO 2	26	1	804	14	1
623503	COLSTRIP GN3	26	1	794.5	62	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
40297	COULEE23	15	1	697.7	40	1
40298	COULEE24	15	1	697.7	40	1
40296	COULEE22	15	1	648	40	1
40291	COULEE19	15	1	600	40	1
70777	COMAN_3	27	C3	600	70	1
65386	BRIDGER1	22	1	550	65	1
65387	BRIDGER2	22	1	550	65	1
65388	BRIDGER3	22	1	550	65	1
65389	BRIDGER4	22	1	550	65	1
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	516.7	10	1
54490	GENES 39	22	3	474.7	54	1

54403	KEEP#3GN	22	3	468.7	54	1
65490	EHUNTR 1	24	1	460	65	1
65495	EHUNTR 2	24	1	460	65	1
79015	CRAIG 1	22	1	451	73	1
79016	CRAIG 2	22	1	451	73	1
50639	MCA 16G3	16	3	444.7	50	1
50637	MCA 16G1	16	1	443.4	50	1
72500	SPR GEN3	21	1	430	73	1
15971	CORONAD1	22	1	429	14	1
14914	FCNGN4CC	22	H	424.1	14	1
16519	SPR GEN4	21	1	420	14	1
34600	HELMS 1	18	1	404	30	1
65191	BONANZA	24	1	250	65	1
66730	WYODAK 1	22	1	375	65	1
	20% MW =	27,203.96	**MW total =**	27279.8	**# units =**	75

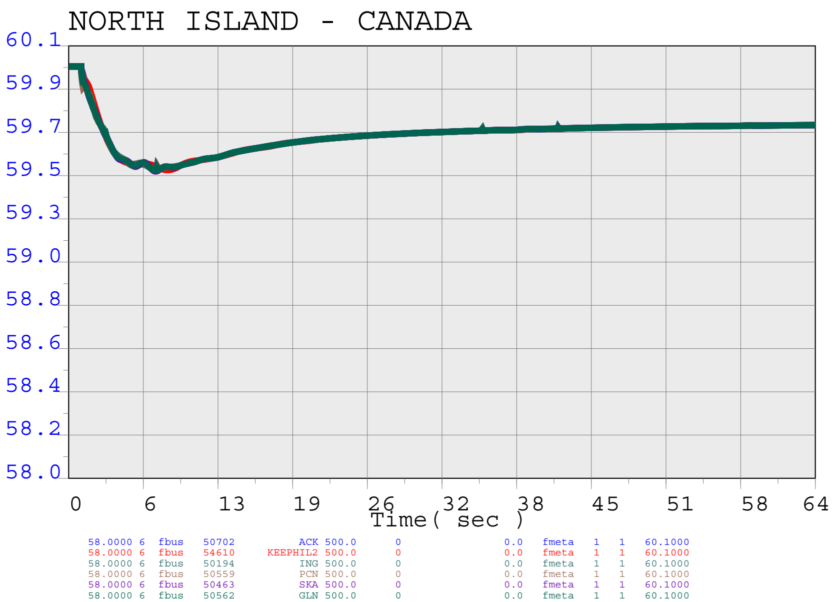
25% Gen loss units: 2015 Heavy Spring - WECC Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
43407	PELTON	13.8	1	36.8	40	1
43407	PELTON	13.8	2	26.6	40	1
43407	PELTON	13.8	3	26.6	40	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
65021	MAGCORP	13.8	1	10.5	65	1
79162	CRYSTAL	12.5	1	15	73	1
60032	TUANAGEN	0.69	1	50	60	1
35040	KERNRDGE	9.11	1	40	30	1
35040	KERNRDGE	9.11	2	1	30	1
33171	TRSVQ+NW	9.11	1	14.7	30	1
33171	TRSVQ+NW	9.11	2	8.4	30	1
36413	UNION OL	13.8	1	5.3	30	1
32740	HILLSIDE	115	1	25.7	30	1
27358	GRAY_8BC	13.8	8b	36.5	26	1
60417	HIGHMESA	0.6	1	10	60	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	204	30	1
33119	GATEWAY2	18	1	192.6	30	1
33120	GATEWAY3	18	1	192.6	30	1
31906	COLEMAN	6.6	1	11	30	1
80416	DSQ 7G	6.9	1	0.4	50	1

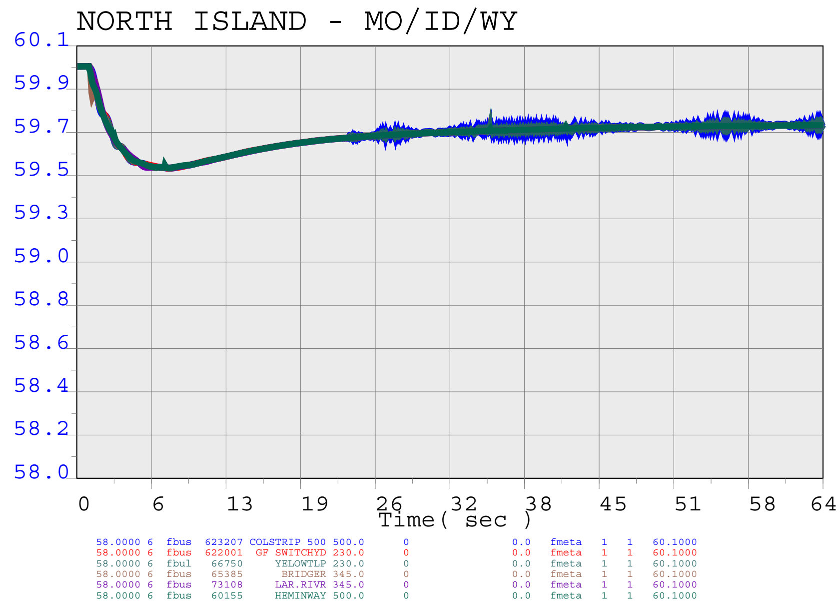
61811	MINIDOKA	2.4	7	4	60	1
61811	MINIDOKA	2.4	6	2	60	1
61812	MINIDOKA	4.16	9	9	60	1
61812	MINIDOKA	4.16	8	8	60	1
80594	FKR G1-3	13.8	1	13.1	50	1
80594	FKR G1-3	13.8	2	13.1	50	1
50437	KMO 13G1	13.8	1	106.2	50	1
50438	KMO 13G2	13.8	2	106.2	50	1
50439	KMO 13G3	13.8	3	106.2	50	1
50440	KMO 13G4	13.8	4	106.2	50	1
50441	KMO 13G5	13.8	5	106.2	50	1
50442	KMO 13G6	13.8	6	106.2	50	1
50443	KMO 13G7	13.8	7	106.2	50	1
50444	KMO 13G8	13.8	8	106.2	50	1
622531	RYAN GEN1-3	6.6	3	9	62	1
622531	RYAN GEN1-3	6.6	1	9	62	1
622531	RYAN GEN1-3	6.6	2	9	62	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
40361	DWOR 1	13.8	1	91.7	40	1
50641	KLY 12C1	12.5	1	0	50	1
31460	0105-WD	115	FW	5.5	30	1
31465	WHEELBR1	9.1	3	16.6	30	1
31465	WHEELBR1	9.1	1	16.6	30	1
31465	WHEELBR1	9.1	2	16.6	30	1
31824	VOLTA1-2	9.11	1	7	30	1
31824	VOLTA1-2	9.11	2	0.7	30	1
31826	SOUTH G	4.16	1	7	30	1
60036	BLISS 1	13.8	1	24	60	1
60037	BLISS 2	13.8	1	16	60	1
60201	L SAMN 1	13.8	1	16	60	1
60202	L SAMN 2	13.8	1	16	60	1
60246	MILNER	13.8	1	14	60	1
60246	MILNER	13.8	2	9	60	1
40015	ADAIR	115	1	5.6	40	1
60353	TWINFALS	13.8	1	19	60	1
60160	HUNT	138	1	45	60	1
31800	SMPSN-AN	12.47	1	42	30	1
623541	MONTANA ONE	13.8	1	40	62	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1199	30	1
40063	CGS	25	1	1151.2	40	1
26039	INTERM1G	26	1	925	26	1

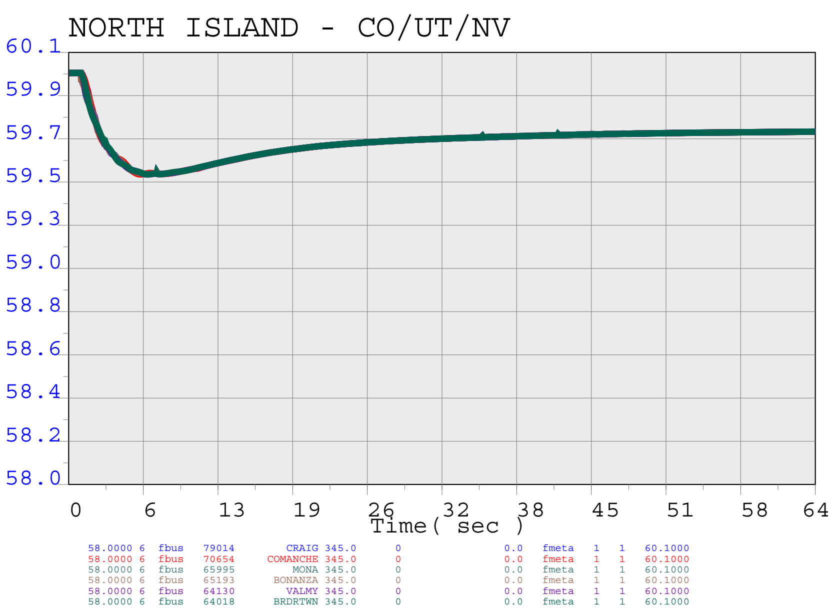
15981	NAVAJO 1	26	1	805	14	1
15983	NAVAJO 3	26	1	805	14	1
623504	COLSTRIP GN4	26	1	805	62	1
15982	NAVAJO 2	26	1	804	14	1
623503	COLSTRIP GN3	26	1	794.5	62	1
47740	CENTR G1	20	1	712	40	1
47744	CENTR G2	20	2	712	40	1
40297	COULEE23	15	1	697.7	40	1
40298	COULEE24	15	1	697.7	40	1
40296	COULEE22	15	1	648	40	1
40291	COULEE19	15	1	600	40	1
65386	BRIDGER1	22	1	550	65	1
65387	BRIDGER2	22	1	550	65	1
65388	BRIDGER3	22	1	550	65	1
65389	BRIDGER4	22	1	550	65	1
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	516.7	10	1
54490	GENES 39	22	3	474.7	54	1
54403	KEEP#3GN	22	3	468.7	54	1
65490	EHUNTR 1	24	1	460	65	1
65495	EHUNTR 2	24	1	460	65	1
79015	CRAIG 1	22	1	451	73	1
79016	CRAIG 2	22	1	451	73	1
50639	MCA 16G3	16	3	444.7	50	1
50637	MCA 16G1	16	1	443.4	50	1
72500	SPR GEN3	21	1	430	73	1
15971	CORONAD1	22	1	429	14	1
14914	FCNGN4CC	22	H	424.1	14	1
16519	SPR GEN4	21	1	420	14	1
34600	HELMS 1	18	1	404	30	1
66730	WYODAK 1	22	1	375	65	1
34602	HELMS 2	18	1	404	30	1
34604	HELMS 3	18	1	369	30	1
29041	IEEC-G1	19.5	1	400	24	1
70310	PAWNEE	22	C1	400	70	1
18407	HIGGINS3	21	1	328	18	1
65191	BONANZA	24	1	250	65	1
55497	BAT #5	21	5	301.6	54	1
70350	RAWHIDE	24	C1	300	70	1
24004	ALAMT4 G	18	4	284.8	24	1
33107	DEC STG1	24	1	280	30	1
50504	GMS13G10	13.8	10	280	50	1
73129	MBPP-1	24	1	279.2	73	1
64131	VALMY G1	22	1	260	64	1
35306	RUSELST1	18	3	254	30	1
65795	HUNTN G1	22	1	250	65	1
65800	HUNTN G2	22	1	250	65	1

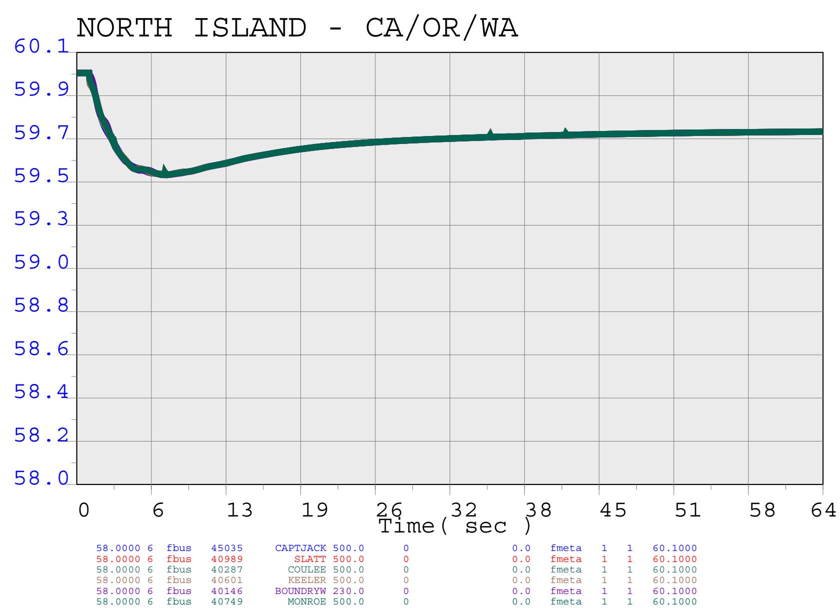
70106	CHEROK4	22	C4	250	70	1
70119	COMAN_1	24	C1	250	70	1
70120	COMAN_2	24	C2	250	70	1
76404	DRYFORK	19	1	250	73	1
15142	DBG-ST1	18	1	240	14	1
64954	TRACYW10	18	1	240	64	1
38825	HYATT 1	12.5	1	88	30	1
	25% MW =	34,004.95	**MW total =**	34071.8	**# units =**	126

WECC ISLAND NORTH BUSES: 2015HS - 5% GENERATION LOSS









Page 1

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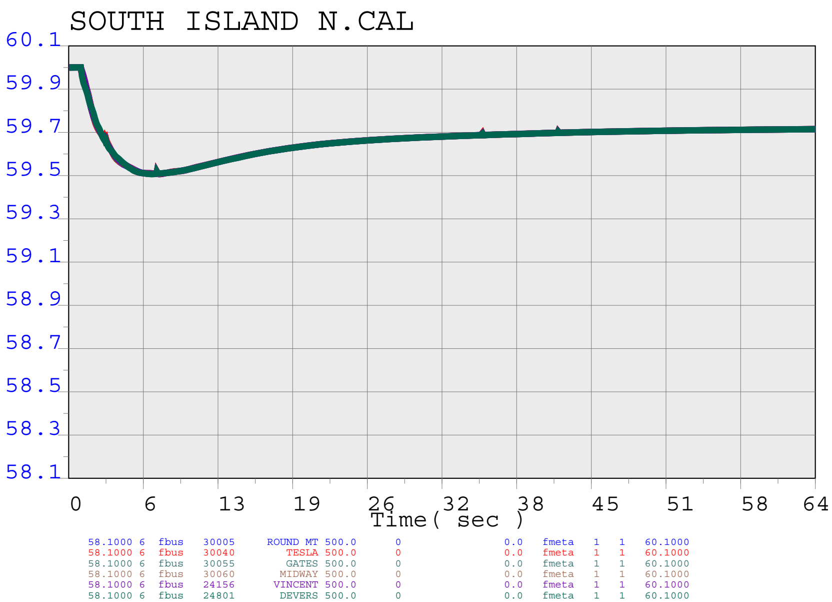
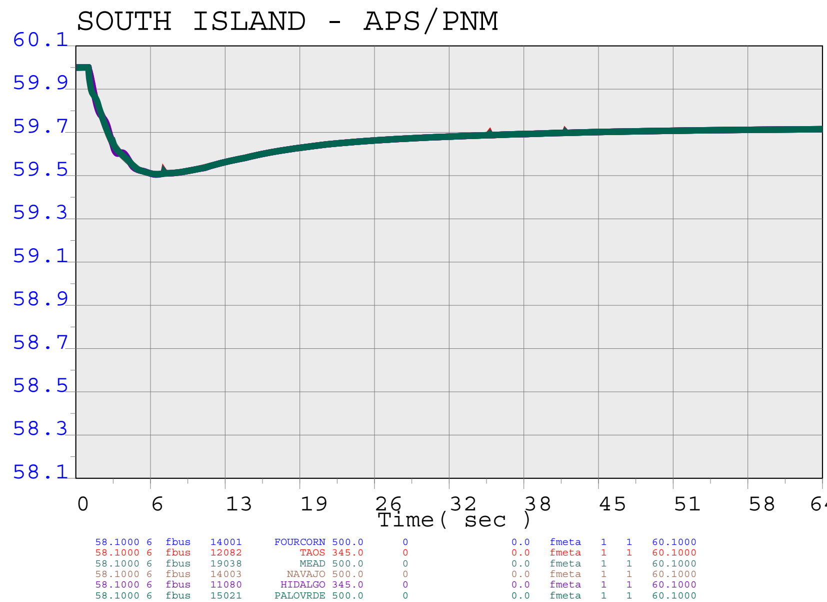
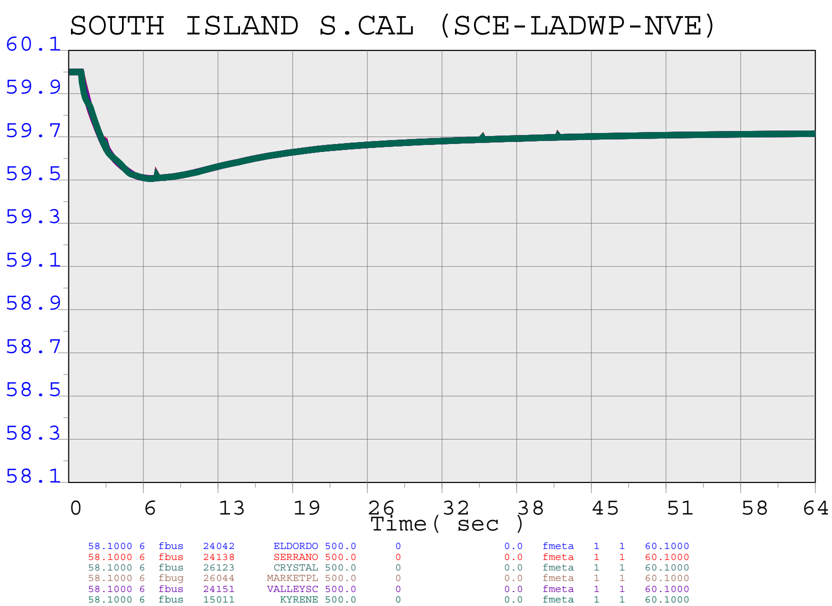
top\Final UFLS\Summer\15h

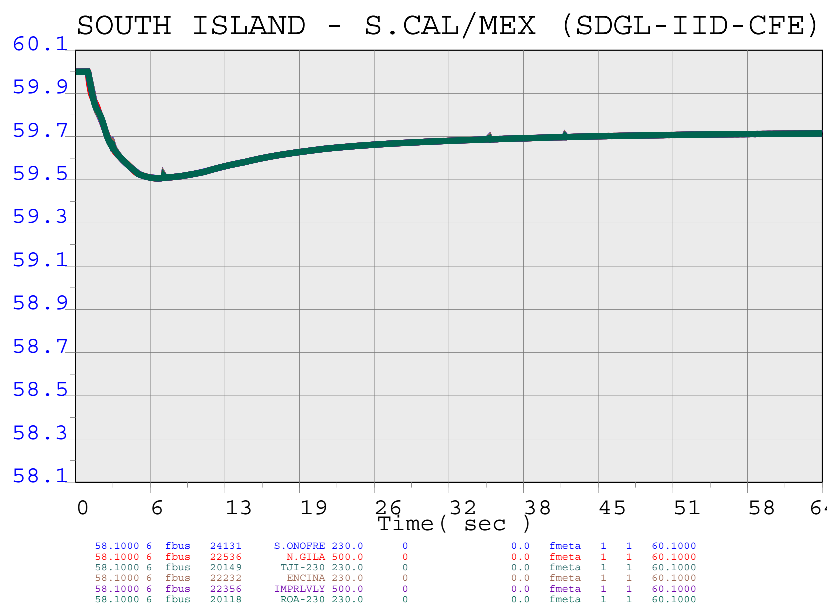
Mon Aug 17 14:45:19 2015

WECC ISLAND SOUTH BUSES: 2015HS - 5% GENERATION LOSS









Page 1

15hs_W_5.chf

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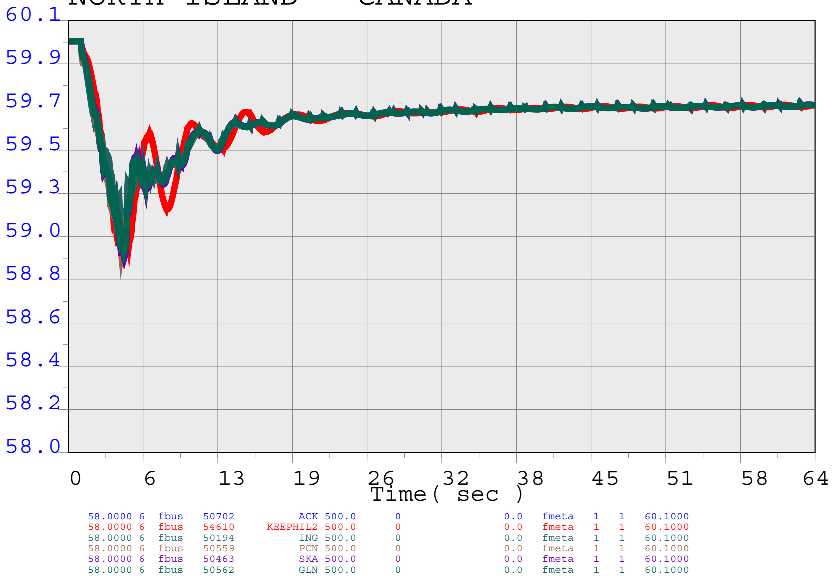
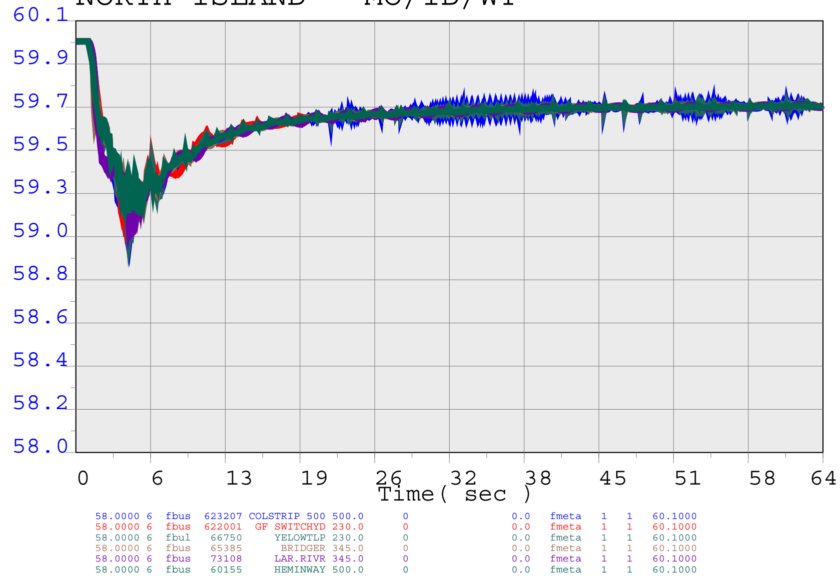
Mon Aug 17 14:51:36 2015

WECC ISLAND NORTH BUSES: 2015HS - 10% GENERATION LOSS

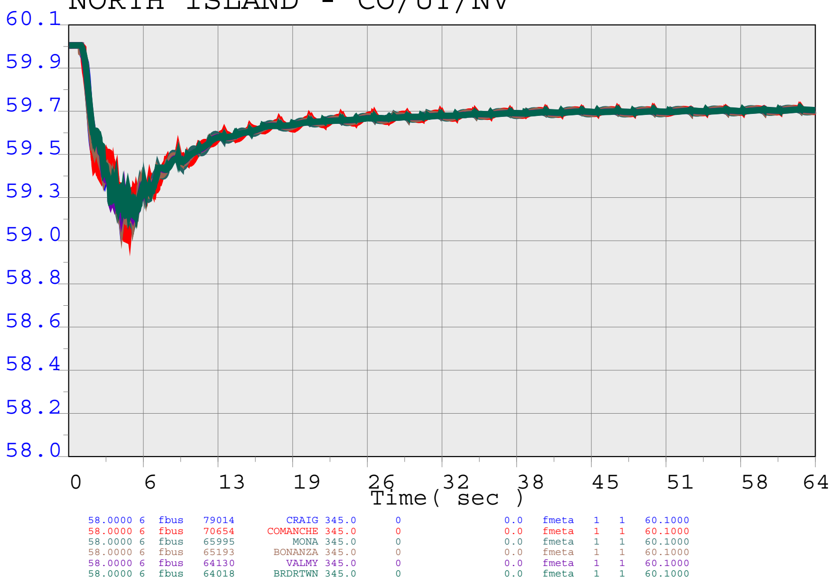
NORTH ISLAND - CANADA



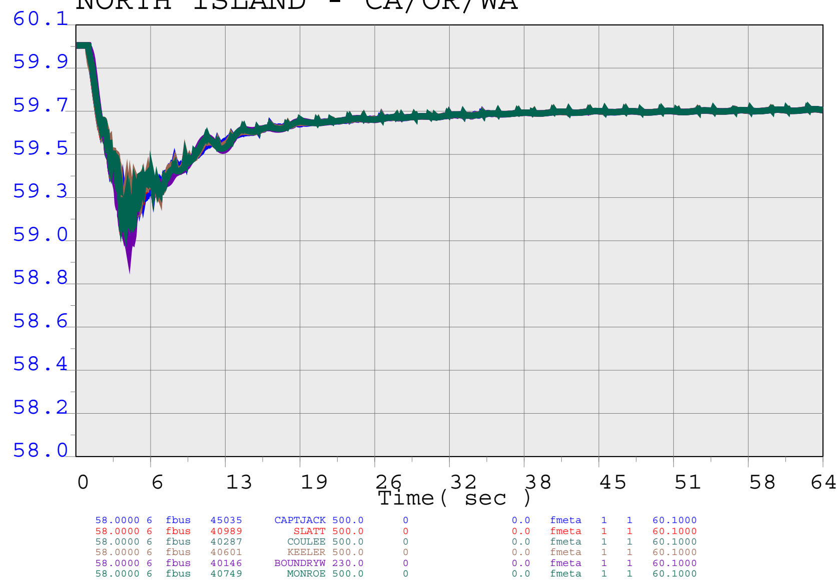
NORTH ISLAND - MO/ID/WY



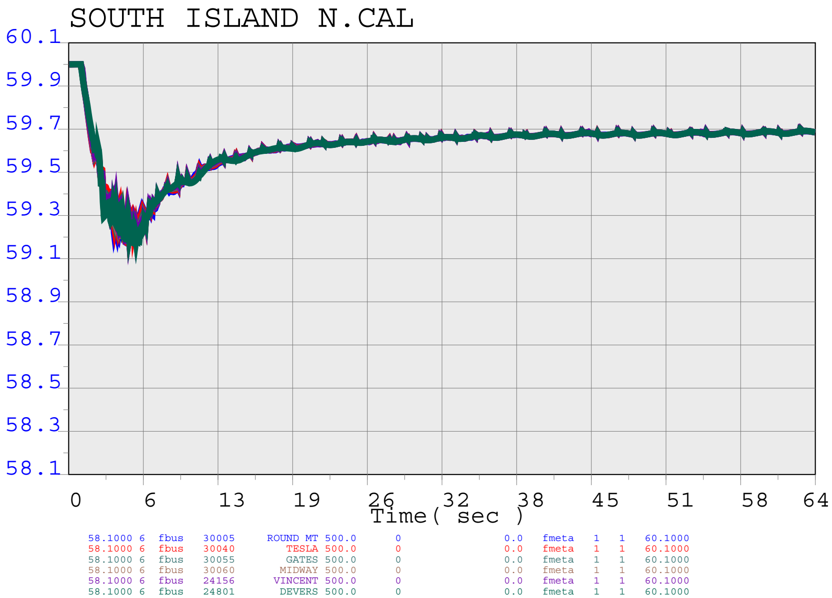
NORTH ISLAND - CO/UT/NV

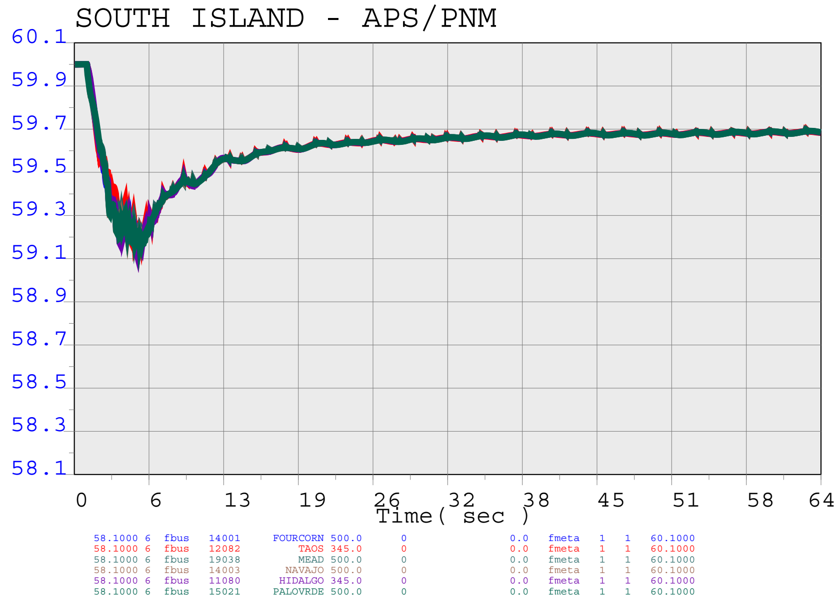


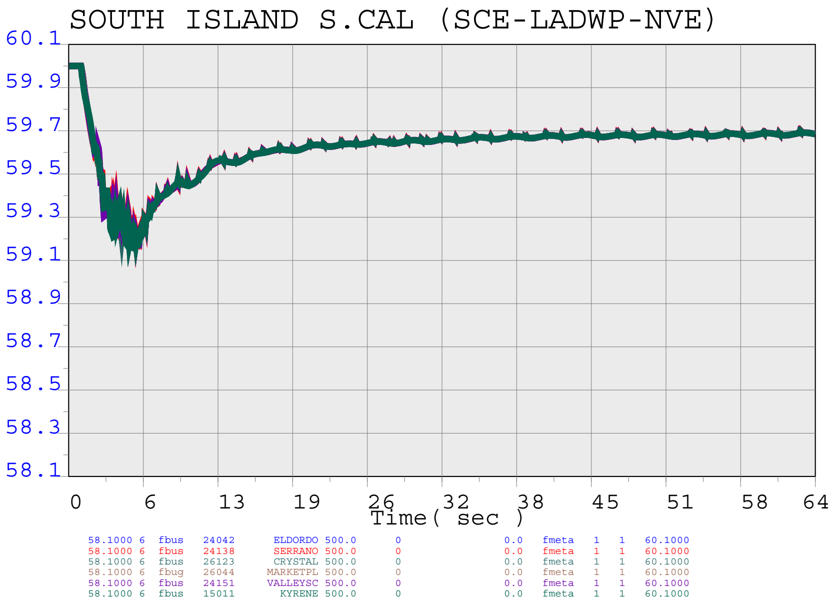
NORTH ISLAND - CA/OR/WA

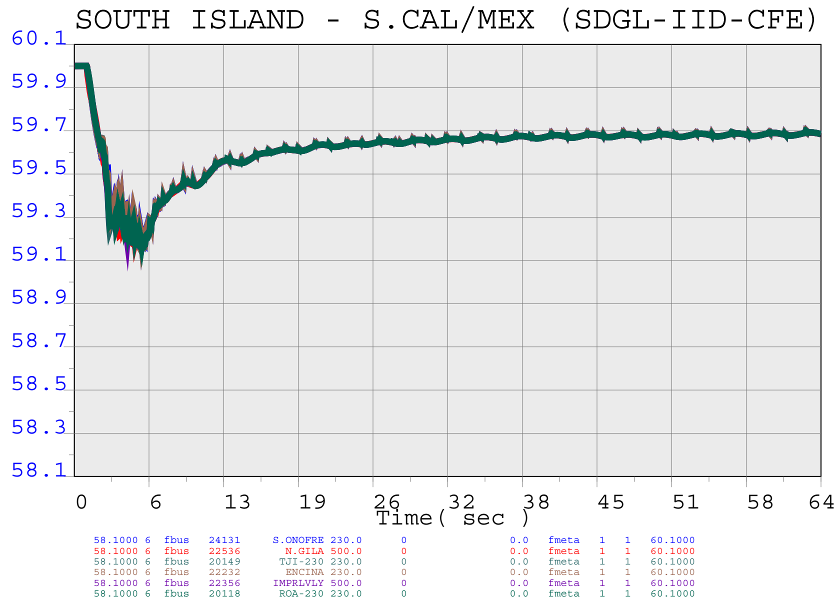


WECC ISLAND SOUTH BUSES: 2015HS - 10% GENERATION LOSS









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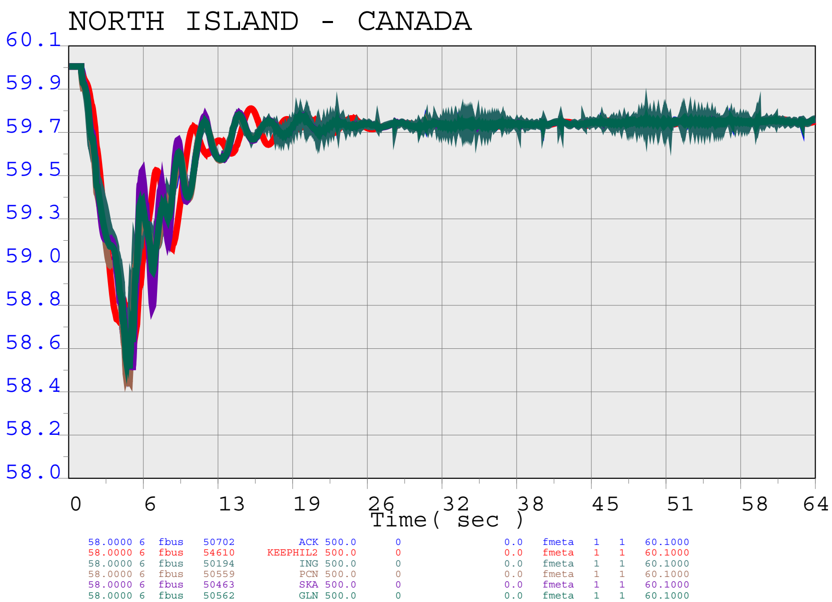
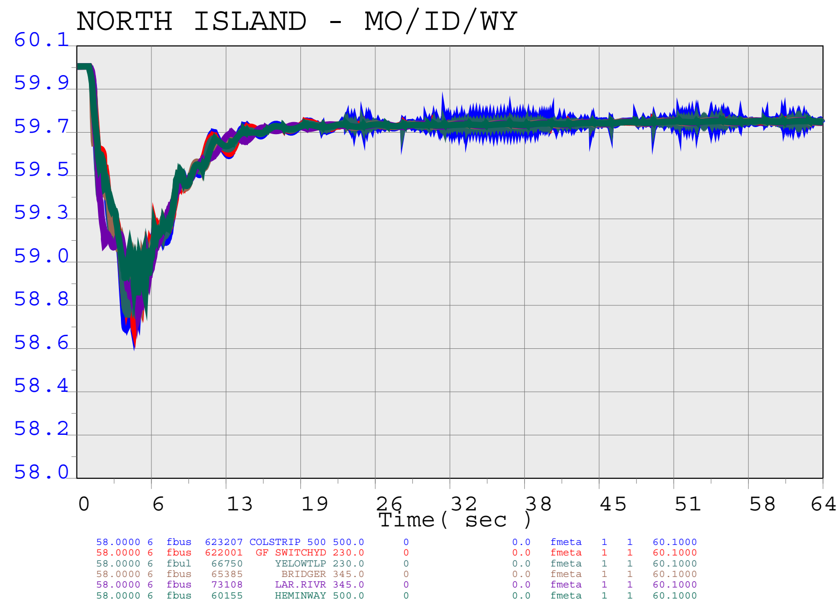
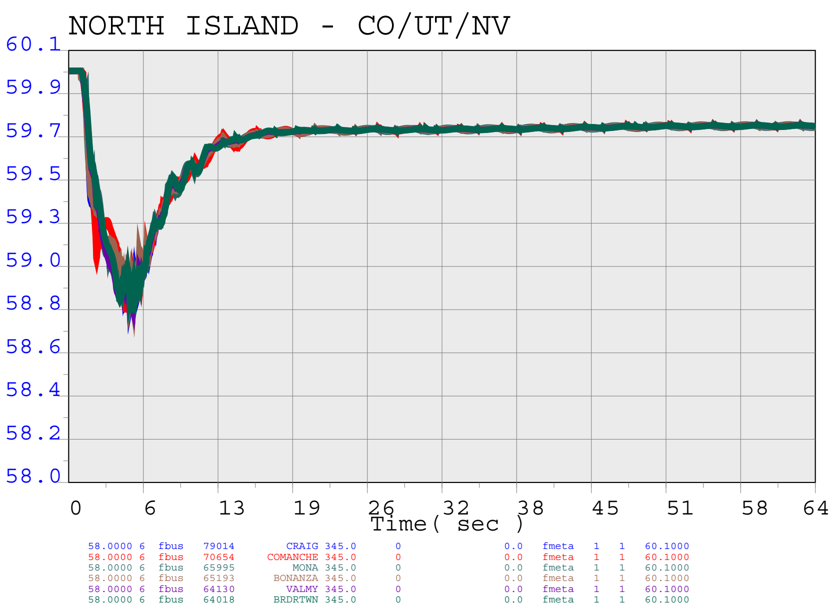
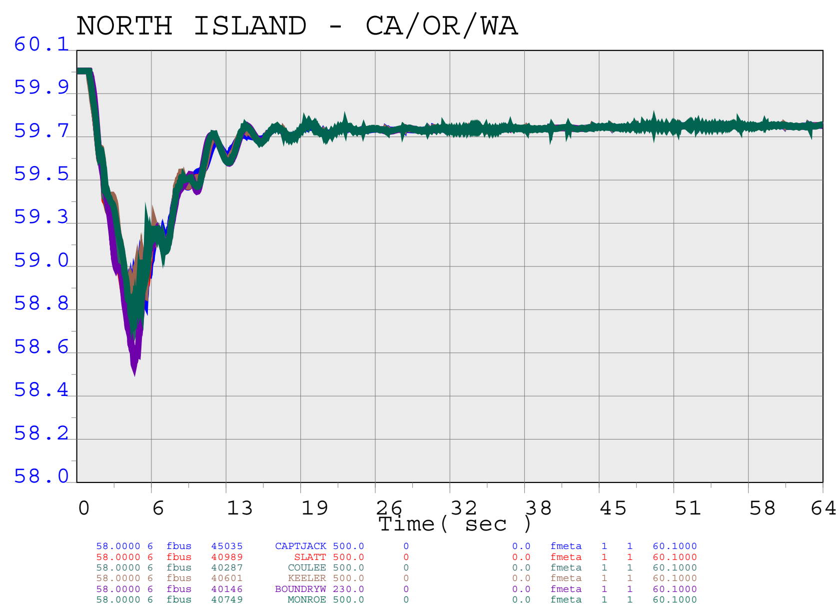
Mon Aug 17 14:52:33 2015

WECC ISLAND NORTH BUSES: 2015HS - 15% GENERATION LOSS









Page 1

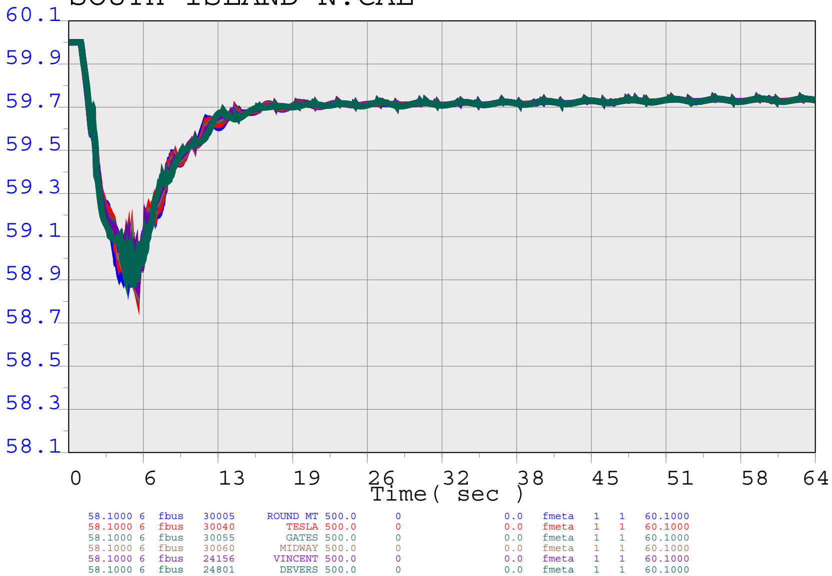
15hs_W_15.chf

top\Final UFLS\Summer\15h

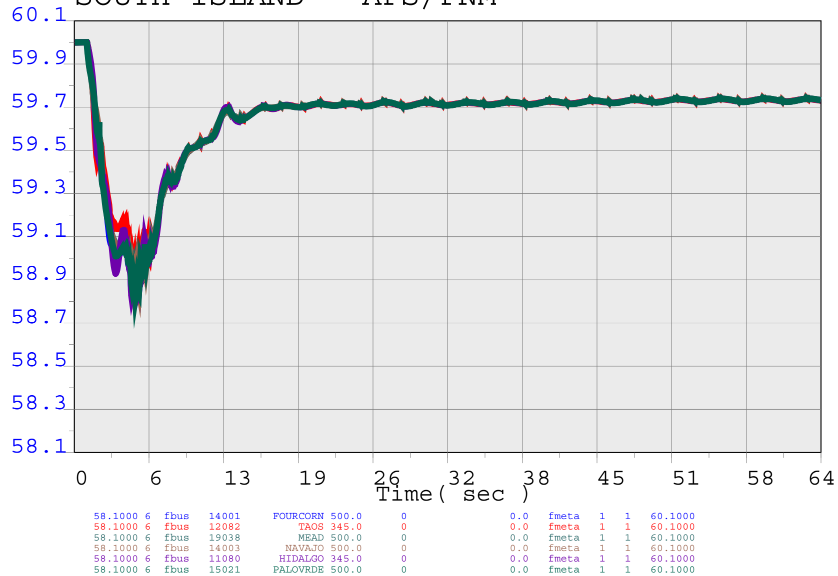
Mon Aug 17 14:39:48 2015

WECC ISLAND SOUTH BUSES: 2015HS - 15% GENERATION LOSS

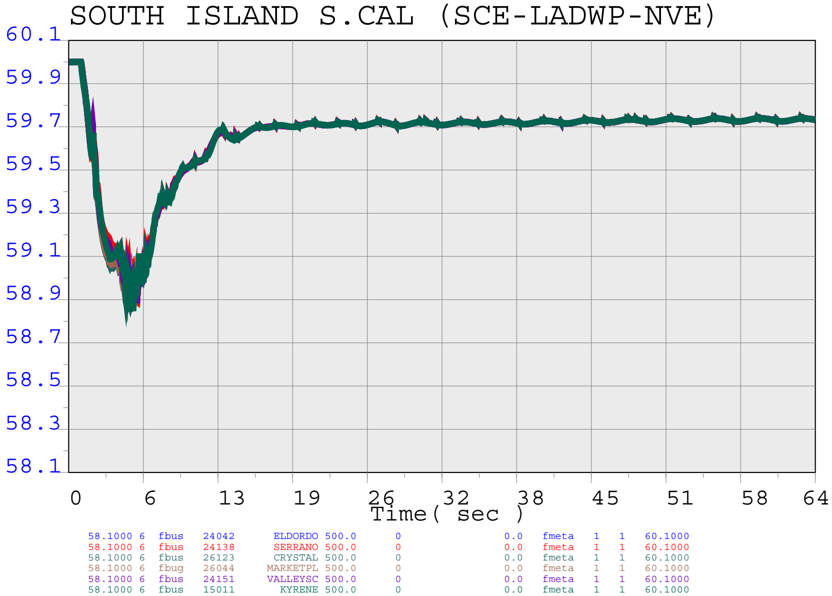
SOUTH ISLAND N.CAL



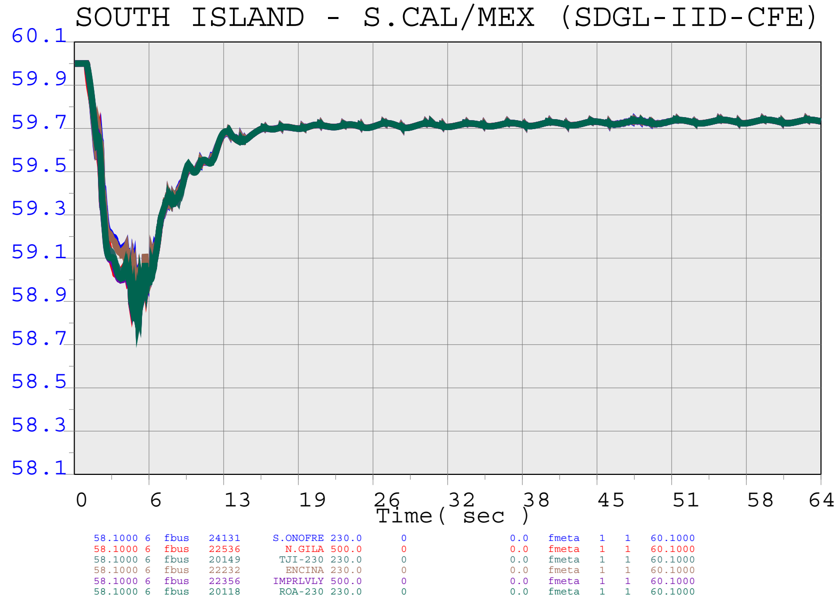
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



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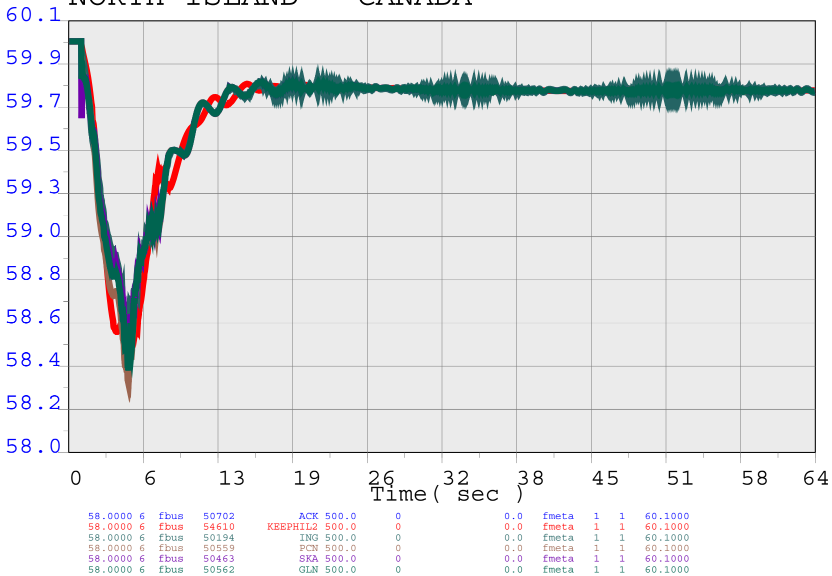
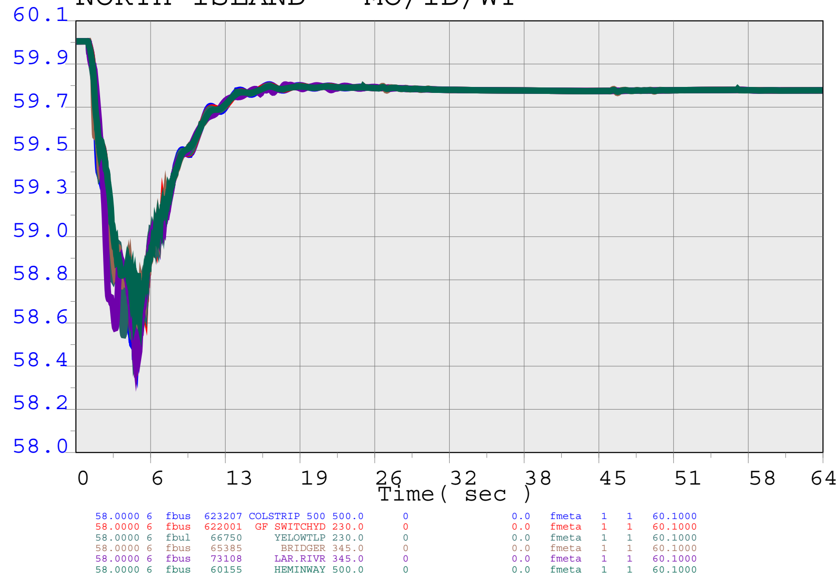
WECC ISLAND NORTH BUSES: 2015HS - 20% GENERATION LOSS

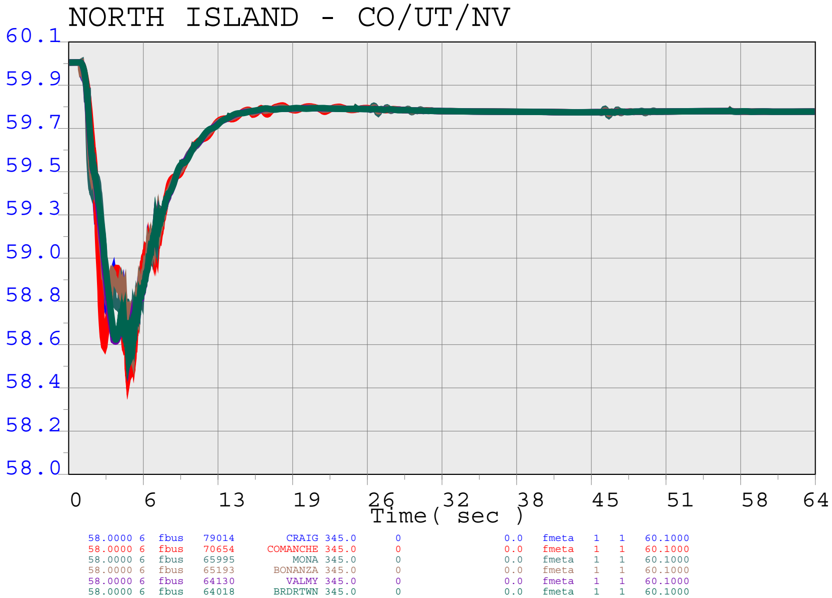
NORTH ISLAND - CANADA



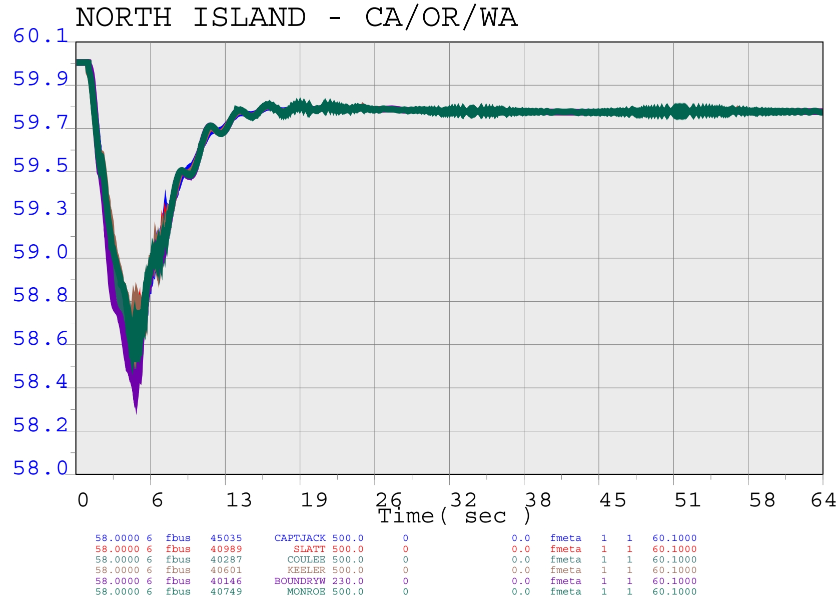
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



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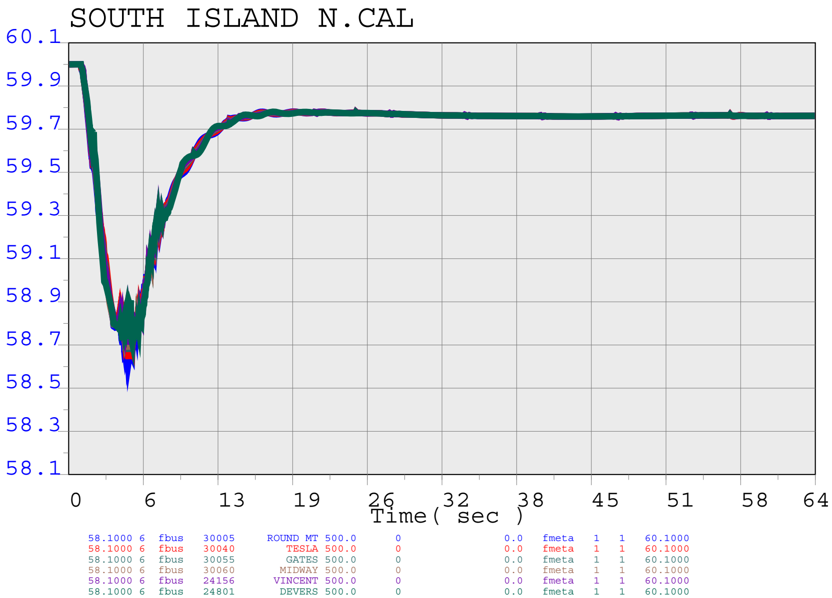
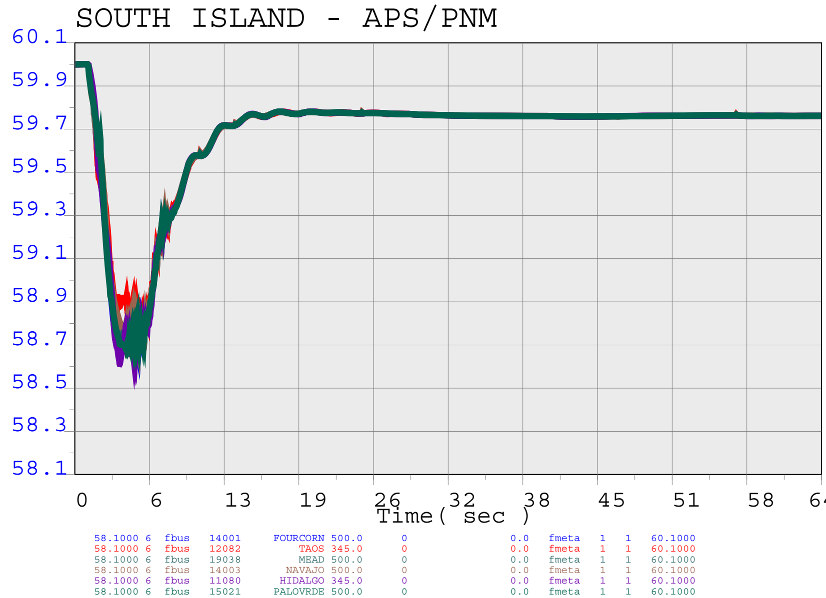
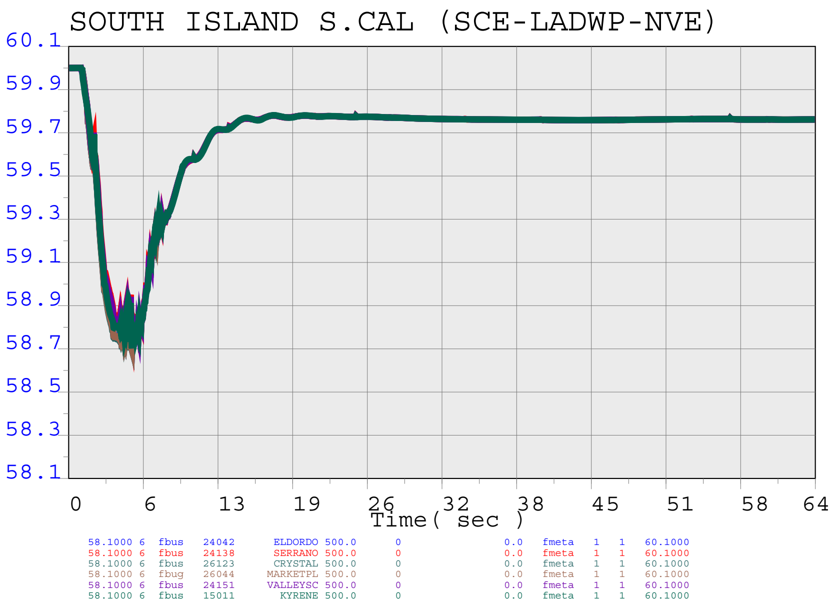
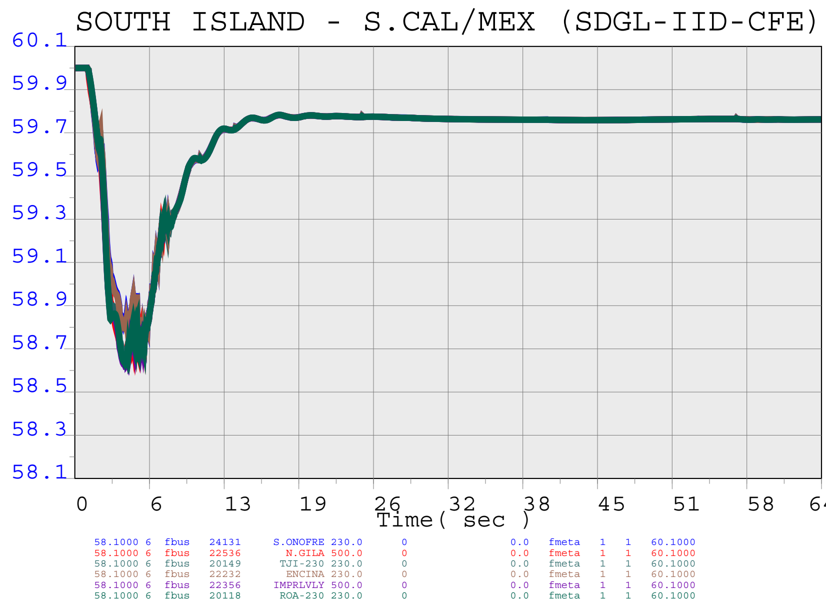
Mon Aug 17 14:35:47 2015

WECC ISLAND SOUTH BUSES: 2015HS - 20% GENERATION LOSS









Page 1

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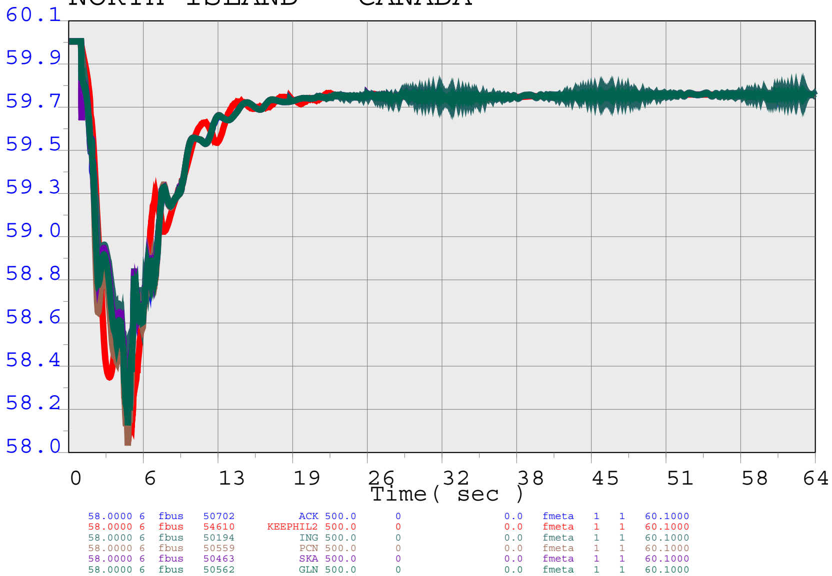
top\Final UFLS\Summer\hs_

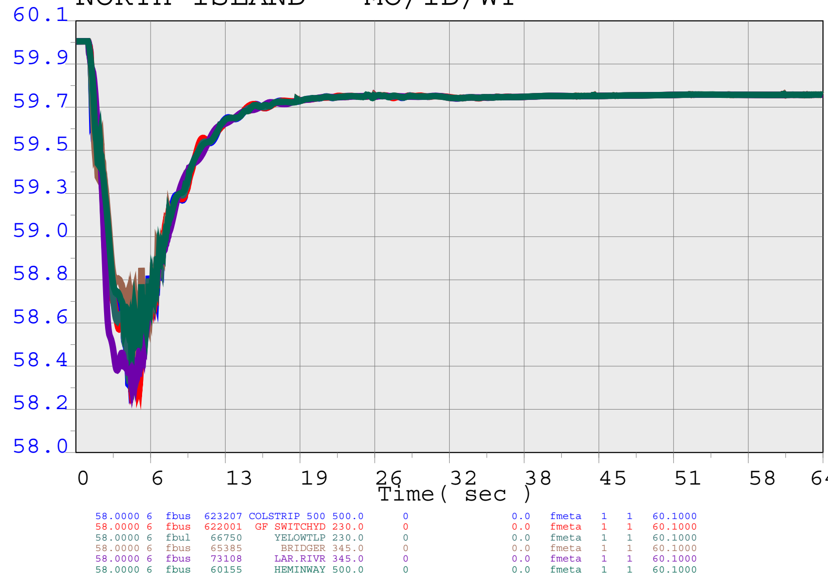
Mon Aug 17 14:54:11 2015

WECC ISLAND NORTH BUSES: 2015HS - 25% GENERATION LOSS

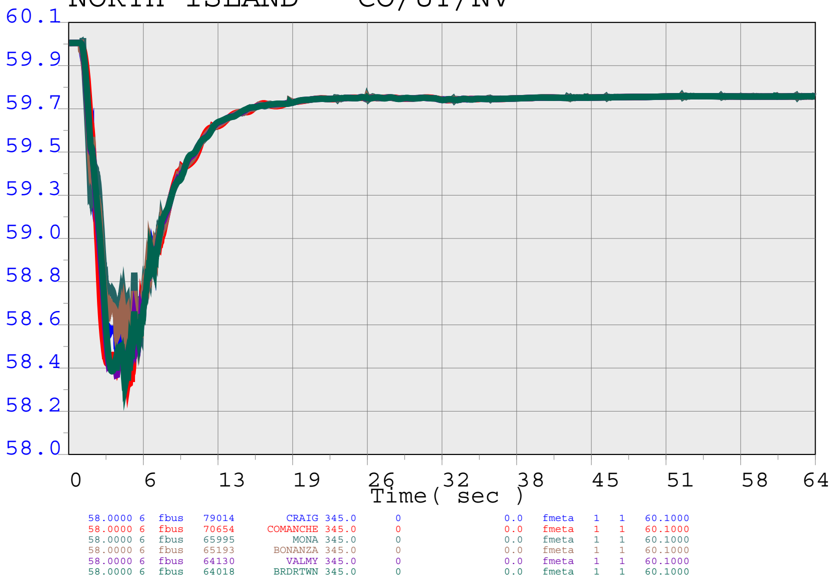
NORTH ISLAND - CANADA



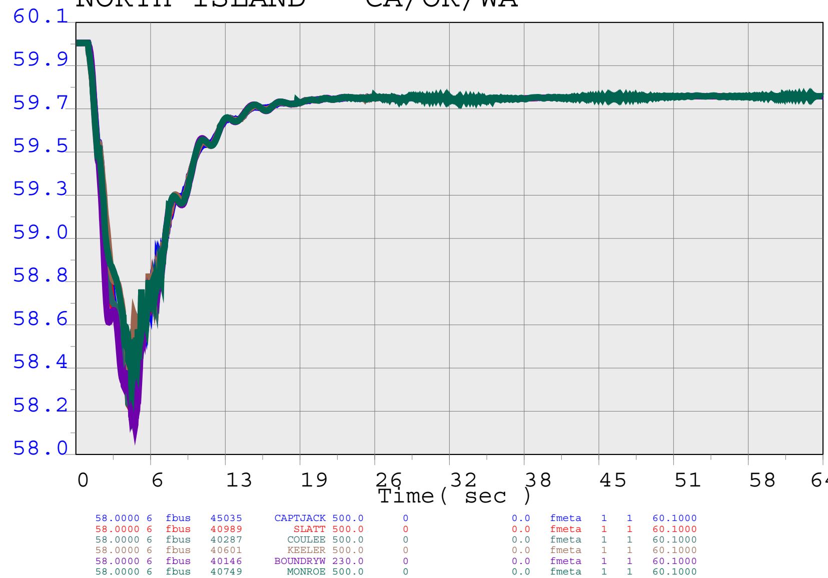
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



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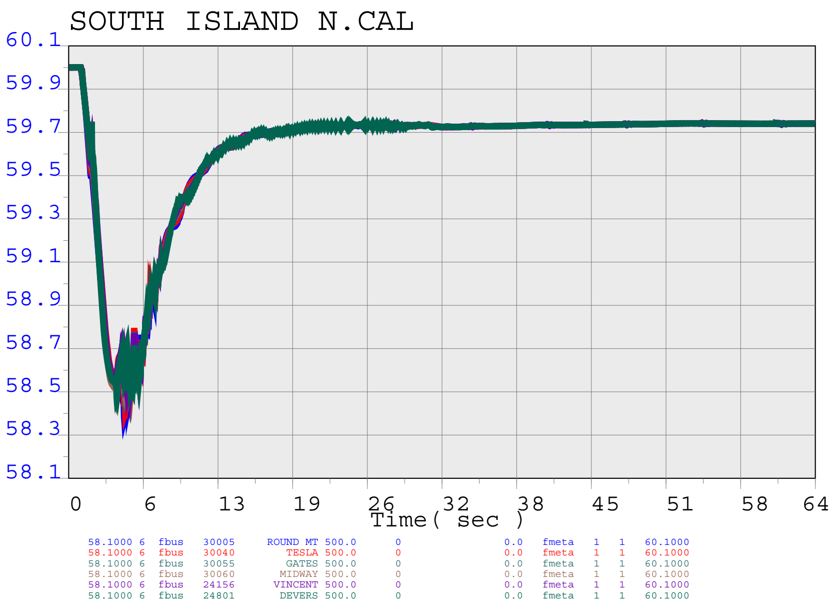
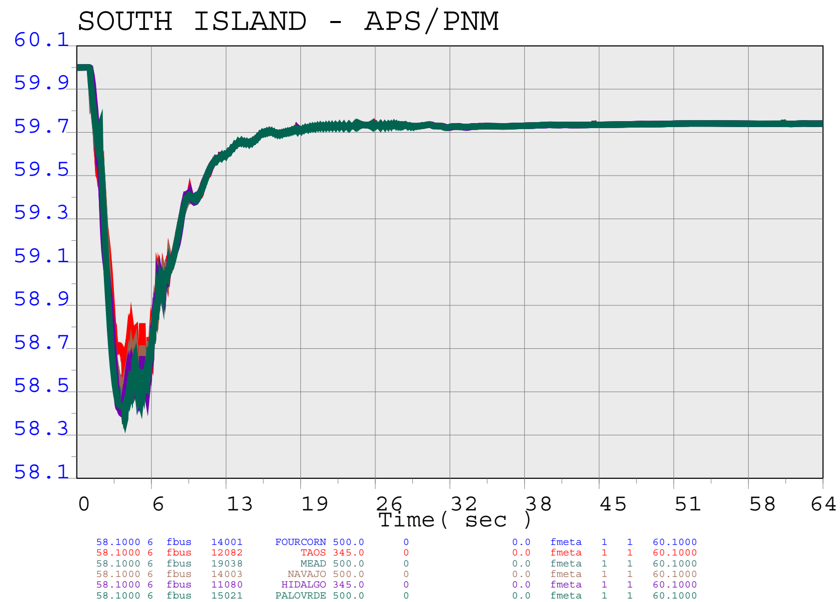
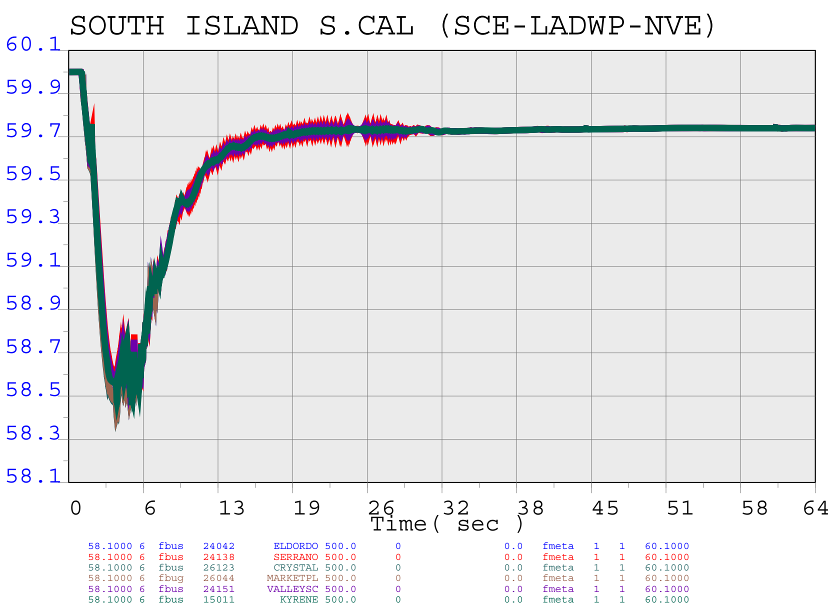
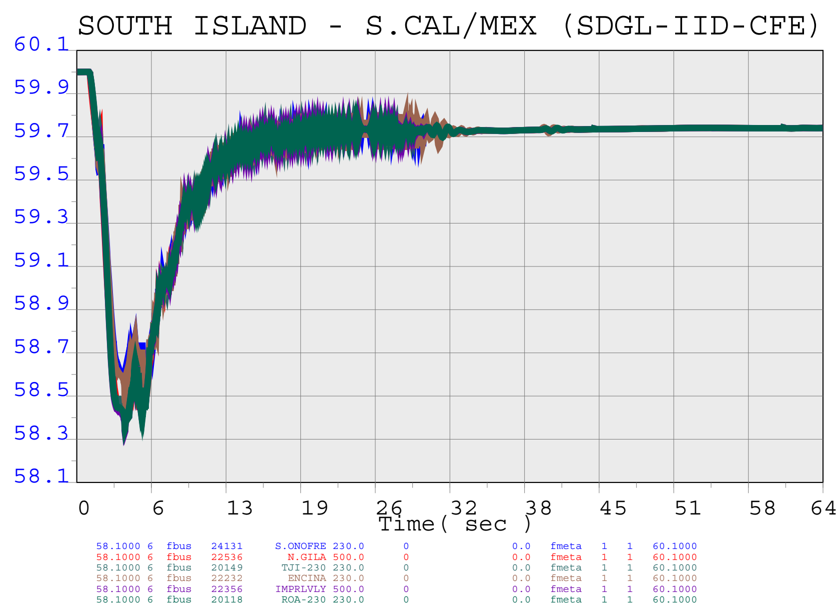
WECC ISLAND SOUTH BUSES: 2015HS - 25% GENERATION LOSS



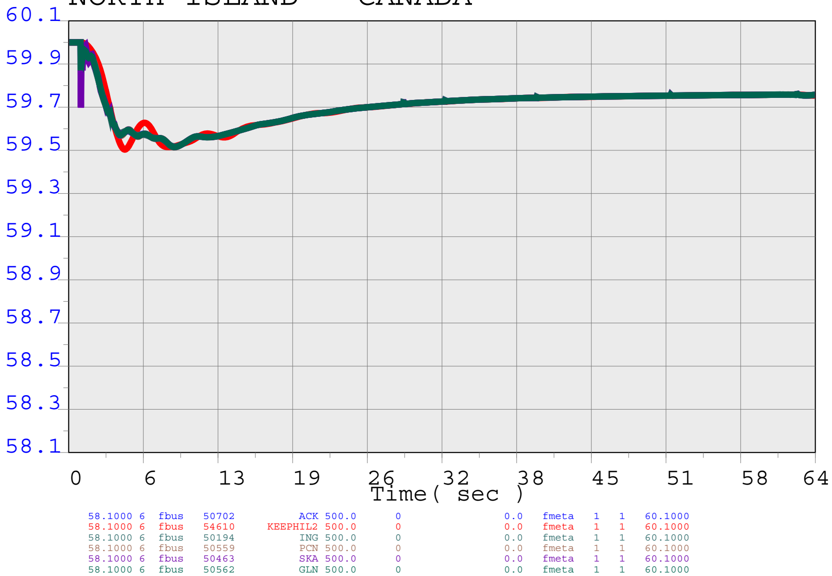




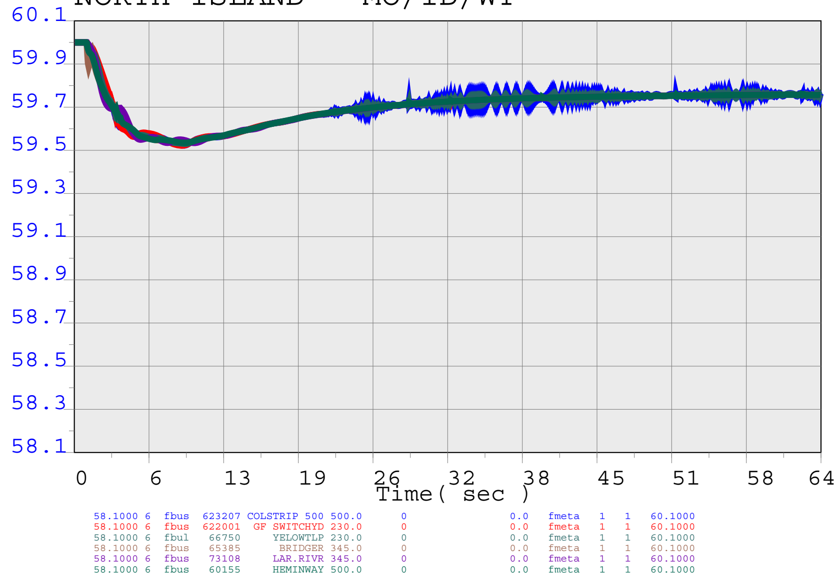


WECC ISLAND NORTH BUSES: 2015HSP - 5% GENERATION LOSS

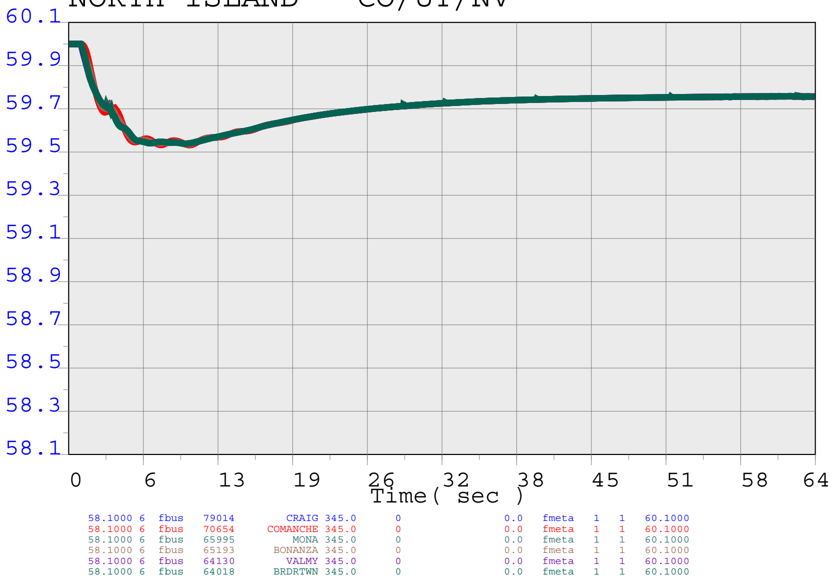
NORTH ISLAND - CANADA



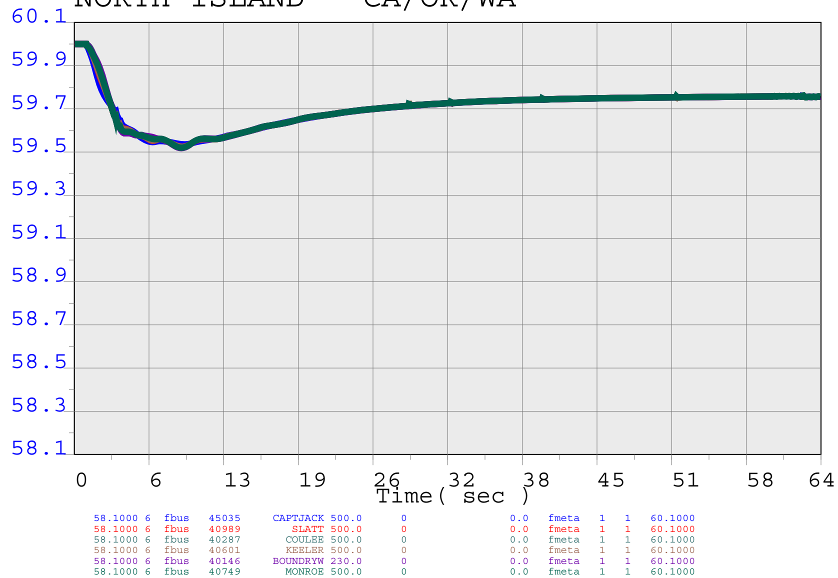
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



Page 1

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top\Final UFLS\Spring\201

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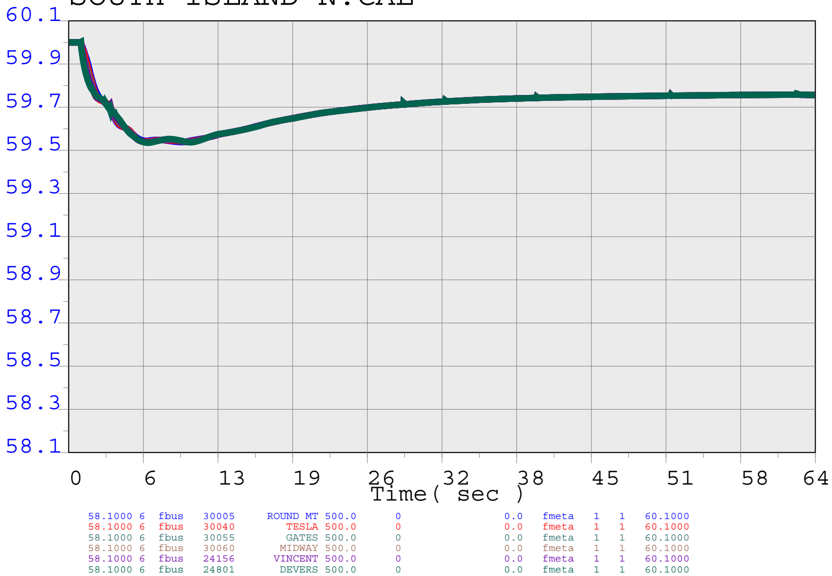
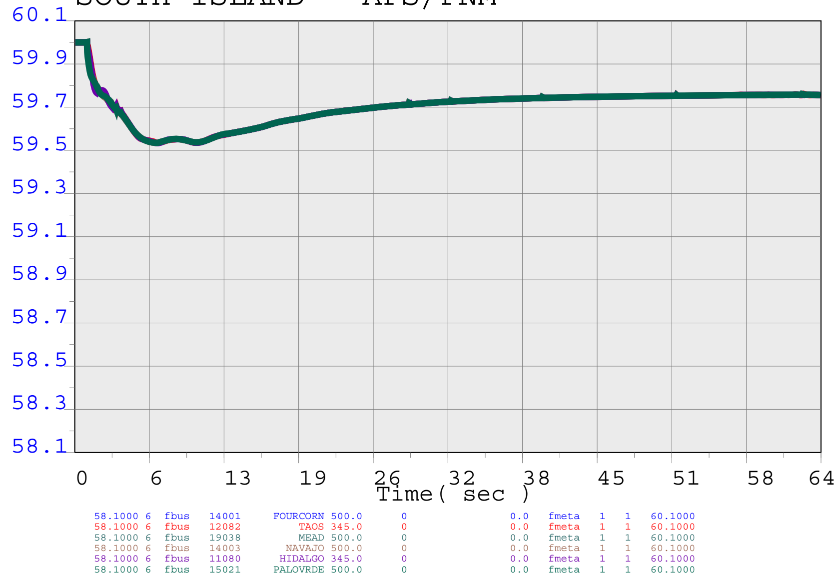
WECC ISLAND SOUTH BUSES: 2015HSP - 5% GENERATION LOSS

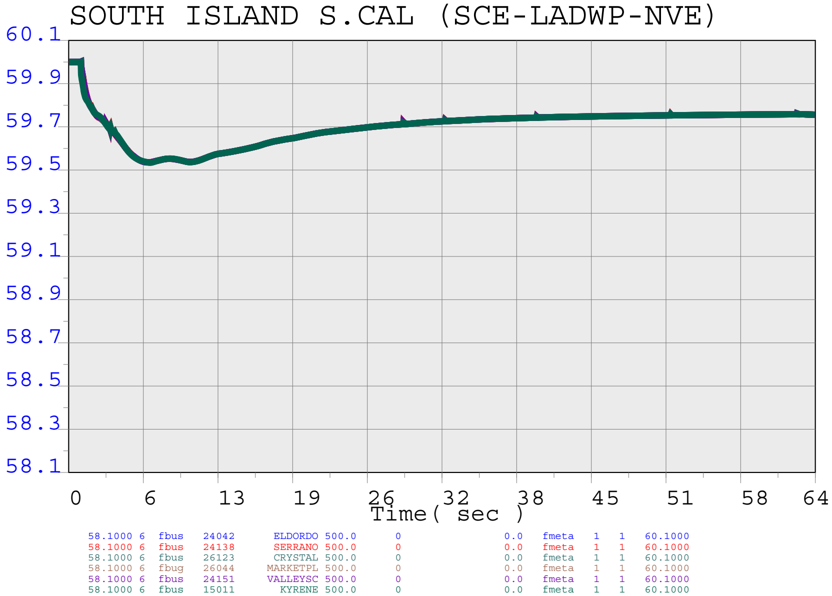
SOUTH ISLAND N.CAL



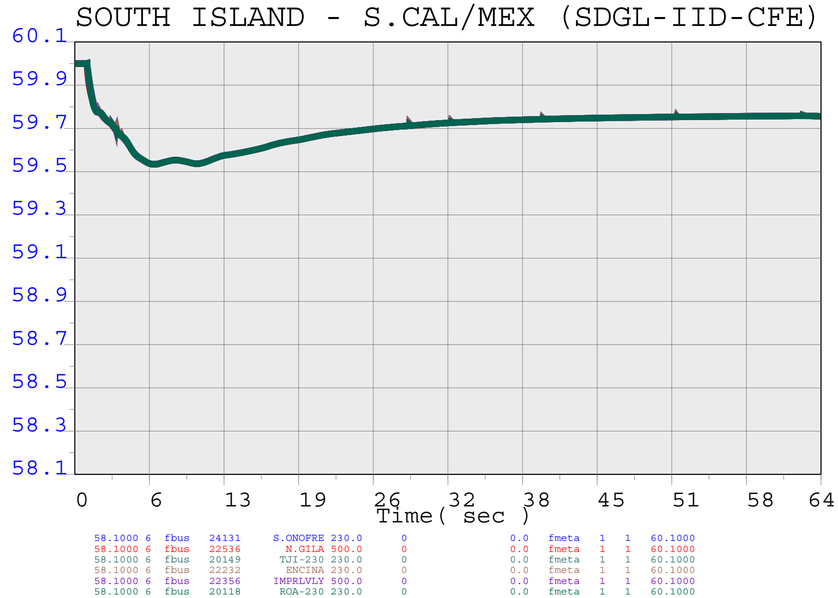
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



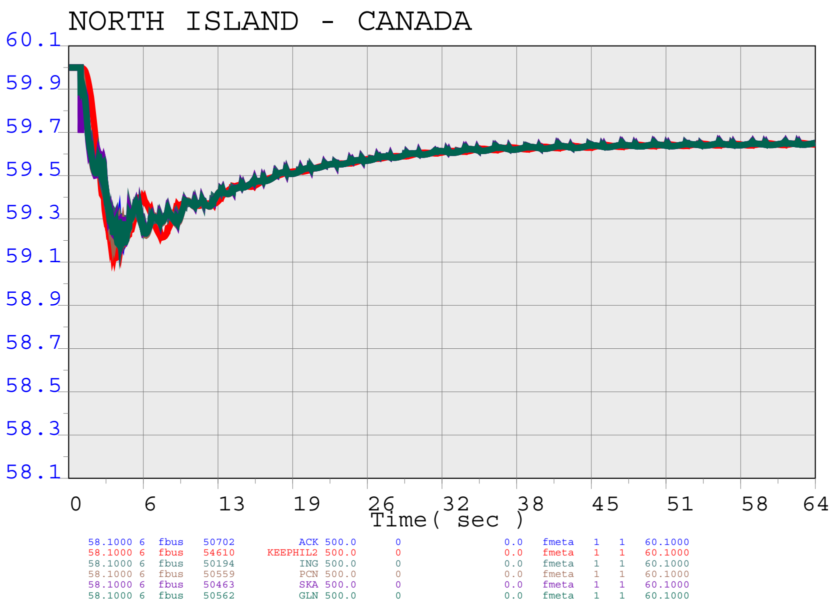
Page 1

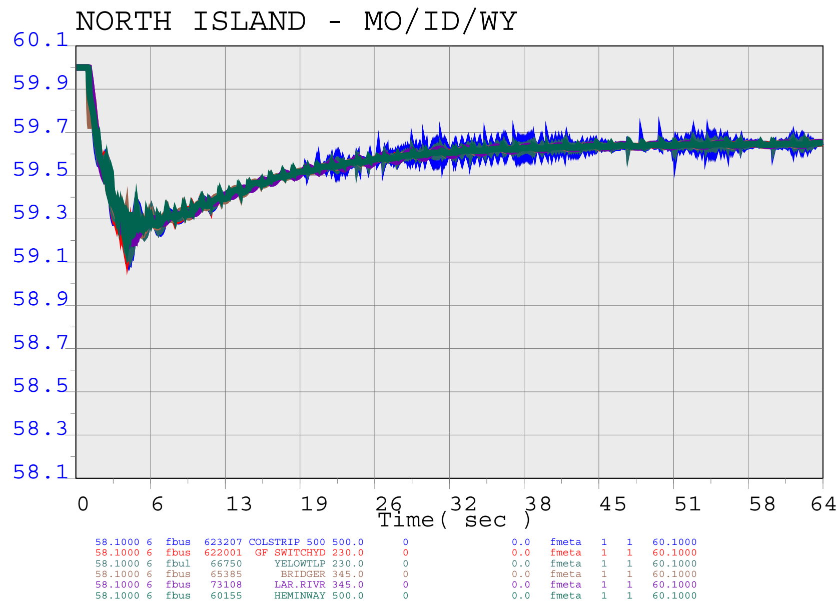
15hsp_W_5.chf

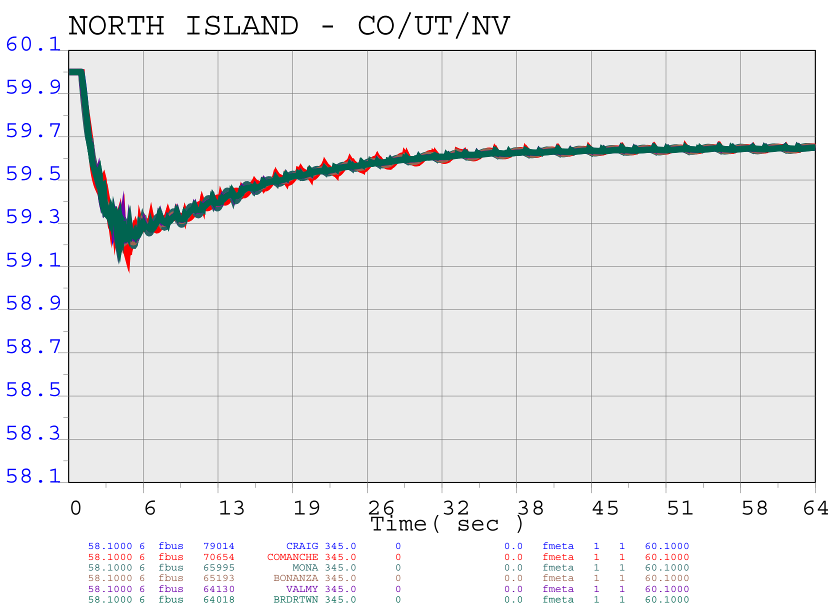
top\Final UFLS\Spring\201

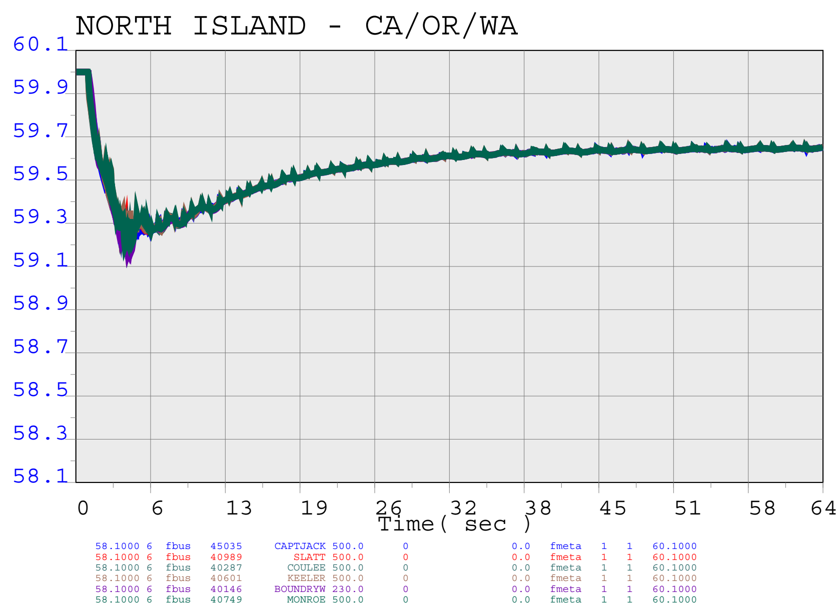
Mon Aug 17 09:47:57 2015

WECC ISLAND NORTH BUSES: 2015HSP - 10% GENERATION LOSS



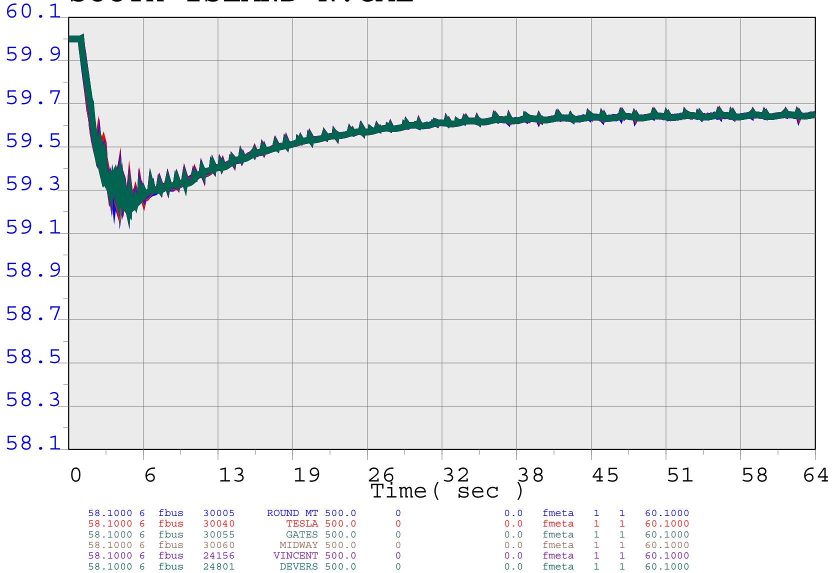




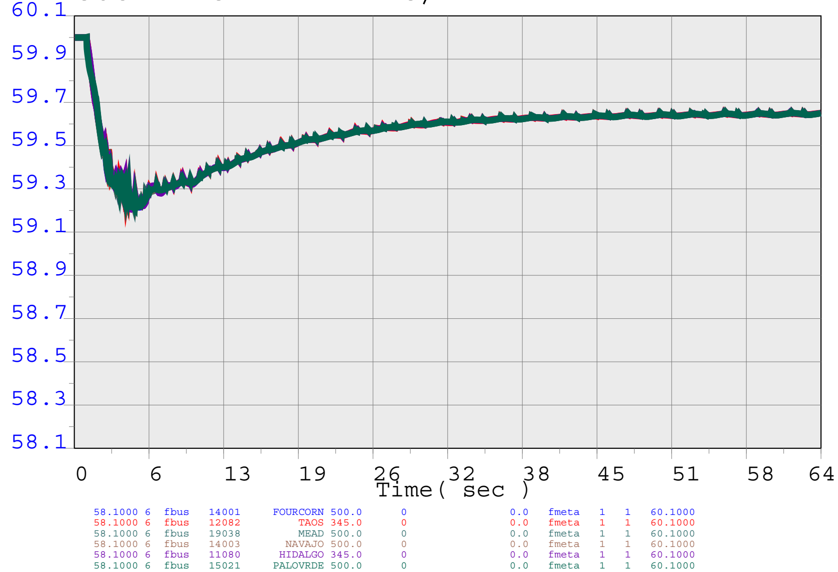


WECC ISLAND SOUTH BUSES: 2015HSP - 10% GENERATION LOSS

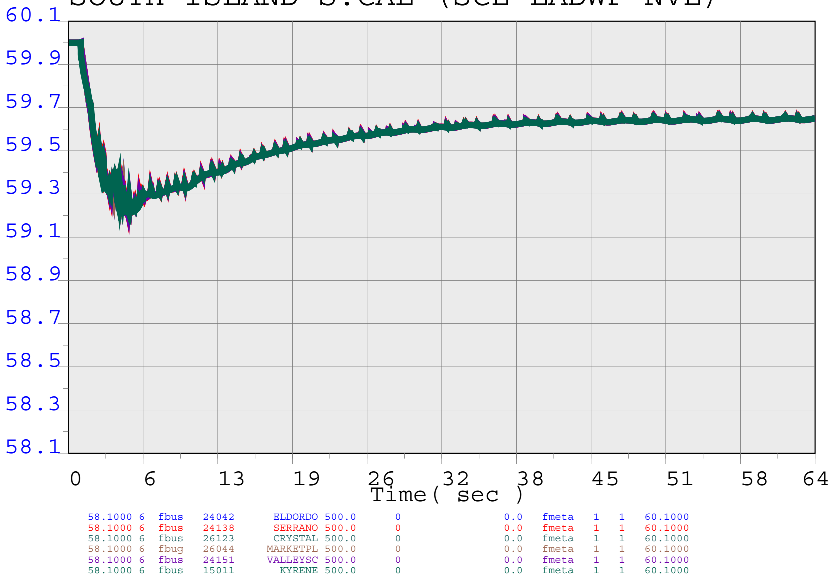
SOUTH ISLAND N.CAL



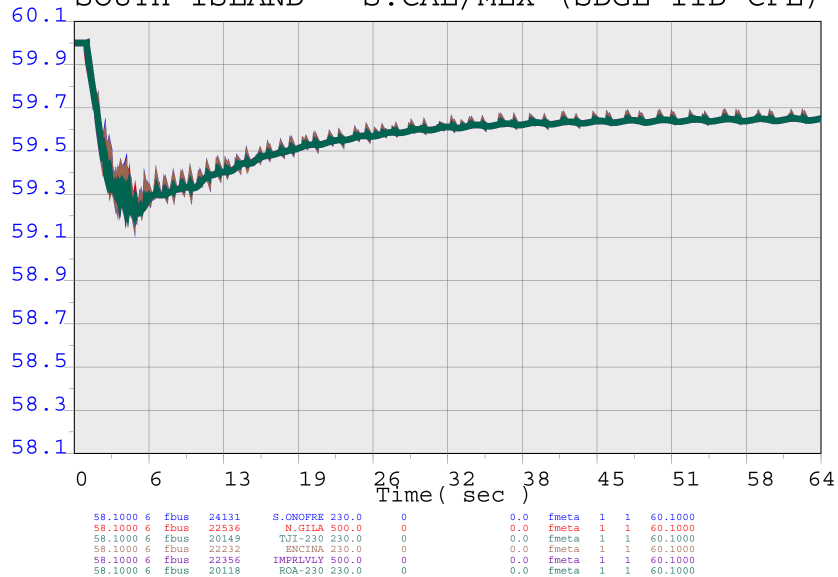
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



Page 1

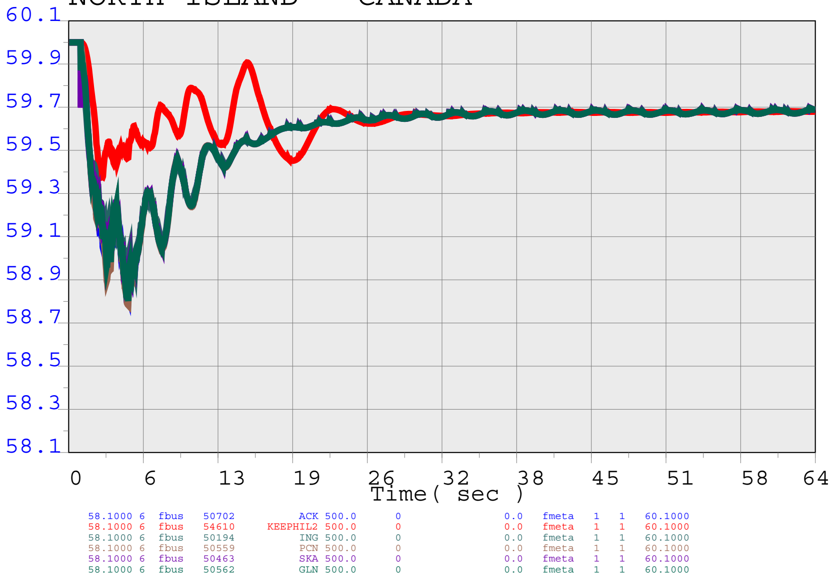
15hsp_W_10.chf

top\Final UFLS\Spring\201

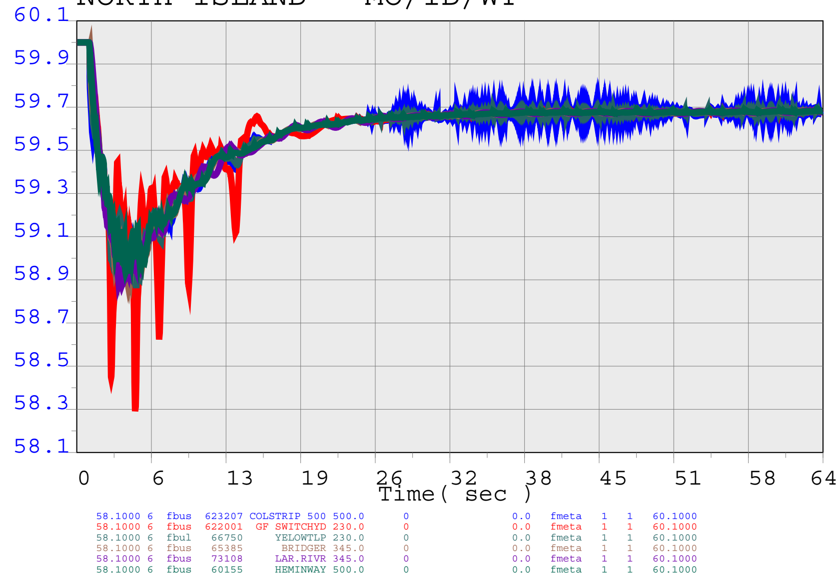
Mon Aug 17 09:51:36 2015

WECC ISLAND NORTH BUSES: 2015HSP - 15% GENERATION LOSS

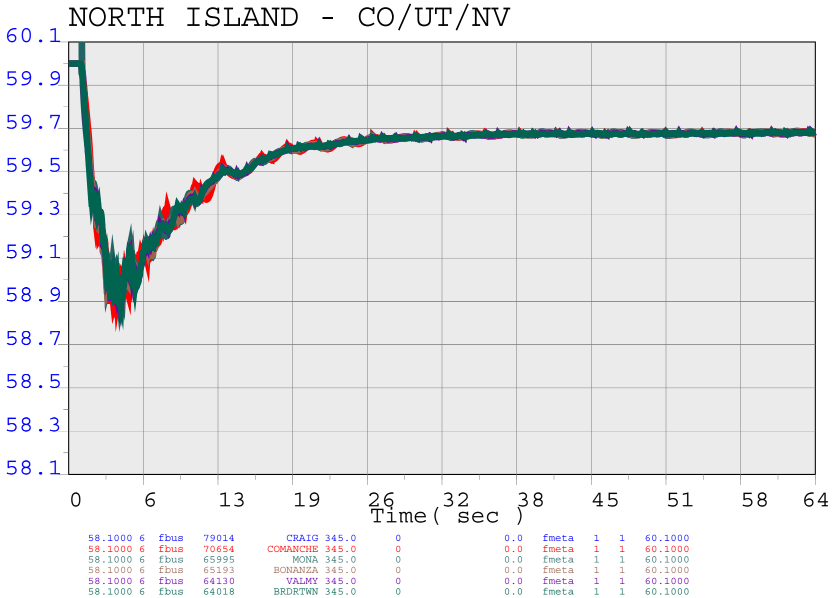
NORTH ISLAND - CANADA



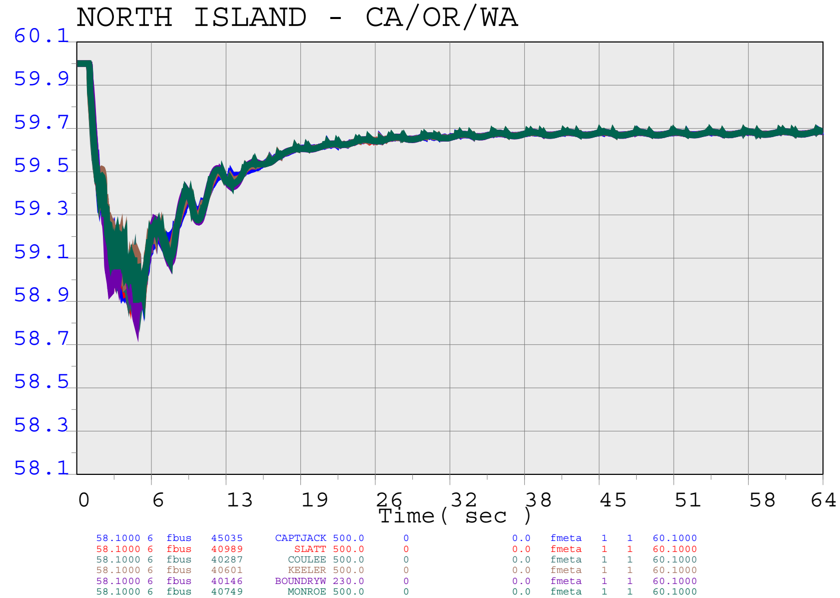
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



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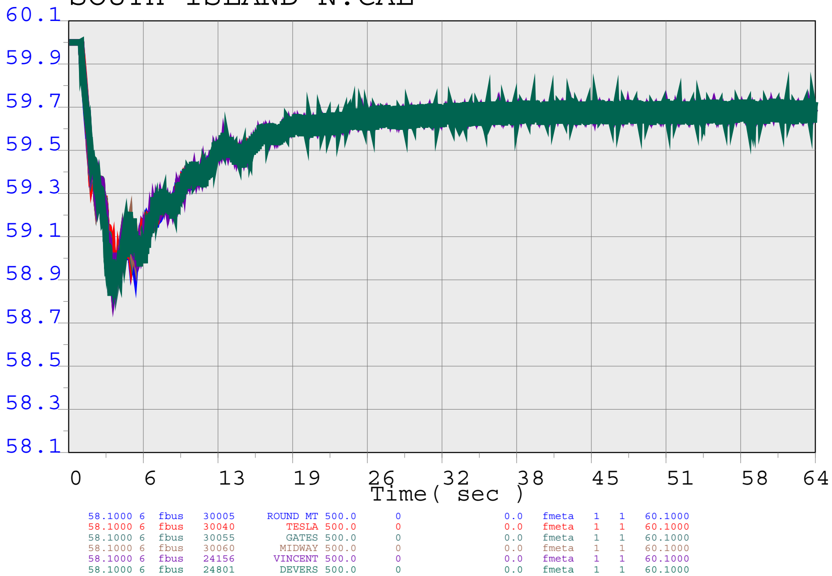
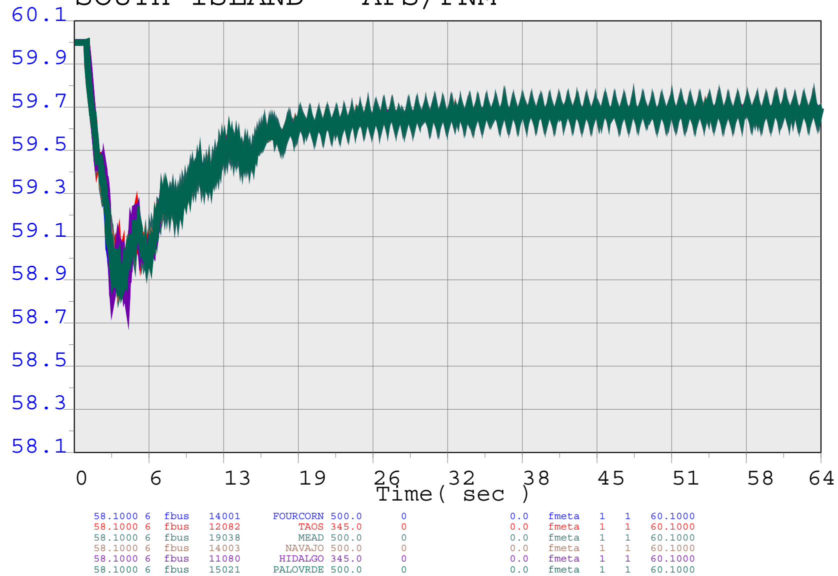
Mon Aug 17 11:39:00 2015

WECC ISLAND SOUTH BUSES: 2015HSP - 15% GENERATION LOSS

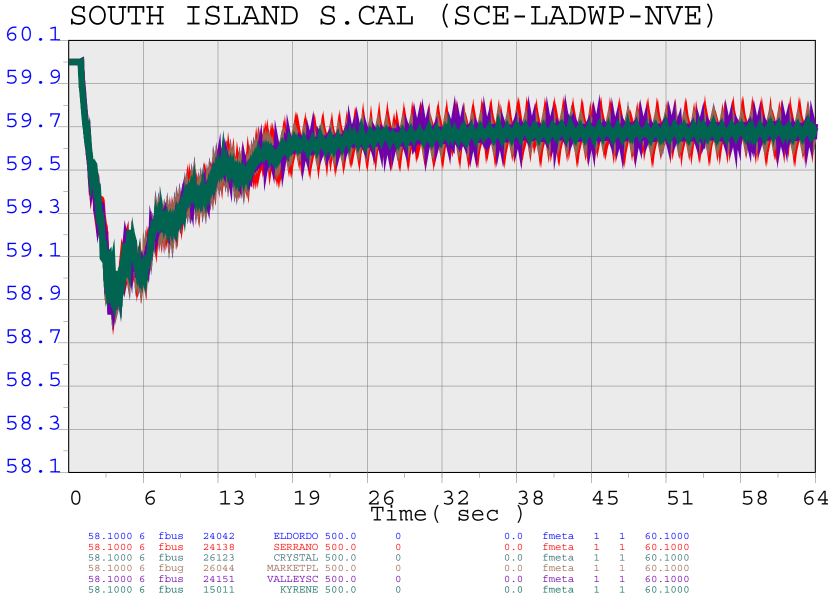
SOUTH ISLAND N.CAL



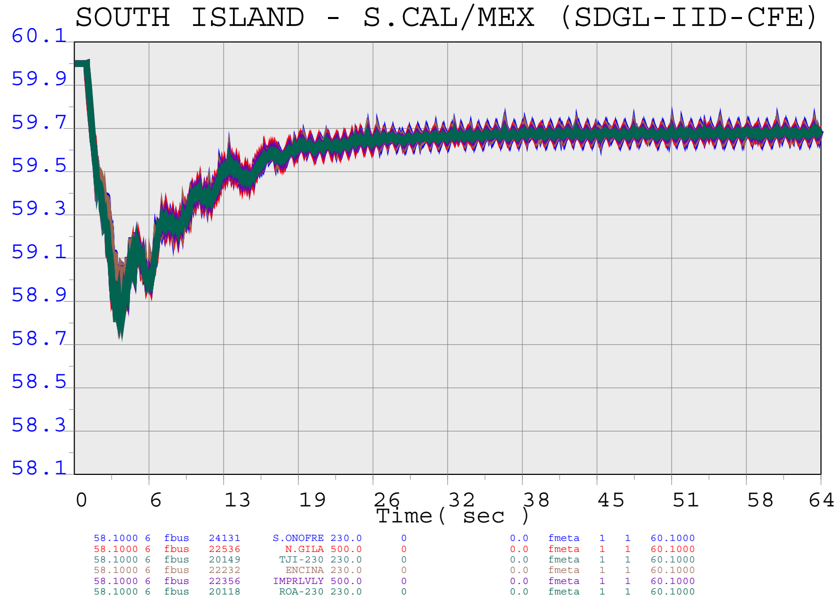
SOUTH ISLAND - APS/PNM



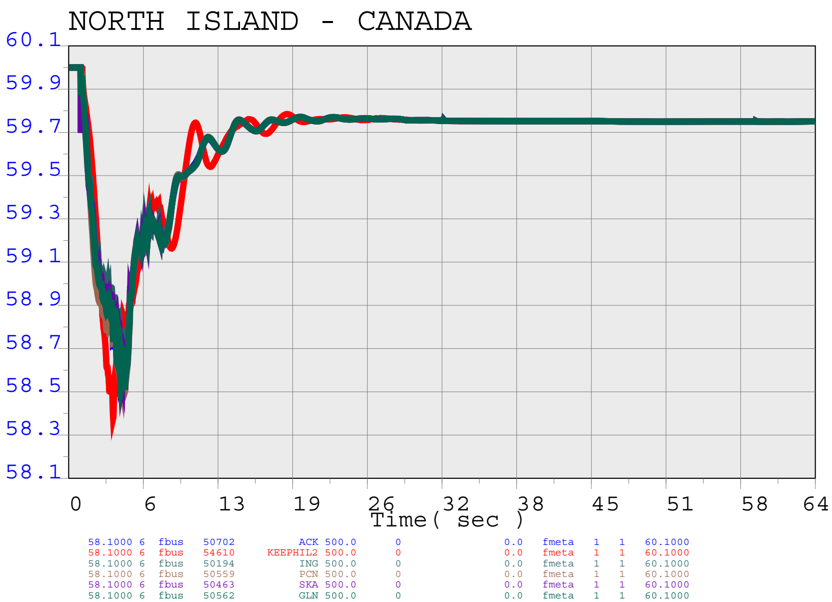
SOUTH ISLAND S.CAL (SCE-LADWP-NVE)

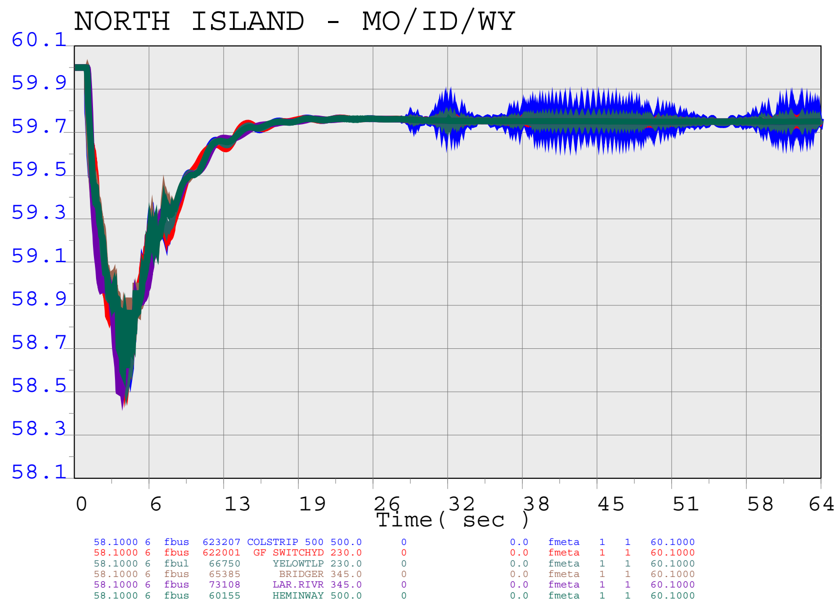


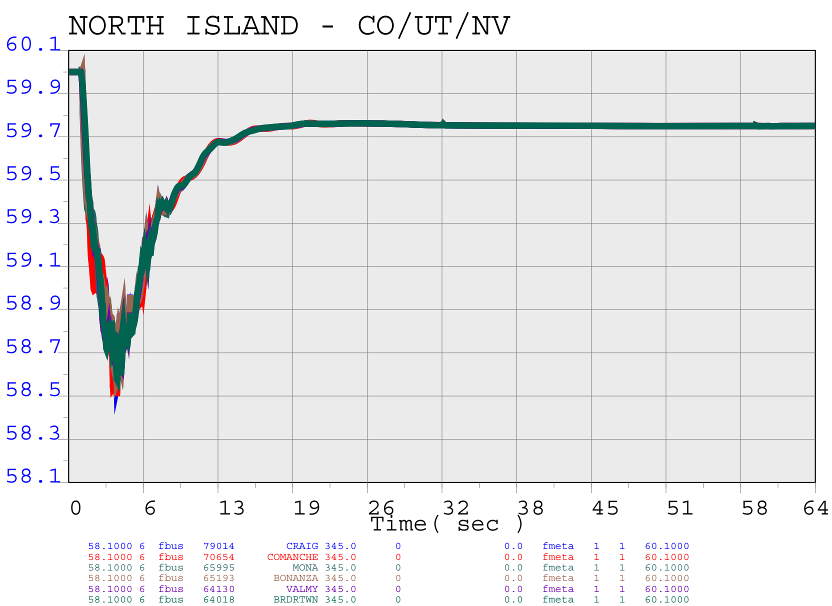
SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)

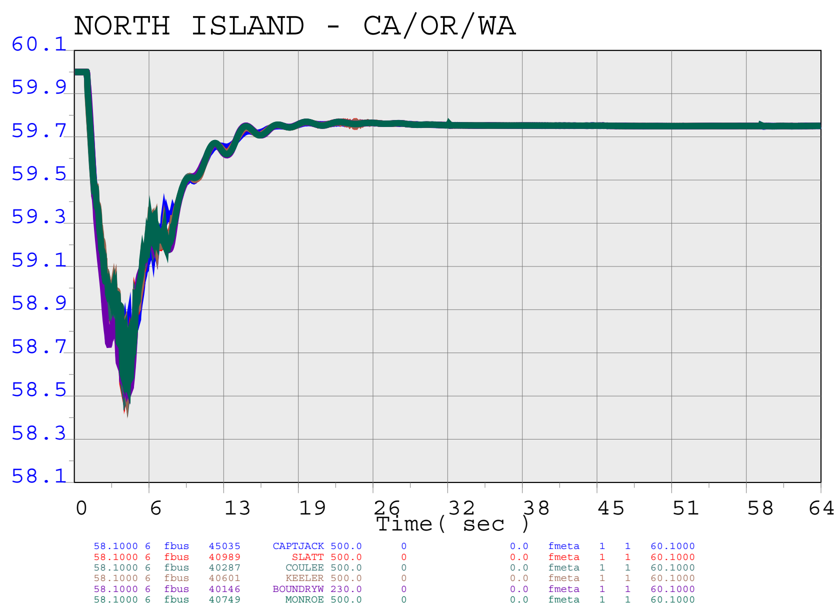


WECC ISLAND NORTH BUSES: 2015HSP - 20% GENERATION LOSS



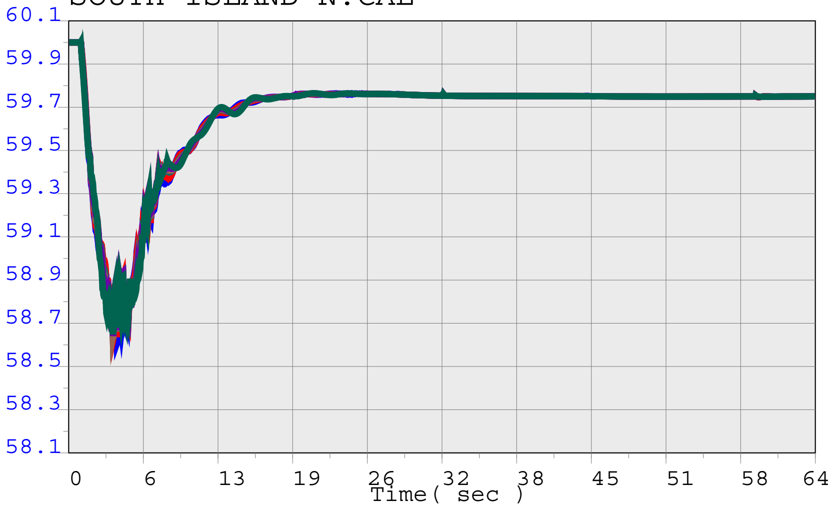






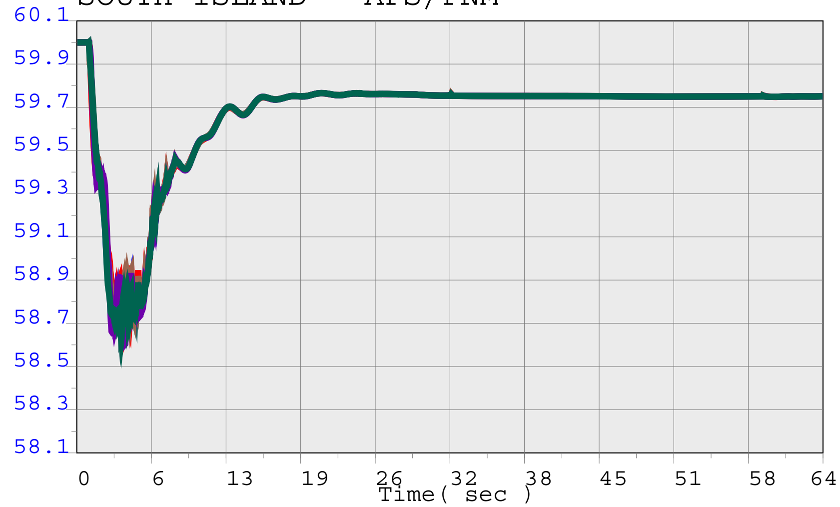
WECC ISLAND SOUTH BUSES: 2015HSP - 20% GENERATION LOSS

SOUTH ISLAND N.CAL



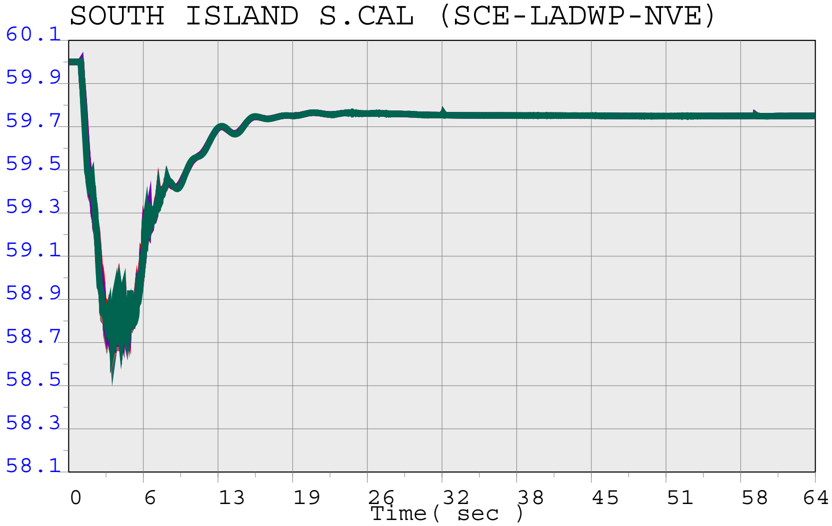
58.1000	6	fbus	30005	ROUND MT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	30040	TESLA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	30055	GATES	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	30060	MIDWAY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	24156	VINCENT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	24801	DEVERS	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - APS/PNM



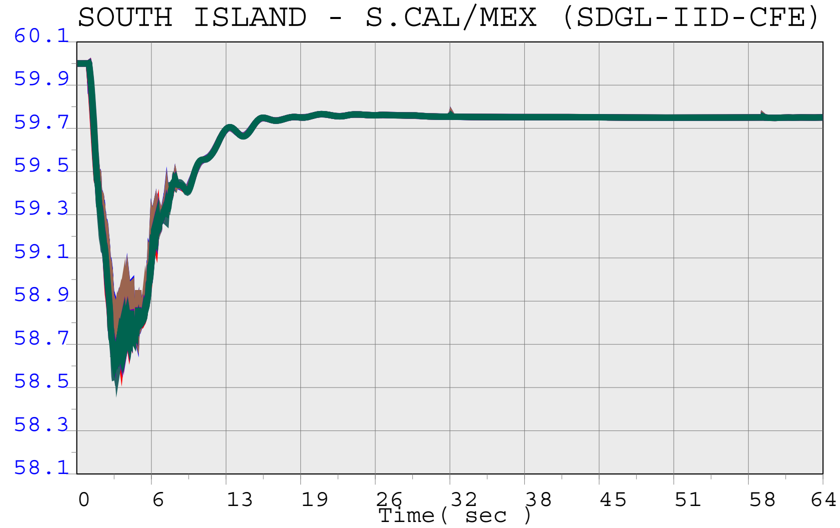
58.1000	6	fbus	14001	FOURCORN	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	12082	TAOS	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	19038	MEAD	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	14003	NAVAJO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	11080	HIDALGO	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	15021	PALOVRDE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



58.1000	6	fbus	24042	ELDORDO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	24138	SERRANO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	26123	CRYSTAL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbug	26044	MARKETPL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	24151	VALLEYSC	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	15011	KYRENE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



58.1000	6	fbus	24131	S.ONOFRE	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	22536	N.GILA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	20149	TJI-230	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	22232	ENCINA	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	22356	IMPRLVLY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	6	fbus	20118	ROA-230	230.0	0	0.0	fmeta	1	1	60.1000

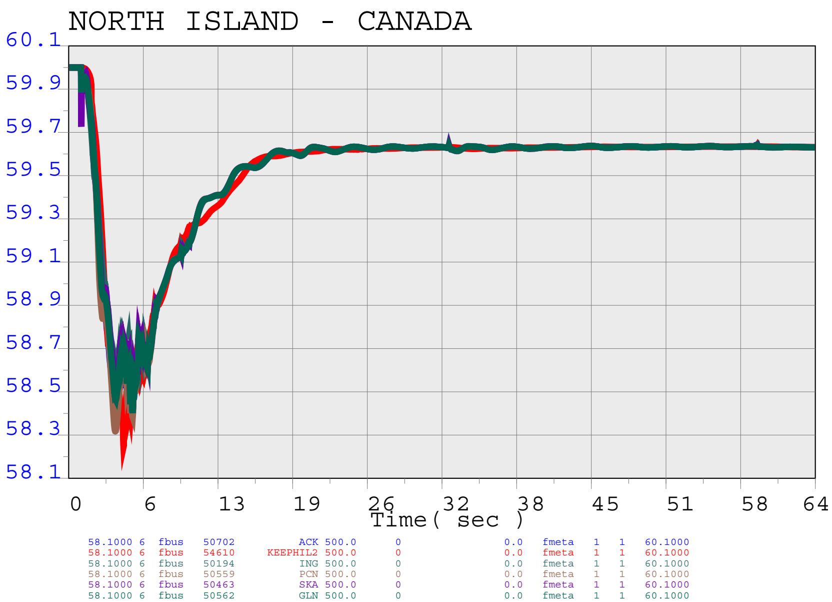
Page 1

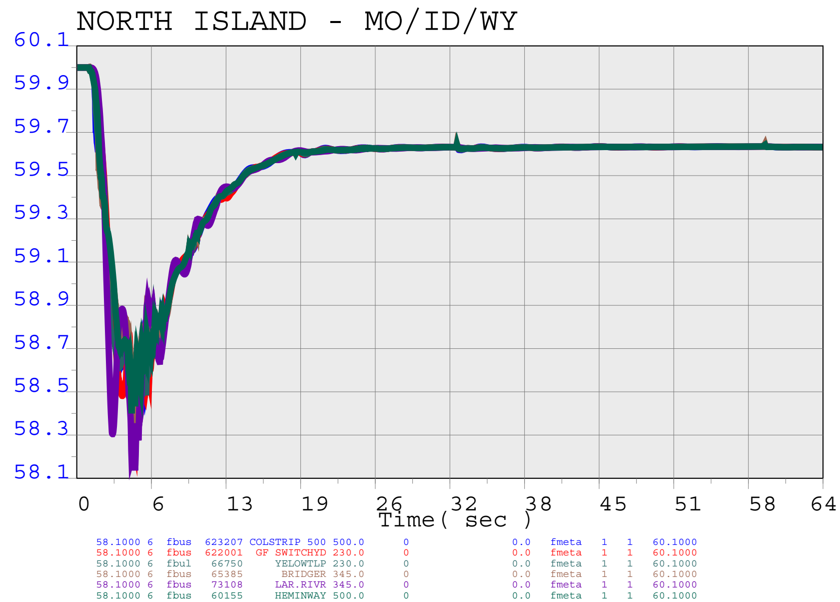
15hsp_W_20.chf

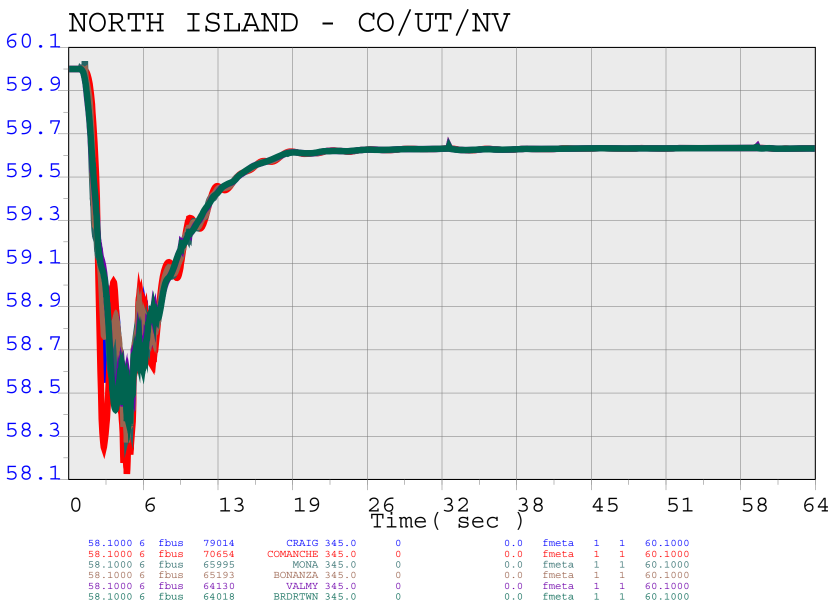
top\Final UFLS\Spring\201

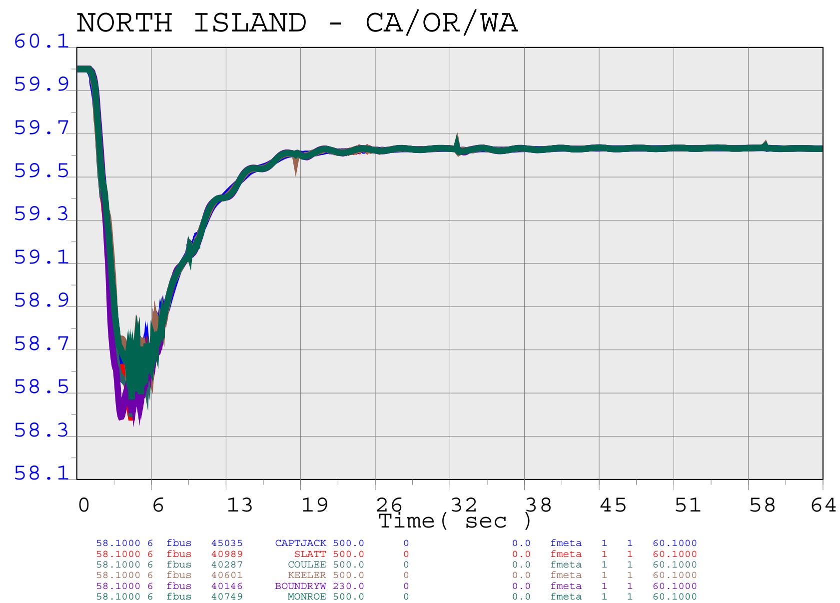
Mon Aug 17 09:46:15 2015

WECC ISLAND NORTH BUSES: 2015HSP - 25% GENERATION LOSS









Page 1

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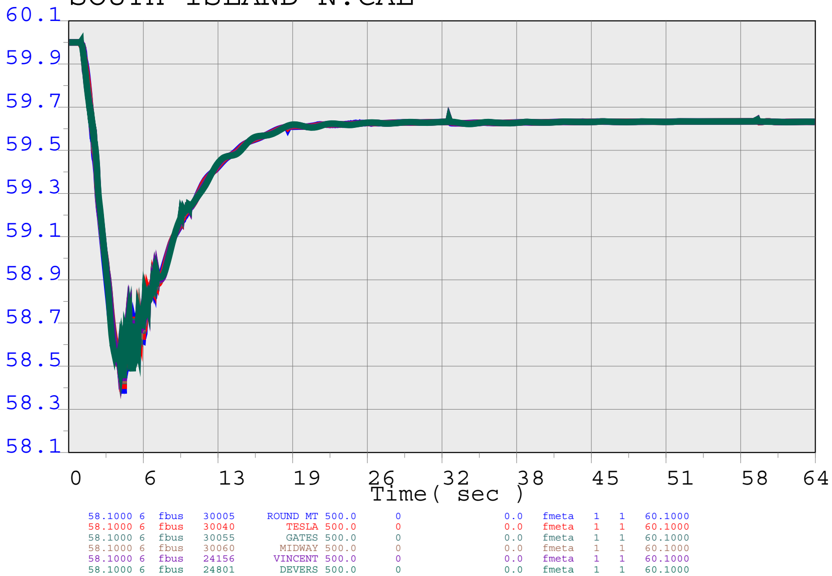
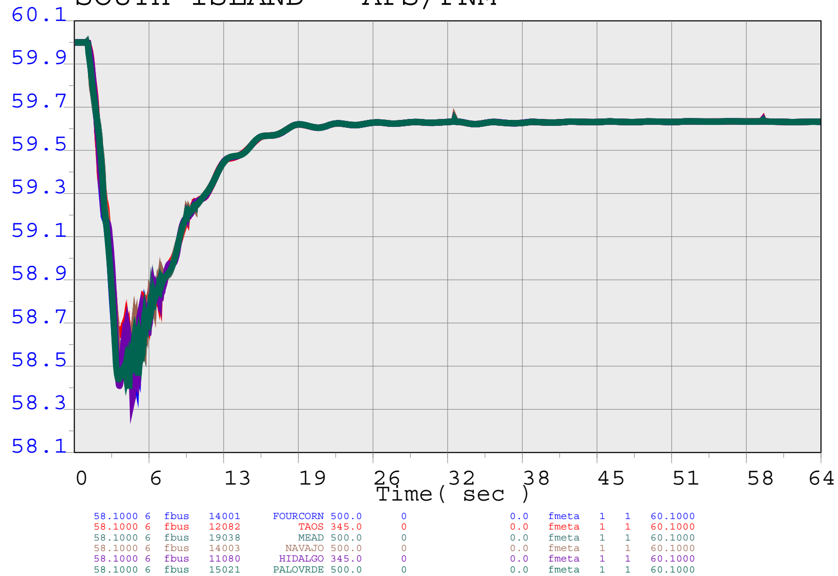
WECC ISLAND SOUTH BUSES: 2015HSP - 25% GENERATION LOSS

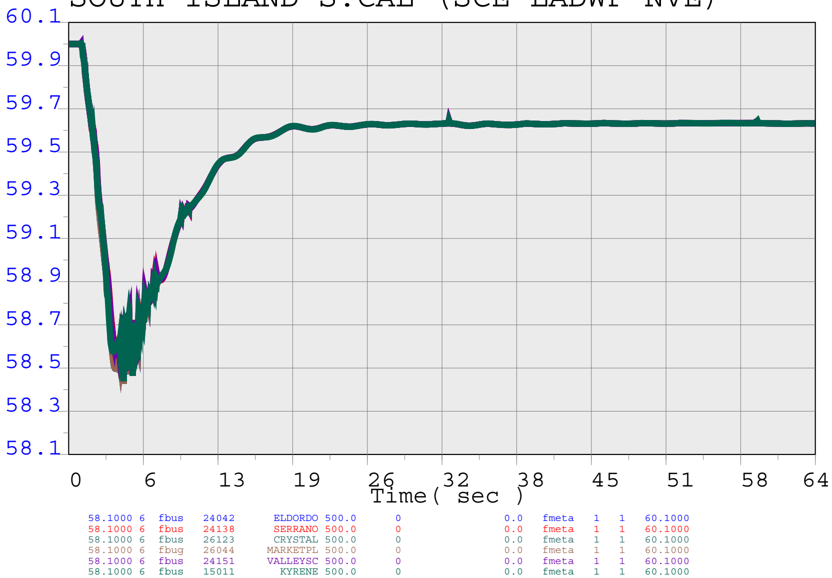
SOUTH ISLAND N.CAL



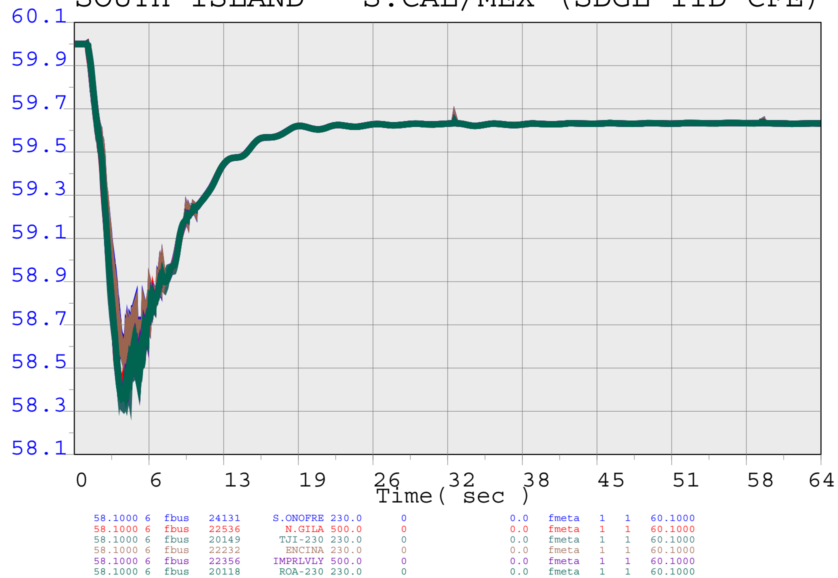
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



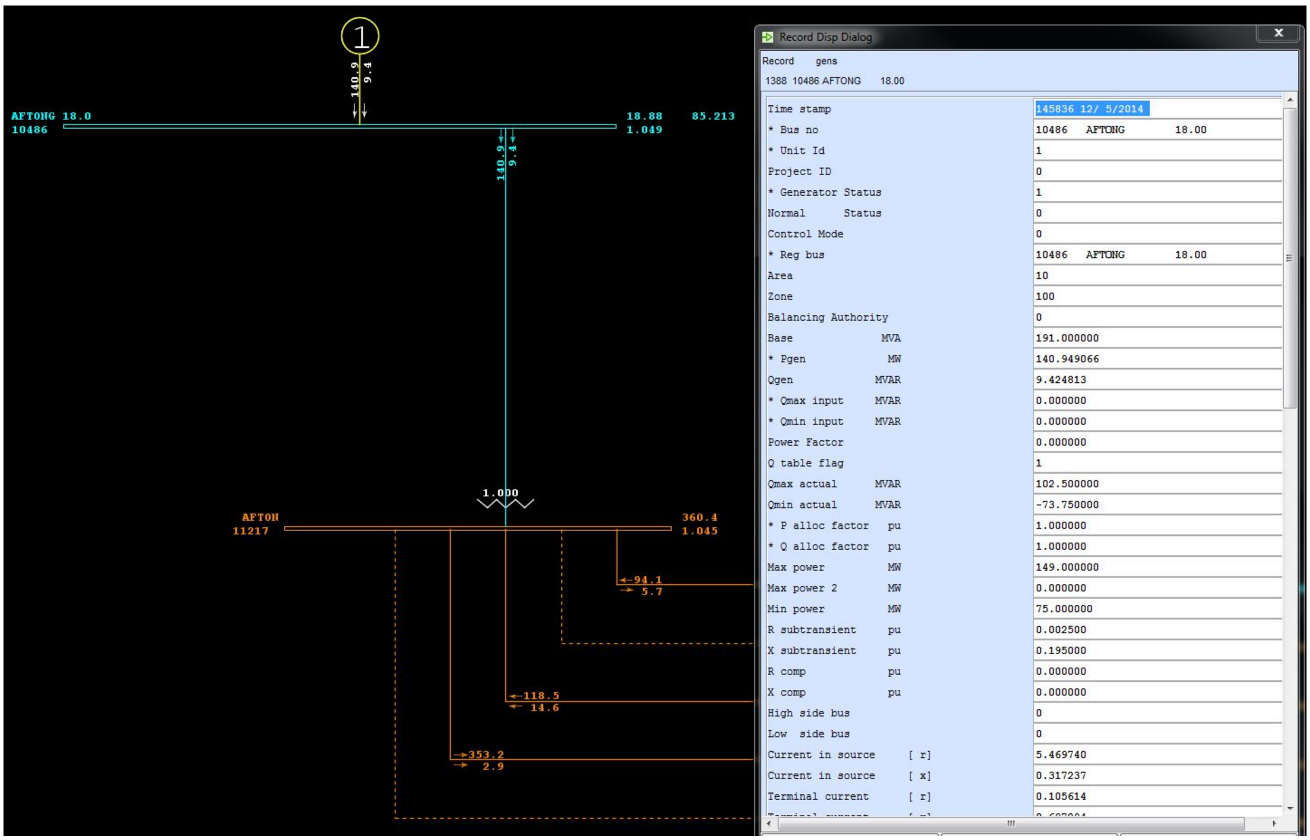
Appendix C: WECC Island Simulations: Volts per Hz Plots

Unit ID:

- AFTONG

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

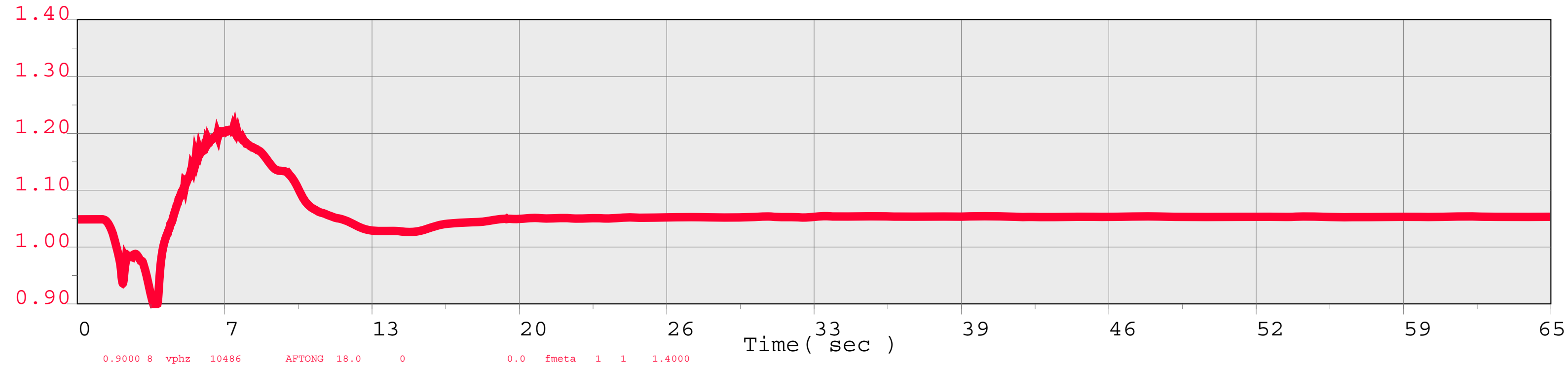


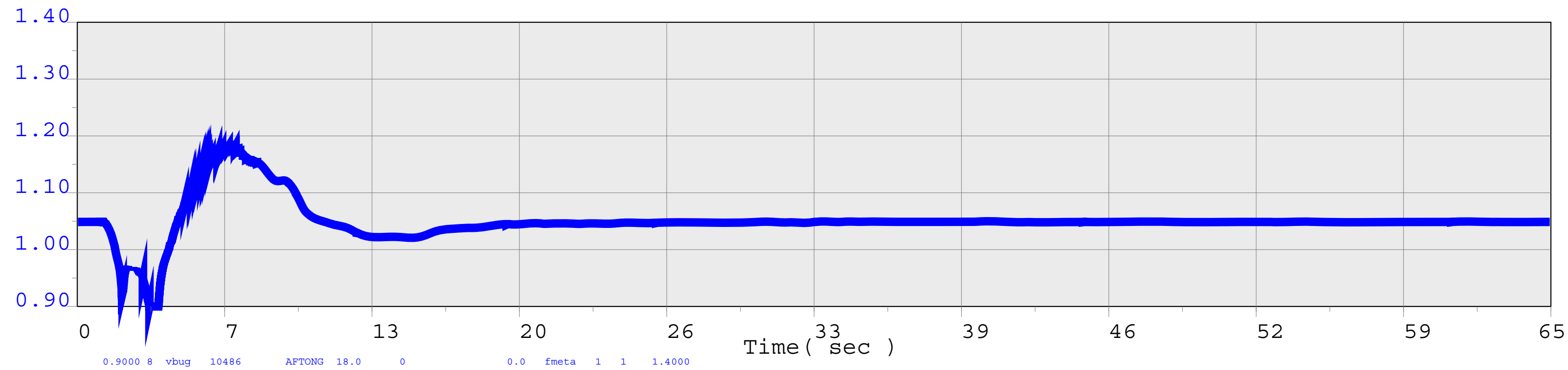
Likely Cause:

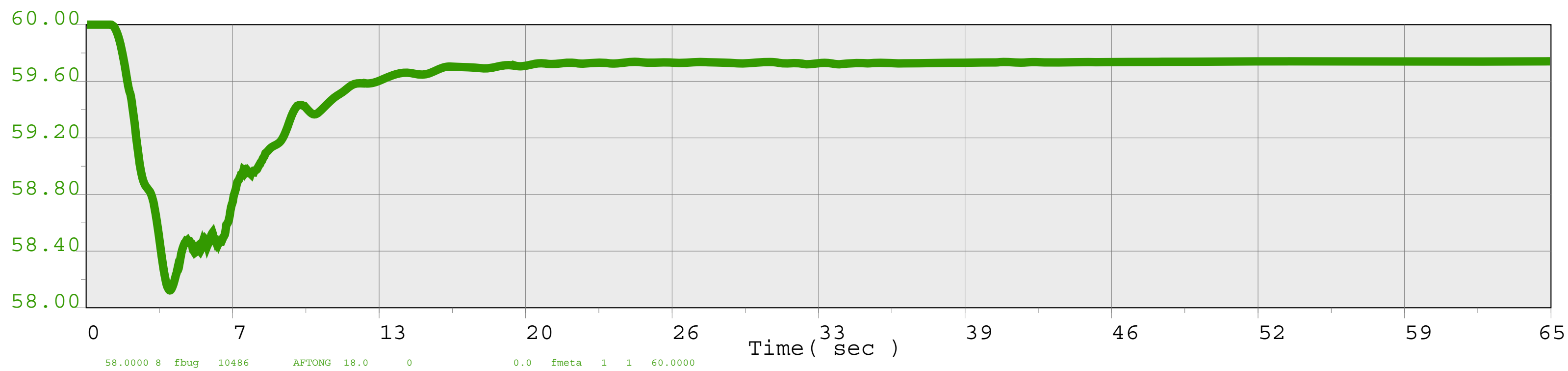
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 9.4 MVAR and reached 102.5 MVAR at one point, which exceed its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY





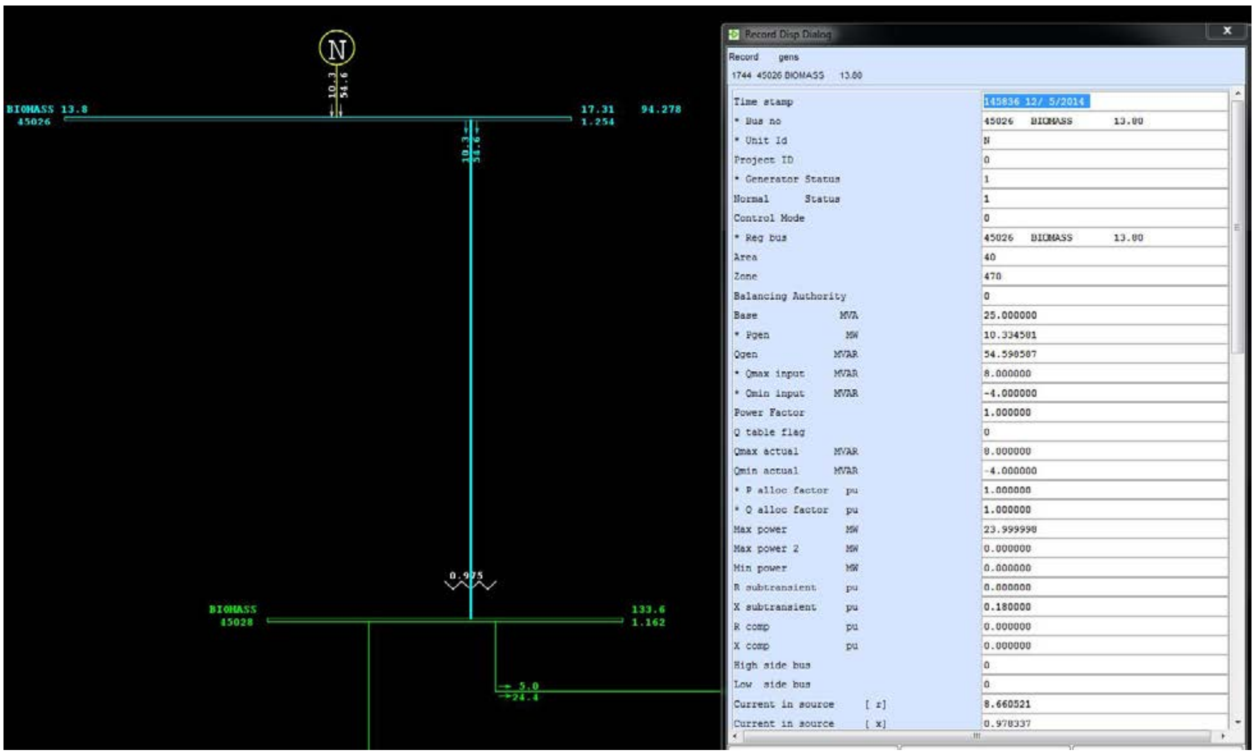


Unit ID:

- BIOMASS

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

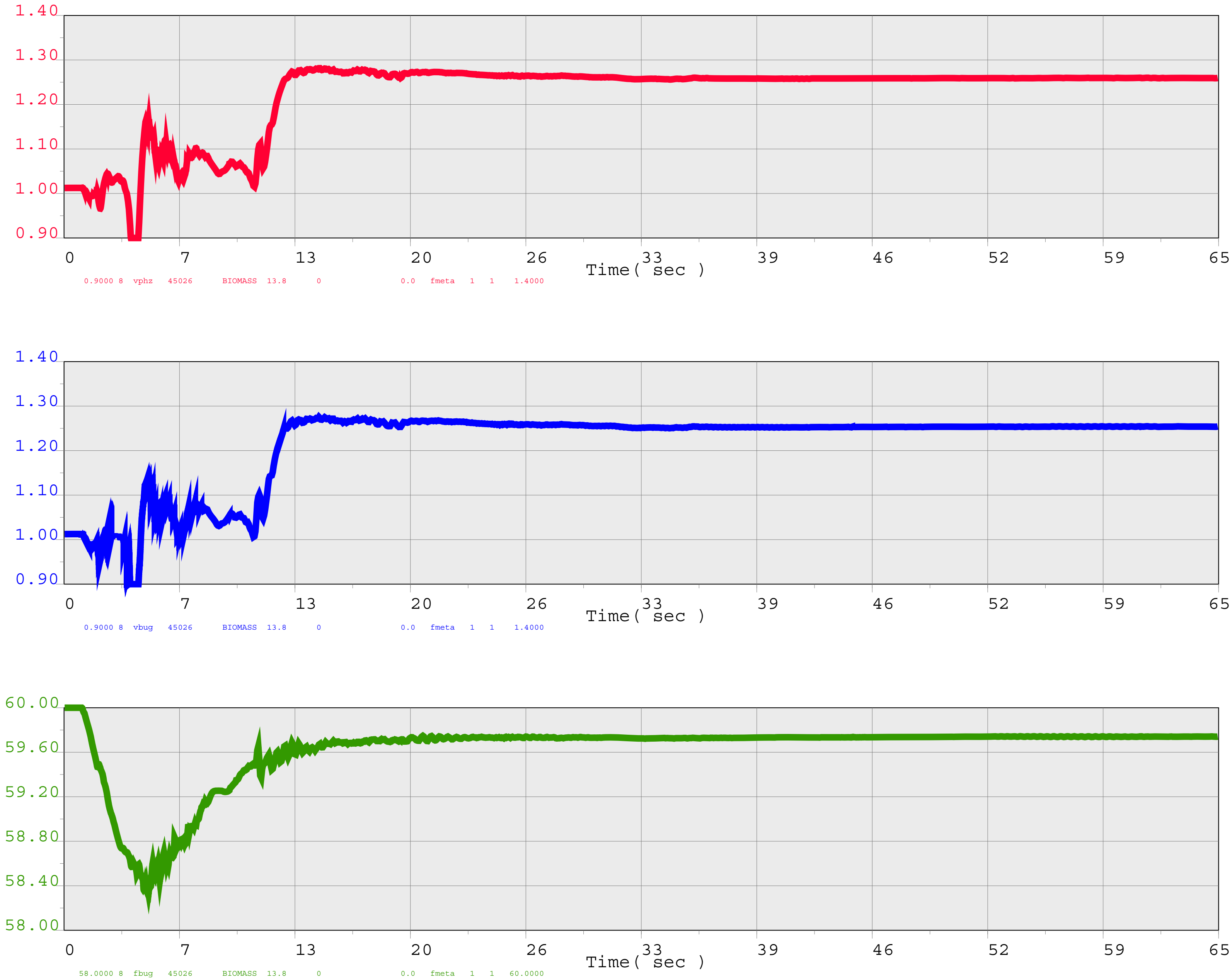


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 54.6 MVAR, which exceeds its Qmax (8 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



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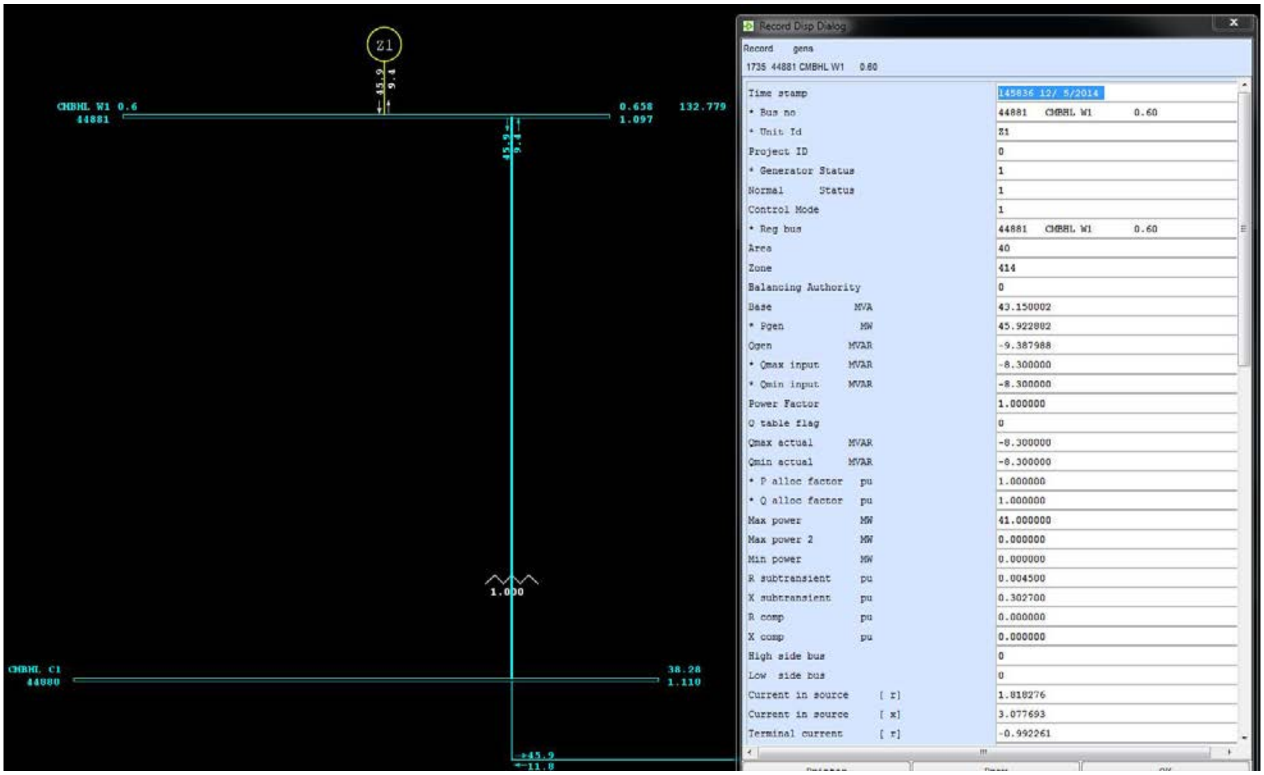
Unit ID:

- CMBHL W1

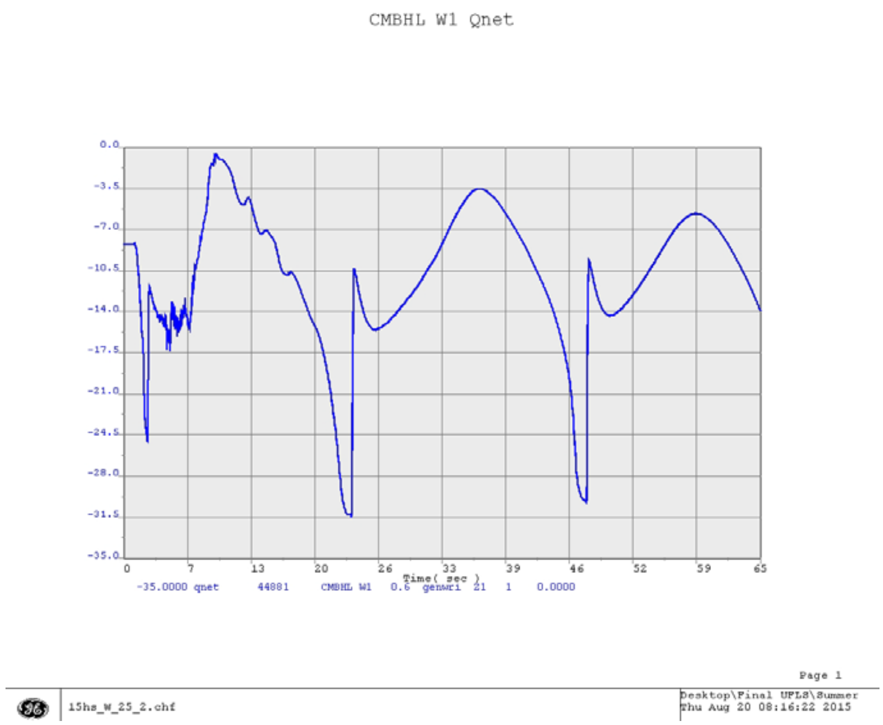
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.



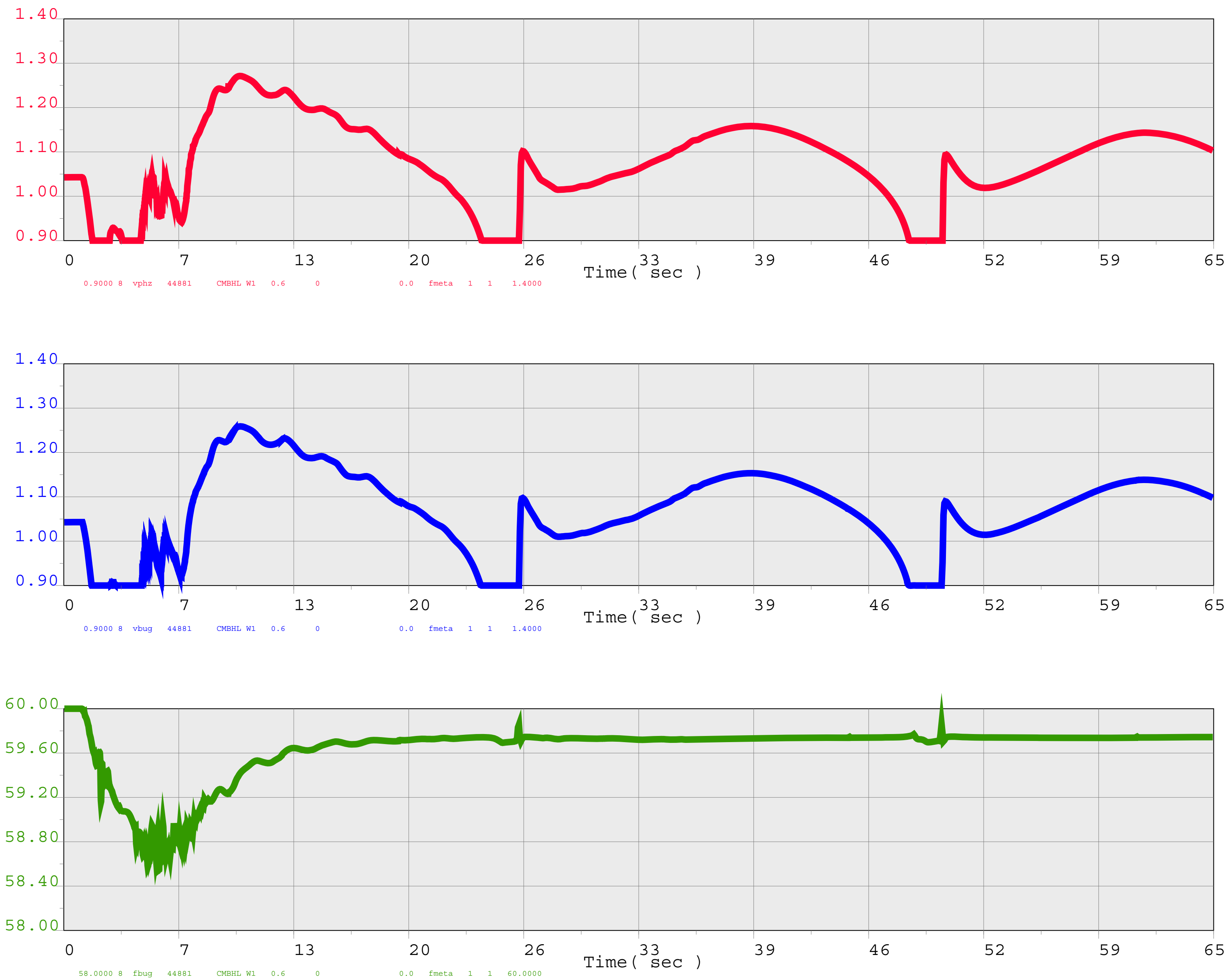
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -9.4 MVAR, which barely exceeds its Qmin (-8.3 MVAR).
- As can be seen in the plot below, the net reactive power this generator is outputting fluctuates between 0 and -31.5 MVAR, which is far outside its Qmin and Qmax (a constant -8.3 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.



__Issue deemed not caused by UFLS program shortfalls.__

VIOLATES 1.18 V/Hz CRITERIA ONLY

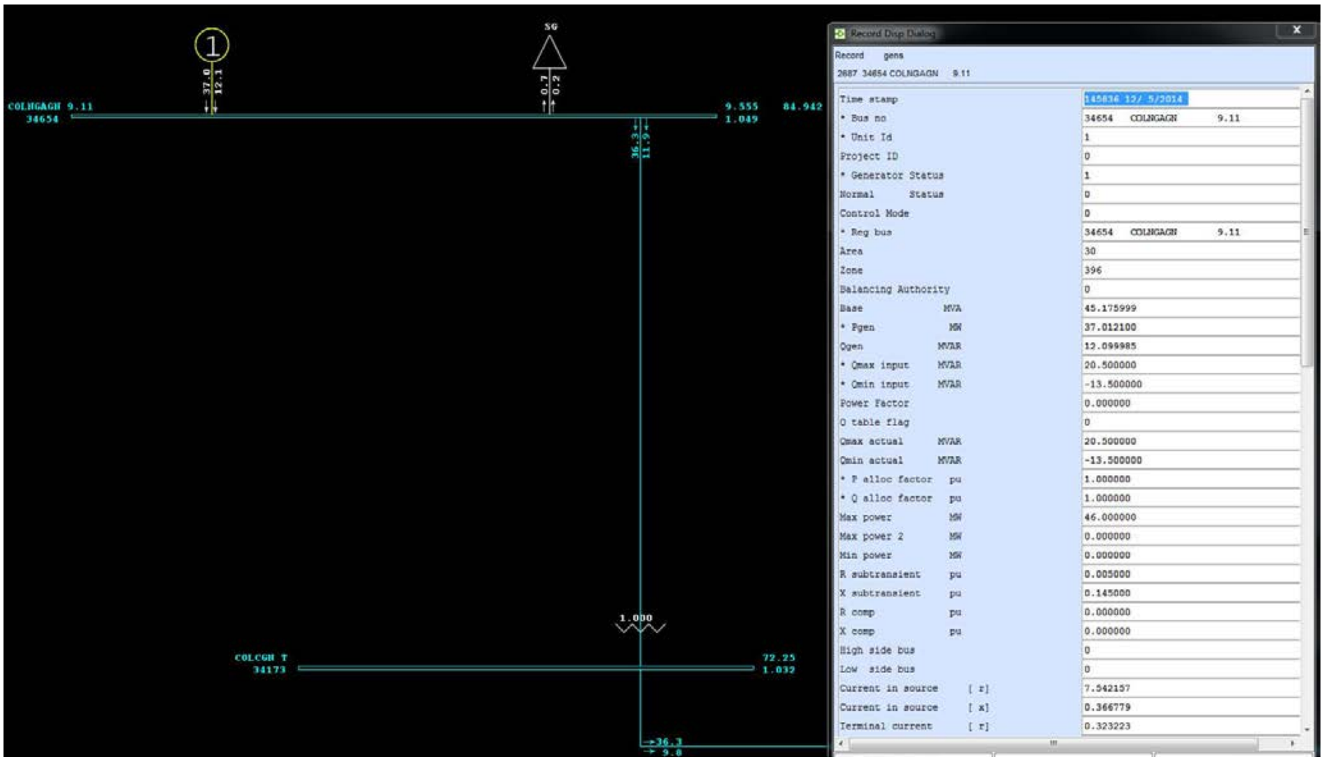


Unit ID:

- COLNGAGN

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

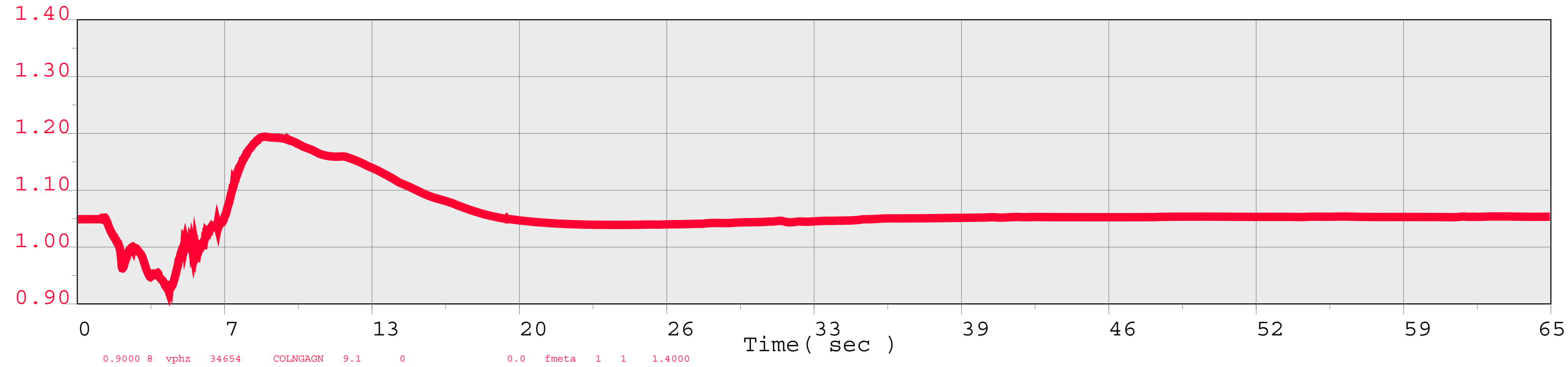


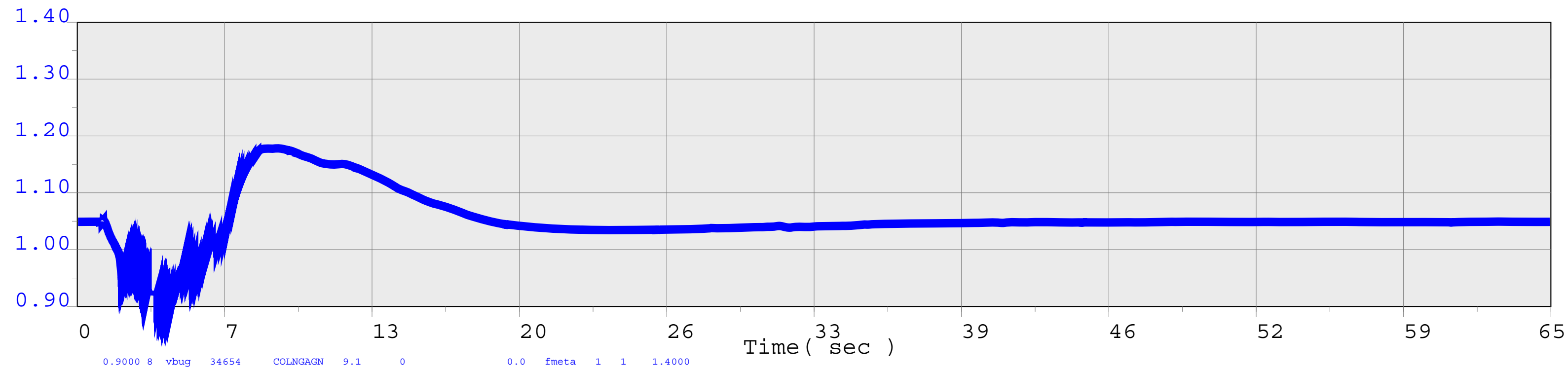
Likely Cause:

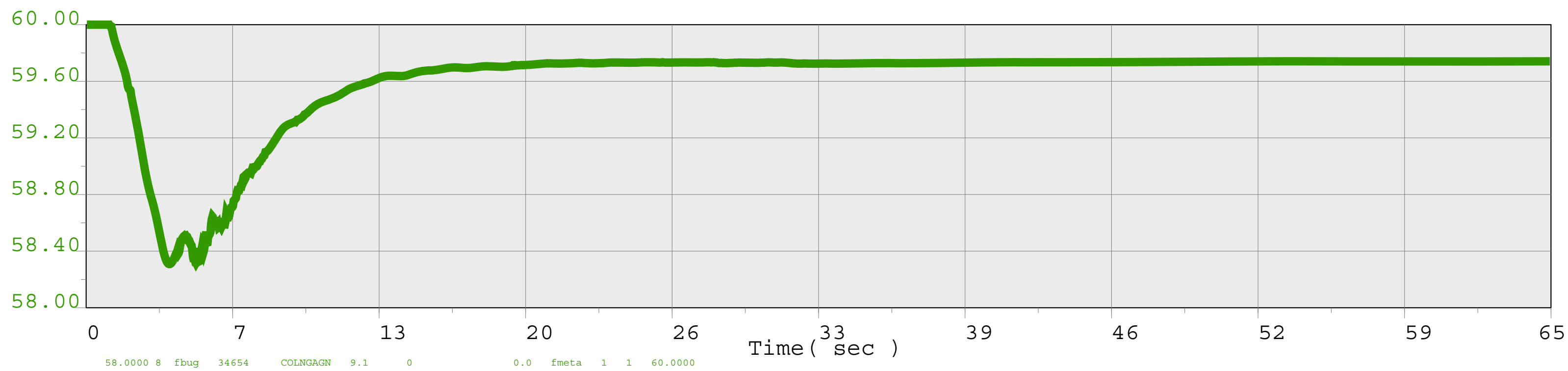
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 12.1 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY





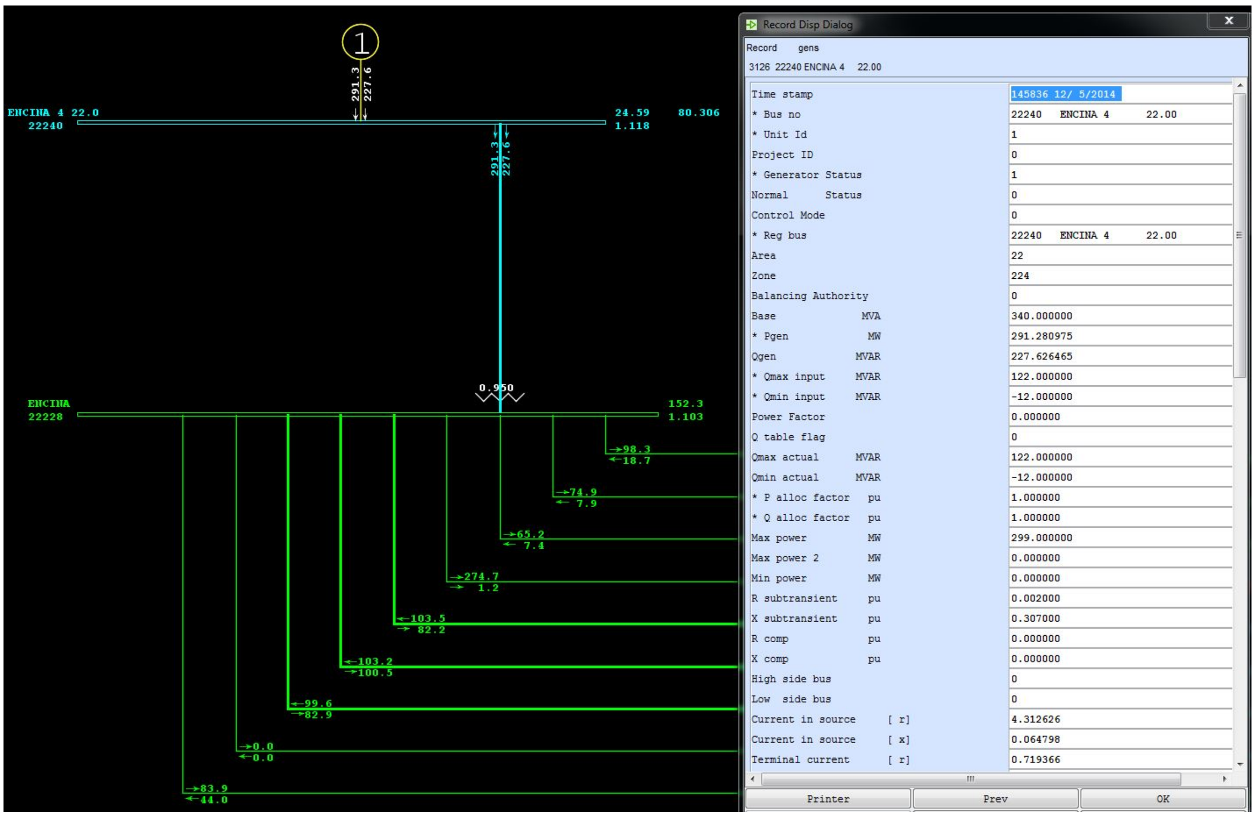


Unit ID:

- ENCINA 4

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

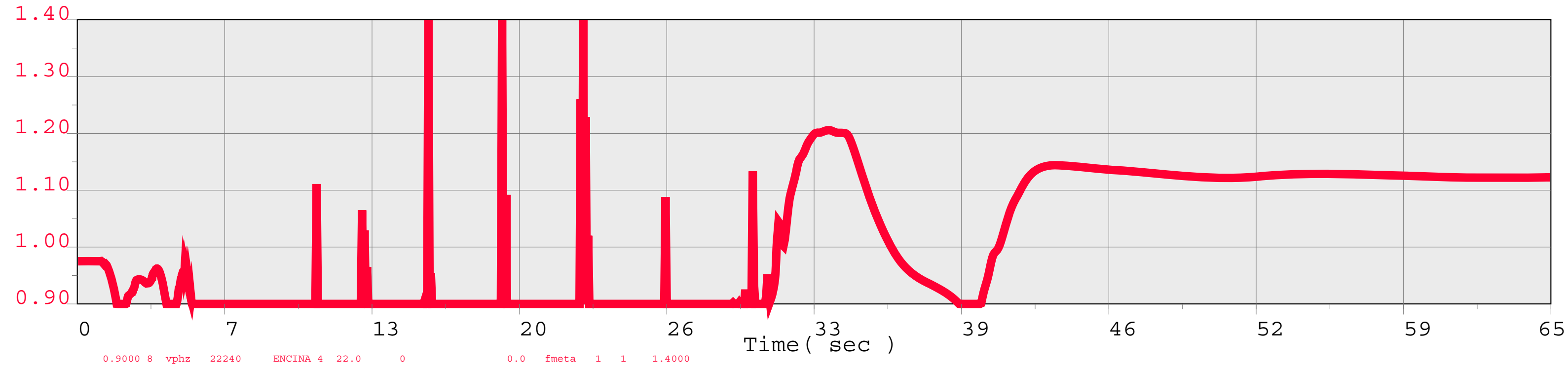


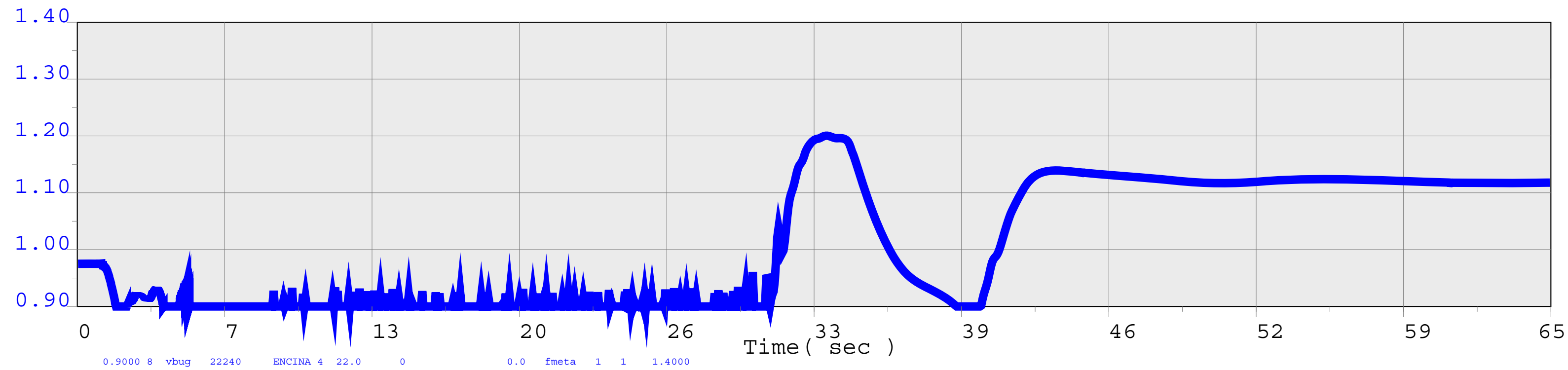
Likely Cause:

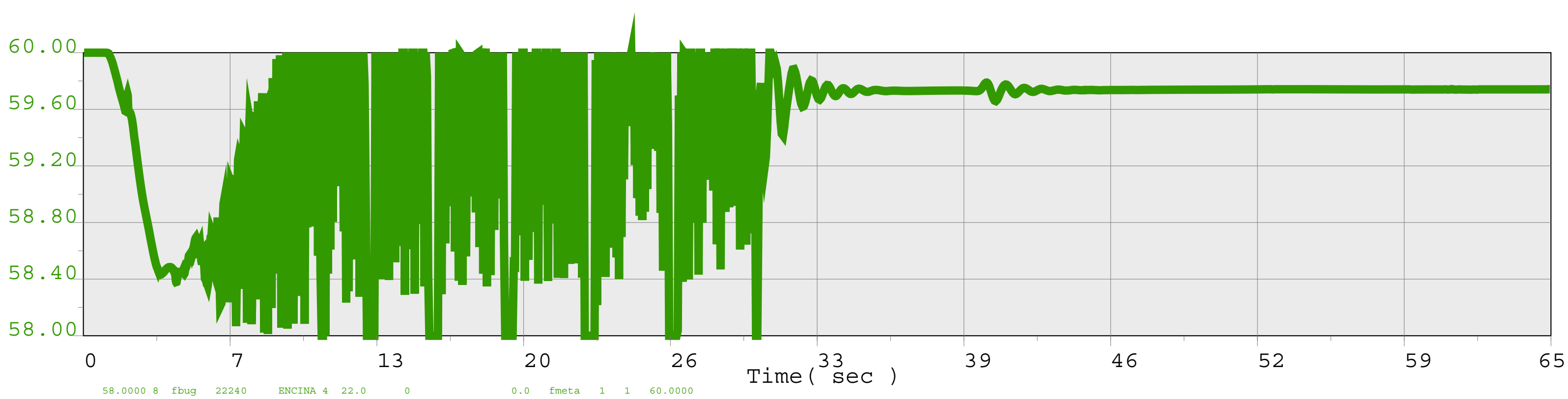
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 227.6 MVAR, which exceeds its Qmax (122 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY





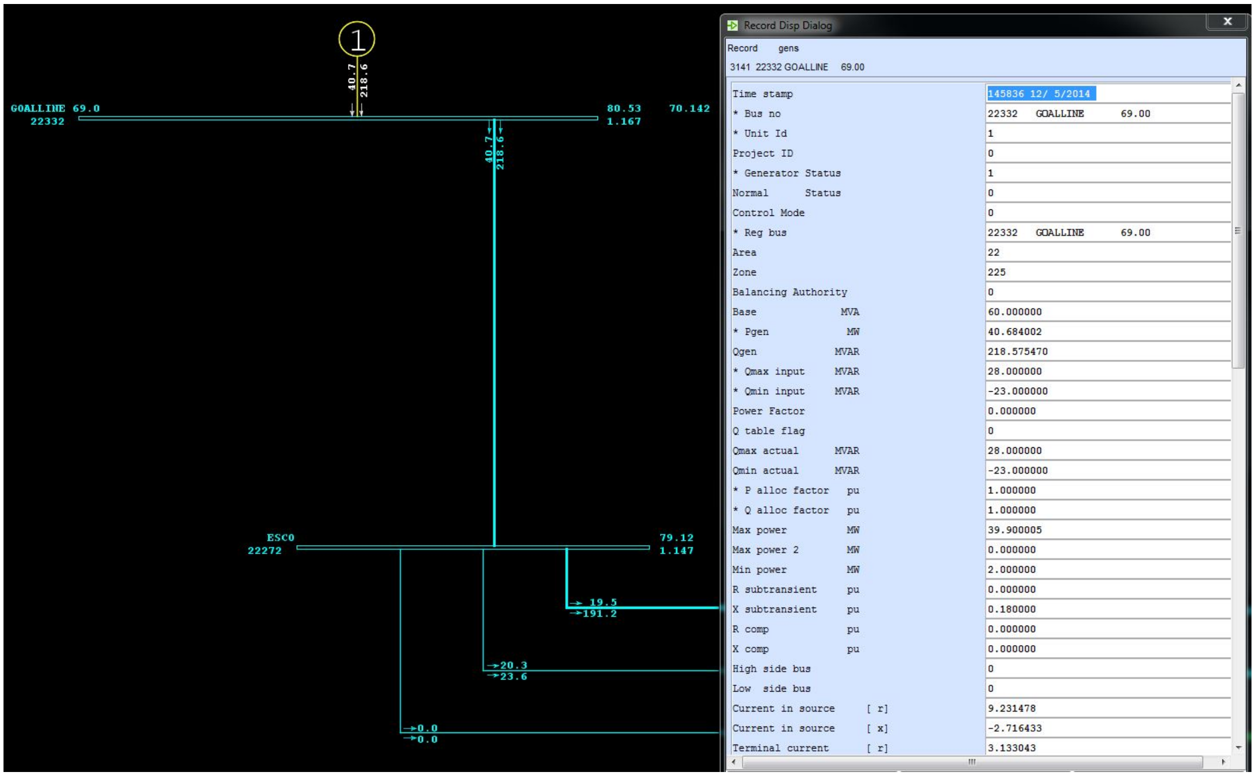


Unit ID:

- GOALLINE

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.

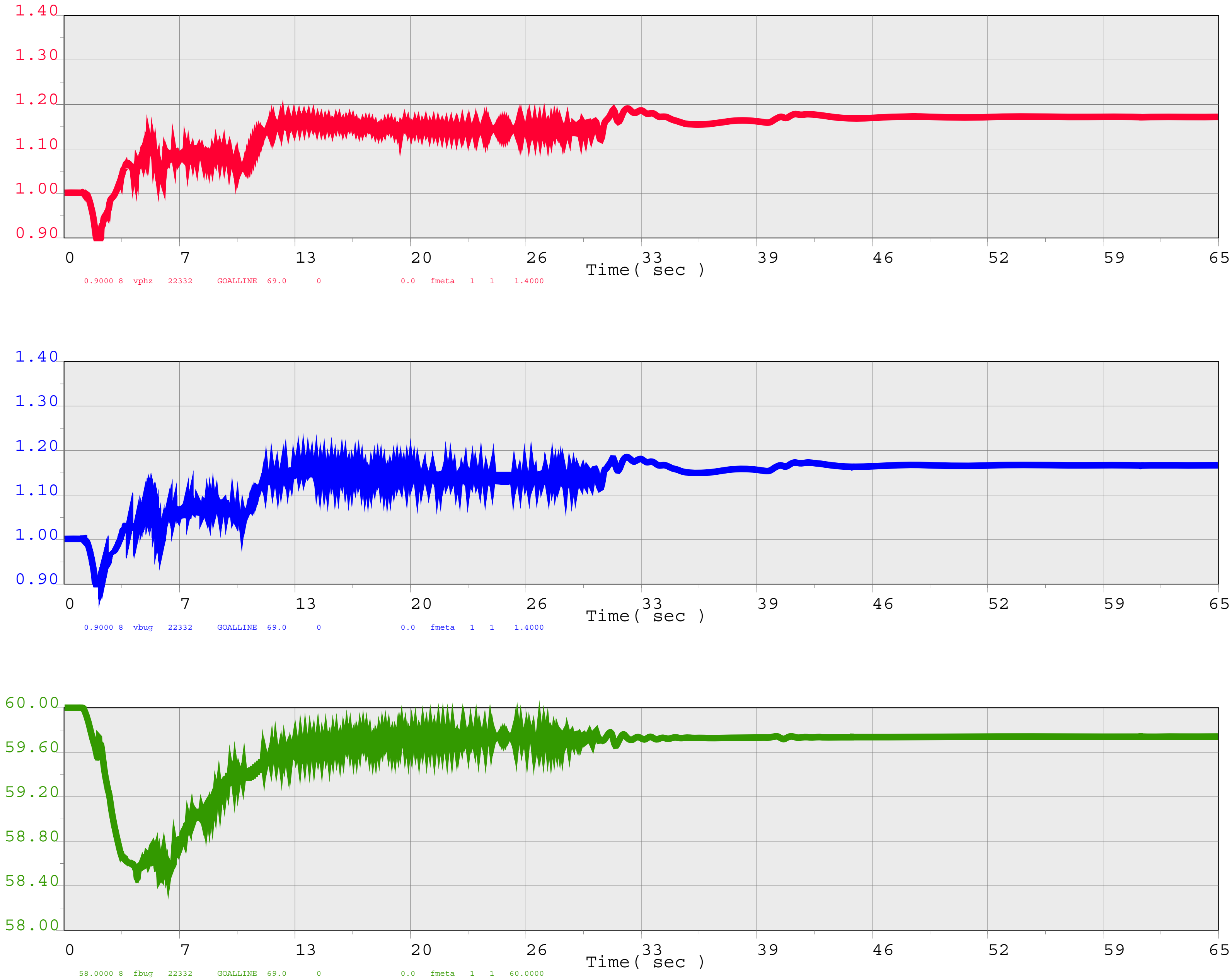


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 218.6 MVAR, which exceeds its Qmax (28 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY



Page 6

15hs_W_25.chf

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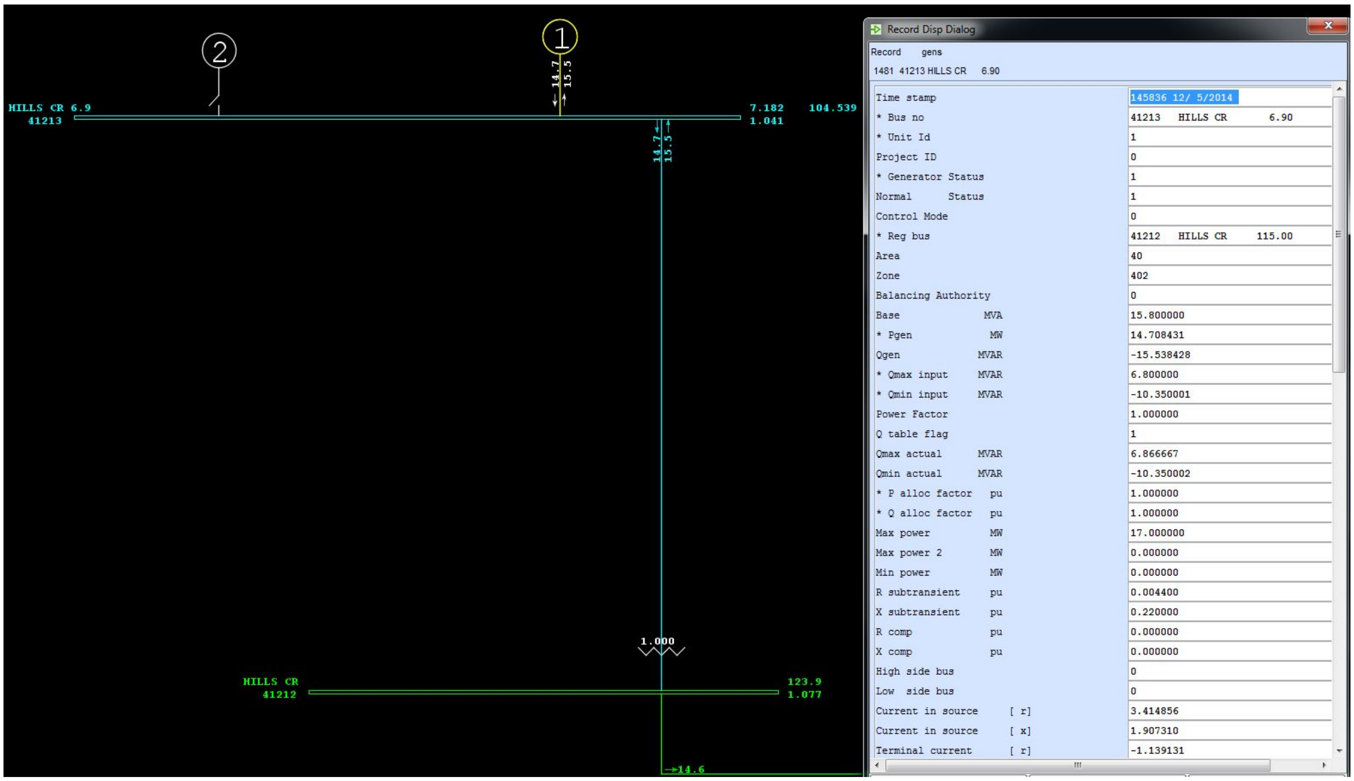
Wed Aug 19 16:29:42 2015

Unit ID:

- HILLS CR

Flagged Potential Violation:

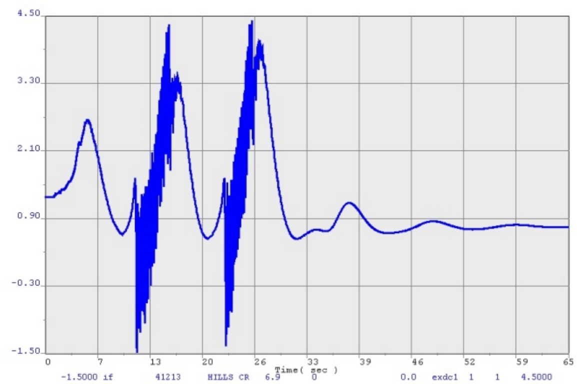
- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.



Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -15.5 MVAR, which exceeds its Qmin (-10.4 MVAR).
- Also as can be seen in the plot below, the field current for this generator is fluctuating between -1.5 and 4.5 p.u. which is suspected to be due to an incorrect exciter model which should not allow this.

Field Current at HILLS CR



Page 20

15hs_W_25.chf

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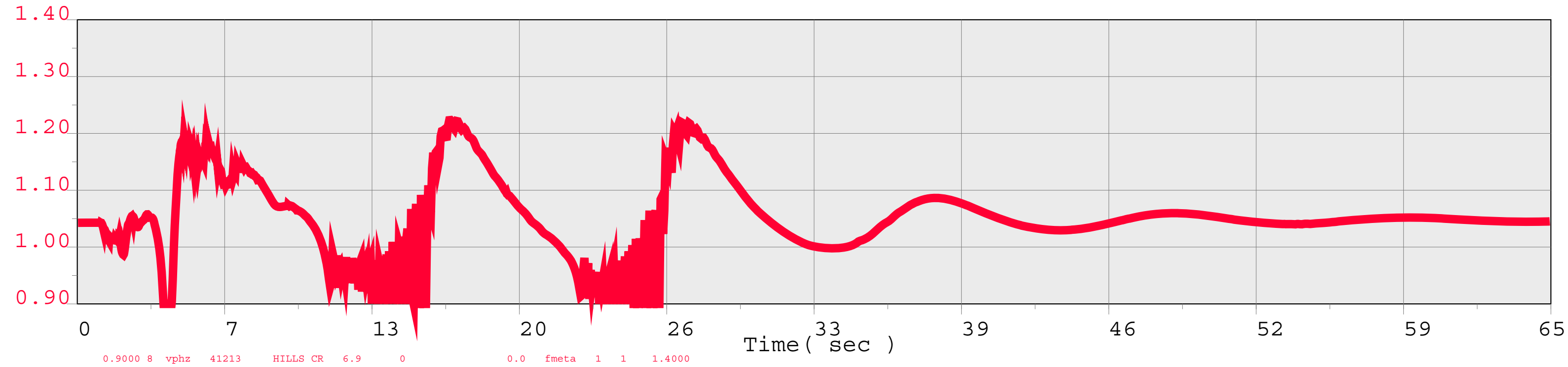
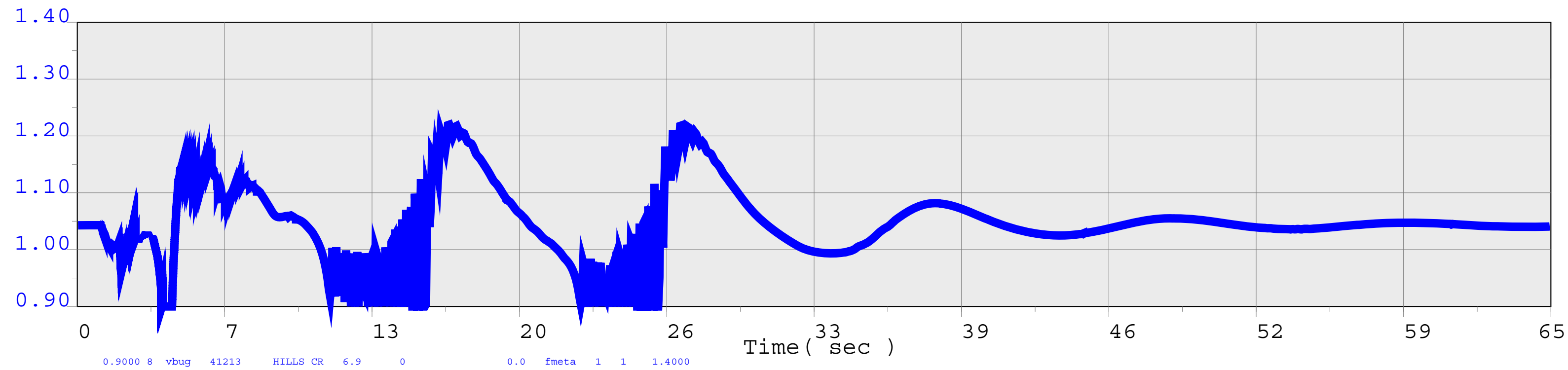
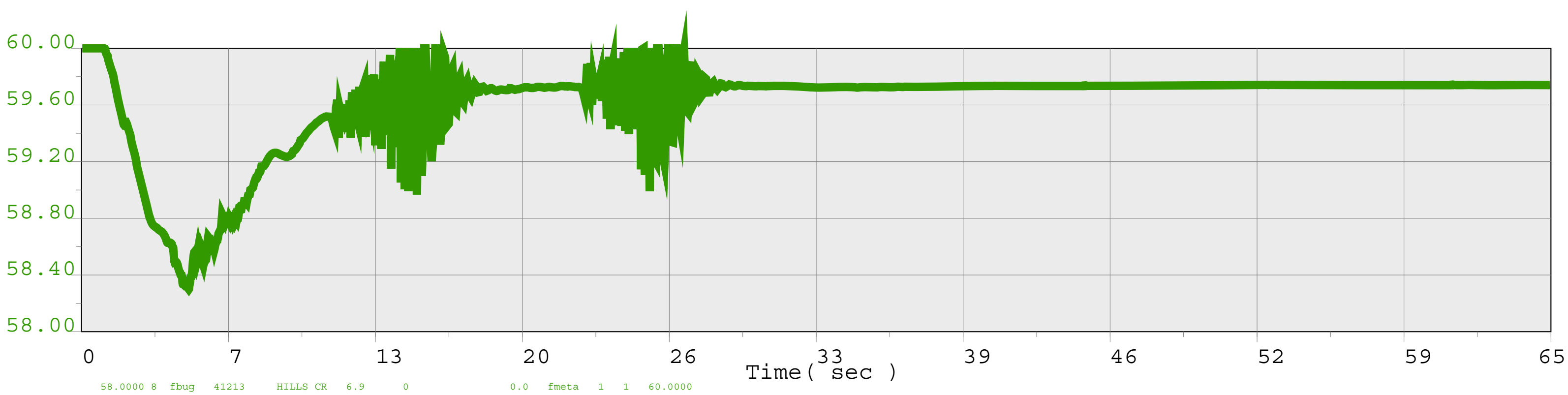
<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES 1.18 V/Hz CRITERIA ONLY





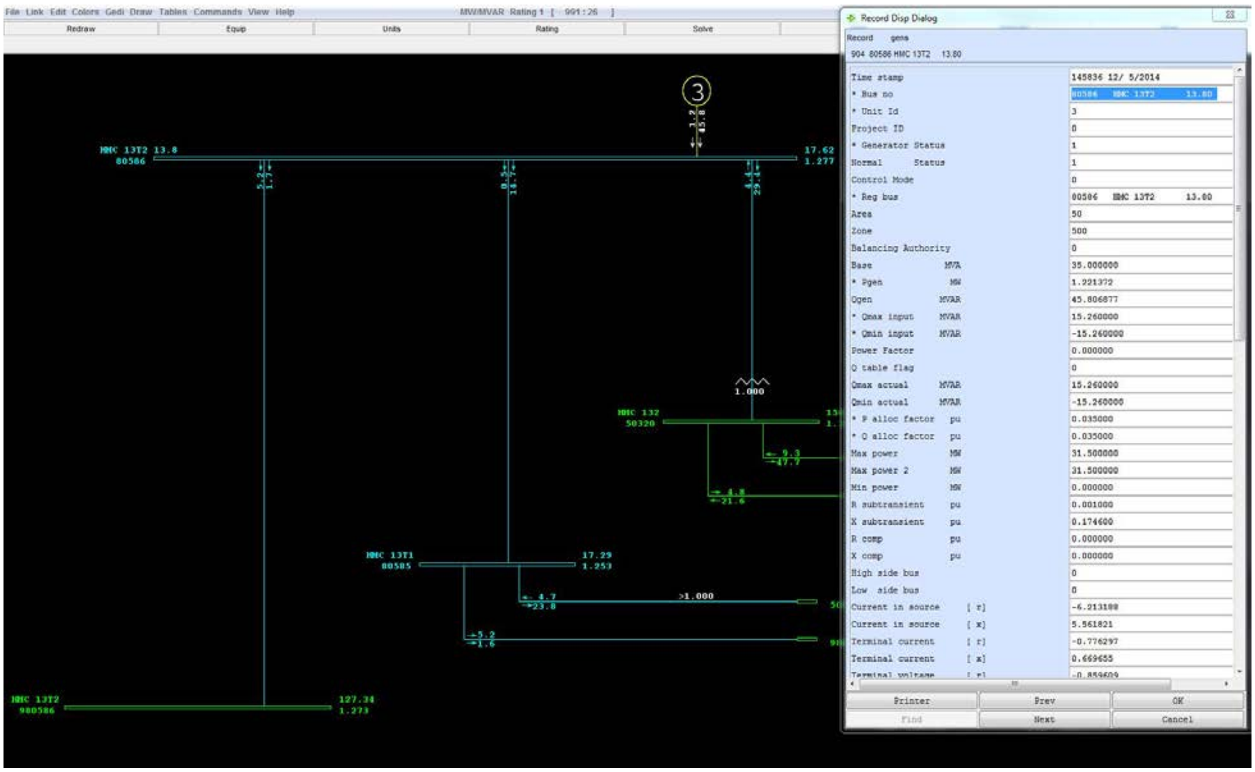


Unit ID:

- HMC 13T2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

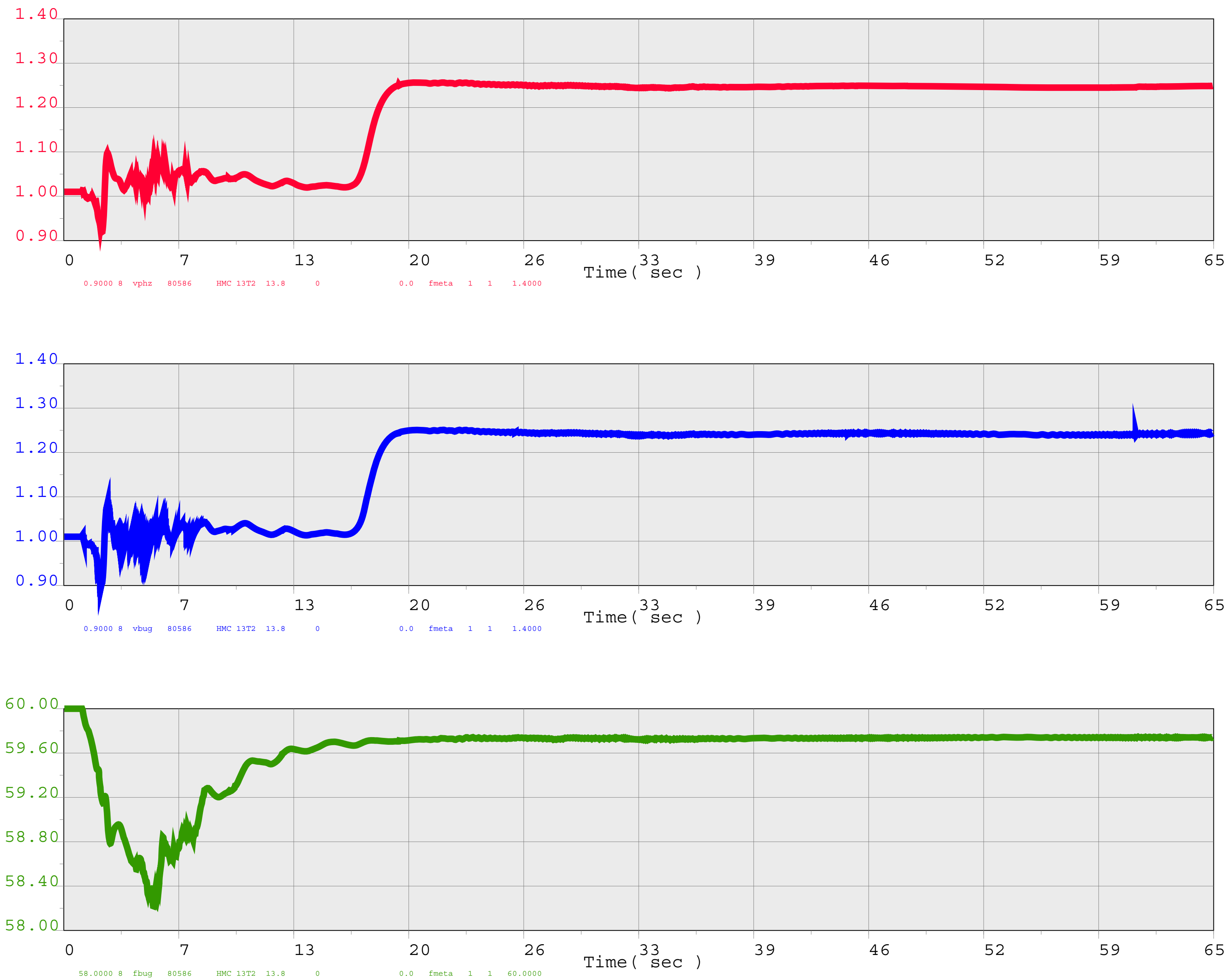


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 45.8 MVAR, which exceeds its Qmax (15 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.10 AND 1.18 V/Hz CRITERIA



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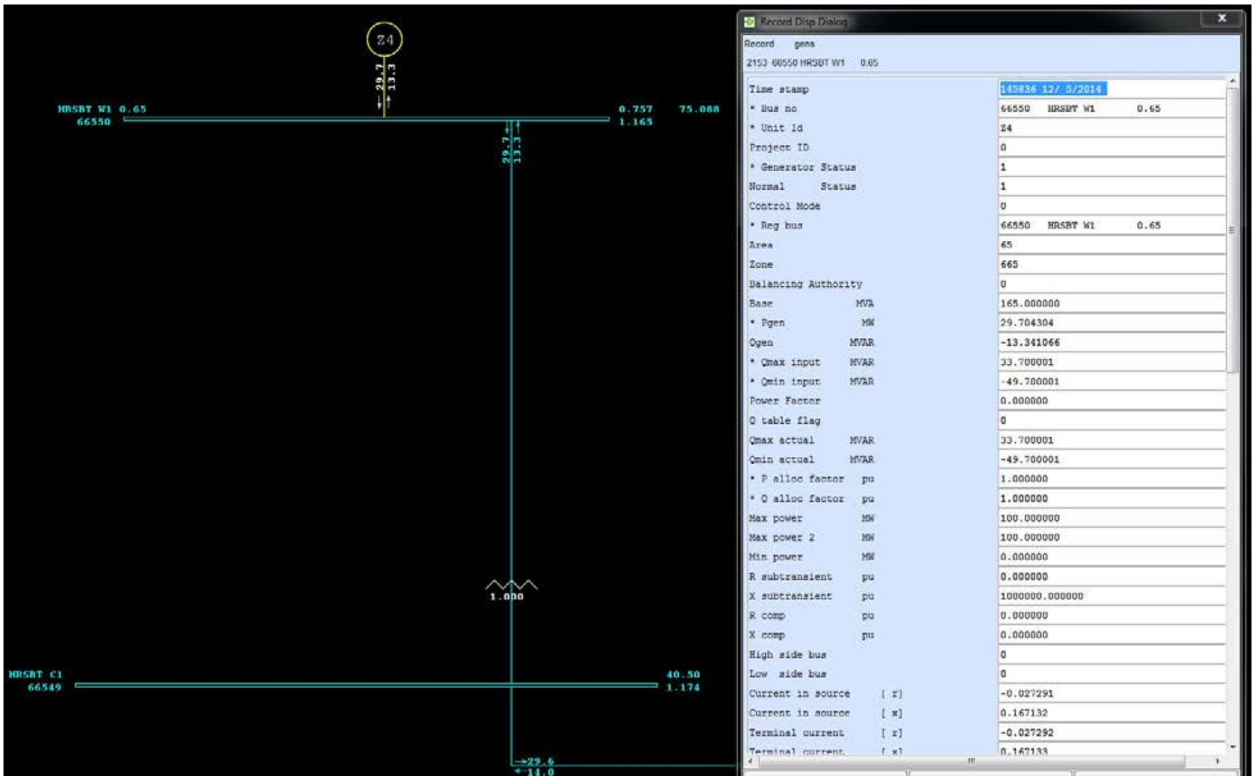
Wed Aug 19 16:29:42 2015

Unit ID:

- HRSBT W1

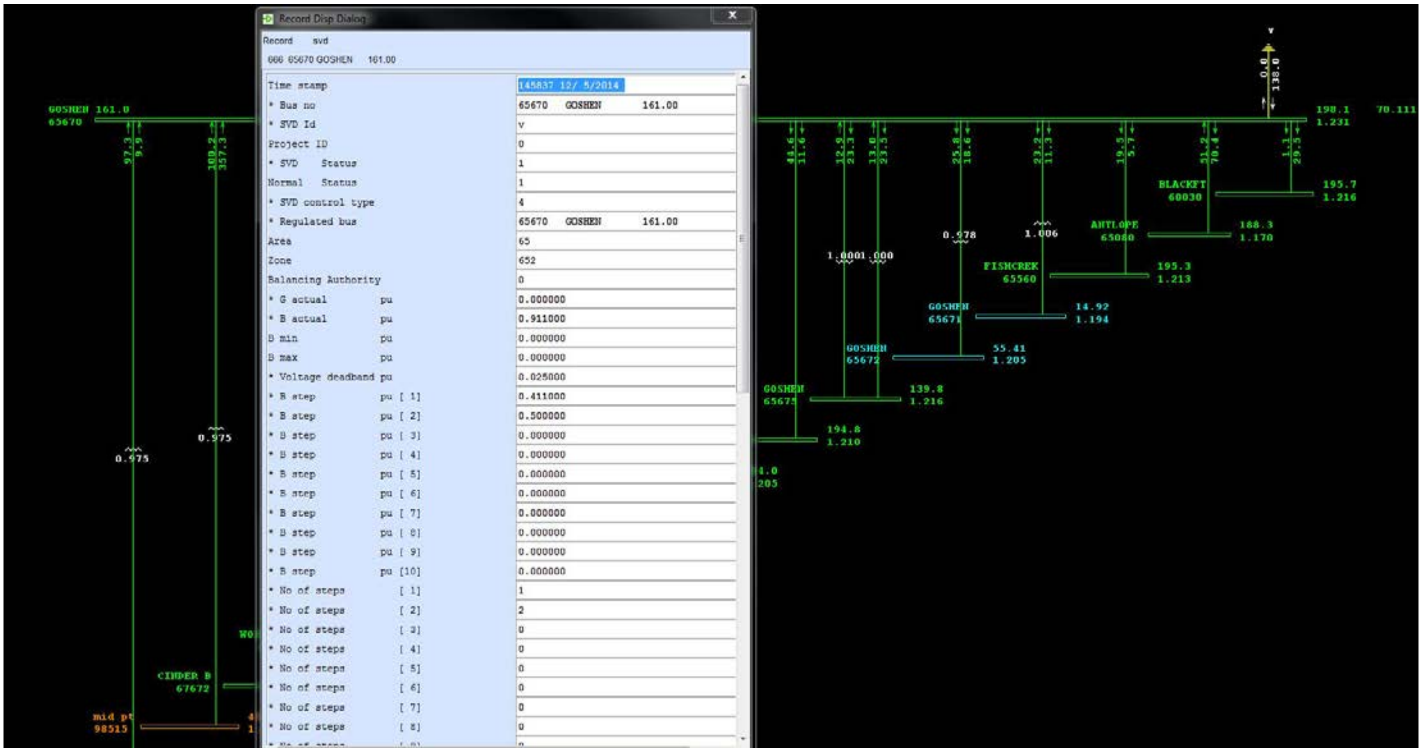
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.



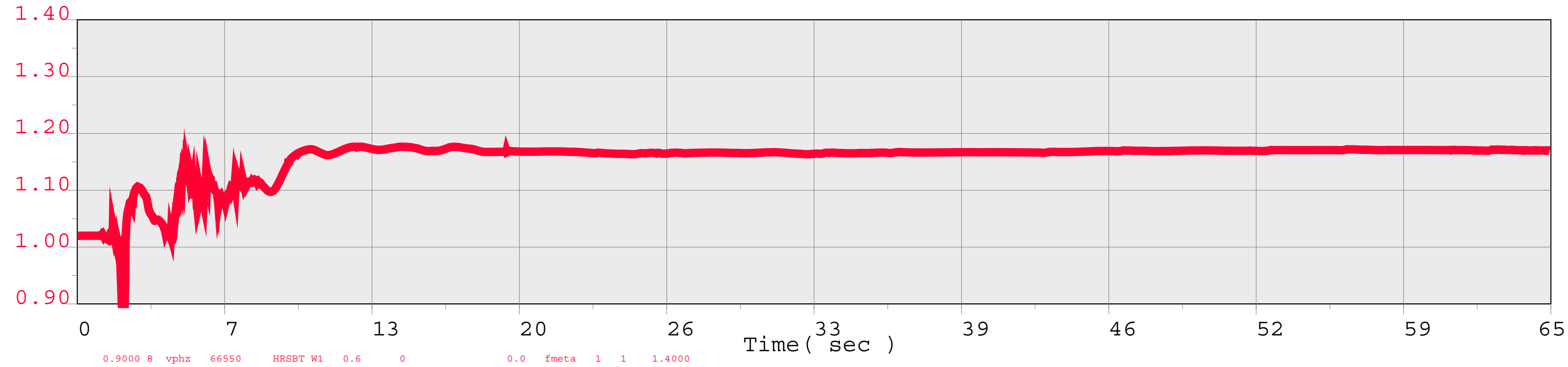
Likely Cause:

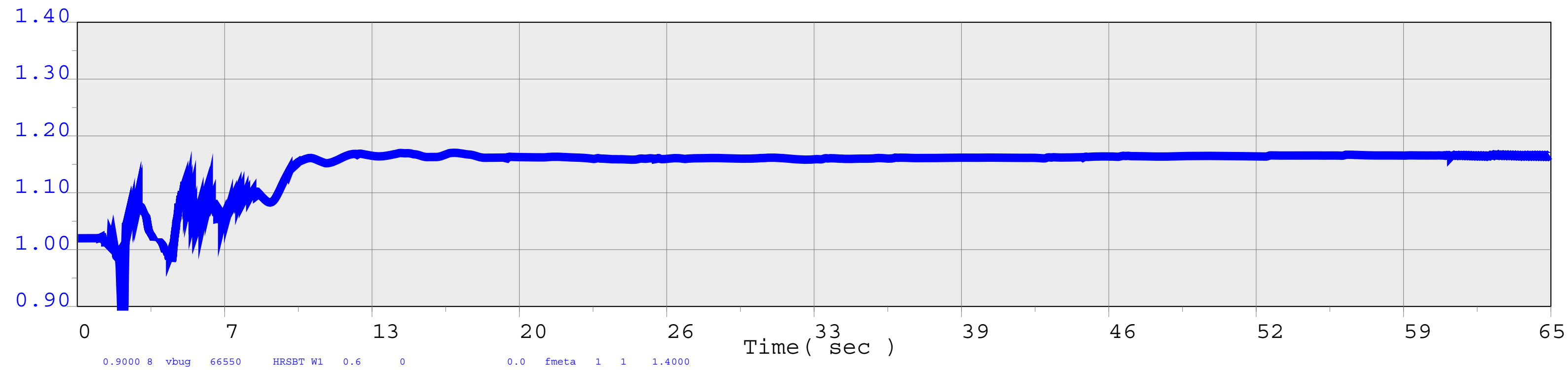
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -13.3 MVAR, which is normal.
- An SVD at a nearby bus (65670) is outputting significant of VARs holding its bus voltage to 1.231 pu (diagram below). This caused HRSBT W1 voltage to be very high
- Suspect incorrect SVD model performance as the model should not allow this.

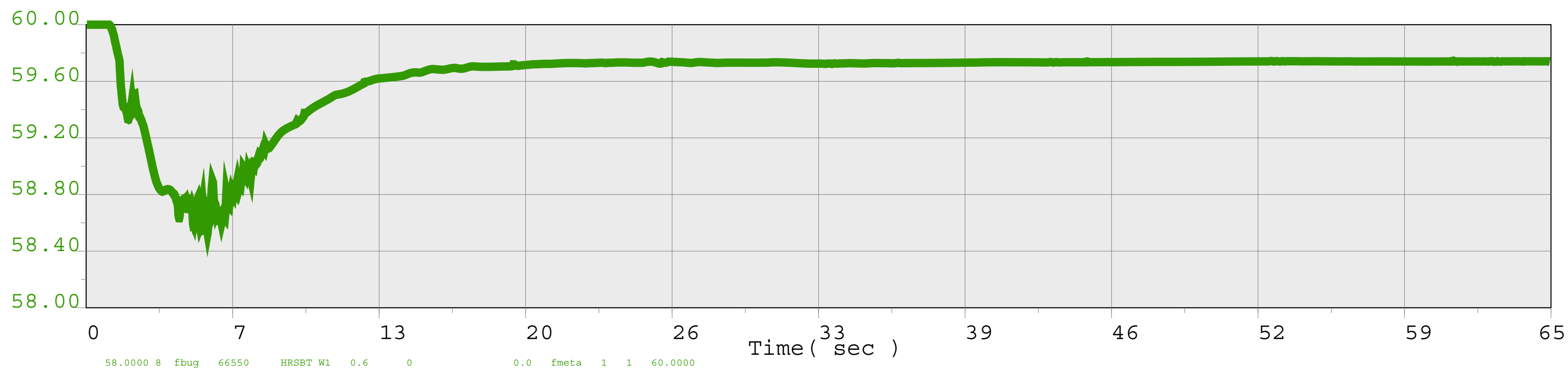


Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY





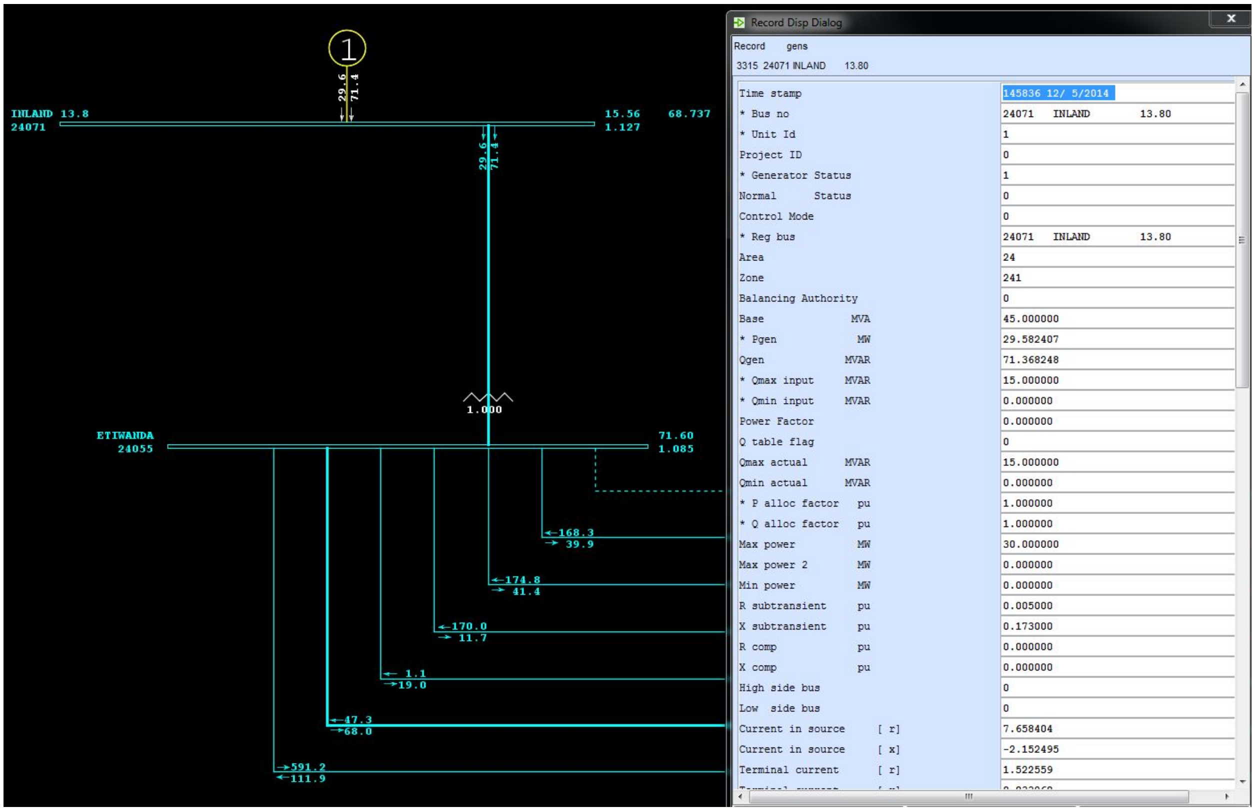


Unit ID:

- INLAND

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.

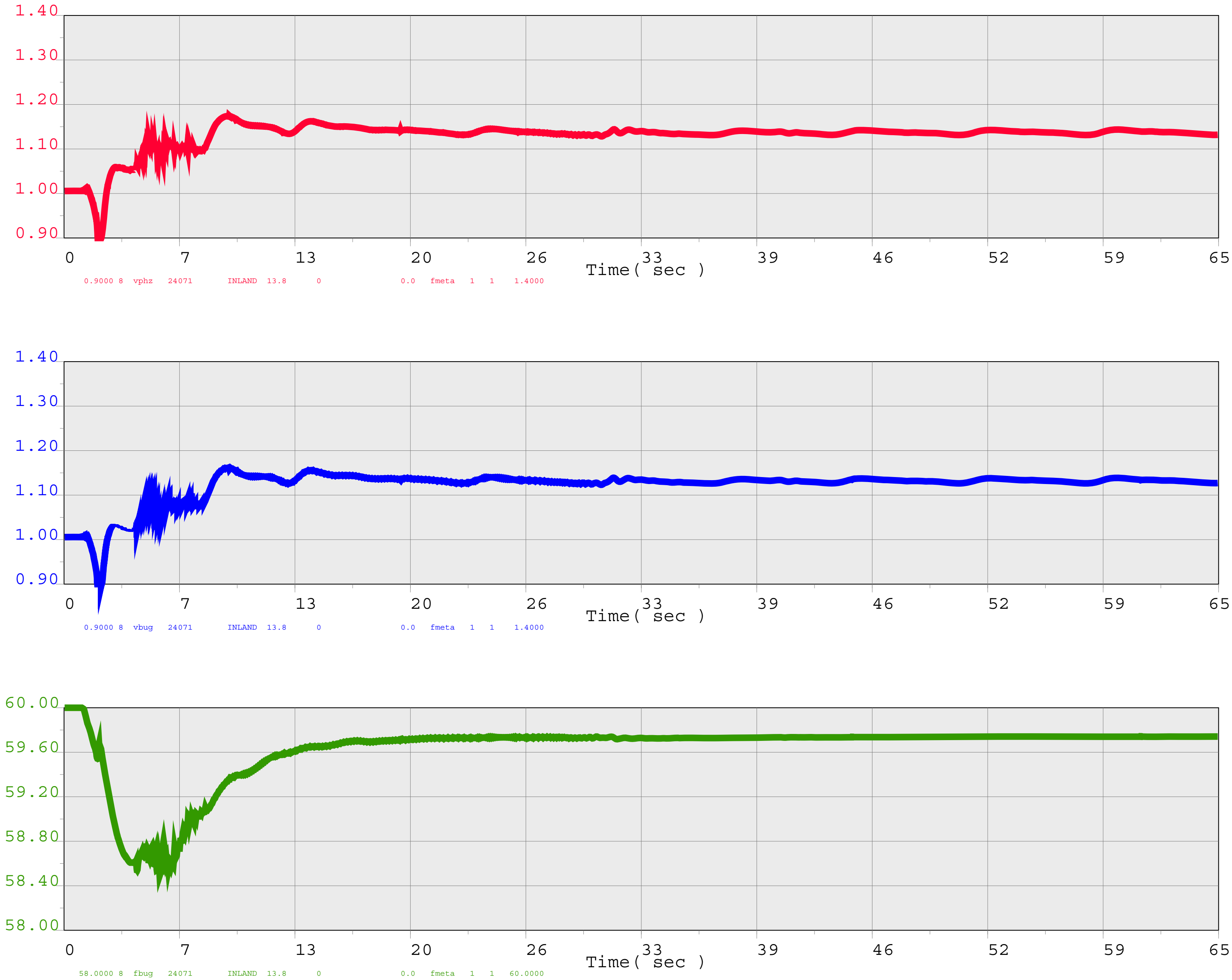


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 71.4 MVAR, which exceeds its Qmax (15 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY

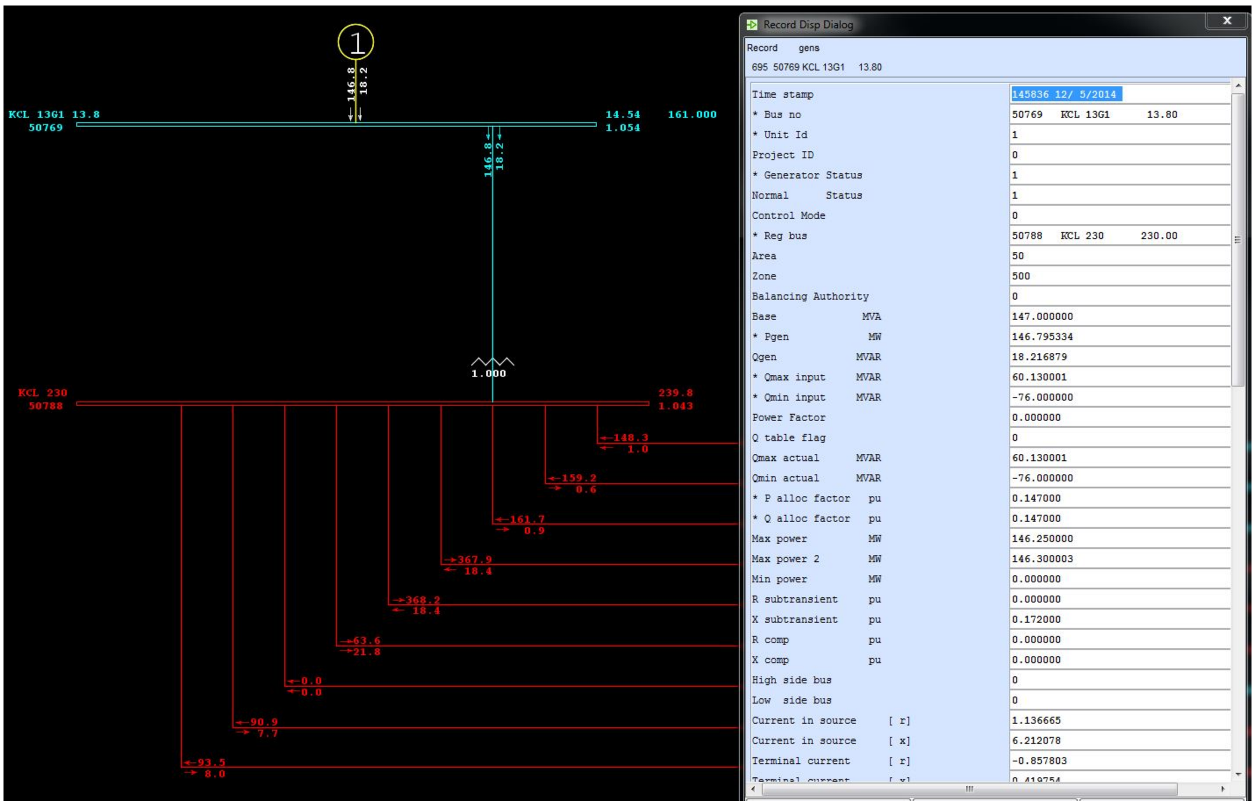


Unit ID:

- KCL 13G1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

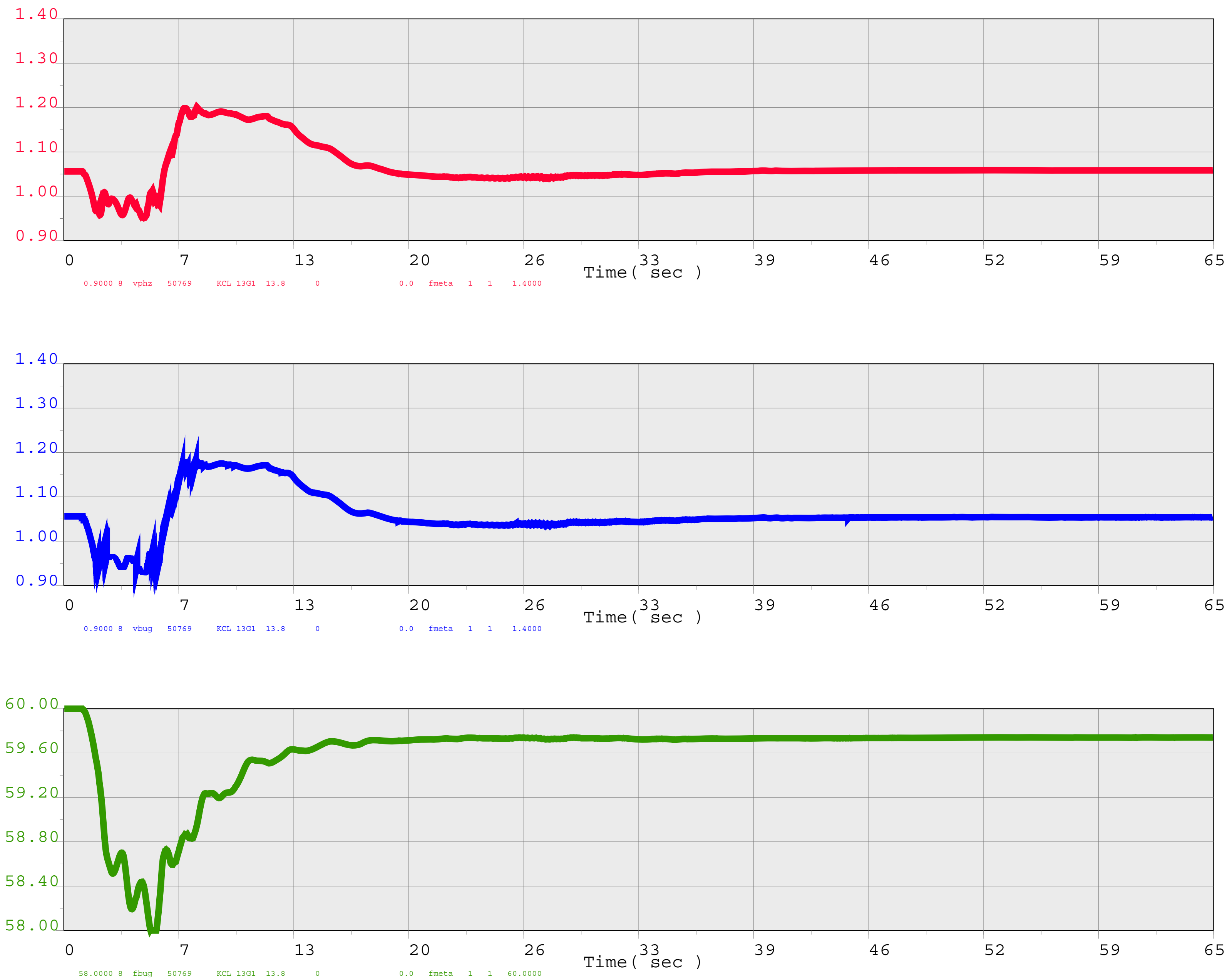


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 18.2 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY



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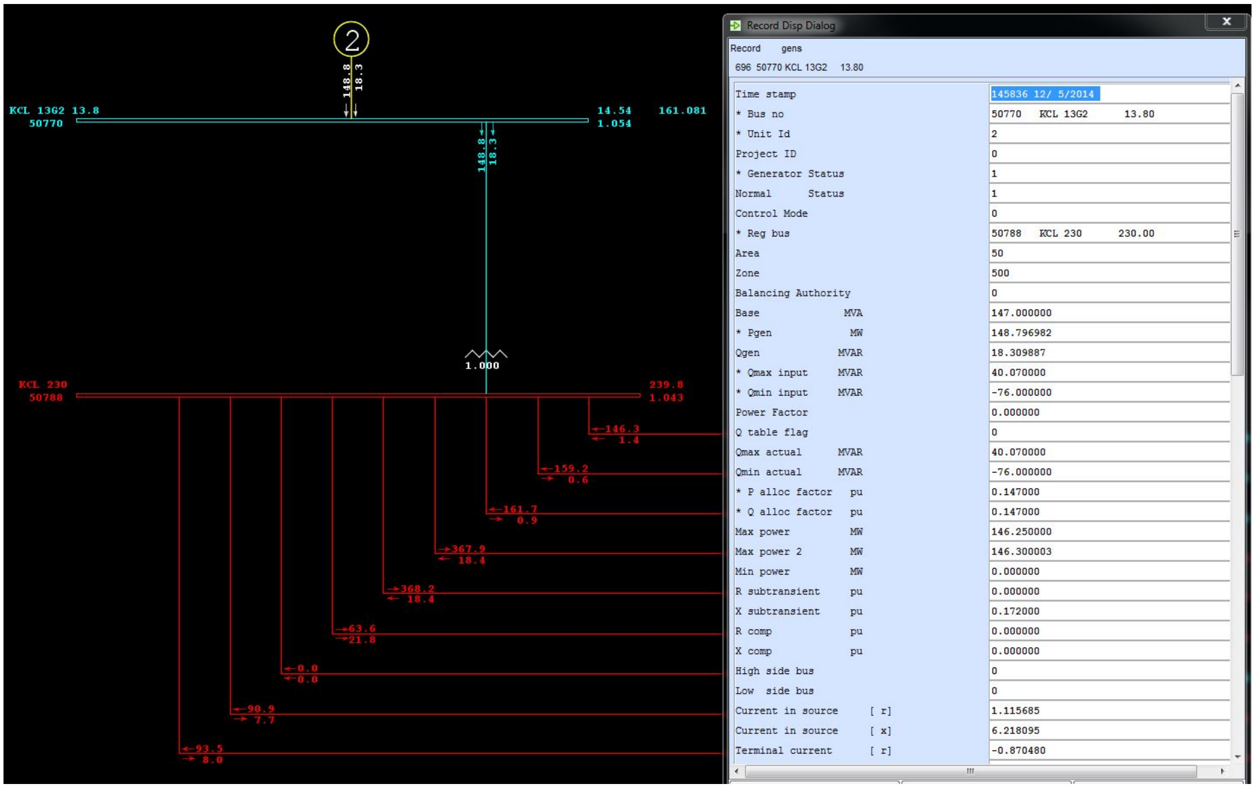
Wed Aug 19 16:29:42 2015

Unit ID:

- KCL 13G2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

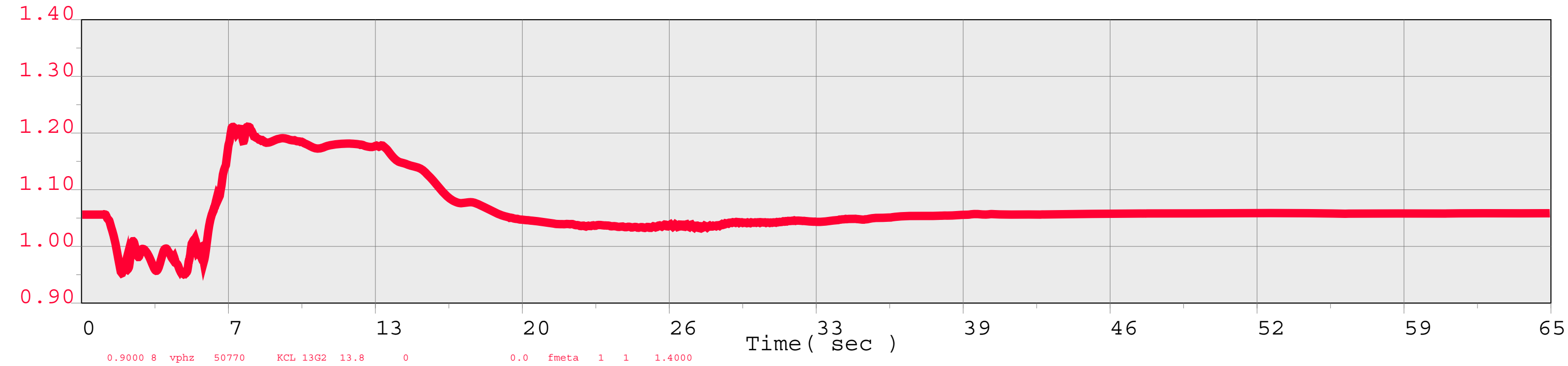


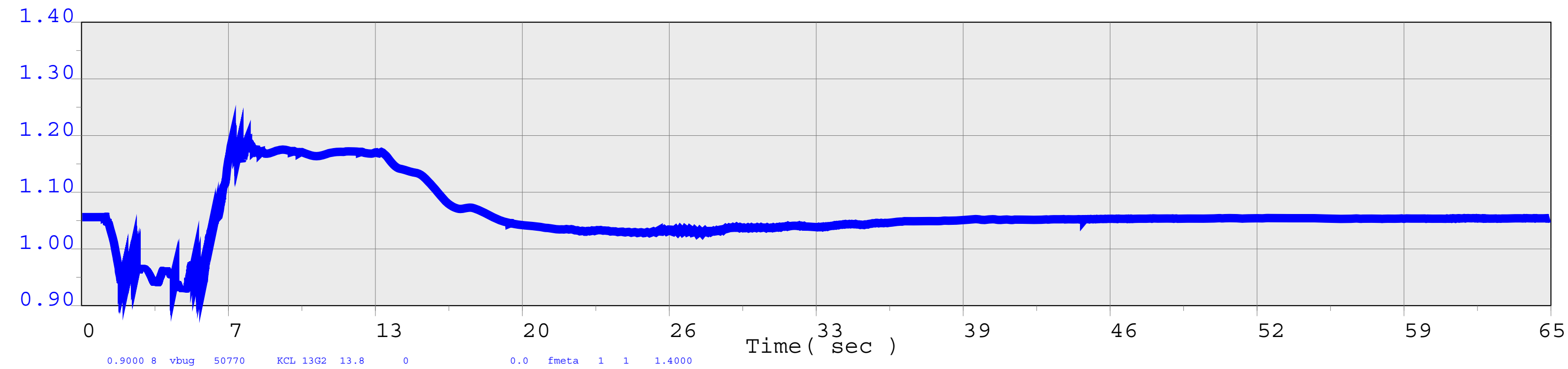
Likely Cause:

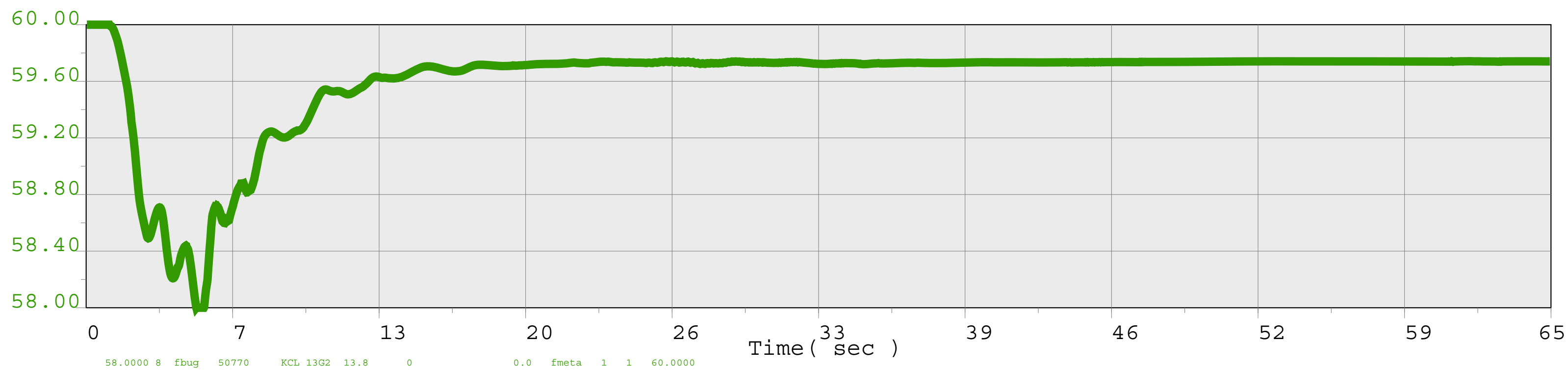
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 18.3 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY





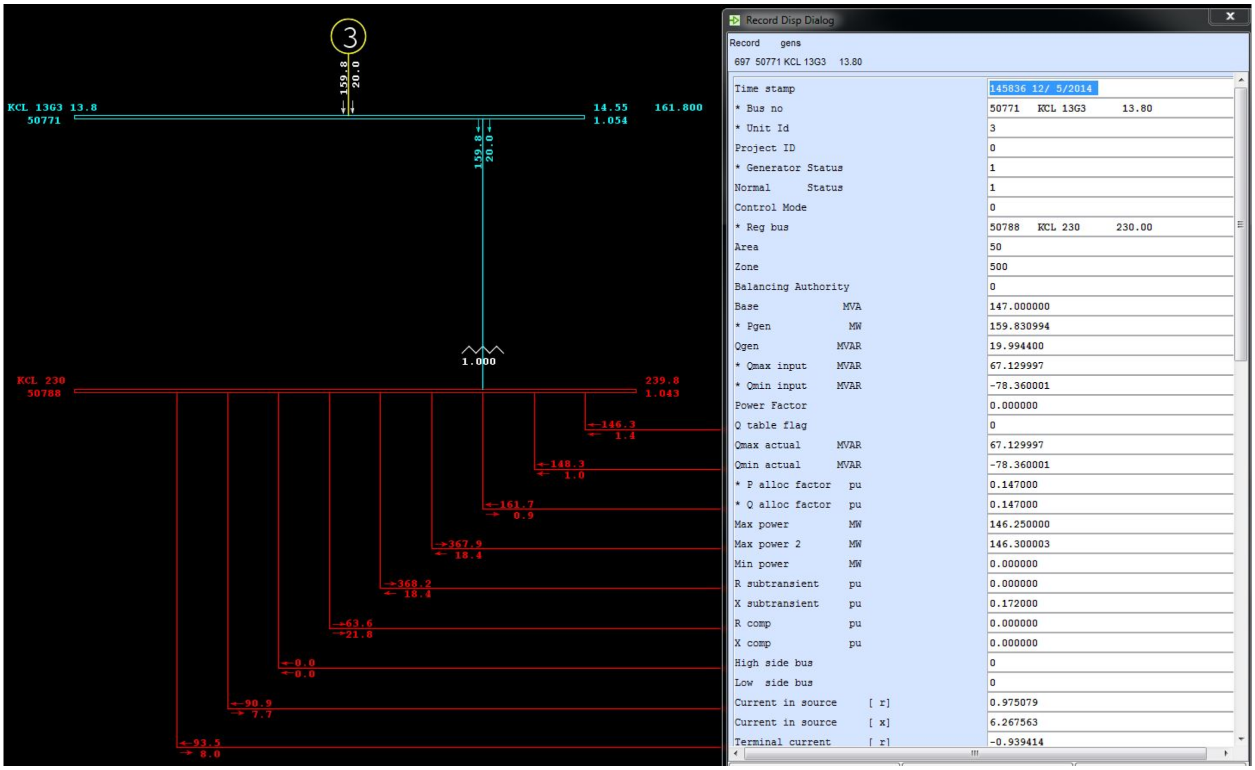


Unit ID:

- KCL 13G3

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

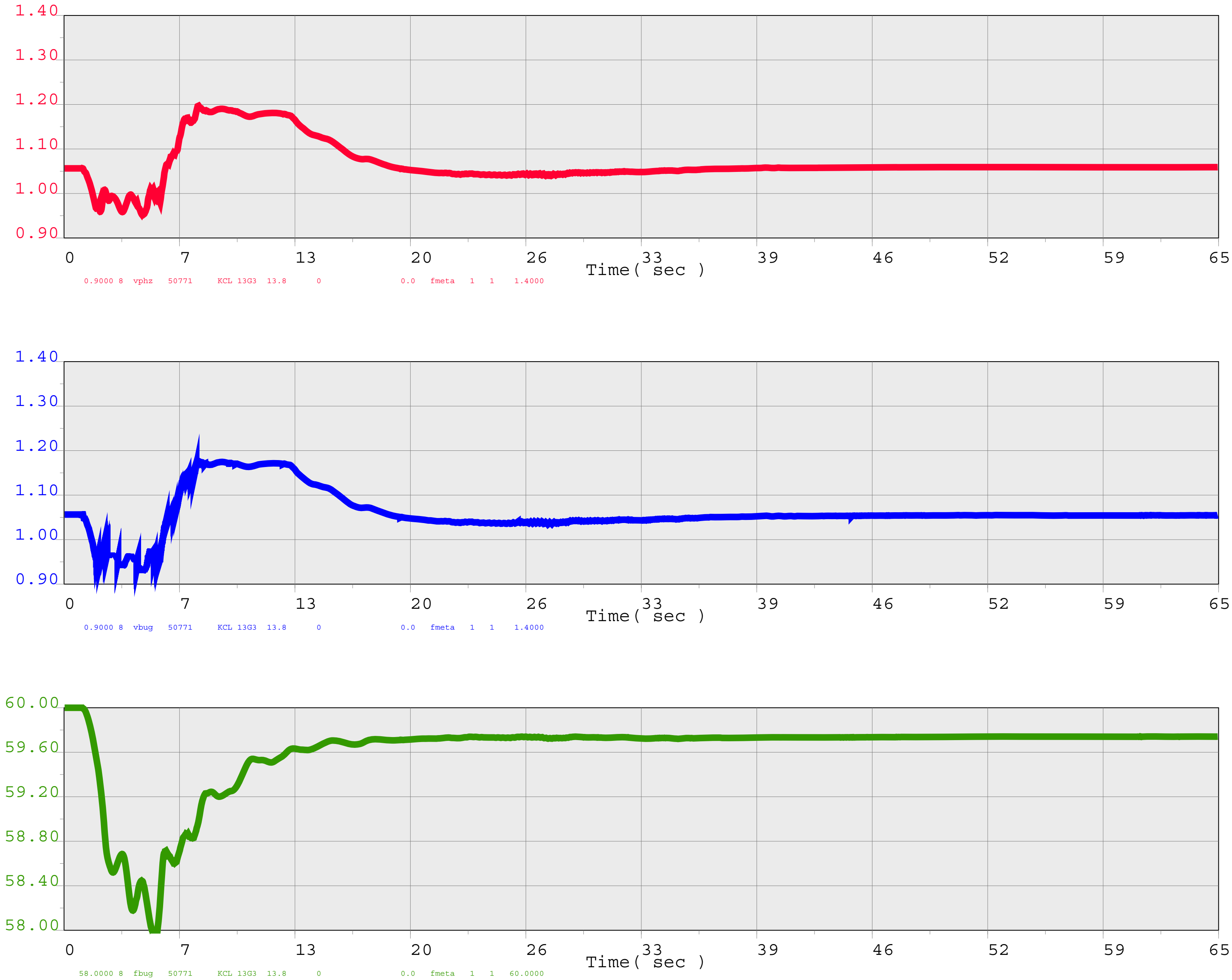


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 20.0 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY



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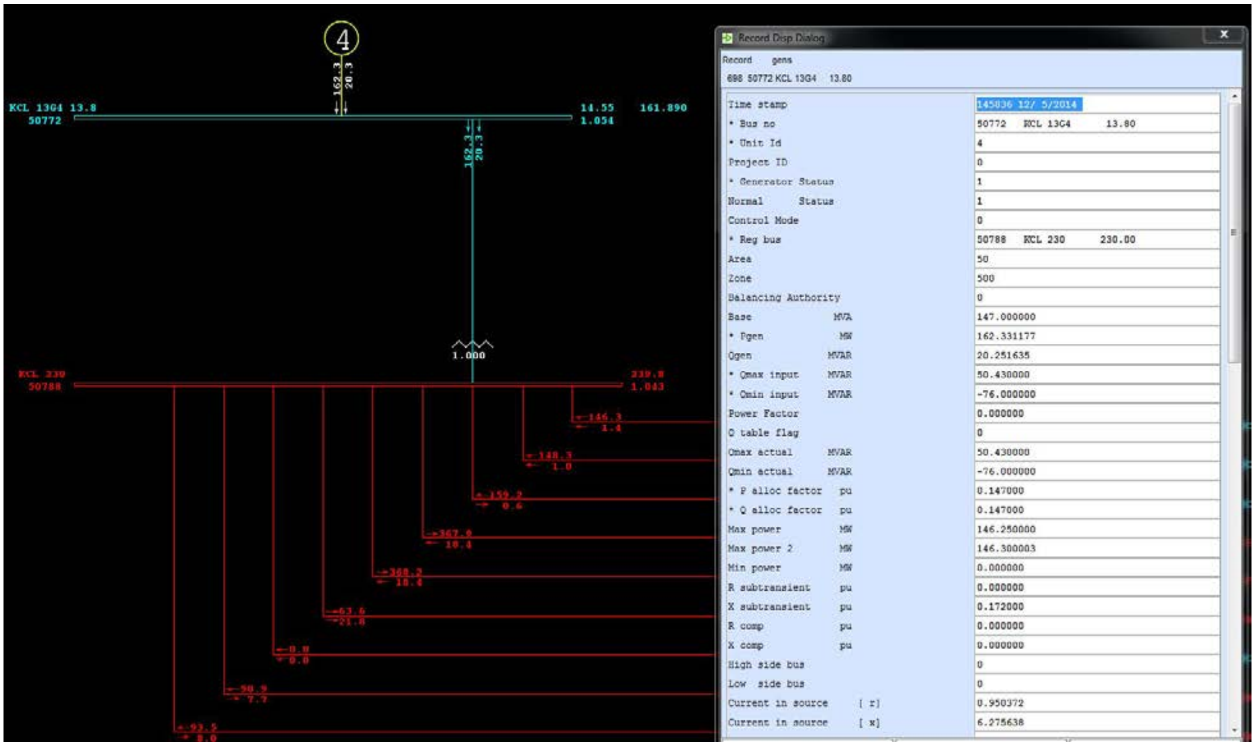
Wed Aug 19 16:29:42 2015

Unit ID:

- KCL 13G4

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

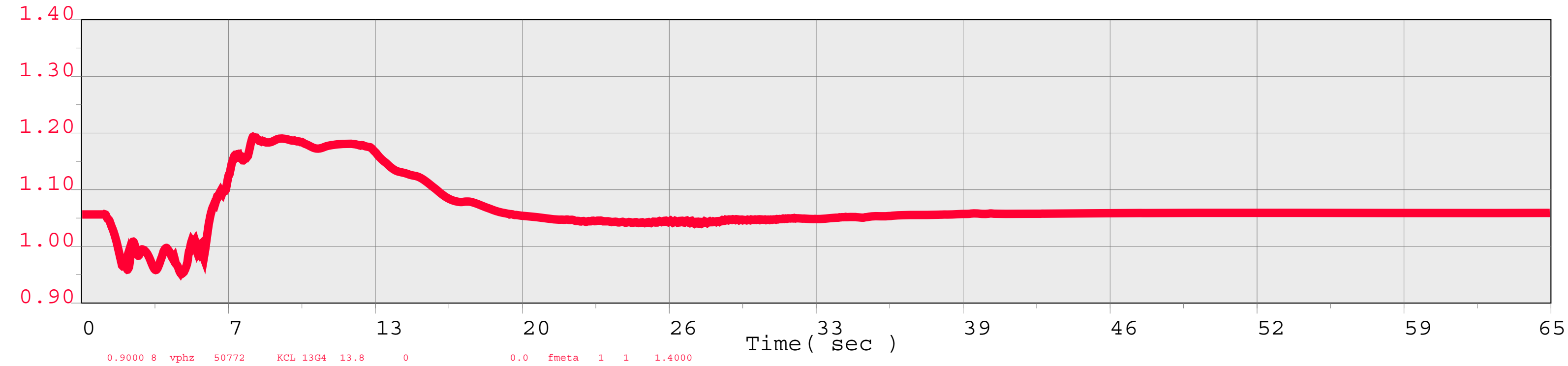


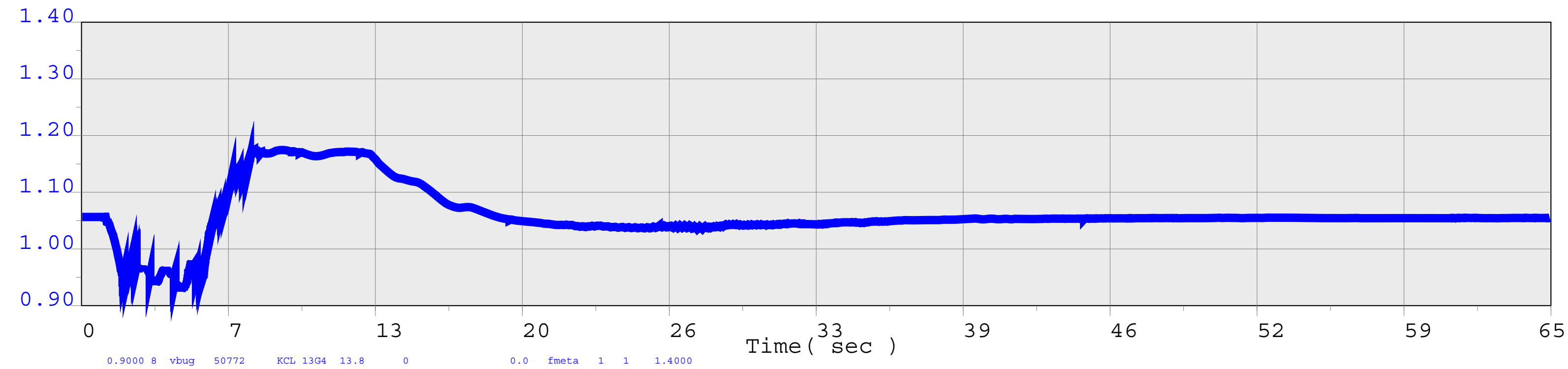
Likely Cause:

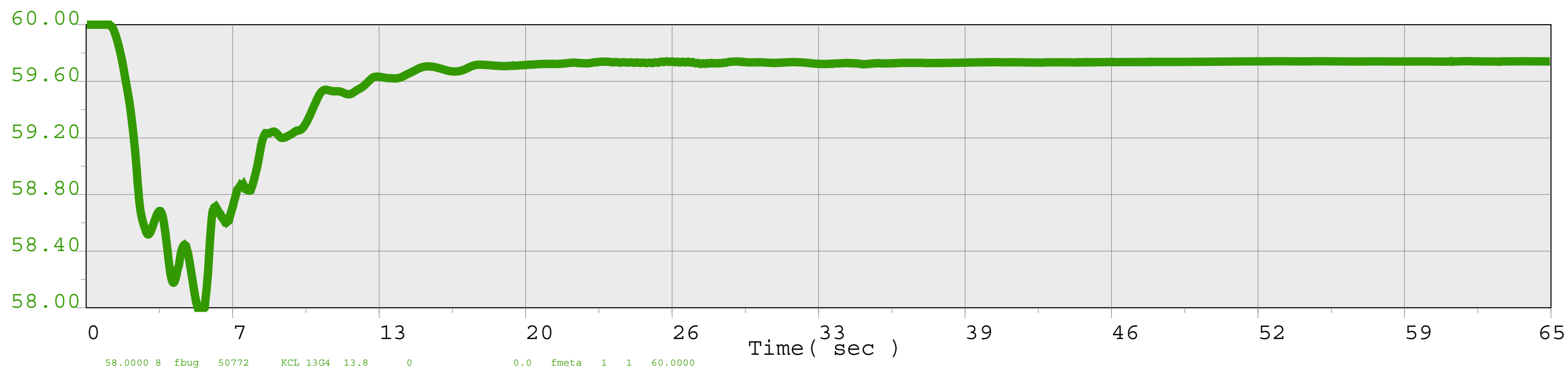
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 20.3 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY







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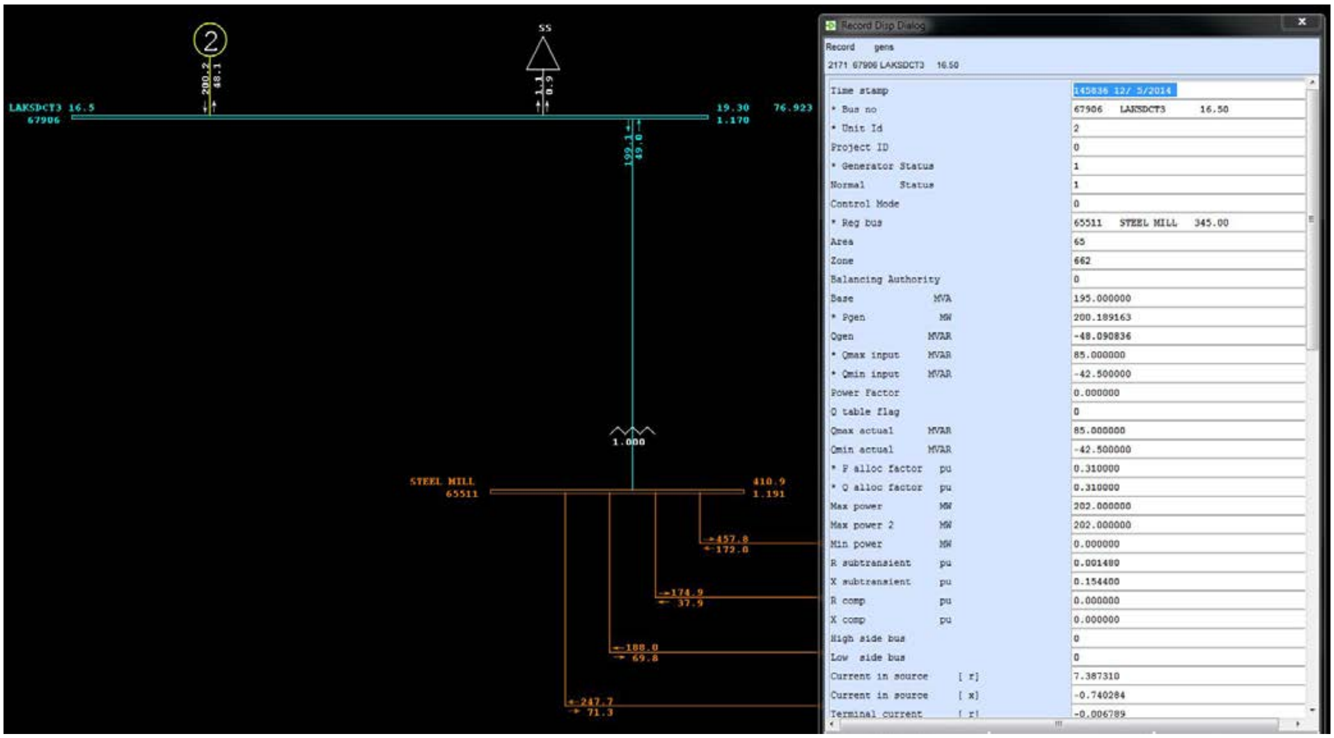
Wed Aug 19 16:29:42 2015

Unit ID:

- LAKSDCT3

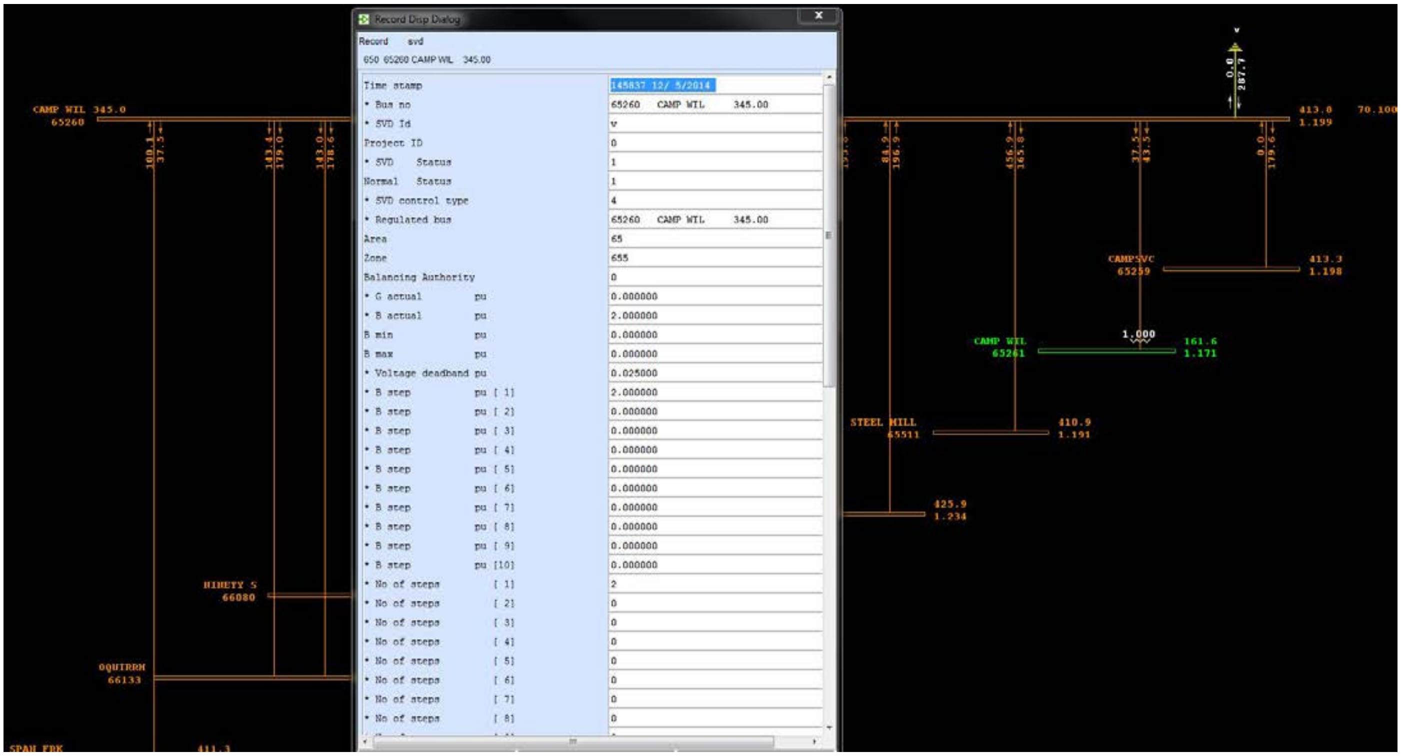
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.



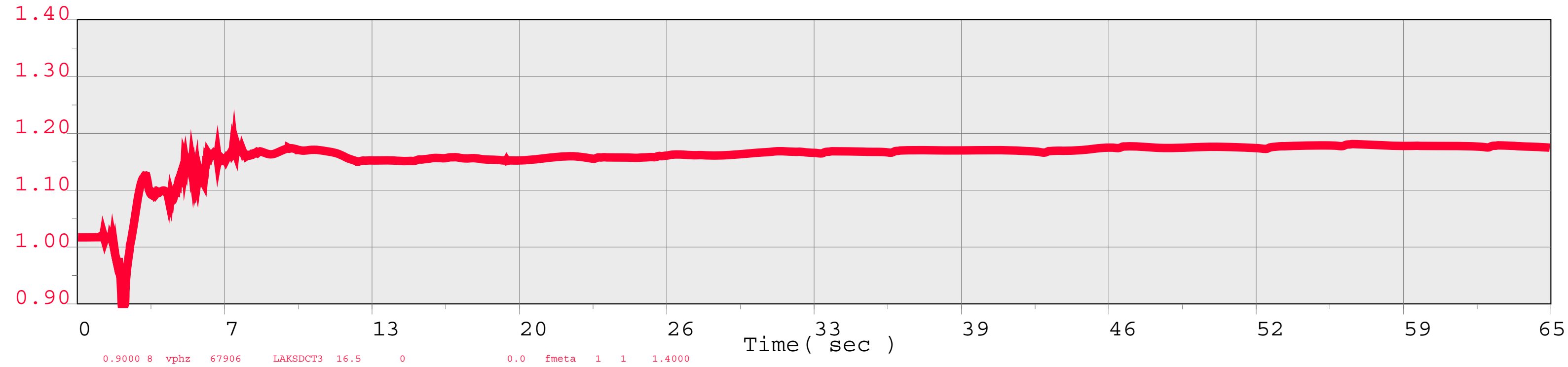
Likely Cause:

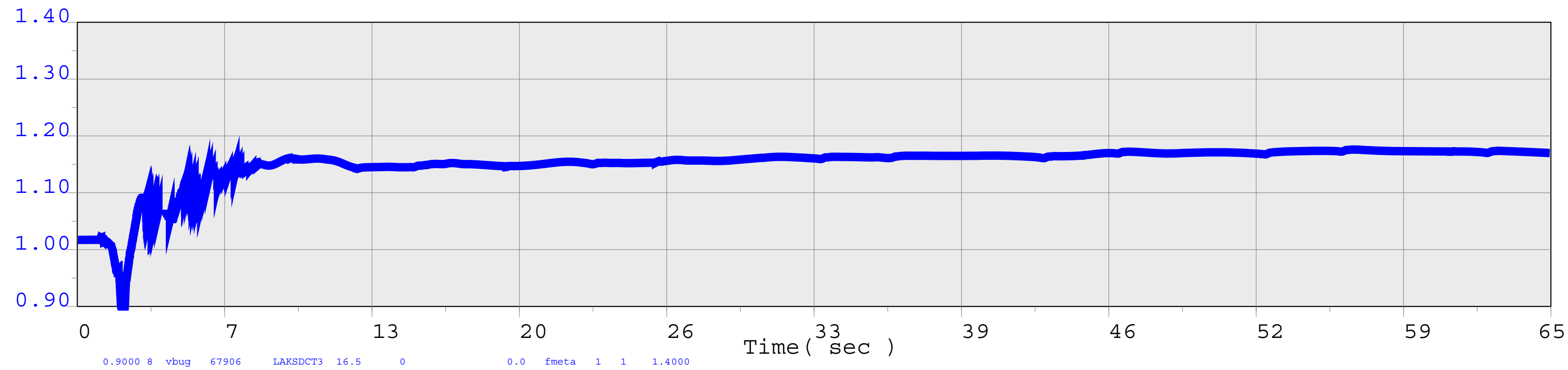
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -48.1 MVAR, which is just outside the Qmin.
- An SVD at a nearby bus (65260) is outputting significant of VARs holding its bus voltage to 1.199 pu (diagram below). This caused LAKSDCT3 voltage to be very high
- Suspect incorrect SVD model performance as the model should not allow this.

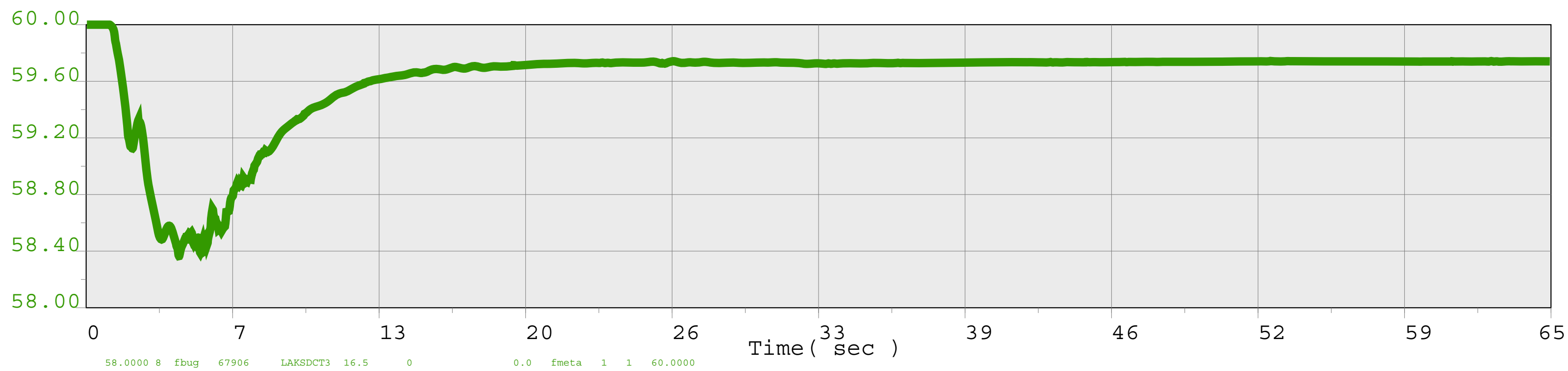


<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES 1.10 V/Hz CRITERIA ONLY





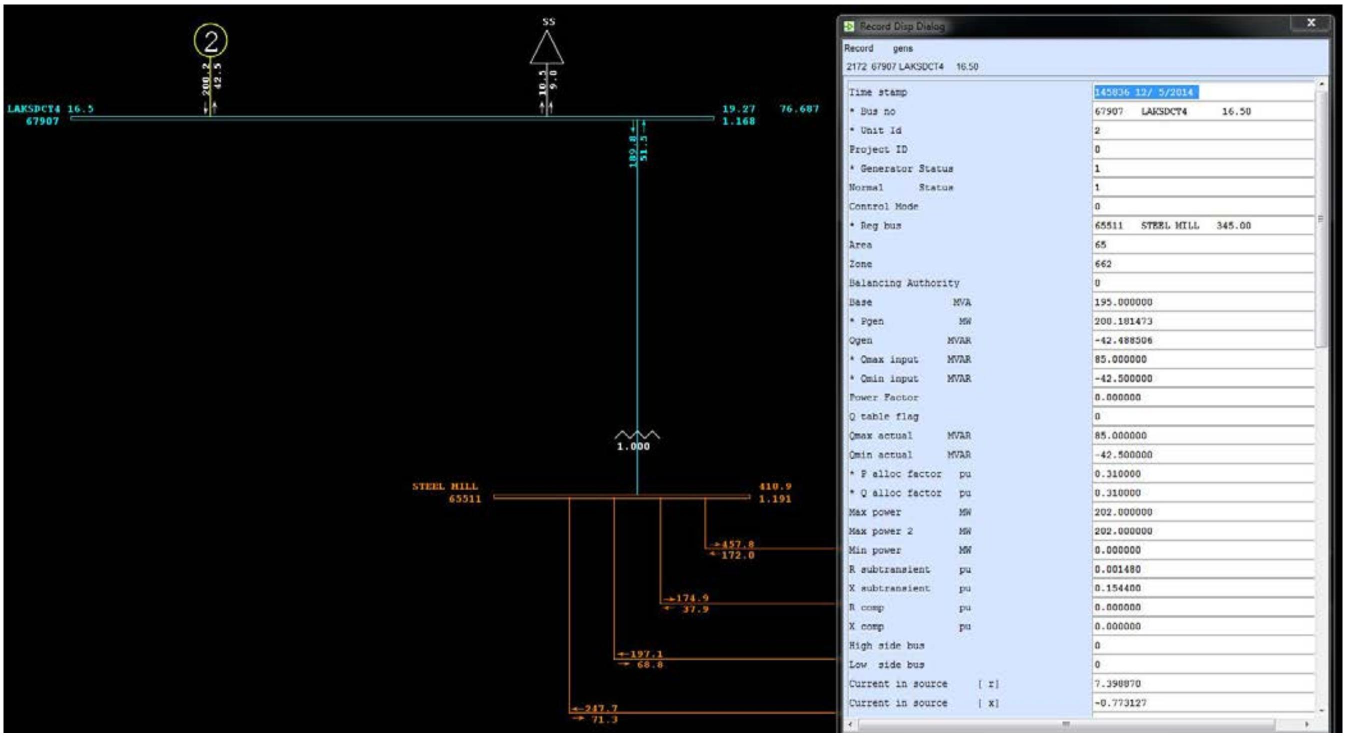


Unit ID:

- LAKSDCT4

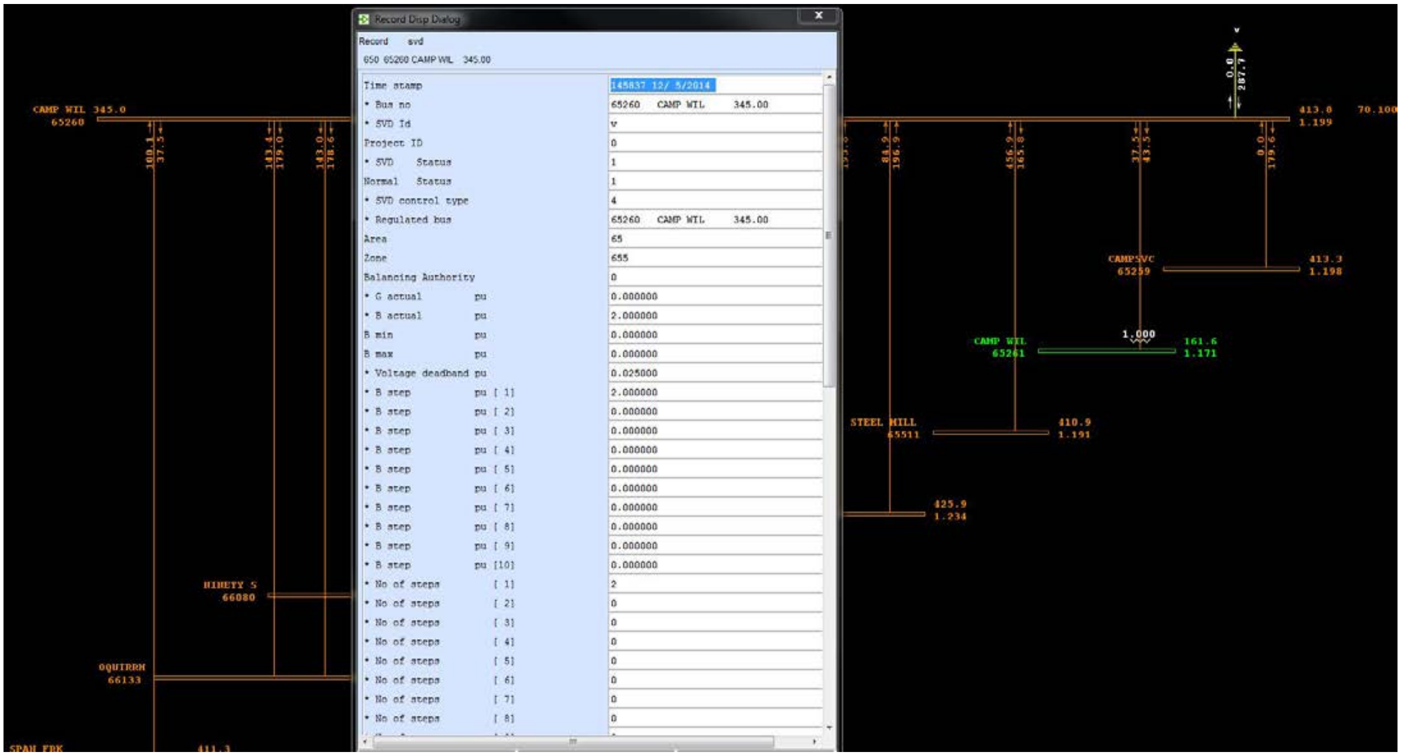
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.



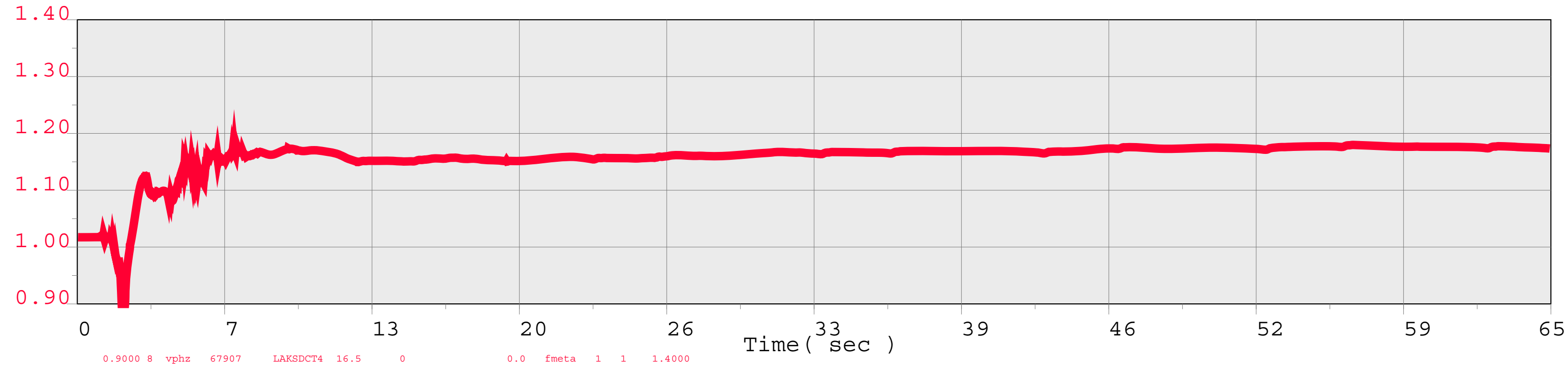
Likely Cause:

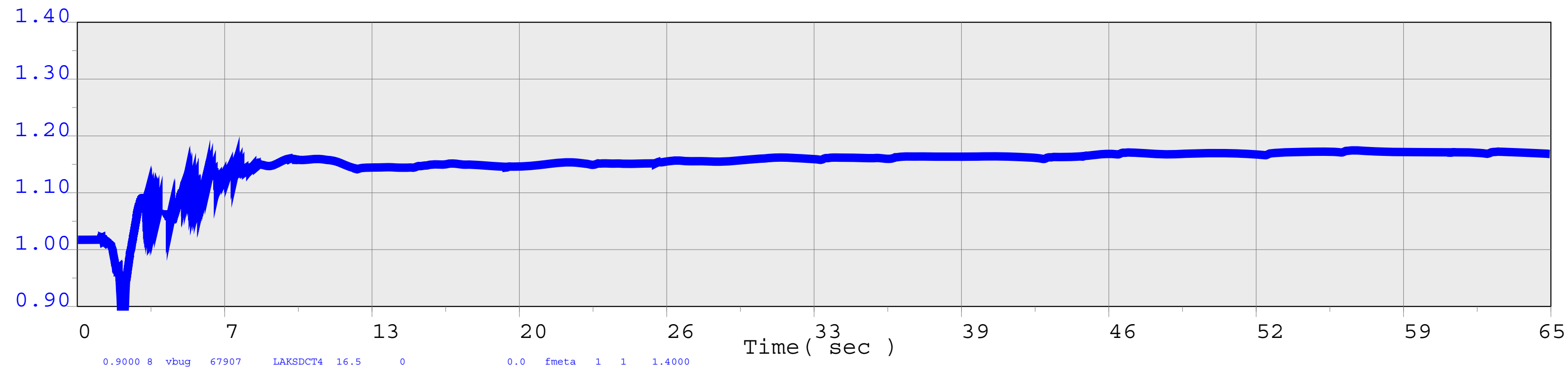
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -42.5 MVAR, which is normal.
- An SVD at a nearby bus (65260) is outputting significant of VARs holding its bus voltage to 1.199 pu (diagram below). This caused LAKSDCT4 voltage to be very high
- Suspect incorrect SVD model performance as the model should not allow this.

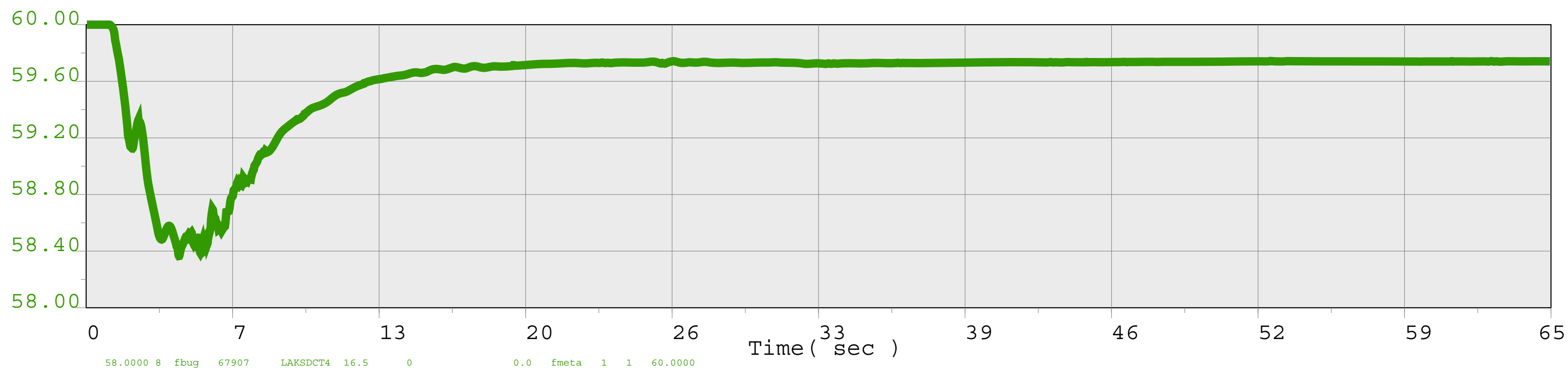


Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY





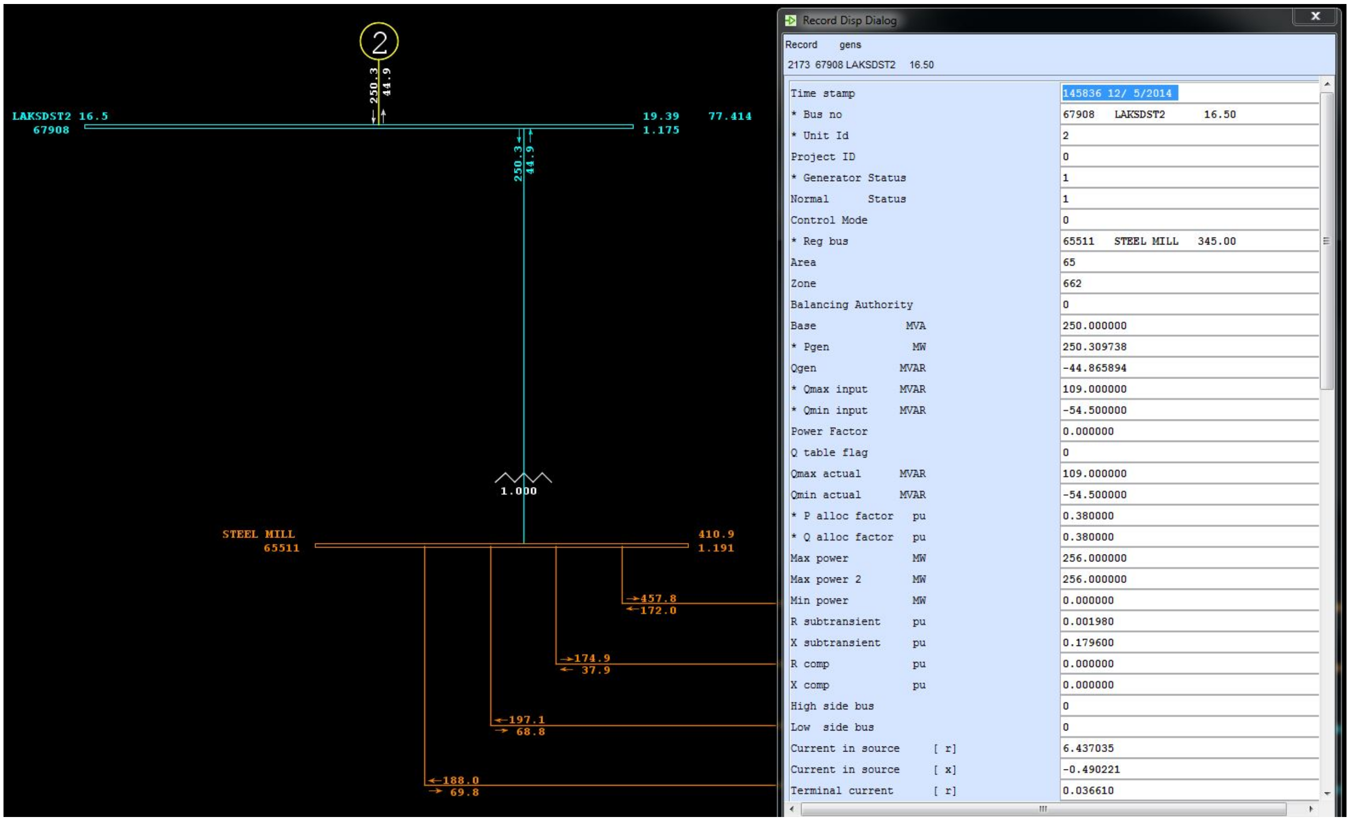


Unit ID:

- LAKSDST2

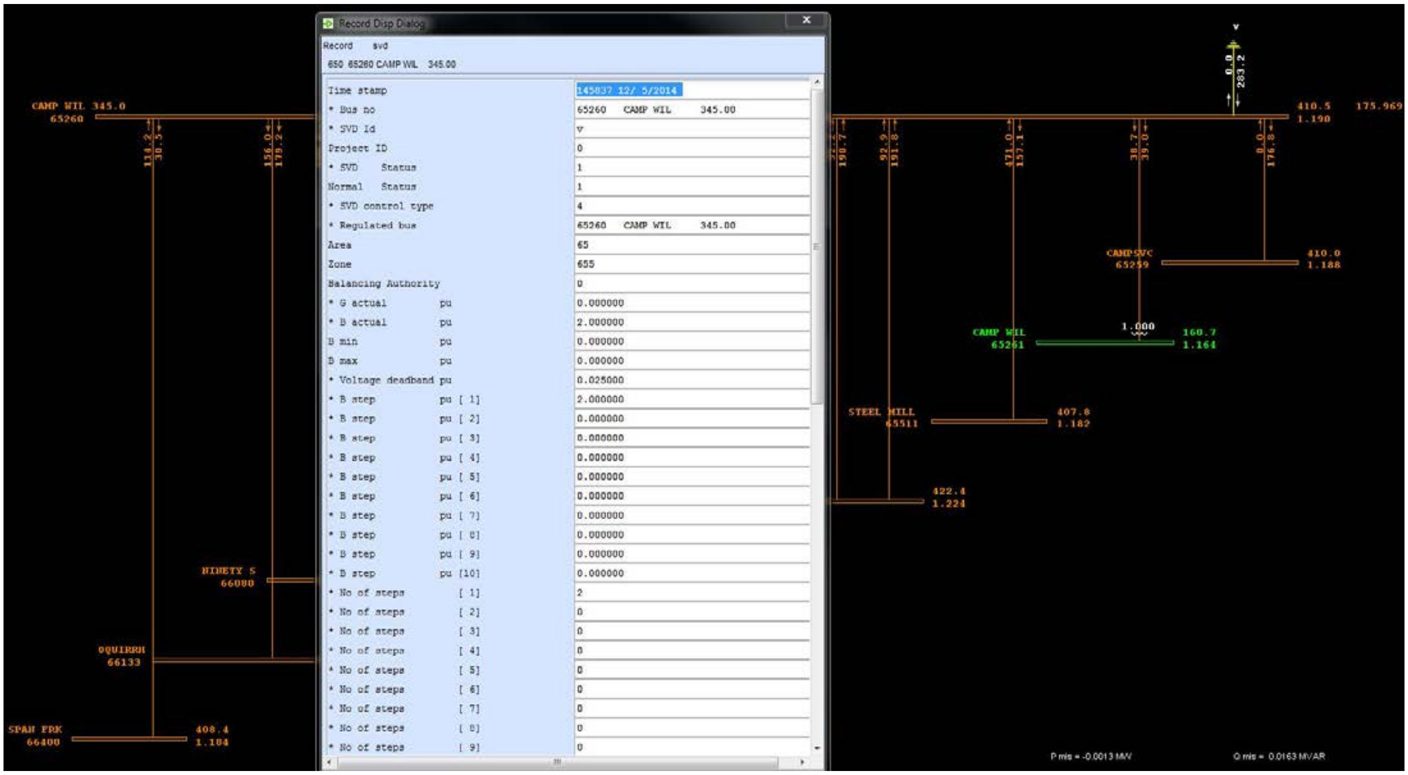
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



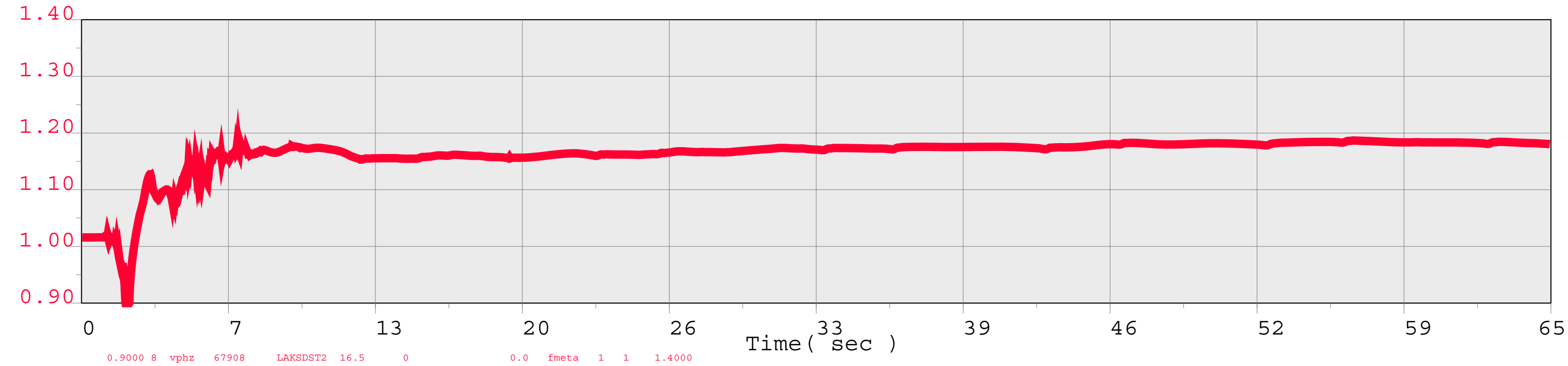
Likely Cause:

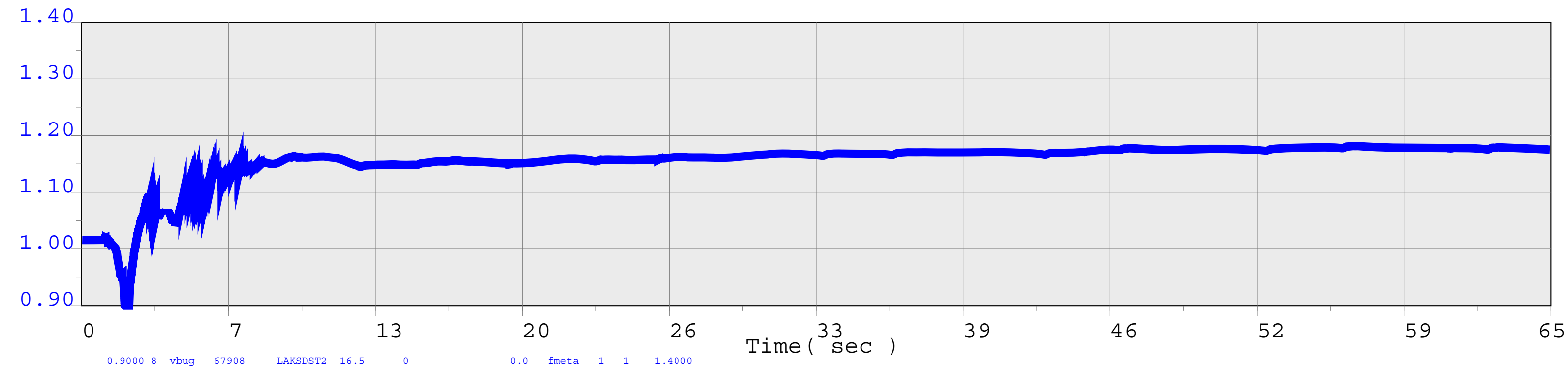
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -44.9 MVAR, which is normal.
- An SVD at a nearby bus (65260) is outputting significant of VARs holding its bus voltage to 1.199 pu (diagram below). This caused LAKSDST2 voltage to be very high
- Suspect incorrect SVD model performance as the model should not allow this.

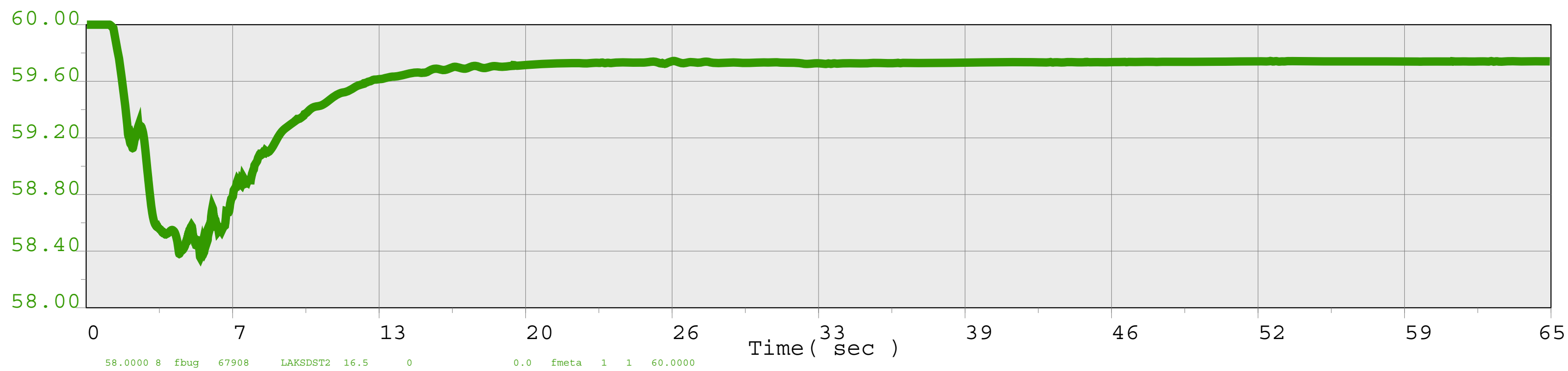


<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES 1.10 V/Hz CRITERIA ONLY







15hs_W_25.chf

inal UFLS\Summer\vpHz\vpH

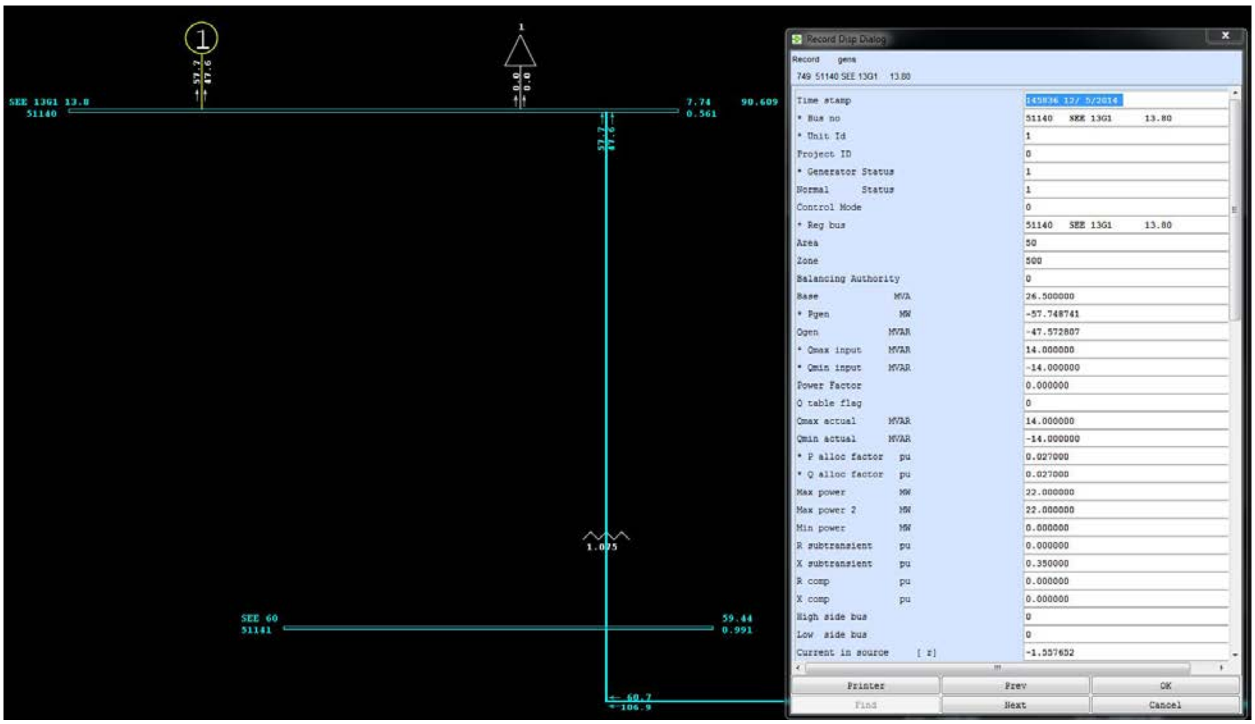
Wed Aug 19 16:29:42 2015

Unit ID:

- SEE 13G1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

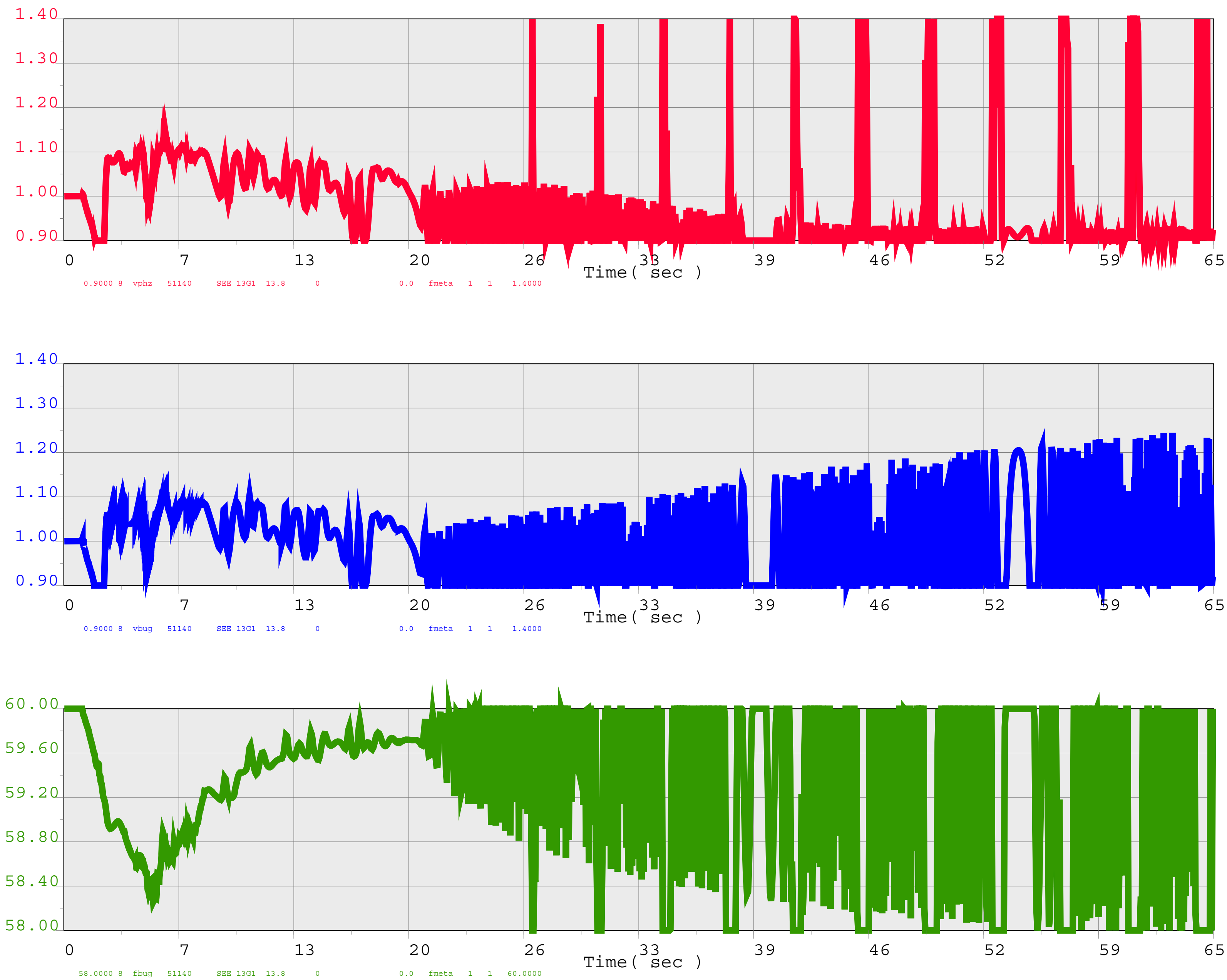


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating -47.6 MVAR, which exceeds its Qmin (-14 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY

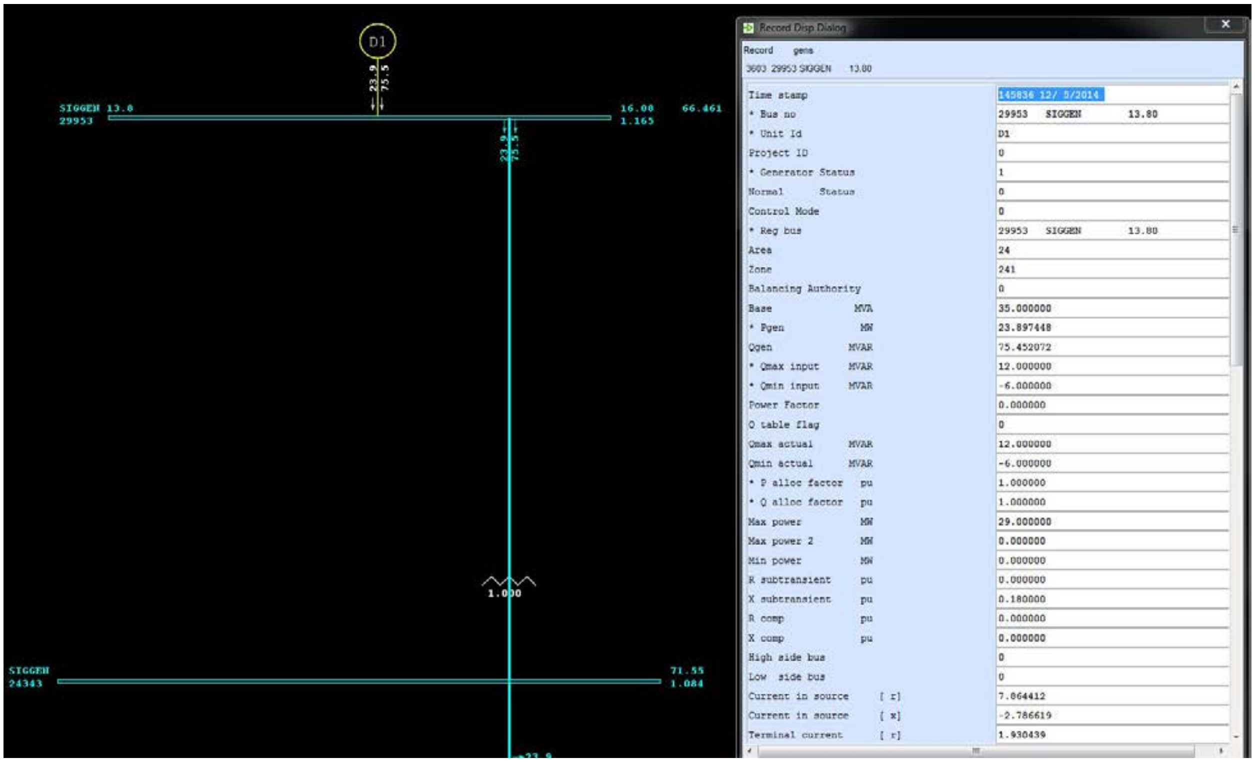


Unit ID:

- SIGGEN

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.

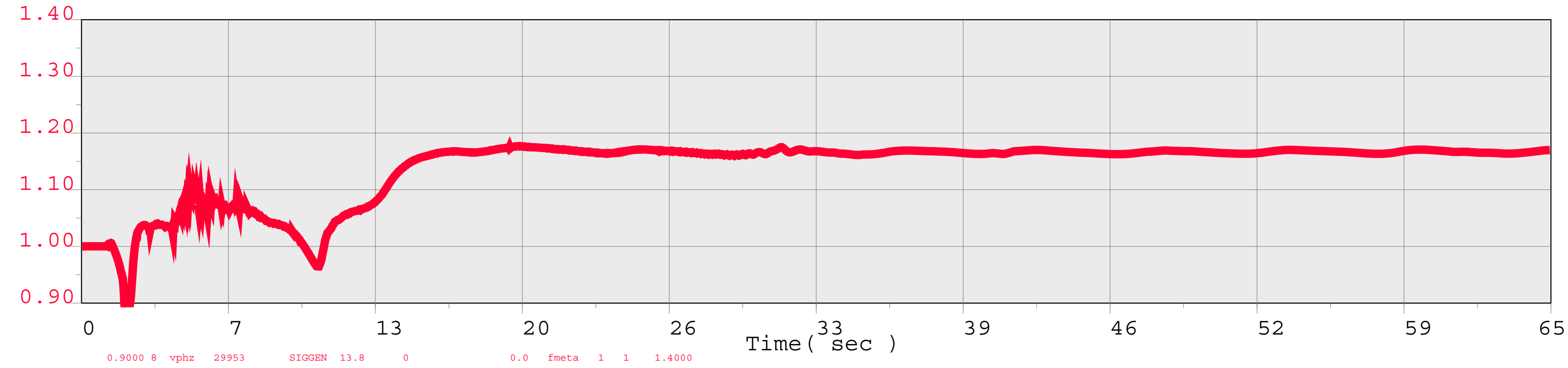


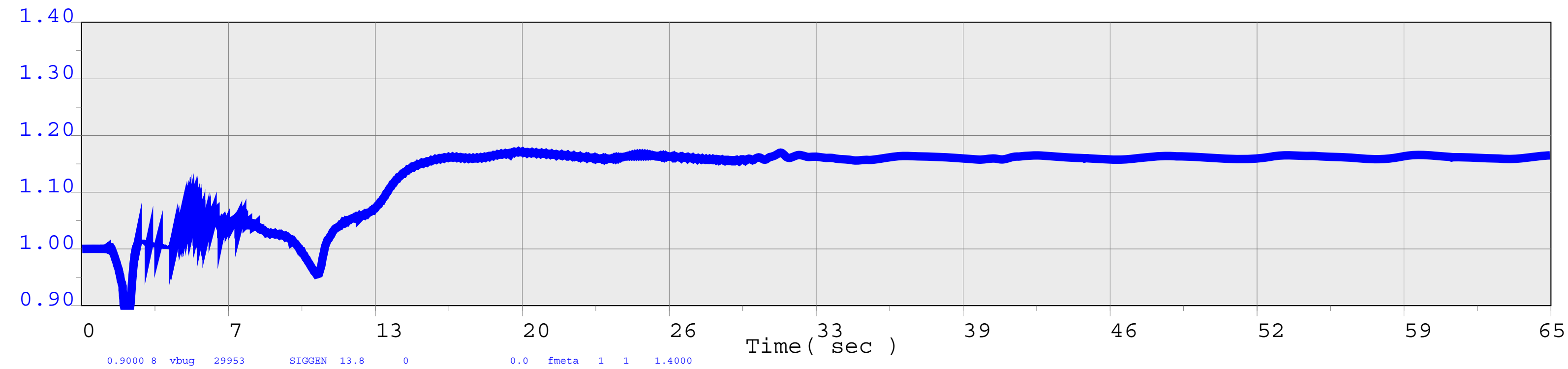
Likely Cause:

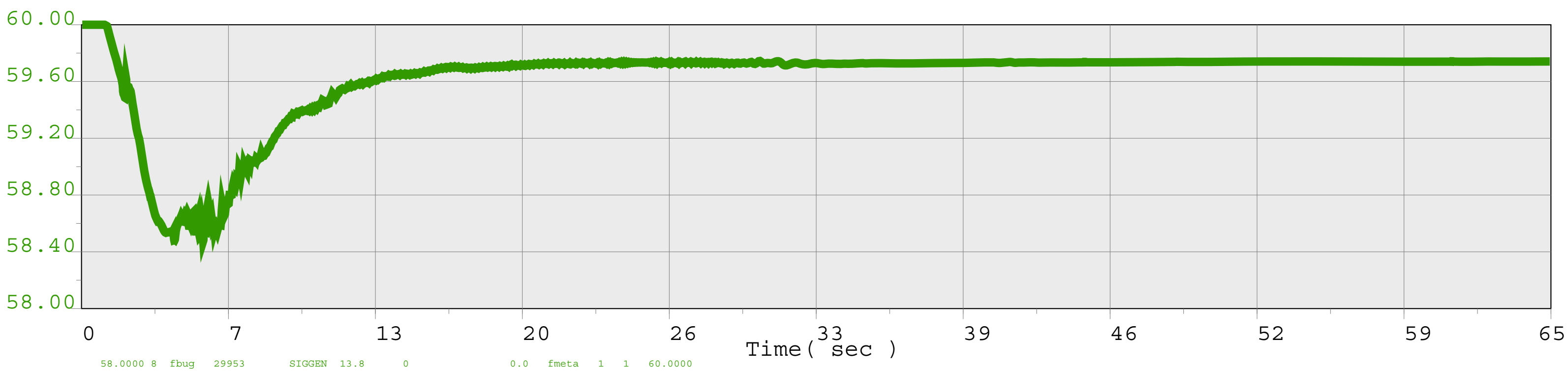
- Diagram above shows generator status at the conclusion of a 65 second, heavy summer 25% generation loss simulation.
- The unit is generating 75.5 MVAR, which exceeds its Qmax (12 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY





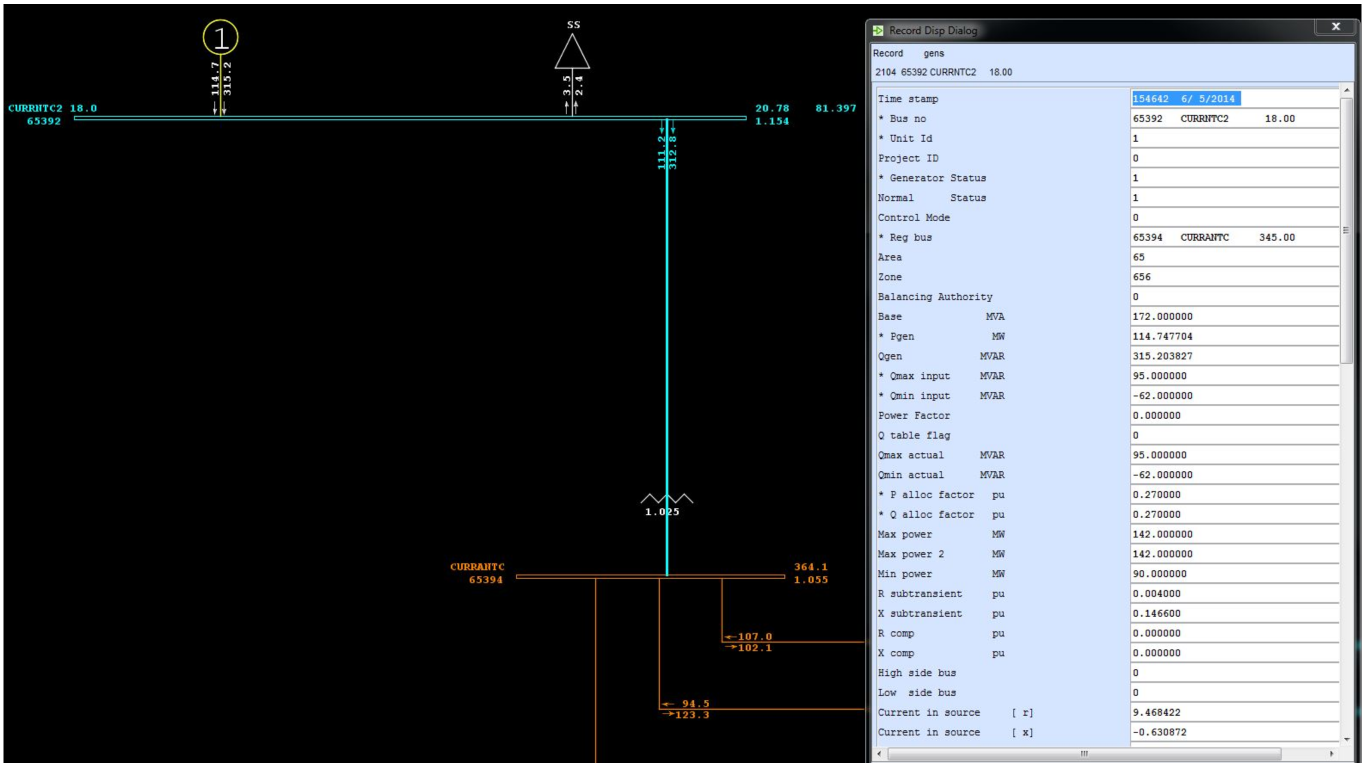


Unit ID:

- CURRNTC2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.

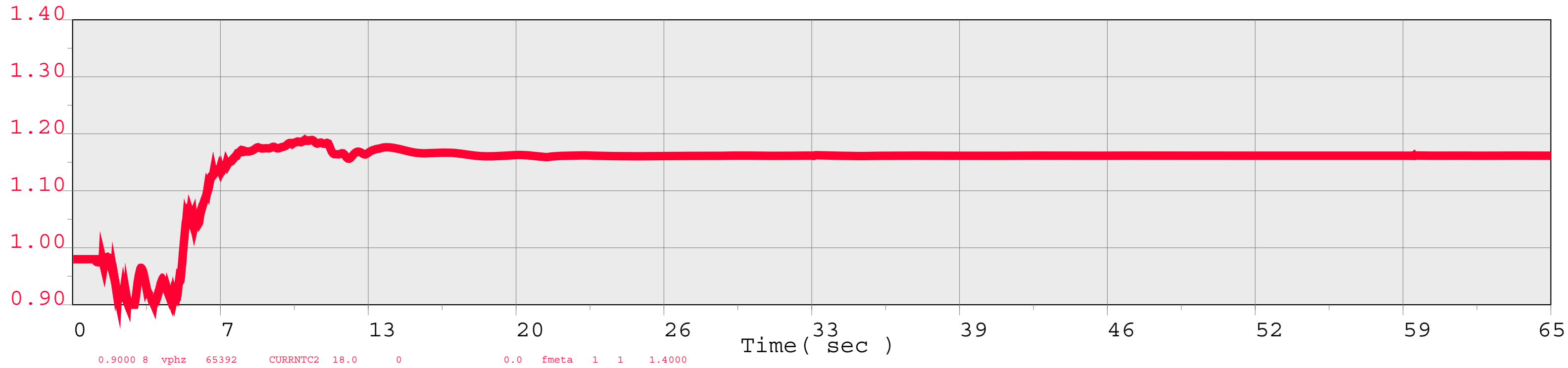


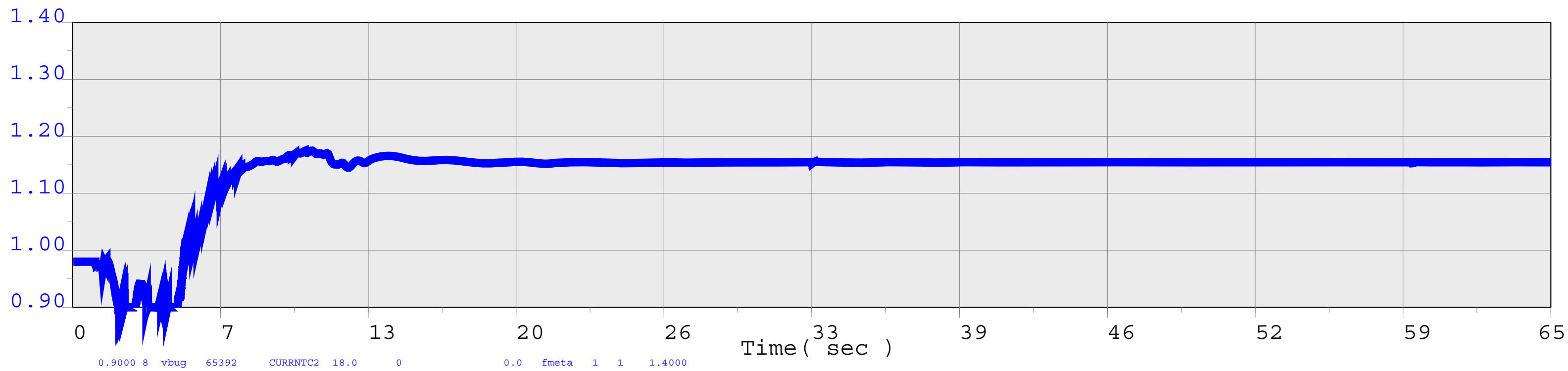
Likely Cause:

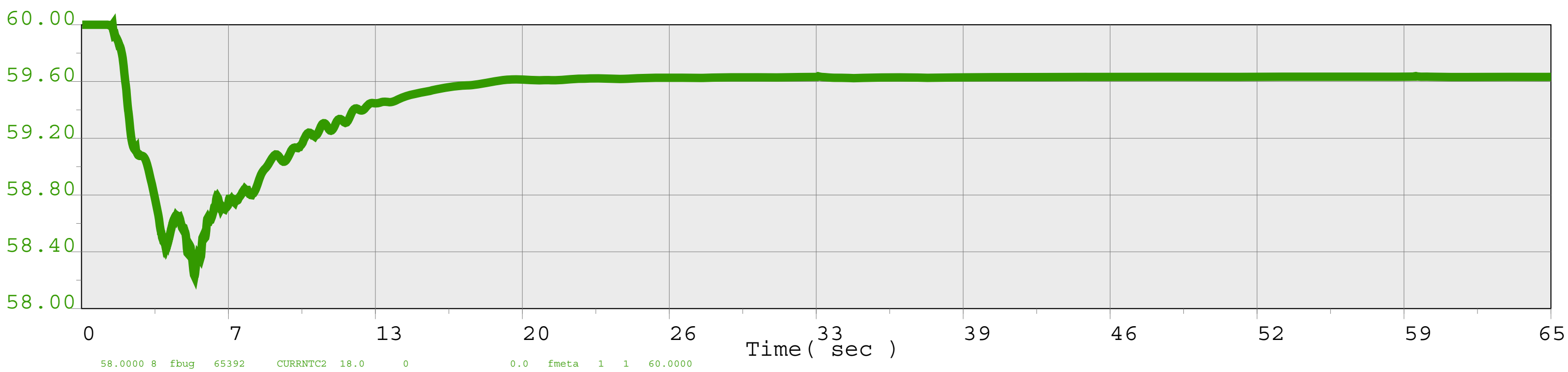
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 315 MVAR, which exceeds its Qmax (95 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY







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top\Final UFLS\Spring\vpH

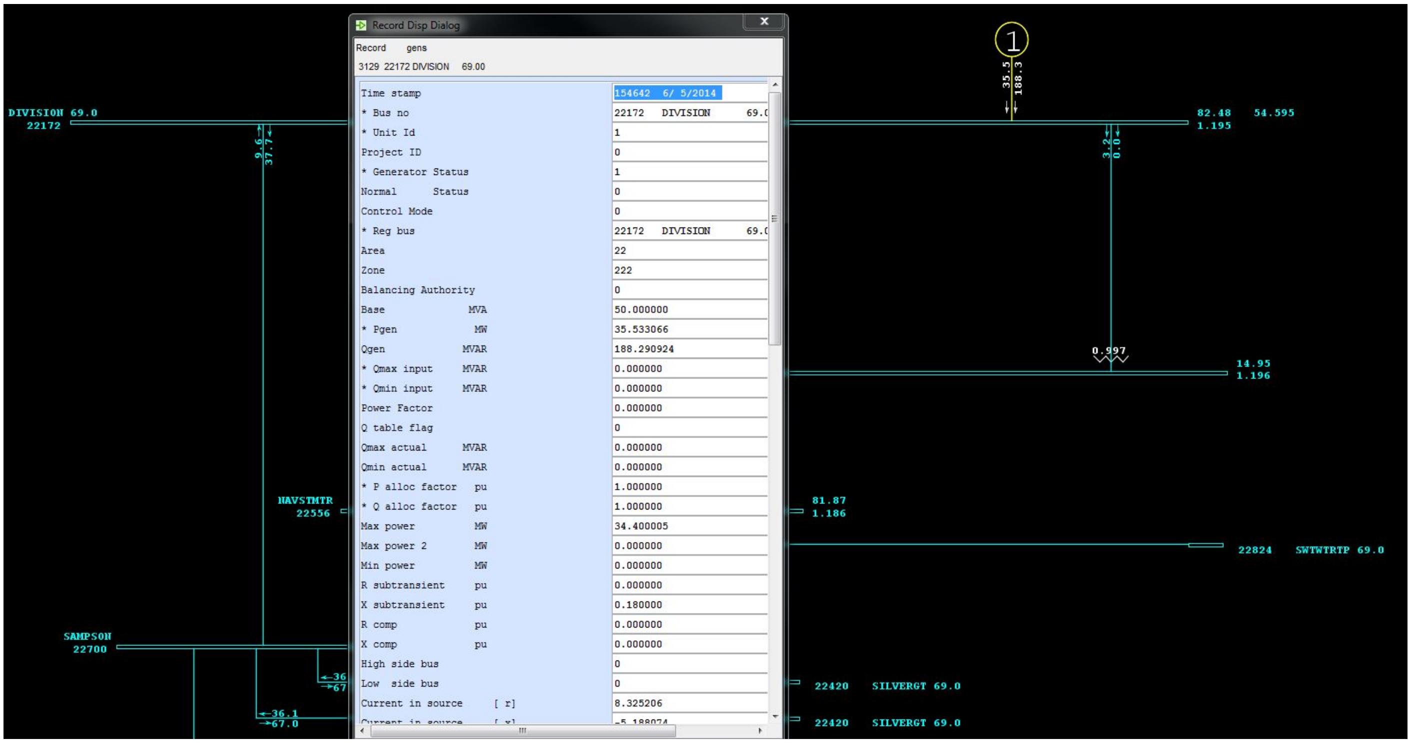
Tue Aug 18 08:28:20 2015

Unit ID:

- DIVISION

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

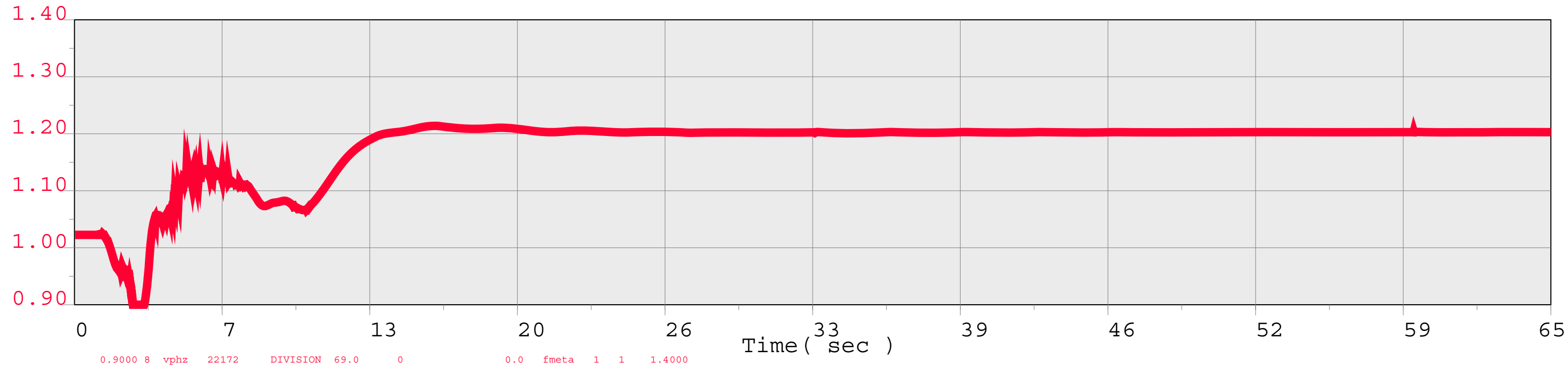


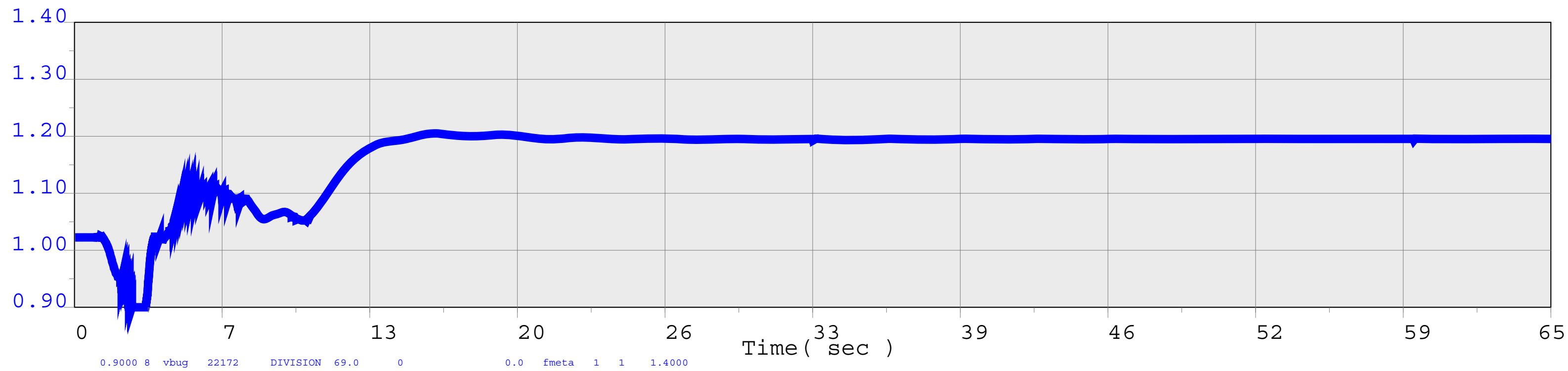
Likely Cause:

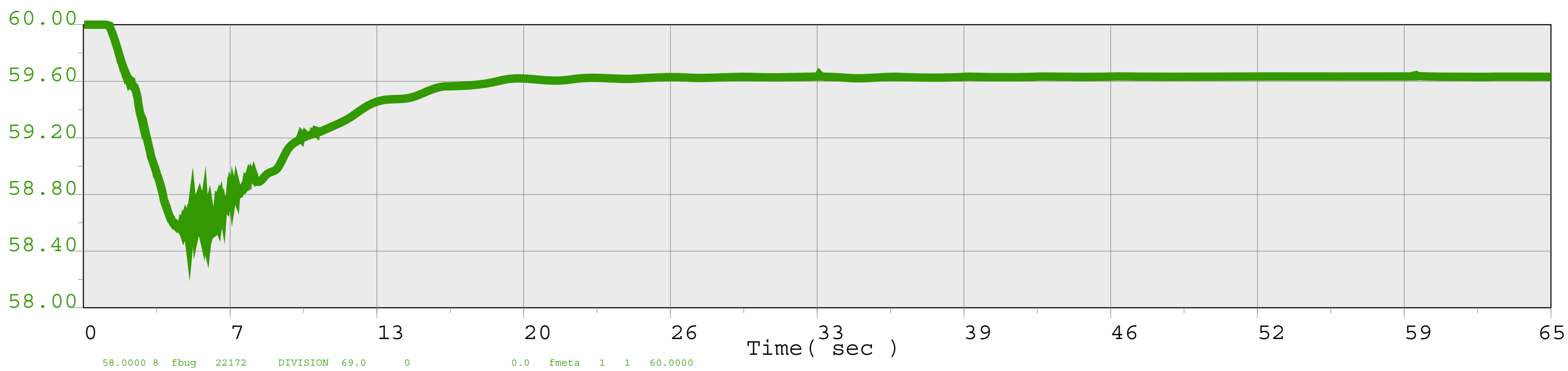
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 189 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





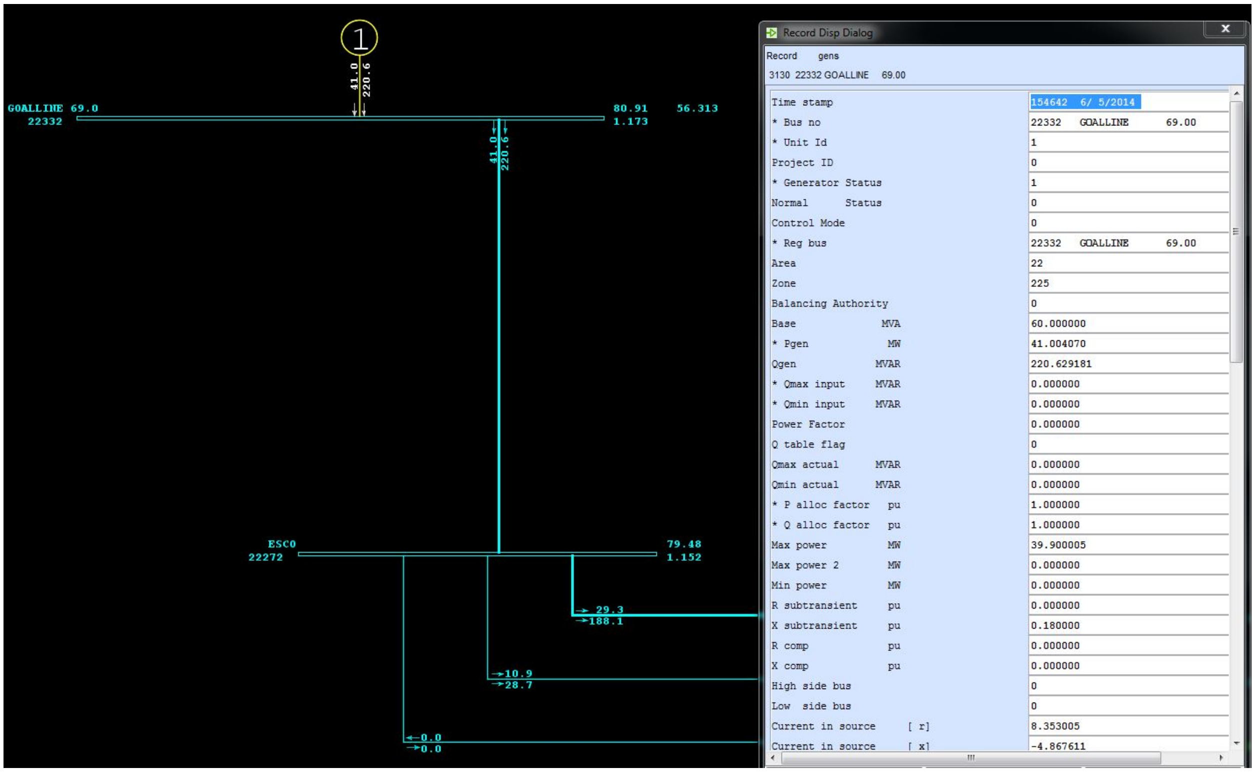


Unit ID:

- GOALLINE

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

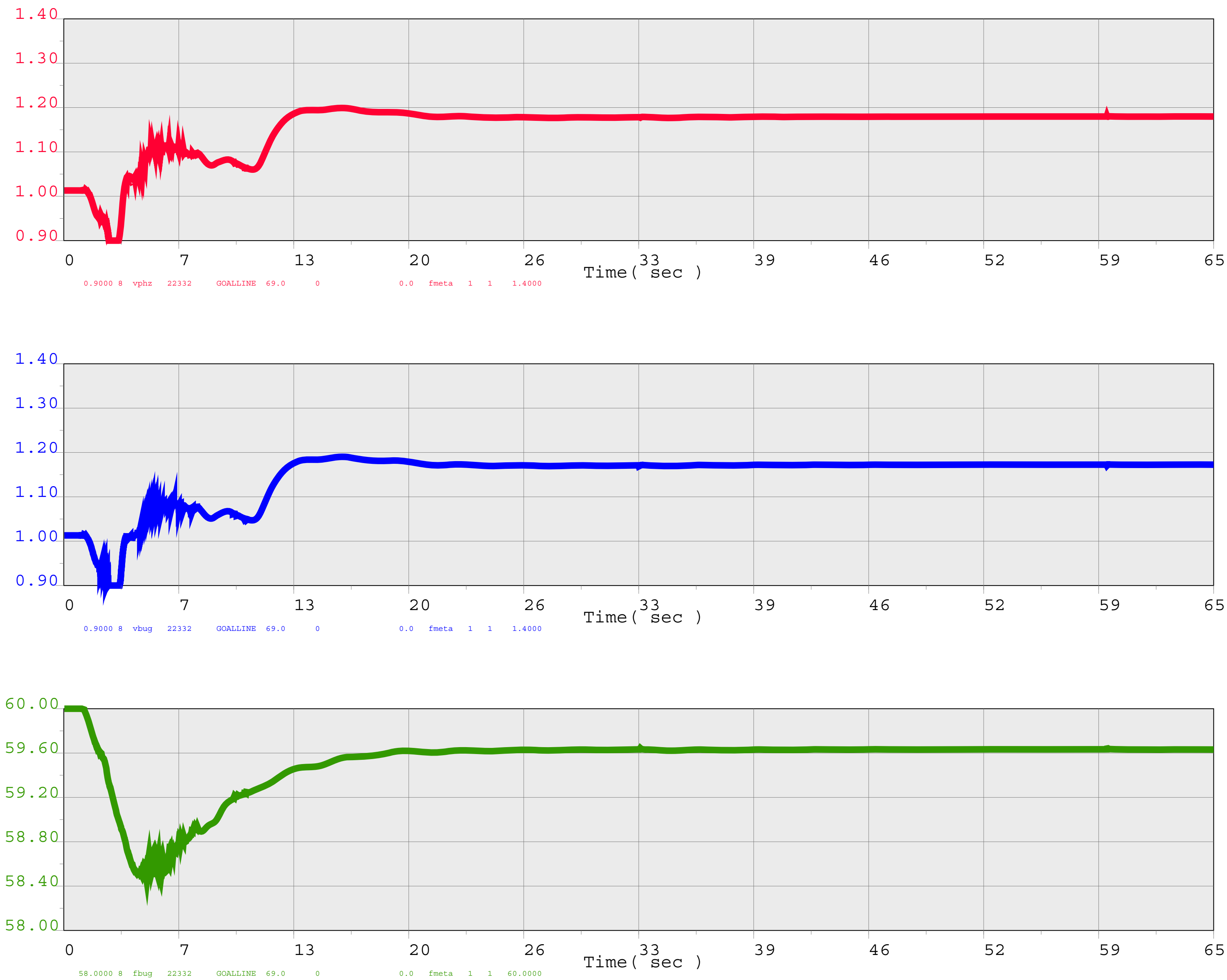


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 221 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



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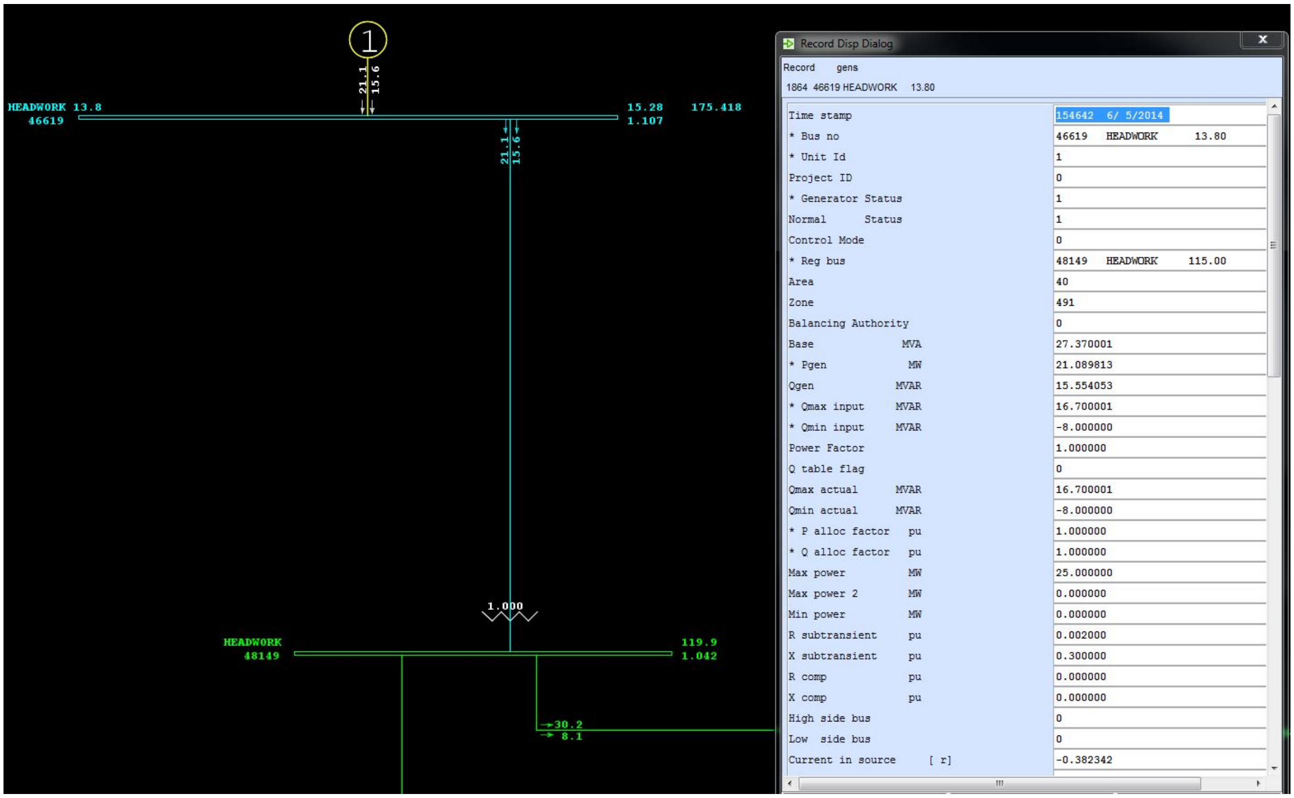
Tue Aug 18 08:28:20 2015

Unit ID:

- HEADWORK

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.

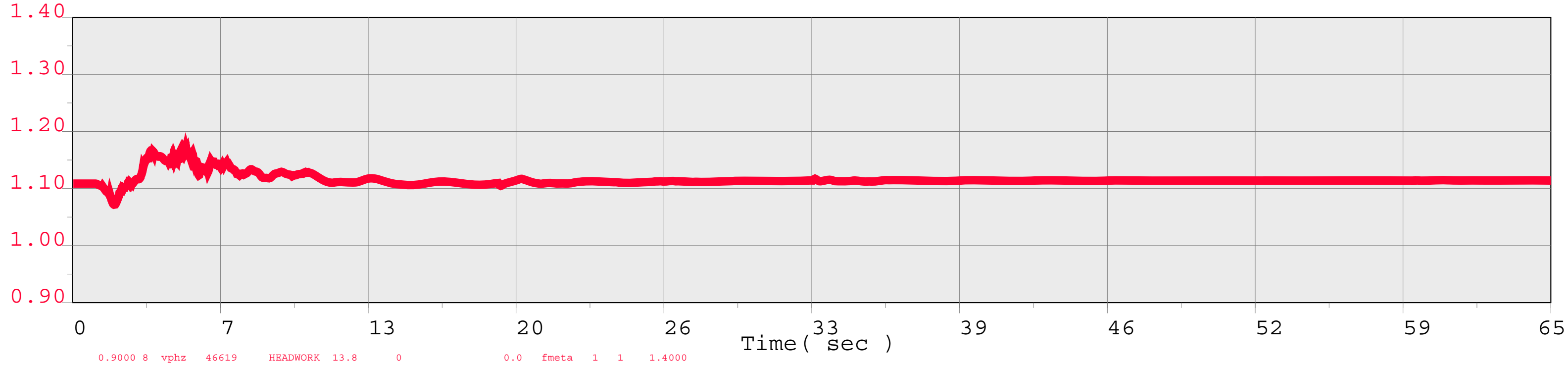


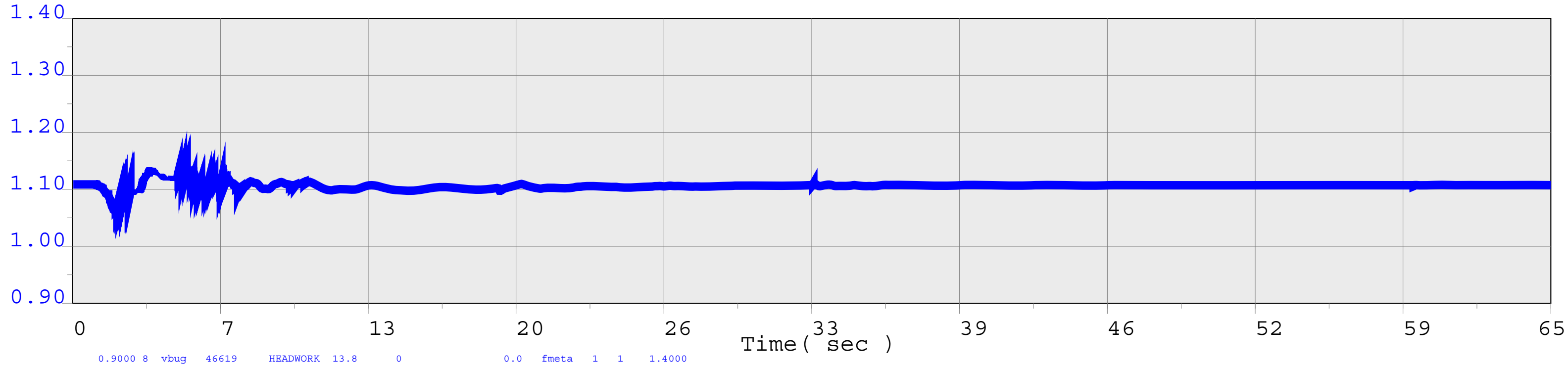
Likely Cause:

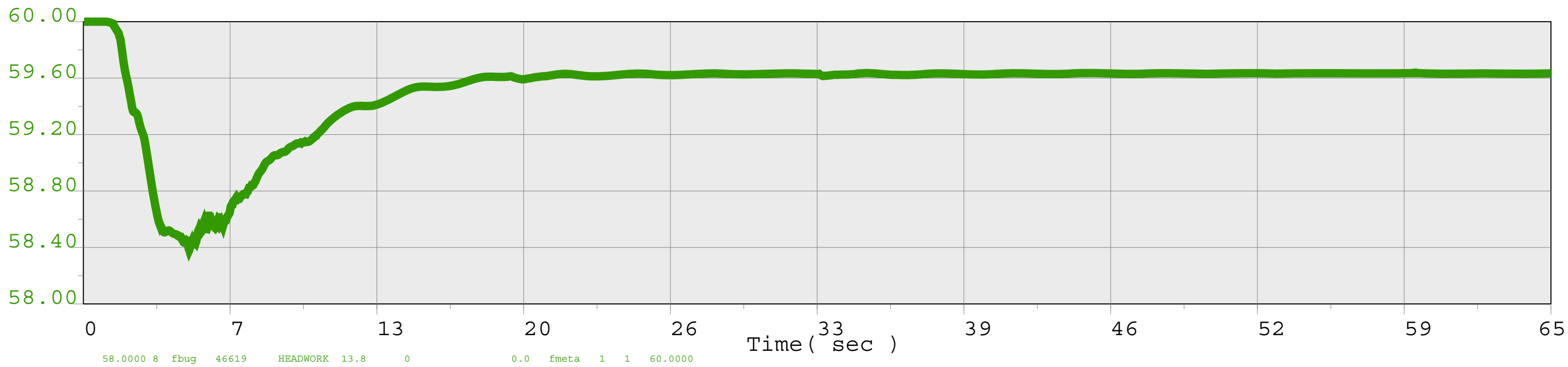
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 15.5 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the initial voltage is above 1.1 p.u. Therefore, the voltage recovers to its previous value before the load shedding and is considered not an issue.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.10 V/Hz CRITERIA ONLY





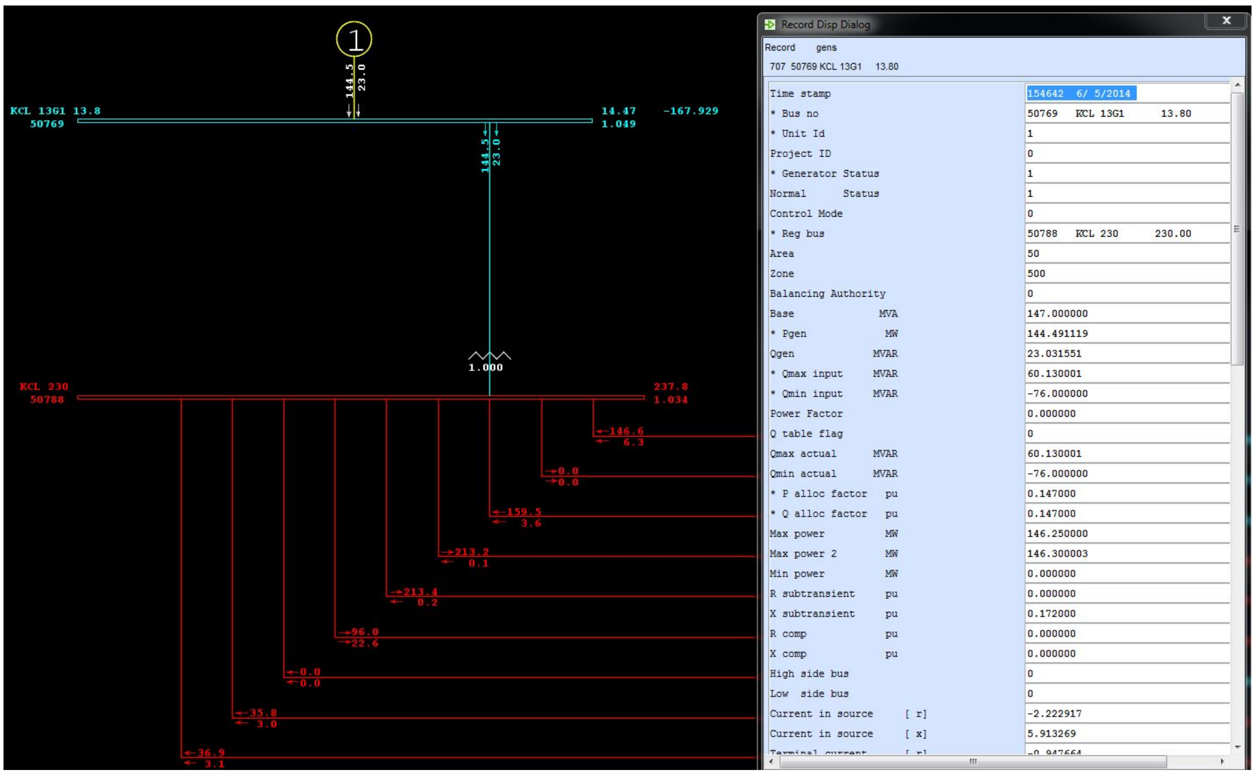


Unit ID:

- KCL 13G1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

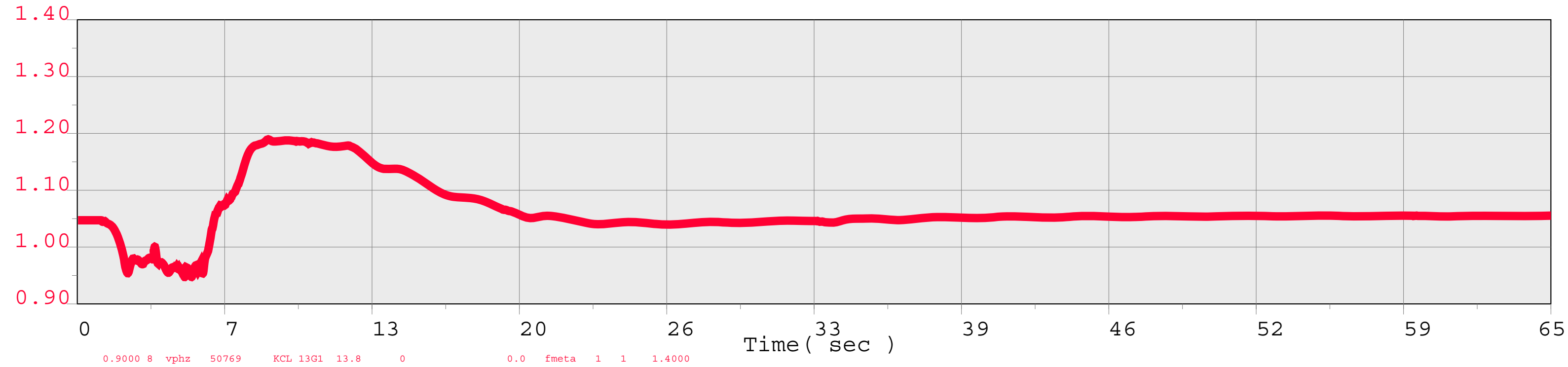


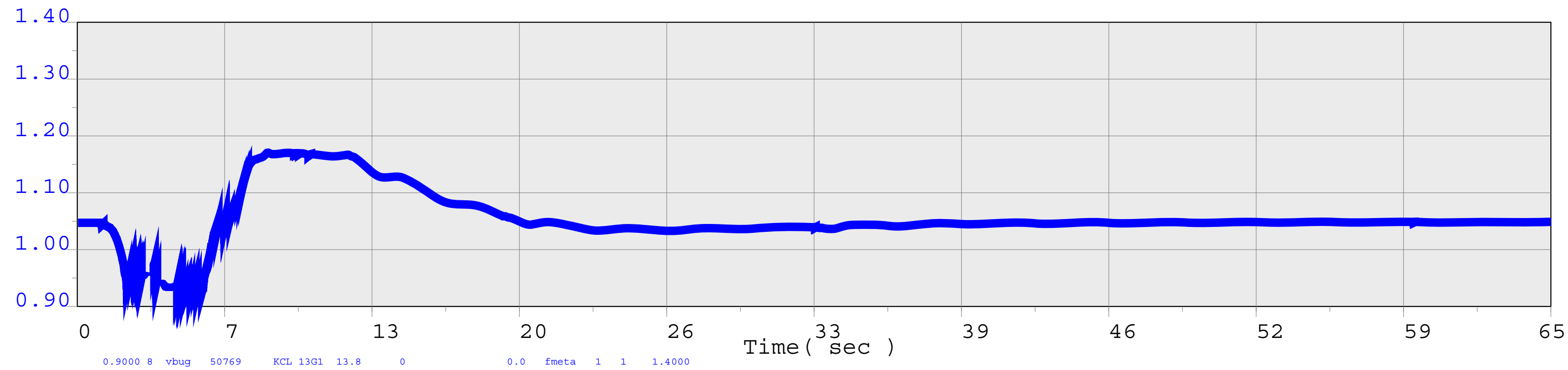
Likely Cause:

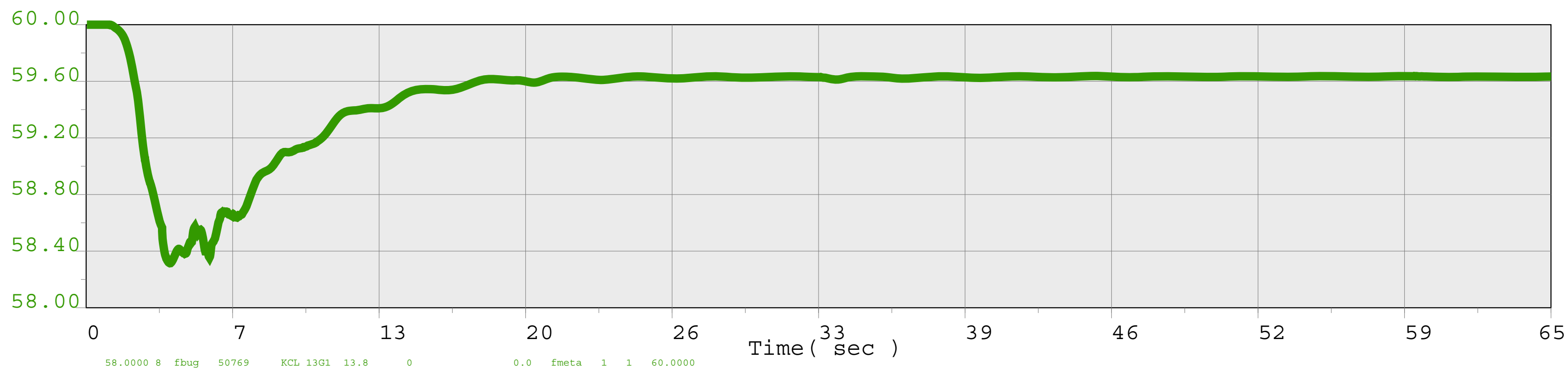
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 23 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY





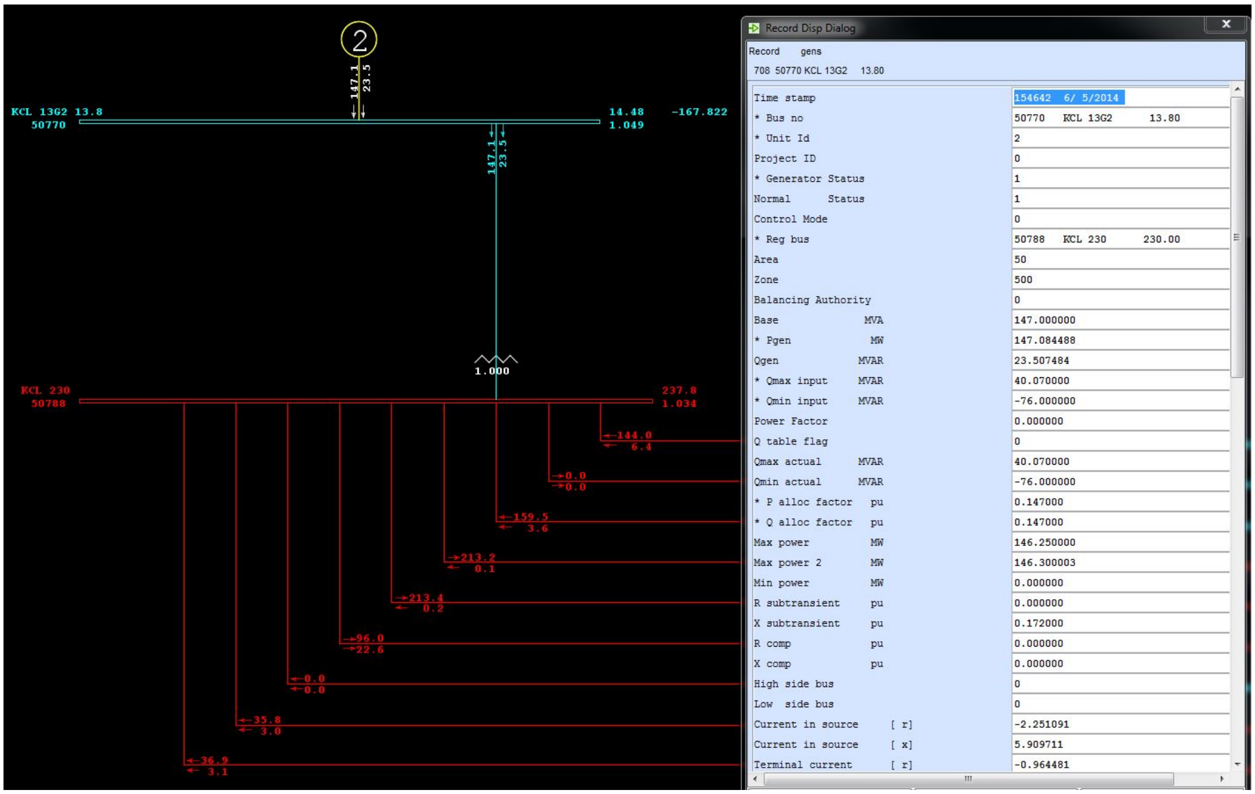


Unit ID:

- KCL 13G2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

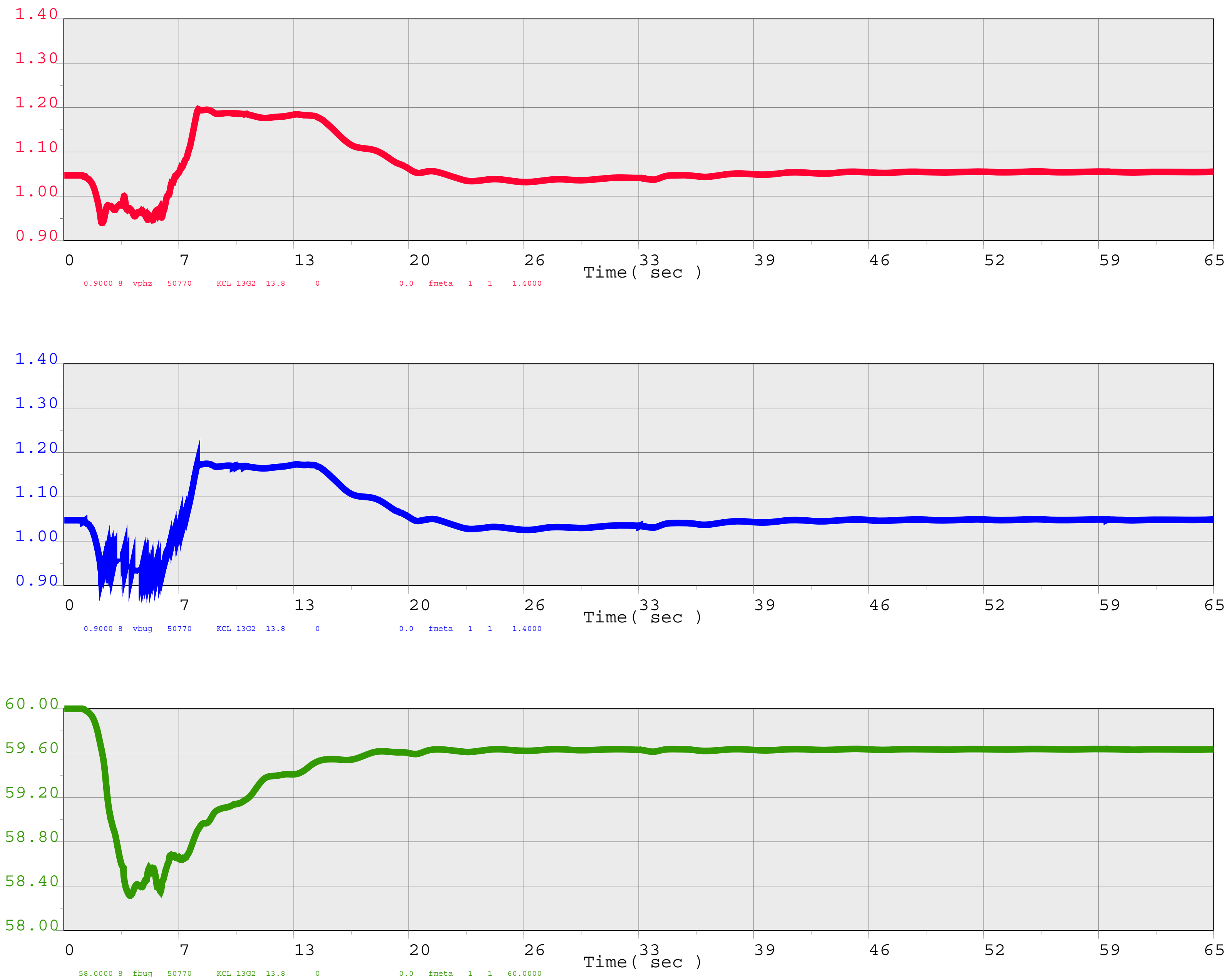


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 24 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY



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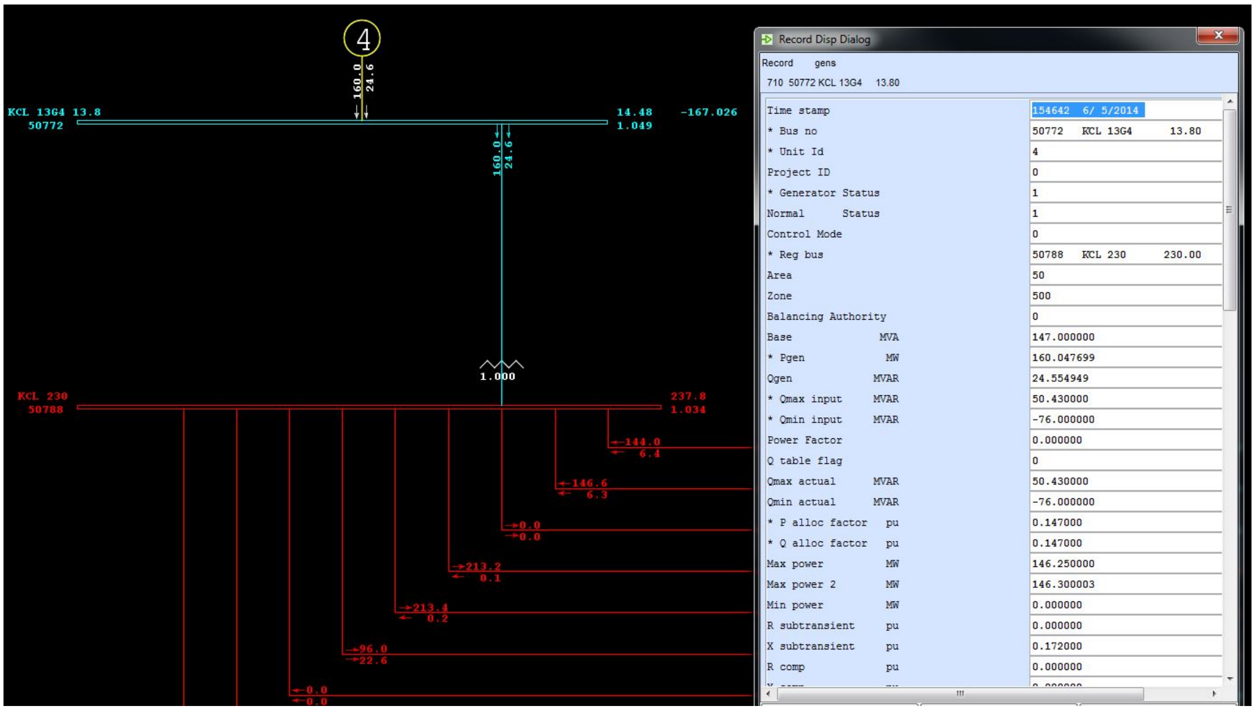
Tue Aug 18 08:28:20 2015

Unit ID:

- KCL 13G4

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

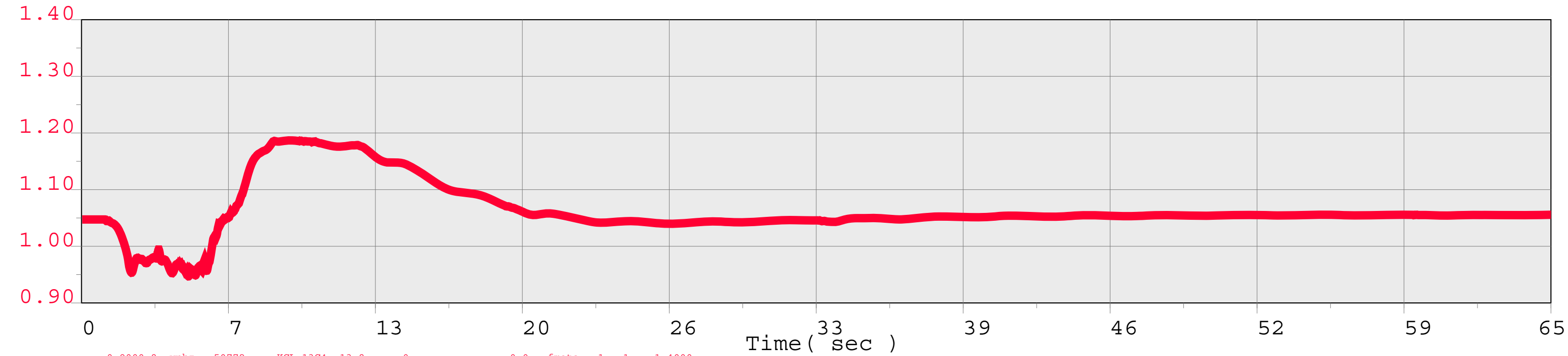


Likely Cause:

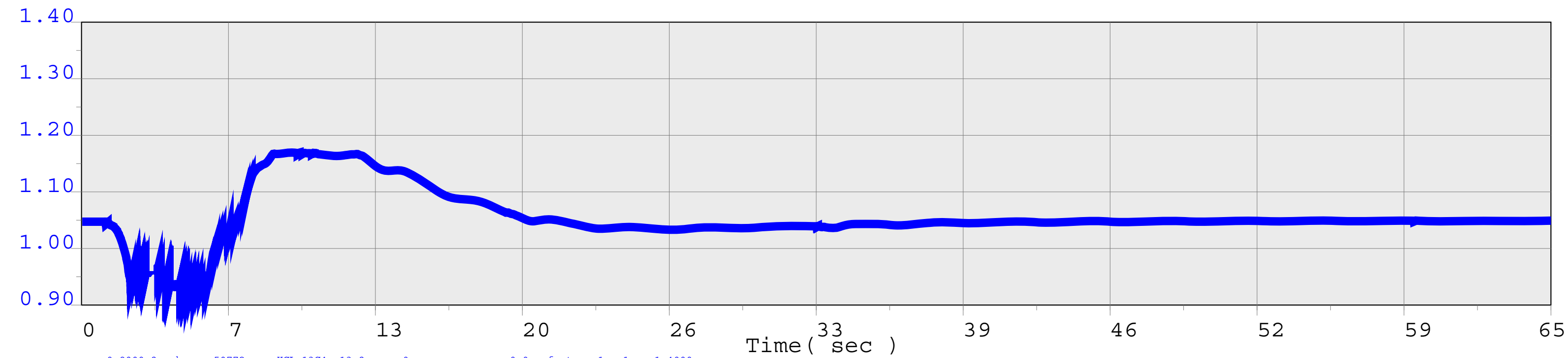
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 24.5 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

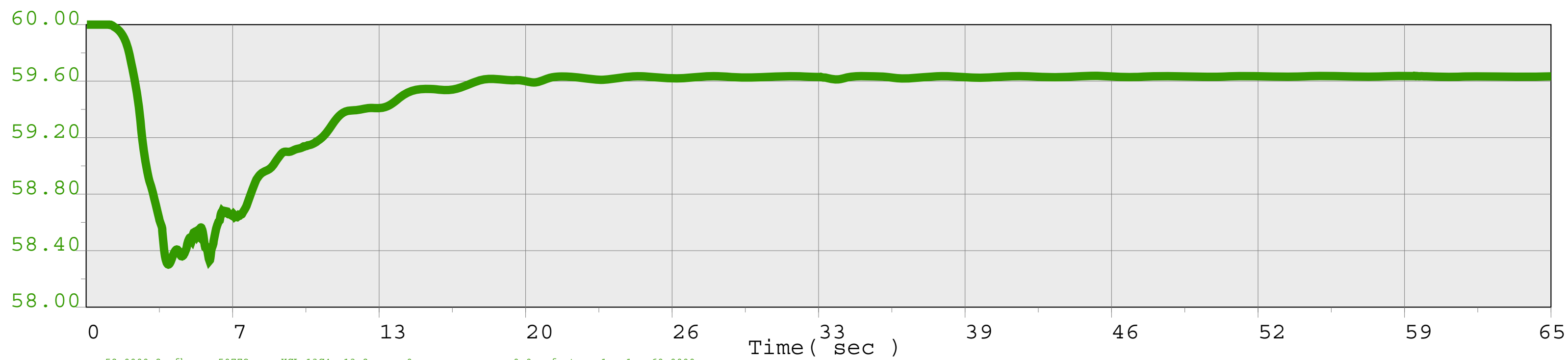
VIOLATES 1.18 V/Hz CRITERIA ONLY



0.9000 8 vphz 50772 KCL 13G4 13.8 0 0.0 fmeta 1 1 1.4000



0.9000 8 vbug 50772 KCL 13G4 13.8 0 0.0 fmeta 1 1 1.4000



58.0000 8 fbug 50772 KCL 13G4 13.8 0 0.0 fmeta 1 1 60.0000

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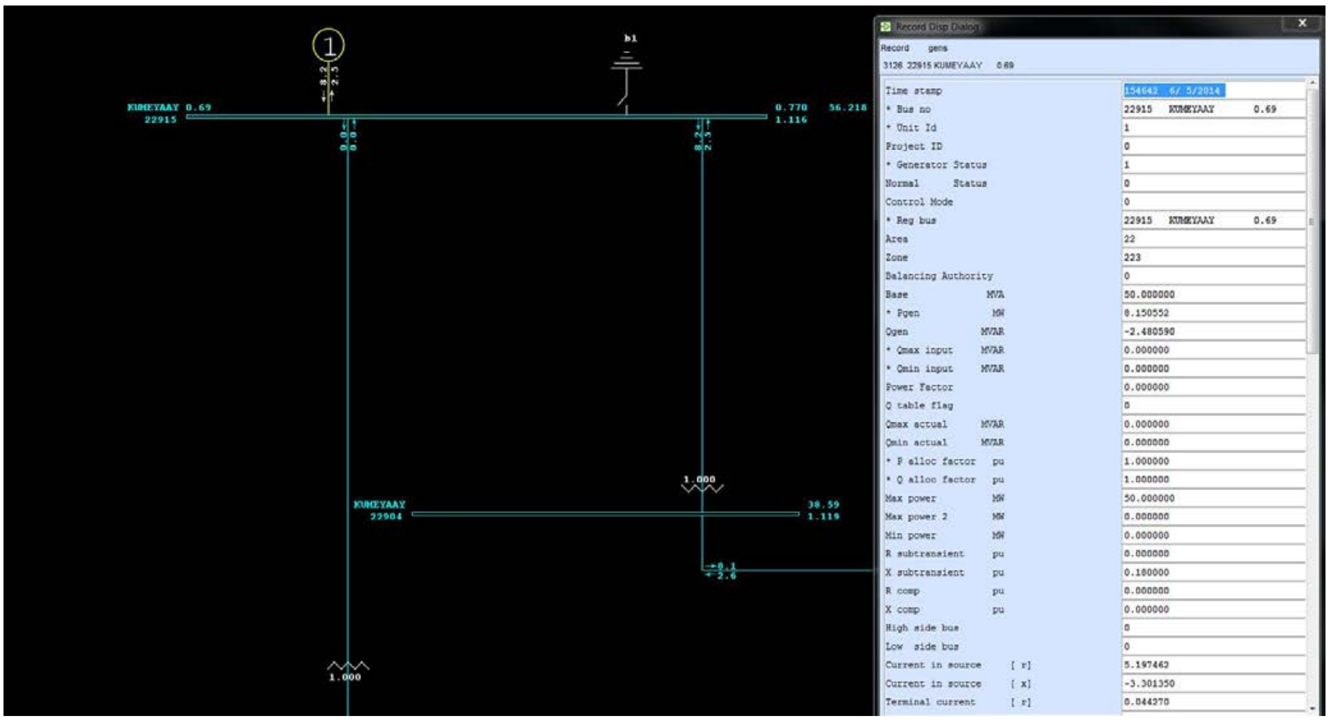
Tue Aug 18 08:28:20 2015

Unit ID:

- KUMEYAAY

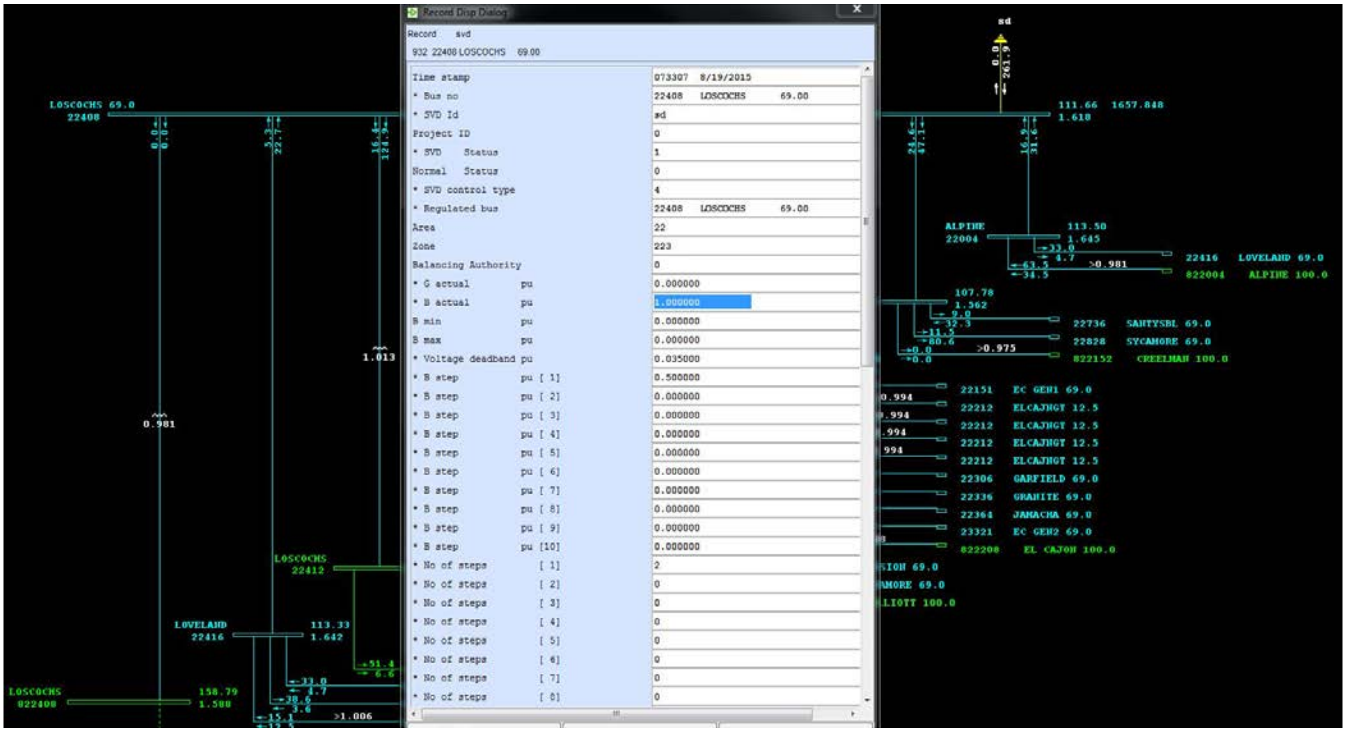
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.



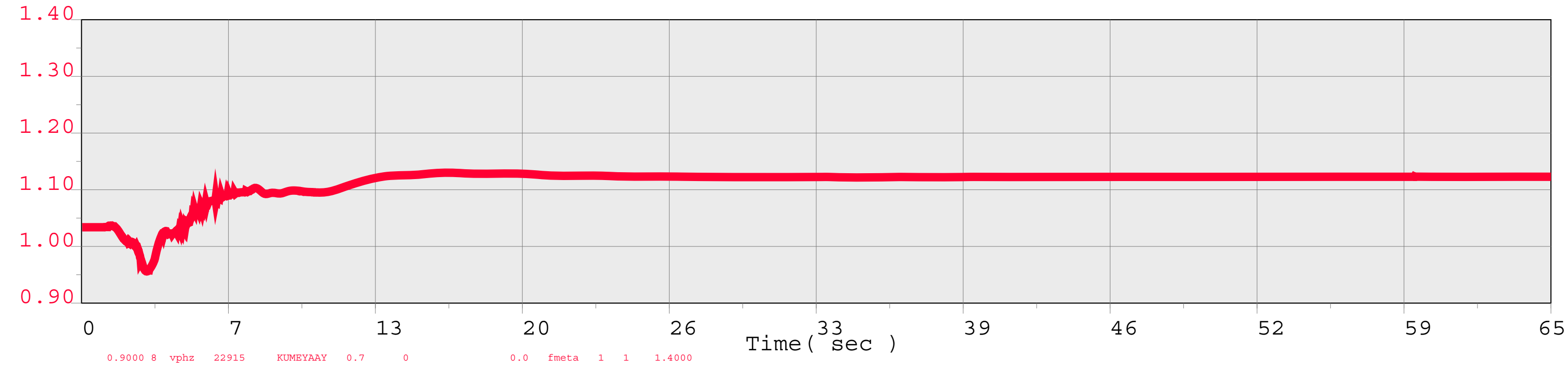
Likely Cause:

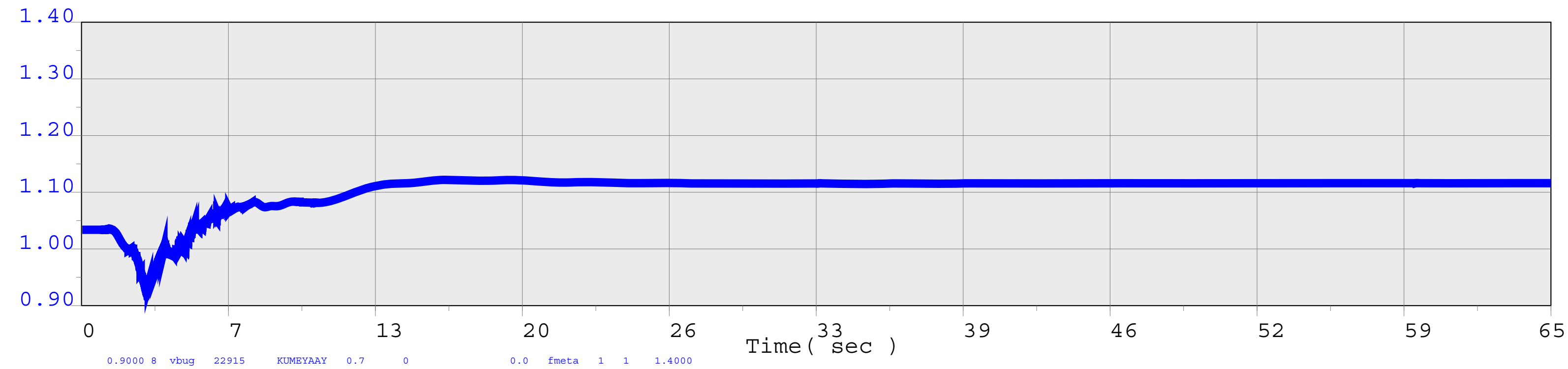
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating -2.5 MVAR, which is normal.
- An SVD at a nearby bus (22408) is outputting significant of VARs holding its bus voltage to 1.22 pu (diagram below). This caused Kumeyaay voltage to be very high
- Suspect incorrect SVD model performance as the model should not allow this.

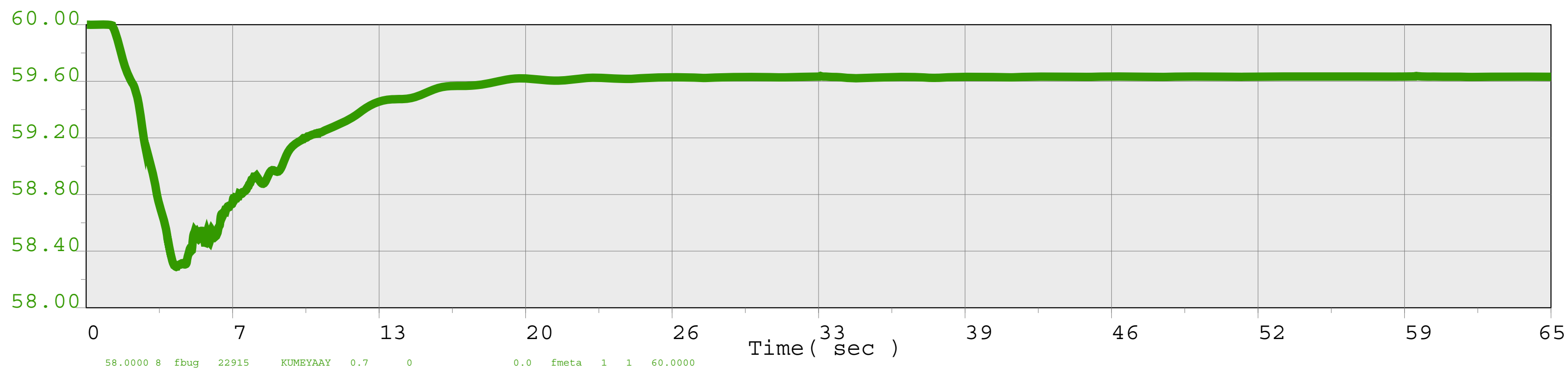


<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES 1.10 V/Hz CRITERIA ONLY





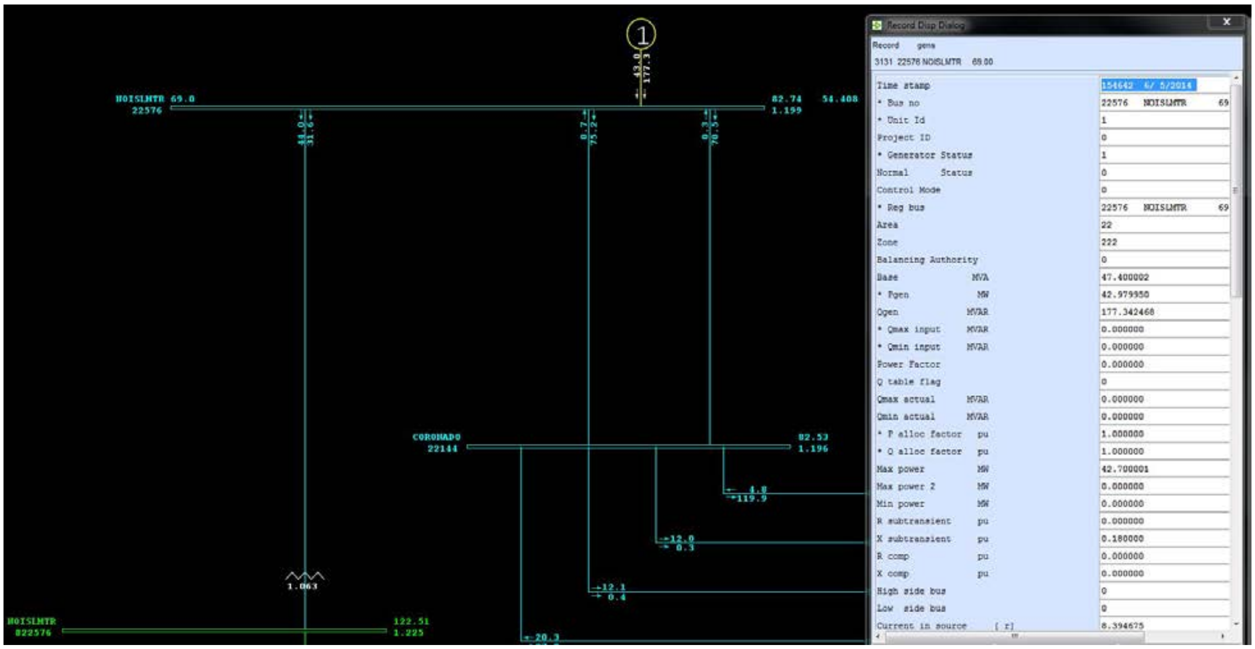


Unit ID:

- NOISLMTR

Flagged Potential Violation:

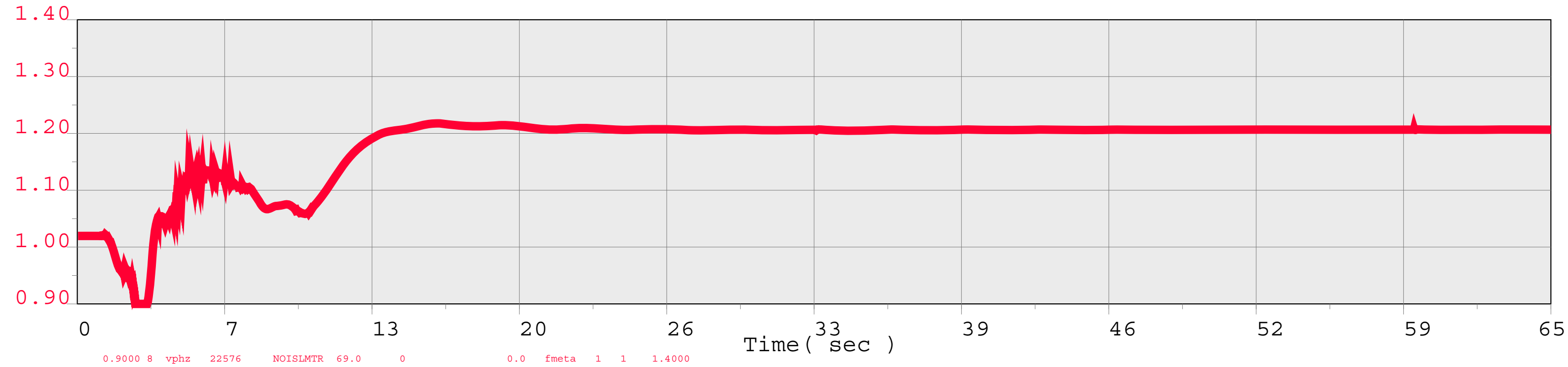
- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

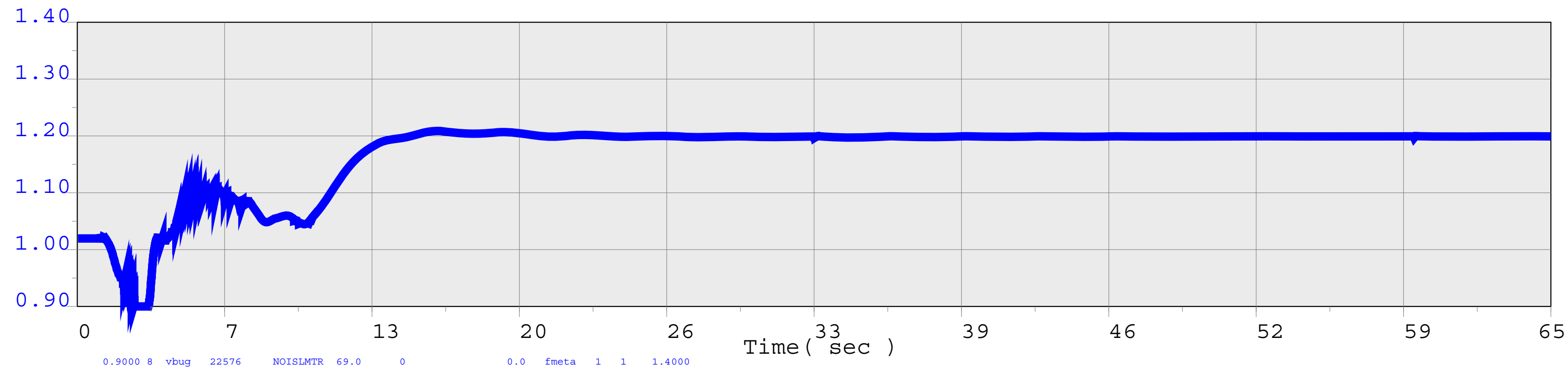


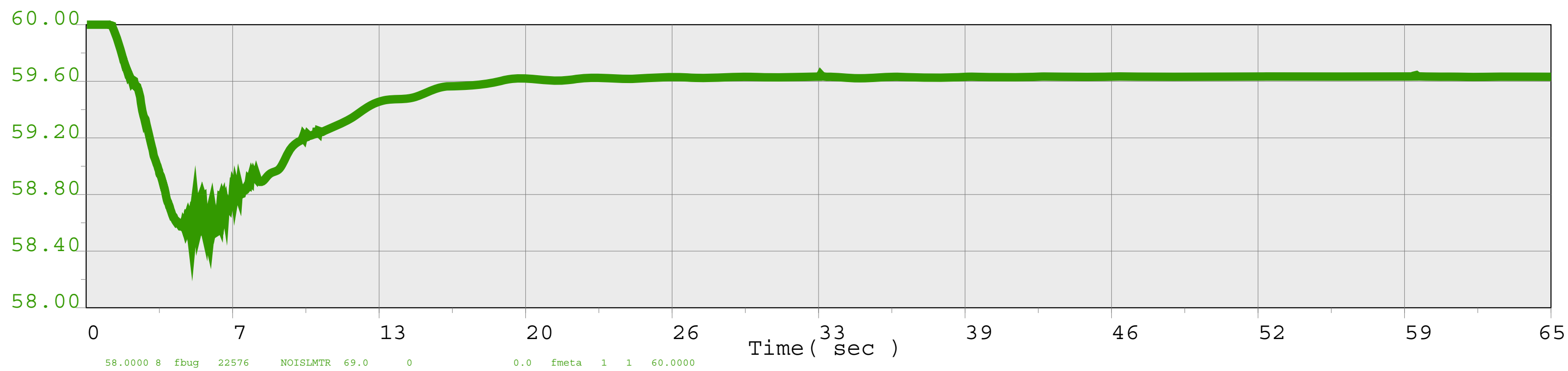
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 177 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.


1.40
1.30
1.20
1.10
1.00
0.90
0
7
13
20
26
33
39
46
52
59
65
Time(sec)
0.9000 8 vphz 22576 NOISLMTR 69.0 0 0.0 fmeta 1 1 1.4000


1.40
1.30
1.20
1.10
1.00
0.90
0
7
13
20
26
33
39
46
52
59
65
Time(sec)
0.9000 8 vbug 22576 NOISLMTR 69.0 0 0.0 fmeta 1 1 1.4000


60.00
59.60
59.20
58.80
58.40
58.00
0
7
13
20
26
33
39
46
52
59
65
Time(sec)
58.0000 8 fbug 22576 NOISLMTR 69.0 0 0.0 fmeta 1 1 60.0000

Appendix D: Northern Island Simulations: Generator Loss Summary

5% Gen Loss Units: 2015 Heavy Spring - Northern Island						
BUS-NO	**NAME1**	**KV1**	**ID**	**PGEN**	**AREA**	**Trip Unit?**
40063	CGS	25	1	1008.9	40	1
26039	INTERM1G	26	1	932.2	26	1
26040	INTERM2G	26	2	932.2	26	1
70777	COMAN_3	27	C3	600	70	1
43407	PELTON	13.8	1	35.1	40	1
43407	PELTON	13.8	2	26.3	40	1
43407	PELTON	13.8	3	26.3	40	1
	5% Imbalance =	3,415.63	**MW Total =**	3,561.00	**# Units =**	7

10% Gen Loss Units: 2015 Heavy Spring - Northern Island						
BUS-NO	**NAME1**	**KV1**	**ID**	**PGEN**	**AREA**	**Trip Unit?**
40063	CGS	25	1	1008.9	40	1
26039	INTERM1G	26	1	932.2	26	1
26040	INTERM2G	26	2	932.2	26	1
65386	BRIDGER1	22	1	815.6	65	1
623504	COLSTRIP GN4	26	1	805	62	1
623503	COLSTRIP GN3	26	1	794.5	62	1
47740	CENTR G1	20	1	624	40	1
47744	CENTR G2	20	2	624	40	1
70310	PAWNEE	22	C1	400	70	1
43407	PELTON	13.8	1	35.1	40	1
43407	PELTON	13.8	2	26.3	40	1
43407	PELTON	13.8	3	26.3	40	1
622531	RYAN GEN1-3	6.6	1	9	62	1
622531	RYAN GEN1-3	6.6	2	9	62	1
622531	RYAN GEN1-3	6.6	3	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
623541	MONTANA ONE	13.8	1	40	62	1
65021	MAGCORP	13.8	1	10.5	65	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
	10% Imbalance =	6,831.26	**MW Total =**	7,149.60	**# Units =**	22

15% Gen Loss Units: 2015 Heavy Spring - Northern Island

BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip Unit?
40063	CGS	25	1	1008.9	40	1
26039	INTERM1G	26	1	932.2	26	1
26040	INTERM2G	26	2	932.2	26	1
65386	BRIDGER1	22	1	815.6	65	1
623504	COLSTRIP GN4	26	1	805	62	1
623503	COLSTRIP GN3	26	1	794.5	62	1
47740	CENTR G1	20	1	624	40	1
47744	CENTR G2	20	2	624	40	1
40297	COULEE23	15	1	611.4	40	1
40298	COULEE24	15	1	611.4	40	1
70777	COMAN_3	27	C3	600	70	1
40296	COULEE22	15	1	567.9	40	1
65387	BRIDGER2	22	1	550	65	1
65388	BRIDGER3	22	1	550	65	1
66730	WYODAK 1	22	1	375	65	1
43407	PELTON	13.8	1	35.1	40	1
43407	PELTON	13.8	2	26.3	40	1
43407	PELTON	13.8	3	26.3	40	1
622531	RYAN GEN1-3	6.6	1	9	62	1
622531	RYAN GEN1-3	6.6	2	9	62	1
622531	RYAN GEN1-3	6.6	3	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
623541	MONTANA ONE	13.8	1	40	62	1
65021	MAGCORP	13.8	1	10.5	65	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
32910	UNOCAL	12	1	13.7	30	
32910	UNOCAL	12	2	13.6	30	
32910	UNOCAL	12	3	13.6	30	
34648	DINUBA E	13.8	1	11.7	30	
35050	SLR-TANN	9.11	1	13.4	30	
34618	MCCALL1T	13.2	1	0	30	
34621	MCCALL3T	13.2	1	0	30	
36413	UNION OL	13.8	1	5.3	30	
59741	LONGLK18	13.8	21	-3.6	54	
	15% Imbalance =	10,246.89	**MW Total =**	10,615.30	**# Units =**	28

20% Gen Loss Units: 2015 Heavy Spring - Northern Island

BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip Unit?
40063	CGS	25	1	1008.9	40	1
26039	INTERM1G	26	1	932.2	26	1
26040	INTERM2G	26	2	932.2	26	1
65386	BRIDGER1	22	1	815.6	65	1
623504	COLSTRIP GN4	26	1	805	62	1
623503	COLSTRIP GN3	26	1	794.5	62	1
47740	CENTR G1	20	1	624	40	1
47744	CENTR G2	20	2	624	40	1
40297	COULEE23	15	1	611.4	40	1
40298	COULEE24	15	1	611.4	40	1
70777	COMAN_3	27	C3	600	70	1
40296	COULEE22	15	1	567.9	40	1
65387	BRIDGER2	22	1	550	65	1
65388	BRIDGER3	22	1	550	65	1
65389	BRIDGER4	22	1	550	65	1
40291	COULEE19	15	1	525.8	40	1
40293	COULEE20	15	1	525.8	40	1
40295	COULEE21	15	1	524.1	40	1
65500	EHUNTR 3	22	1	500	65	1
54490	GENES 39	22	3	474.7	54	1
66730	WYODAK 1	22	1	375	65	1
43407	PELTON	13.8	1	35.1	40	1
43407	PELTON	13.8	2	26.3	40	1
43407	PELTON	13.8	3	26.3	40	1
622531	RYAN GEN1-3	6.6	1	9	62	1
622531	RYAN GEN1-3	6.6	2	9	62	1
622531	RYAN GEN1-3	6.6	3	9	62	1
622532	RYAN GEN4-6	6.6	4	9	62	1
622532	RYAN GEN4-6	6.6	5	9	62	1
622532	RYAN GEN4-6	6.6	6	9	62	1
623541	MONTANA ONE	13.8	1	40	62	1
65021	MAGCORP	13.8	1	10.5	65	1
65021	MAGCORP	13.8	2	10.5	65	1
65021	MAGCORP	13.8	3	10.5	65	1
50641	KLY 12C1	12.5	1	0	50	1
32910	UNOCAL	12	1	13.7	30	
32910	UNOCAL	12	2	13.6	30	
32910	UNOCAL	12	3	13.6	30	
34648	DINUBA E	13.8	1	11.7	30	
35050	SLR-TANN	9.11	1	13.4	30	
34618	MCCALL1T	13.2	1	0	30	
34621	MCCALL3T	13.2	1	0	30	

36413	UNION OL	13.8	1	5.3	30	
59741	LONGLK18	13.8	21	-3.6	54	
	20% Imbalance =	13,662.52	**MW Total =**	13,715.70	**# Units =**	35

25% Gen Loss Units: 2015 Heavy Spring - Northern Island						
BUS-NO	**NAME1**	**KV1**	**ID**	**PGEN**	**AREA**	**Trip Unit?**
40063	CGS	25	1	1030.1	40	1
26039	INTERM1G	26	1	950	26	1
26040	INTERM2G	26	2	950	26	1
623503	COLSTRIP GN3	26	1	800.3	62	1
47740	CENTR G1	20	1	637.1	40	1
47744	CENTR G2	20	2	637.1	40	1
65387	BRIDGER2	22	1	554	65	1
65389	BRIDGER4	22	1	554	65	1
40291	COULEE19	15	1	536.9	40	1
40293	COULEE20	15	1	536.9	40	1
40295	COULEE21	15	1	535.1	40	1
43047	BOARD F	24	1	519	40	1
70310	PAWNEE	22	C1	505	70	1
65500	EHUNTR 3	22	1	500	65	1
40296	COULEE22	15	1	499.1	40	1
65795	HUNTN G1	22	1	495	65	1
65191	BONANZA	24	1	488	65	1
65800	HUNTN G2	22	1	485	65	1
65490	EHUNTR 1	24	1	474	65	1
65495	EHUNTR 2	24	1	474	65	1
54403	KEEP#3GN	22	3	471	54	1
79015	CRAIG 1	22	1	451	73	1
79016	CRAIG 2	22	1	451	73	1
65386	BRIDGER1	22	1	421	65	1
66730	WYODAK 1	22	1	380	65	1
43407	PELTON	13.8	1	32.9	40	1
43407	PELTON	13.8	2	23.8	40	1
43407	PELTON	13.8	3	23.8	40	1
27119	WTGGE	0.57	GE	34.1	26	1
27123	WTGGE2	0.57	1	49.2	26	1
60417	HIGHMESA	0.6	1	10	60	1
69020	MTNWD G2	0.6	1	17	65	1
69022	MTNWD G4	0.6	1	22	65	1
70503	PONNEQUI	26.1	W1	6.3	70	1
70723	RDGCREST	34.5	W1	6.3	70	1

74014	NSS_CT1	13.8	1	28	73	1
74015	NSS_CT2	13.8	1	40	73	1
74016	WYGEN	13.8	1	93	73	1
74017	WYGEN2	13.8	1	100	73	1
74018	WYGEN3	13.8	1	110	73	1
74029	LNG_CT1	13.8	1	40	73	1
76404	DRYFORK	19	1	420	73	1
50641	KLY 12C1	12.5	1	0	50	1
45485	SLATECRK	4.2	1	0.9	40	1
65393	CURRNTS1	18	1	245	65	1
61811	MINIDOKA	2.4	7	4	60	1
61811	MINIDOKA	2.4	6	2	60	1
61812	MINIDOKA	4.16	9	9	60	1
61812	MINIDOKA	4.16	8	8	60	1
60032	TUANAGEN	0.69	1	25	60	1
50437	KMO 13G1	13.8	1	83.5	50	1
50438	KMO 13G2	13.8	2	83.5	50	1
50439	KMO 13G3	13.8	3	83.5	50	1
50440	KMO 13G4	13.8	4	83.5	50	1
50441	KMO 13G5	13.8	5	83.5	50	1
50442	KMO 13G6	13.8	6	83.5	50	1
50443	KMO 13G7	13.8	7	83.5	50	1
50444	KMO 13G8	13.8	8	83.5	50	1
65953	MATHNTON	138	1	0	65	1
64131	VALMY G1	22	1	240	64	1
64132	VALMY G2	18	1	260	64	1
44971	LAKESISK	69	1	0.9	40	1
64150	BEOWAWE	4.16	1	15	64	1
65625	GEMST G1	13.8	1	10	65	1
45485	SLATECRK	4.2	1	0.9	40	1
45026	BIOMASS	13.8	N	8.9	40	1
56405	CONKLIN2	13.8	1	71.1	54	1
57405	CONKLIN4	13.8	2	71.6	54	1
570157	GENCOG57	13.8	57	12	54	1
570158	GENCOG58	13.8	58	8	54	1
570107	GENCOG7	20	7	0	54	1
57249	LNGLKCG1	13.8	G1	67.1	54	1
56249	LNGLKCG2	13.8	G2	67.1	54	1
56264	HORUP6	13.8	5	13.5	54	1
57264	HORUP7	13.8	G1	70.7	54	1
59741	LONGLK18	13.8	21	-3.6	54	
58941	LONGLK14	13.8	22	-3.6	54	
56941	LONGLK17	13.8	M1	-14.5	54	
57438	CAN LIQ8	4.16	5	-7	54	

59241	LONGLK19	4.2	11	-1.2	54	
59841	LONGLK16	4.2	12	-1.2	54	
59941	LONGLK15	13.8	M2	-14.5	54	
58205	AMOCO R9	4.16	2	-1.5	54	
58205	AMOCO R9	4.16	1	-1.5	54	
58384	UNION C9	13.8	2	-5.4	54	
58384	UNION C9	13.8	1	-7	54	
57259	HORUP8	13.8	1B	-2.1	54	
57265	HORUP9	13.8	51	-1.1	54	
58462	HORUP11	13.8	1A	-2.1	54	
59264	HORUP12	13.8	M1	-2.1	54	
	25% Imbalance =	17,078.15	**MW Total =**	17,269.70	**# Units =**	75

5% Gen Loss Units: 2015 Heavy Summer - Northern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip Unit?
40063	CGS	25	1	1030.1	40	1
26039	INTERM1G	26	1	950	26	1
26040	INTERM2G	26	2	950	26	1
40291	COULEE19	15	1	536.9	40	1
40293	COULEE20	15	1	536.9	40	1
43407	PELTON	13.8	1	32.9	40	1
43407	PELTON	13.8	2	23.8	40	1
43407	PELTON	13.8	3	23.8	40	1
70503	PONNEQUI	26.1	W1	6.3	70	1
70723	RDGCREST	34.5	W1	6.3	70	1
	5% Imbalance =	3,873.72	MW Total =	4,097.00	# Units =	10

10% Gen Loss Units: 2015 Heavy Summer - Northern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip Unit?
40063	CGS	25	1	1030.1	40	1
26039	INTERM1G	26	1	950	26	1
26040	INTERM2G	26	2	950	26	1
623504	COLSTRIP GN4	26	1	805	62	1
623503	COLSTRIP GN3	26	1	800.3	62	1
70777	COMAN_3	27	C3	780	70	1
47740	CENTR G1	20	1	637.1	40	1
47744	CENTR G2	20	2	637.1	40	1
65388	BRIDGER3	22	1	555	65	1
65387	BRIDGER2	22	1	554	65	1
43407	PELTON	13.8	1	32.9	40	1
43407	PELTON	13.8	2	23.8	40	1
43407	PELTON	13.8	3	23.8	40	1
70503	PONNEQUI	26.1	W1	6.3	70	1
70723	RDGCREST	34.5	W1	6.3	70	1
	10% Imbalance =	7,747.44	MW Total =	7,791.70	# Units =	15

15% Gen Loss Units: 2015 Heavy Summer - Northern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip Unit?
40063	CGS	25	1	1030.1	40	1
26039	INTERM1G	26	1	950	26	1

26040	INTERM2G	26	2	950	26	1
623504	COLSTRIP GN4	26	1	805	62	1
623503	COLSTRIP GN3	26	1	800.3	62	1
70777	COMAN_3	27	C3	780	70	1
47740	CENTR G1	20	1	637.1	40	1
47744	CENTR G2	20	2	637.1	40	1
65388	BRIDGER3	22	1	555	65	1
65387	BRIDGER2	22	1	554	65	1
65389	BRIDGER4	22	1	554	65	1
40291	COULEE19	15	1	536.9	40	1
40293	COULEE20	15	1	536.9	40	1
40295	COULEE21	15	1	535.1	40	1
43047	BOARD F	24	1	519	40	1
43407	PELTON	13.8	1	32.9	40	1
43407	PELTON	13.8	2	23.8	40	1
43407	PELTON	13.8	3	23.8	40	1
27119	WTGGE	0.57	GE	34.1	26	1
27123	WTGGE2	0.57	1	49.2	26	1
60417	HIGHMESA	0.6	1	10	60	1
61293	BTCKWIND	0.6	1	20	60	1
69020	MTNWD G2	0.6	1	17	65	1
69022	MTNWD G4	0.6	1	22	65	1
70503	PONNEQUI	26.1	W1	6.3	70	1
70723	RDGCREST	34.5	W1	6.3	70	1
74014	NSS_CT1	13.8	1	28	73	1
74015	NSS_CT2	13.8	1	40	73	1
74016	WYGEN	13.8	1	93	73	1
74017	WYGEN2	13.8	1	100	73	1
74018	WYGEN3	13.8	1	110	73	1
74029	LNG_CT1	13.8	1	40	73	1
76404	DRYFORK	19	1	420	73	1
50641	KLY 12C1	12.5	1	0	50	1
45485	SLATECRK	4.2	1	0.9	40	1
65393	CURRNTS1	18	1	245	65	1
	15% Imbalance =	11,621.16	**MW Total =**	11,702.80	**# Units =**	36

20% Gen Loss Units: 2015 Heavy Summer - Northern Island						
BUS-NO	**NAME1**	**KV1**	**ID**	**PGEN**	**AREA**	**Trip Unit?**
40063	CGS	25	1	1030.1	40	1
26040	INTERM2G	26	2	950	26	1
623503	COLSTRIP GN3	26	1	800.3	62	1
47740	CENTR G1	20	1	637.1	40	1

47744	CENTR G2	20	2	637.1	40	1
65387	BRIDGER2	22	1	554	65	1
65389	BRIDGER4	22	1	554	65	1
65490	EHUNTR 1	24	1	474	65	1
65495	EHUNTR 2	24	1	474	65	1
54403	KEEP#3GN	22	3	471	54	1
79015	CRAIG 1	22	1	451	73	1
79016	CRAIG 2	22	1	451	73	1
66730	WYODAK 1	22	1	380	65	1
43407	PELTON	13.8	1	32.9	40	1
43407	PELTON	13.8	2	23.8	40	1
43407	PELTON	13.8	3	23.8	40	1
27119	WTGGE	0.57	GE	34.1	26	1
27123	WTGGE2	0.57	1	49.2	26	1
60417	HIGHMESA	0.6	1	10	60	1
61293	BTCKWIND	0.6	1	20	60	1
69020	MTNWD G2	0.6	1	17	65	1
69022	MTNWD G4	0.6	1	22	65	1
70503	PONNEQUI	26.1	W1	6.3	70	1
70723	RDGCREST	34.5	W1	6.3	70	1
74014	NSS_CT1	13.8	1	28	73	1
74015	NSS_CT2	13.8	1	40	73	1
74016	WYGEN	13.8	1	93	73	1
74017	WYGEN2	13.8	1	100	73	1
74018	WYGEN3	13.8	1	110	73	1
74029	LNG_CT1	13.8	1	40	73	1
76404	DRYFORK	19	1	420	73	1
50641	KLY 12C1	12.5	1	0	50	1
45485	SLATECRK	4.2	1	0.9	40	1
65393	CURRNTS1	18	1	245	65	1
61811	MINIDOKA	2.4	7	4	60	1
61811	MINIDOKA	2.4	6	2	60	1
61812	MINIDOKA	4.16	9	9	60	1
61812	MINIDOKA	4.16	8	8	60	1
60032	TUANAGEN	0.69	1	25	60	1
50437	KMO 13G1	13.8	1	83.5	50	1
50438	KMO 13G2	13.8	2	83.5	50	1
50439	KMO 13G3	13.8	3	83.5	50	1
50440	KMO 13G4	13.8	4	83.5	50	1
50441	KMO 13G5	13.8	5	83.5	50	1
50442	KMO 13G6	13.8	6	83.5	50	1
50443	KMO 13G7	13.8	7	83.5	50	1
50444	KMO 13G8	13.8	8	83.5	50	1
65953	MATHNTON	138	1	0	65	1

64131	VALMY G1	22	1	240	64	1
64132	VALMY G2	18	1	260	64	1
44971	LAKESISK	69	1	0.9	40	1
64150	BEOWAWE	4.16	1	15	64	1
65625	GEMST G1	13.8	1	10	65	1
45485	SLATECRK	4.2	1	0.9	40	1
45026	BIOMASS	13.8	N	8.9	40	1
59741	LONGLK18	13.8	21	-3.6	54	
58941	LONGLK14	13.8	22	-3.6	54	
56941	LONGLK17	13.8	M1	-14.5	54	
	20% Imbalance =	15,494.88	**MW Total =**	15,537.60	**# Units =**	65

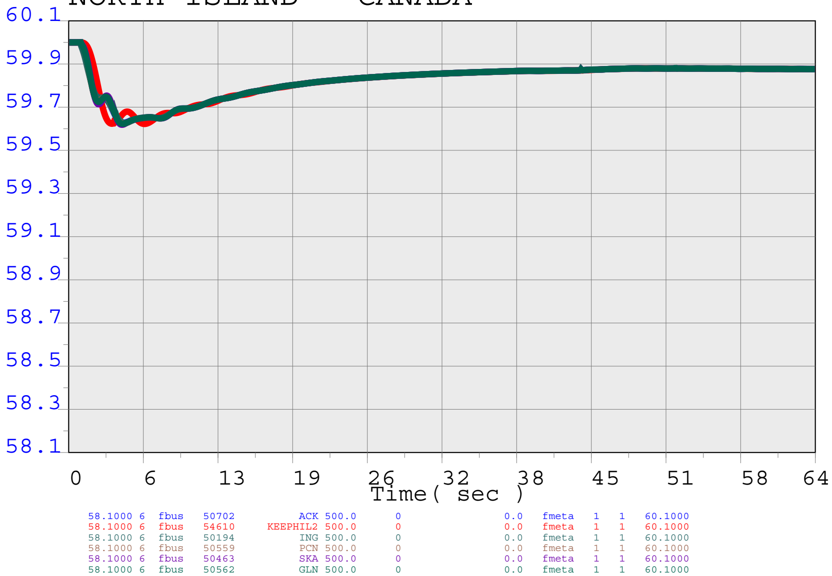
25% Gen Loss Units: 2015 Heavy Summer - Northern Island						
BUS-NO	**NAME1**	**KV1**	**ID**	**PGEN**	**AREA**	**Trip Unit?**
40063	CGS	25	1	1030.1	40	1
26039	INTERM1G	26	1	950	26	1
26040	INTERM2G	26	2	950	26	1
623503	COLSTRIP GN3	26	1	800.3	62	1
47740	CENTR G1	20	1	637.1	40	1
47744	CENTR G2	20	2	637.1	40	1
65387	BRIDGER2	22	1	554	65	1
65389	BRIDGER4	22	1	554	65	1
40291	COULEE19	15	1	536.9	40	1
40293	COULEE20	15	1	536.9	40	1
40295	COULEE21	15	1	535.1	40	1
43047	BOARD F	24	1	519	40	1
70310	PAWNEE	22	C1	505	70	1
65500	EHUNTR 3	22	1	500	65	1
40296	COULEE22	15	1	499.1	40	1
65795	HUNTN G1	22	1	495	65	1
65191	BONANZA	24	1	488	65	1
65800	HUNTN G2	22	1	485	65	1
65490	EHUNTR 1	24	1	474	65	1
65495	EHUNTR 2	24	1	474	65	1
54403	KEEP#3GN	22	3	471	54	1
79015	CRAIG 1	22	1	451	73	1
79016	CRAIG 2	22	1	451	73	1
65386	BRIDGER1	22	1	421	65	1
76404	DRYFORK	19	1	420	73	1
54490	GENES 39	22	3	417.4	54	1
73129	MBPP-1	24	1	396.2	73	1
54422	KEEP#1GN	19	1A	394.5	54	1

51032	REV 16G5	16	5	393.1	50	1
54424	KEEP#2GN	19	2A	392.8	54	1
66730	WYODAK 1	22	1	380	65	1
43407	PELTON	13.8	1	32.9	40	1
43407	PELTON	13.8	2	23.8	40	1
43407	PELTON	13.8	3	23.8	40	1
27119	WTGGE	0.57	GE	34.1	26	1
27123	WTGGE2	0.57	1	49.2	26	1
60417	HIGHMESA	0.6	1	10	60	1
61293	BTCKWIND	0.6	1	20	60	1
69020	MTNWD G2	0.6	1	17	65	1
69022	MTNWD G4	0.6	1	22	65	1
70503	PONNEQUI	26.1	W1	6.3	70	1
70723	RDGCREST	34.5	W1	6.3	70	1
74014	NSS_CT1	13.8	1	28	73	1
74015	NSS_CT2	13.8	1	40	73	1
74016	WYGEN	13.8	1	93	73	1
74017	WYGEN2	13.8	1	100	73	1
74018	WYGEN3	13.8	1	110	73	1
74029	LNG_CT1	13.8	1	40	73	1
76404	DRYFORK	19	1	420	73	1
50641	KLY 12C1	12.5	1	0	50	1
45485	SLATECRK	4.2	1	0.9	40	1
65393	CURRNTS1	18	1	245	65	1
61811	MINIDOKA	2.4	7	4	60	1
61811	MINIDOKA	2.4	6	2	60	1
61812	MINIDOKA	4.16	9	9	60	1
61812	MINIDOKA	4.16	8	8	60	1
60032	TUANAGEN	0.69	1	25	60	1
50437	KMO 13G1	13.8	1	83.5	50	1
50438	KMO 13G2	13.8	2	83.5	50	1
50439	KMO 13G3	13.8	3	83.5	50	1
50440	KMO 13G4	13.8	4	83.5	50	1
50441	KMO 13G5	13.8	5	83.5	50	1
50442	KMO 13G6	13.8	6	83.5	50	1
50443	KMO 13G7	13.8	7	83.5	50	1
50444	KMO 13G8	13.8	8	83.5	50	1
65953	MATHNTON	138	1	0	65	1
64131	VALMY G1	22	1	240	64	1
64132	VALMY G2	18	1	260	64	1
44971	LAKESISK	69	1	0.9	40	1
64150	BEOWAWE	4.16	1	15	64	1
65625	GEMST G1	13.8	1	10	65	1
45485	SLATECRK	4.2	1	0.9	40	1

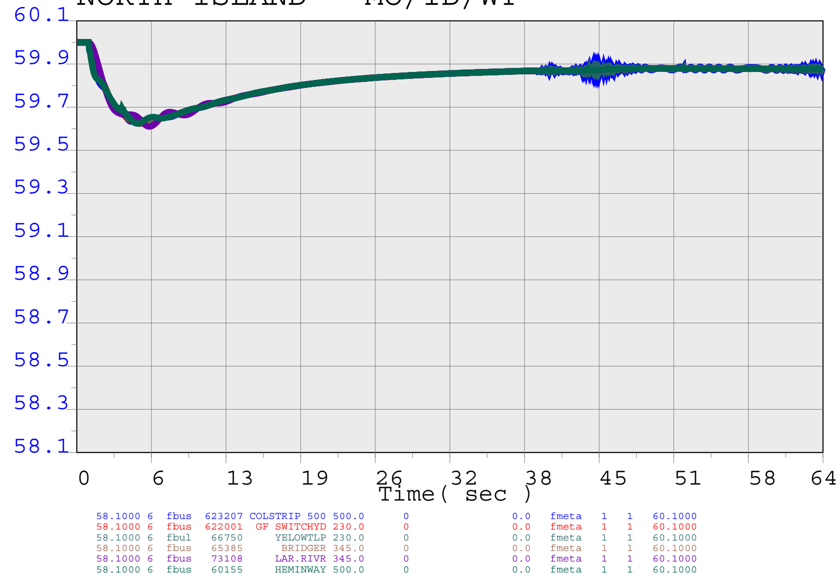
45026	BIOMASS	13.8	N	8.9	40	1
56405	CONKLIN2	13.8	1	71.1	54	1
57405	CONKLIN4	13.8	2	71.6	54	1
570157	GENCOG57	13.8	57	12	54	1
570158	GENCOG58	13.8	58	8	54	1
570107	GENCOG7	20	7	0	54	1
57249	LNGLKCG1	13.8	G1	67.1	54	1
56249	LNGLKCG2	13.8	G2	67.1	54	1
56264	HORUP6	13.8	5	13.5	54	1
57264	HORUP7	13.8	G1	70.7	54	1
59741	LONGLK18	13.8	21	-3.6	54	
58941	LONGLK14	13.8	22	-3.6	54	
56941	LONGLK17	13.8	M1	-14.5	54	
57438	CAN LIQ8	4.16	5	-7	54	
59241	LONGLK19	4.2	11	-1.2	54	
59841	LONGLK16	4.2	12	-1.2	54	
59941	LONGLK15	13.8	M2	-14.5	54	
58205	AMOCO R9	4.16	2	-1.5	54	
58205	AMOCO R9	4.16	1	-1.5	54	
58384	UNION C9	13.8	2	-5.4	54	
58384	UNION C9	13.8	1	-7	54	
57259	HORUP8	13.8	1B	-2.1	54	
57265	HORUP9	13.8	51	-1.1	54	
58462	HORUP11	13.8	1A	-2.1	54	
59264	HORUP12	13.8	M1	-2.1	54	
	25% Imbalance =	19,368.60	**MW Total =**	19,703.70	**# Units =**	82

NORTH ISLAND: 2015HS - 5% GENERATION LOSS

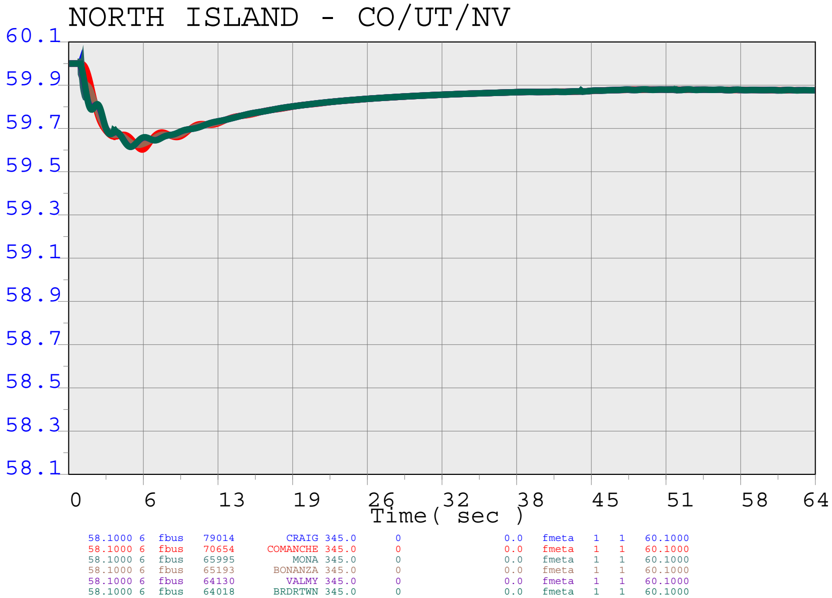
NORTH ISLAND - CANADA



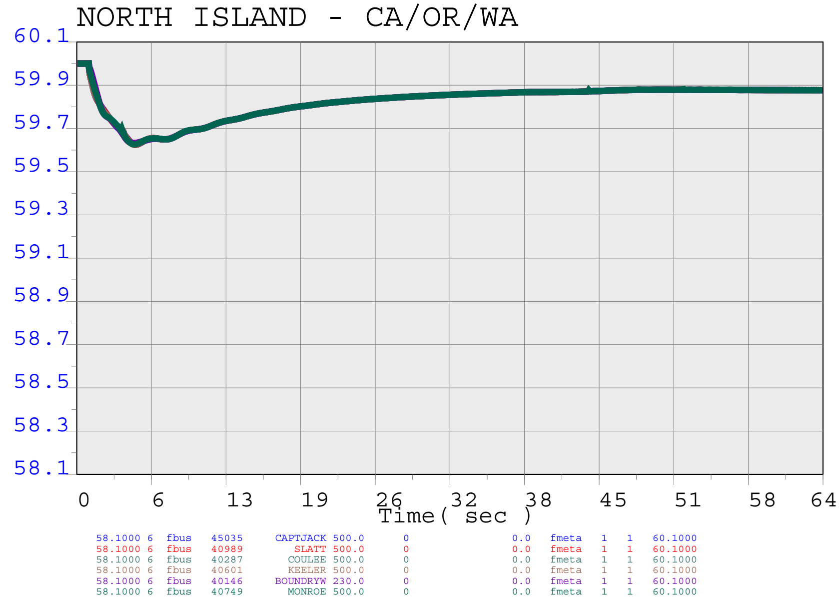
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV

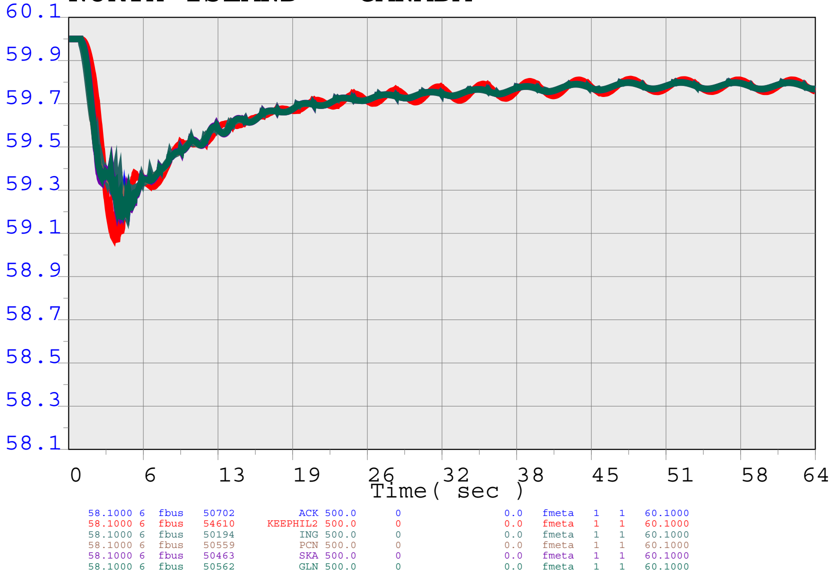


NORTH ISLAND - CA/OR/WA

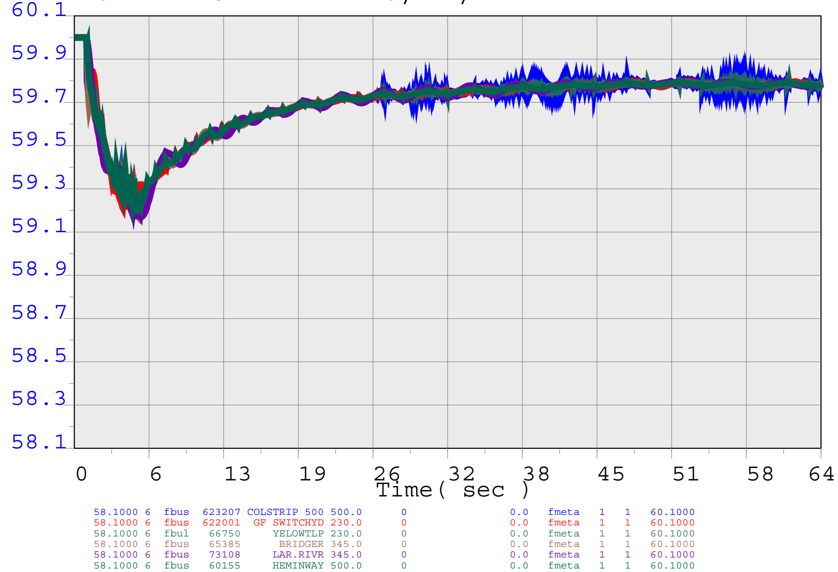


NORTH ISLAND: 2015HS - 10% GENERATION LOSS

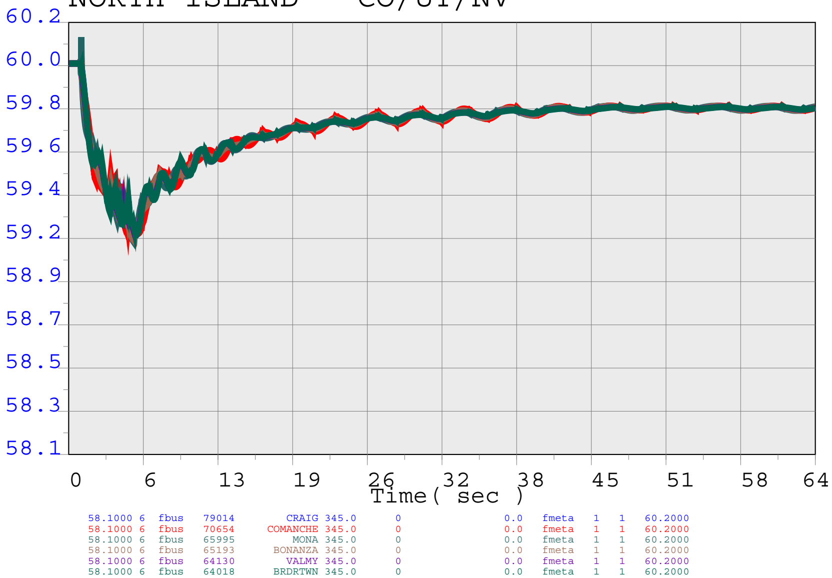
NORTH ISLAND - CANADA



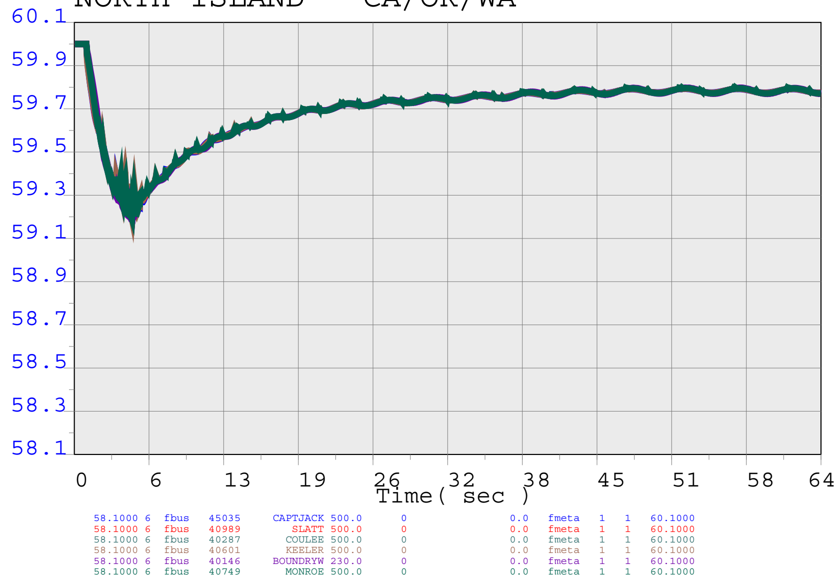
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



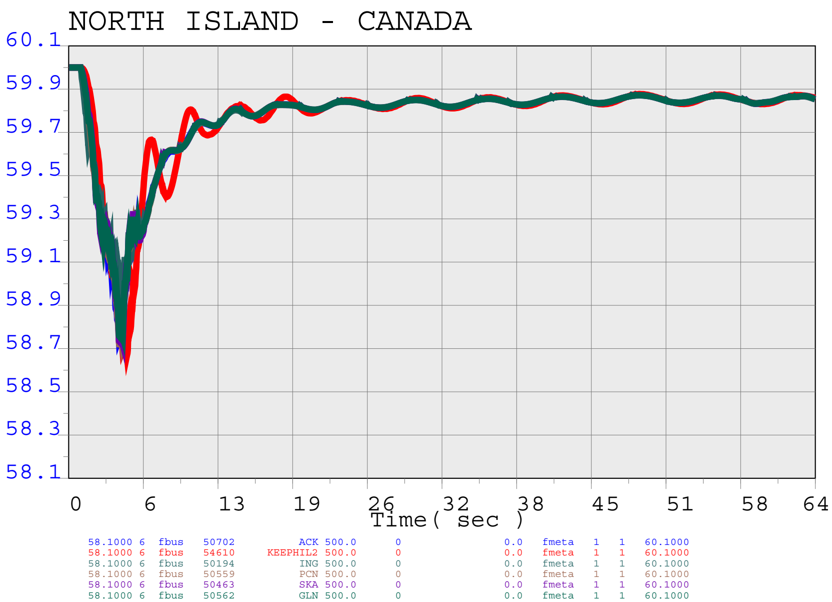
Page 1

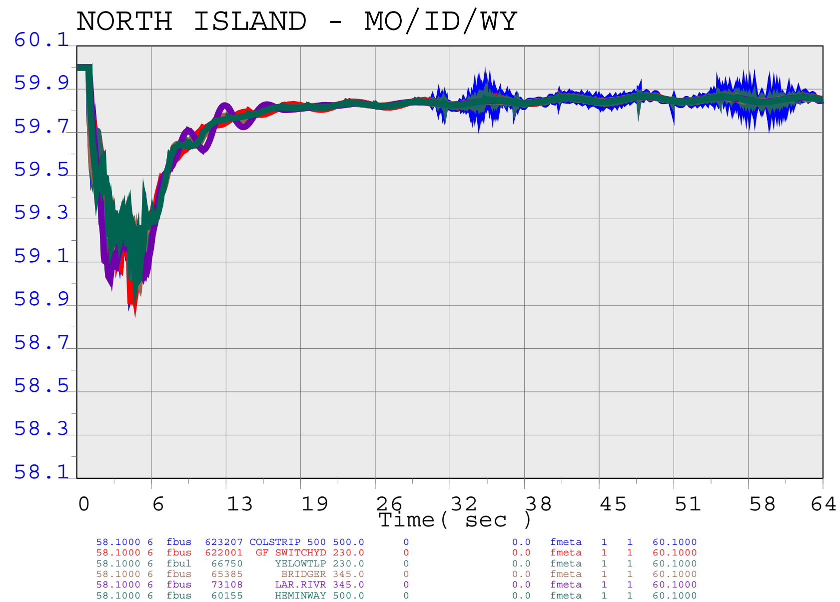
15hs_n_10.chf

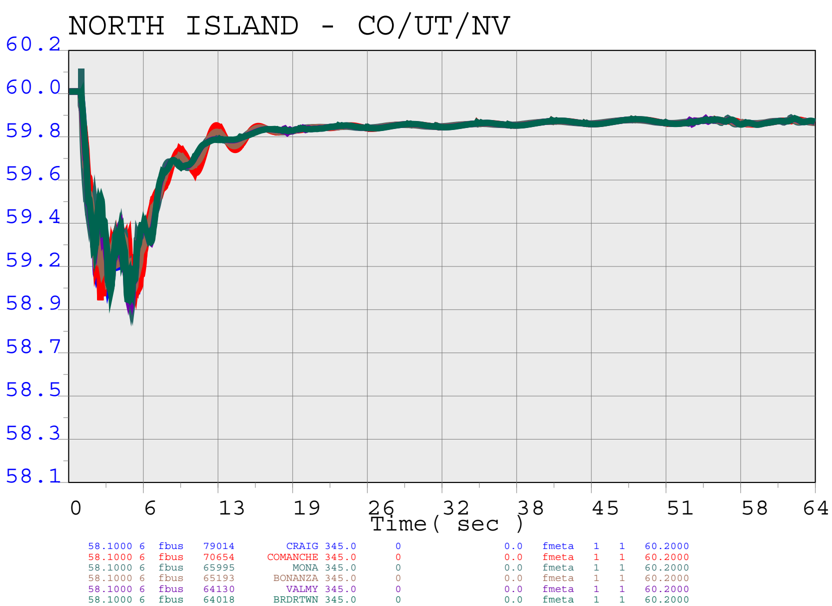
North_Island\2015hs_north

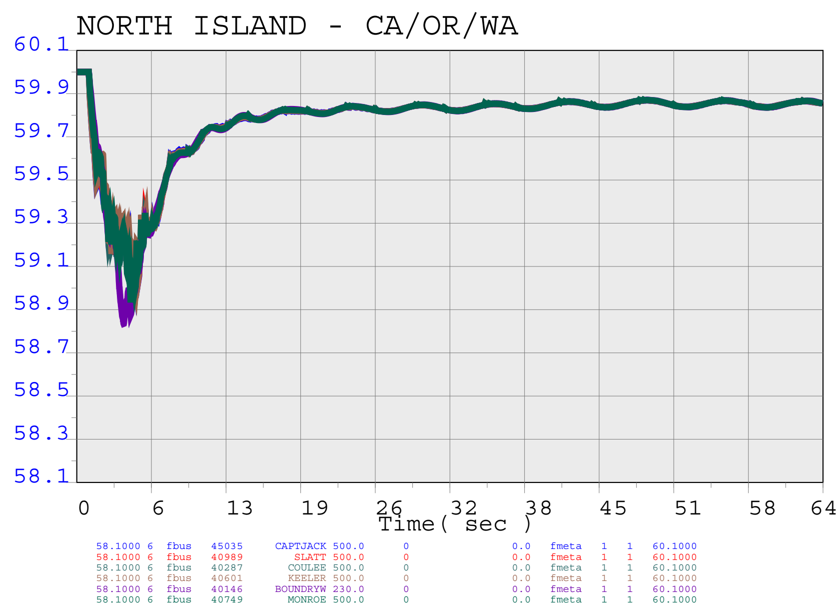
Fri Aug 14 09:54:52 2015

NORTH ISLAND: 2015HS - 15% GENERATION LOSS









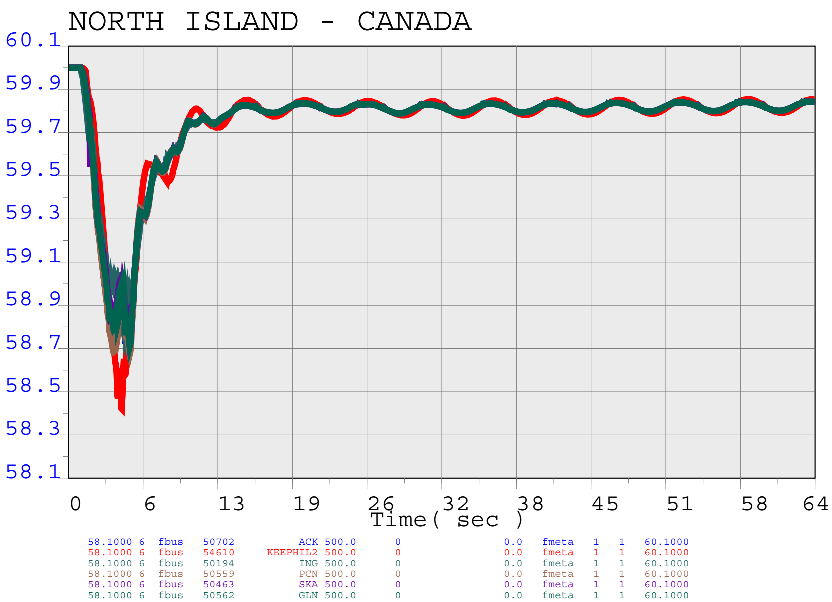
Page 1

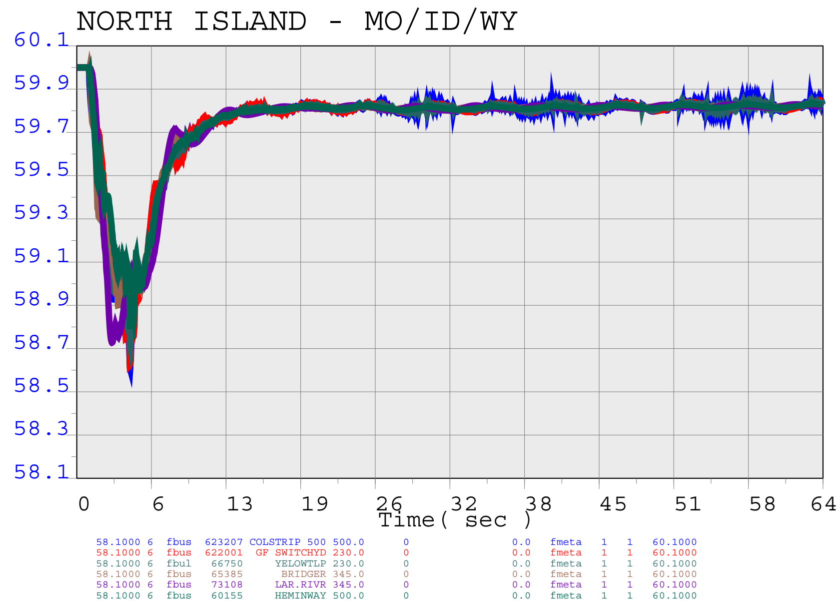
15hs_n_15.chf

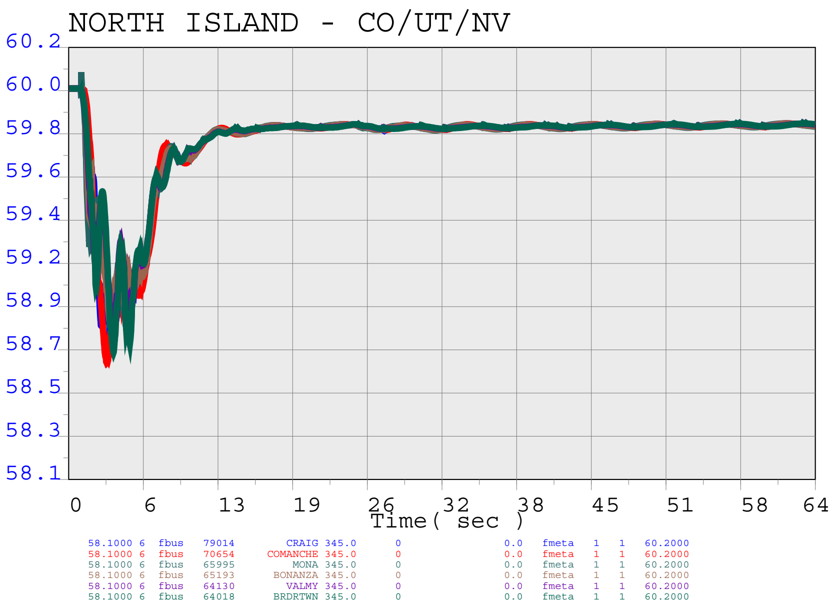
North_Island\2015hs_north

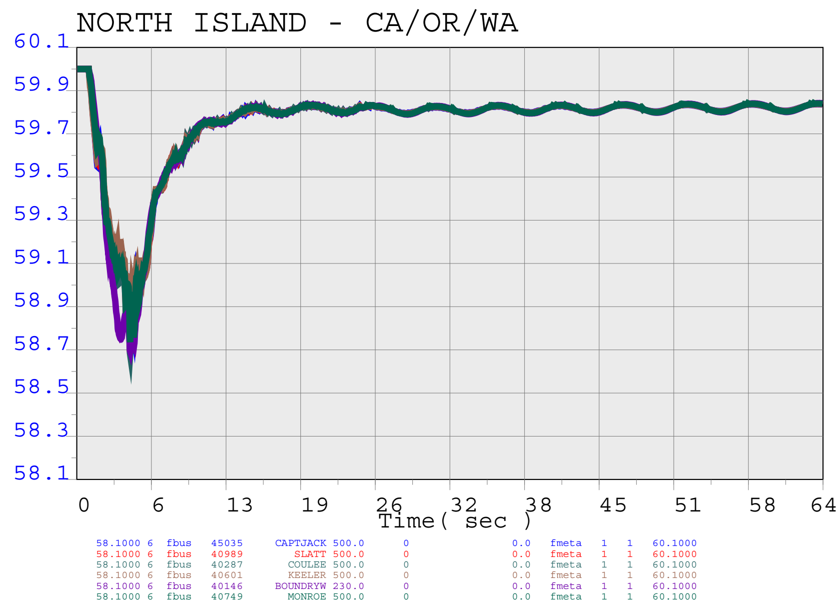
Fri Aug 14 09:55:46 2015

NORTH ISLAND: 2015HS - 20% GENERATION LOSS









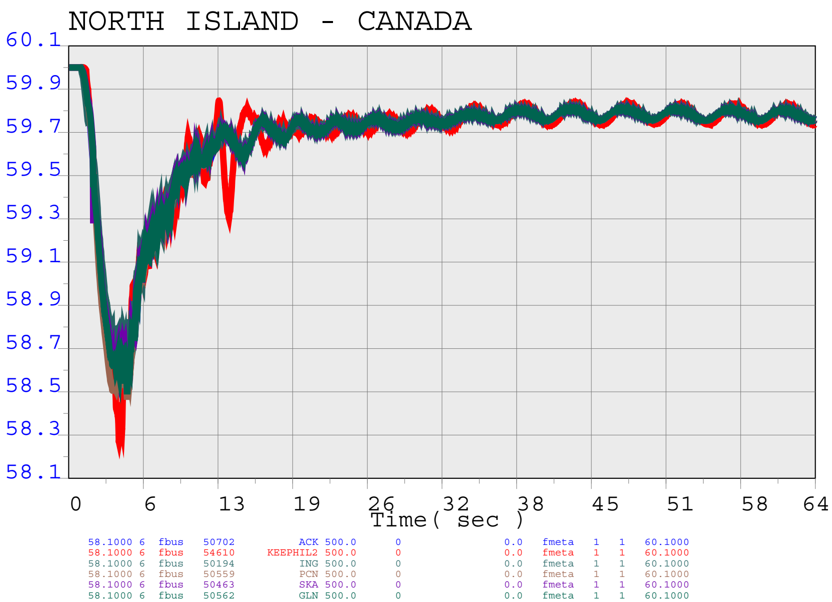
Page 1

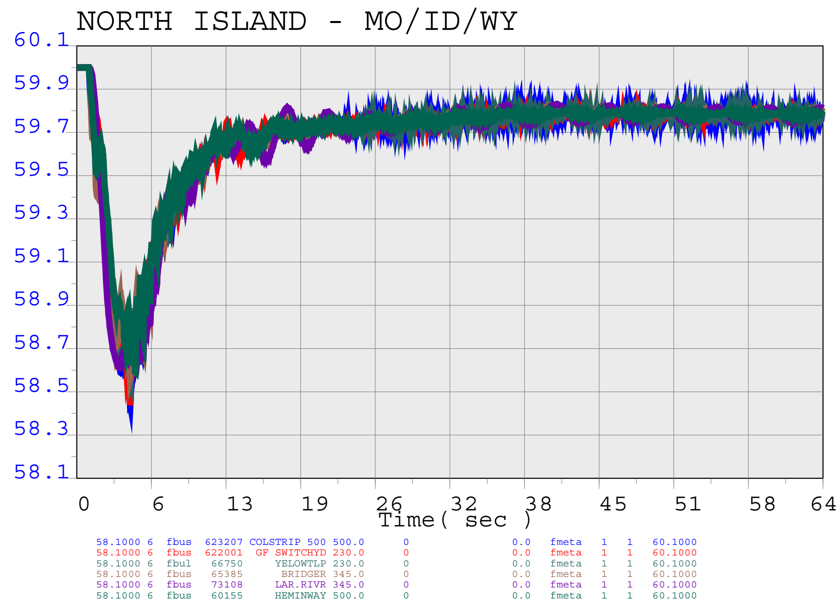
15hs_n_20.chf

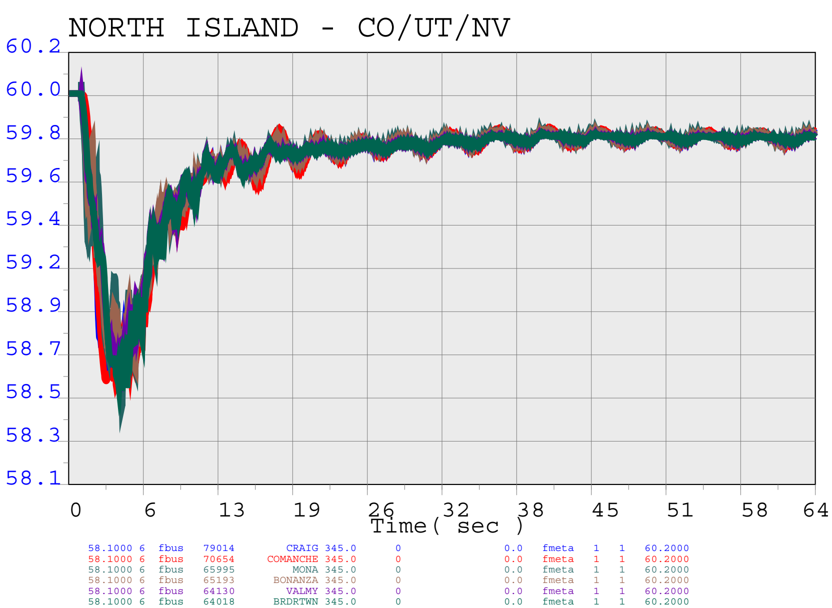
s\johngu\Desktop\20refine

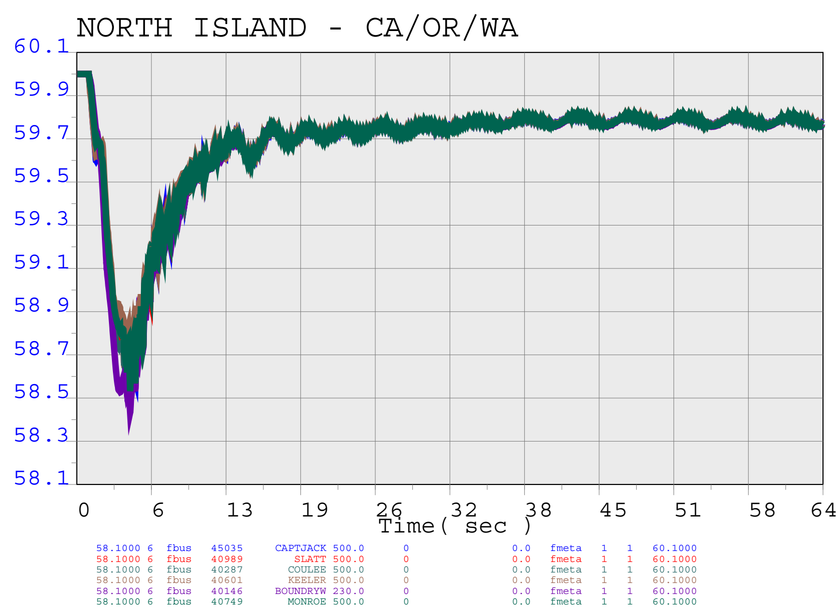
Fri Aug 14 10:00:26 2015

NORTH ISLAND: 2015HS - 25% GENERATION LOSS









Page 1

15hs_n_25_6.chf

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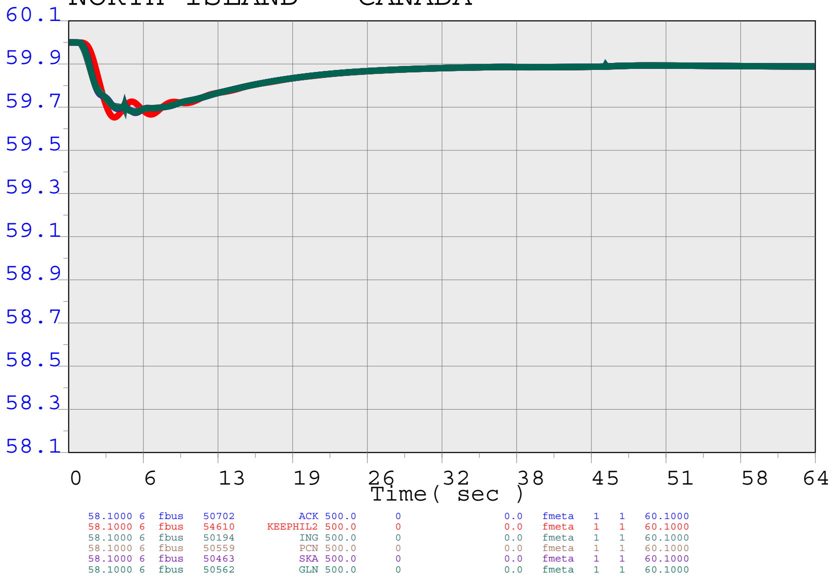
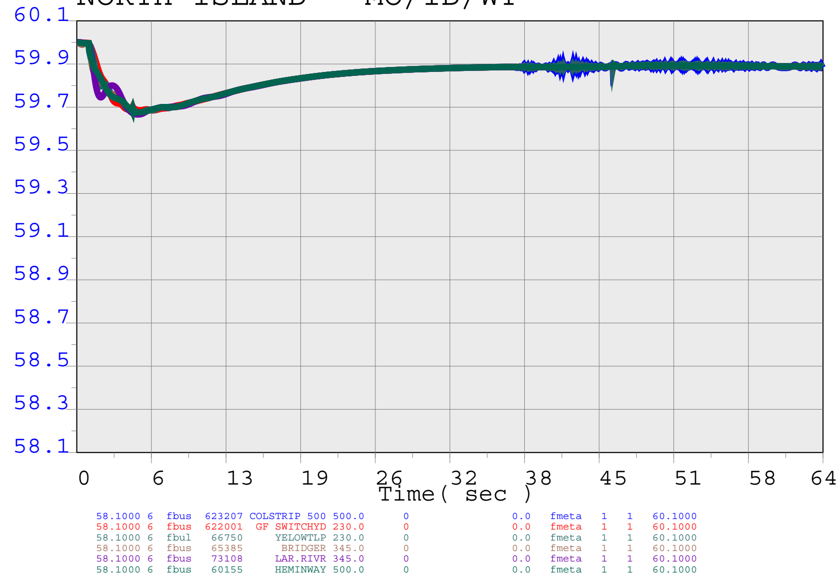
Fri Aug 14 10:02:25 2015

NORTH ISLAND: 2015HSP - 5% GENERATION LOSS

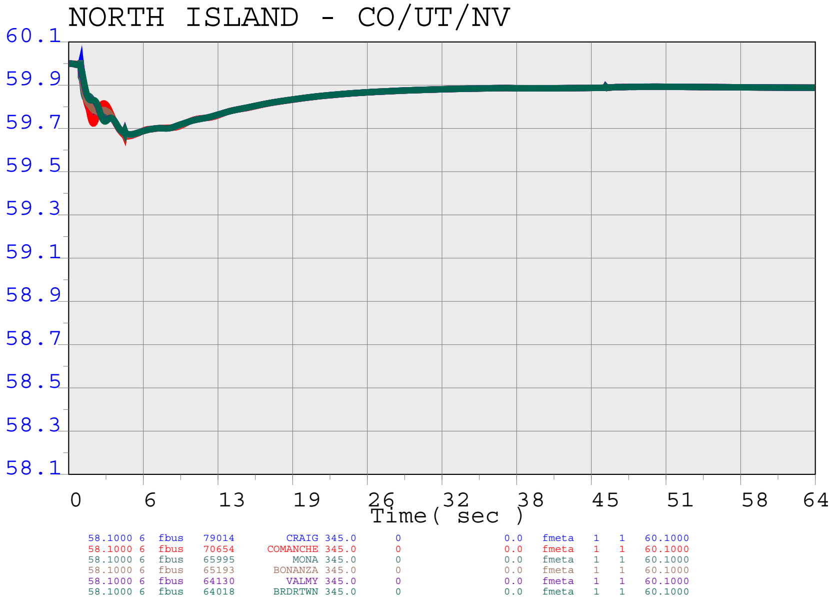
NORTH ISLAND - CANADA



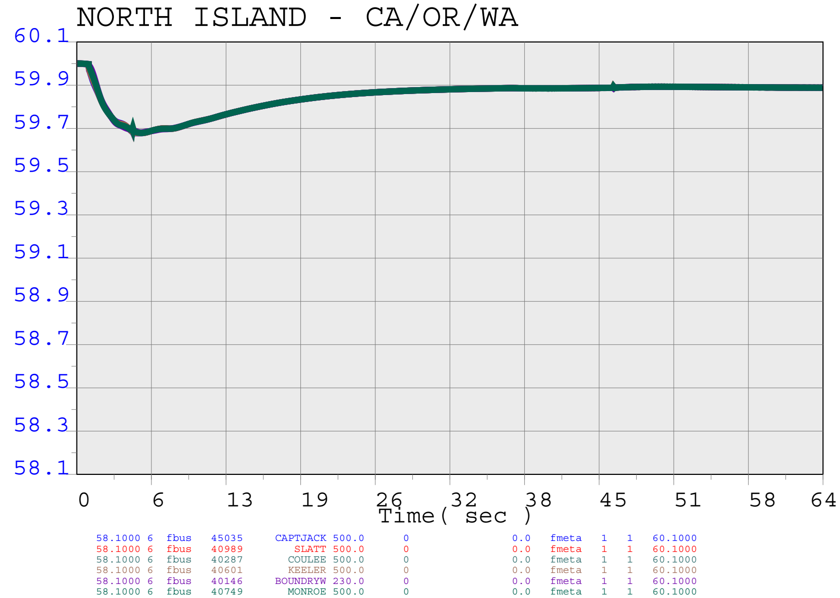
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



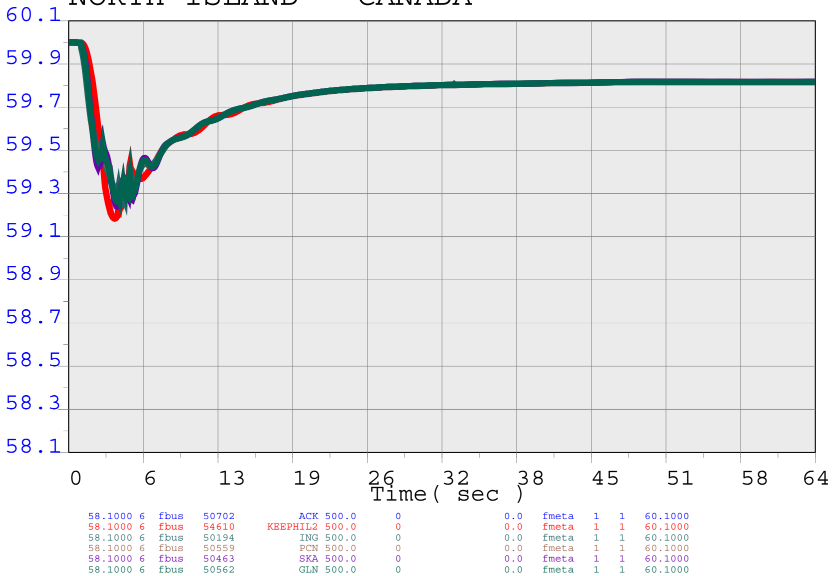
15hsp_n_5.chf

orth_Island\2015hsp_north

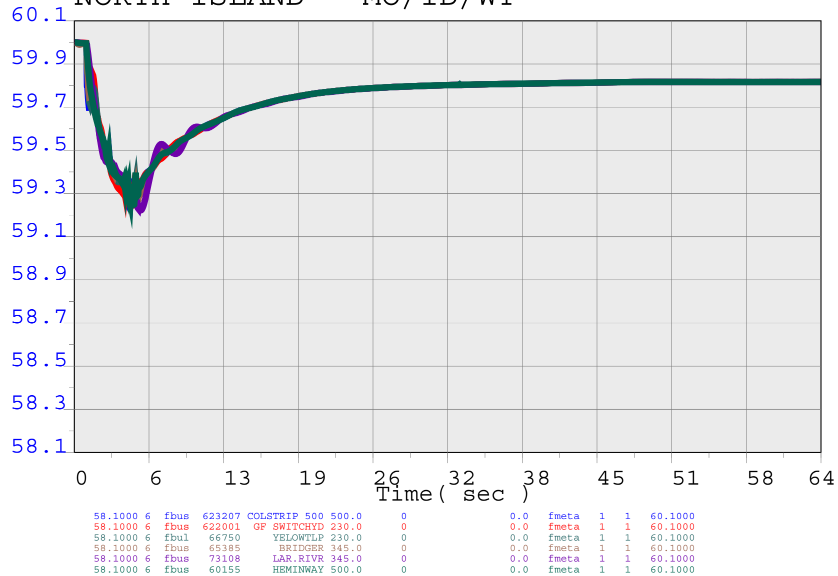
Fri Aug 14 10:04:01 2015

NORTH ISLAND: 2015HSP - 10% GENERATION LOSS

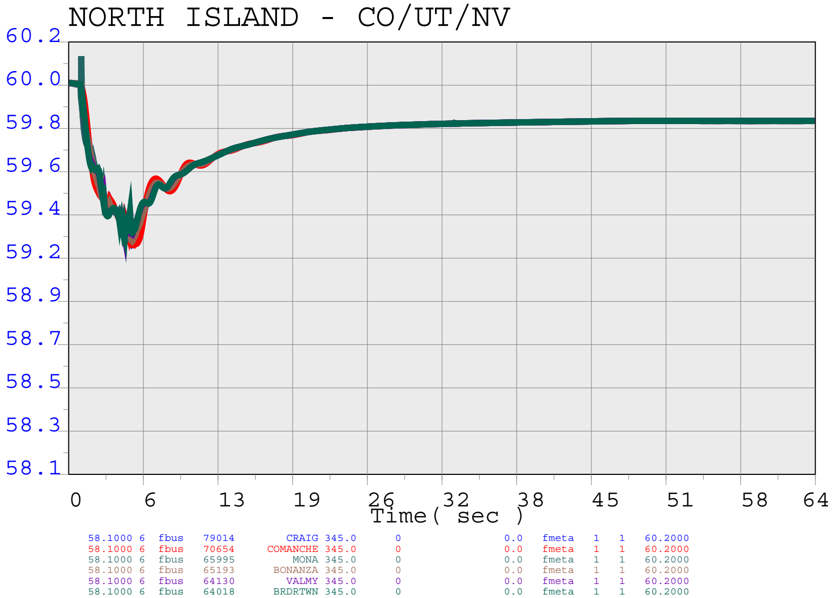
NORTH ISLAND - CANADA



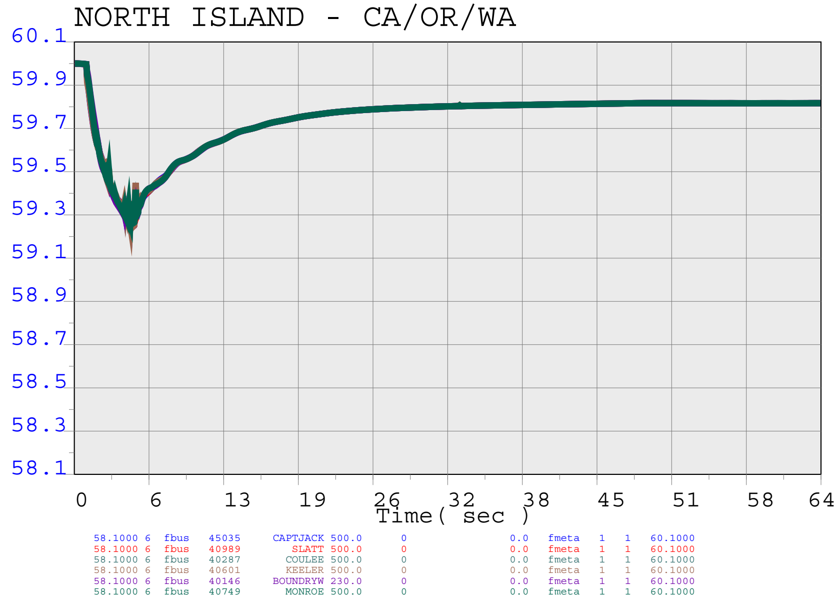
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



Page 1

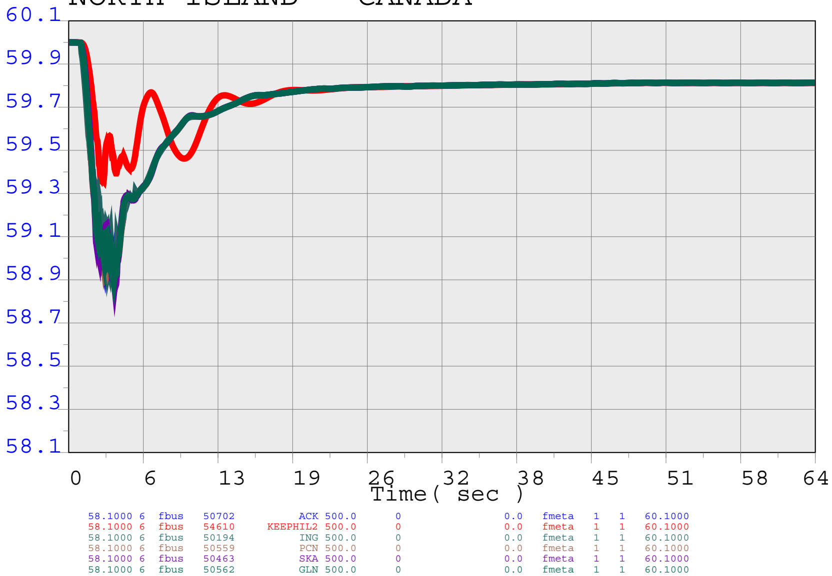
15hsp_n_10.chf

orth_Island\2015hsp_north

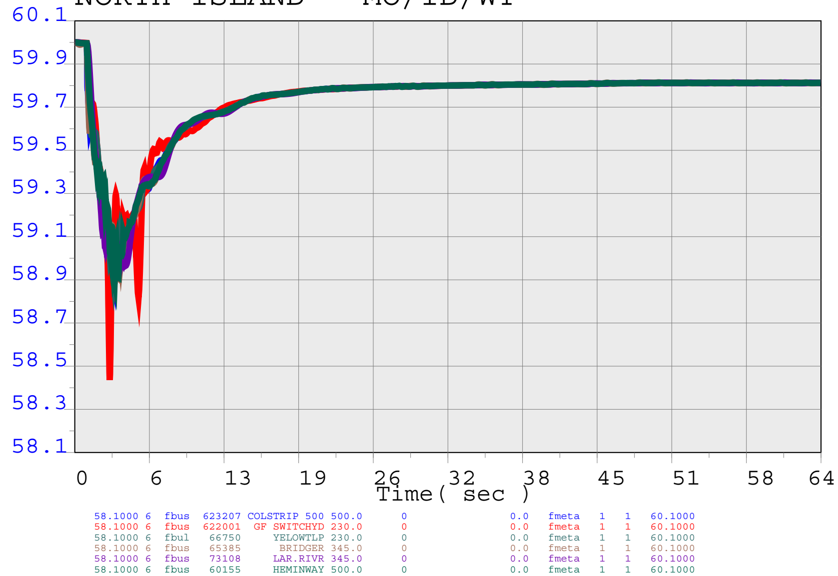
Fri Aug 14 10:04:49 2015

NORTH ISLAND: 2015HSP - 15% GENERATION LOSS

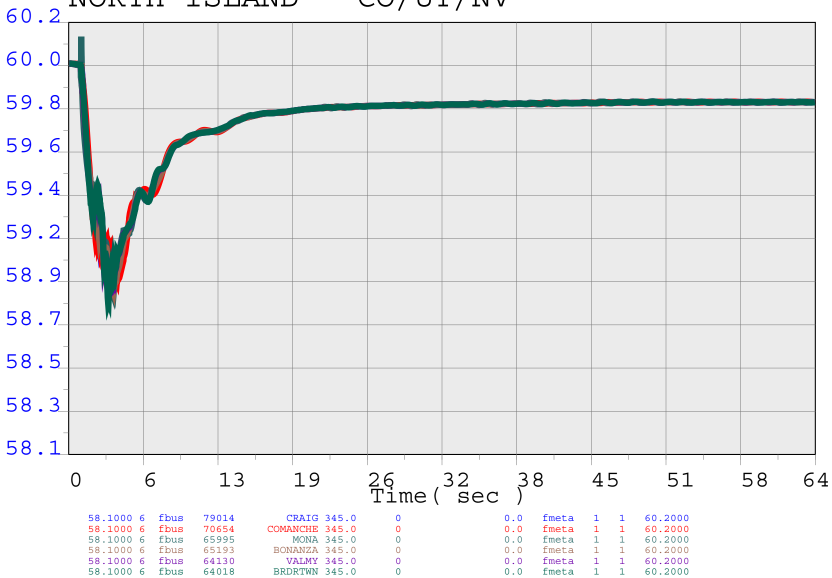
NORTH ISLAND - CANADA



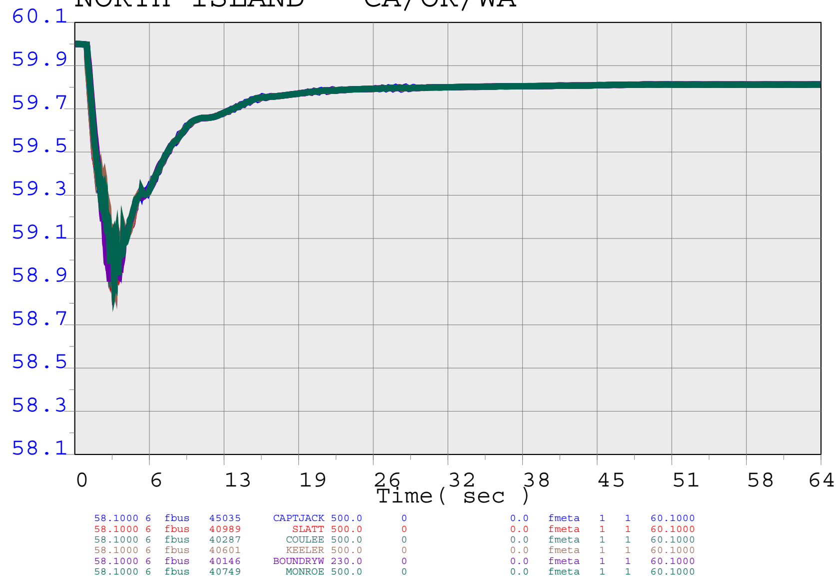
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



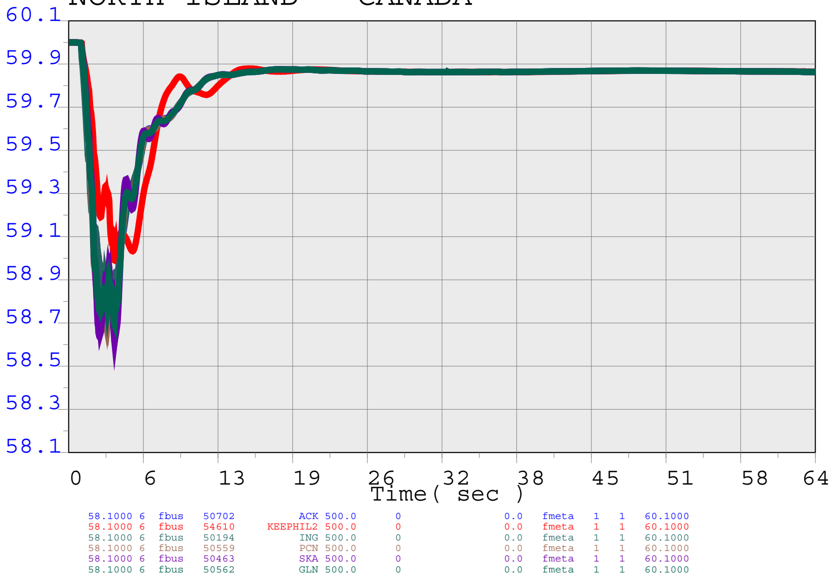
15hsp_n_15.chf

orth_Island\2015hsp_north

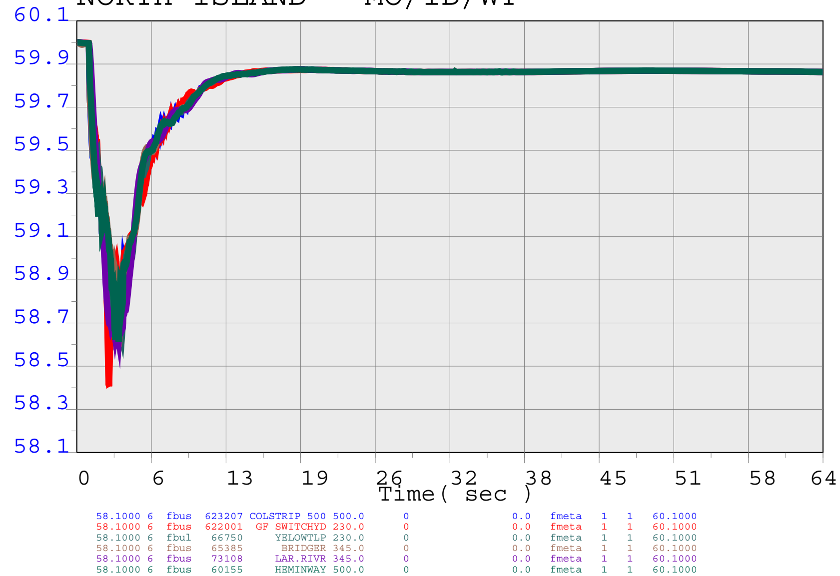
Fri Aug 14 10:05:33 2015

NORTH ISLAND: 2015HSP - 20% GENERATION LOSS

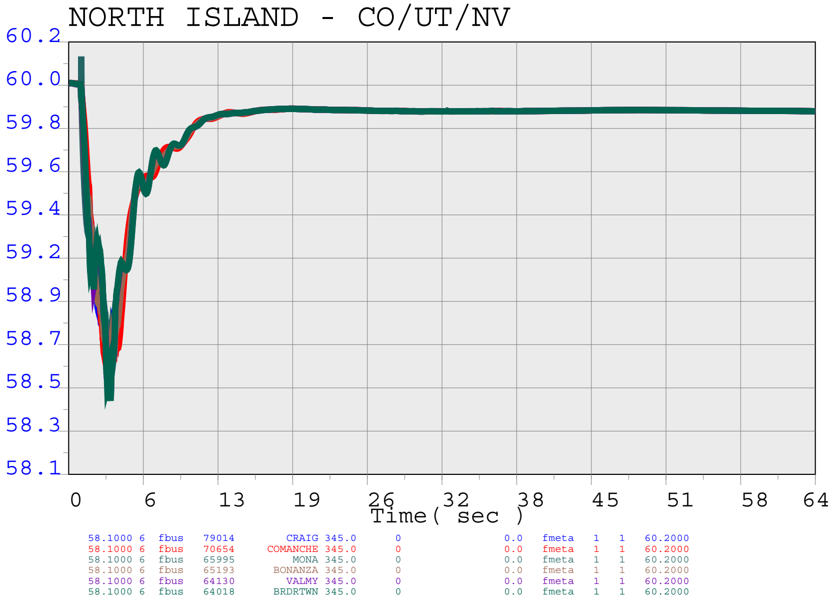
NORTH ISLAND - CANADA



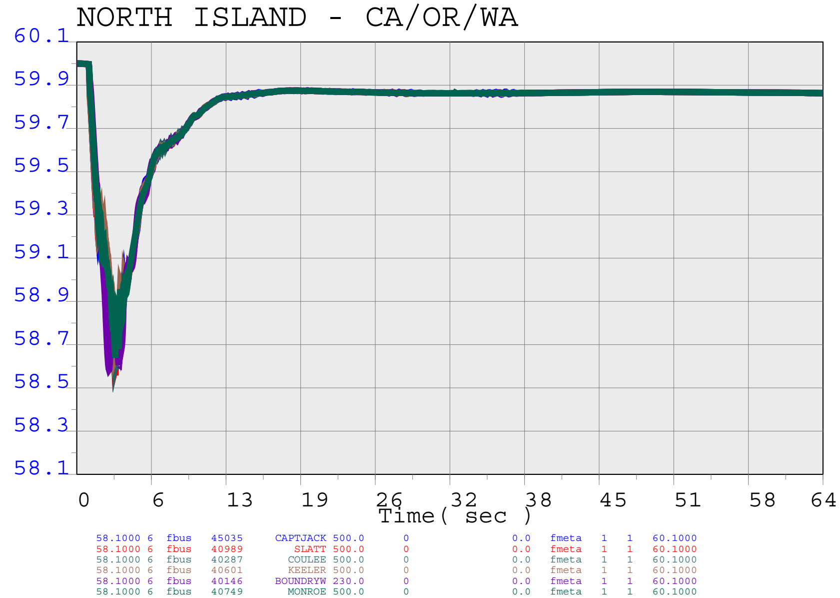
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



Page 1

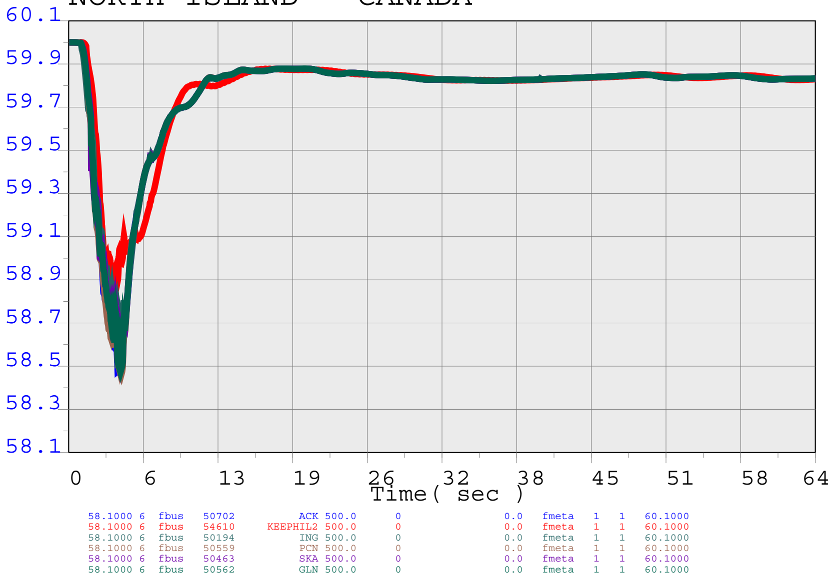
15hsp_n_20.chf

orth_Island\2015hsp_north

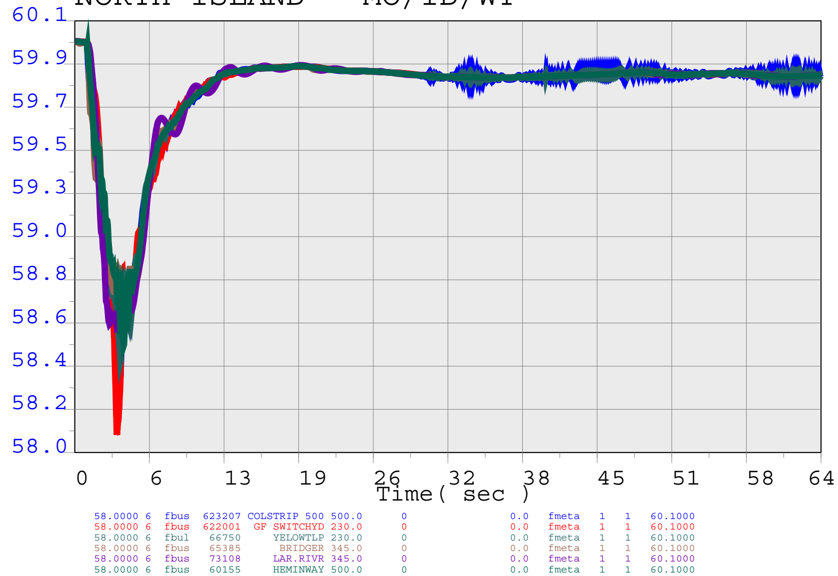
Fri Aug 14 10:06:35 2015

NORTH ISLAND: 2015HSP - 25% GENERATION LOSS

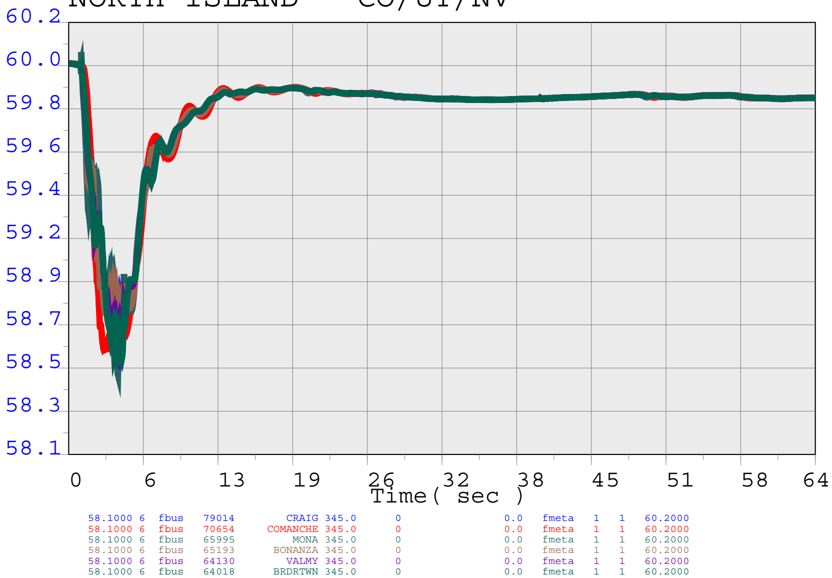
NORTH ISLAND - CANADA



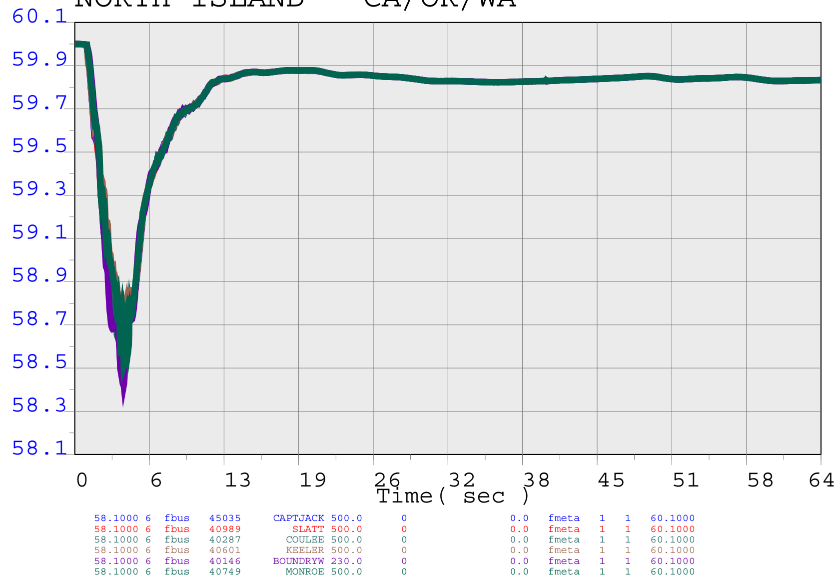
NORTH ISLAND - MO/ID/WY



NORTH ISLAND - CO/UT/NV



NORTH ISLAND - CA/OR/WA



Page 1

15hsp_n_25a.chf

orth_Island\2015hsp_north

Fri Aug 14 10:07:38 2015

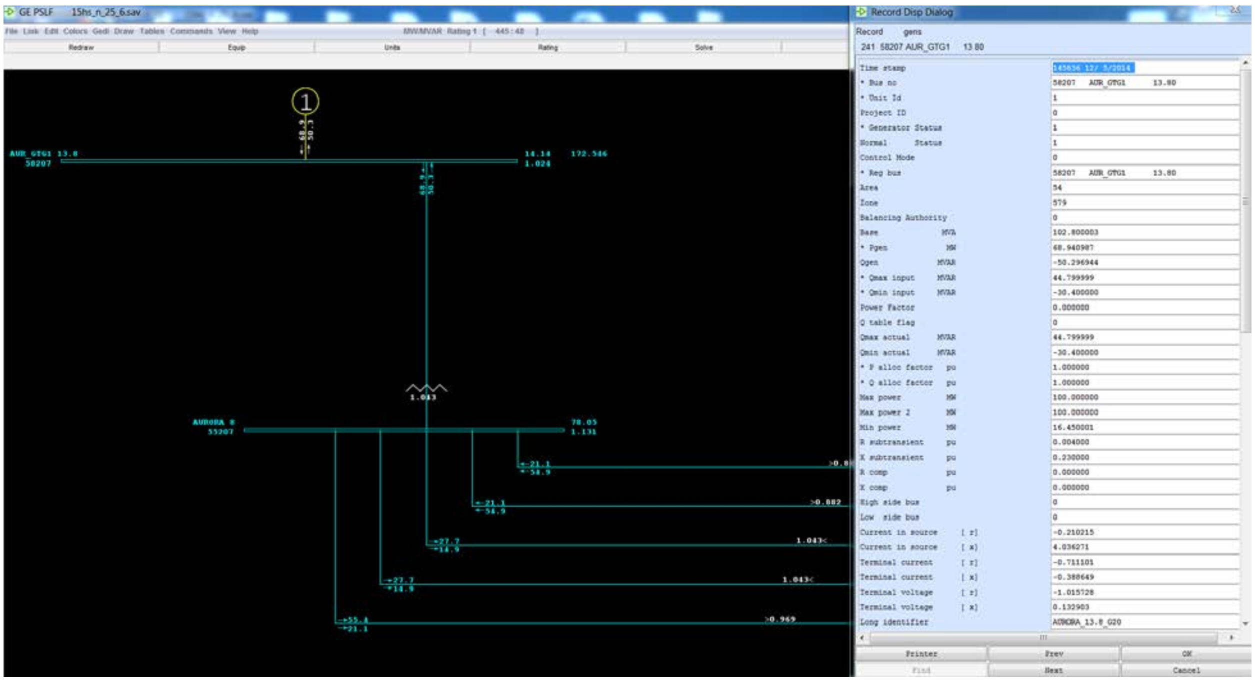
Appendix F: Northern Island Simulations: Volts per Hz Plots

<u>Unit ID:</u>

- AUR GTG1

<u>Flagged Potential Violation:</u>

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

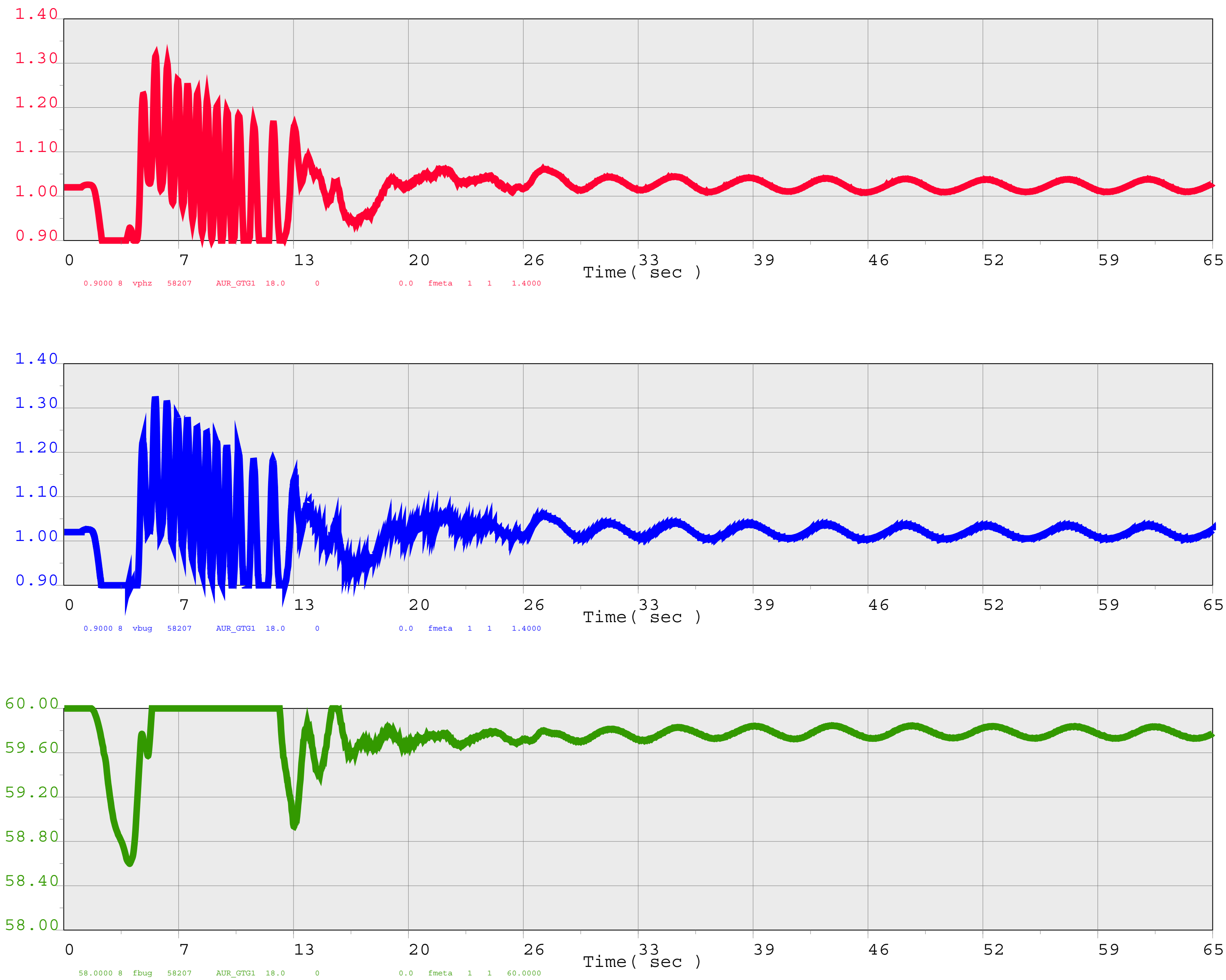


<u>Likely Cause:</u>

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is absorbing 50.3 MVAR, which exceeds its Qmin (30.4 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES 1.18 V/Hz CRITERIA ONLY

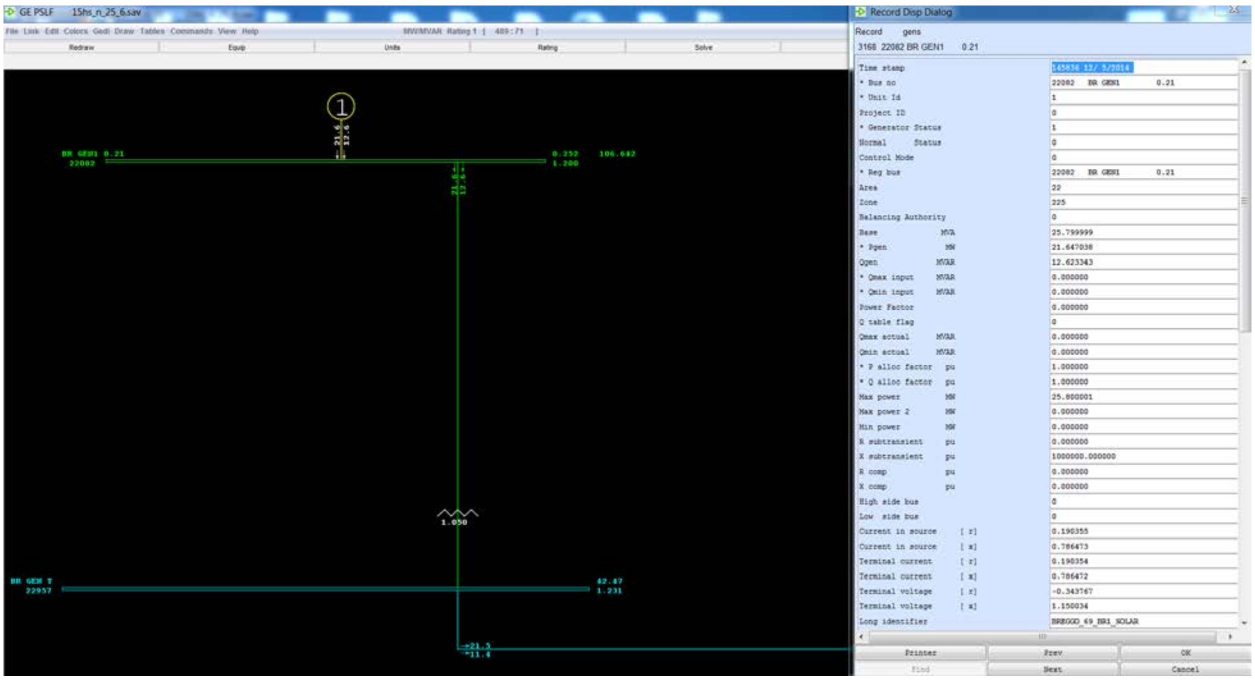


Unit ID:

- BR GEN1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

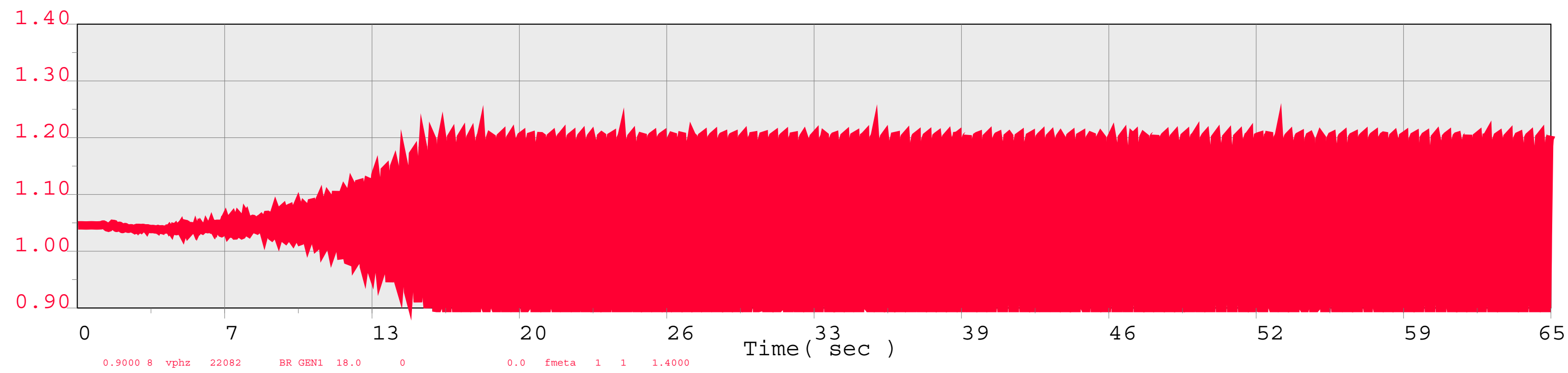


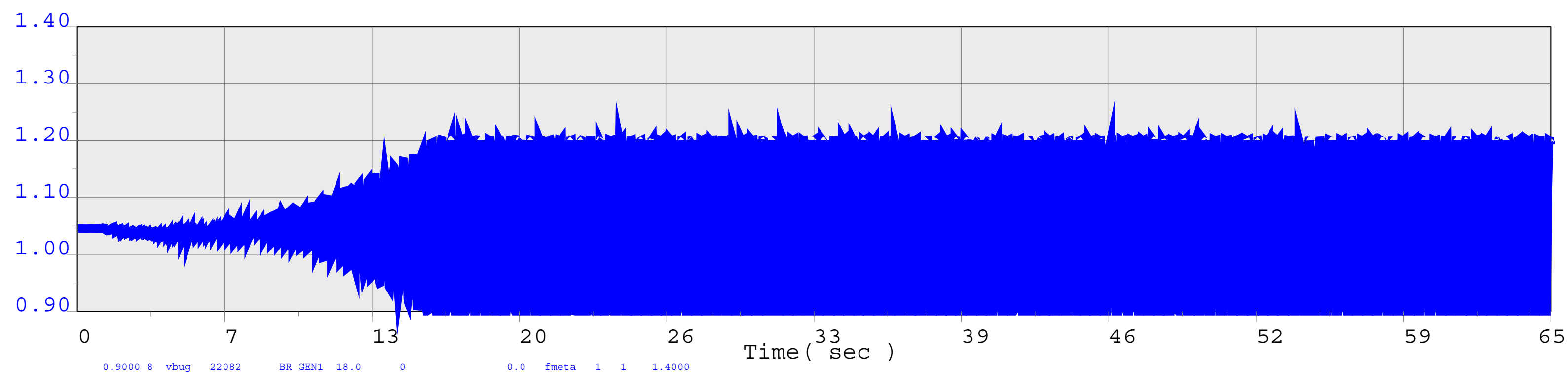
Likely Cause:

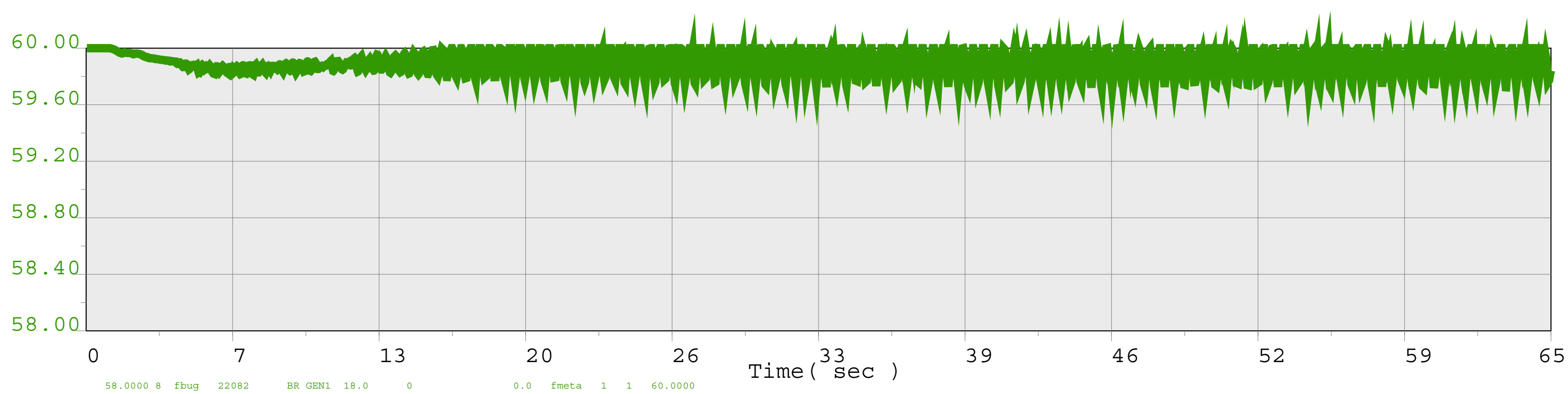
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 12.6 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY







15hs_n_25_6.chf

ISLAND FINAL\2015hs_north

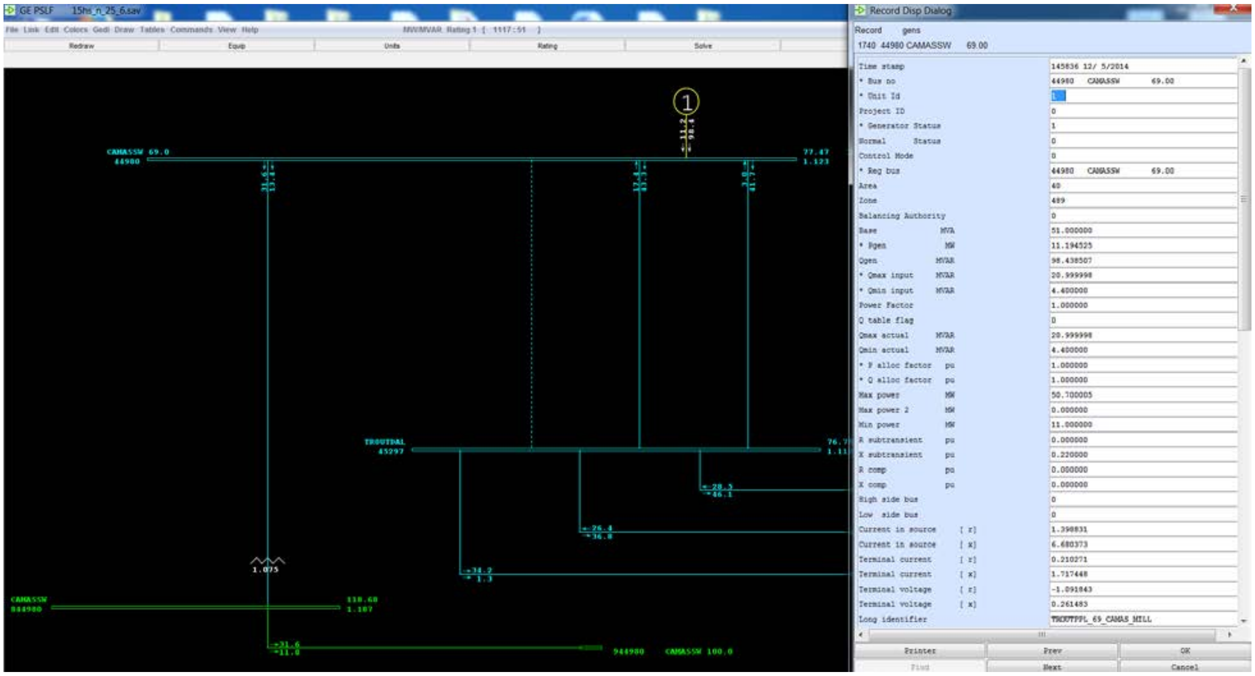
Fri Aug 14 15:07:27 2015

<u>Unit ID:</u>

- CAMASSW

<u>Flagged Potential Violation:</u>

- V/Hz measurement on the bus to which the unit is connected exceeds 1.1 for longer than 45 seconds.

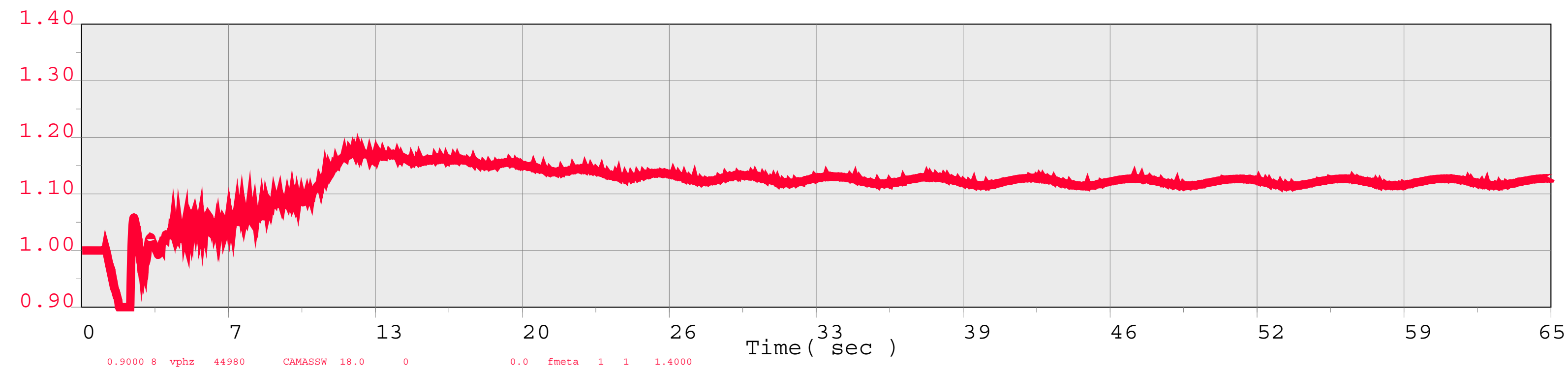


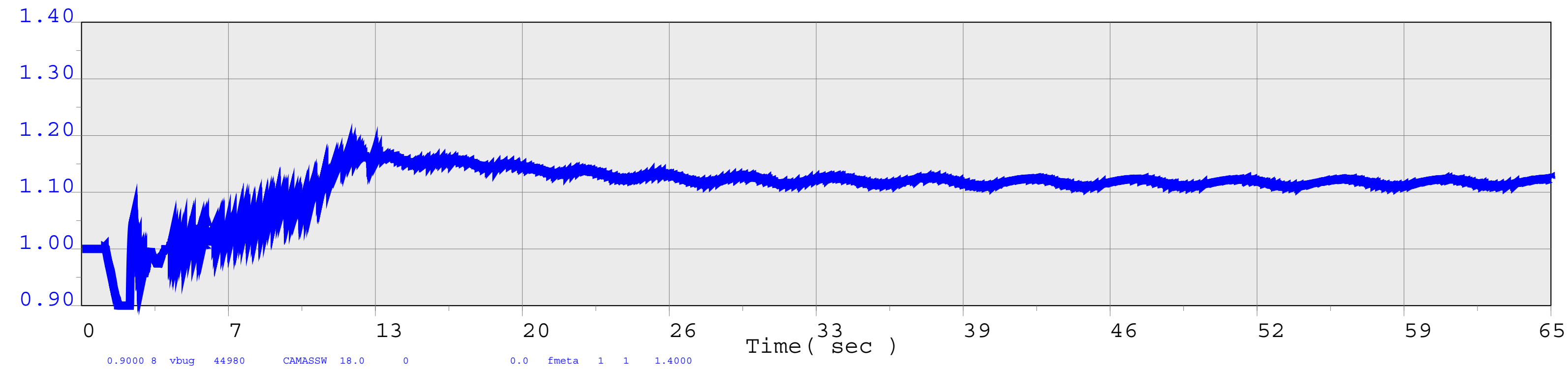
<u>Likely Cause:</u>

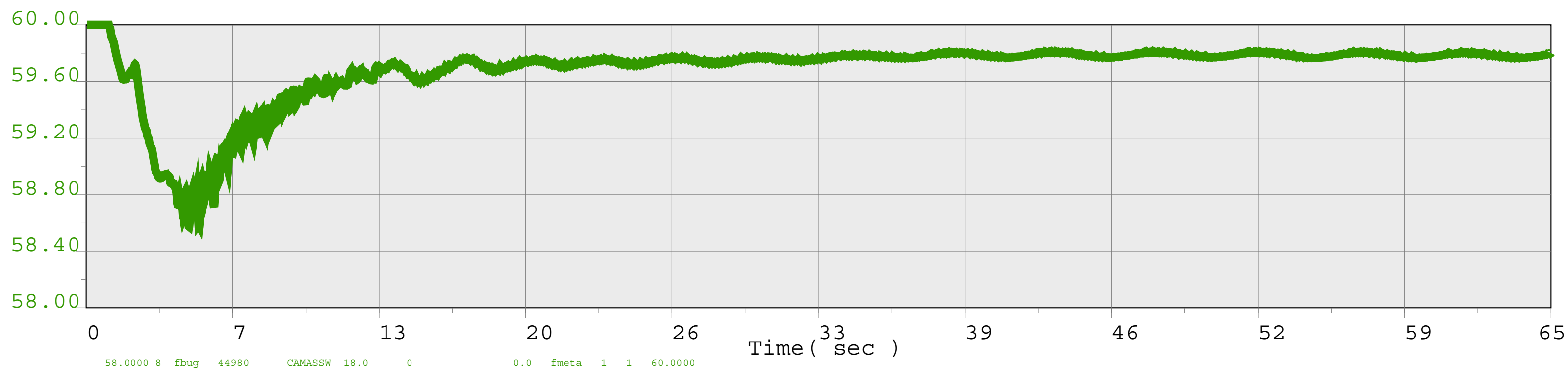
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 98.4 MVAR, which exceeds its Qmax (21 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES 1.10 V/Hz CRITERIA ONLY





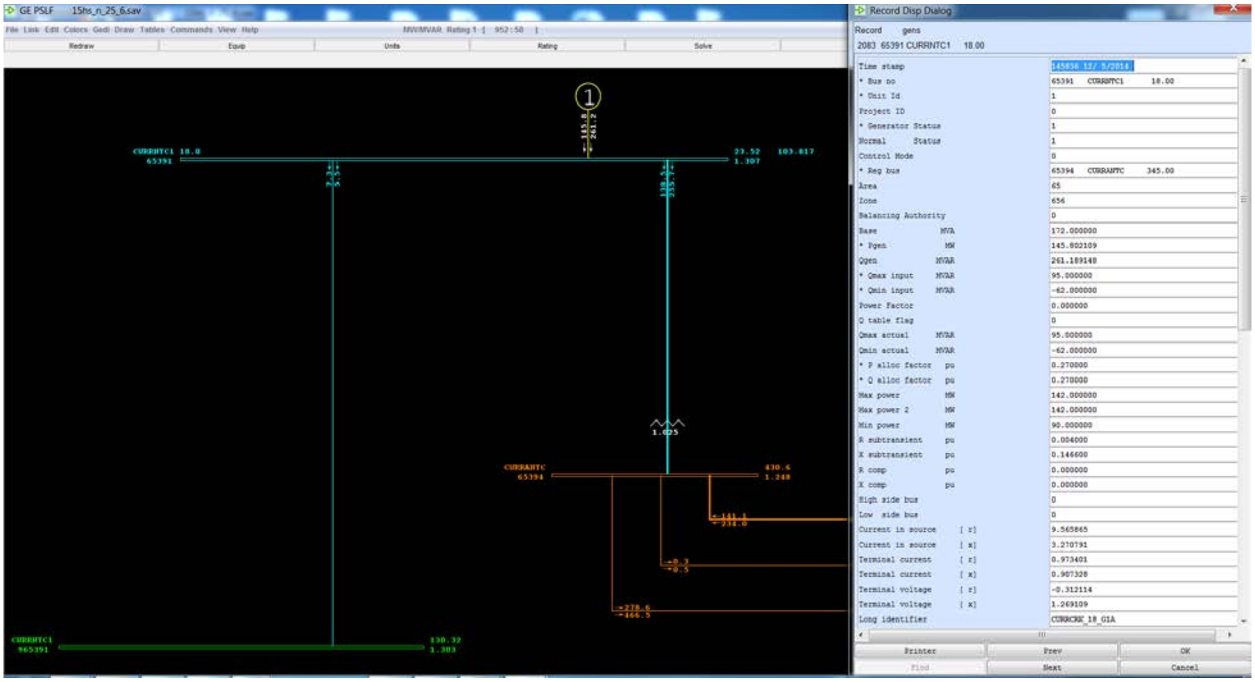


Unit ID:

- CURRNTC1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

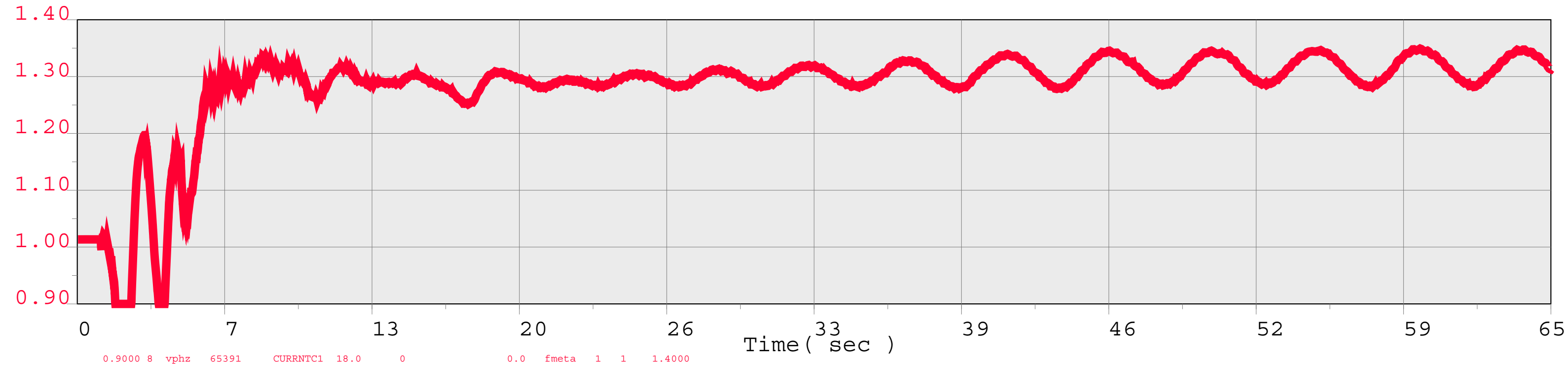


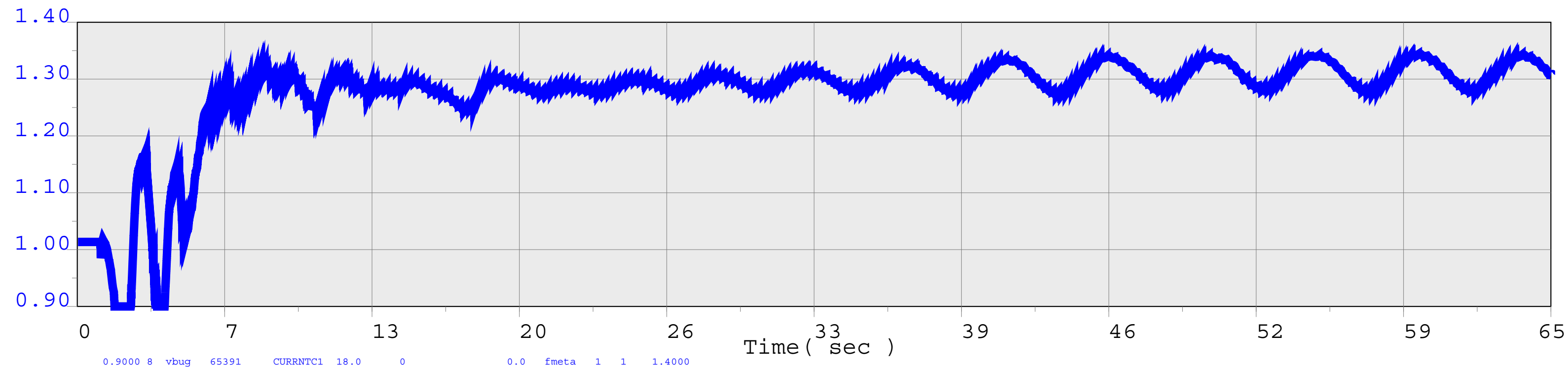
Likely Cause:

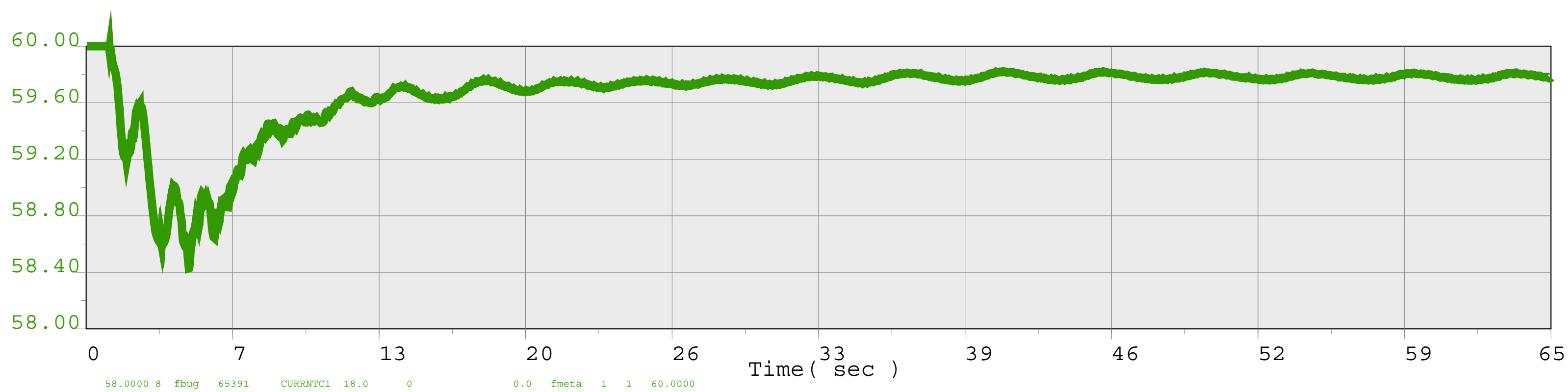
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 261.2 MVAR, which exceeds its Qmax (95 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA







15hs_n_25_6.chf

ISLAND FINAL\2015hs_north

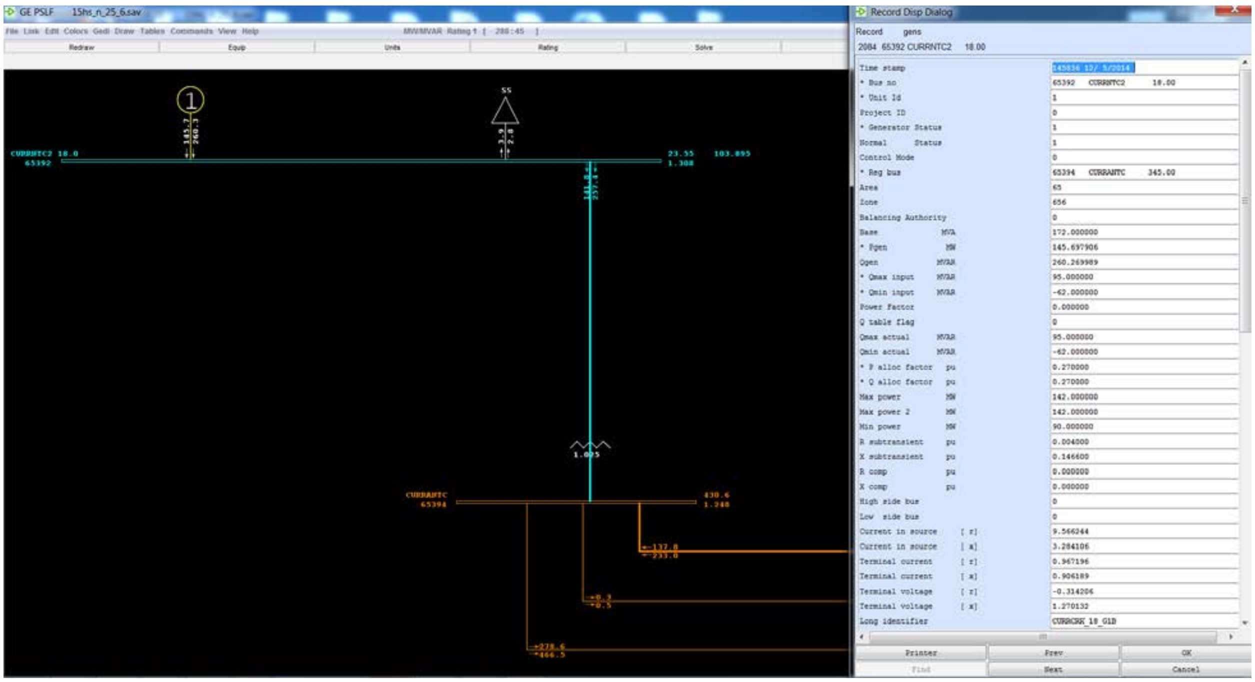
Fri Aug 14 15:03:00 2015

Unit ID:

- CURRNTC2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

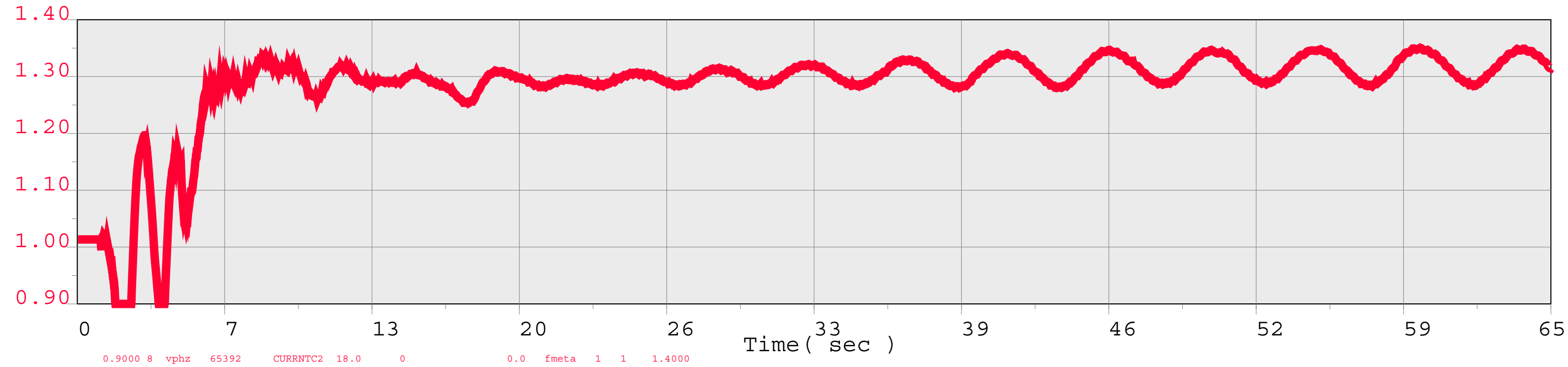


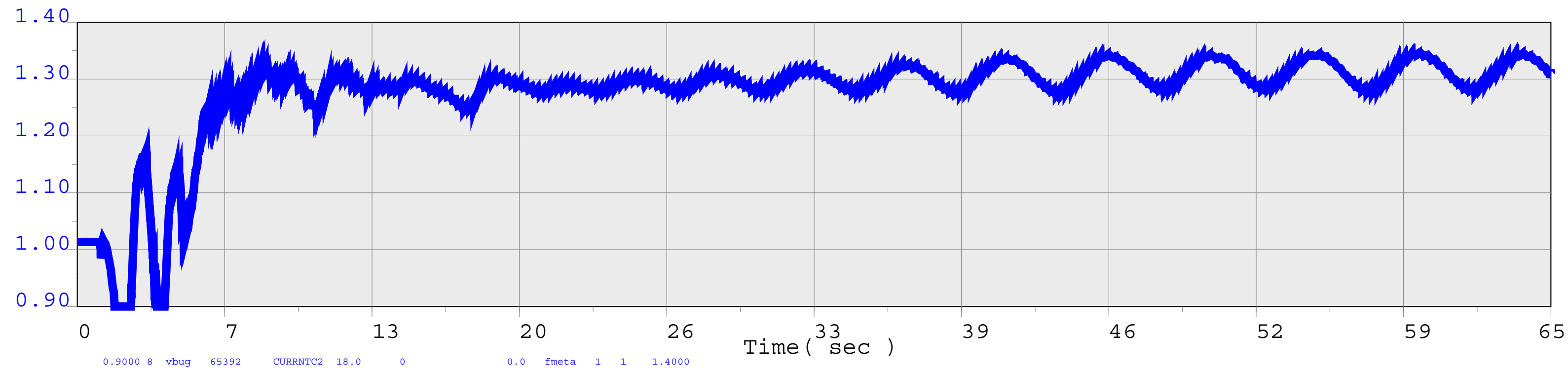
Likely Cause:

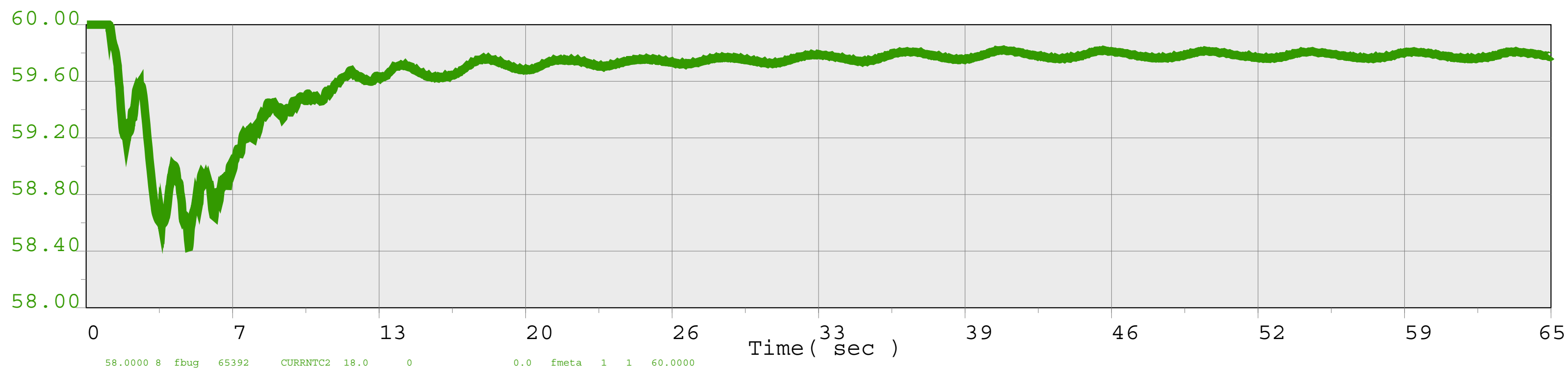
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 260.3 MVAR, which exceeds its Qmax (95 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA







15hs_n_25_6.chf

ISLAND FINAL\2015hs_north

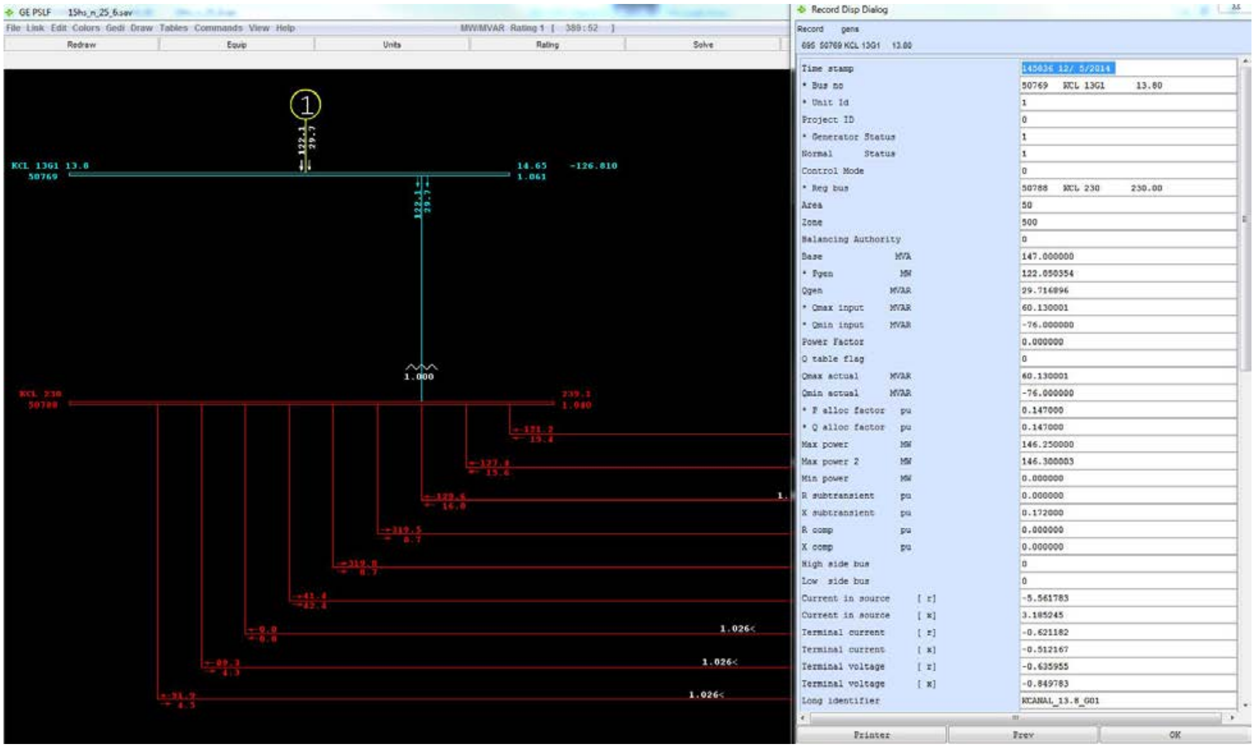
Fri Aug 14 14:59:40 2015

Unit ID:

- KCL 13G1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

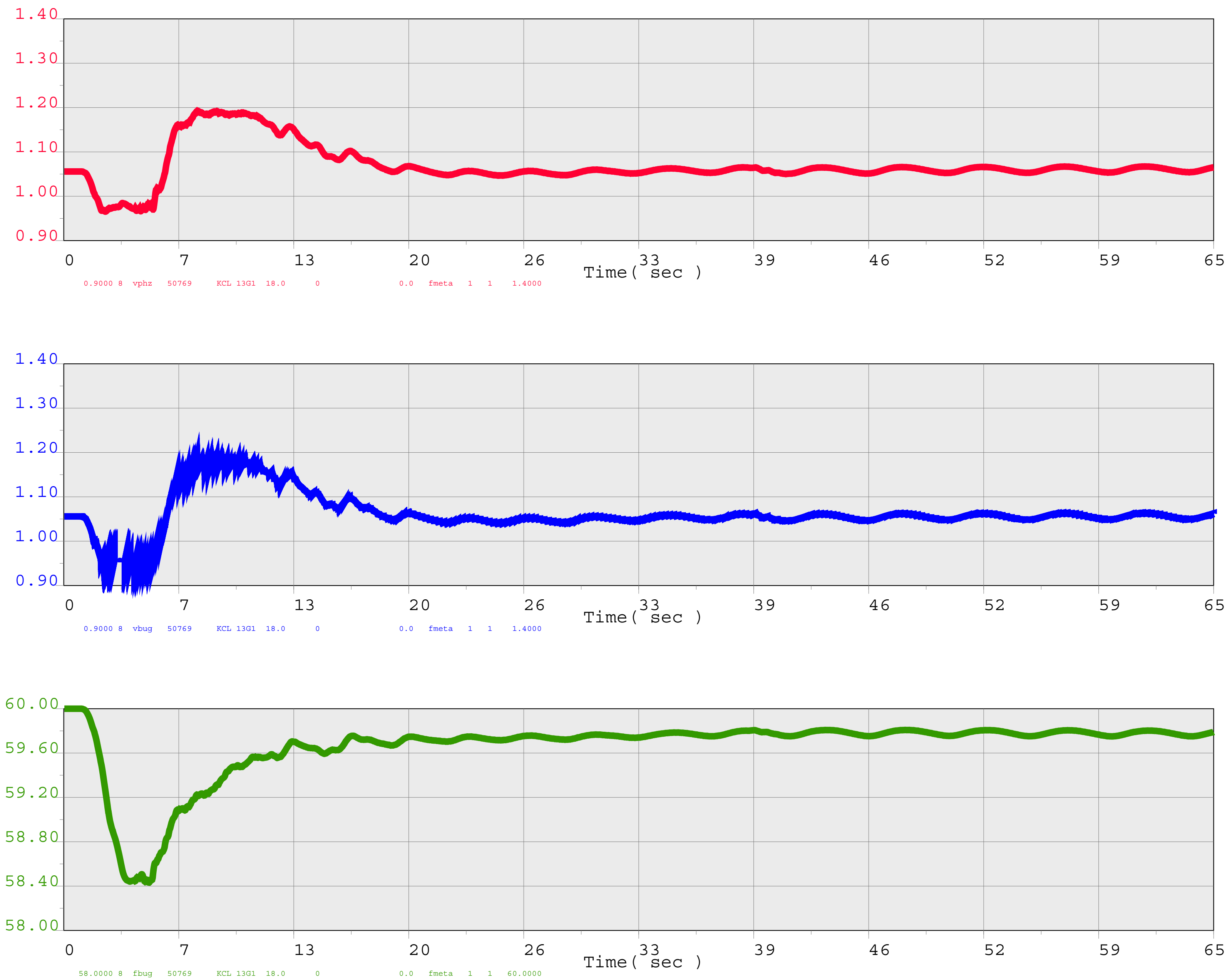


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 29.7 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY

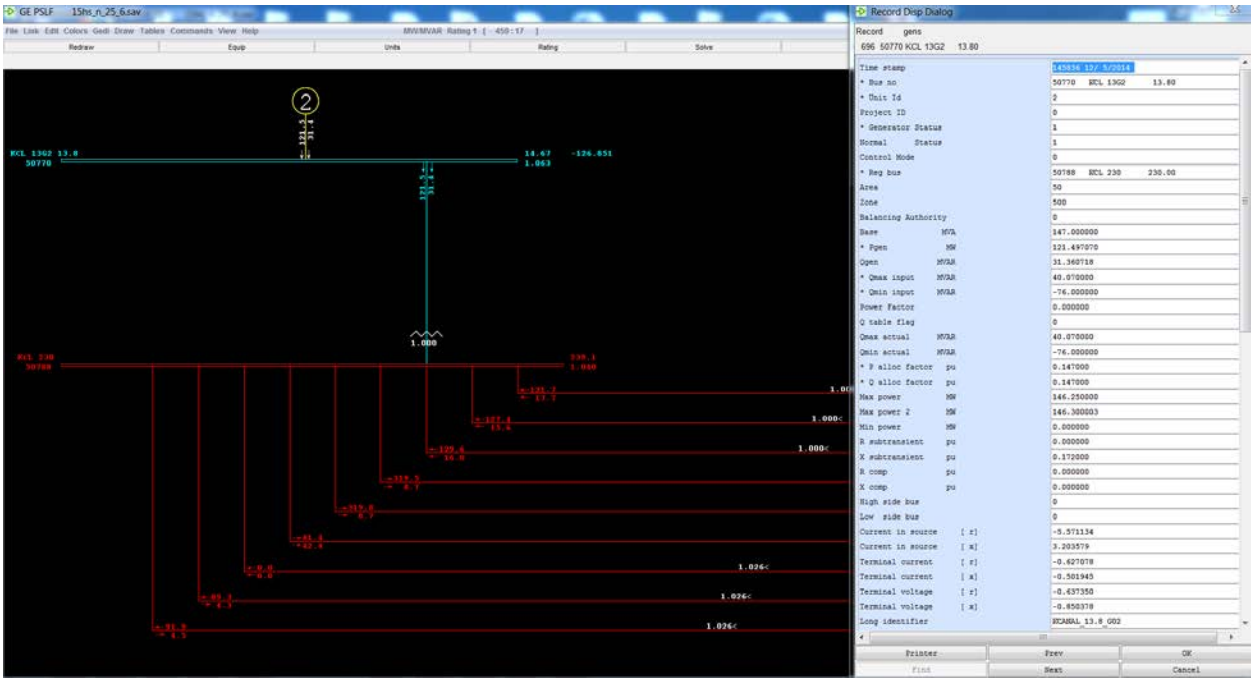


Unit ID:

- KCL 13G2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

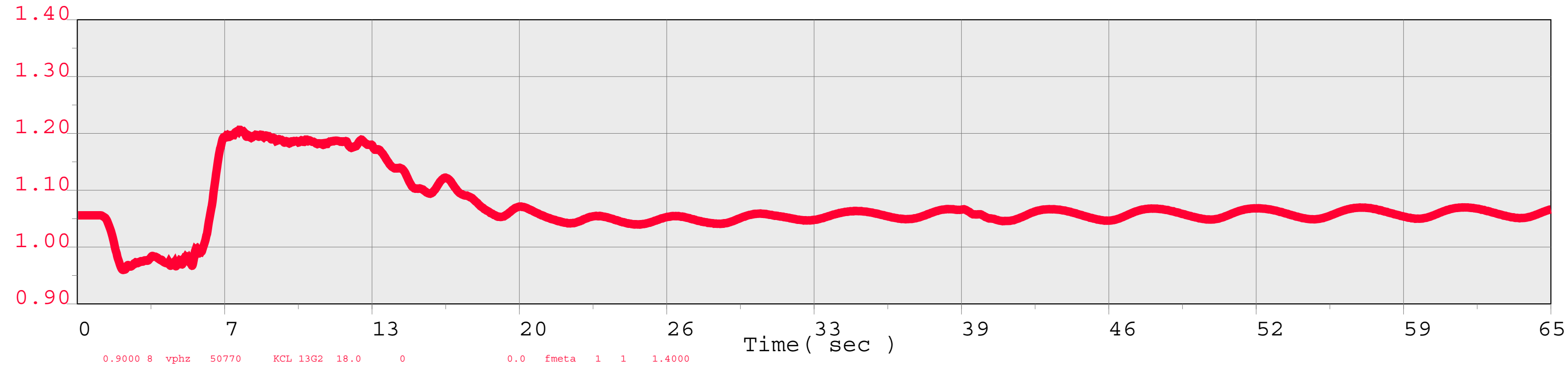


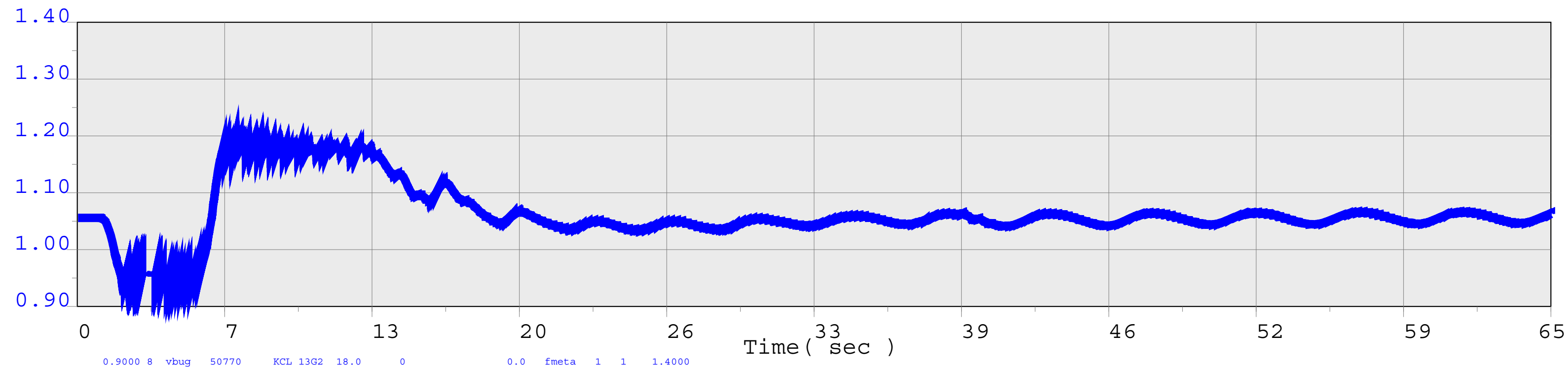
Likely Cause:

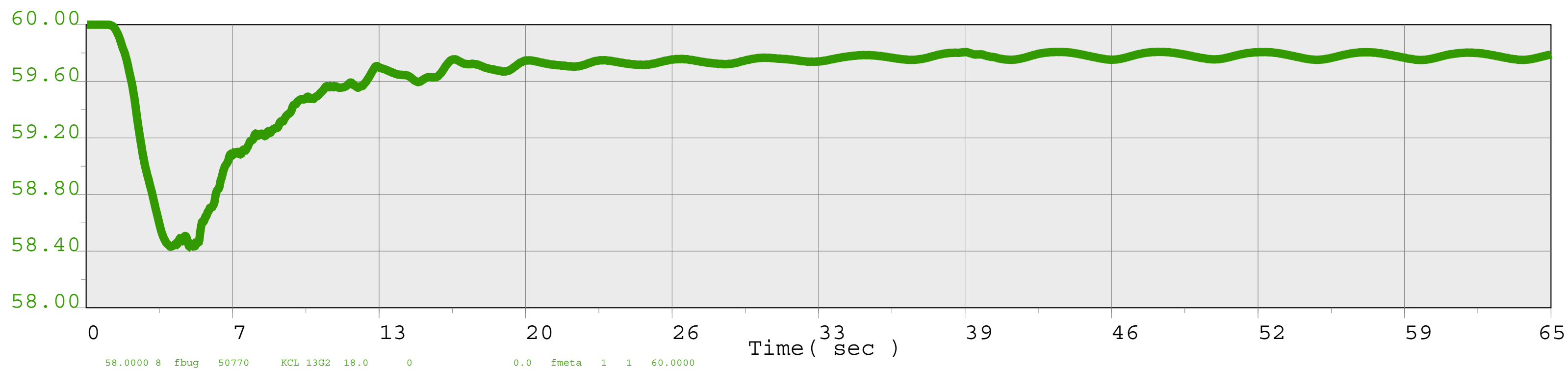
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 31.4 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY







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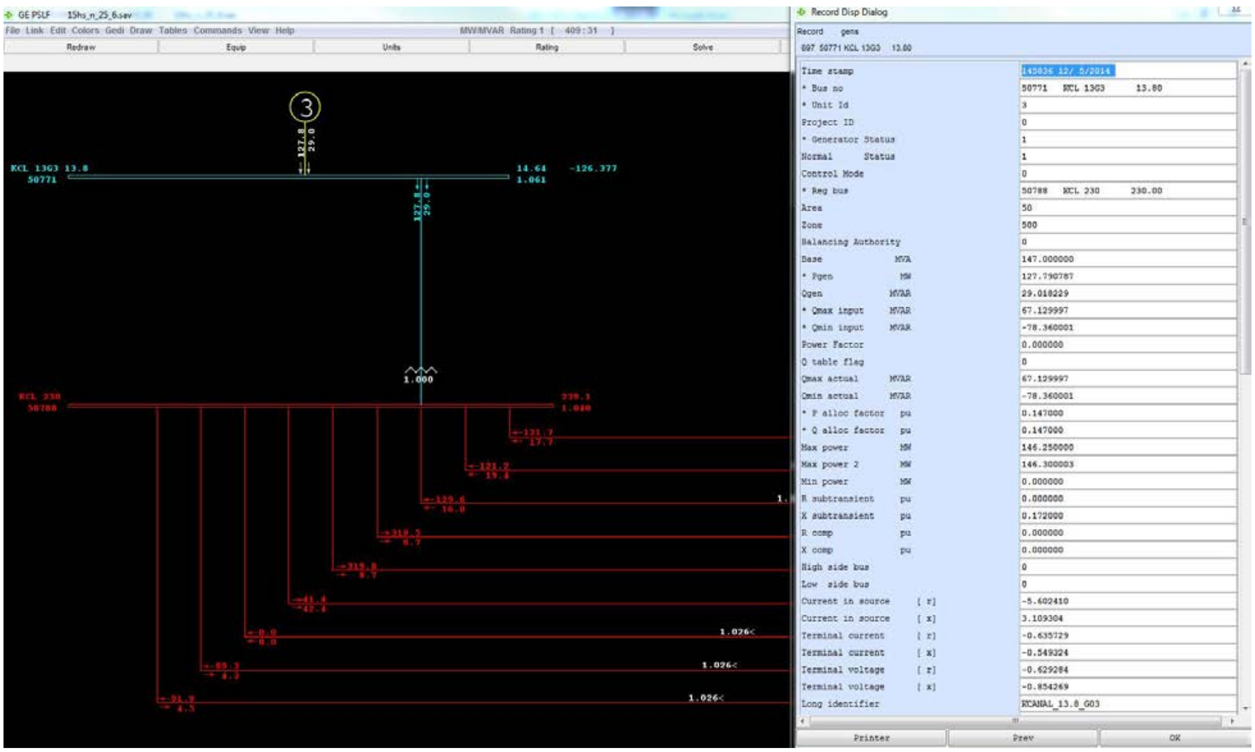
Fri Aug 14 15:45:34 2015

Unit ID:

- KCL 13G3

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

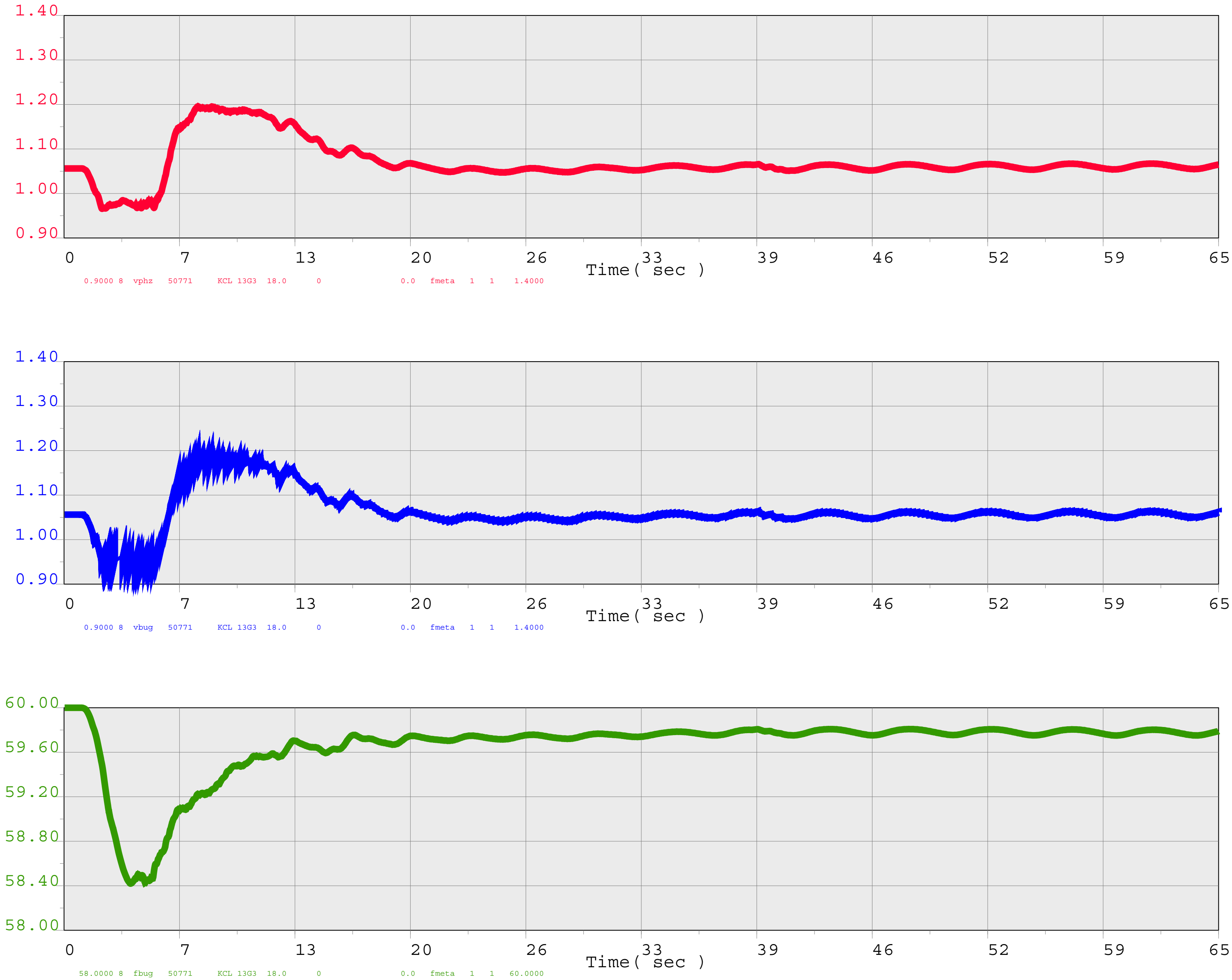


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 29.0 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY



Page 1

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ISLAND FINAL\2015hs_north

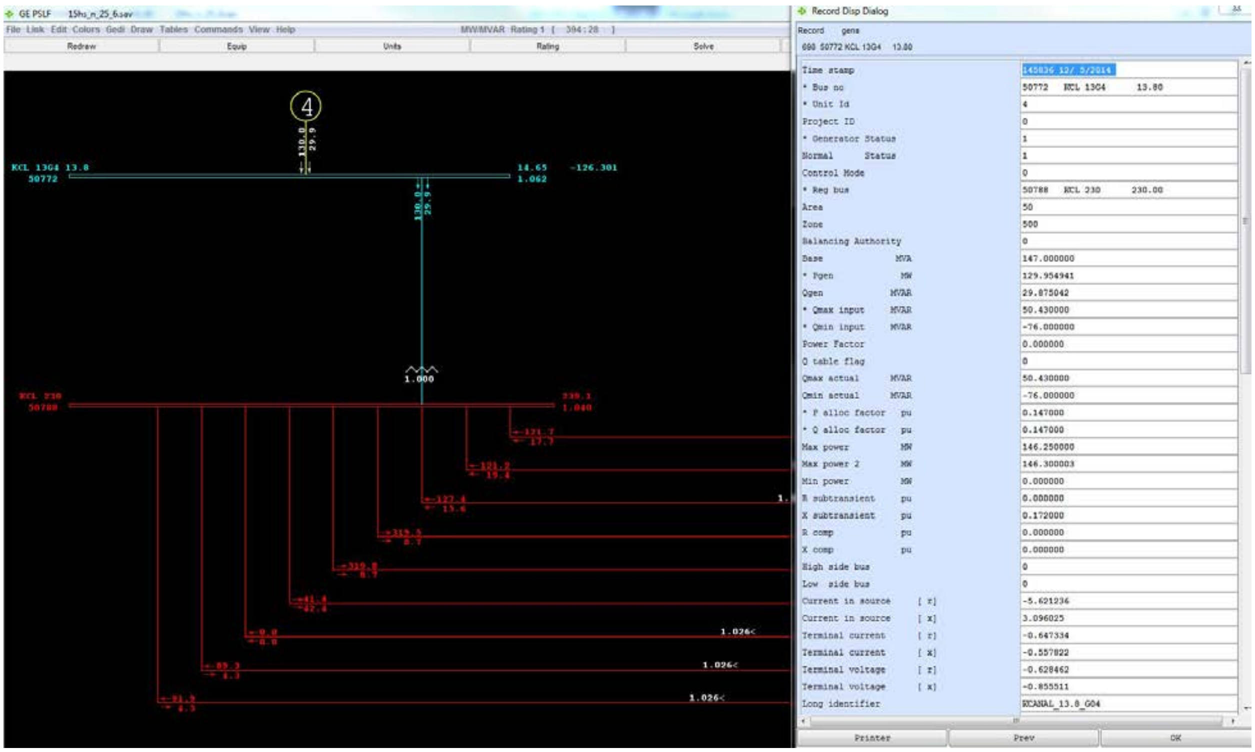
Fri Aug 14 15:46:41 2015

Unit ID:

- KCL 13G4

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

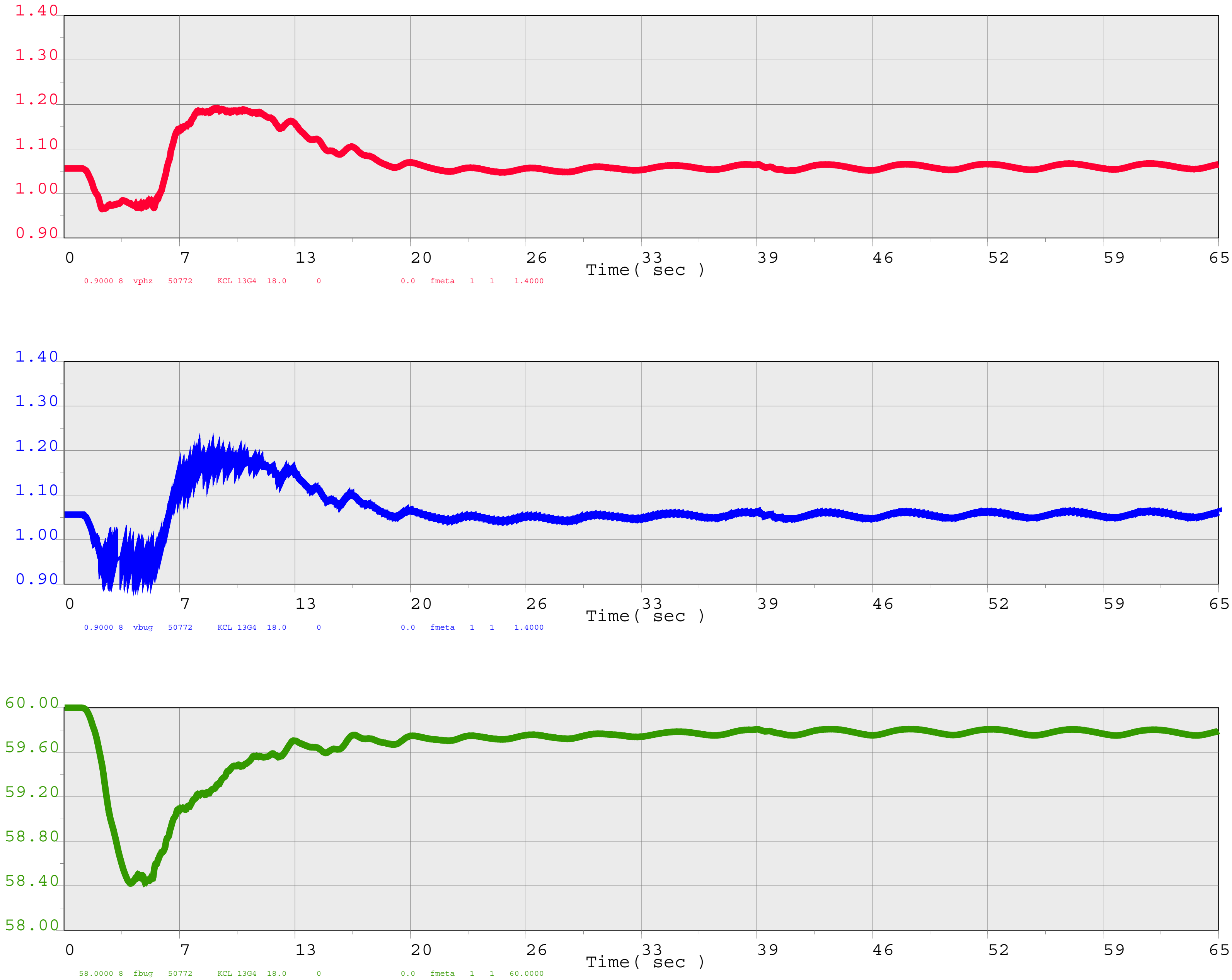


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 29.9 MVAR, which is normal.
- As can be seen in the voltage plots for this bus, the exciter response is driving this V/Hz violation. Only a change to the exciter's performance will keep the voltage from going above 1.18 p.u. A change to the UFLS scheme will not affect the exciter response.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY



Page 1

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ISLAND FINAL\2015hs_north

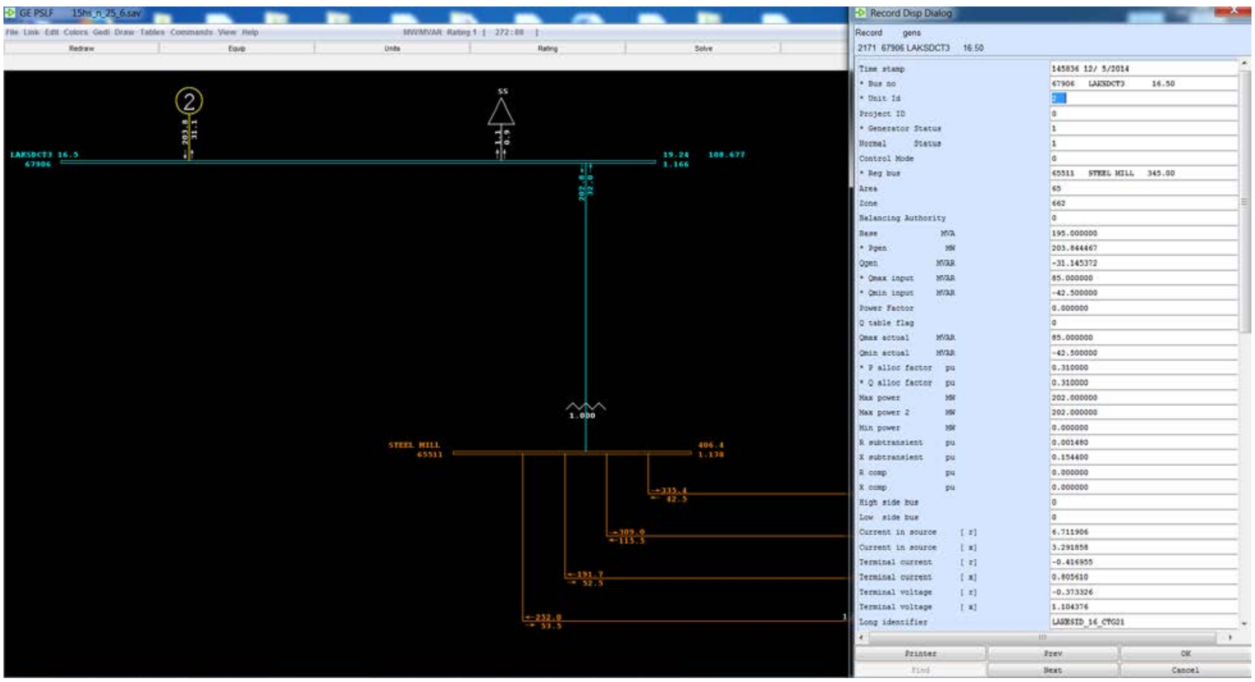
Fri Aug 14 15:47:59 2015

Unit ID:

- LAKSDCT3

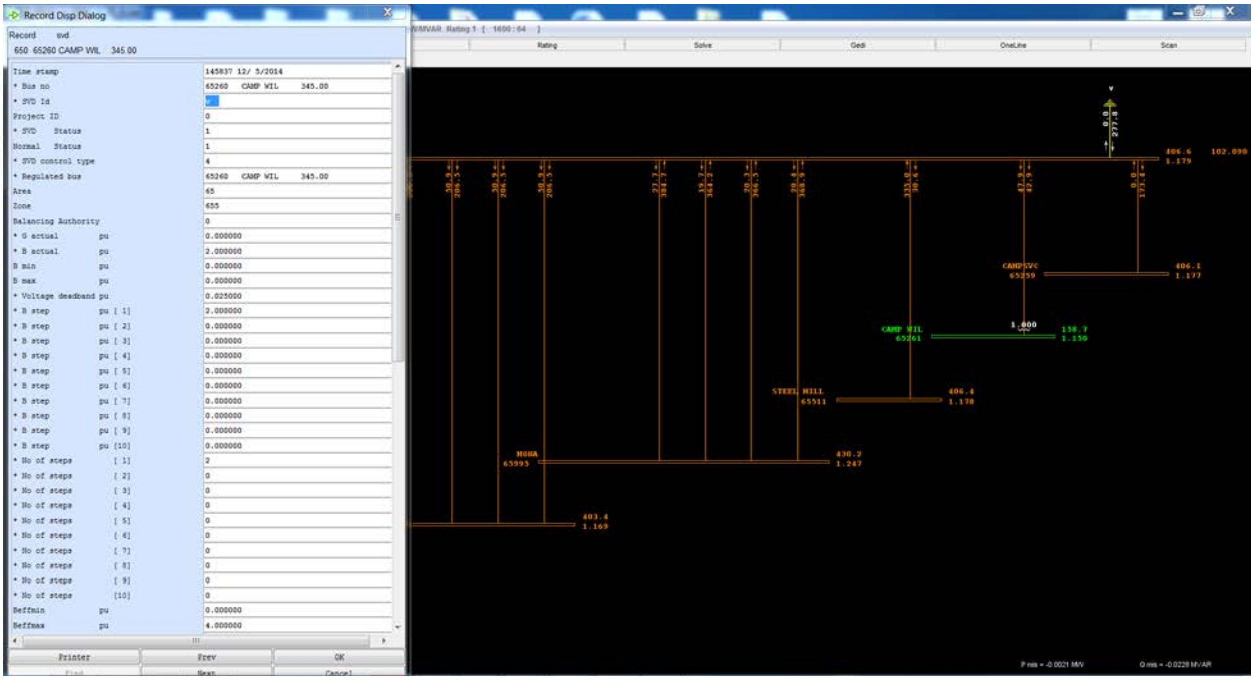
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



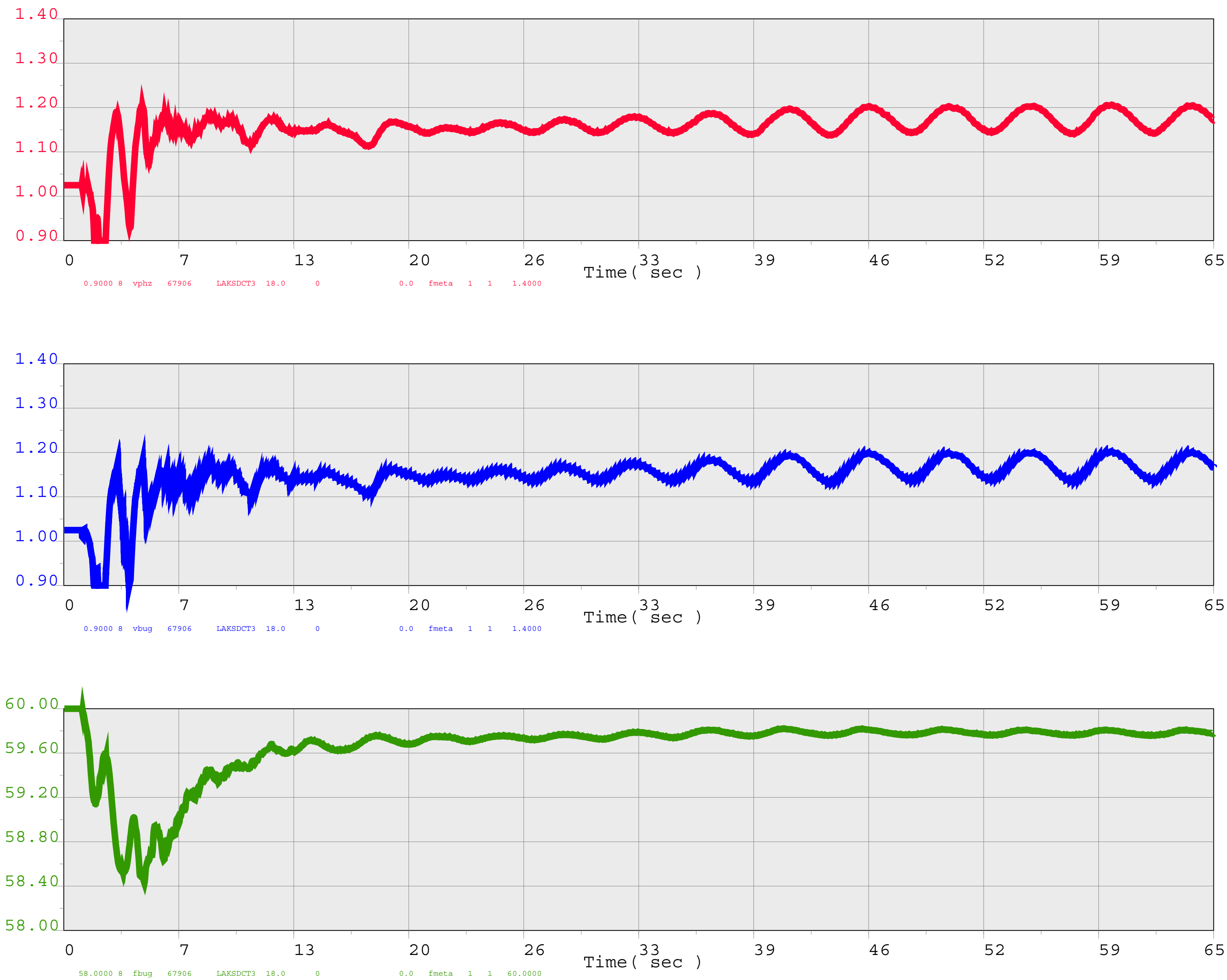
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is absorbing 31.1 MVAR, which is normal.
- An SVD at a nearby bus (65260) is outputting significant of VARs holding its bus voltage to 1.18 pu (diagram below). This caused LAKSDCT3 voltage to be very high.
- Suspect incorrect SVD model performance as the model should not allow this.



Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



Page 1

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ISLAND FINAL\2015hs_north

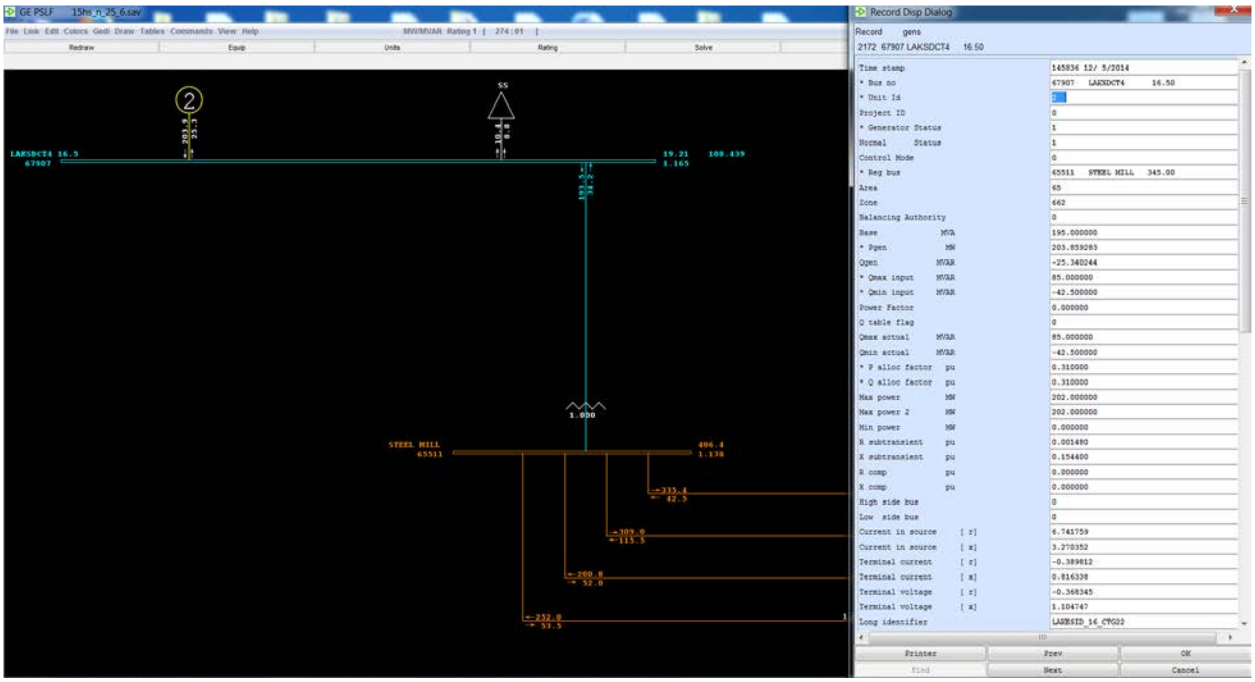
Fri Aug 14 15:33:33 2015

Unit ID:

- LAKSDCT4

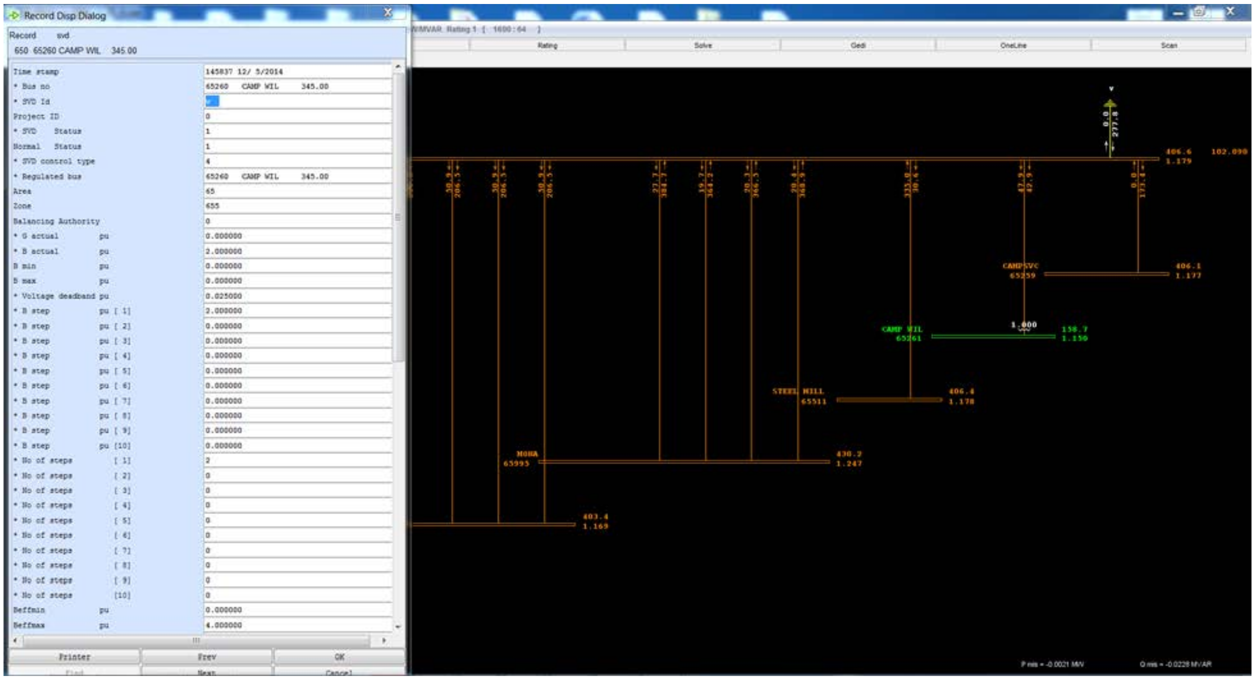
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



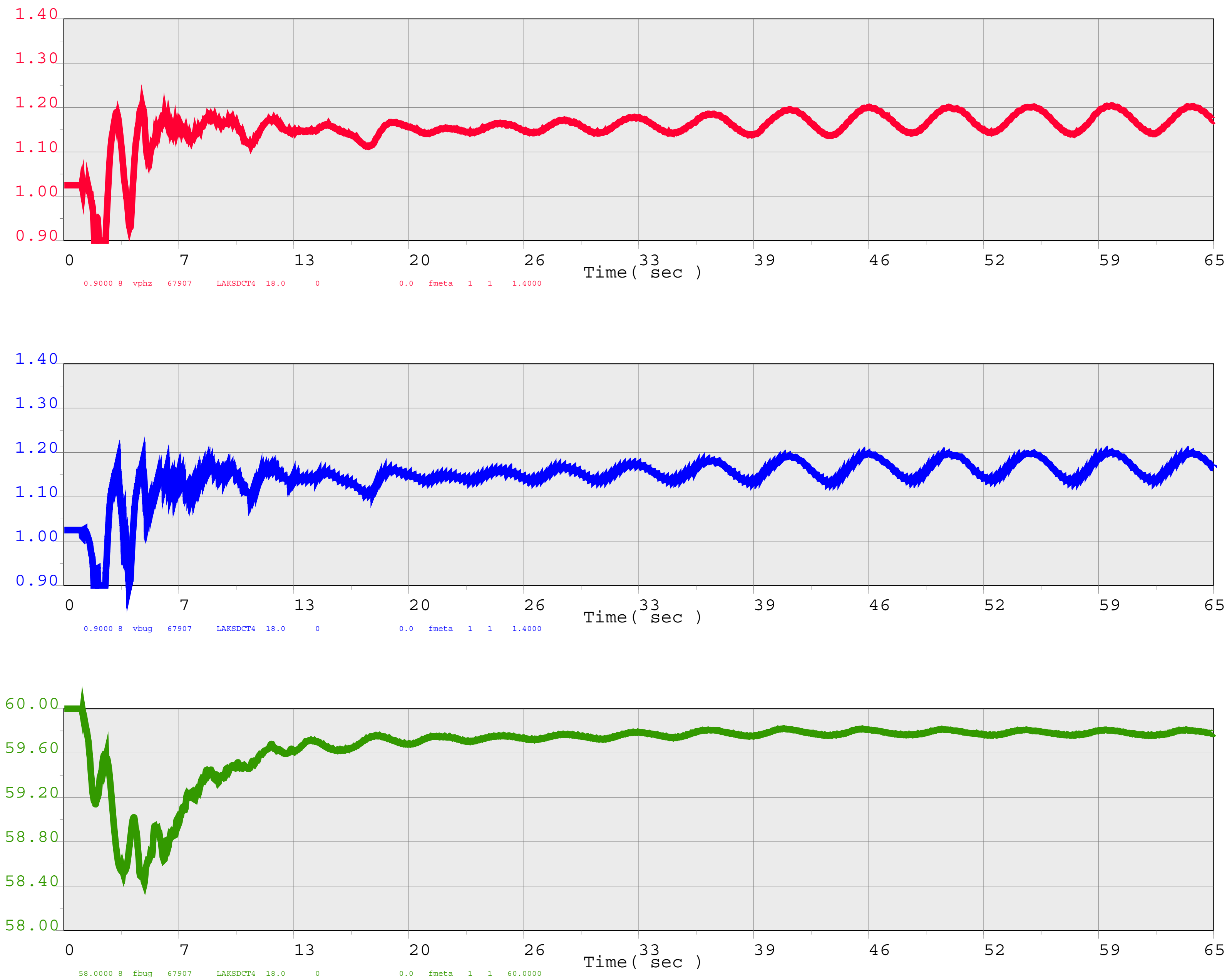
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is absorbing 25.3 MVAR, which is normal.
- An SVD at a nearby bus (65260) is outputting significant of VARs holding its bus voltage to 1.18 pu (diagram below). This caused LAKSDCT4 voltage to be very high.
- Suspect incorrect SVD model performance as the model should not allow this.



Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



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ISLAND FINAL\2015hs_north

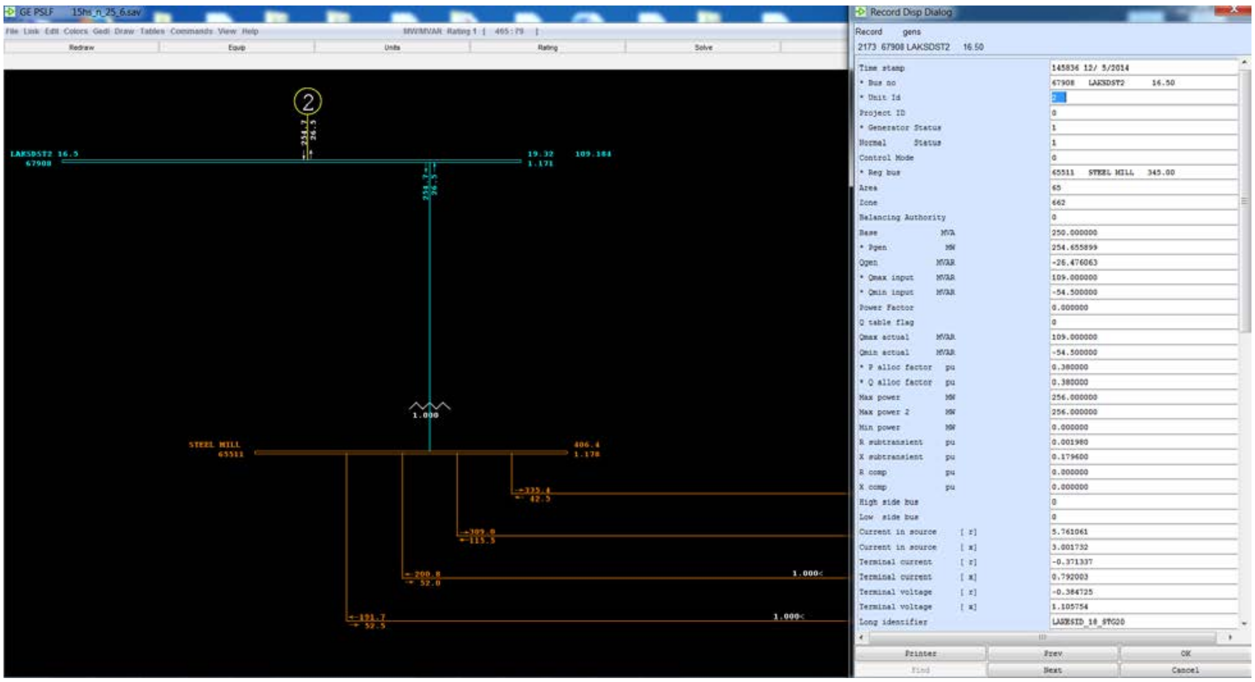
Fri Aug 14 15:37:01 2015

Unit ID:

- LAKSDST2

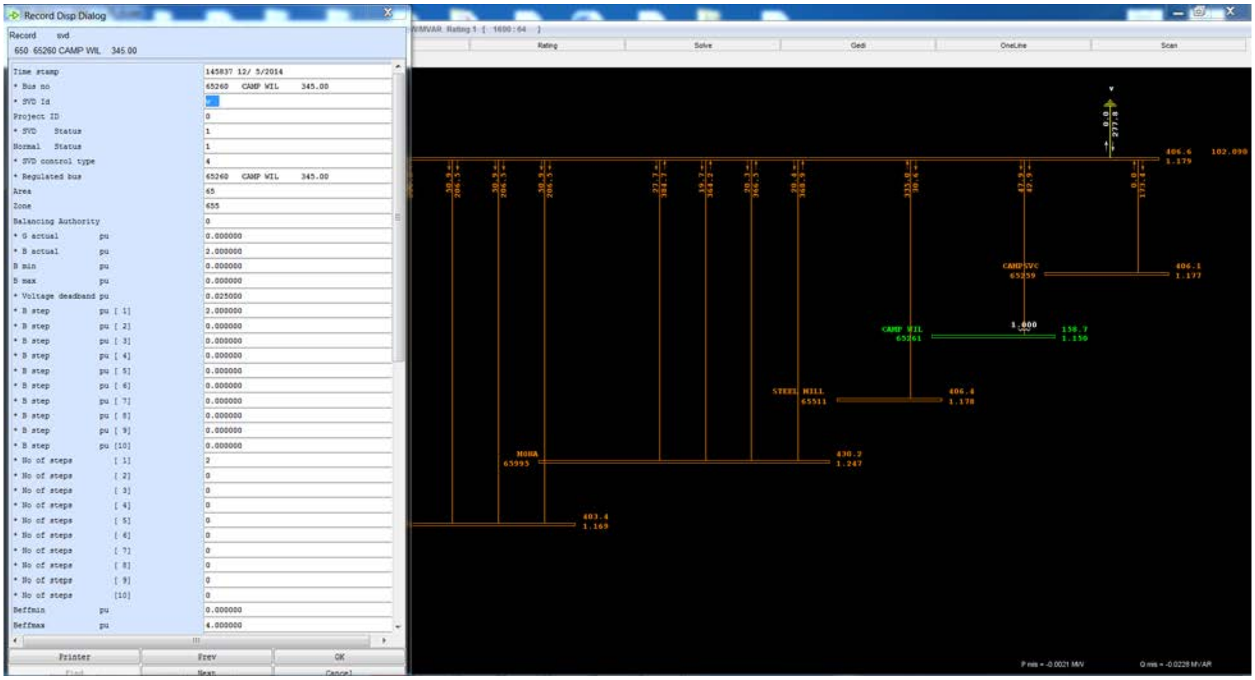
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



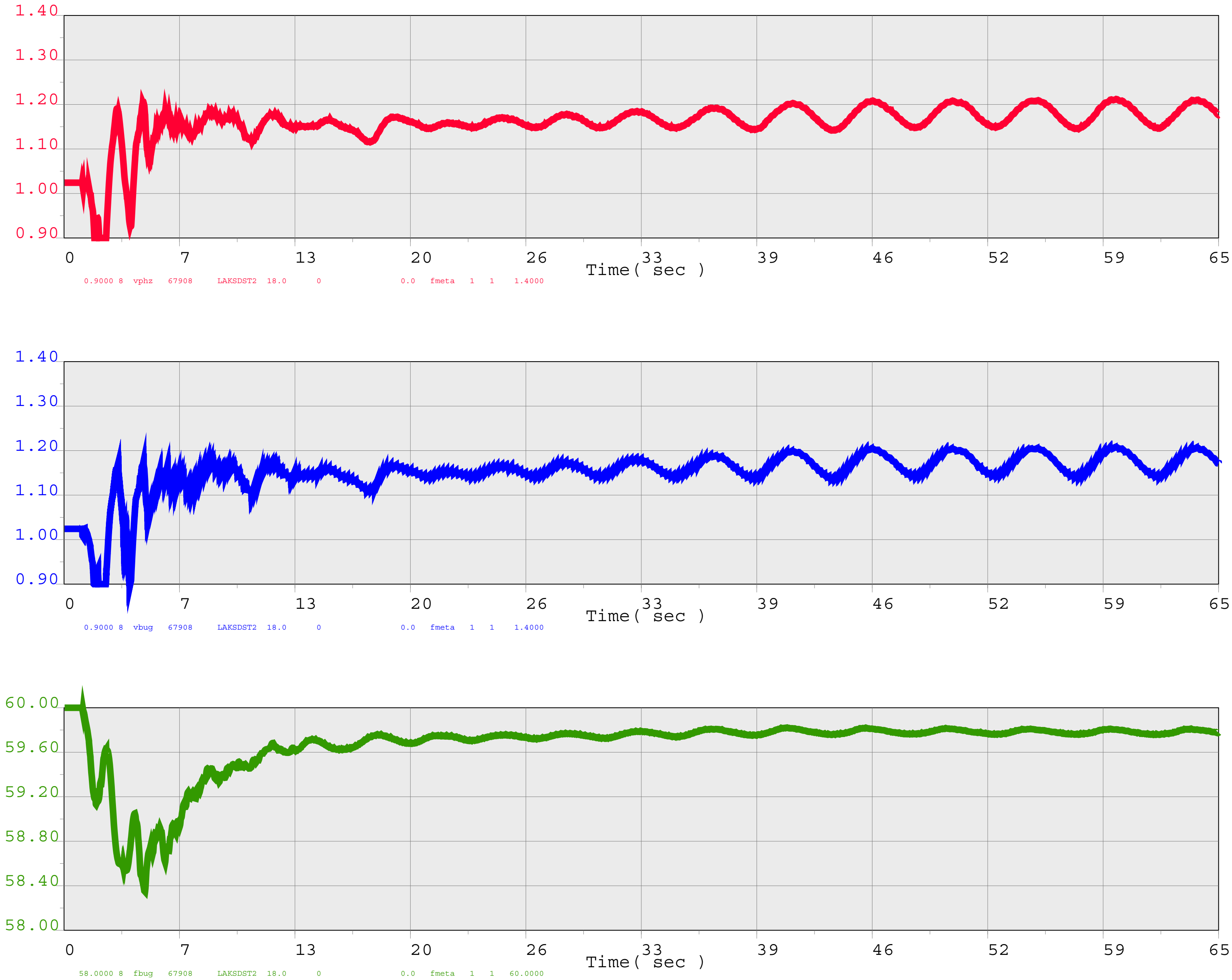
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is absorbing 26.5 MVAR, which is normal.
- An SVD at a nearby bus (65260) is outputting significant of VARs holding its bus voltage to 1.18 pu (diagram below). This caused LAKSDST2 voltage to be very high.
- Suspect incorrect SVD model performance as the model should not allow this.



<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



Page 1

15hs_n_25_6.chf

ISLAND FINAL\2015hs_north

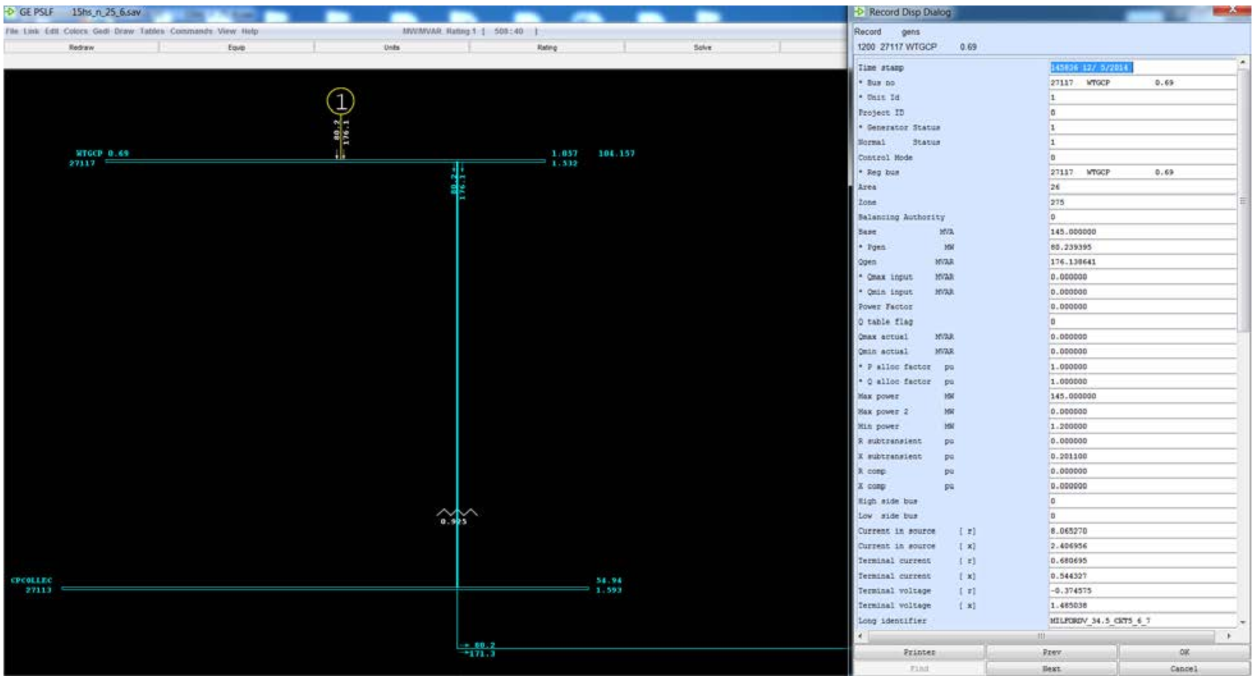
Fri Aug 14 15:32:37 2015

Unit ID:

- WTGCP

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

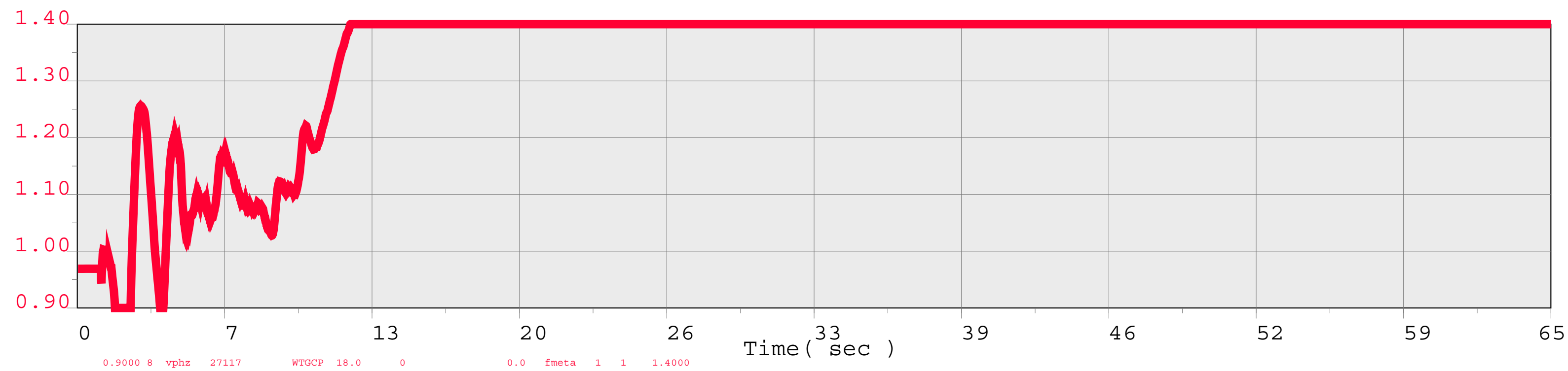


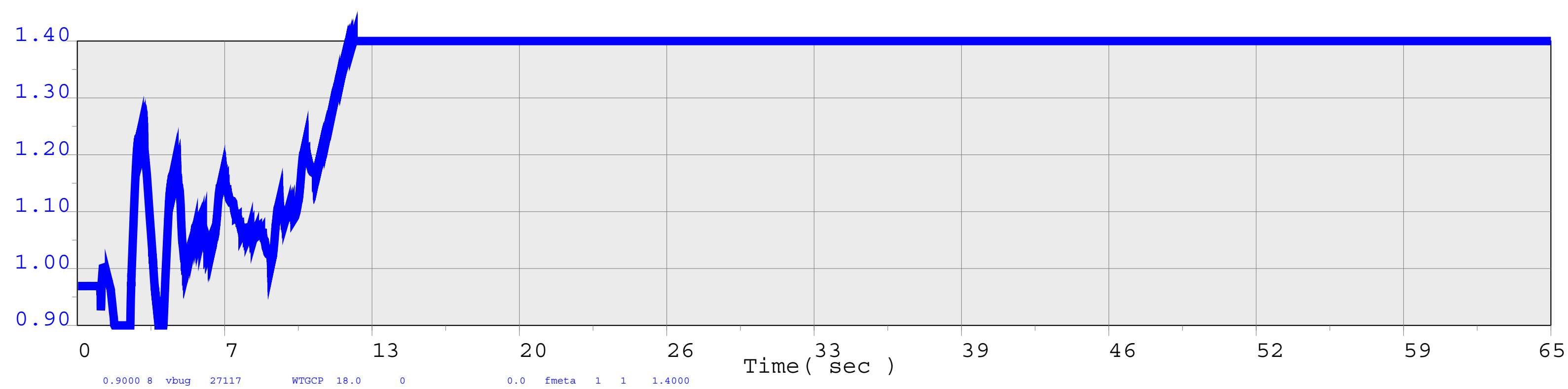
Likely Cause:

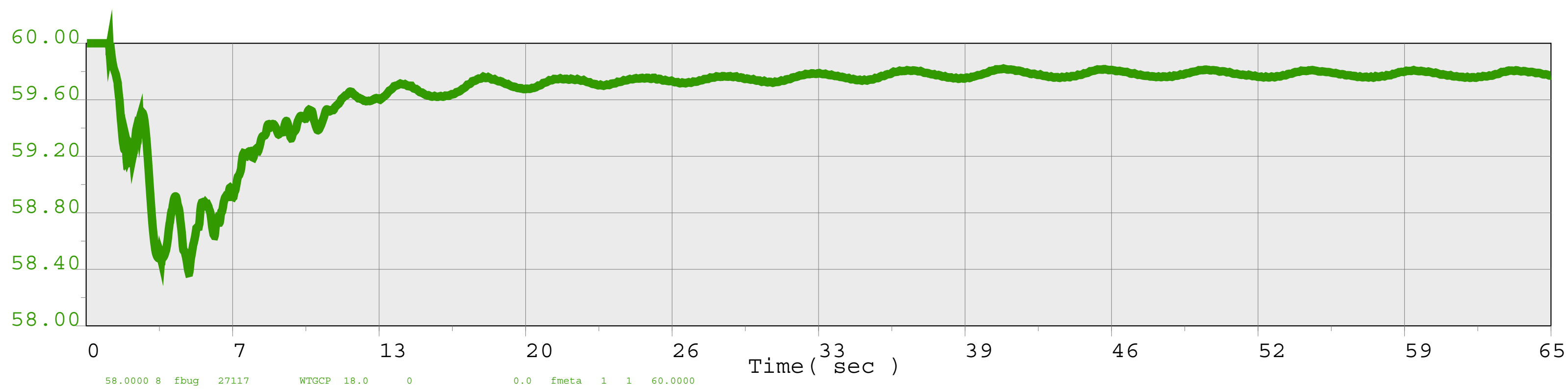
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 176.1 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





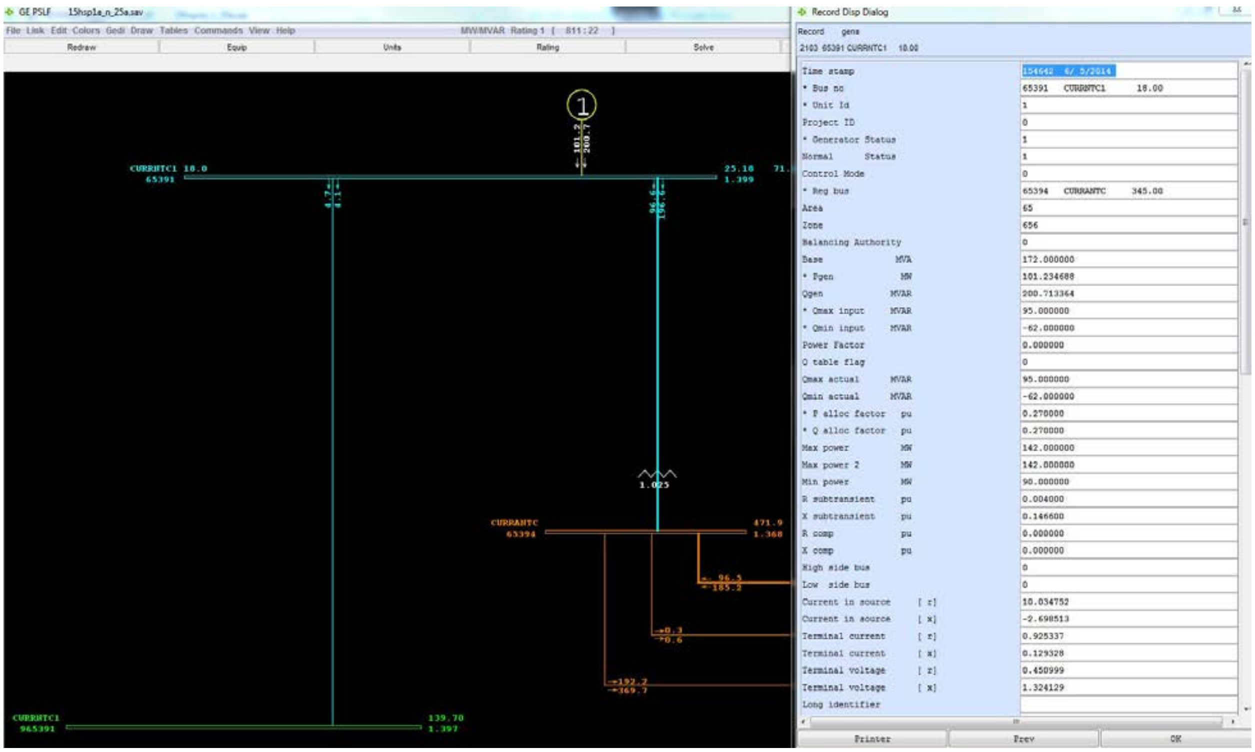


Unit ID:

- CURRNTC1

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

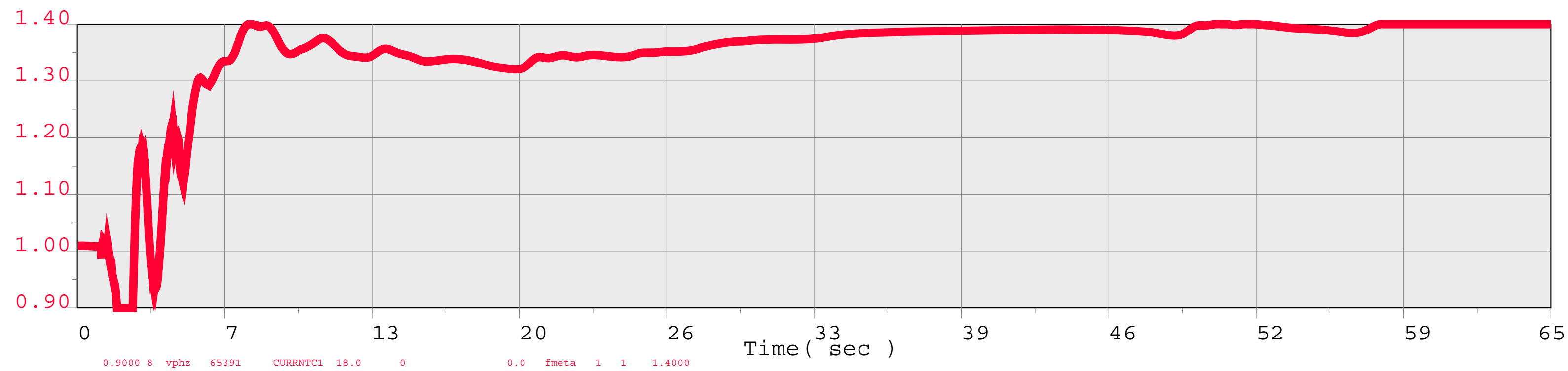


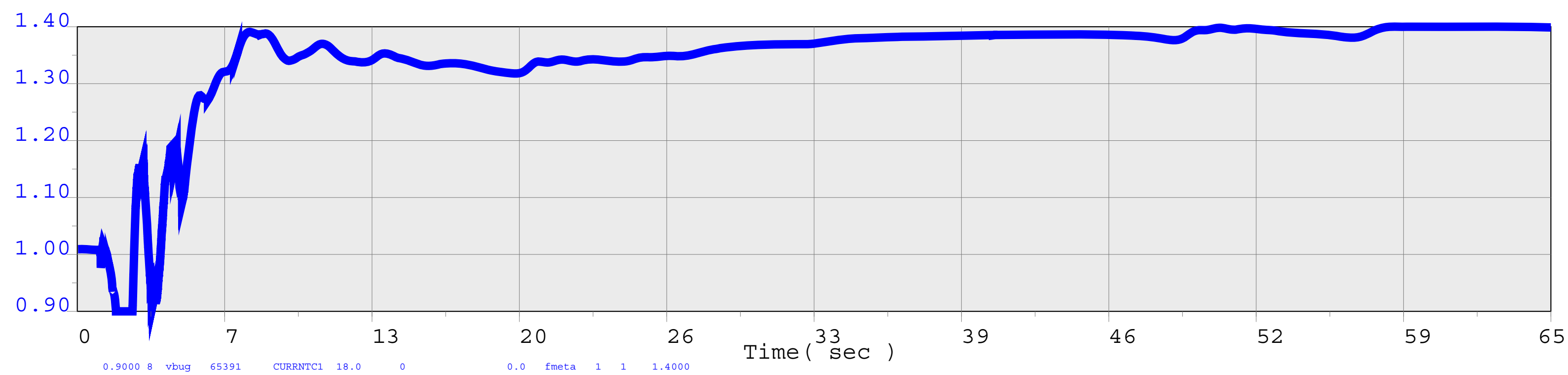
Likely Cause:

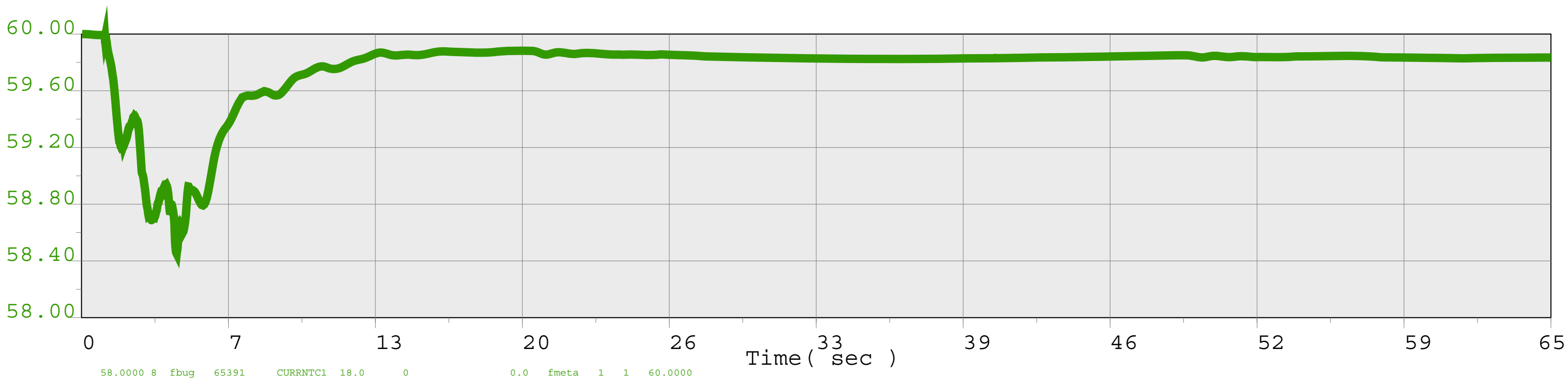
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 200.7 MVAR, which exceeds its Qmax (95 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





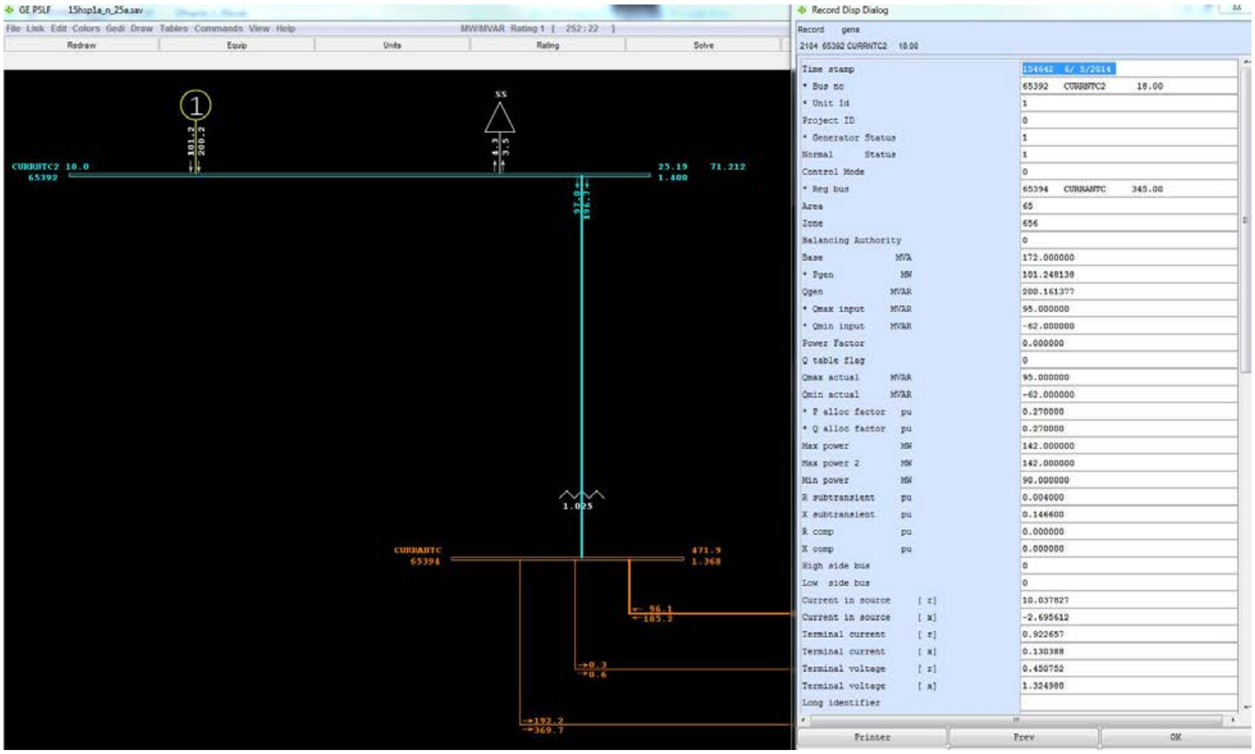


Unit ID:

- CURRNTC2

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

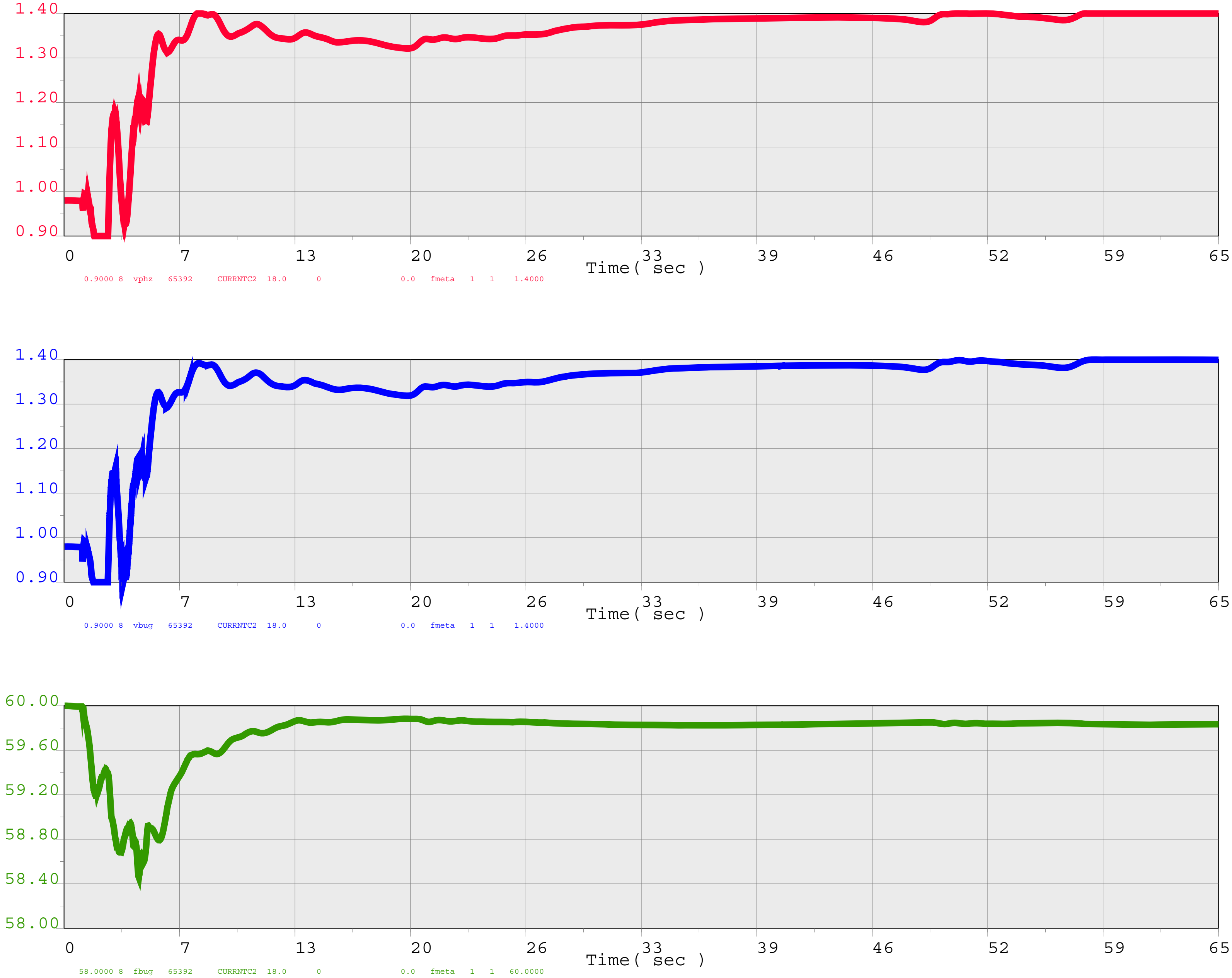


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 200.2 MVAR, which exceeds its Qmax (95 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



Page 3

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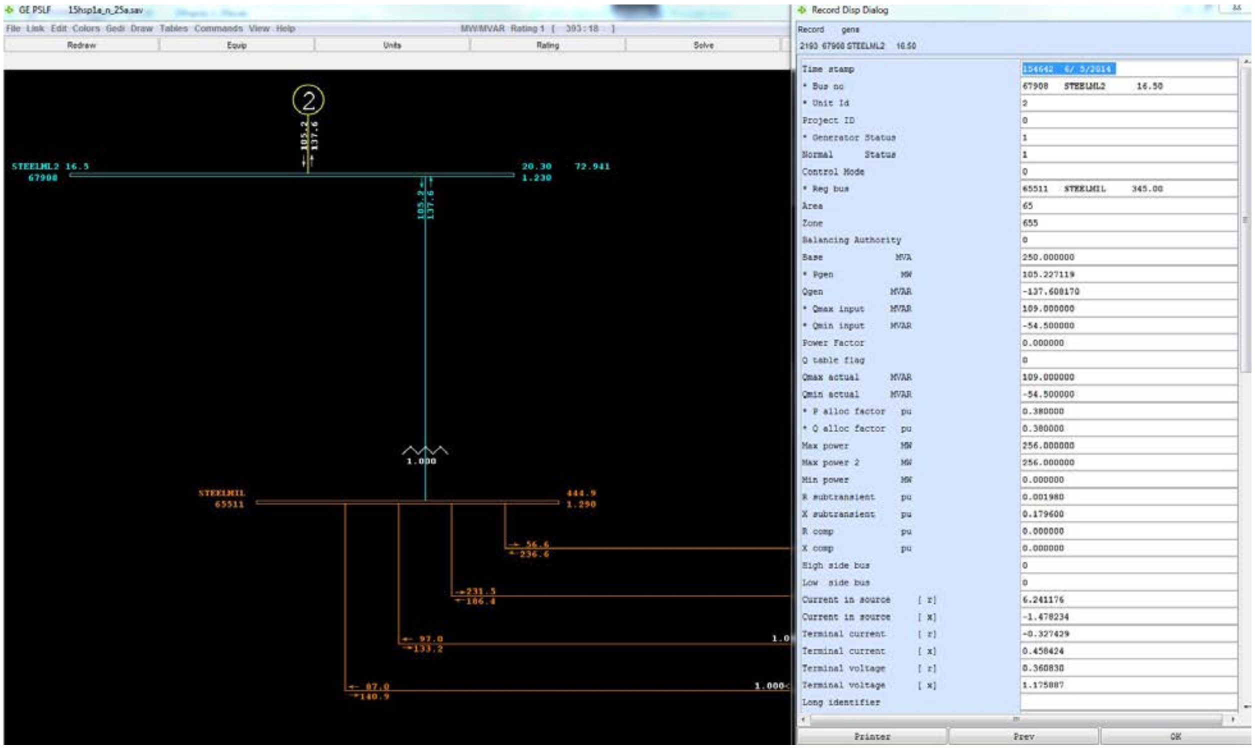
Thu Aug 20 16:30:22 2015

Unit ID:

- STEELML2

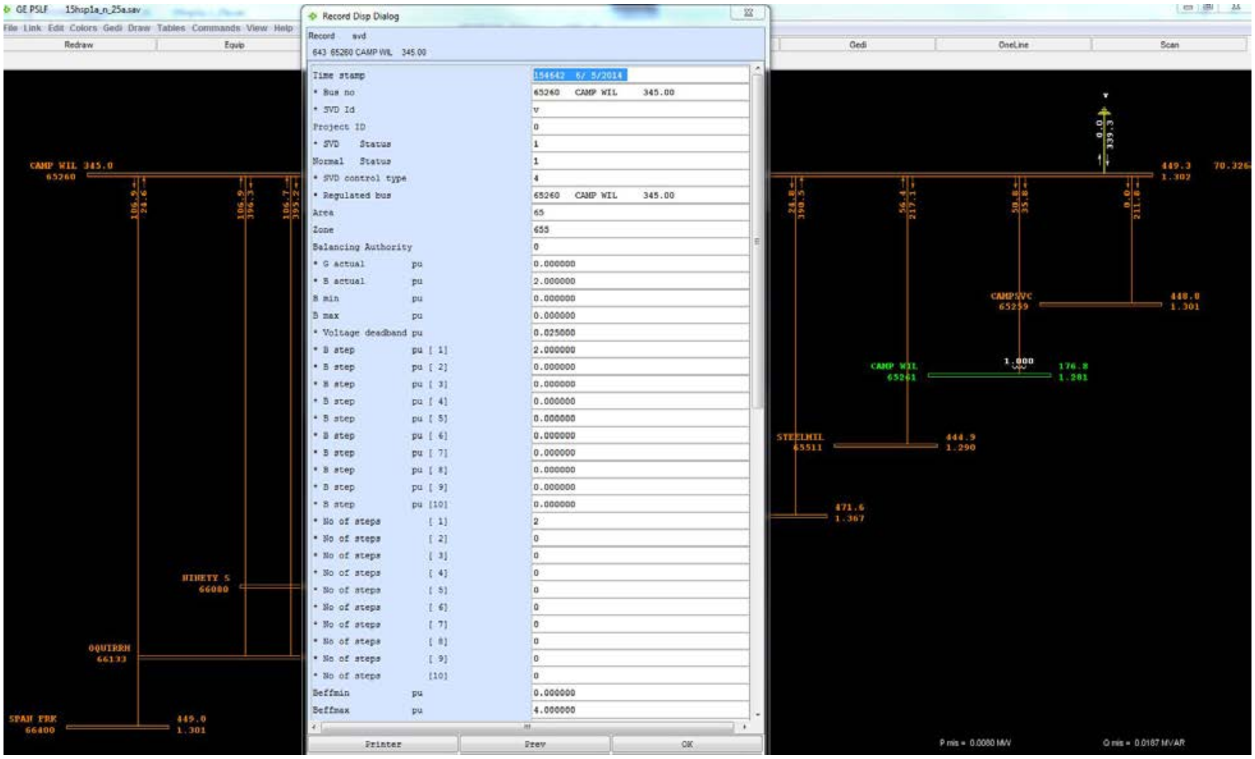
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



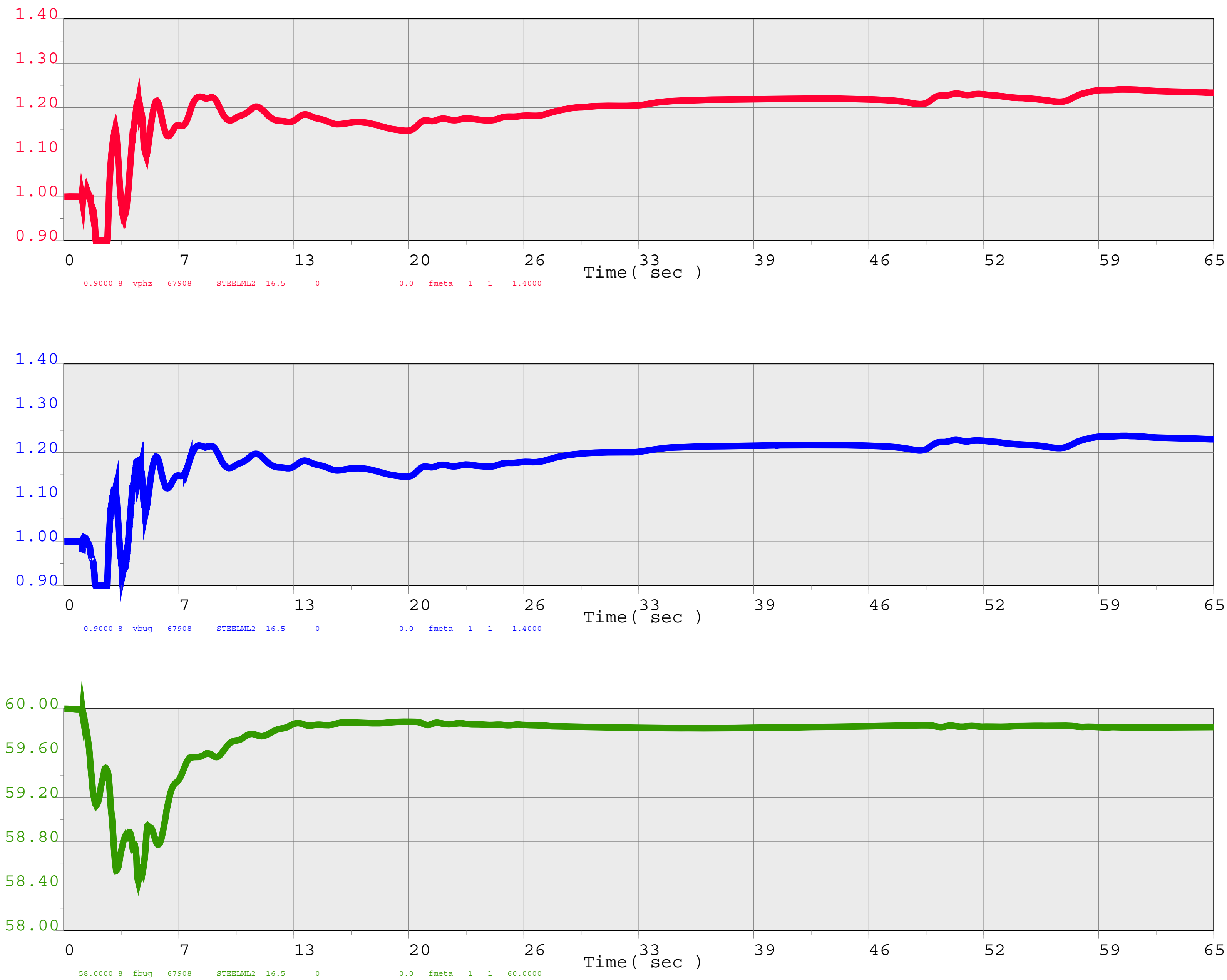
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is absorbing 137.6 MVAR, which exceeds its Qmin (-54.5 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.
- An SVD at a nearby bus (65260) is also outputting significant of VARs holding its bus voltage to 1.302 pu (diagram below). This also caused STEELML2 voltage to be very high.
- Suspect incorrect SVD model performance as the model should not allow this.



Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

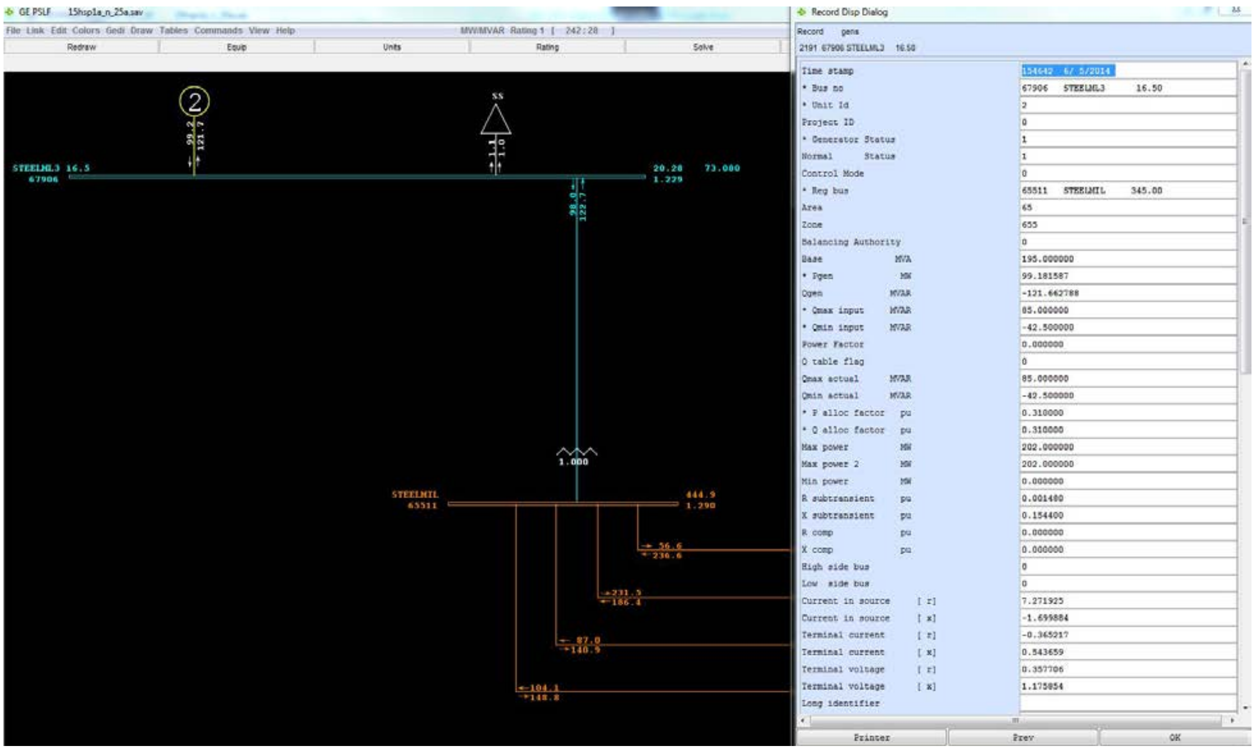


Unit ID:

- STEELML3

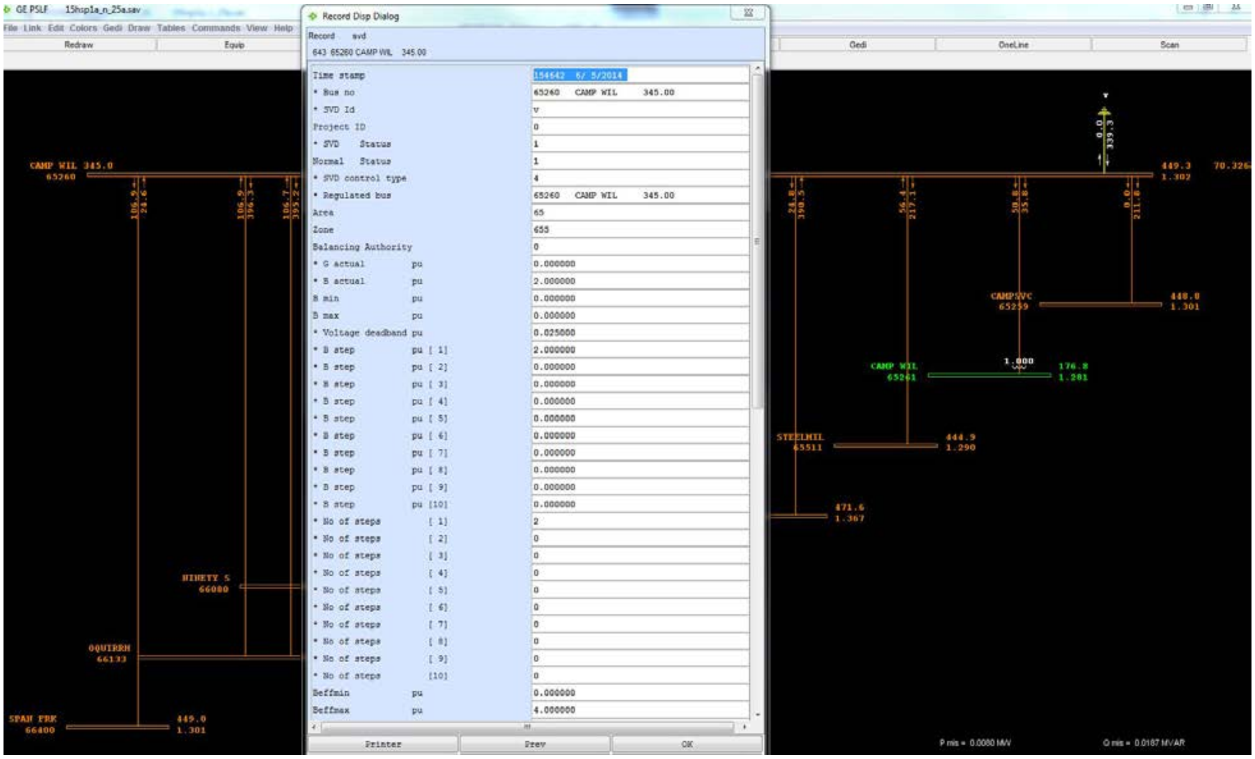
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



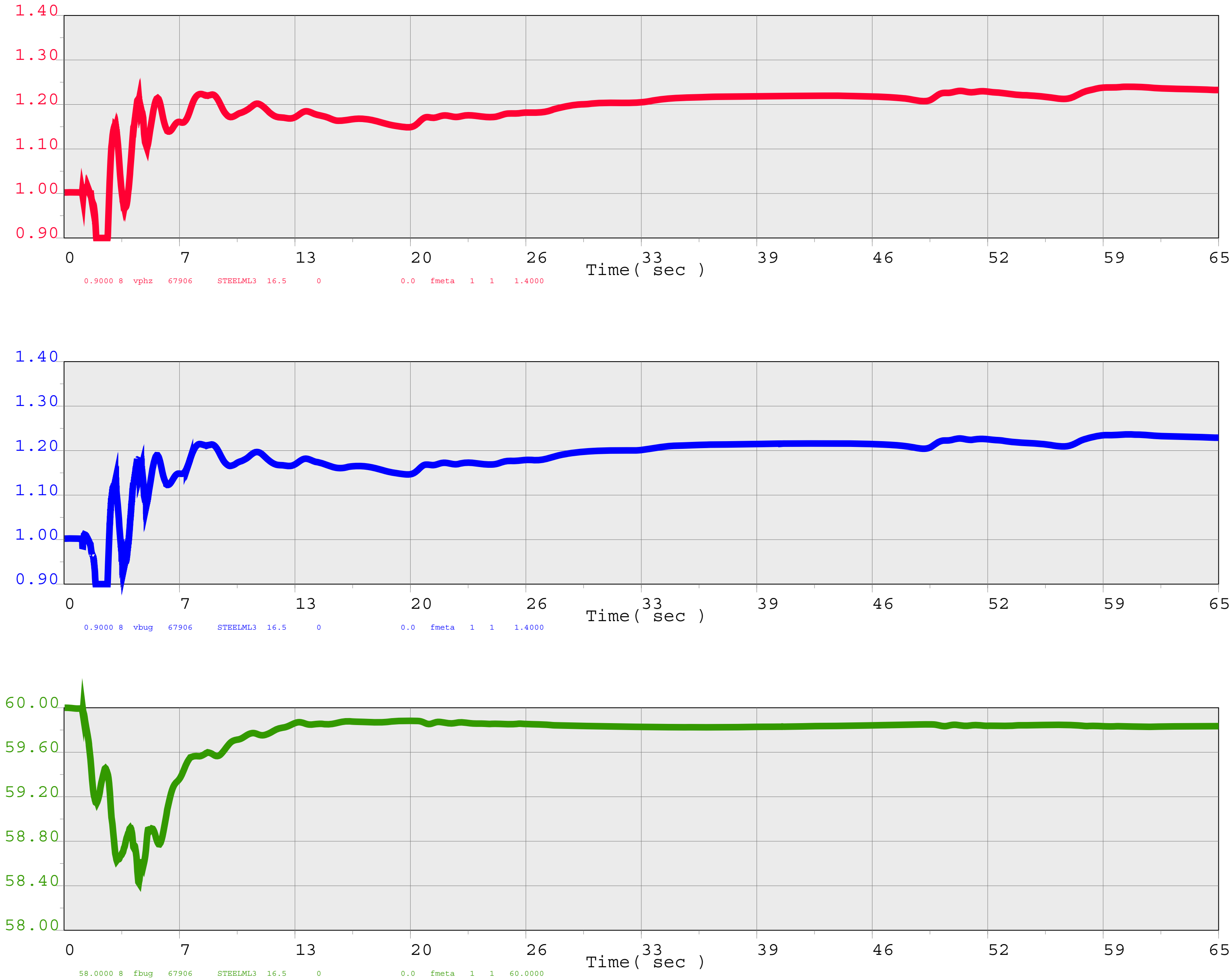
Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is absorbing 121.7 MVAR, which exceeds its Qmin (-42.5 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.
- An SVD at a nearby bus (65260) is also outputting significant of VARs holding its bus voltage to 1.302 pu (diagram below). This also caused STEELML3 voltage to be very high.
- Suspect incorrect SVD model performance as the model should not allow this.



Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



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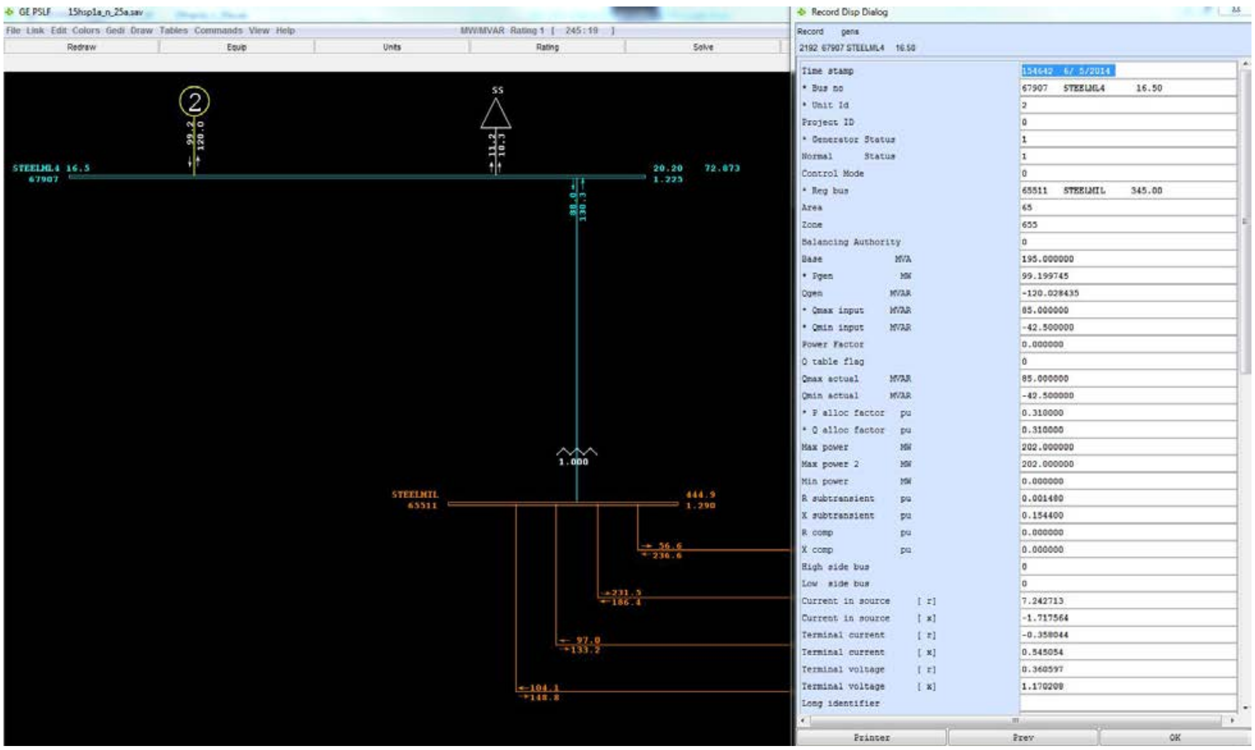
Thu Aug 20 16:30:22 2015

Unit ID:

- STEELML4

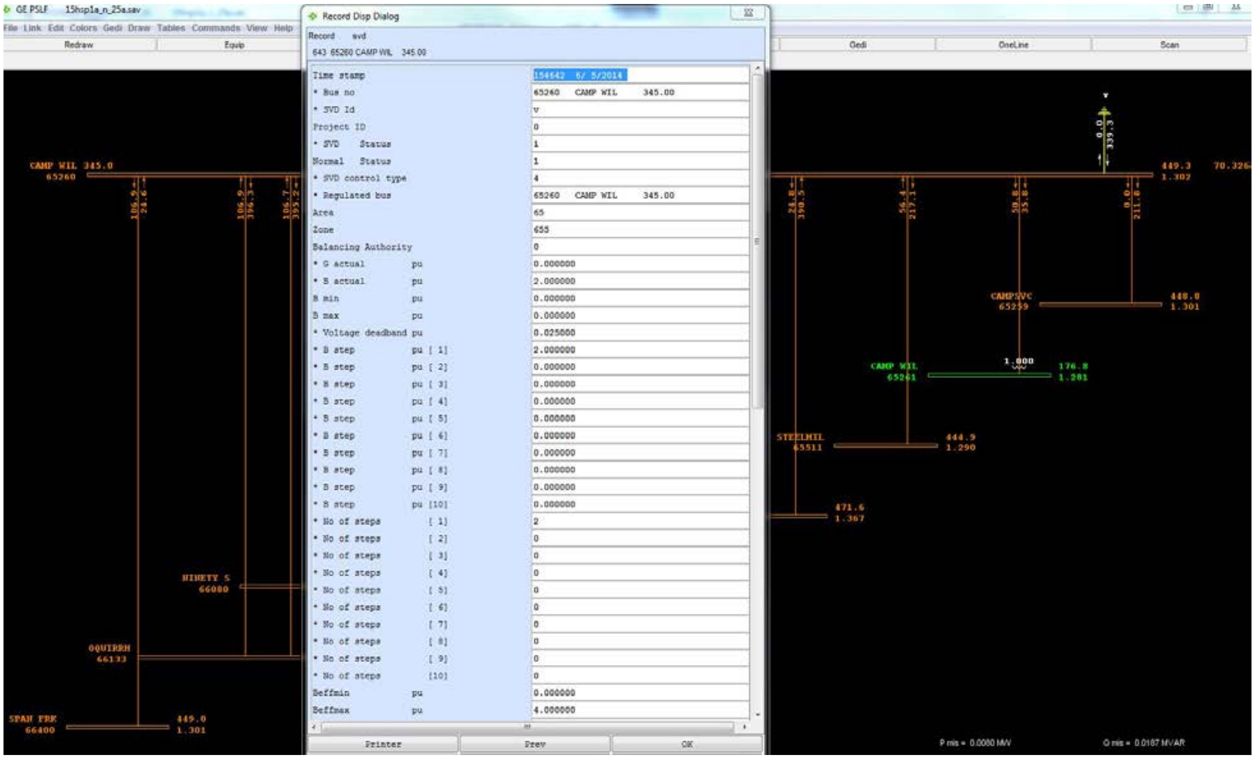
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



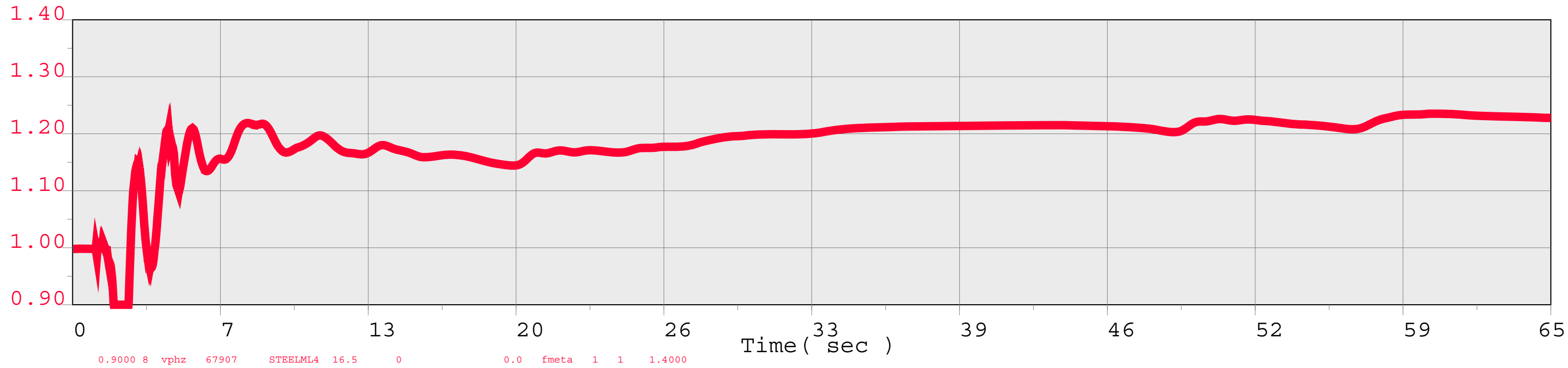
Likely Cause:

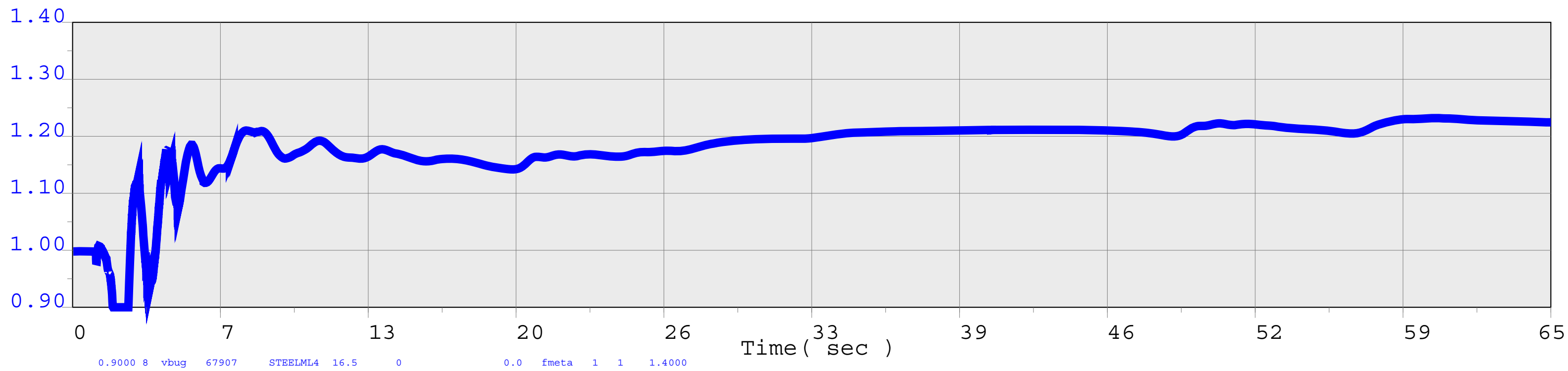
- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is absorbing 120.0 MVAR, which exceeds its Qmin (-42.5 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.
- An SVD at a nearby bus (65260) is also outputting significant of VARs holding its bus voltage to 1.302 pu (diagram below). This also caused STEELML4 voltage to be very high.
- Suspect incorrect SVD model performance as the model should not allow this.

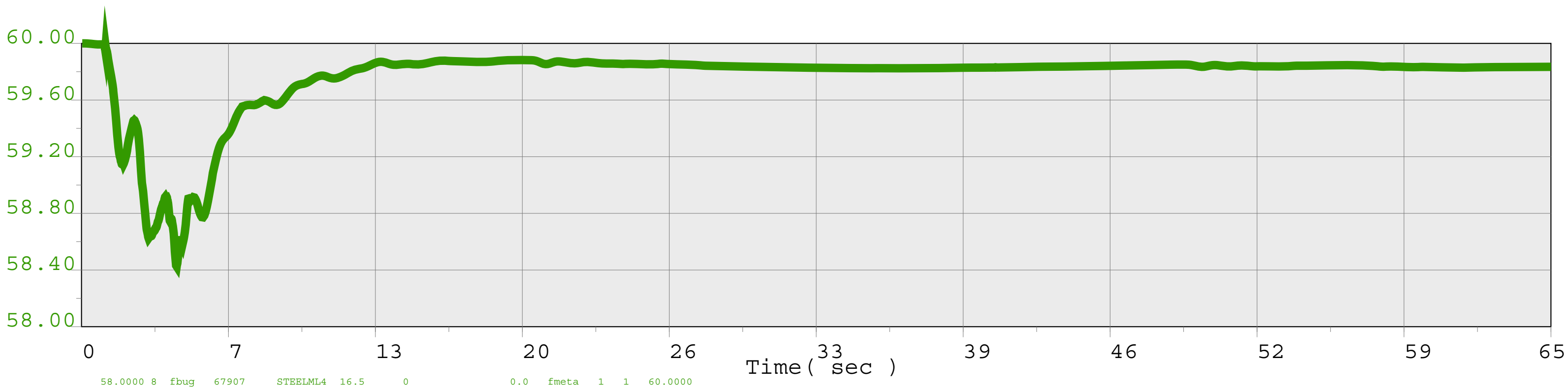


Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





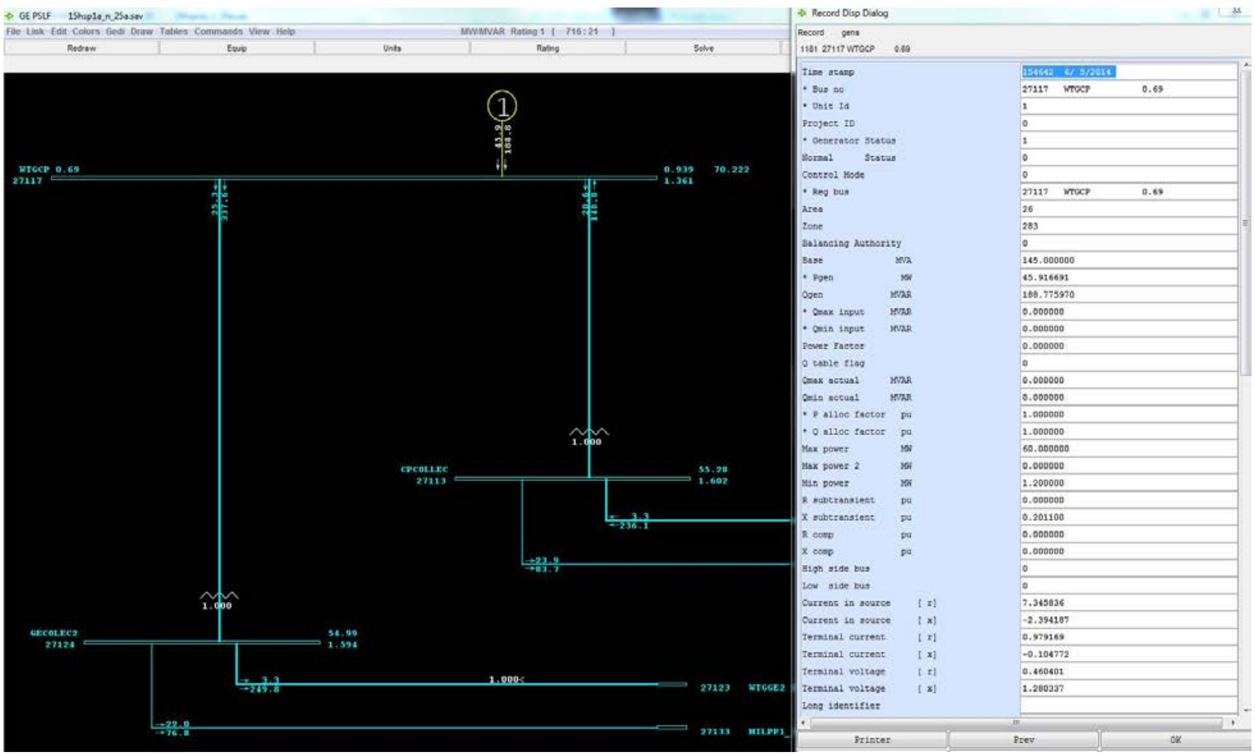


Unit ID:

- WTGCP

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

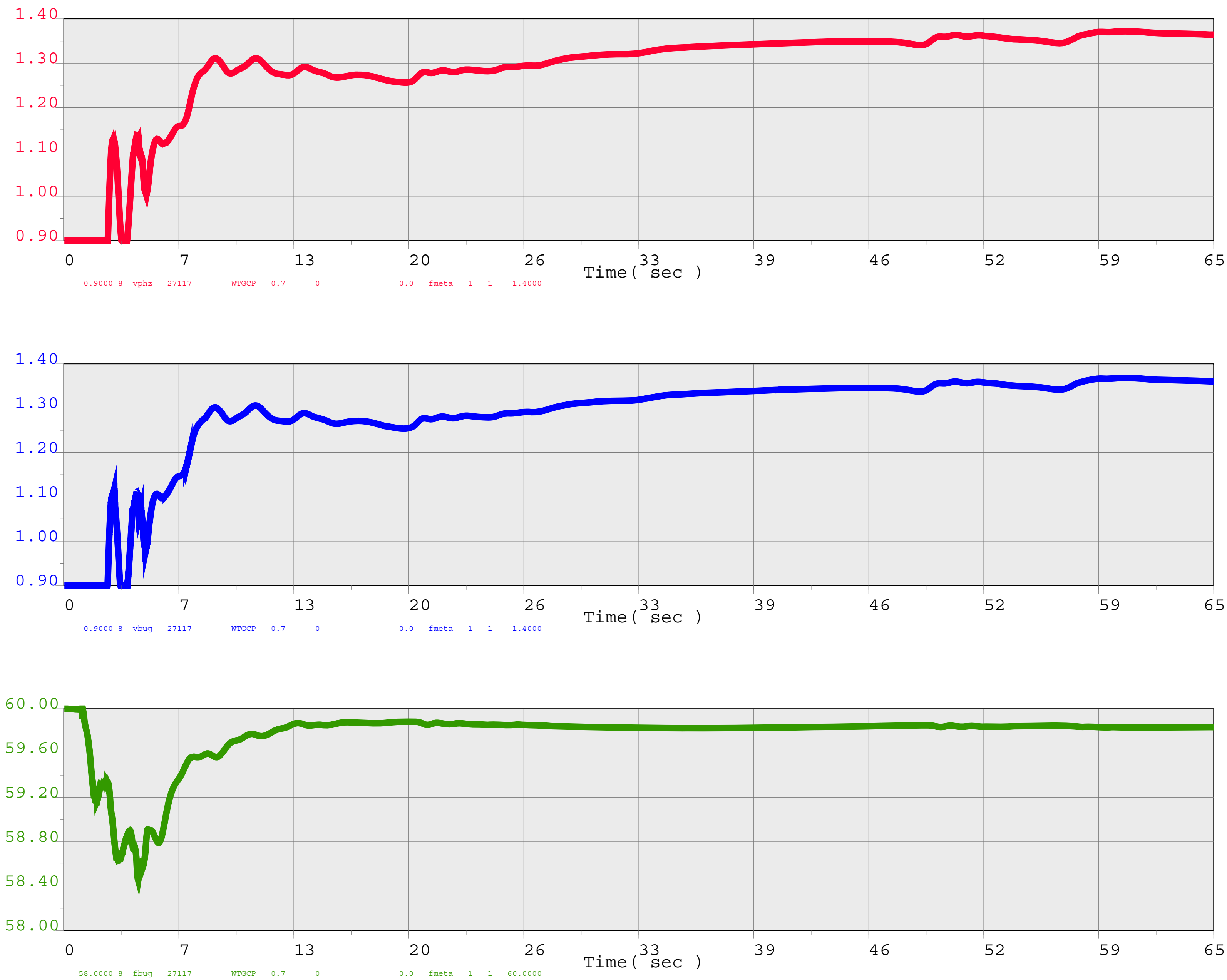


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, heavy spring 25% generation loss simulation.
- The unit is generating 188.8 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA



Page 1

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Thu Aug 20 16:30:22 2015

Appendix G: Southern Island Simulations: Generator Loss Summary

5% Gen loss units: 2015 Heavy Summer - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	492.2	10	1
15193	C643T_G1	0.48	C3	93.8	14	1
14932	PALOVRD2	24	1	1379	14	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
24124	REDON8 G	20	8	470	24	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
72500	SPR GEN3	21	1	458	73	1
	5% Imbalance =	4,551.48	**MW total =**	4714.4	**# units =**	17

10% Gen loss units: 2015 Heavy Summer - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
26039	INTERM1G	26	1	950	26	1
15981	NAVAJO 1	26	1	805	14	1
10320	SJUAN_G3	22	1	544	10	1
72500	SPR GEN3	21	1	458	73	1
	10% MW =	9,102.95	**MW total =**	9460.2	**# units =**	20

15% Gen loss units: 2015 Heavy Summer - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?

15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1082.5	30	1
26039	INTERM1G	26	1	950	26	1
15983	NAVAJO 3	26	1	805	14	1
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	492.2	10	1
24005	ALAMT5 G	20	5	475	24	1
24124	REDON8 G	20	8	470	24	1
24161	ALAMT6 G	20	6	470	24	1
14914	FCNGN4CC	22	H	434	14	1
14915	FCNGN5CC	22	H	434	14	1
16519	SPR GEN4	21	1	430	14	1
16500	SPR GEN1	19	1	378.7	14	1
16501	SPR GEN2	19	1	378.7	14	1
	15% MW =	13,654.43	**MW total =**	14047	**# units =**	29

20% Gen loss units: 2015 Heavy Summer - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1

14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1082.5	30	1
26039	INTERM1G	26	1	950	26	1
15983	NAVAJO 3	26	1	805	14	1
15982	NAVAJO 2	26	1	804.8	14	1
10321	SJUAN_G4	22	1	492.2	10	1
24005	ALAMT5 G	20	5	475	24	1
24123	REDON7 G	20	7	470	24	1
24124	REDON8 G	20	8	470	24	1
24161	ALAMT6 G	20	6	470	24	1
72500	SPR GEN3	21	1	458	73	1
14914	FCNGN4CC	22	H	434	14	1
14915	FCNGN5CC	22	H	434	14	1
16519	SPR GEN4	21	1	430	14	1
15971	CORONAD1	22	1	425.3	14	1
15972	CORONAD2	22	1	416.5	14	1
34600	HELMS 1	18	1	404	30	1
29041	IEEC-G1	19.5	1	400	24	1
29042	IEEC-G2	19.5	2	400	24	1
38951	TBC_POT2	180.5	1	400	30	1
14914	FCNGN4CC	22	L	383.4	14	1
14915	FCNGN5CC	22	L	383.4	14	1
16500	SPR GEN1	19	1	378.7	14	1
16501	SPR GEN2	19	1	378.7	14	1
24003	ALAMT3 G	18	3	310	24	1
	20% MW =	18,205.90	**MW total =**	18759	**# units =**	40

25% Gen loss units: 2015 Heavy Summer - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
15193	C643T_G1	0.48	C3	93.8	14	1
36413	UNION OL	13.8	1	5.6	30	1
32740	HILLSIDE	115	1	25.5	30	1
27358	GRAY_8BC	13.8	8b	42.9	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	203	30	1
33119	GATEWAY2	18	1	192.2	30	1
33120	GATEWAY3	18	1	192.2	30	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1082.5	30	1

26039	INTERM1G	26	1	950	26	1
15981	NAVAJO 1	26	1	805	14	1
15983	NAVAJO 3	26	1	805	14	1
15982	NAVAJO 2	26	1	804.8	14	1
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	492.2	10	1
24005	ALAMT5 G	20	5	475	24	1
24123	REDON7 G	20	7	470	24	1
24124	REDON8 G	20	8	470	24	1
24161	ALAMT6 G	20	6	470	24	1
72500	SPR GEN3	21	1	458	73	1
14915	FCNGN5CC	22	H	434	14	1
16519	SPR GEN4	21	1	430	14	1
15971	CORONAD1	22	1	425.3	14	1
15972	CORONAD2	22	1	416.5	14	1
34600	HELMS 1	18	1	404	30	1
29042	IEEC-G2	19.5	2	400	24	1
38951	TBC_POT2	180.5	1	400	30	1
14914	FCNGN4CC	22	L	383.4	14	1
14915	FCNGN5CC	22	L	383.4	14	1
16501	SPR GEN2	19	1	378.7	14	1
14903	CHOLLA4	22	1	372.9	14	1
34602	HELMS 2	18	1	367.2	30	1
10318	SJUAN_G1	22	1	360	10	1
10319	SJUAN_G2	24	1	350	10	1
34604	HELMS 3	18	1	346.4	30	1
26067	SCATT3G	24	3	329.9	26	1
18407	HIGGINS3	21	1	328	18	1
22244	ENCINA 5	24	1	320	22	1
24003	ALAMT3 G	18	3	310	24	1
15166	MES-ST1	18	1	299.9	14	1
14902	CHOLLA3	22	1	299.5	14	1
15147	ARL-ST1	18	1	299.5	14	1
33107	DEC STG1	24	1	296.2	30	1
22240	ENCINA 4	22	1	290	22	1
22981	IV GEN1 STG	21	1	270	22	1
	25% MW =	22,757.38	**MW total =**	23425	**# units =**	53

5% Gen loss units: 2015 Heavy Spring - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
33171	TRSVQ+NW	9.11	1	14.7	30	
33171	TRSVQ+NW	9.11	2	8.4	30	
10320	SJUAN_G3	22	1	544	10	1
14932	PALOVRD2	24	1	1379	14	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
24124	REDON8 G	20	8	470	24	1
27358	GRAY_8BC	13.8	8b	36.5	26	1
36413	UNION OL	13.8	1	5.3	30	1
32740	HILLSIDE	115	1	25.7	30	1
33118	GATEWAY1	18	1	204	30	1
33119	GATEWAY2	18	1	192.6	30	1
33120	GATEWAY3	18	1	192.6	30	1
	5% MW =	3,483.06	**MW total =**	3665.7	**# units =**	14

10% Gen loss units: 2015 Heavy Spring - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
33171	TRSVQ+NW	9.11	1	14.7	30	1
33171	TRSVQ+NW	9.11	2	8.4	30	1
36413	UNION OL	13.8	1	5.3	30	1
32740	HILLSIDE	115	1	25.7	30	1
27358	GRAY_8BC	13.8	8b	36.5	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	204	30	1
33119	GATEWAY2	18	1	192.6	30	1
33120	GATEWAY3	18	1	192.6	30	1
14932	PALOVRD2	24	1	1379	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
26039	INTERM1G	26	1	932.2	26	1
15981	NAVAJO 1	26	1	805	14	1
72500	SPR GEN3	21	1	430	73	1
	10% MW =	6,966.12	**MW total =**	7418	**# units =**	19

15% Gen loss units: 2015 Heavy Spring - Southern Island						
BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
33171	TRSVQ+NW	9.11	1	14.7	30	1
33171	TRSVQ+NW	9.11	2	8.4	30	1

36413	UNION OL	13.8	1	5.3	30	1
32740	HILLSIDE	115	1	25.7	30	1
27358	GRAY_8BC	13.8	8b	36.5	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	204	30	1
33119	GATEWAY2	18	1	192.6	30	1
33120	GATEWAY3	18	1	192.6	30	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1082.6	30	1
26039	INTERM1G	26	1	932.2	26	1
15983	NAVAJO 3	26	1	805	14	1
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	516.7	10	1
24005	ALAMT5 G	20	5	475	24	1
24124	REDON8 G	20	8	470	24	1
24161	ALAMT6 G	20	6	470	24	1
14914	FCNGN4CC	22	H	427.8	14	1
14915	FCNGN5CC	22	H	427.8	14	1
16519	SPR GEN4	21	1	423.5	14	1
16500	SPR GEN1	19	1	195.4	14	1
16501	SPR GEN2	19	1	378.5	14	1
	15% MW =	10,449.18	**MW total =**	11020.3	**# units =**	28

20% Gen loss units: 2015 Heavy Spring - Southern Island

BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
33171	TRSVQ+NW	9.11	1	14.7	30	1
33171	TRSVQ+NW	9.11	2	8.4	30	1
36413	UNION OL	13.8	1	5.3	30	1
32740	HILLSIDE	115	1	25.7	30	1
27358	GRAY_8BC	13.8	8b	36.5	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	204	30	1
33119	GATEWAY2	18	1	192.6	30	1
33120	GATEWAY3	18	1	192.6	30	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36411	DIABLO 1	25	1	1082.6	30	1
26039	INTERM1G	26	1	932.2	26	1

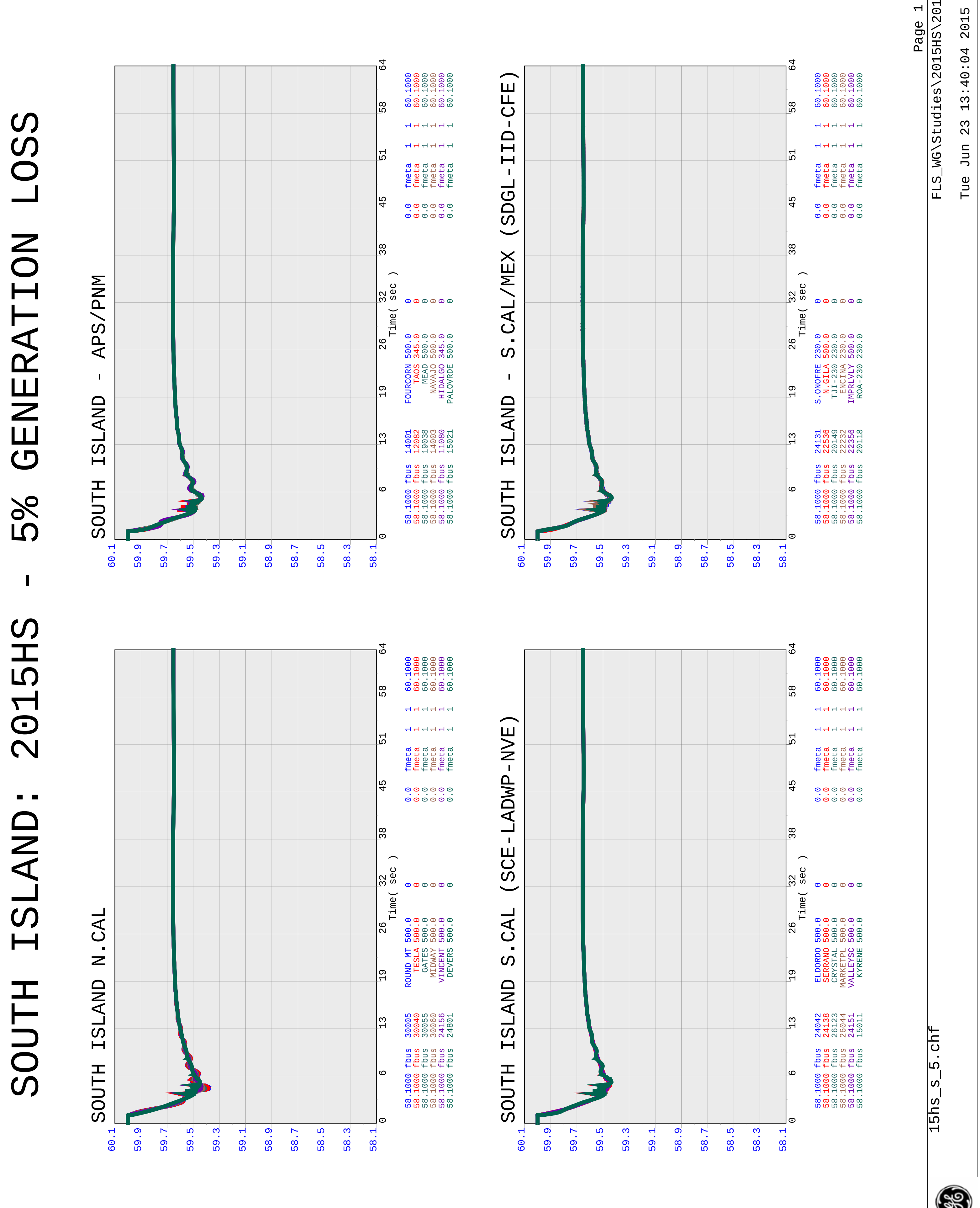
15983	NAVAJO 3	26	1	805	14	1
15982	NAVAJO 2	26	1	804.3	14	1
10321	SJUAN_G4	22	1	516.7	10	1
24005	ALAMT5 G	20	5	475	24	1
24123	REDON7 G	20	7	470	24	1
24124	REDON8 G	20	8	470	24	1
24161	ALAMT6 G	20	6	470	24	1
72500	SPR GEN3	21	1	430	73	1
14914	FCNGN4CC	22	H	427.8	14	1
14915	FCNGN5CC	22	H	427.8	14	1
16519	SPR GEN4	21	1	423.5	14	1
15971	CORONAD1	22	1	429	14	1
15972	CORONAD2	22	1	421	14	1
34600	HELMS 1	18	1	404	30	1
24003	ALAMT3 G	18	3	310	24	1
	20% MW =	13,932.24	**MW total =**	14726.7	**# units =**	33

25% Gen loss units: 2015 Heavy Spring - Southern Island

BUS-NO	NAME1	KV1	ID	PGEN	AREA	Trip unit?
35040	KERNRDGE	9.11	1	53.2	30	1
35040	KERNRDGE	9.11	2	5.6	30	1
33171	TRSVQ+NW	9.11	1	14.7	30	1
33171	TRSVQ+NW	9.11	2	8.4	30	1
36413	UNION OL	13.8	1	5.3	30	1
32740	HILLSIDE	115	1	25.7	30	1
27358	GRAY_8BC	13.8	8b	36.5	26	1
21015	DPWR#3	13.8	1	50	21	1
21092	UNIT5L	13.8	1	46	21	1
29207	BLY1CT1	16	1	170	24	1
29208	BLY1CT2	16	1	170	24	1
29209	BLY1ST1	16	1	180	24	1
33118	GATEWAY1	18	1	204	30	1
33119	GATEWAY2	18	1	192.6	30	1
33120	GATEWAY3	18	1	192.6	30	1
14932	PALOVRD2	24	1	1379	14	1
14933	PALOVRD3	24	1	1377	14	1
14931	PALOVRD1	24	1	1376	14	1
36412	DIABLO 2	25	1	1200	30	1
36411	DIABLO 1	25	1	1082.6	30	1
26039	INTERM1G	26	1	932.2	26	1
15981	NAVAJO 1	26	1	805	14	1
15983	NAVAJO 3	26	1	805	14	1
15982	NAVAJO 2	26	1	804.3	14	1
10320	SJUAN_G3	22	1	544	10	1
10321	SJUAN_G4	22	1	516.7	10	1
24005	ALAMT5 G	20	5	475	24	1
24123	REDON7 G	20	7	470	24	1
24124	REDON8 G	20	8	470	24	1

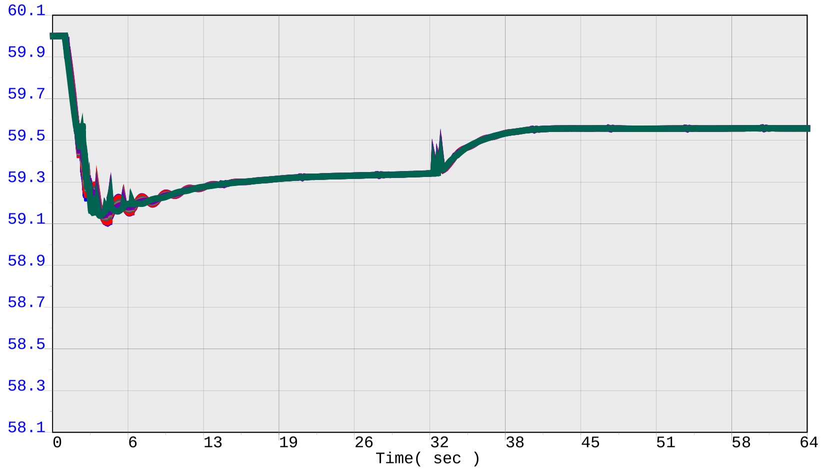
24161	ALAMT6 G	20	6	470	24	1
72500	SPR GEN3	21	1	430	73	1
14915	FCNGN5CC	22	H	427.8	14	1
16519	SPR GEN4	21	1	423.5	14	1
15971	CORONAD1	22	1	429	14	1
15972	CORONAD2	22	1	421	14	1
34600	HELMS 1	18	1	404	30	1
38951	TBC_POT2	180.5	1	400	30	1
14914	FCNGN4CC	22	L	377.2	14	1
14915	FCNGN5CC	22	L	377.2	14	1
16501	SPR GEN2	19	1	378.5	14	1
14903	CHOLLA4	22	1	372.5	14	1
	25% MW =	17,415.30	**MW total =**	18502.1	**# units =**	41

Appendix H: Southern Island Simulations: Frequency Plots



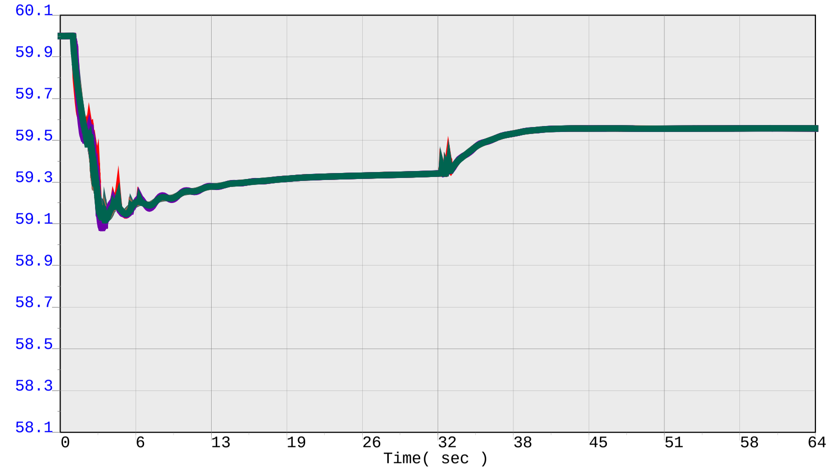
SOUTH ISLAND: 2015HS - 10% GENERATION LOSS

SOUTH ISLAND N.CAL



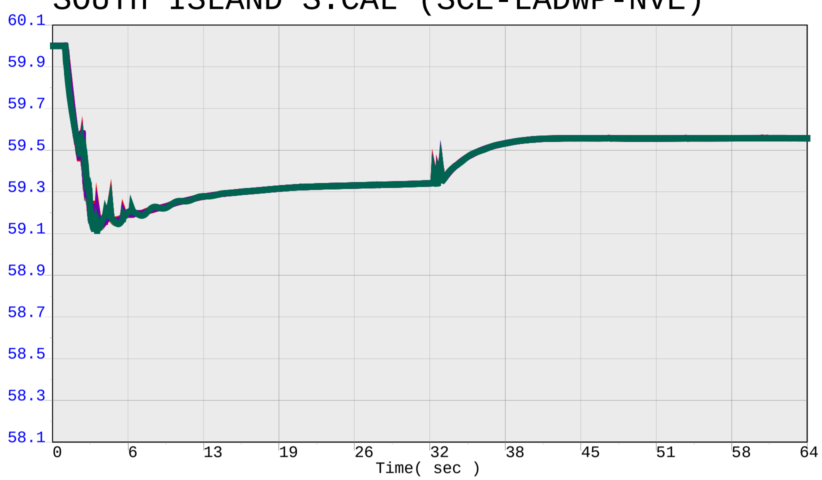
58.1000	fbus	30005	ROUND MT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30040	TESLA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30055	GATES	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30060	MIDWAY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24156	VINCENT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24801	DEVERS	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - APS/PNM



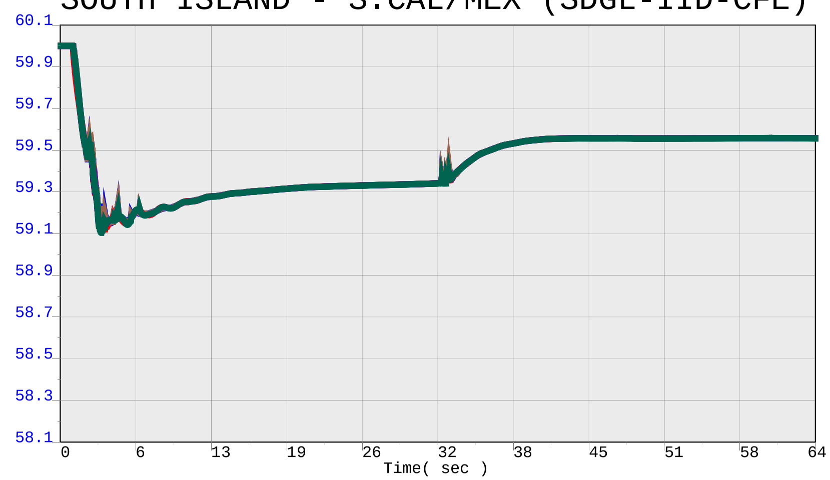
58.1000	fbus	14001	FOURCORN	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	12082	TAOS	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	19038	MEAD	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	14003	NAVAJO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	11080	HIDALGO	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15021	PALOVRDE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



58.1000	fbus	24042	ELDORDO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24138	SERRANO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26123	CRYSTAL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26044	MARKETPL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24151	VALLEYSC	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15011	KYRENE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



58.1000	fbus	24131	S.ONOFRE	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22536	N.GILA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20149	TJI-230	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22232	ENCINA	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22356	IMPRLVLY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20118	ROA-230	230.0	0	0.0	fmeta	1	1	60.1000

Page 1

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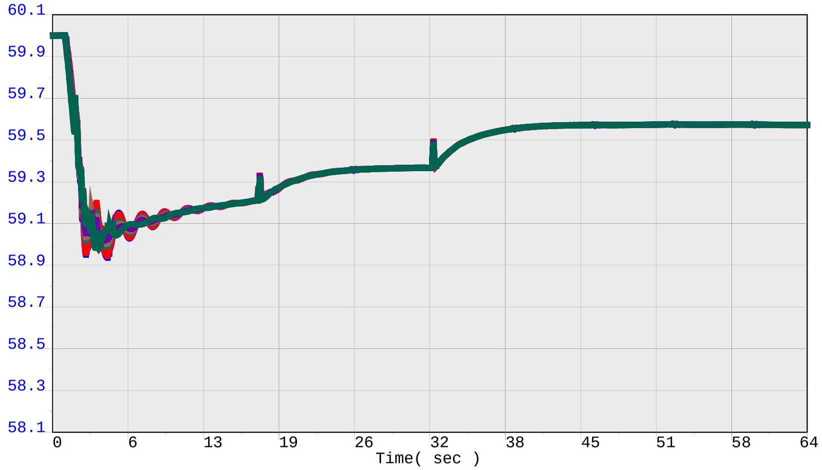
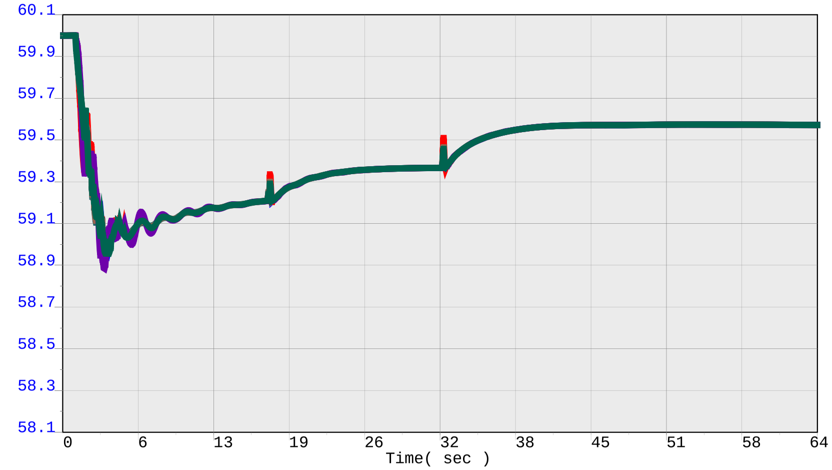
SOUTH ISLAND: 2015HS - 15% GENERATION LOSS

SOUTH ISLAND N.CAL



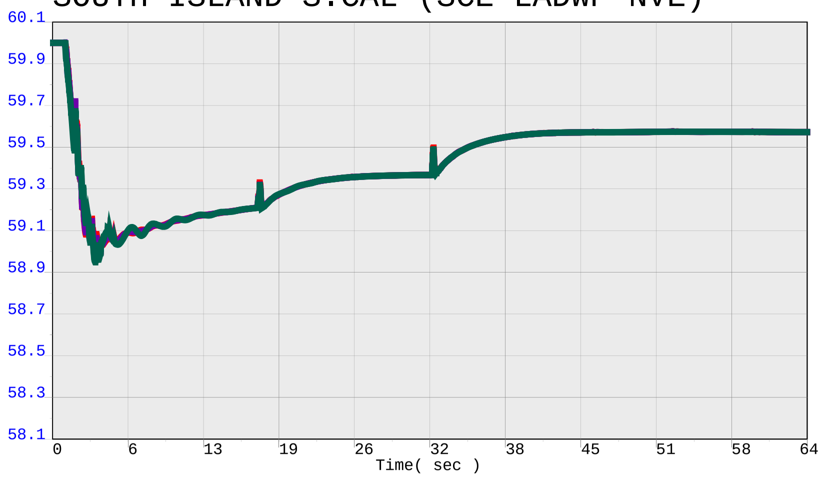
58.1000	fbus	30005	ROUND MT 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30040	TESLA 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30055	GATES 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30060	MIDWAY 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24156	VINCENT 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24801	DEVERS 500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - APS/PNM



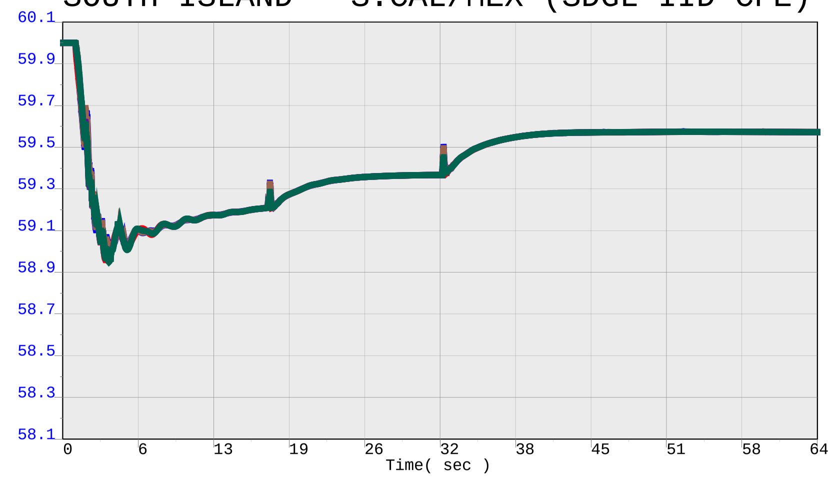
58.1000	fbus	14001	FOURCORN 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	12082	TAOS 345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	19038	MEAD 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	14003	NAVAJO 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	11080	HIDALGO 345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15021	PALOVRDE 500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



58.1000	fbus	24042	ELDORDO 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24138	SERRANO 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26123	CRYSTAL 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26044	MARKETPL 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24151	VALLEYSC 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15011	KYRENE 500.0	0	0.0	fmeta	1	1	60.1000

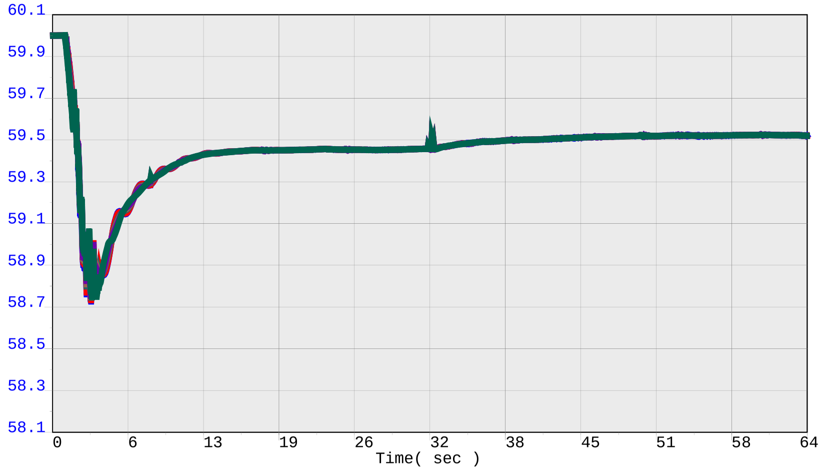
SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



58.1000	fbus	24131	S.ONOFRE 230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22536	N.GILA 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20149	TJI-230 230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22232	ENCINA 230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22356	IMPRLVLY 500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20118	ROA-230 230.0	0	0.0	fmeta	1	1	60.1000

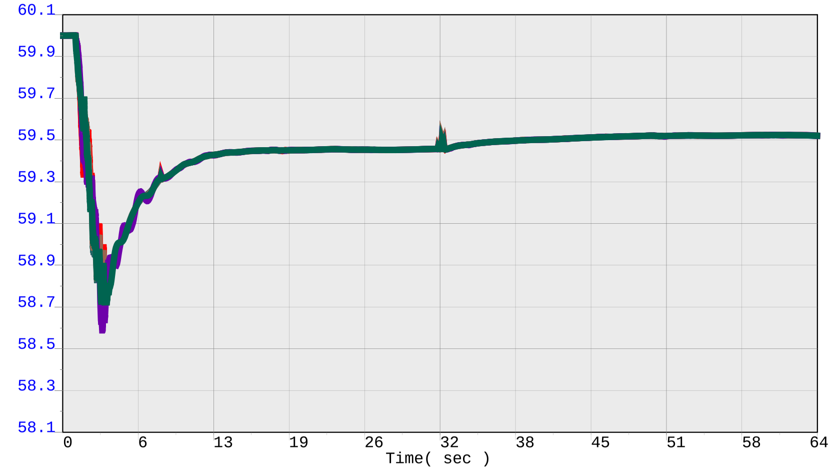
SOUTH ISLAND: 2015HS - 20% GENERATION LOSS

SOUTH ISLAND N.CAL



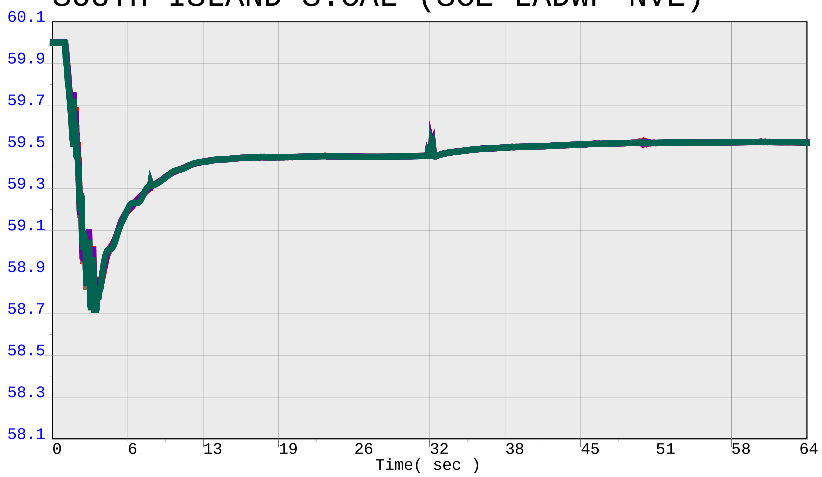
58.1000	fbus	30005	ROUND MT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30040	TESLA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30055	GATES	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30060	MIDWAY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24156	VINCENT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24801	DEVERS	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - APS/PNM



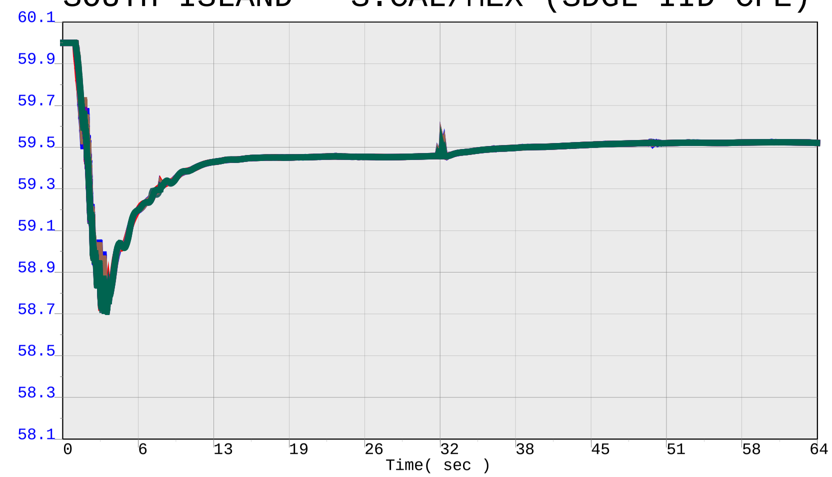
58.1000	fbus	14001	FOURCORN	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	12082	TAOS	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	19038	MEAD	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	14003	NAVAJO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	11080	HIDALGO	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15021	PALOVRDE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



58.1000	fbus	24042	ELDORDO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24138	SERRANO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26123	CRYSTAL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26044	MARKETPL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24151	VALLEYSC	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15011	KYRENE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



58.1000	fbus	24131	S.ONOFRE	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22536	N.GILA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20149	TJI-230	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22232	ENCINA	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22356	IMPRLVLY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20118	ROA-230	230.0	0	0.0	fmeta	1	1	60.1000

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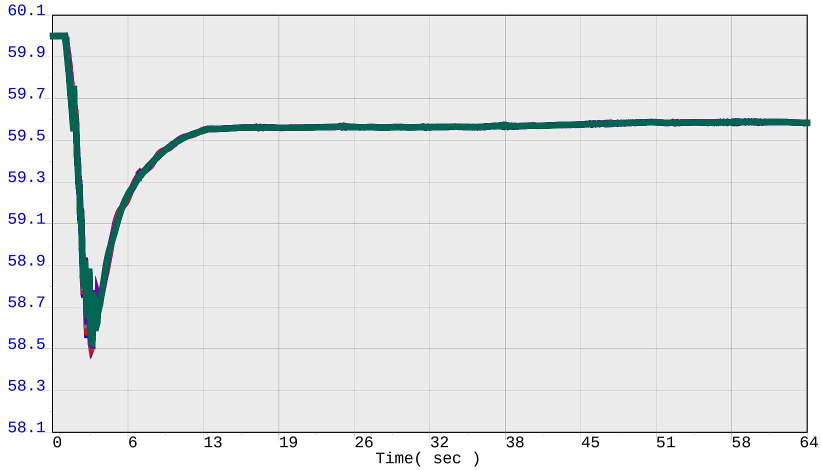
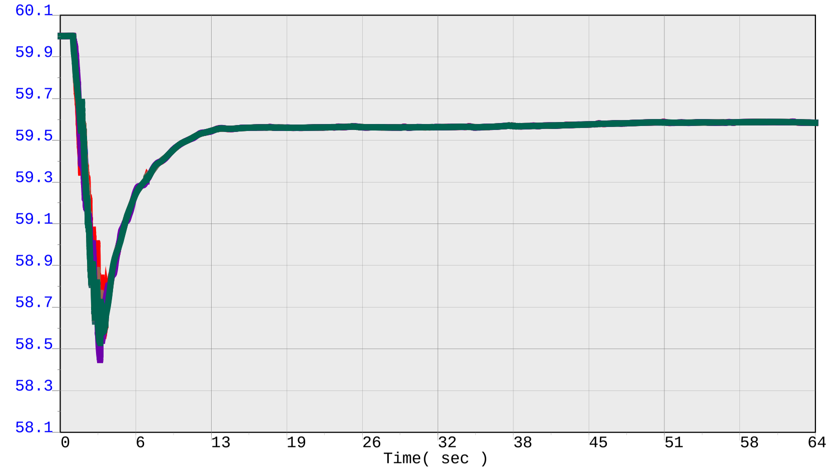
SOUTH ISLAND: 2015HS - 25% GENERATION LOSS

SOUTH ISLAND N.CAL



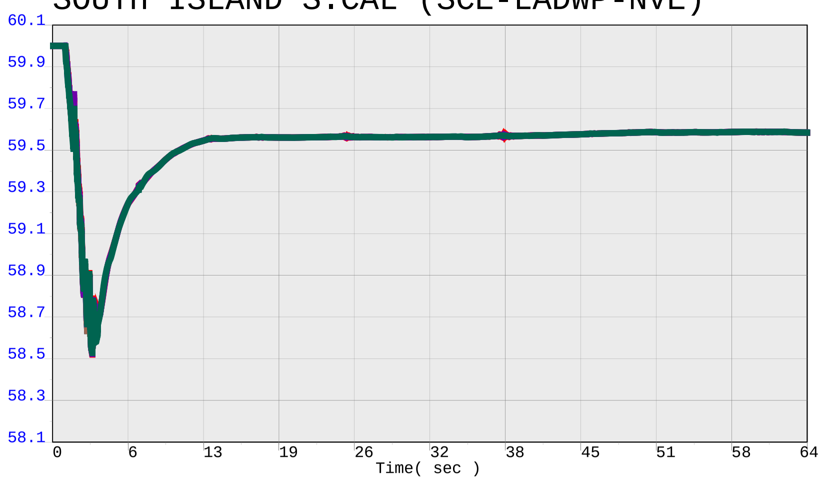
58.1000	fbus	30005	ROUND MT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30040	TESLA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30055	GATES	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	30060	MIDWAY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24156	VINCENT	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24801	DEVERS	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND - APS/PNM



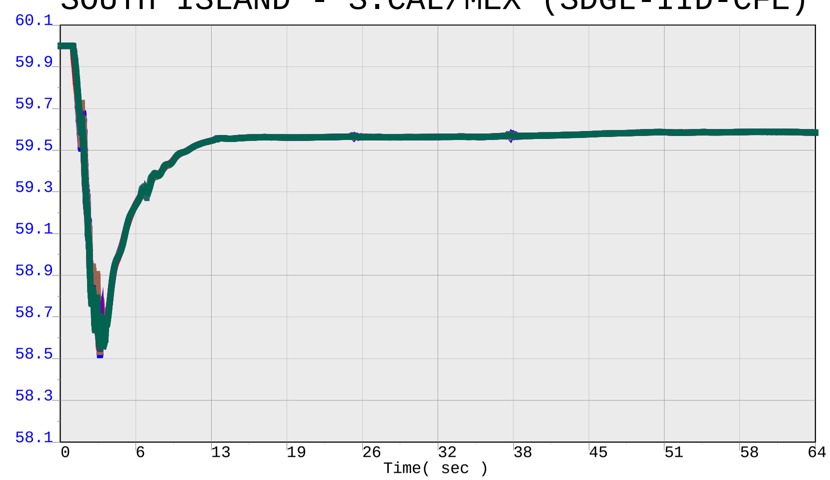
58.1000	fbus	14001	FOURCORN	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	12082	TAOS	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	19038	MEAD	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	14003	NAVAJO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	11080	HIDALGO	345.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15021	PALOVRDE	500.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



58.1000	fbus	24042	ELDORDO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24138	SERRANO	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26123	CRYSTAL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	26044	MARKETPL	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	24151	VALLEYSC	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	15011	KYRENE	500.0	0	0.0	fmeta	1	1	60.1000

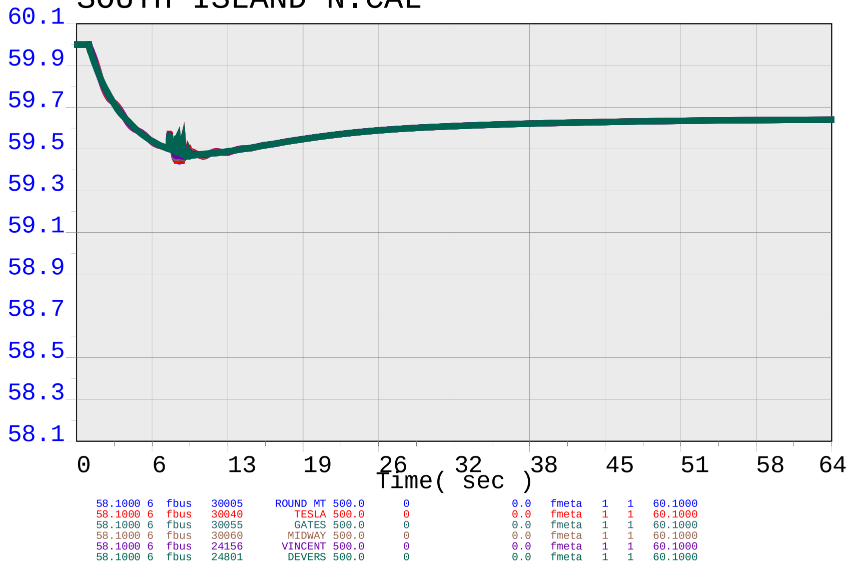
SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



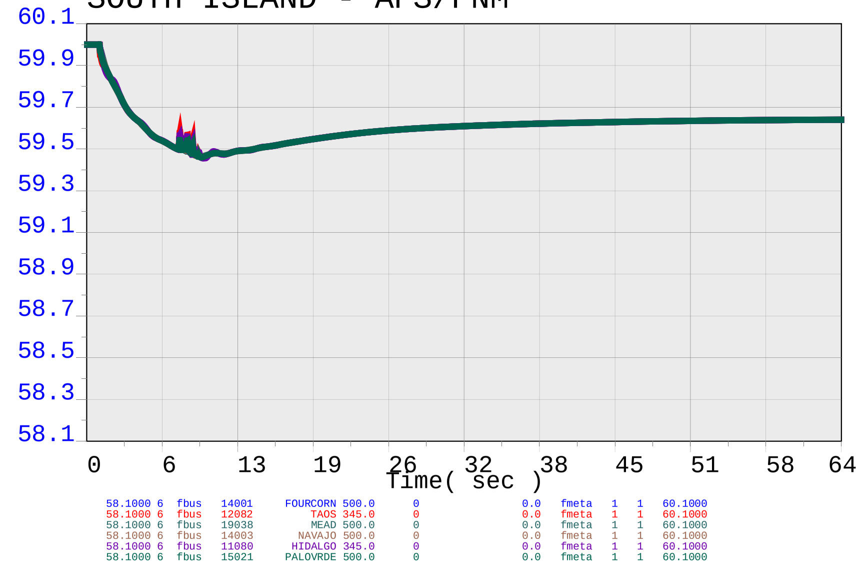
58.1000	fbus	24131	S.ONOFRE	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22536	N.GILA	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20149	TJI-230	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22232	ENCINA	230.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	22356	IMPRLVLY	500.0	0	0.0	fmeta	1	1	60.1000
58.1000	fbus	20118	ROA-230	230.0	0	0.0	fmeta	1	1	60.1000

SOUTH ISLAND: 2015HSP - 5% GENERATION LOSS

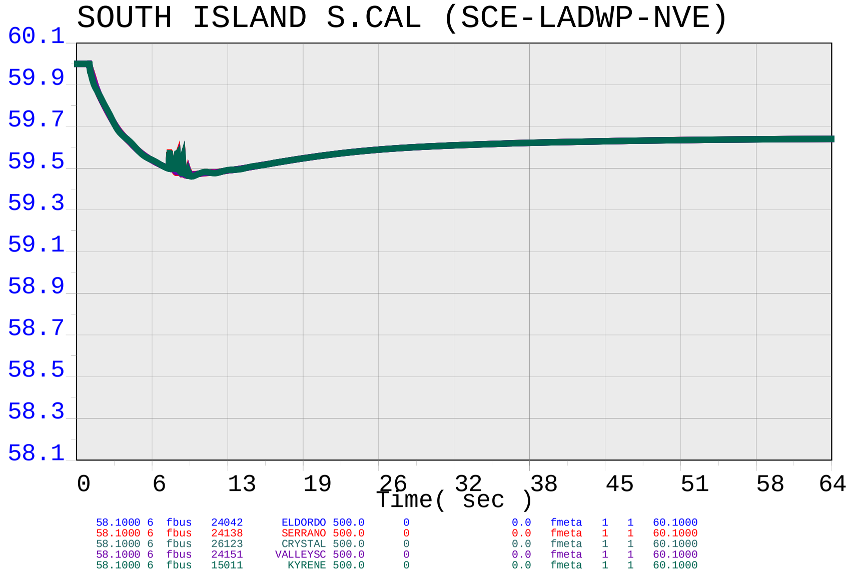
SOUTH ISLAND N.CAL



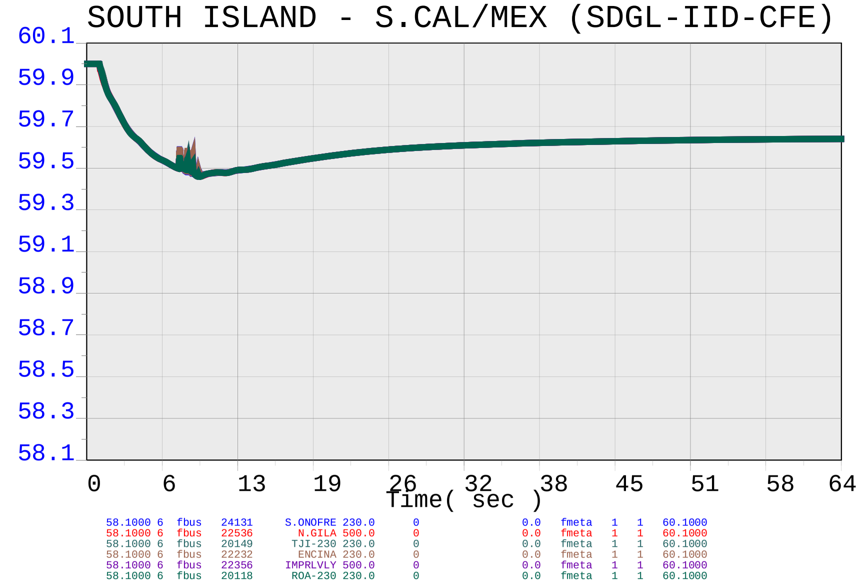
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



Page 1

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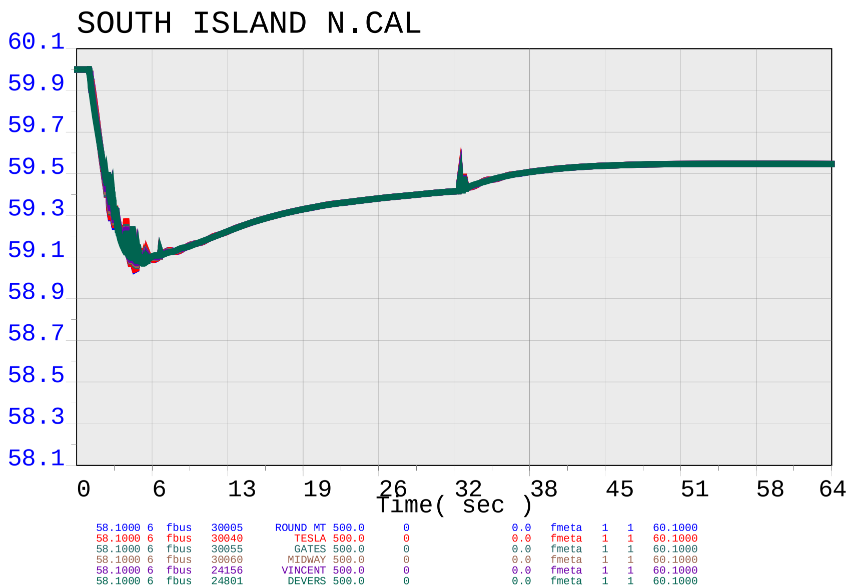
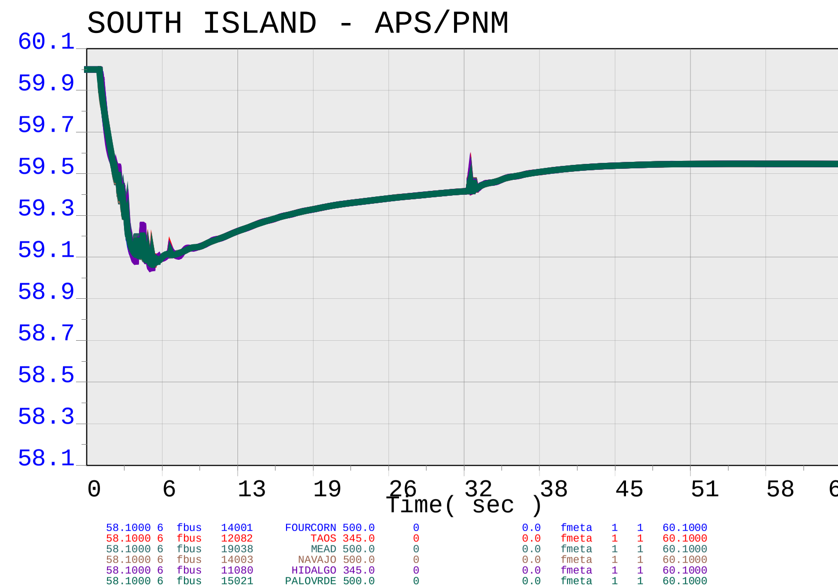
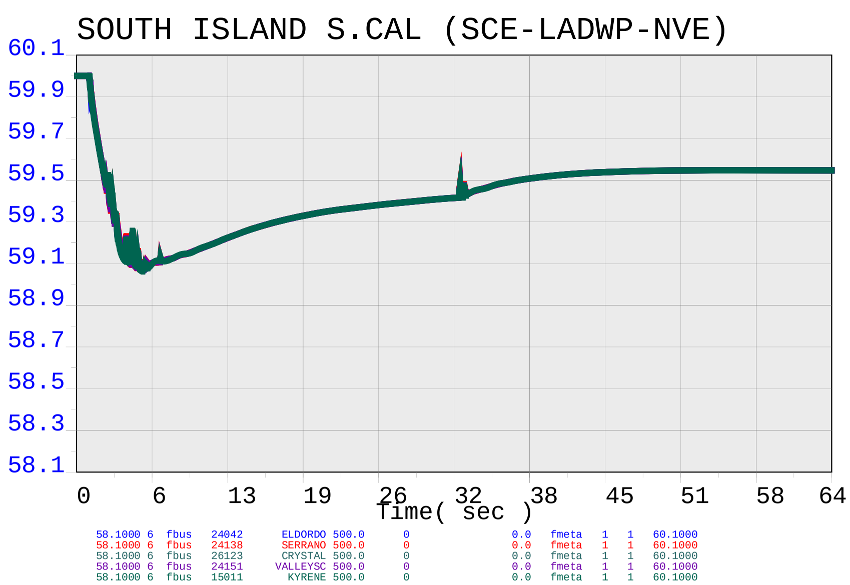
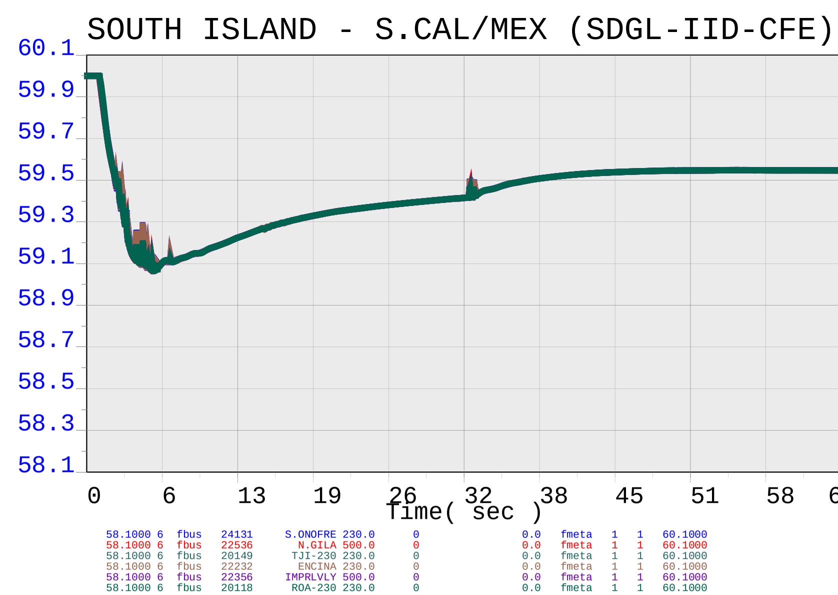
SOUTH ISLAND: 2015HSP - 10% GENERATION LOSS









Page 1

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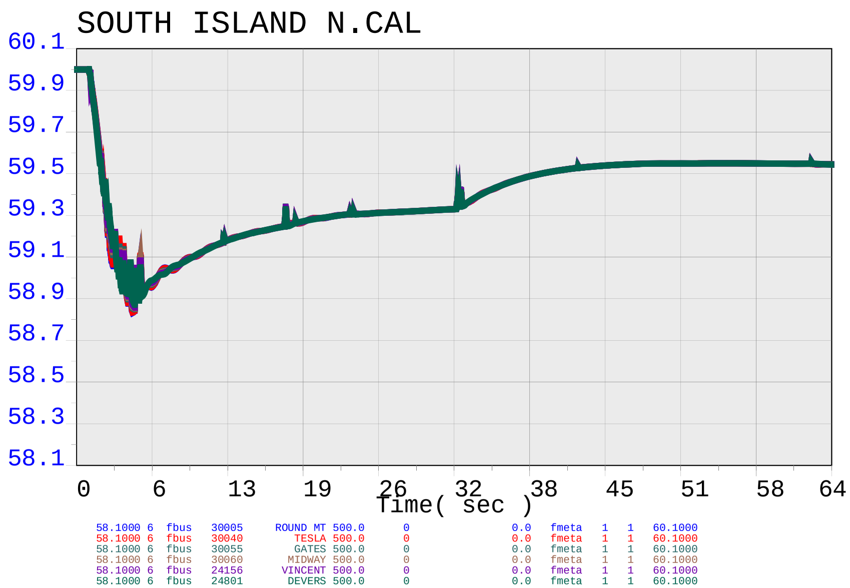
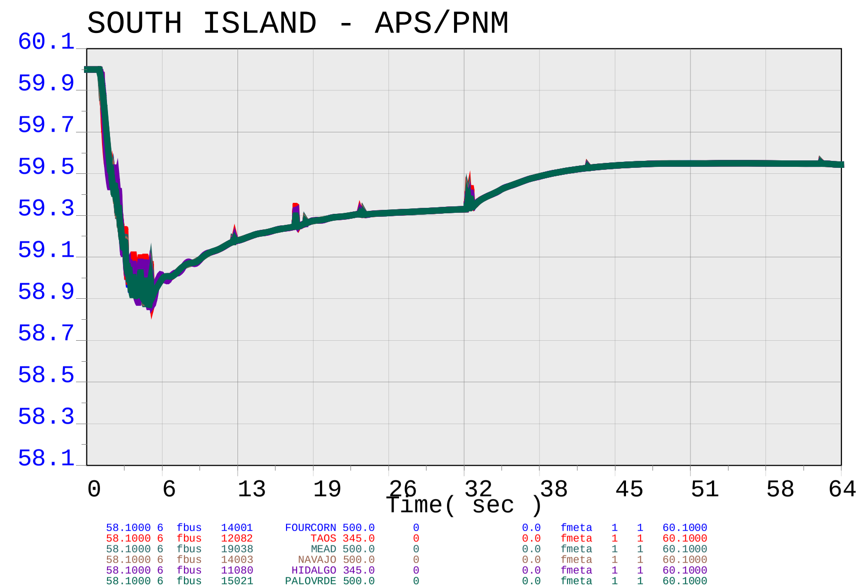
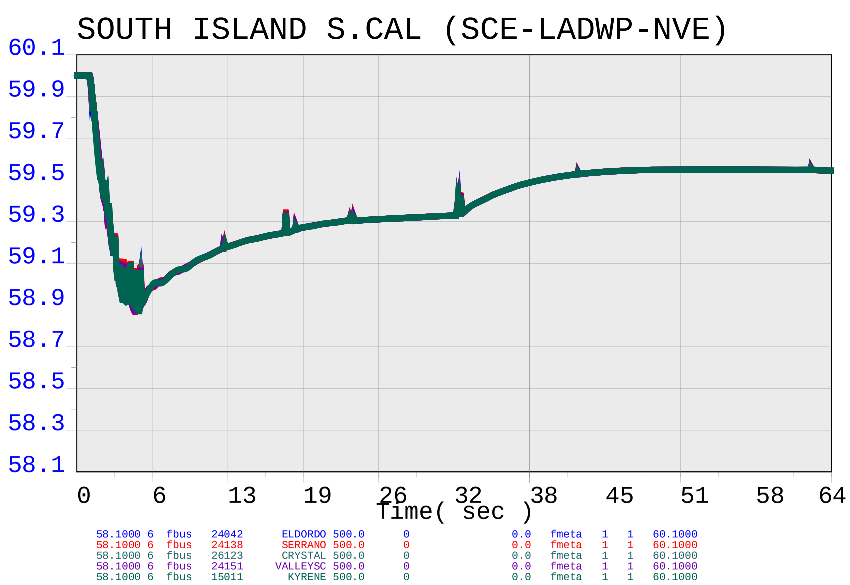
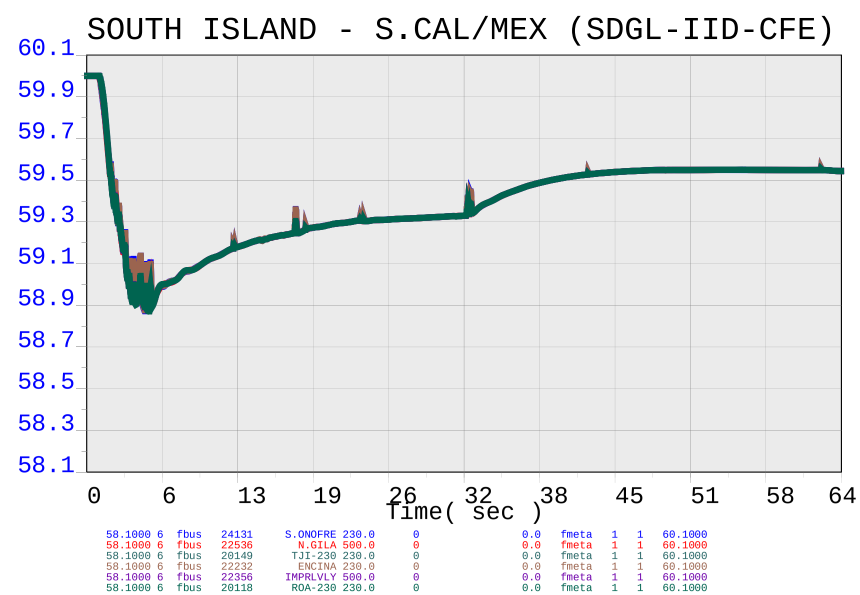
Mon Jul 06 07:30:48 2015

SOUTH ISLAND: 2015HSP - 15% GENERATION LOSS









Page 1

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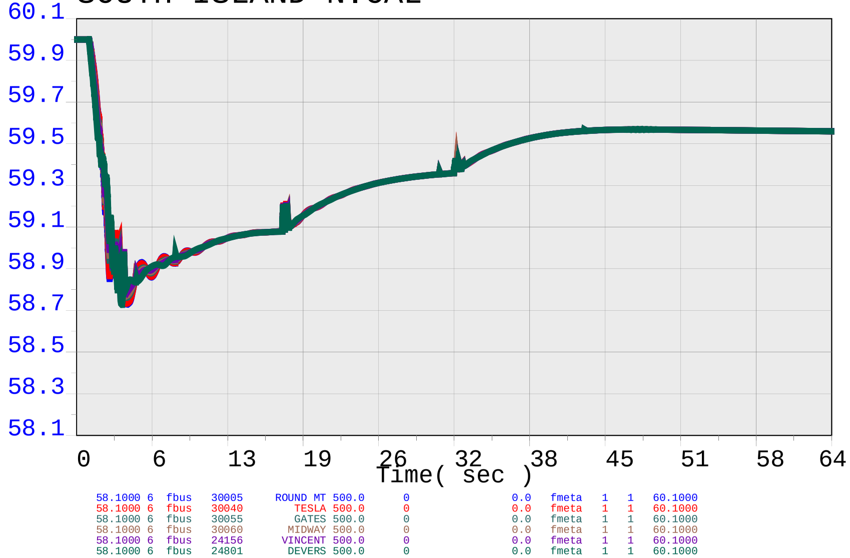
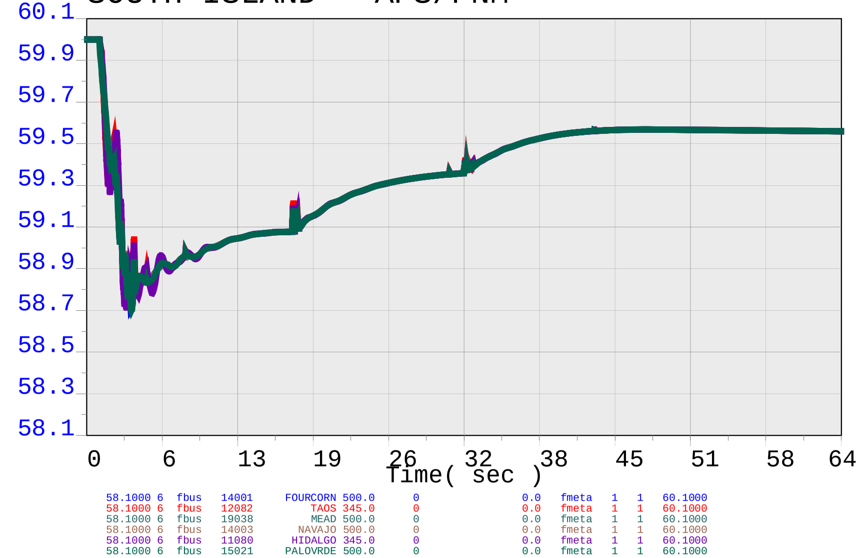
Mon Jul 06 07:39:07 2015

SOUTH ISLAND: 2015HSP - 20% GENERATION LOSS

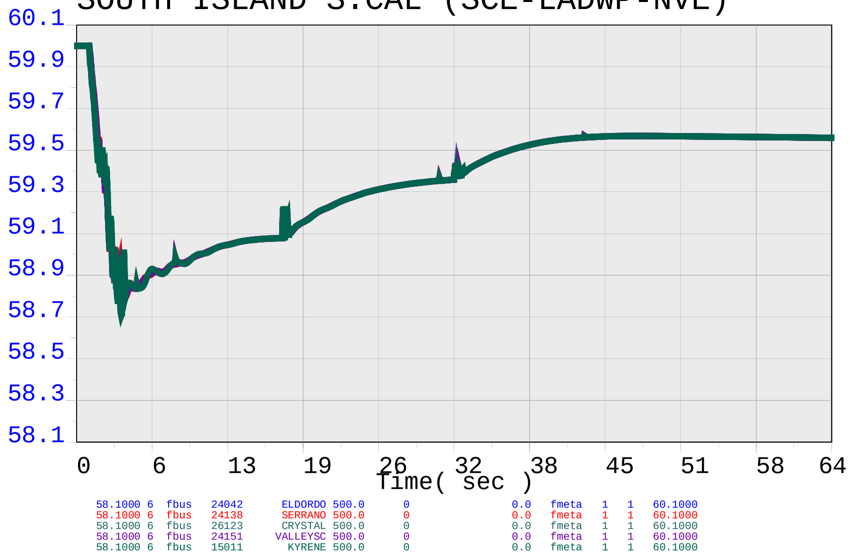
SOUTH ISLAND N.CAL



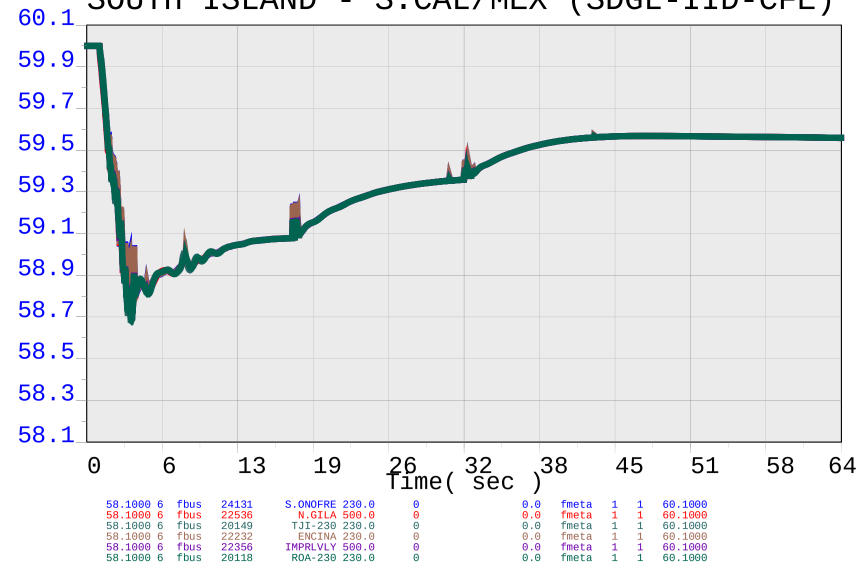
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



Page 1

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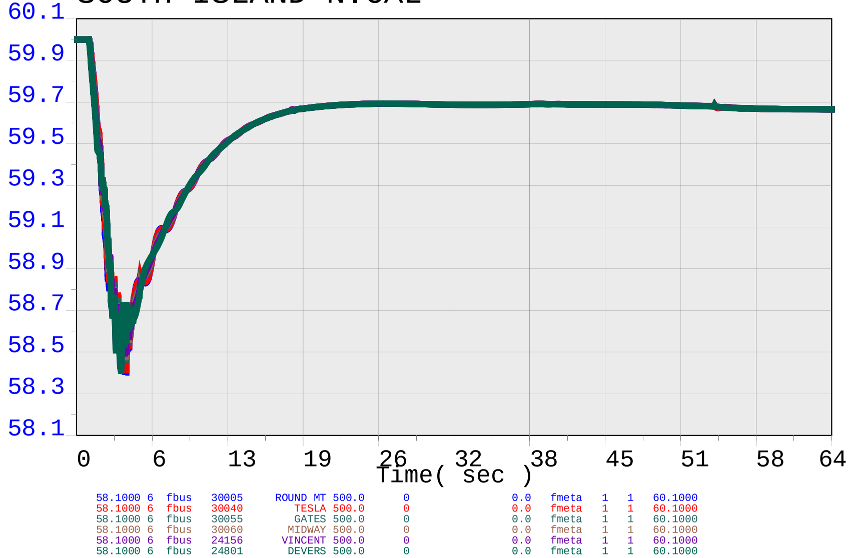
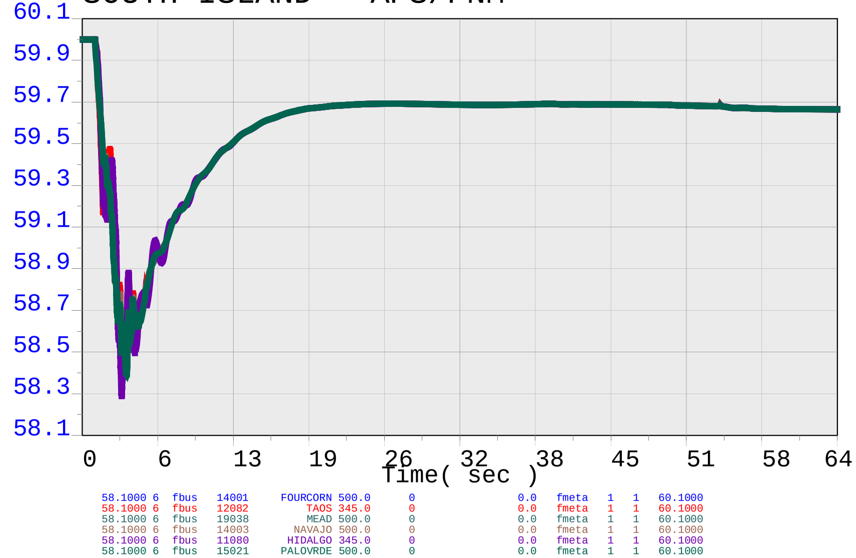
Mon Jul 06 08:45:45 2015

SOUTH ISLAND: 2015HSP - 25% GENERATION LOSS

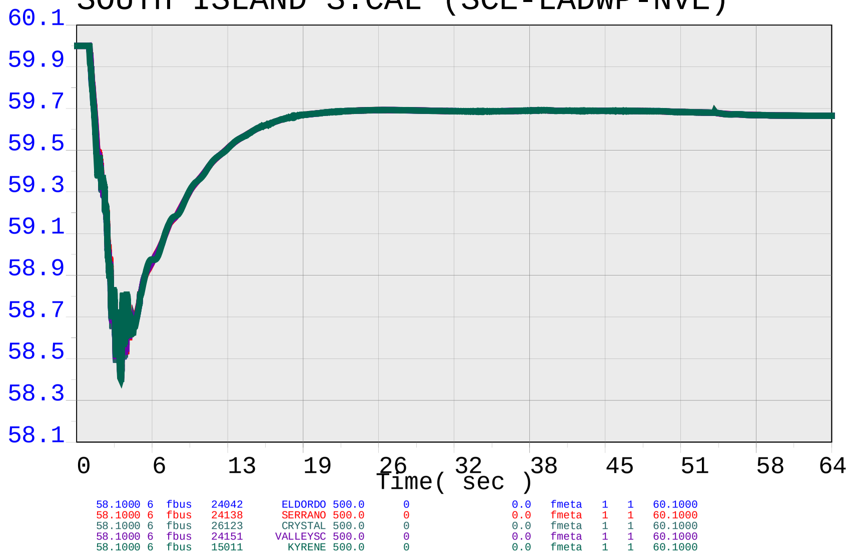
SOUTH ISLAND N.CAL



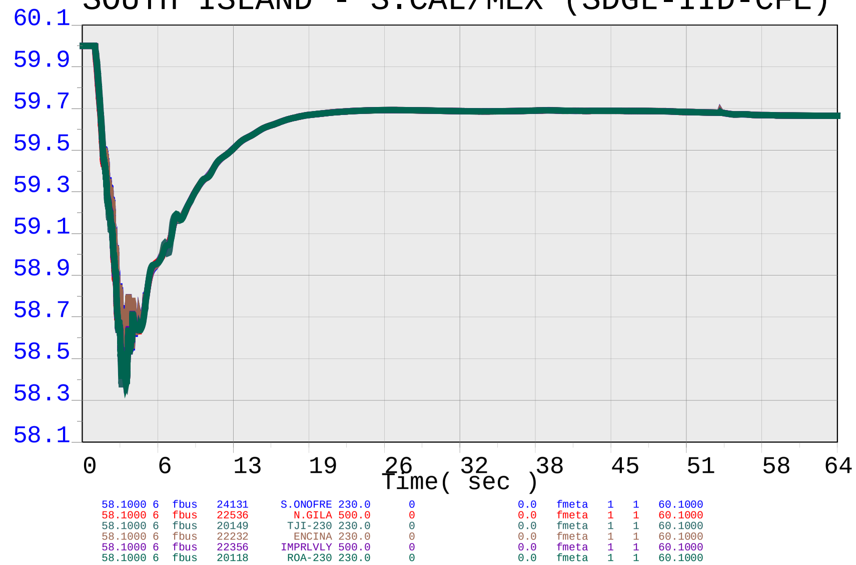
SOUTH ISLAND - APS/PNM



SOUTH ISLAND S.CAL (SCE-LADWP-NVE)



SOUTH ISLAND - S.CAL/MEX (SDGL-IID-CFE)



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Appendix I: Southern Island Simulations: Volts per Hz Plots

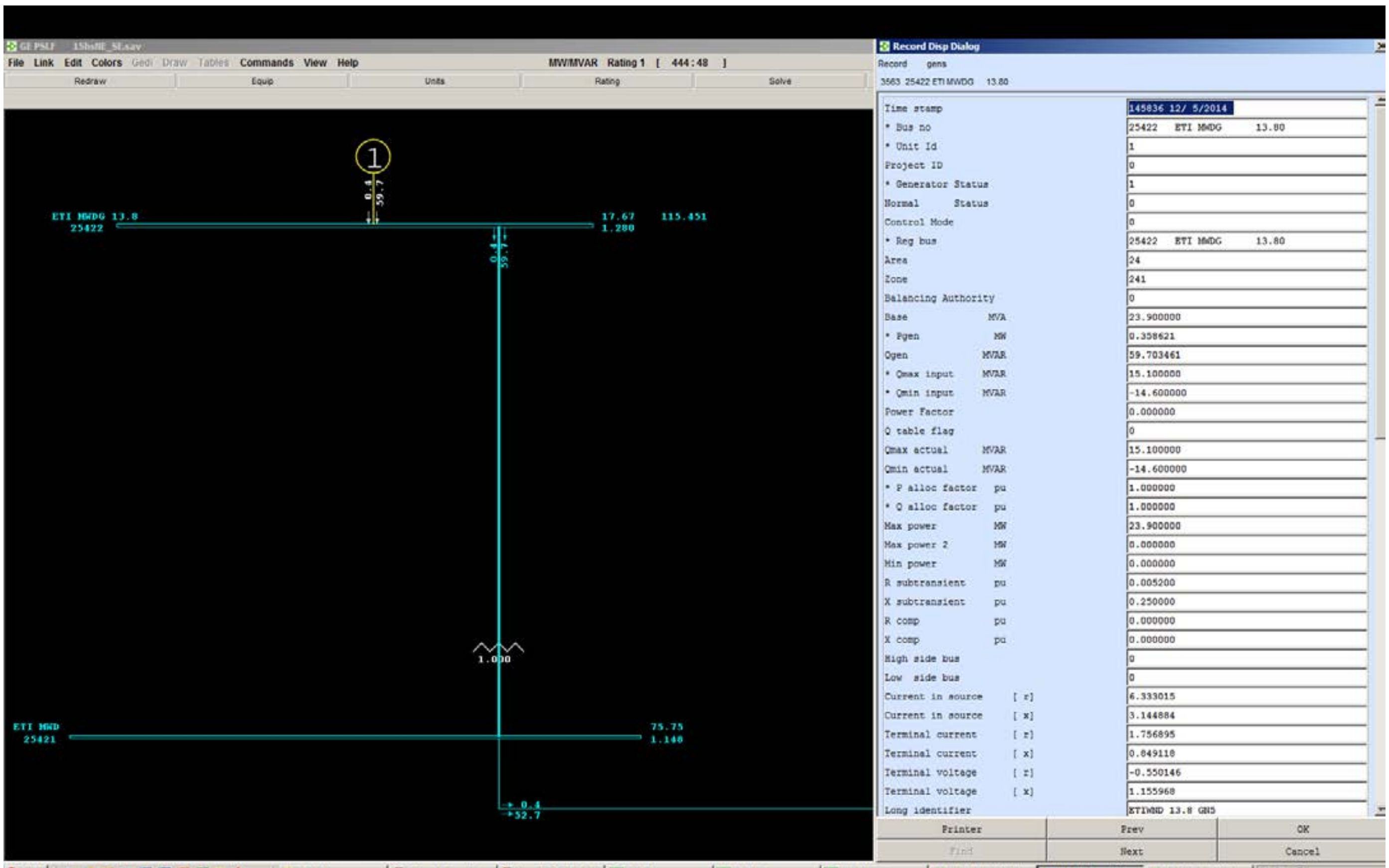
Heavy Summer V/Hz
25% Imbalance

Unit ID:

- ETI MWDG

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.

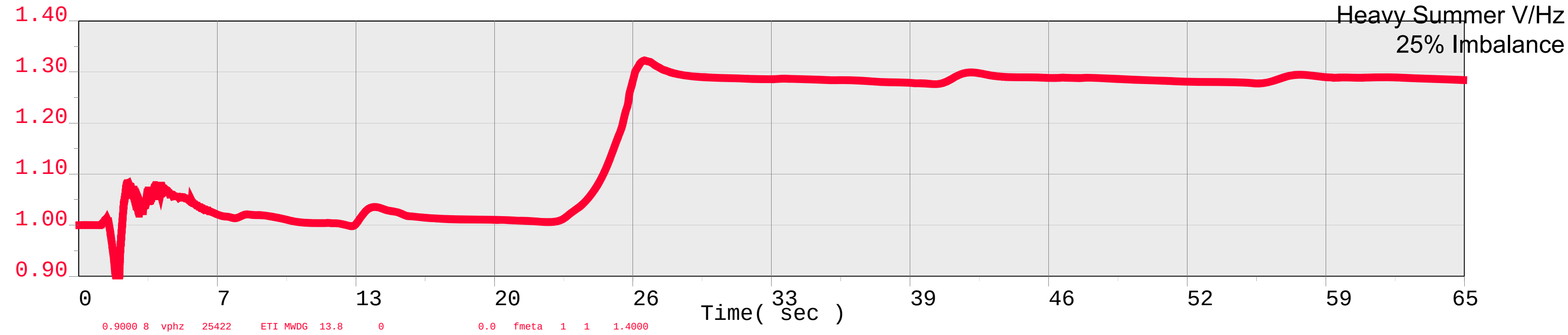


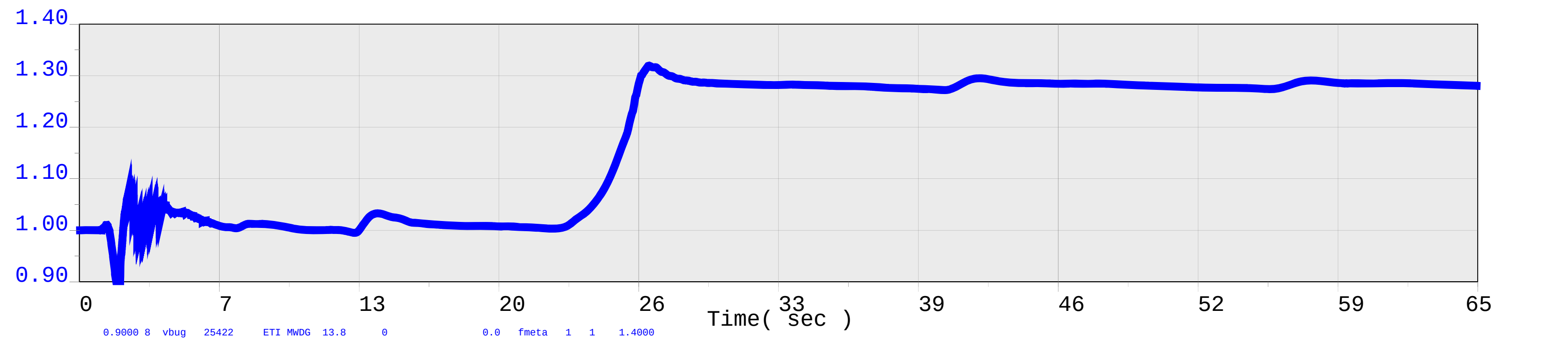
Likely Cause:

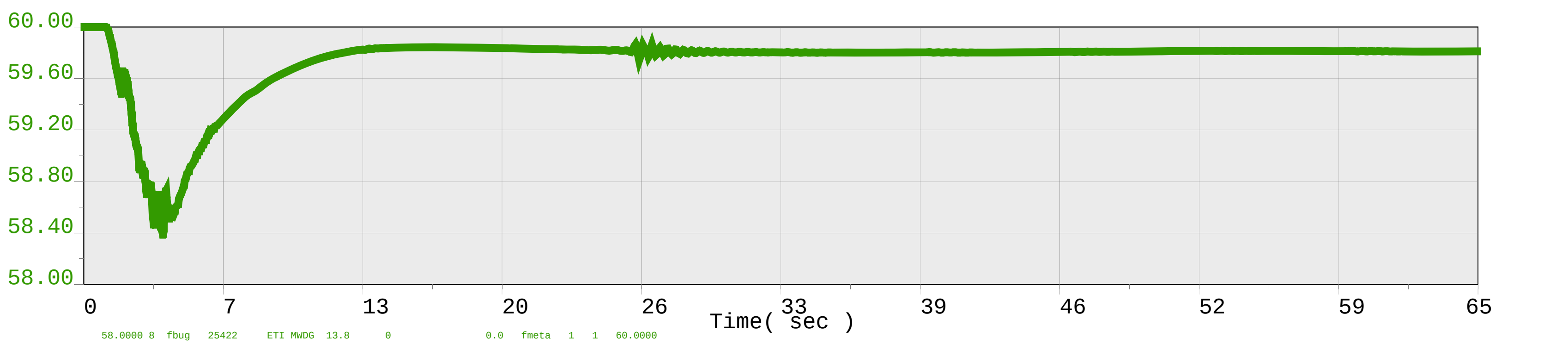
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 60 MVAR, which exceeds its Qmax (15 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY





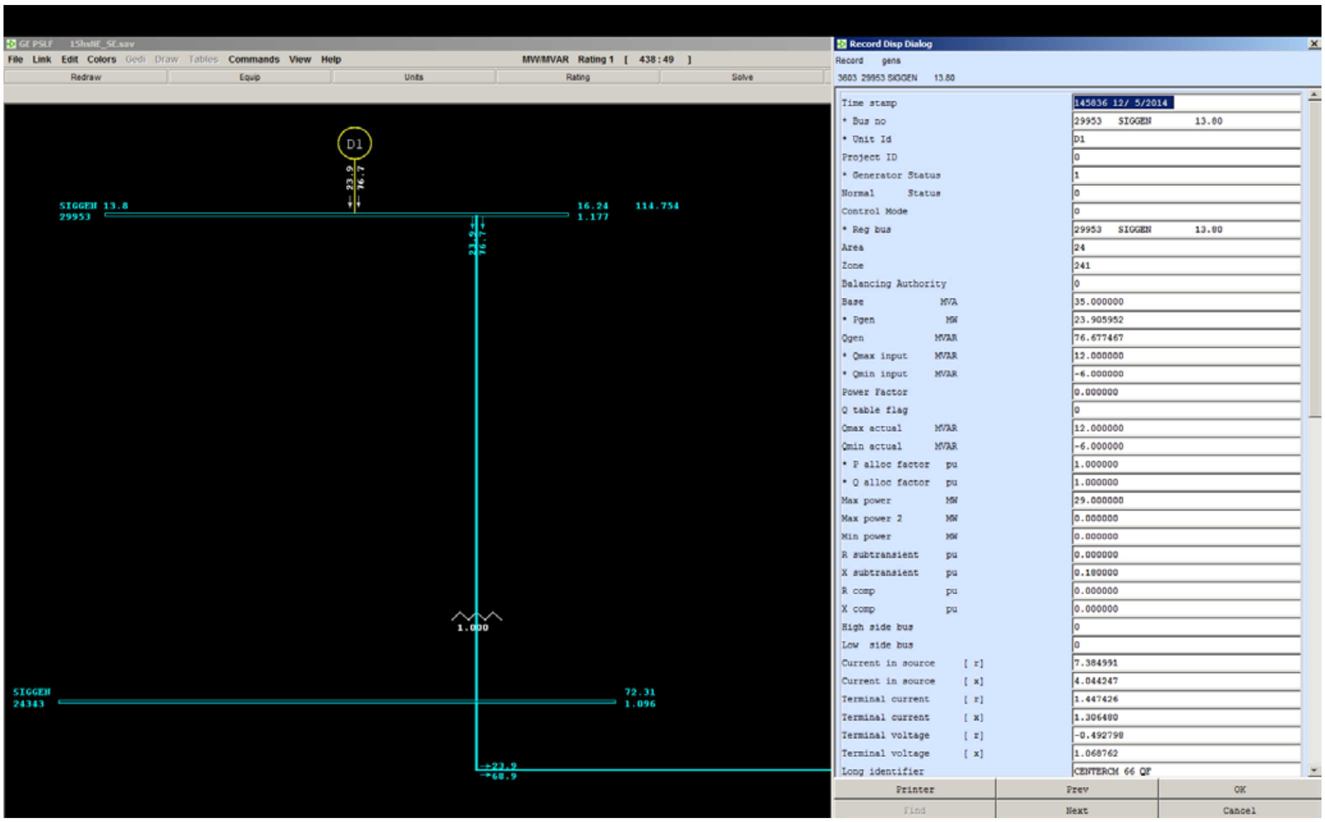


Unit ID:

SIGGEN

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

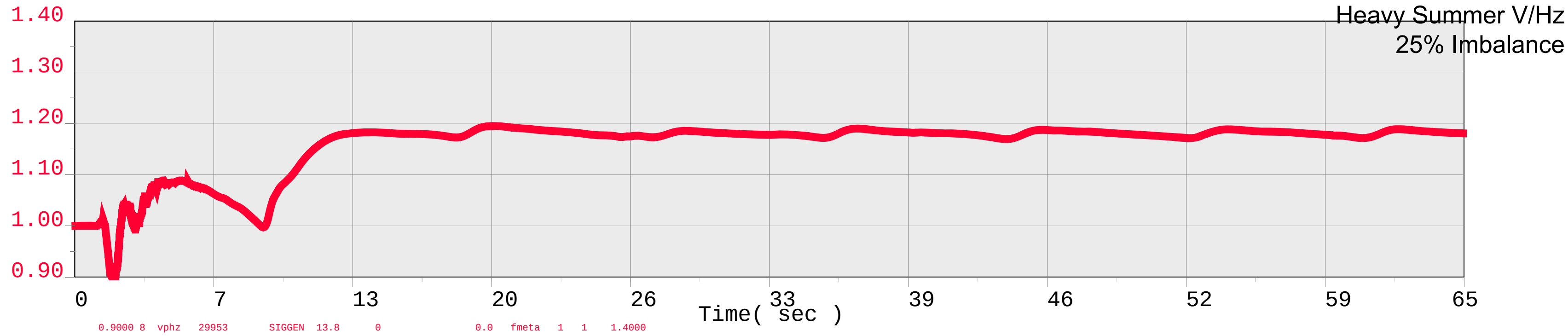


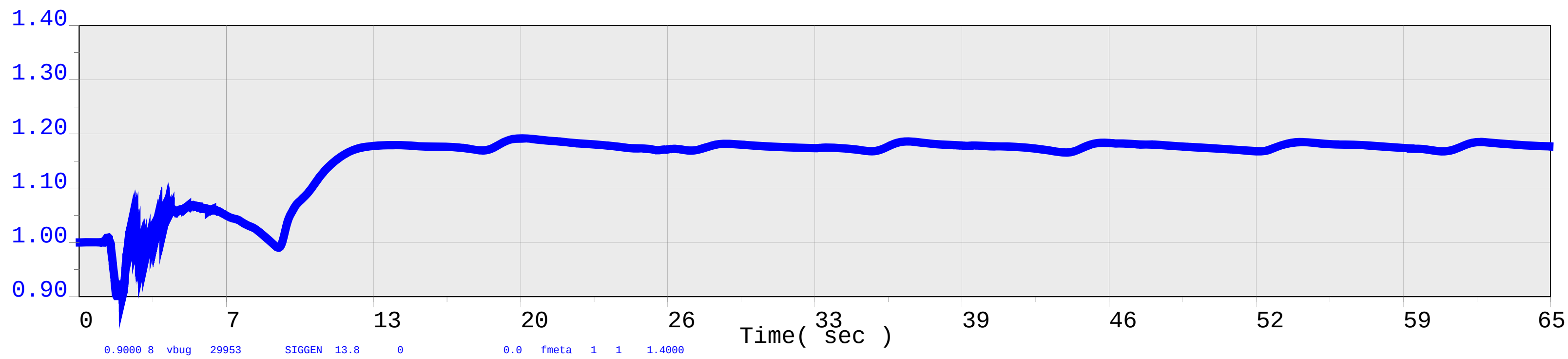
Likely Cause:

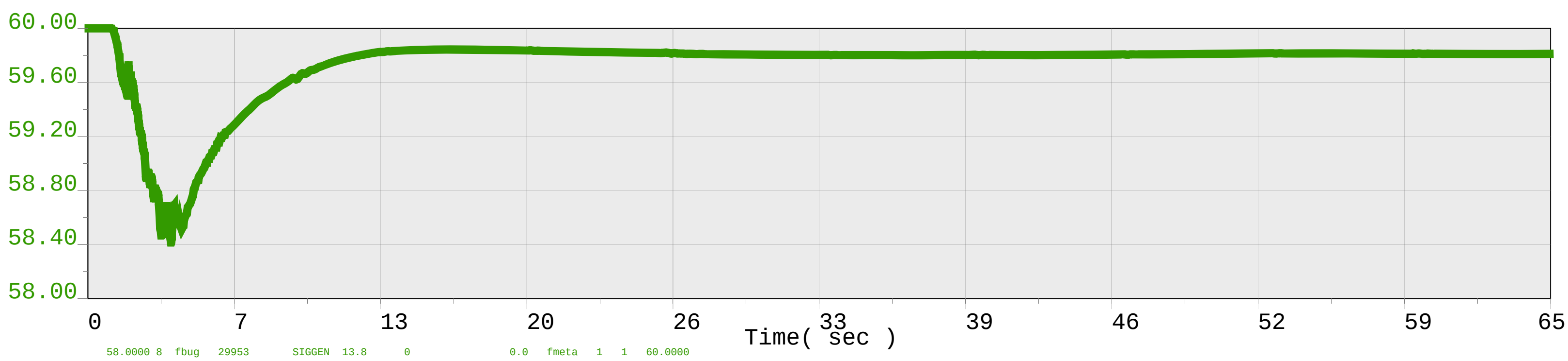
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 76 MVAR, which exceeds its Qmax (12 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





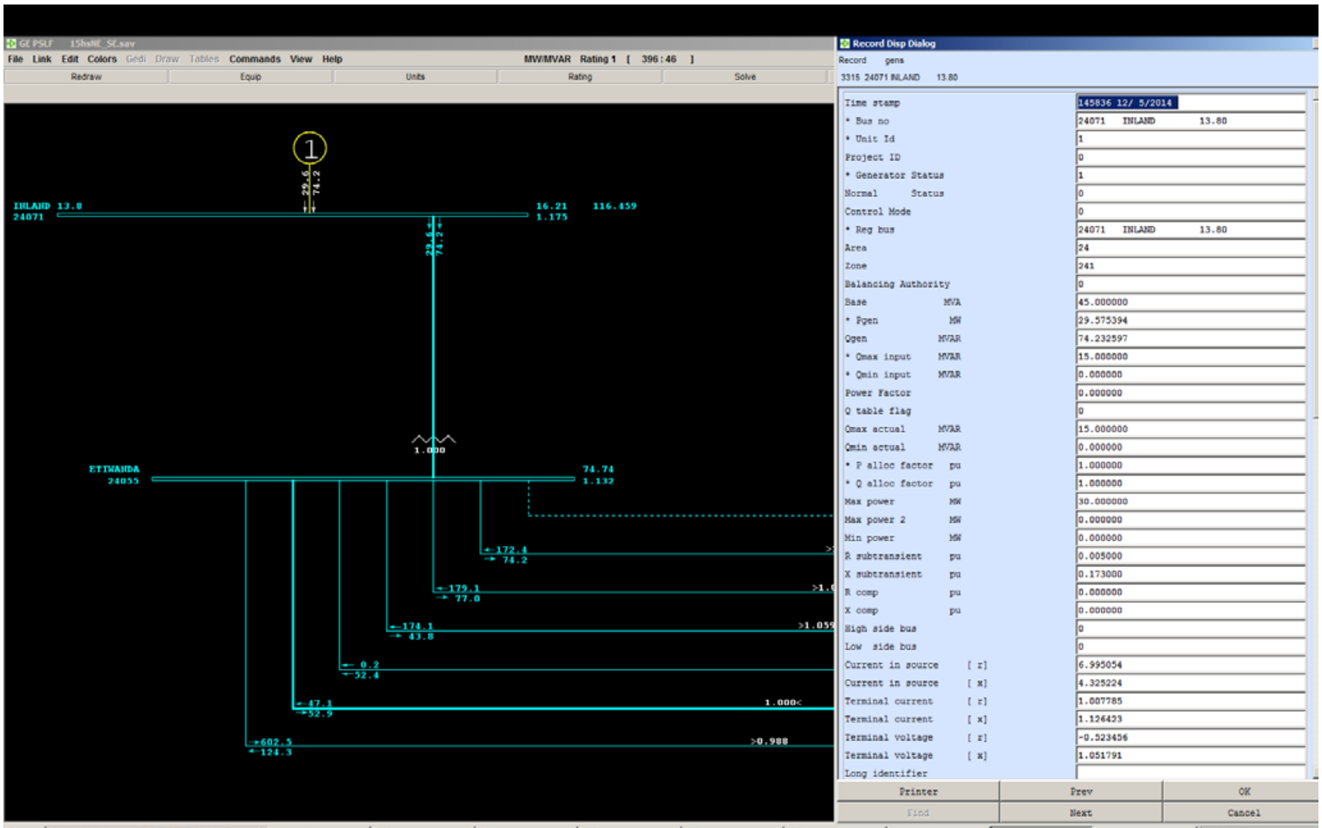


Unit ID:

- INLAND

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

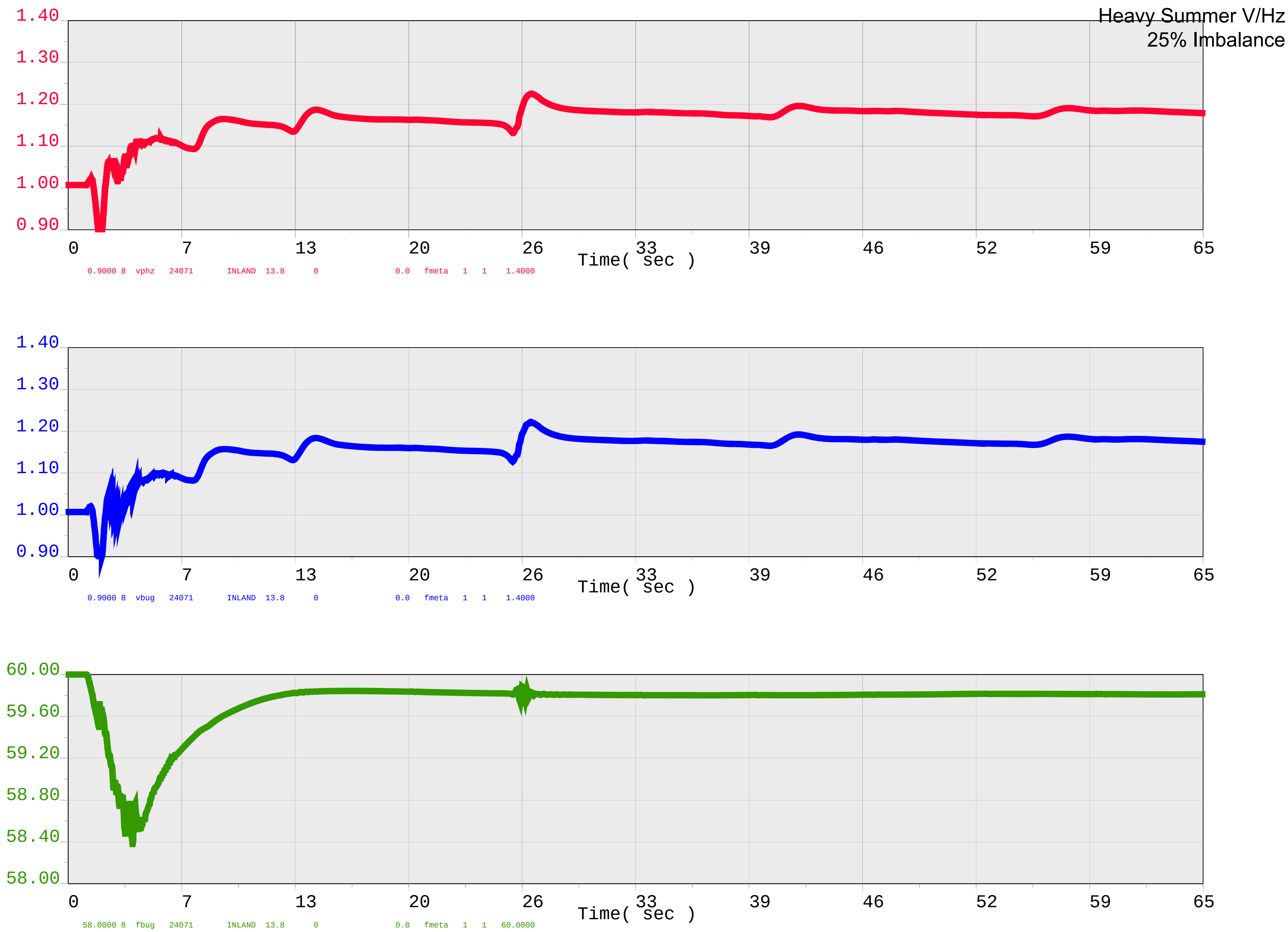


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 74 MVAR, which exceeds its Qmax (15 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

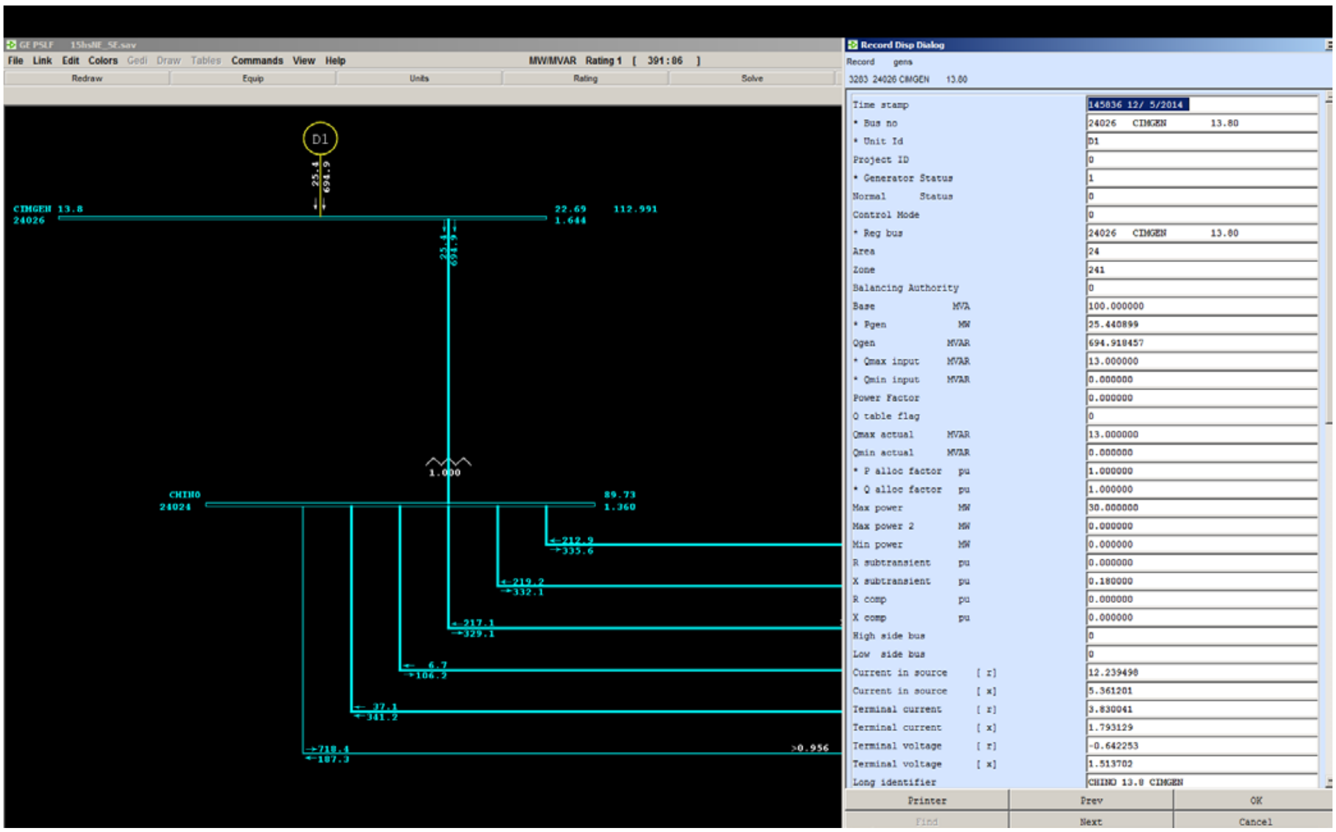


Unit ID:

- CIMGEN

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

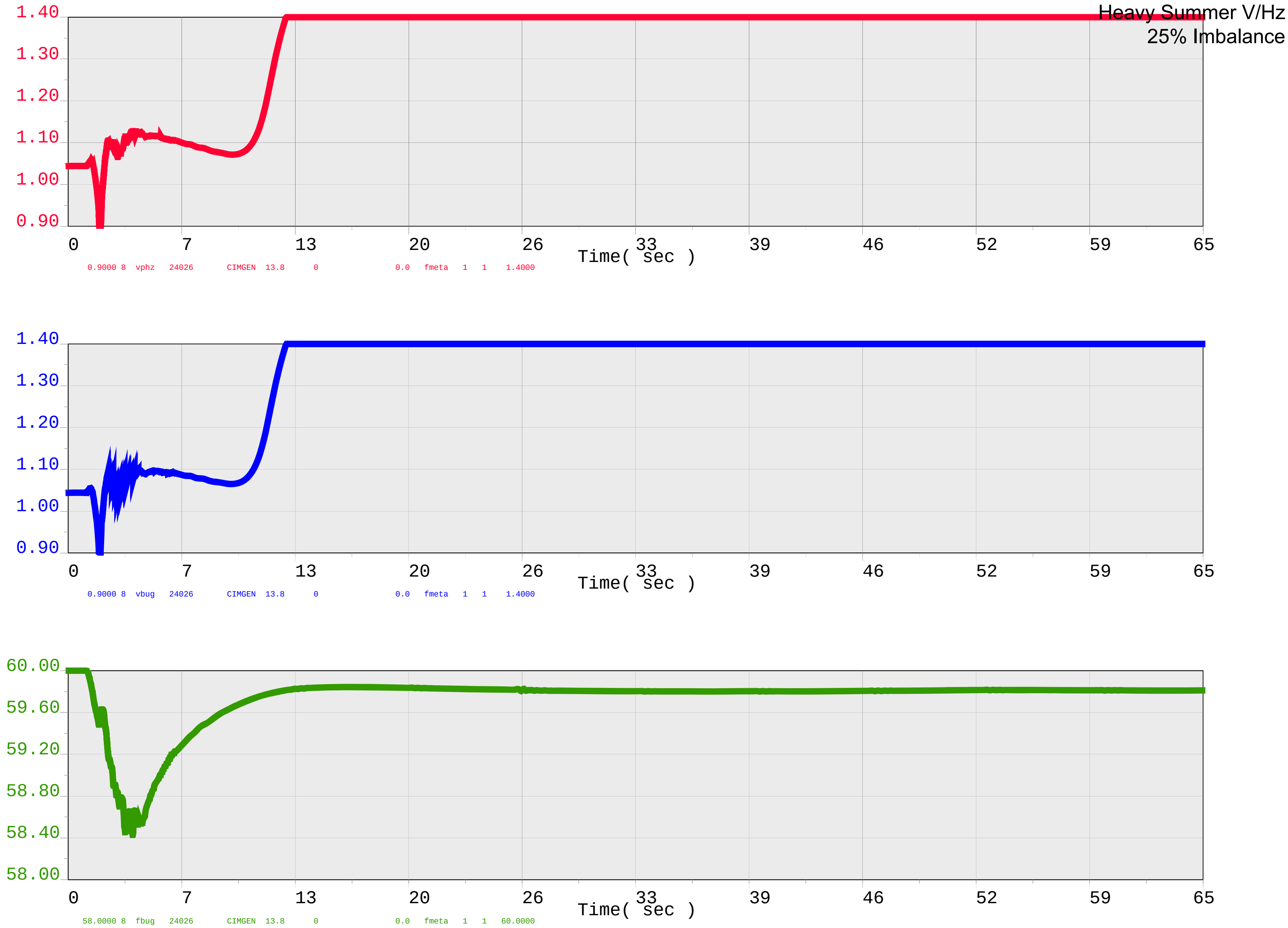


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 700 MVAR, which exceeds its Qmax (13 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

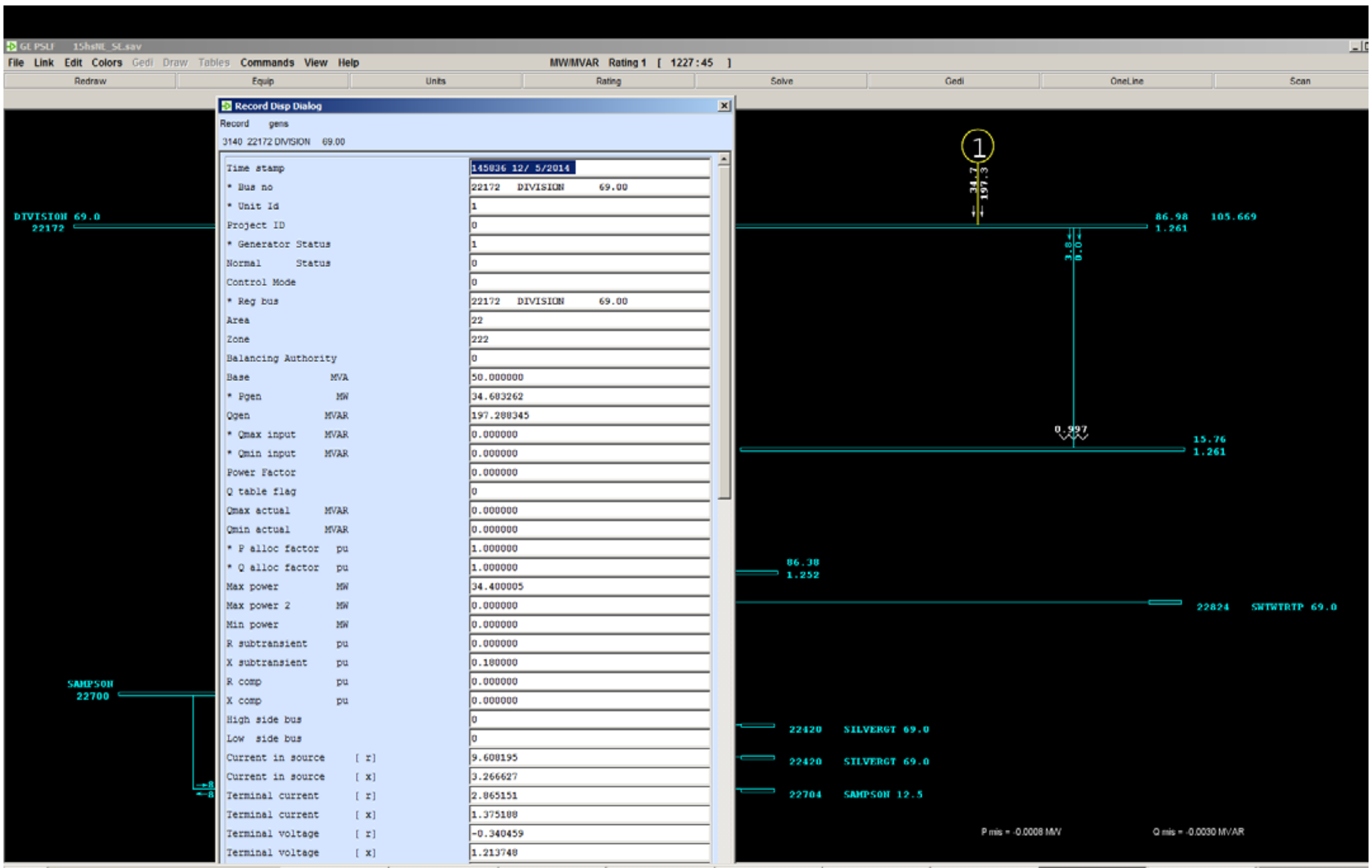


Unit ID:

- DIVISION

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

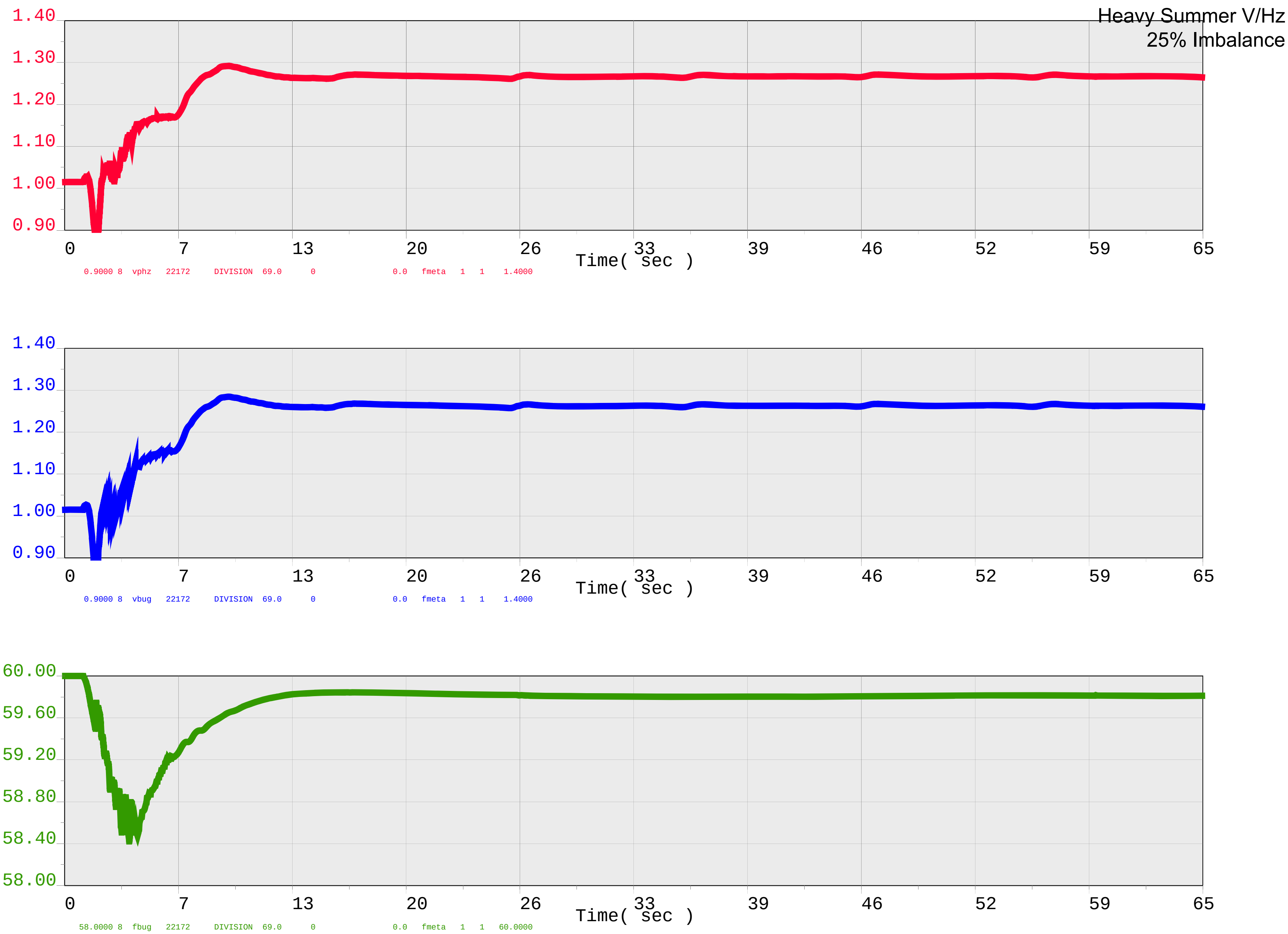


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 197 MVAR, which exceeds its Qmax (0 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

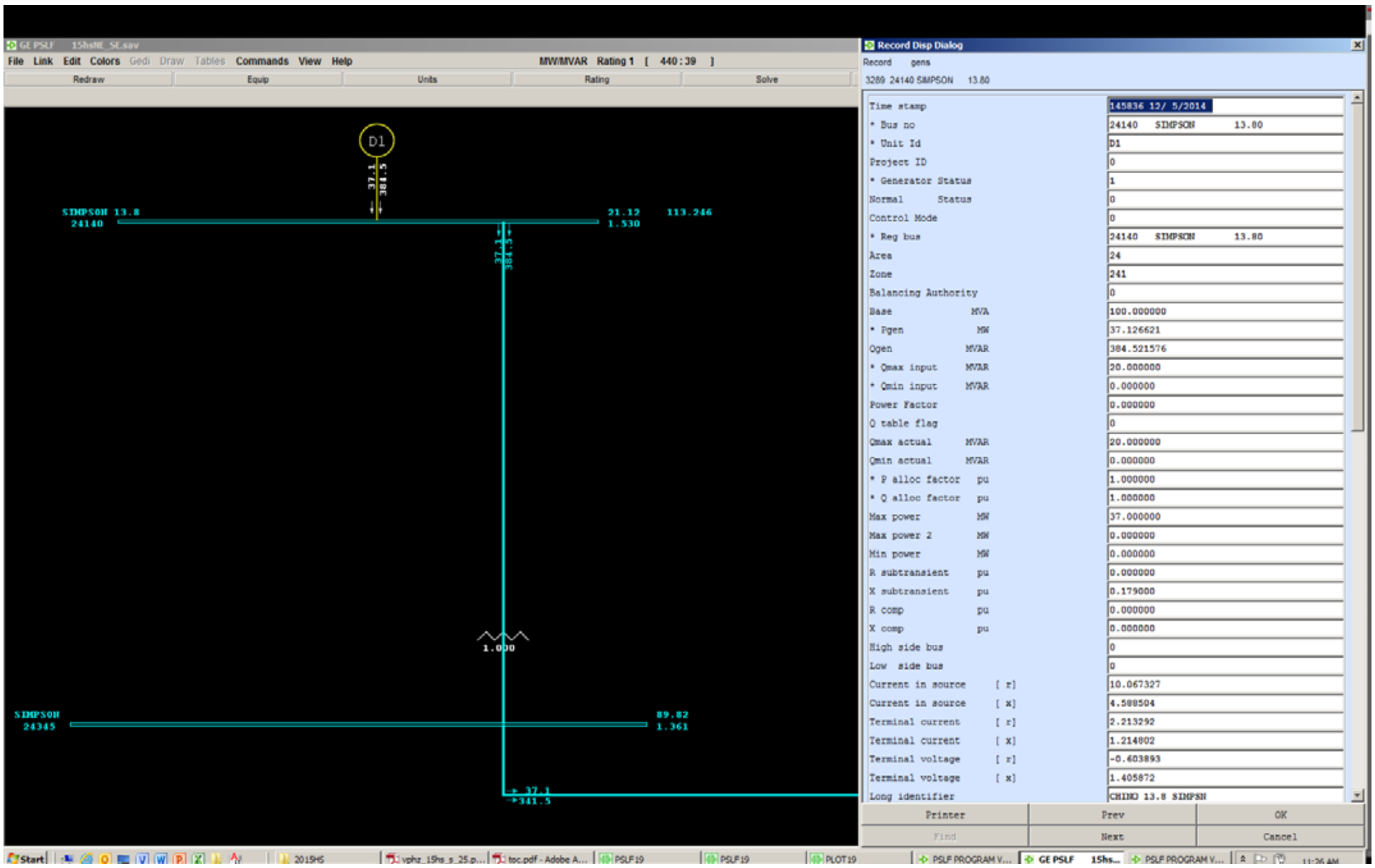


Unit ID:

SIMPSON

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

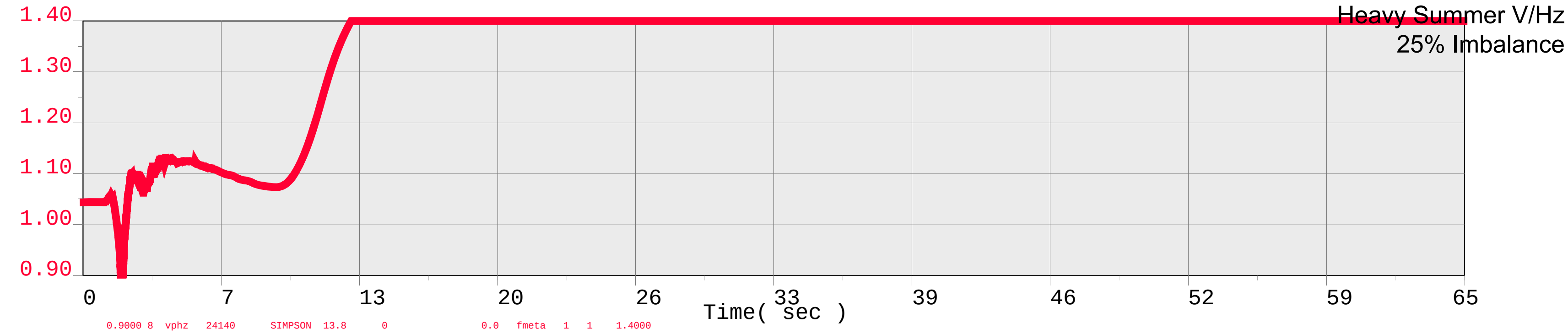


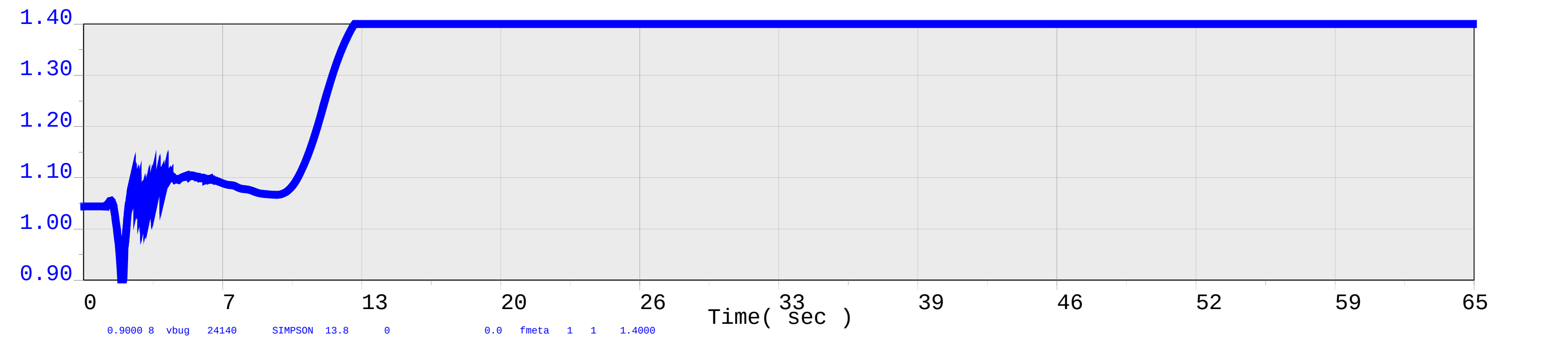
Likely Cause:

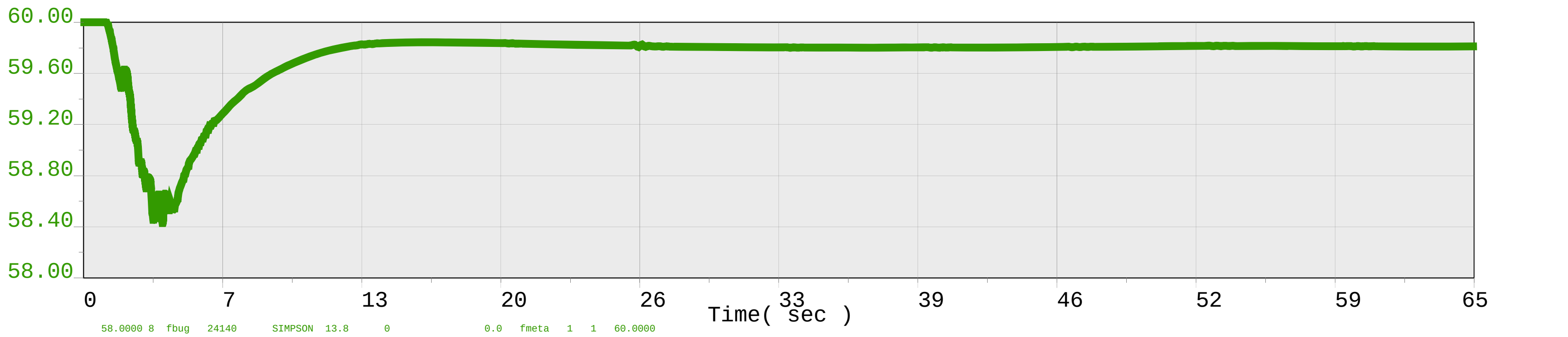
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 385 MVAR, which exceeds its Qmax (20 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





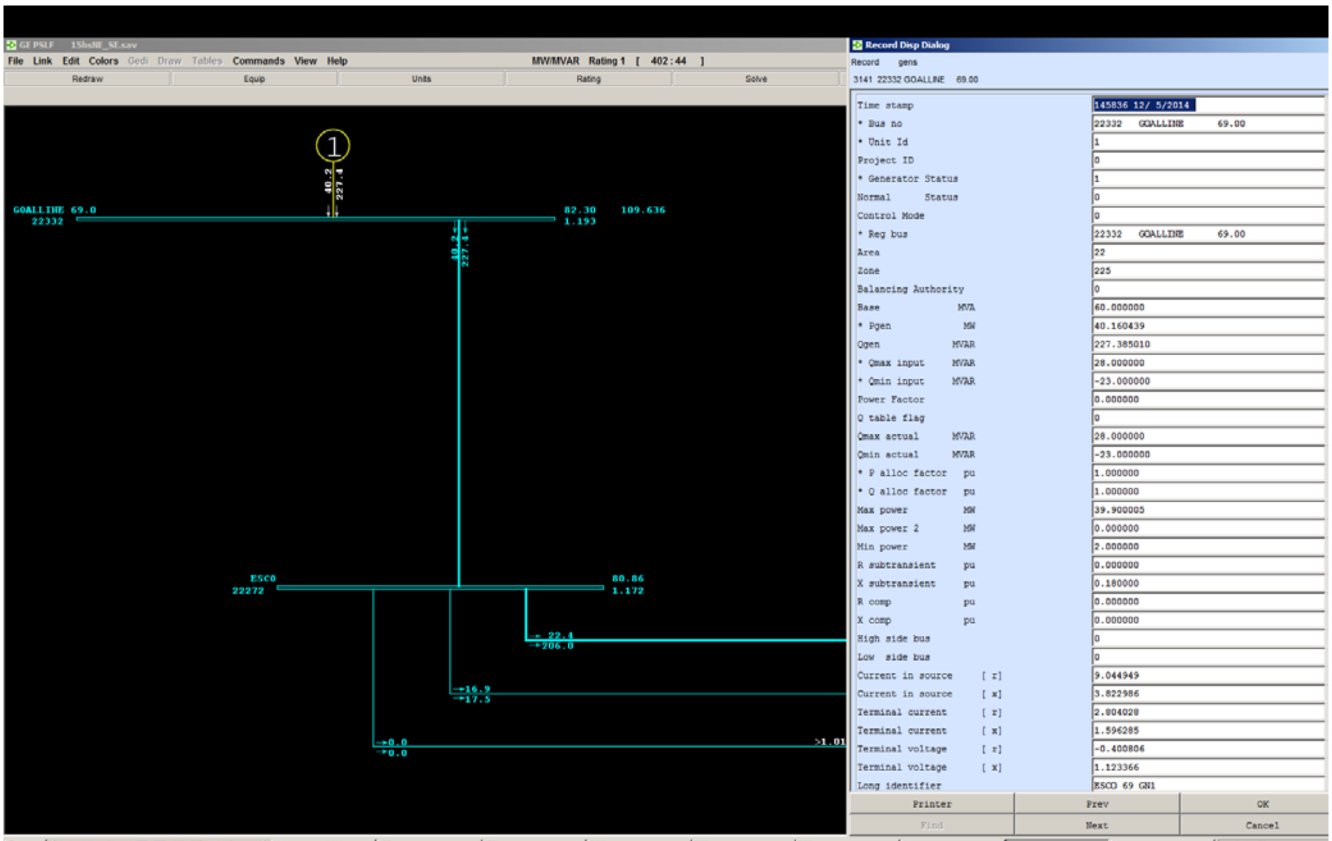


Unit ID:

- GOALLINE

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

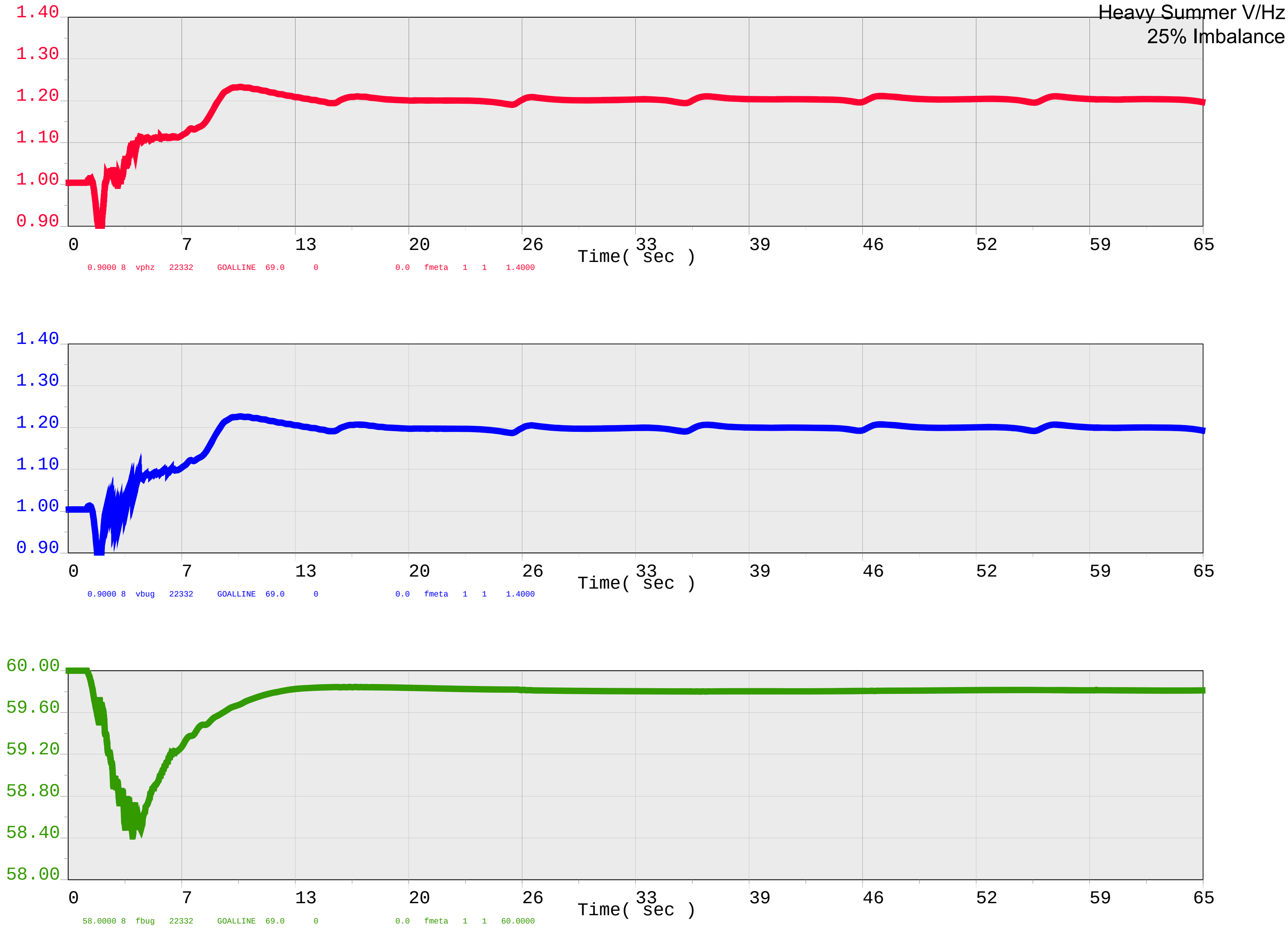


Likely Cause:

- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 227 MVAR, which exceeds its Qmax (20 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

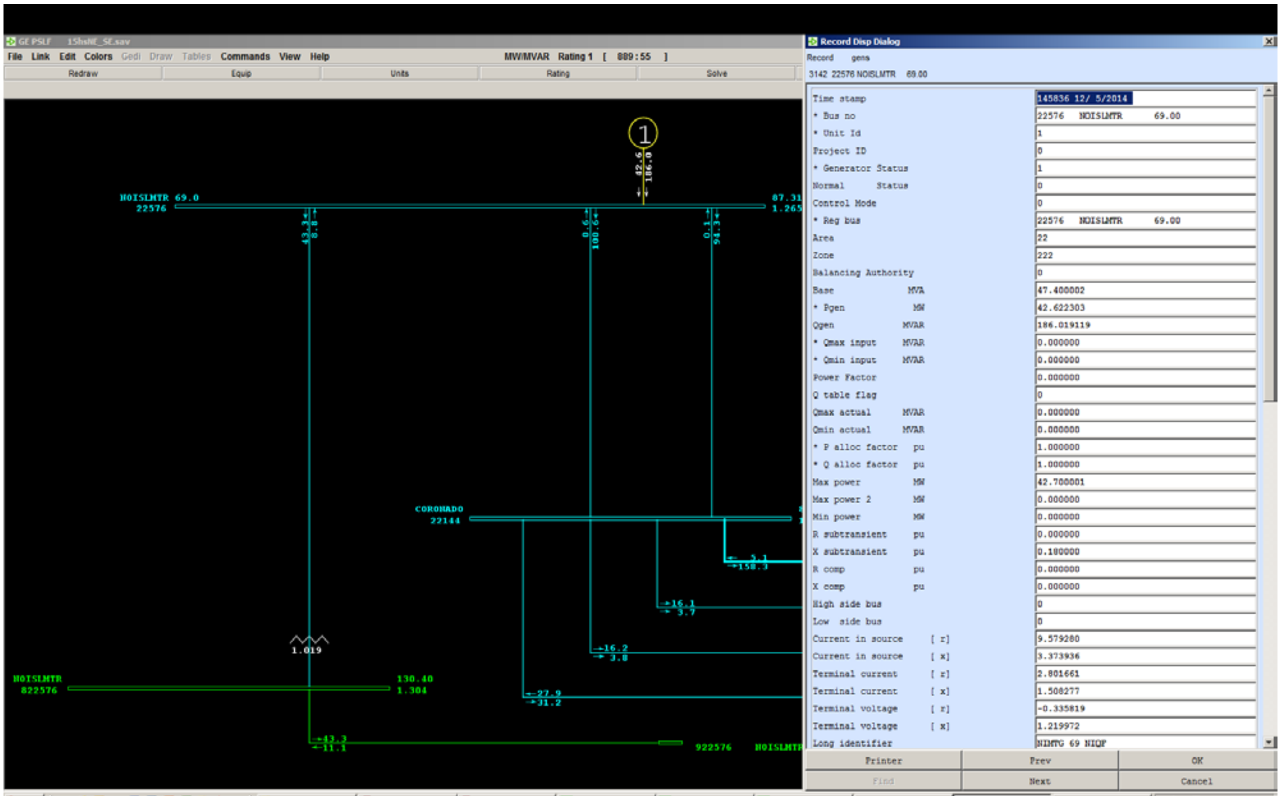


<u>Unit ID:</u>

- NOISLMTR

<u>Flagged Potential Violation:</u>

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.

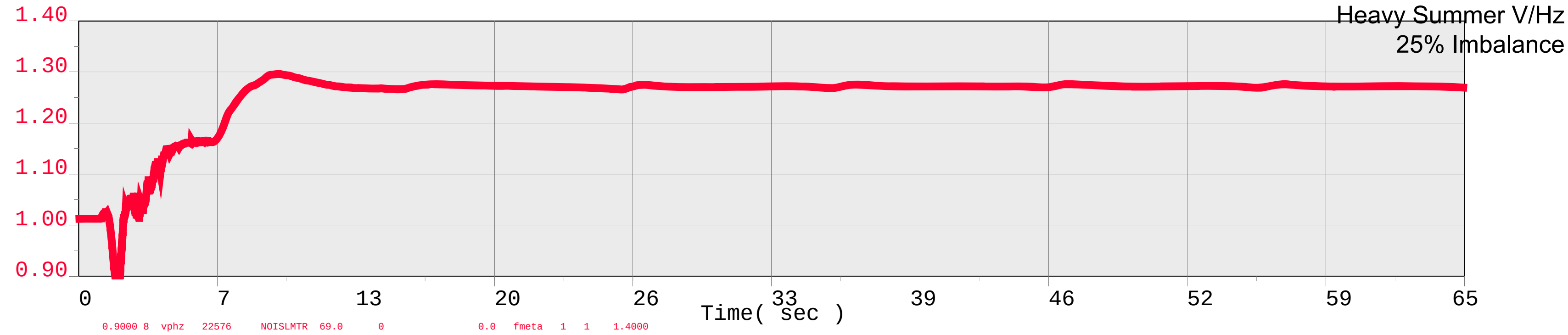


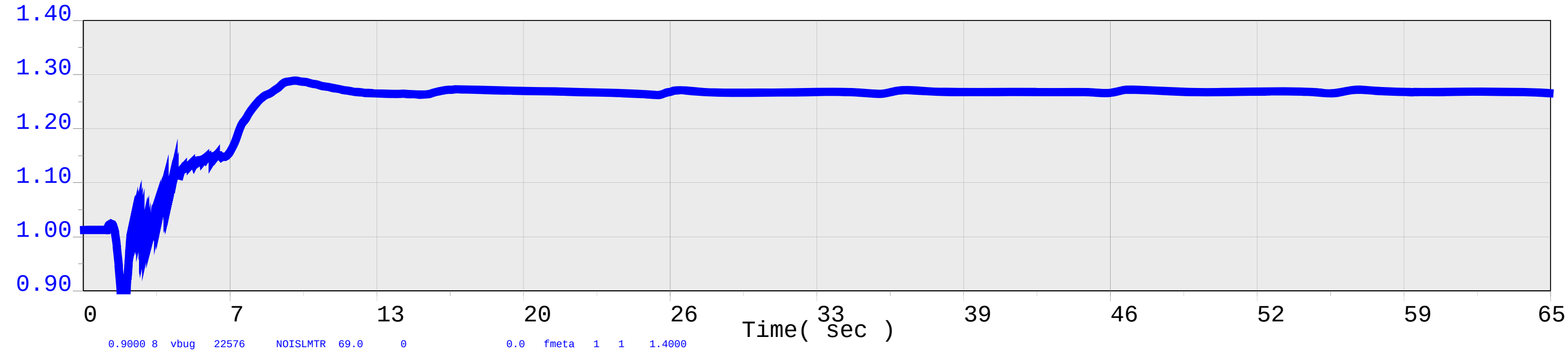
<u>Likely Cause:</u>

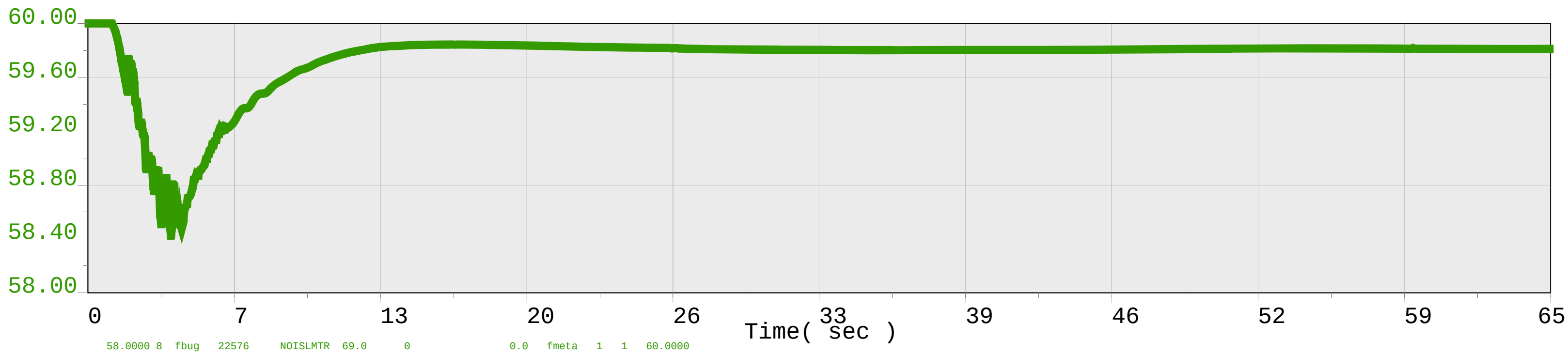
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating 186 MVAR, which exceeds its Qmax (20 MVAR).
- Suspect incorrect exciter model performance as the model should not allow this.

<u>Issue deemed not caused by UFLS program shortfalls.</u>

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA





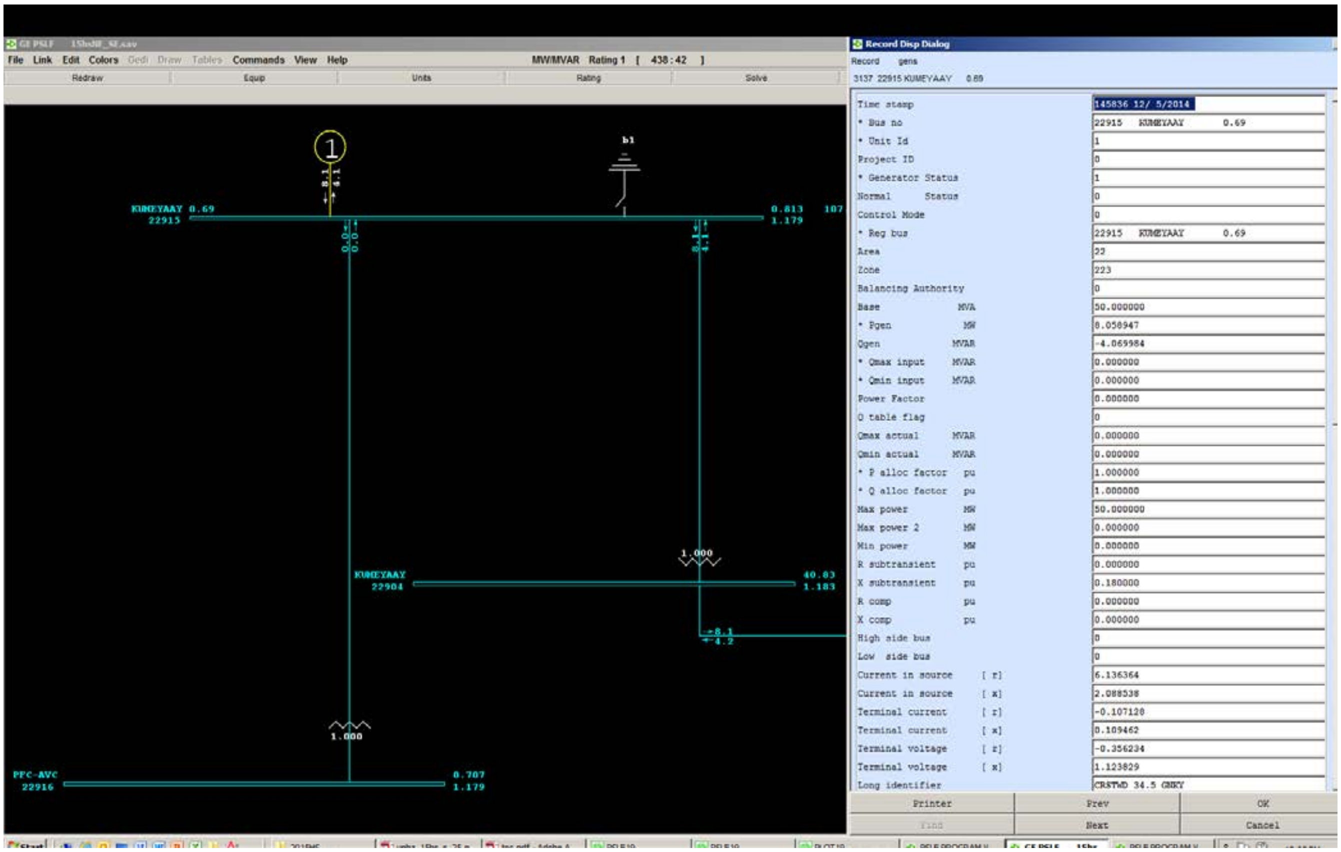


Unit ID:

- KUMEYAAY

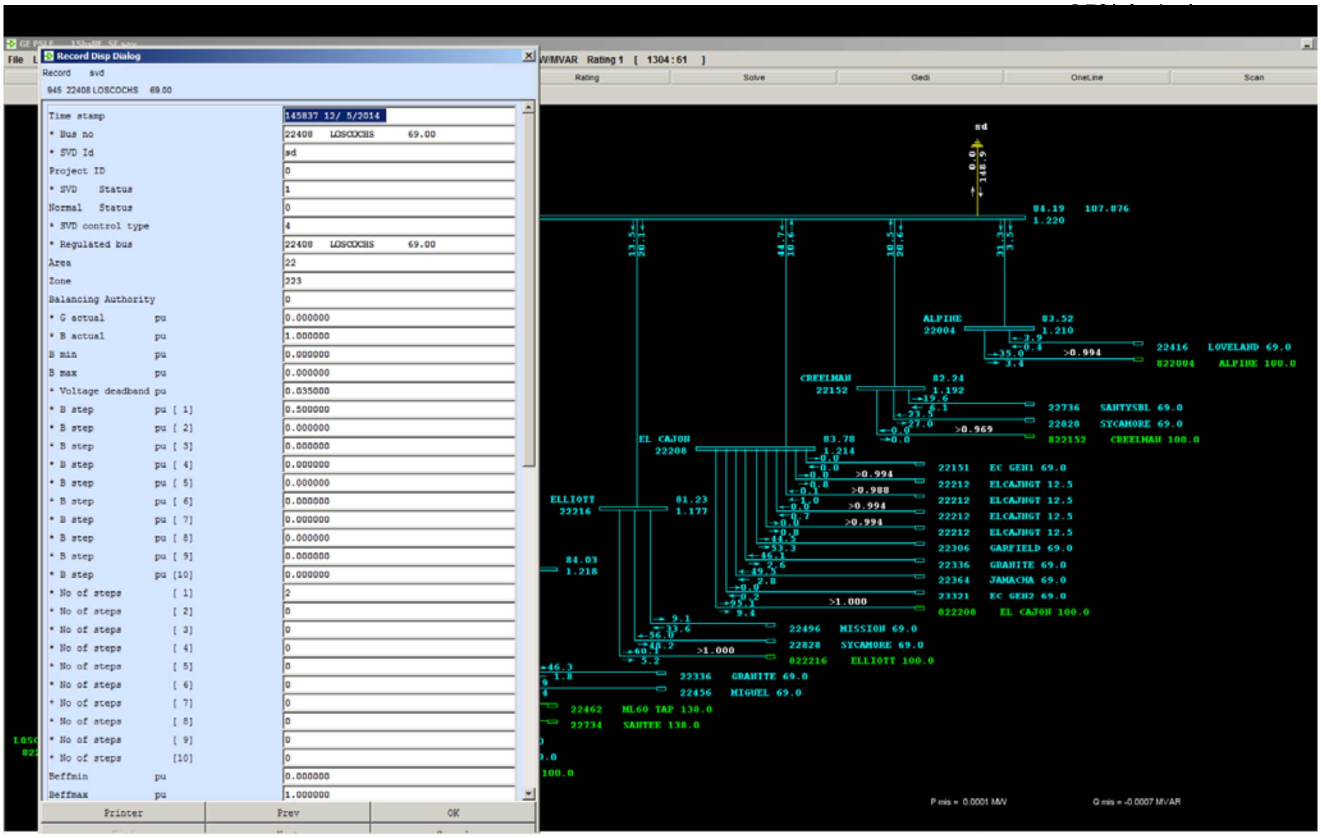
Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds and 1.1 for longer than 45 seconds.



Likely Cause:

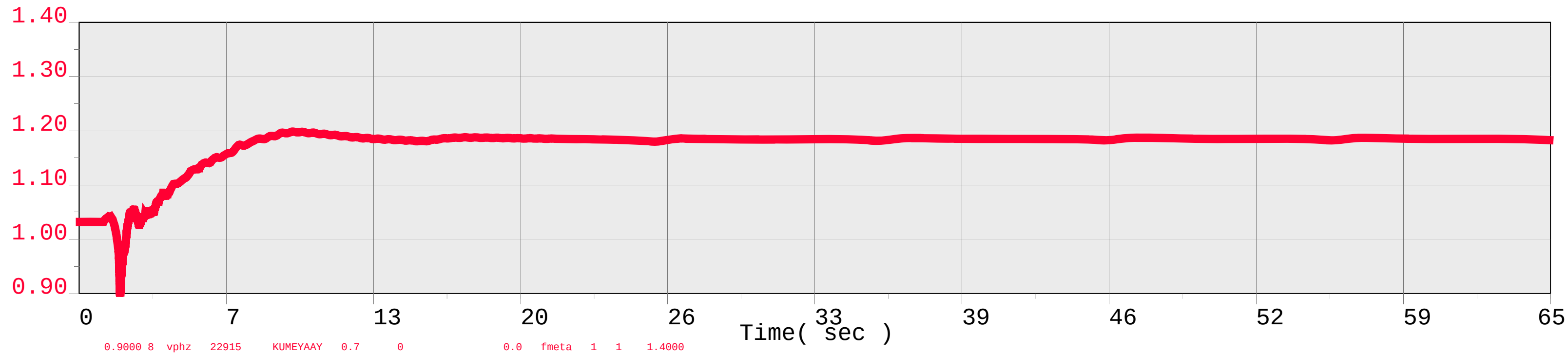
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating -4.1 MVAR, which is normal.
- An SVD at a nearby bus (22408) is outputting significant of VARs holding its bus voltage to 1.22 pu (diagram below). This caused Kumeyaay voltage to be very high
- Suspect incorrect SVD model performance as the model should not allow this.

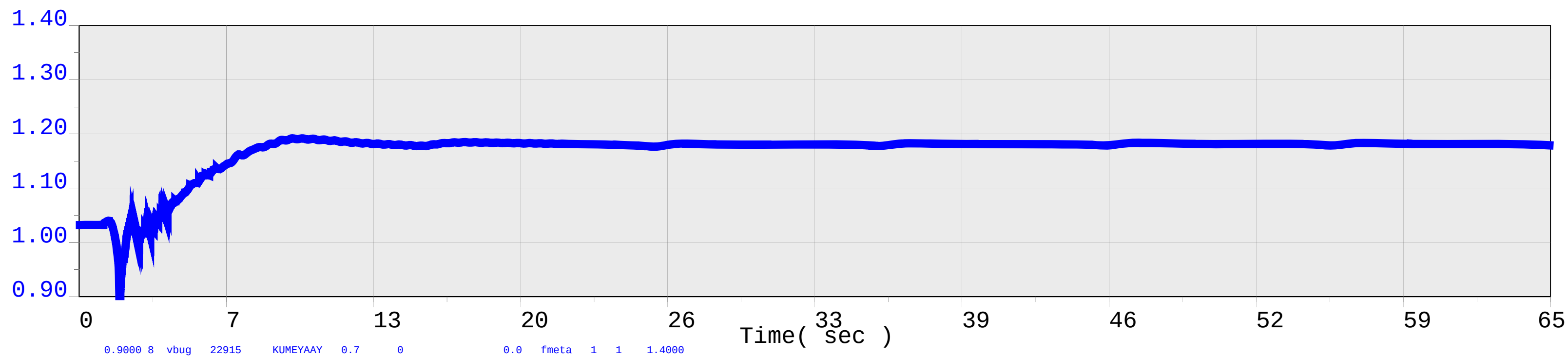


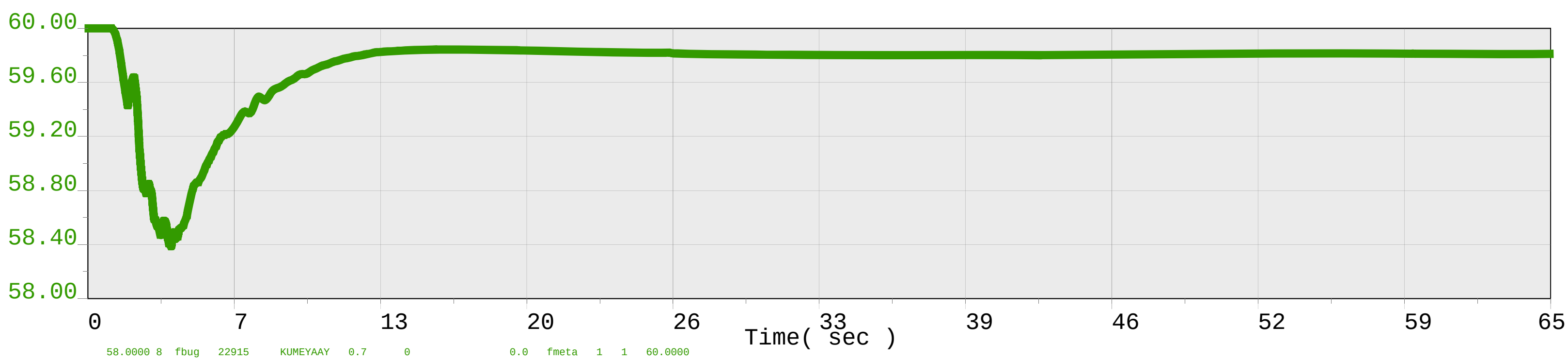
Issue deemed not caused by UFLS program shortfalls.

VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

Heavy Summer V/Hz
25% Imbalance





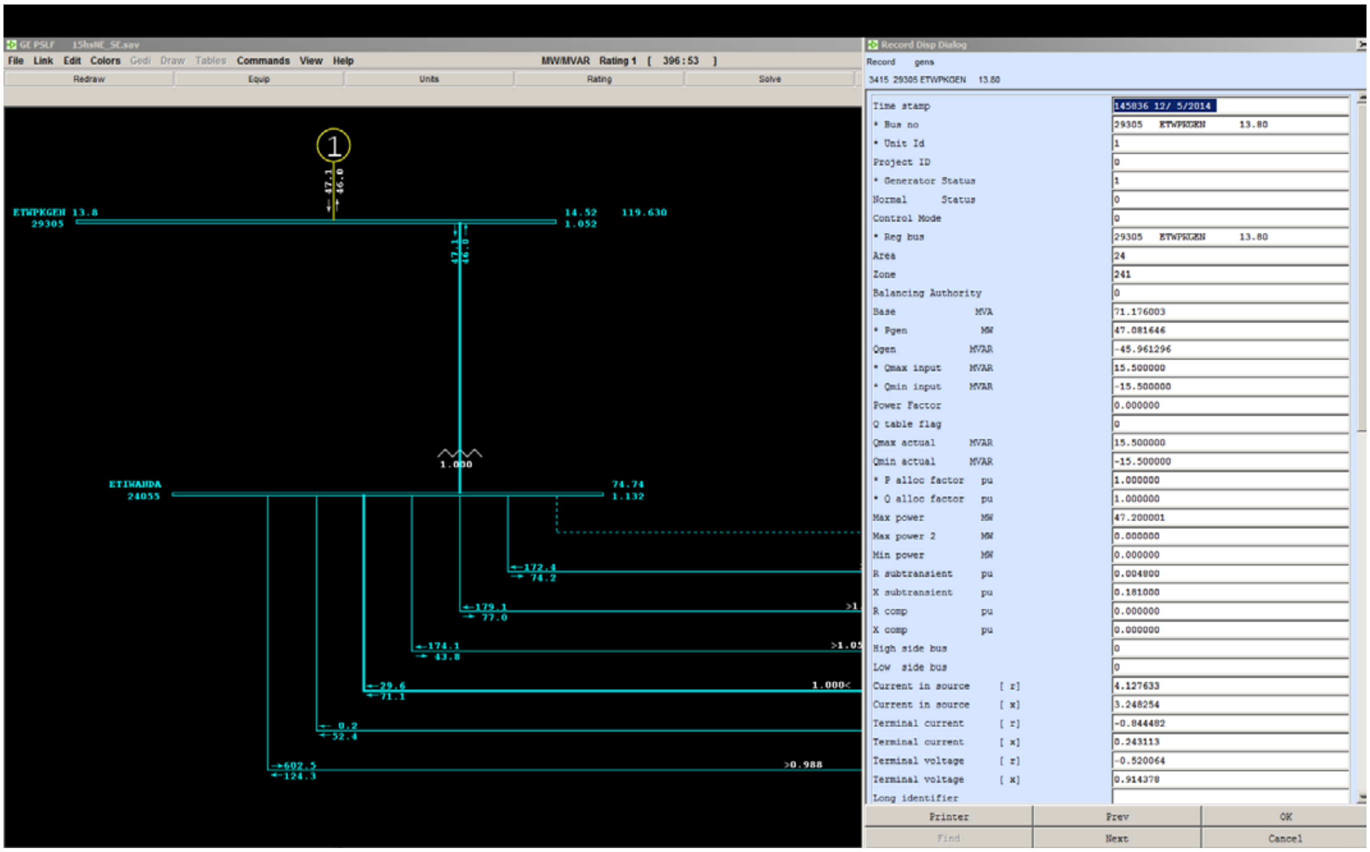


Unit ID:

- ETWPKGEN

Flagged Potential Violation:

- V/Hz measurement on the bus to which the unit is connected exceeds 1.18 for longer than 2 seconds.



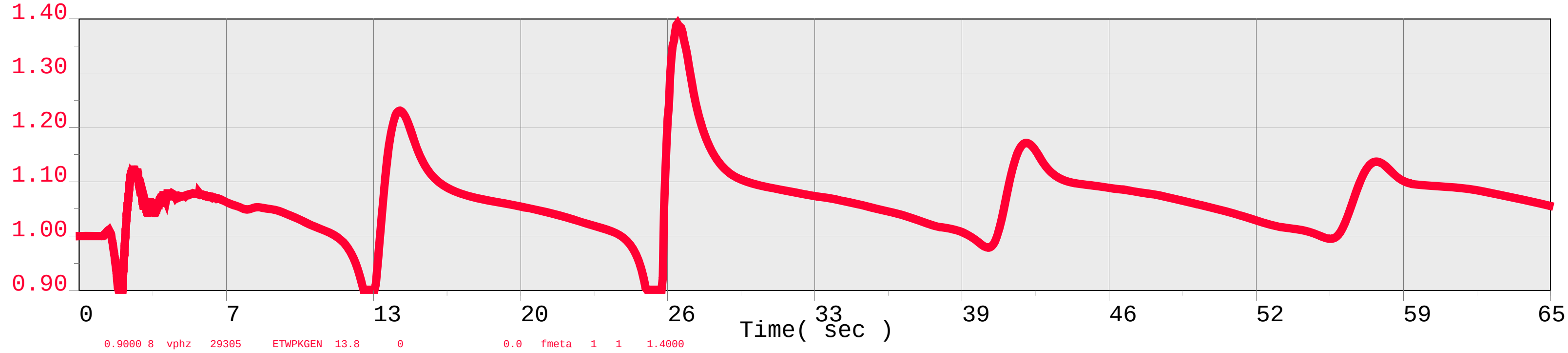
Likely Cause:

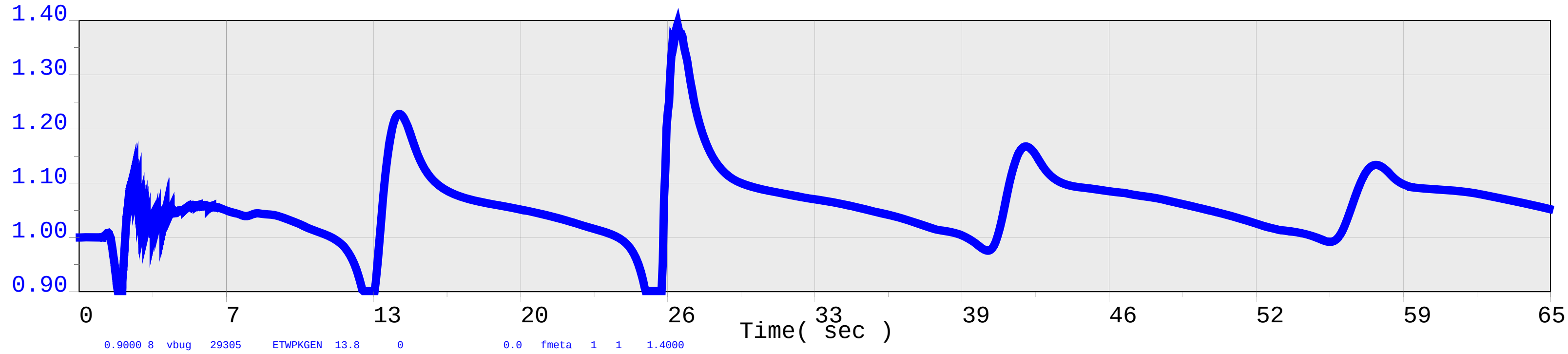
- Diagram above shows generator status at the conclusion of a 65 second, 25% generation loss simulation.
- The unit is generating expected VARs.
- This unit is very close to other units (INLAND, ETI MWDG) and loads (ETIWANDA) that are contributing significant VARs to the system, raising general voltage levels.
- Violation due to high voltages caused by peculiar and likely inaccurate model responses.

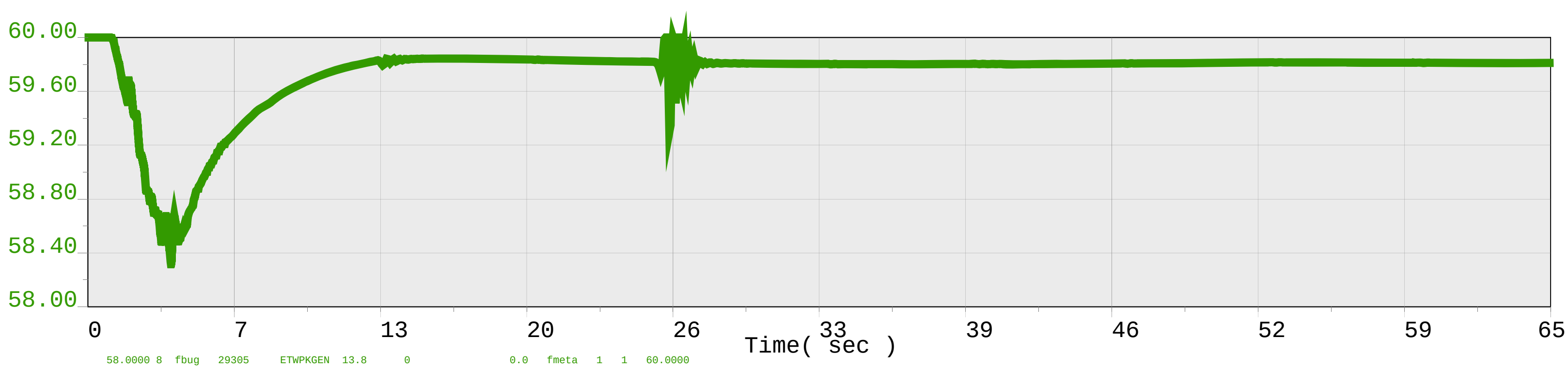
Issue deemed not caused by UFLS program shortfalls.

VIOLATES 1.18 V/Hz CRITERIA ONLY

Heavy Summer V/Hz
25% Imbalance

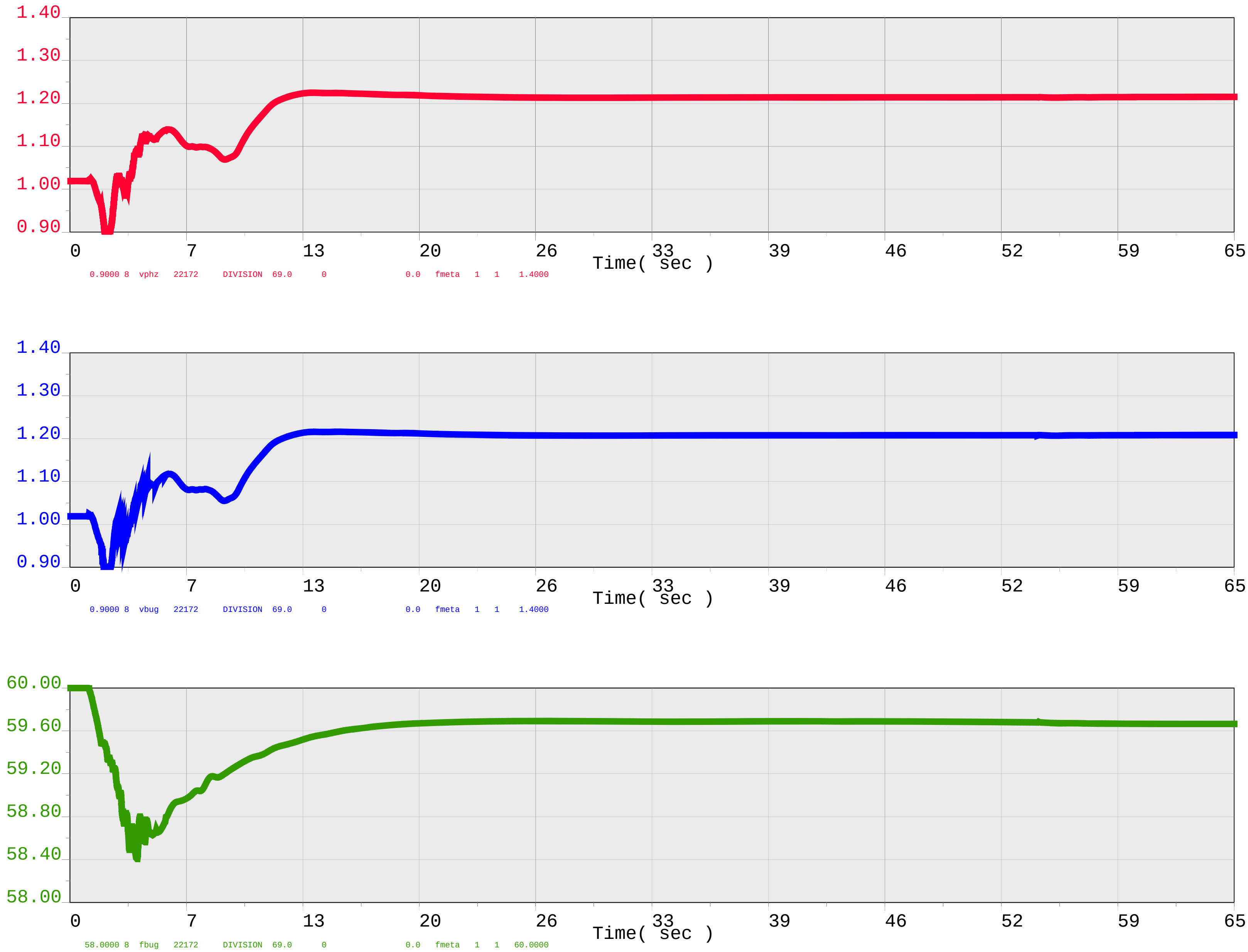






VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

Heavy Spring V/Hz
25% Imbalance



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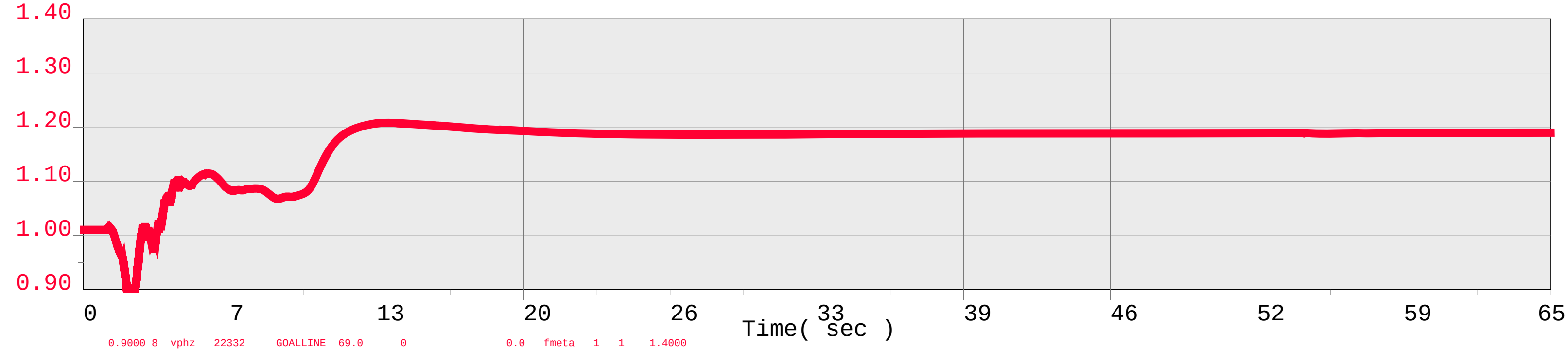
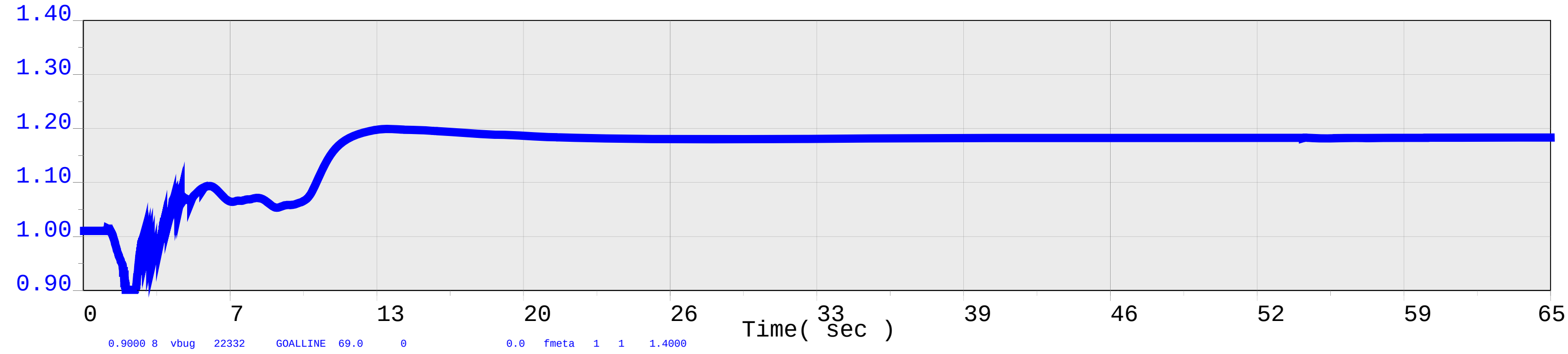
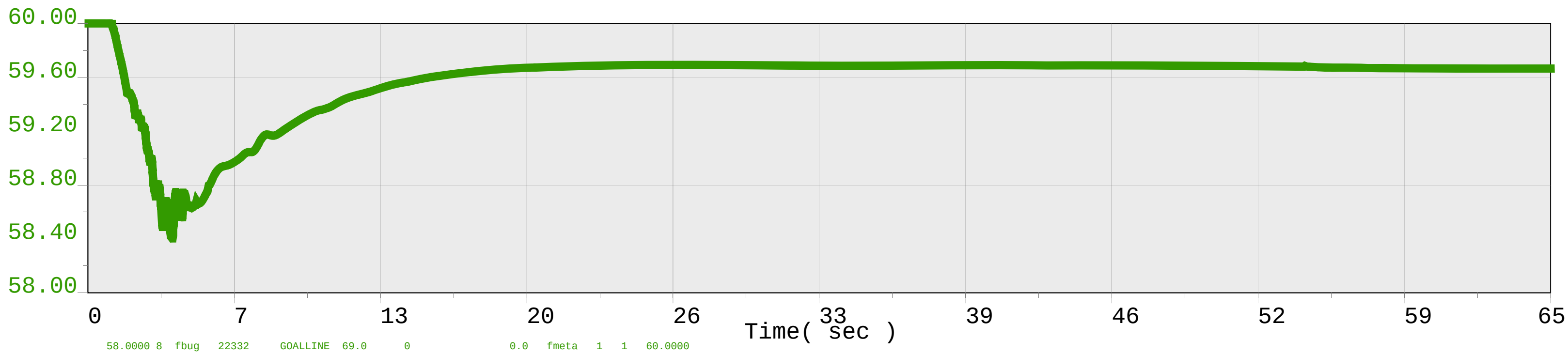
VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

Heavy Spring V/Hz
25% Imbalance

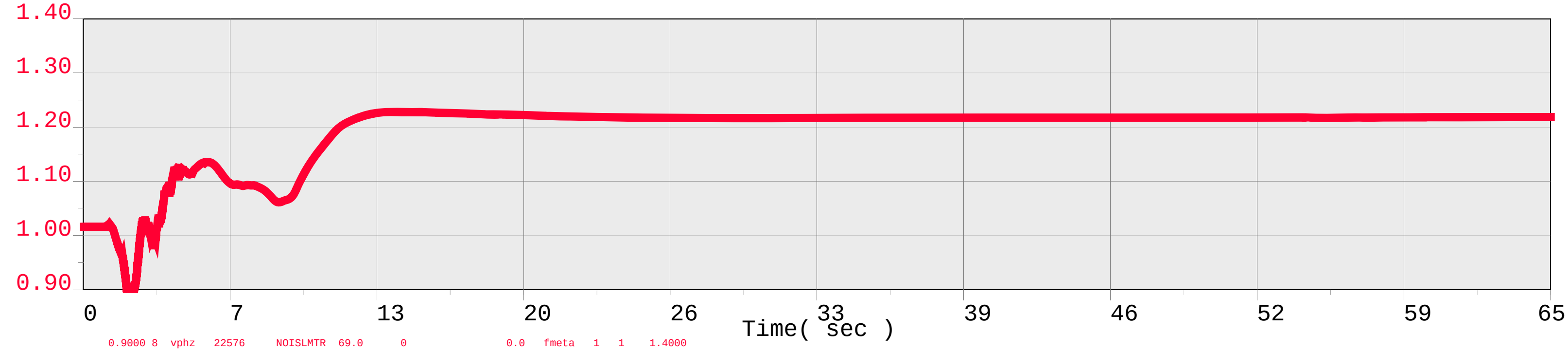


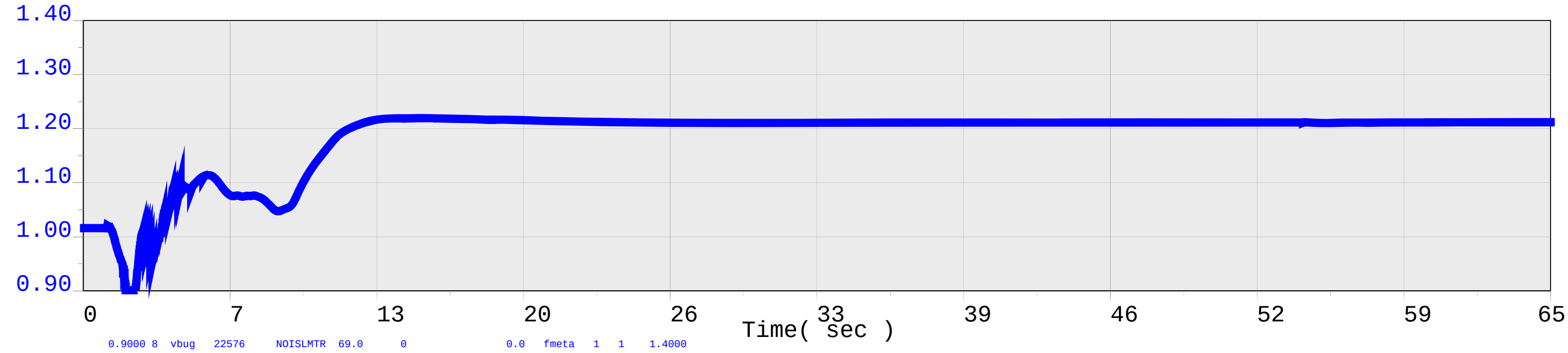


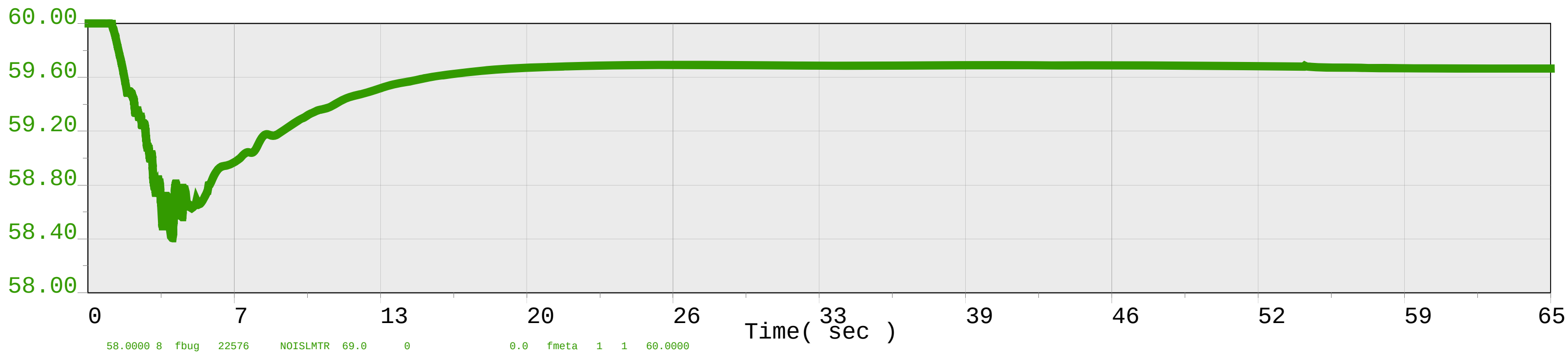


VIOLATES BOTH 1.18 AND 1.10 V/Hz CRITERIA

Heavy Spring V/Hz
25% Imbalance

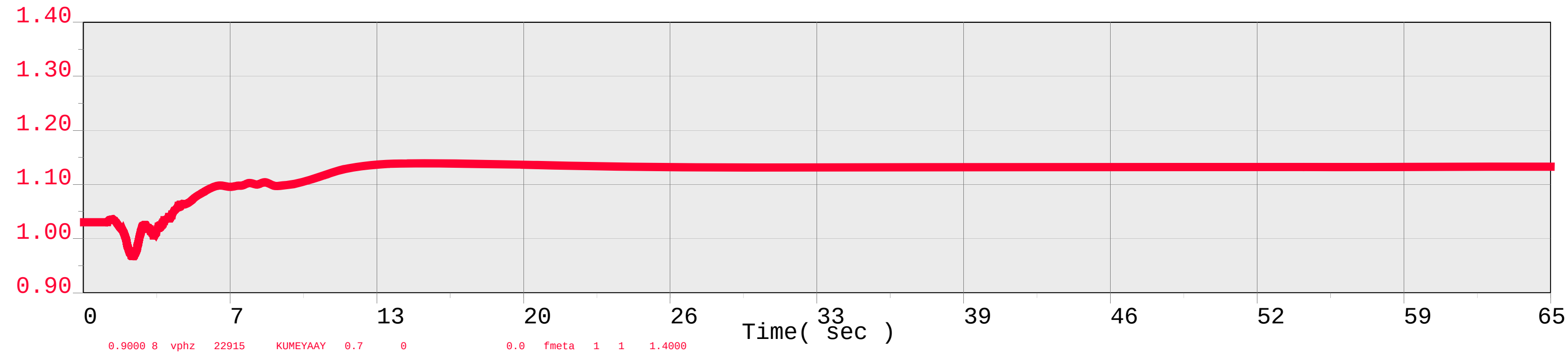


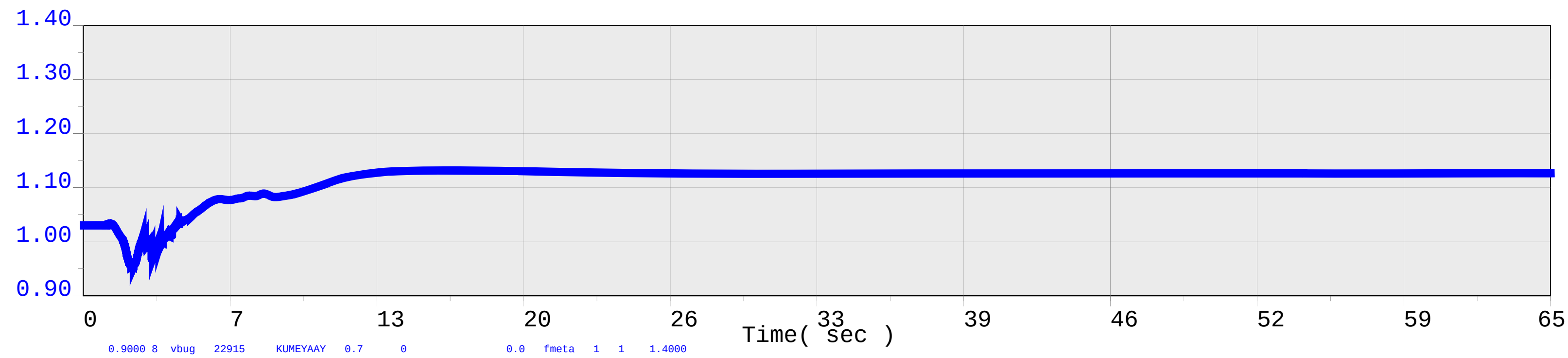


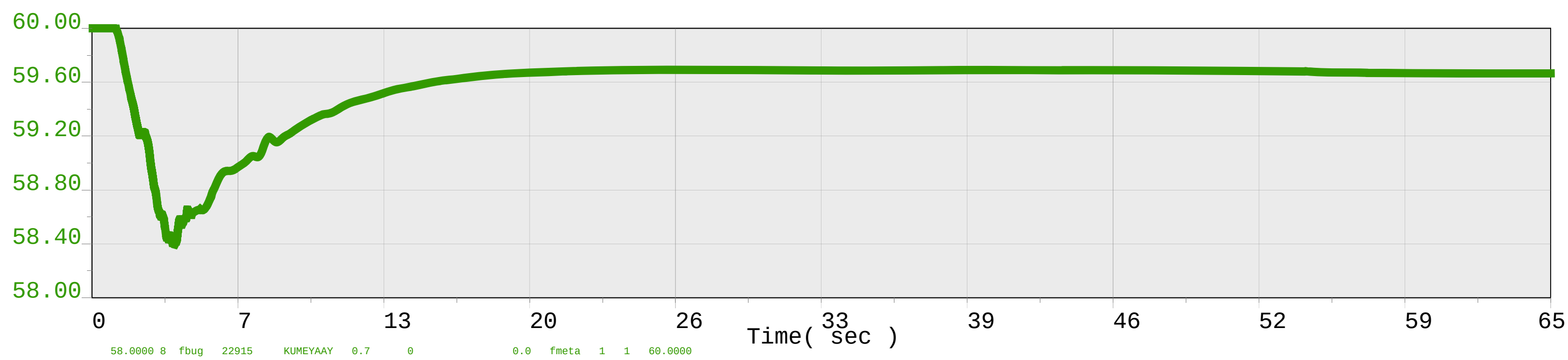


VIOLATES 1.10 V/Hz CRITERIA ONLY

Heavy Spring V/Hz
25% Imbalance







Document name	UFLS Review Group Charter
Category	( ) Regional Reliability Standard ( ) Regional Criteria ( ) Policy ( ) Guideline ( ) Report or other (X) Charter
Document date	May 30, 2013
Adopted/approved by	Joint Guidance Committee
Date adopted/approved	May 30, 2013
Custodian (entity responsible for maintenance and upkeep)	UFLS Review Group
Stored/filed	Physical location: Web URL:
Previous name/number	(if any)
Status	(X) in effect ( ) usable, minor formatting/editing required ( ) modification needed ( ) superseded by ________________________ ( ) other _________________________________ ( ) obsolete/archived

UFLS Review Group

Charter

Revised May 30, 2013

Establishment and Authority

The Under-Frequency Load Shedding Review Group (UFLSRG) is a member review group established by the Joint Guidance Committee (JGC).

Purpose/Responsibilities

The purpose of the UFLSRG is to annually review the WECC Off-Nominal Frequency Load Shedding Plan (Plan) to help WECC Members meet their compliance obligation to evaluate the Plan's consistency in accordance with Reliability Standard PRC-006.

The UFLSRG shall:

a. Annually review the Plan's consistency with the requirements of PRC-006.
b. Conduct annual simulations of the Plan to assess consistency with the performance requirements of PRC-006.
c. Review the submitted UFLS data for consistency and accuracy of modeling.
d. Collaborate with all applicable entities to develop an annual report of the findings of the review and simulations.

Composition and Governance

1. *Membership*

a. The UFLSRG shall be comprised of WECC member representatives and is open to all interested WECC member organizations.
b. UFLSRG representatives shall not be marketing function employees.

2. Leadership

a. The chair of the JGC shall appoint one of the UFLSRG members to serve as the UFLSRG's chair, and one to serve as vice chair. The UFLSRG chair shall appoint a secretary.

b. The UFLSRG chair shall manage the review group and its meetings.

c. The vice chair shall perform the duties of the chair in the chair's absence or in the event of a vacancy in the office of chair.

d. The secretary shall prepare minutes of UFLSRG meetings for the review group's approval.

3. Meetings

a. The UFLSRG shall meet in accordance with the WECC Meeting Policy. The UFLSRG shall meet at least twice per year and as often as necessary to carry out its responsibilities.

b. The UFLSRG shall determine the procedures for its meetings, except:

   i. A quorum for meetings is not required.

   ii. Action taken by the UFLSRG shall require a majority vote of those members present.

   iii. UFLSRG meetings may be in person or by conference call, as determined by the chair.

c. The chair (or designee) shall provide email notice of the time and place of all meetings to each member of the UFLSRG, no later than three days prior to each meeting. An agenda of the items for which action may be taken shall be attached to the email notice. Others who wish to participate in UFLSRG meetings may provide notice of their interest to the chair (or designee) by e-mail. Upon receiving such a notice, the chair (or designee) shall provide an e-mail copy of the notice and agenda of meetings to that person at the time the notice and agenda are provided to UFLSRG members.

Reporting

The UFLSRG shall report to JGC on its activities and any recommendations.

Review and Changes to the Charter

The UFLSRG shall review this charter annually and recommend any changes to the JGC.

Approved by Joint Guidance Committee, May 30, 2013

WESTERN ELECTRICITY COORDINATING COUNCIL

PLANNING COORDINATION COMMITTEE (PCC) MEETING

Meeting No. 36

March 25, 2014 – 1:00 p.m. to 5:00 p.m. Mountain Time

March 26, 2014 – 8:00 a.m. to noon Mountain Time

WECC Office
155 North 400 West, Suite 200
Salt Lake City, UT 84103

Meeting Minutes

I. Welcome/Introductions/WECC Antitrust Policy – Bob Easton

Mr. Easton, Planning Coordination Committee (PCC) Chair, called the meeting to order at 1:01 p.m. on March 25, 2014. Mr. Easton reviewed the WECC Antitrust policy. Attendees were asked to introduce themselves. A list of attendees is attached as Appendix A.

II. Changes to the Agenda – Bob Easton

Minor changes to the agenda were proposed, changes were limited to the ordering of topics and the person(s) presenting. Robert Jenkins made a motion to approve the agenda as adjusted and Peter Mackin seconded. Motion passed by consensus.

III. Approve Minutes October 2013 PCC Meeting (No. 35) – Branden Sudduth

Discussion on the October 2013 meeting minutes was held. A request to ensure that acronyms are defined at least once before they are used was made. Two minor grammatical changes were suggested and made.

Motion to approve the meeting minutes from the October 2013 PCC meeting (Meeting No. 35) with changes was made by Don Johnson and seconded by Marv Landauer. The motion passed by consensus with one abstention (Russell Noble).

IV. Report of Chair – Bob Easton

- WECC Board of Directors (Board) Activities
  - The Board unanimously elected Gary Leidich and Lee Beyer as, respectively, Board Chair and Vice Chair.
  - The Board committee appointments were proposed and approved and are as follows:
    a) Nominating Committee
       1. Lee Beyer, Chair
       2. Shelly Longmuir
       3. Armando Perez
    b) Standards Committee
       1. Joe McArthur, Chair
    c) Finance and Audit Committee
       1. Richard Woodward, Chair
       2. Kristine Hafner
       3. Joe McArthur
       4. Gary Leidich
    d) Governance Committee
       1. Michael Core, Chair
       2. Shelly Longmuir
       3. Ian McKay
       4. Joe McArthur
    e) Human Resources and Compensation Committee
       1. Shelly Longmuir, Chair
       2. Armando Perez
       3. Ian McKay
       4. Kristine Hafner
    f) Transmission Expansion Planning Policy Committee
       1. Ian McKay, Chair
       2. Armando Perez, Vice Chair
  - In accordance with the Bylaws, the newly elected directors drew lots to determine term length. The directors' terms are:
    a) Mike Core – 2017
    b) Kristine Hafner – 2016

c) Ian McKay – 2017
d) Richard Woodward – 2017

- Doug Larson and Jennifer Gardner provided a presentation from the Western Interconnection Regional Advisory Body (WIRAB). The Board discussed WIRAB's concerns regarding Information sharing and how WECC, working with the Member Advisory Committee (MAC), WIRAB, and industry leaders can create a shared view of reliability in the West.
- Jim Robb, WECC CEO, reported that WECC is currently under budget and has open staff positions due to the budget saving efforts and noted that Peak Reliability (Peak) owes WECC for intra-company loans (~$7 million). Mr. Robb also reported that the first draft of a 2015 budget has been posted and reviewed the issues around it. The 2015 WECC budget has a 5 percent overall increase. In addition, assessments will increase approximately 60 percent due to numerous federal grants going away; redistributing reserves; and under-executing full-time employees (FTE) purposely.
- Based on the recommendation from the MAC, the Board dissolved the following Board committees:
  a) Reliability Policy Issues Committee
  b) WECC Compliance Committee
  c) Efficient Dispatch Toolkit Steering Committee
- The Board directed the Western Renewable Energy Generating Information System (WREGIS) Committee to review its charter and composition and to provide recommendations at the next Board meeting regarding the continuing existence, purpose, and composition of the WREGIS Committee.
- The Board approved the creation of a joint task force with Peak Reliability, including participation of WECC staff and stakeholders, to address revisions to the Universal Non-Disclosure Agreement (UNDA) or develop an alternate solution for obtaining and sharing data from Peak.
- The Board approved the revisions to the Delegation Agreement, comprised of revisions to the WECC Reliability Standards Development Procedures (as recommended by the WECC Standards Committee), revisions to the Common Attributes, and revisions to the WECC Bylaws.
- Mr. Leidich noted that receiving Standing Committee reports is the least the Board can do and asked committee chairs and Board

members to consider how the Board can best support the committees. He expressed appreciation for the work being done on data sharing and stressed the Board's desire to focus on the issues that affect reliability.

- Mr. Leidich suggested holding a Board meeting on May 14 or 15 to address charters and create a high-quality Annual Meeting. He suggested that the June Board and Annual Meetings be held June 24-25; that the Board meet September 17-18 and December 3-4.

V. Joint Guidance Committee (JGC) Activities – Brian Keel

- Jim Robb, WECC CEO, provided a presentation to the JGC that outlined his focus. The items outlined in Mr. Robb's presentation as the most important to WECC's future were:
  - Long-term reliability.
  - For WECC to be viewed as a partner.
  - To bring the best experience to help solve problems.
  - This time is an opportunity to view ourselves in the future as WECC evolves into the new environment with bifurcation.
  - Resolve Planning Coordinator and Planning Authority coverage differences.
  - Pursuit of best practices and standards.
  - For Mr. Robb to strengthen his relationship with the industry and WECC membership.
- Jim Shetler provided comments from the Member Advisory Committee (MAC). The MAC has done or is working on the following:
  - Establishing a 2014 work plan and calendar (done).
  - Reviewing Board expenses periodically.
  - Reviewing communication protocols between MAC and WECC membership.
  - Establishing a MAC subcommittee to review the WECC committee structure, and assigning Rob Kondziolka as the chair (done).
  - Establishing measures of effectiveness of the Board and MAC.
  - Reaching out to Canadian and Mexican members for their continued participation.
- Matt Hunsaker provided a bifurcation update.

- Bert Peters provided a presentation from the Path Operator Task Force (POTF). The POTF is set to complete its deliverables for Phase 1. The Phase 2 data has been collected and the POTF should provide that deliverable by April 2014. The POTF will provide the JGC a recommendation at the June meeting. If approved, the POTF will move the work forward for approval by the Operating Committee (OC). There is still some confusion regarding how to move forward and final to obtain approval. This confusion will need to be worked out among the POTF, JGC, and OC.
- Kent Bolton provided an Underfrequency Load Shedding (UFLS) review to the JGC. The UFLS plan was placed on the PCC and OC agendas.
- Standing Committees:
    - The Market Interface Committee (MIC) changed its March 2014 meeting to a webinar.
    - The OC is concerned about the subcommittee structure within WECC and Peak.
    - The OC is voting on Automatic Time Error Correction as it is trying to open the window to +/- 30 seconds.
    - The OC is discussing the Unscheduled Flow Administrative Subcommittee (UFAS) dues as there is an issue regarding whether payment should be provided by the Load-Serving Entity or the PSE.
- Brian Keel will become the JGC chair in June of 2014.
- TEPPC provided a status update. TEPPC has been working on a TEPPC-to-power-flow conversion. The data is getting better but there are still 2000 phantom generators. The 2014 TEPPC studies open season closed on January 31, 2014 and TEPPC will prioritize the study request for the year after that.
- Peak’s MAC provided an update. It is working on budgets and metrics for determining the value Peak supplies to its members.
- An update concerning the NERC Planning Committee and the issue between Operations and Planning models was communicated to the JGC.
- Discussion regarding the future of the JGC was held. It was determined that the JGC will continue for the next 22 months except:
    - Meetings will be webinars except for one in-person annually, which is currently held during September.
    - The fall meeting will coordinate with the training meetings.

VI. Progress Report Policy Modification – Tom Green

This presentation can be found on the PCC meeting page.

The modified Progress Report Policies and Procedure will be brought before the PCC at the July 2014 meeting. The current redline version (additional revisions expected) of the progress report is available now on the PCC meeting page.

The question regarding the role of the subregional planning groups and the progress planning process was asked. Mr. Green feels this is an important question but one that should be considered by the entire PCC not the Progress Report Policy Task Force.

VII. Planning Coordinator (PC) Gaps Update – Branden Sudduth

This presentation can be found on the PCC meeting page.

After the presentation and group discussion, Mr. Easton determined that a Planning Coordinator Task Force with membership from the PCC would be established. The task force should be able to form a common understanding of PCs, and what their role and responsibilities should be.

VIII. Underfrequency Load Shedding (UFLS) Review Group Update – Jerry Rust

This presentation can be found on the PCC meeting page.

Approve UFLS Review Group Studies for 2014-15

The Underfrequency Load Shedding (UFLS) Work Group requests that PCC approve the islands to be simulated by the WECC UFLS Review Group for the period of 2014-15 as: WECC, North Island, and South Island. Motion made by Scott Waples and seconded by John Phillips. A consensus approval was requested. The PCC voted affirmative for the motion. There were no negative votes and no abstentions. Motion passed.

IX. Remedial Action Scheme Reliability Subcommittee (RASRS) – Gene Henneberg

This presentation can be found on the PCC meeting page.

X. Reliability Subcommittee Report – Vishal Patel

This presentation can be found on the PCC meeting page.

An in-person meeting has been scheduled for April 10th that will be dedicated to the BES Inclusion process. The goal is to finish drafting a white paper or guideline for presentation to the PCC at the July 2014 meeting.

In addition, NERC recently posted their revised BES definition and exclusion process that information can be found on the NERC website.

Approve Retirement of the Loads and Resources Subcommittee Charter

The PCC approves retirement of the Loads and Resources Subcommittee Charter and the merger into the Reliability Performance Evaluation Work Group. Robert Jenkins made a motion for the retirement and merger that was seconded by Dave Angell. A consensus approval was requested. The PCC voted affirmative for the motion. There were no negative votes and no abstentions. Motion passed.

XI. Technical Studies Subcommittee (TSS) Report – Tracy Rolstad

This presentation can be found on the PCC meeting page.

The Data Preparation Manual (DPM) was not noticed for approval so an email ballot for approval is planned to take place before the July 2014 PCC meeting. In the interim, discussion regarding the Data Preparation Manual (DPM) was held. Several members expressed concerns with the word “overcurrent” in the Line Transformer Protection section. It was suggested that the word be replaced with “primary.” The Study Review Work Group (SRWG) will make the suggested change and provide another review of the DPM.

Approve Node-Breaker White Paper

The TSS requests that the PCC approve the Node-Breaker White Paper. Scott Waples made a motion to approve that was seconded by Abbas Abed. A consensus approval was requested. The PCC voted affirmative for the motion. There were no negative votes and no abstentions. Motion passed.

The TSS asked for a conversation and guidance regarding the collection of latitude and longitudes in the base-case data collection process. The TSS feels that due to several NERC Standards under development, this will be an issue that must be addressed soon.

The membership presented two positions on the issues. The first opinion of the group was that this data should not be collected as a part of the base cases. The concern is that once the data is shared it becomes more challenging to guarantee the confidentiality and provides greater risk that it will be released publicly.

The second position, agreement to provide the data, was distilled down to the following statement, “protect the data as best as possible and move one…if someone wants the data they will get it.”

XII. Variable Generation Subcommittee Update – Ann Finley

This presentation can be found on the PCC meeting page.

XIII. Peak Reliability (Peak) Update – Brett Wangen

This presentation can be found on the PCC meeting page.

Mr. Wangen brought up the RC forum that will be held March 26 at 1:00 p.m. and asked for PCC participation because the forum is not only for OC members but for all Standing Committee meeting participants.

The Peak Board assigned Mr. Wangen the task of reviewing the Reliability Coordinator's obligations in regard to seasonal planning. Mr. Wangen has requested the PCC provide feedback to help frame the recommendation to the Peak Board.

XIV. Technical Studies Subcommittee Report Continued – Tracy Rolstad

The document can be found on the PCC meeting page.

Discussion on the 2013 WECC Annual Study Program was held. A PCC member requested more detail in the section describing disturbance simulations that did not meet performance requirements. WECC staff and the PCC chair agreed that these changes weren't substantive and the document was modified.

Approve 2013 WECC Annual Study Program Report

The TSS requests that the PCC approve the revised 2013 WECC Annual Study Program Report with the addition of the requested clarifying language. Don Johnson made a motion for approval that was seconded by Scott Waples. A consensus approval was requested. The PCC voted affirmative for the motion. There were no negative votes and no abstentions. Motion passed.

XV. Path Operator Task Force (POTF) Report – Bert Peters

This presentation can be found on the PCC meeting page.

The POTF has published a draft white paper with its recommendations concerning the role of the Path Operators. The white paper can be found here. The POTF is soliciting industry comments on the draft white paper and next steps in the process.

XVI. Path Concept Task Force Report – Chifong Thomas

This presentation can be found on the PCC meeting page.

XVII. Transmission Expansion Planning Policy Committee (TEPPC) Update – Branden Sudduth

Mr. Sudduth provided a quick update on the TEPPC activities and recommended members contact Keegan Moyer with additional questions:

- The Board approved retention of TEPPC. Ian McKay was appointed Chair and Armando Perez was appointed Vice Chair.
- TEPPC is in the process of developing the 2024 Common Case.
- Work continues to reconcile the SRWG power flow and TEPPC data sets.

XVIII. WECC Staff Report – Branden Sudduth

- 2015 WECC Business Plan and Budget – Branden Sudduth

  This presentation can be found on the PCC meeting page.

- WECC Information Sharing Policy – Victoria Ravenscroft

  This presentation can be found on the PCC meeting page.

  Ms. Ravenscroft informed PCC members that they would be receiving a poll in regard to the Loads and Resources data for years 1-3 that is currently handled as confidential. The poll is to gather input on if this data should be shared.

  A question about where the data sharing policies could be found on the WECC website was asked. The page was temporarily unavailable but is accessible now. Data sharing documents can now be found here.

XIX. Peak Funding Initiative Funding Group Update – Maude Grantham-Richards

This presentation can be found on the PCC meeting page.

Ms. Grantham-Richards stressed the point that registered entities are encouraged to participate and can contact Russ Noble at rnoble@cowlitzpud.org with questions or for meeting information. The next meeting will be held April 9, 2014.

XX. NERC Activities and Committee Reports

- NERC Planning Committee (NERC PC) – Layne Brown

  Layne Brown provided a brief update of the NERC PC activities.

a. The NERC PC is in the process of establishing a new task force comprised of NERC OC and PC representatives that will look at "Big Issues" across the regions.

b. A new Geomagnetic Disturbance Task Force reporting to the NERC PC has been established.

c. At its March meeting, the NERC PC approved the revision to the ALR-1-4 metric, enhancements to the Severity Risk Index (SRI), and the retirement of the Key Compliance Monitoring Index (KCMI).

d. NERC plans on presenting their 2014 State of Reliability Report to the NERC Board in May.

e. Midcontinent Independent System Operator (MISO) provided an update to the NERC PC in regard to its gas-electricity interdependency as MISO has concerns regarding the amount of upcoming coal plant retirements.

XXI. Subregional Planning Status Reports

- Subregional Coordination Group – Bob Easton

  The group is changing its name to "Regional Coordination Group." This group works with TEPPC to develop the Common Case Transmission Assumptions (CCTA) that are included in the TEPPC Common Case. It was determined that the group will continue its function and not retire but another meeting probably won't be scheduled until 2016.

- ColumbiaGrid – Marv Landauer

  This presentation can be found on the PCC meeting page.

- Northern Tier Transmission Group – Dave Angell

  This presentation can be found on the PCC meeting page.

XXII. Peak Member Advisory Committee (Peak MAC) Update – Terry Baker

Terry Baker supplied an update of the Peak MAC activities. They are as follows:

- The Peak MAC has a place on the Peak website. It can be accessed here.
- The Peak MAC is working on 2014 goals and developing metrics.
- A review of the committee structure and what groups should "move" to Peak is underway. A survey to membership was sent out in December but there were not many responses received. Mr. Baker handed out printed surveys and asked for response to be returned to him. The Peak MAC will compile

the responses and provide to the Peak Board to coordinate with the WECC Board.

- The Peak MAC has some concerns with the 2015 budget. Meetings of the Peak Board and Finance and Audit Committee are open to the public and members are encouraged to attend. The budget numbers were first released on March 25 and revisions are currently being made. A suggestion to split the assessment into two payments a year to help cushion the sticker shock and absorb the increase was suggested by the Peak MAC and is being considered by the Peak Board.

XXIII. WECC Member Advisory Committee Update – Maude Grantham-Richards

This presentation can be found on the PCC meeting page.

Ms. Grantham-Richards provided a brief update on the WECC MAC that highlighted several items covered by Mr. Baker in the Peak MAC update. Several key items include:

- The 4.9 review;
- Annual Meeting for Peak and WECC in June;
- Input and participation in the WECC CEO's 2014 goals; and
- Focus on the questions, 'What keeps you up at night?" and "How are we going to measure what WECC is doing and if it is successful?"

XXIV. Subregional Planning Status Reports continued

- WestConnect Subregional Planning – Mukhlesur Bhuiyan

  WestConnect is further behind on the FERC 1000 order than Northern Tier Transmission Group (NTTG) but that is because the issue is complicated by the municipal utilities and their governing boards. The goal is to move in the direction that NTTG outlined, but the question of who will pay is still a concern. WestConnect has a request for proposal to hire a company to handle the transmission planning work.
- Southwest Area Transmission Study (SWAT) – Gary Trent

  There was a SWAT meeting in February in Las Vegas. Current items of work included:

  - Looking at seams between CAISO and SWAT.
  - Two study requests submitted to TEPPC; High Photovoltaic and High large-scale solar.

- Looking at the impact of coal reductions in a short-term window because there is approximately 2700 MW shutting down in the next five years.
- There is a task force addressing questions concerning the shutdown of the San Onofre Nuclear Generating Station (SONGS) combined with the Once-Through-Cooling requirements in 2018-19.
- Looking at impacts on reliability in regard to path ratings and inertia due to renewables.

- Colorado Coordinated Planning Group – Tom Green

  This presentation can be found on the PCC meeting page.

- Sierra Subregional Planning Group – Craig Cameron

  Currently working with TEPPC on mapping of generators. The next meeting is April 23, 2014 in Reno, Nevada.

- CAISO Subregional Planning Update – Jeffery Billinton

  The 2013/14 Transmission plan was approved on March 20, 2014 with the exception of one project, the Delany-Colorado River project. The plan can be found on the CAISO website. The 2014/15 plan is underway.

  Discussion on TPL-001-4 is underway.

- AESO Planning Update – Ata Rehman

  This presentation can be found on the PCC meeting page.

XXV. Member Reports and Project Status – Bob Easton

- **Gateway West Project – David Angell**

  The project received approval with a small subset exception. There have been filings in Wyoming and litigation is in progress.

XXVI. Action Items – Branden Sudduth

- Steve Rueckert to work with the Reliability Subcommittee to draft a document that outlines the three options regarding TPL-001-4 R5. Paper to be sent to the PCC group in late May or early June for action at the July PCC Meeting.
- Modeling Validation Work Group to address the recommendations from the WECC-0099 Drafting Team.
- Bob Easton to form a Planning Coordinator Gap Task Force from PC members to address the PC gap issue.
- Tracy Rolstad and the Study Review Work Group to review the Data Preparation Manual again and make the suggested change in Line

Transformer Protection from “overcurrent” to “primary.” Then will send the DPM out for email ballot through SRWG, TSS and then the PCC.

- Tracy Rolstad/and or WECC staff to add the Document Category tag to the Node-Breaker White Paper
- Enoch Davies to update the 2013 Study Review Program with the changes that were discussed during the PCC meeting.

XXVII. Next Meeting: July 2014 – Salt Lake City, UT

XXVIII. Adjourn

Exhibit A: Attendance List

Planning Coordination Committee Meeting (PCC)
March 25-26, 2014

Members in Attendance (In person and Webinar)

First	Last	Company
Abbas	Abed	Transmission Agency of Northern California
David	Angell	Idaho Power Company
Ron	Belval	Tucson Electric Power
Mukhlesur	Bhuiyan	Los Angeles Department of Water & Power
Jeff	Billinton	California ISO
Jeremy	Brownrigg	Platte River Power Authority
Craig	Cameron	Sacramento Municipal Utilities District
Ken	Che	Public Utility District No. 2 of Grant County
Jerry	Dolyniuk	Arizona Public Service Co.
Bob	Easton	Western Area Power Administration
Sedina	Eric	Federal Energy Regulatory Commission
Ann	Finley	Metropolitan Water District of Southern California
Thomas	Green	Public Service Company of Colorado
Laurie	Hammack	Seattle City Light
Patrick	Harwood	Western Area Power Administration
Curt	Hatton	Pacific Gas & Electric Co.
Robert	Jenkins	Flynn Resource Consultants, Inc.
Don	Johnson	Portland General Electric
Brian	Keel	Salt River Project
Kyle	Kohne	Bonneville Power Administration
Marv	Landauer	ColumbiaGrid
Kenneth	Laughlin	Tres Amigas LLC

John	Leland	NorthWestern Energy
Caitlin	Liotiris	Western Power Trading Forum
Franklin	Lu	Snohomish County PUD No. 1
Peter	Mackin	Utility System Efficiencies, Inc.
Richard	Malloy	Idaho Falls Power
Laura	Manz	Tres Amigas LLC - Webinar
Esteban	Martinez	Turlock Irrigation District
Jeff	Mechenbier	Public Service Company of New Mexico
Debbie	Miller	WECC
Russell	Noble	Public Utility District No. 1 of Cowlitz County
Mike	Olson	WAPA
Steven	Pai	BC Hydro
Atefeh	Palizban	Powerex
Vishal	Patel	Southern California Edison
Maggie	Peacock	WECC
John	Phillips	Puget Sound Energy
Chris	Pink	Tri-State Generation and Transmission Association, Inc.
Dana	Reedy	Northwest Power Pool
Ata	Rehman	AESO
Melvin	Rodrigues	Bonneville Power Administration
Tracy	Rolstad	Avista
Steve	Rueckert	WECC
Will	Speer	San Diego Gas & Electric
Boone	Staples	Tenaska, Inc.
Branden	Sudduth	WECC
Spencer	Tacke	Modesto Irrigation District - Webinar

Amanda	Thames	Black Hills Corporation
Chifong	Thomas	Smart Wire Grid, Inc.
Lawrence	Tobias	Western Area Power Admin. - Sierra Nevada Region
Gary	Trent	Tucson Electric Power
Boric	Tumarin	Southwest Transmission Company
Rick	Vail	PacifiCorp
Brett	Wangen	Peak Reliability
Scott	Waples	Avista
Craig	Williams	WECC
Joseph	Wilson	Tacoma Power
Randy	Young	Arizona Public Service Co.
George	Zhou	Siemens Energy, Inc.

Appendix L: UFLS Data Request Respondents

Entity	Entity Type (GO, TO, DP, etc.)	Plan (1a, 1b, 1c, none)	Own or operate UFLS Program?
Black Hills Colorado IPP	GO	*	Yes
Black Hills Wyoming	GO	*	Yes
Burney Forest Power	GO	*	Yes
City of Roseville	GO	*	Yes
Dynegy Power LLC	GO	*	Yes
Eugene Water & Electric Board	TO,GO,DP	*	Yes
Grand Coulee Project Hydroelectric Authority	GO	*	Yes
Griffith Energy, LLC	GO	*	Yes
High Desert Power Project, LLC	GO	*	Yes
Iberdrola Renewables	GO	*	Yes
Kings River Conservation District	GO	*	Yes
La Paloma Generating Company LLC	GO	*	Yes
Larkspur Energy, LLC	GO	*	Yes
Milford Wind Corridor Phase !, LLC	GO	*	Yes
Northwest Power Pool	*	*	*
Orange Grove Energy, L.P.	GO	*	Yes
Otay Mesa Energy Center, LLC	GO	*	*
Pacific Ultrapower Cinese Station	GO	*	Yes
Palouse Wind, LLC	GO	*	Yes
Pasadena Water and Power	*	*	Yes
PPL Montana, LLC	GO	*	Yes
Public Service Co of New Mexico (PNM)	TO, GO	*	Yes
Rio Bravo Fresno	GO	*	Yes
Rio Bravo Rocklin	GO	*	Yes
RockTenn	GO	*	Yes
Russell City Energy Company, LLC	GO	*	Yes
Sierra Pacific Industries	GO	*	Yes
Southern California Edison	GO	*	Yes
Spokane Regional Waste to Energy Facility	GO	*	Yes
Springfield Utility Board	DP	*	Yes
SWG Colorado, LLC	GO	*	Yes
SWG Fountain Valley Power, LLC	GO	*	Yes
Tacoma Power	BA, DP, GO, TO	*	Yes
Three Buttes Windpower	GO	*	Yes
Top of the World Windpower	GO	*	Yes
Tucson Electric Power	GO, BA	*	Yes
Us Army Corps of Engineers - Walla Walla District	GO	*	Yes
Valencia Power, LLC	GO	*	Yes
Alameda Municipal Power	*	1a	Yes
Basin Electric Power Cooperative	TO, GO, TP	1a	Yes
Black Hills Colorado Electric	GO, TO, DP	1a	Yes
Blick Hills Power, Inc	GO	1a	Yes
Burbank Water & Power	GO,DP,RP	1a	Yes
California Pacific Electric Company	*	1a	Yes
City of Anaheim	DP	1a	Yes
City of Shasta Lake	LSE, DP	1a	Yes
City of Ukiah	DP	1a	Yes
Colorado Springs Utilities	GO	1a	Yes
Dixie Escalante Rural Electric Assocation	DP	1a	Yes
Holy Cross Energy	TO, DP, LSE	1a	Yes
Idaho Power Company	GO, TO	1a	Yes
Intermountain Rural Electric Association	*	1a	Yes
Merced Irrigation District	TO, GO, DP	1a	Yes

* Information not provided.

UFLS Data Request Respondents

Entity	Entity Type (GO, TO, DP, etc.)	Plan (1a, 1b, 1c, none)	Own or operate UFLS Program?
Moon Lake Electric Assn., Inc.	TO, DP	1a	Yes
NNSAL	*	1a	Yes
NorthWestern Energy	GO	1a	Yes
Pacific Gas and Electric	GO, TO, DP	1a	Yes
PacifiCorp	TO, GO	1a	Yes
Palo Alto	DP	1a	Yes
Platte River Power Authority	TO, GO	1a	Yes
Plumas - Sierra Rural Electric Cooperative	DP	1a	Yes
Southern California Edison	TO, DP	1a	Yes
Turlock Irrigation District	BA,TO,GO,DP,LSE	1a	Yes
Valley Electric Association, Inc	TO	1a	Yes
Western Area Power Administration	PA,TP,TO	1a	Yes
Western Area Power Administration - Rpcky Mountain Region	*	1a	Yes
Xcel Energy	TO, DP, LSE, GO	1a	Yes
Public Utility District No. 1 of Okanogan County	*	1a, 1b	Yes
Salt River Project	BA, GO	1a, 1c	Yes
Tri-State Generation and Transmission Association	TO, GO	1a, 1c	Yes
Modesto Irrigation District	TO,TOP,GO,LSE, DP	1a,1c	Yes
Avista	GO	1b	Yes
Bonneville Power Administration	TO, DP	1b	Yes
Douglas County PUD	BA,DP,GO,TO	1b	Yes
Grant County PUD	BA,DP,GO,LSE,TO,PSE	1b	Yes
PacifiCorp	*	1b	Yes
Portland General Electric	TO, GO, DP	1b	Yes
Public Utility District No. 1 of Chelan County	GO	1b	Yes
Public Utility District No. 1 of Snohomish County	TO, GO, DP	1b	Yes
Puget Sound Energy	TO, DP	1b	Yes
Seattle City Light	GO	1b	Yes
Sierra Pacific Power dba NV Energy	BA, TO, GO, DP	1b	Yes
Southwest Transmission Cooperative	*	1b	Yes
Western Area Power Administration- Desert Southwest Region	*	1b, 1c	Yes
Arizona Public Service Company	GO, TO	1c	Yes
City of Farmington Electric Utility System	GO	1c	Yes
City of Glendale	DP	1c	Yes
City of Redding	GO, DP	1c	Yes
City of Riverside Public Utilities	DP, LSE, RP & PSE	1c	Yes
City of Santa Clara/Silicon Valley Power	GO, TO,DP,LSE,PSE	1c	Yes
El Paso Electric Company	TO, GO, DP	1c	Yes
Imperial Irrigation District	*	1c	Yes
Los Angeles Department of Water and Power	BA, TO, TOP, GO	1c	Yes
National Nuclear Security Administration and Sandia National Laboratories	*	1c	Yes
Nevada Power Company	BA, TO, GO, DP	1c	Yes
Sacramento Municipal Utillity District	TO, TOP, GO, DP	1c	Yes
San Diego Gas and Electric	*	1c	Yes
AES Alamitos LLC	GO	None	No
AES Huntington Beach LLC	*	None	No
AES Redondo Beach LLC	*	None	No
Agua Caliente	GO	None	No
Algonquin Power Sanger	GO	None	No
Alta Wind I, LLC	GO	None	No

* Information not provided.

UFLS Data Request Respondents

Entity	Entity Type (GO, TO, DP, etc.)	Plan (1a, 1b, 1c, none)	Own or operate UFLS Program?
Alta Wind II, LLC	GO	None	No
Alta Wind III, LLC	GO	None	No
Alta Wind IV, LLC	GO	None	No
Alta Wind V, LLC	GO	None	No
Alta Wind VIII, LLC	GO	None	No
Alta Wind X, LLC	GO	None	No
Alta Wind XI, LLC	GO	None	No
Aragonne Wind LLC	GO	None	No
Arizona Electric Power Cooperative	GO	None	No
Arlington Valley Solar Energy II, LLC	GO	None	No
Arlington Valley, LLC	GO, BA	None	No
Arlington Wind Power Partners LLC	GO	None	No
Big Bend Electric Cooperative, Inc	DP, LSE	None	No
BIV Generation Company, LLC	GO	None	No
Blythe Energy Inc.	GO	None	No
Boise-Kuna Irrigation District	GO	None	No
Boston Energy Trading and Marketing	GO	None	No
Bountiful City Light & Power	*	None	No
Bureau of Reclamation	*	None	No
Cabrillo Power 1	GO	None	No
Caithness Shepherds Flat, LLC	GO	None	No
California Department of Water Resources	TO, GO	None	No
California ISO	*	None	No
Calpeak Power - Panoche, LLC	GO	None	No
Calpeak Power - Vaca Dixon, LLC	GO	None	No
Calpine Corporation	GO	None	No
Cedar Creek II, LLC	GO	None	No
Cedar Creek Wind Energy LLC	GO	None	No
Centinela Solar Energy, LLC	GO	None	No
Central Electric Cooperative	DP,LSE	None	No
Central Lincoln People's Utility District	DP	None	No
City of Gallup	*	None	No
Clark Public Utilities	GO	None	No
Colorado Commission of Nevada	*	None	No
Colorado Power Partners	GO	None	No
Colstrip Energy Limited Partnership	GO	None	No
Columbia River PUD	*	None	No
Consumers Power Inc.	DP, LSE	None	No
Coolidge Power LLC	GO	None	No
Coolwater Generating Station	GO	None	No
Coos-Curry Electric Cooperative	DP,LSE	None	No
Copper Mountain Solar 2, LLC	GO	None	No
CPV Sentinel, LLC	*	None	No
Delta-Montrose Electric Association	*	None	No
Desert Generation & Transmission	GO	None	No
Elk Hills Power, LLC	GO	None	No
Emerald People's Utility District	DP	None	No
Empire Electric Association	TO, DP	None	No
Energy Northwest - Columbia Generation Station	GO	None	No
Fall River Rural Electric Cooperative	DP, LSE	None	No
Frederickson Power LP	GO	None	No
Gila River Power	GO	None	No
Goshen Phase II LLC	GO	None	No

* Information not provided.

UFLS Data Request Respondents

Entity	Entity Type (GO, TO, DP, etc.)	Plan (1a, 1b, 1c, none)	Own or operate UFLS Program?
Grays Harbor Energy LLC	GO	None	No
Harbor Cogeneration Company, LLC	GO	None	No
Hatchet Ridge Wind LLC	GO	None	No
Hermiston Generating Co, L.P.	GO	None	No
Hetch Hetchy Water ad Power	TO	None	No
High Plains Ranch II LLC	*	None	No
Highline Electric Association	DP	None	No
Hudson Rance Power 1 LLC	GO	None	No
Idaho Wind partners I, LLC	GO	None	No
Imperial Valley Solar 1, LLC	GO	None	No
Indigo Generation, LLC	GO	None	No
Inland Empire Energy Center, LLC	GO	None	No
Ivanpah Holding Company LLC	GO	None	No
Kern River Cogeneration Company	GO	None	No
KES Kingsburg, L.P.	GO	None	No
Klickitat County PUD	*	None	No
Kootenai Electric Cooperative, Inc	DP	None	No
La Plata Electric Assocation Inc.	DP	None	No
Las Vegas Cogeneration	GO	None	No
Malacha Hydro Limited Partnership	GO	None	No
ManChief Power Company LLC	GO	None	No
March Point Cogeneration Company	GO	None	No
Mariposa Energy, LLC	GO	None	No
Medow Creek Project Company, LLC	GO	None	No
Mesquite Solar 1, LLC	GO	None	No
Mid-Set Cogeneration Company	GO	None	No
Midway Peaking, LLC	GO	None	No
Midway Sunset Cogeneration Company	GO	None	No
Mojave 16/17/18, LLC	GO	None	No
NAES Corporation - Harvest Wind Project	GO	None	No
NAES Corporation - White Creek Wind 1	GO	None	No
Navajo Tribal Utility Authority	DP	None	No
Nevada Solar One, LLC	GO	None	No
New Harquahala Generating Facility, LLC	GO	None	No
NRG El Segundo Energy Center	GO	None	No
NRG Energy Etiwanda Generating Station	GO	None	No
NRG Energy Mandalay Generating Station	GO	None	No
NRG Energy Marsh Landing Generating Station	GO	None	No
NRG Energy Ormond Beach	GO	None	No
Ocotillo Express LLC	*	None	No
Pend Oreille County Public Utility District #1	*	None	No
Peninsula Light Company	*	None	No
Pinyon Pines Wind I, LLC	GO	None	No
Pittsburg Generating Station	GO	None	No
Poudre Valley REA	DP	None	No
Public Utility District No 1 of Lewis County	TO, GO	None	No
Public Utility District No. 1 of Cowlitz County, WA	TO, GO, DP	None	No
Public Utility District No. 1 of Grays Harbor County, WA	TO, DP	None	No
Public Utility District No. 1 of Whatcom County	TO, DP	None	No
PUD#1 of Clallam County	DP	None	No
Raft River Rural Electric Cooperative	DP, LSE	None	No
Rathdrum Power, LLC	GO	None	No
Rio Bravo Poso	GO	None	No

* Information not provided.

UFLS Data Request Respondents

Entity	Entity Type (GO, TO, DP, etc.)	Plan (1a, 1b, 1c, none)	Own or operate UFLS Program?
Ripon Cogeneration, LLC	GO	None	No
Rockland Wind Farm, LLC	GO	None	No
Rocky Mountain Power, LLC	GO	None	No
Sagebrush Power Partners LLC	GO	None	No
Salem Electric	*	None	No
Salmon River Electric Coop	*	None	No
San Carlos Irrigation Project	DP	None	No
San Joaquin Cogen, LLC	GO	None	No
Solar Star California XIX, LLC	GO	None	No
Solar Star California XX, LLC	GO	None	No
South Feather Power Project	GO	None	No
Southern Montana Electric Generation and Transmission	DP, GO	None	No
Spindle Hill Energy LLC	GO	None	No
Spring Valley Wind LLC	GO	None	No
Sunray Energy, Inc	GO	None	No
Sunrise Power Company LLC	GO	None	No
Sycamore Cogeneration Company	GO	None	No
Telocaset Wind Power Partners, LLC	GO	None	No
Termoelectrica de Mexicali	GO	None	No
Termoelectrica U.S., LLC	GO	None	No
Thermal Energy Development Partnership, LP	GO	None	No
Topaz Solar Farms LLC	GO	None	No
Town of Estes Park	*	None	No
Trans Bay Cable LLC	TO	None	No
Transmission Agency of Northern California	TO	None	No
Umatilla Electric Cooperative	DP, LSE	None	No
US Army Corps of Engineers - Omaha	GO	None	No
US Army Corps of Engineers - Seattle District	GO	None	No
US Borax and Chemical Corp	GO	None	No
US Navy, Naval Base Kitsap	TO, LSE, DP	None	No
USDOE Richland Operations	TO, DP	None	No
Vantage Wind Energy LLC	GO	None	No
Vera Water and Power	*	None	No
WCGN	GO	None	No
Wellhead Power Panoche	GO	None	No
Wheat Field Wind Farm LLC	GO	None	No
Williams Flexible Generation	GO	None	No
Windstar Energy, LLC	GO	None	No
Windy Flats Partners, LLC	*	None	No
Yuba County Water Agency	GO	None	No

* Information not provided.

Document name	**WECC Off-Nominal Frequency Load Shedding Plan**
Category	( ) Regional Reliability Standard ( ) Regional Criteria (X) Policy ( ) Guideline ( ) Report or other ( ) Charter
Document date	May 24, 2011
Adopted/approved by	Board of Directors
Date adopted/approved	December 5, 2012
Custodian (entity responsible for maintenance and upkeep)	Operating Committee
Stored/filed	Physical location: Web URL:
Previous name/number	(if any)
Status	(X) in effect ( ) usable, minor formatting/editing required ( ) modification needed ( ) superseded by ______________________ ( ) other ______________________________ ( ) obsolete/archived

Western Electricity Coordinating Council Off-Nominal Frequency Load Shedding Plan

May 24, 2011

TABLE OF CONTENTS

Executive Summary

Background

In the aftermath of system-wide disturbances occurring within the Western Interconnection on July 2 and 3, and August 10, 1996, President Clinton appointed a "Blue Ribbon" panel to perform a comprehensive assessment of these disturbances and make recommendations to enhance reliability within the Western Interconnection. The investigations culminated in two reports: the *WSCC Disturbance Report for the Power System Outages that Occurred on the Western Interconnection on July 2, 1996 and July 3, 1996*; and the *WSCC Disturbance Report for the Power System Outage that Occurred on the Western Interconnection on August 10, 1996* (Disturbance Reports). The Disturbance Reports' recommendations identified several reliability issues for further investigation. One of these issues was the efficacy of existing policies and procedures related to off-nominal frequency (underfrequency load shedding (UFLS) programs); the purposes of which are to arrest potential system collapses due to large frequency deviations, minimize associated adverse impacts caused by cascading outages, and aid in quickly restoring the system to normal operations.

Status

The Western Systems Coordinating Council's (WSCC) Planning Coordination Committee (PCC) and Operating Committee (OC) developed a coordinated off-nominal frequency load shedding and restoration plan for the Western Interconnection in the fall of 1997 (1997 Coordinated Plan). The WSCC Board of Trustees approved the 1997 Coordinated Plan on December 4, 1997.

The WSCC was succeeded by the Western Electricity Coordinating Council (WECC) on April 18, 2002.

In 2009, the WECC PCC and OC formed a task force to review the effectiveness of the existing protection relays associated with the 1997 Coordinated Plan. The results indicated that WECC members' relay settings conform to the 1997 Coordinated Plan performance requirements, both in arresting frequency decline before frequency reaches 58.0 Hz and in recovering frequency to 59.5 Hz or higher. These results also indicated that UFLS relays will not activate until there has been a cascading disturbance across multiple entities' systems. In addition, none of the Western Interconnection's sub-areas will experience an off-nominal frequency event due to either single or dual most-severe-contingency losses of generation resources if the losses occur within known island configurations.

In 2010, NERC proposed a revision to NERC Standard PRC-006-0 to create PRC-006-1, which was approved by the industry and incorporates a WECC variance that references this revised Coordinated Plan.

Comprehensive Coordinated Plan

This document is the comprehensive coordinated plan of the WECC Off-Nominal Frequency Load Shedding Plan.

A. Introduction

One objective of WECC is to achieve a high level of reliable operations within the Western Interconnection. To further this objective, the members of WECC recognize the need for a common plan for underfrequency load shedding.

The objectives of this WECC Off-Nominal Frequency Load Shedding Plan (Coordinated Plan) report are to:

1. Outline the characteristics of a well-planned interconnected bulk power supply.
2. Describe the basis for model testing.
3. List the reliability and adequacy requirements to be used to evaluate the performance of the Western Interconnection electric system.
4. Identify operating procedures necessary to maintain a reliable and efficient electric system.

The members of WECC have agreed to follow and operate their systems in accordance with this Coordinated Plan as an essential element of the well-planned and operated Western Interconnection electric system.

After the predecessor to this Coordinated Plan (the 1997 Coordinated Plan) was initially approved in 1997, either the WSCC or WECC Planning Coordination Committee and Operating Committee have reviewed the 1997 Coordinated Plan and tested its effectiveness at least once every five years.

In 2009, the WECC PCC and OC formed a task force to review the effectiveness of the 1997 Coordinated Plan as implemented, based on the installed under frequency relays as reported by entities that are required to provide off-nominal frequency protection (hereafter called UFLS Entities). The results indicated the system performance conformed to the WECC Plan’s performance requirements, both in arresting frequency decline before frequency reaches 58.0 Hz and recovering frequency to 59.5 Hz or higher. The results also showed that UFLS relays will not activate until there has been a cascading disturbance. Further, it was noted that within known island configurations, no single or dual loss of generation contingency will cause an off-nominal frequency event.

B. Criteria

In accordance with this Coordinated Plan, entities required to provide off-nominal frequency protection (UFLS Entities) will establish a program of automatic load shedding that is designed to arrest frequency decays that could result in an uncontrolled failure of components of the Western Interconnection. In the event of a system-wide disturbance, the Coordinated Plan is designed to: (i) maintain the integrity of the Western Interconnection as long as possible; (ii) prevent unbalanced load shedding (which may cause high transmission loading), extreme voltage deviations, and damage to generating equipment and other facilities; (iii) limit any islanding that might occur to as few islands as possible; and (iv) manage islanding and load loss so that operators can rapidly restore load and re-establish interconnections.

This Coordinated Plan includes (but is not limited to):

- Frequency set-points
- Size of corresponding load shedding blocks (percent of connected loads)
- Intentional and total tripping delays
- Generation protection
- Tie-tripping schemes
- Islanding schemes
- Automatic load restoration schemes
- Any other schemes that are part of or otherwise affect this Coordinated Plan

C. Objectives

The objectives of the Coordinated Plan include (but are not limited to):

- Minimize the risk of total Western Interconnection system collapse.
- Protect generating equipment and transmission facilities against damage.
- Provide for effective load shedding within the Western Interconnection to arrest frequency decline.
- Improve overall system reliability.
- Match overall generation to overall load and, where islands are created or remain, match generation and load as required to meet island area needs.
- Coordinate load-shedding with underfrequency protection of generating units.
- Coordinate load-shedding with any other actions that can be expected to occur under conditions of frequency decline.
- Base load-shedding on studies of system dynamic performance, using the latest state-of-the-art computer analytical techniques.
- Minimize the risk of further separation, loss of generation, or excessive load shedding accompanied by excessive overfrequency conditions.
- Incorporate automatic generator tripping or other remedial measures to prevent excessive high frequency that could result in uncontrolled generator tripping or equipment damage.
- Address load controlled by customer-owned relays where the load is counted toward meeting minimum load-shedding requirements.

D. Methodology

The design of the Coordinated Plan was based on the following performance criteria:

- Load/generation imbalances based upon load of up to 25 percent should be accounted for.
- Potential system separation points should reflect historical system load conditions and transfer levels.
- This Coordinated Plan should conform to the 5% loss of life of turbine blades recommendations as determined by generator manufacturers.
- Sufficient load must be dropped by UFLS Entities to keep the system frequency within the continuous operating range of the generating units (59.5 Hz and 60.5 Hz).
- Minimum permissible dynamic frequency during a disturbance is 58 Hz. The maximum permissible dynamic frequency during a disturbance is 61.0 Hz.
- Load shedding blocks will be in a five-step sequence with a minimum separation between steps of 0.1 Hz.
- Underfrequency relays must have a maximum operating time of six cycles for the high speed trip.
- System average operating time of breakers used to trip load is to be no more than fourteen cycles.
- Post-disturbance frequency ideally will settle out above 60 Hz, as opposed to below 60 Hz.
- Implementation of the Coordinated Plan should not cause other adverse system conditions that result in generation tripping that would exacerbate the loss-of-generation event.

The typical time needed to shed load in response to an underfrequency disturbance is between 0.3 and 10 seconds. As governors cannot appreciably adjust megawatt output levels in this time frame, the magnitude of frequency change is primarily dictated by system inertia characteristics.

The General Electric Positive Sequence Load Flow (GE PSLF) program was used for modeling various system conditions in WECC's reference model. If necessary, UFLS Entities may use other models if WECC approves them as being equivalent to the reference model. Simulations must still be optimized using the system average inertia and nominal load/frequency response characteristics.

This Coordinated Plan is designed to accommodate a wide range of generator inertias and load/frequency characteristics. This Coordinated Plan must be able to meet the criteria specified above with generator inertia as low as 2.5 per unit (pu) (generally associated with large steam units) and as high as 6.0 pu (generally associated with hydro units).

Load sensitivity to frequency is expressed as a ratio between the percent load changes to the percent frequency change. This Coordinated Plan used a system-wide load sensitivity value of 1.5 pu.

This Coordinated Plan is designed to fulfill the criteria, objectives, and assumptions described above for losses of generation percents of 1, 2, 3, 4, 10, 15, 20, 25, and 30.

E. Coordinated Plan Details

Currently, UFLS Entities in the WECC Region have adopted one or a combination of the following three plans where the frequency set-points are illustrated in the tables in items 1a, 1b, or 1c below. Items 2 through 22 apply to all three plans.

1a. UFLS Entities participating in the Coordinated Plan are required to shed their first block of load as soon as frequency has declined to 59.1 Hz, with additional minimum requirements for further load shedding steps as set forth in the following table:

Load Shedding Block	Percent of Balancing Authority Area Load Dropped	Frequency Set-Point (Hz)	Tripping Time*
1	5.3	59.1	no more than 14 cycles
2	5.9	58.9	no more than 14 cycles
3	6.5	58.7	no more than 14 cycles
4	6.7	58.5	no more than 14 cycles
5	6.7	58.3	no more than 14 cycles
Additional automatic load shedding to correct underfrequency stalling			
	2.3	59.3	15 sec
	1.7	59.5	30 sec
	2.0	59.5	1 min
Load automatically restored from 59.1 Hz block to correct frequency overshoot			
	1.1	60.5	30 sec
	1.7	60.7	5 sec
	2.3	60.9	0.25 sec

* Relay and breaker total trip time

1b. UFLS Entities participating in the Northwest Power Pool sub-area Coordinated Plan are required to shed their first block of load as soon as frequency has declined to 59.3 Hz, with additional minimum requirements for further load shedding steps as set forth in the following table:

Load Shedding Block	Percent of NWPP Sub-Area Load Dropped	Frequency Set-Point (Hz)	Tripping Time*
1	5.6	59.3	no more than 14 cycles
2	5.6	59.2	no more than 14 cycles
3	5.6	59.0	no more than 14 cycles
4	5.6	58.8	no more than 14 cycles
5	5.6	58.6	no more than 14 cycles
Additional automatic load shedding to correct underfrequency stalling			
	2.3	59.3	15 sec
	1.7	59.5	30 sec
	2.0	59.5	1 min
Load automatically restored from 59.3 Hz block to correct frequency overshoot			
	1.1	60.5	30 sec
	1.7	60.7	5 sec
	2.3	60.9	0.25 sec

* Relay and breaker total trip time

1c: UFLS Entities participating in the Southern Island Load Tripping sub-area Coordinated Plan shall implement the requirements as detailed year-to-year in the Southern Island Load Tripping report as provided to the WECC Reliability Assurer. In addition to participating in the Southern Island Load Tripping Sub-area Coordinated Plan, these UFLS Entities shall implement the requirements as detailed in section 1a above.

2. UFLS Entities may not rely on the shedding of intermittent load unless monitoring is in place to allow changes in real time to accommodate the availability of intermittent load and ensure compliance with the load shedding requirements of this Coordinated Plan.

3. Load can be tripped at frequencies higher than 59.1 Hz provided there is no adverse impact to neighboring systems and frequency overshoot is adequately addressed.

4. It is not permissible to use frequency set-points that allow frequency to decline below 59.1 Hz before shedding the first block of load, or to shed smaller increments than is called for by the applicable Coordinated Plan.

5. It is permissible to include intermediate frequency set-points (in addition to those specified in the table above), as long as they conform to the same methodology, assumptions, and objectives of the applicable Coordinated Plan.

6. UFLS Entities with load-shedding schemes that differ from this Coordinated Plan (as described in 1a, 1b, or 1c) are responsible for conducting studies to verify that their schemes are adequately coordinated with the rest of the Western Interconnection and do not degrade performance under this Coordinated Plan. The WECC PCC and OC will review these studies to ensure consistency with the Coordinated Plan.

7. Any UFLS Entities with load-shedding blocks that include load controlled by customer-owned relays must have contractual arrangements or other means to ensure (i) appropriate set-points, (ii) adequate maintenance (sufficient to meet applicable Reliability Standards), and (iii) availability of any data or documentation needed to demonstrate compliance.

8. All UFLS Entities that intend to automatically restore load following a load-shedding event must demonstrate their compliance with applicable Reliability Standards. For any event, automatic restoration must begin no sooner than thirty minutes after the frequency has been restored to levels above 59.95 Hz and may not be implemented faster than two percent of the system load every five minutes. If a Balancing Authority Area cannot meet the WECC Area Control Error requirements when automatic or manual load restoration begins, the Balancing Authority's dispatchers must manually trip corresponding load to balance available generation and load. Manually-controlled load restoration, if available and practical, is preferable to automatic restoration.

9. To the extent load restoration depends on the availability of transmission facilities, operators must not attempt to restore load until the necessary transmission facilities are operational.

10. Intentional tripping of tie-lines due to underfrequency is permitted at the discretion of the individual UFLS Entities, provided the separation frequency is no higher than 57.9 Hz with a one-second time delay. Even though it is permissible to trip tie-lines at 57.9 Hz, it is preferable that intentional tie-line tripping not be implemented.

11. Transmission Owners shall provide automatic measures such as switching of existing capacitor banks, transmission lines, reactors, generators, or other measures, as necessary, to control overvoltage as a result of UFLS tripping.

12. It is preferred that online generators that protect for off-nominal frequency operation should have relaying protection that accommodates, as a minimum, underfrequency and overfrequency operation for the time frames specified in the following table:

Underfrequency Limit	Overfrequency Limit	* Minimum Time
>59.4 Hz	< 60.6 Hz	N/A (continuous operation)
≤59.4 Hz	≥60.6 Hz	3 minutes
≤58.4 Hz	≥61.6 Hz	30 seconds
≤57.8 Hz		7.5 seconds
≤57.3 Hz		45 cycles
≤57.0 Hz	≥61.7 Hz	Instantaneous trip

* Minimum Time is the time the generator should stay interconnected and producing power.

13. Generator Owners that have generators that do not meet the requirements in Item 12 must either (a) automatically trip load (in addition to the amounts required by Item 1a, 1b, 1c, or combinations thereof of this Section E) to match the anticipated generation loss at comparable frequency levels, or (b) have contractual relationships providing for automatic load shedding.

14. Generator Owners that own or operate generating facilities must provide data regarding the off-nominal frequency protection settings of their units, in accordance with applicable Reliability Standards, and must also report any changes in settings.

15. UFLS Entities may use only solid state or microprocessor underfrequency relays to implement load shedding in accordance with this Coordinated Plan. Load tripped by any other means will not be considered in determining compliance with this Coordination Plan.

16. Generators providing off-nominal frequency protection in the range of 57.9-61.0 Hz in compliance with this Coordinated Plan may use only solid state or microprocessor frequency relays.

17. Generators may use electro-mechanical frequency relays only for settings outside the 57.9-61.0 Hz range.

18. All frequency relays must use the definite time characteristic specified in this Coordinated Plan. They should not be disabled for voltages 80 percent of nominal or higher, but may be disabled for voltages below 80 percent of nominal (at the discretion of the setting entity).

20. UFLS Entities may use direct load tripping if it complements this Coordinated Plan.

21. UFLS Entities within a sub-area of the Western Interconnection may combine their armed load with other UFLS Entities to collectively meet the requirements of the Coordinated Plan. UFLS Entities that elect to meet the requirements of the Coordinated Plan by combining their armed load with others shall have documentation demonstrating that their sub-area plan is adequately coordinated with the rest of the Western Interconnection and does not degrade performance under this Coordinated Plan.

22. The WECC Reliability Coordinator has developed comprehensive and detailed guides for the restoration of load following a load shedding event.

F. Sub-Areas

The WECC PCC and OC recognize the potential for sub-areas to form within the Western Interconnection. These sub-areas may have different set-points and associated armed load, but they must conform to the same methodology, assumptions, and objectives of the Coordinated Plan. Sub-areas with their own plans must demonstrate through simulation that the Western Interconnection does not suffer any degradation due to the sub-area plan. Sub-areas may not have settings that fall below the settings specified in this Coordinated Plan.

Sub-areas must present their plans to the WECC PCC and OC in detail, and in a format similar to Section E of this Coordinated Plan, along with simulation results using the GE PSLF program or another WECC-approved program. There are two sub-area plans that have been accepted by the WECC as compliant with this Coordinated Plan: the Northwest Power Pool Underfrequency Load Shedding Plan, and the Southern Islanding Load Tripping Plan. These two sub-area plans are illustrated above in Section E, items 1b and 1c.

G. Members and Data

A key component of the Coordinated Plan is data submittal by UFLS Entities. This Coordinated Plan relies on each Balancing Authority Area's load to determine the amount of load that must be dropped. The Balancing Authority or its Agent(s) must coordinate among all effective UFLS Entities within its area to assure all requirements of the Coordinated Plan are met.

Each Distribution Provider, Transmission Operator, Generation Owner, and Transmission Owner must:

1. Implement and coordinate its actions; and create, maintain, and submit documentation as necessary to carry out this Coordinated Plan.
2. Annually compile data and dynamics files for their entire loads, in the format specified by WECC and in accordance with applicable Reliability Standards.

3. Submit their compiled data and dynamics files upon request.

The WECC PCC and OC, or a designated subcommittee, will annually review the Coordinated Plan submittals to confirm that all the required information is in the format necessary to comply with applicable Reliability Standards.

H. Individual and Groups

Any WECC member may elect to demonstrate its conformance to this Coordinated Plan on the basis of its own individual program. Other UFLS Entities may elect to work together to meet the requirements of this Coordinated Plan.

Any groups of UFLS Entities constituted for purpose of implementing coordinated load shedding in conformance with this Coordinated Plan:

1. Will have the same responsibilities and obligations as individual UFLS Entities to monitor and meet the plan’s requirements.
2. Must specify in a written document each participant’s responsibilities.
3. Must designate an agent to be responsible for all data submission requirements and simulations to demonstrate compliance.

The WECC PCC and OC will compile an annual listing of the current underfrequency relays and associated armed load.

I. Review and Update

The WECC PCC and OC will maintain a UFLS database containing data within the WECC model for use in event analyses and assessments of the UFLS program at least once each calendar year, with no more than 15 months between maintenance activities.

The WECC PCC and OC will assess and document the effectiveness of the design and implementation of this Coordinated Plan at least once every five years. The WECC PCC and OC may recommend to the WECC Board of Directors changes to this Coordinated Plan as necessary to reflect system changes in the Western Interconnection.

Document name	**Underfrequency Load Shedding Criterion** **PRC-006-WECC-CRT-1** **WECC Criterion**
Category	( ) Regional Reliability Standard (X) Regional Criteria ( ) Regional Business Practice ( ) Policy ( ) Guideline ( ) Report or other ( ) Charter
Document date	December 6, 2012
Adopted/approved by	WECC Board of Directors
Date adopted/approved	December 6, 2012
Custodian (entity responsible for maintenance and upkeep)	UFLS Review Group
Stored/filed	Physical location: Web URL:
Previous name/number	(if any)
Status	(X) in effect ( ) usable, minor formatting/editing required ( ) modification needed ( ) superseded by ______________________ ( ) other ______________________________ ( ) obsolete/archived)

Version Control

Version	Date	Action	Change
1	12/6/2012	WECC Board of Directors Approved	Initial version

A. Introduction

1. Title: Underfrequency Load Shedding Criterion
WECC Criterion

2. Number: PRC-006-WECC-CRT-1

3. Purpose: To document the WECC Off-Nominal Frequency Load Shedding Plan (Coordinated Plan), and to assure consistent and coordinated requirements for the Coordinated Plan among all WECC applicable entities.

4. Applicability:

4.1. Balancing Authority

4.2. Underfrequency load shedding entities (UFLS Entities) shall mean all entities that are responsible for the ownership, operation, or control of UFLS equipment as required by the Coordinated Plan. Such entities may include one or more of the following:

4.2.1. Transmission Owner
4.2.2. Distribution Provider

4.3. Generator Owner
4.4. Transmission Operator
4.5. Reliability Assurer

5. Effective Date: January 1, 2013

B. Requirements and Measures

WR1. The Reliability Assurer (WECC) shall designate the WECC Underfrequency Load Shedding Review Group (Review Group) or its successor, as the WECC group that annually reviews the Coordinated Plan.

WM1. The Reliability Assurer shall have and produce upon request, evidence that it designated the WECC Underfrequency Load Shedding Review Group (Review Group) or its successor as the group that annually reviews the Coordinated Plan, in accordance with WR1. Evidence shall include the minutes from the Joint Guidance Committee, or its successor, indicating the designation.

WR2. The Reliability Assurer (WECC) shall verify the Coordinated Plan contains the comprehensive data and information necessary to comply with NERC Reliability Standard PRC-006-1.

WM2. The Reliability Assurer shall have and provide upon request, evidence verifying the Coordinated Plan contains the comprehensive data and information necessary to comply with NERC Reliability Standard PRC-006-1, in accordance with WR2. Evidence may include, but is not limited to, production of the database containing the data as required in PRC-006-1.

WR3. The Reliability Assurer (WECC) shall instruct the Review Group to annually conduct simulations of the Coordinated Plan (Attachment A) by November 1 of each year, to ensure the Coordinated Plan meets all the requirements of NERC Reliability Standard PRC-006-1.

WM3. The Reliability Assurer shall have and provide upon request, evidence that it instructed the Review Group to annually conduct simulations of the Coordinated Plan (Attachment A) by November 1 of each year, to ensure the Coordinated Plan meets all the requirements of NERC Reliability Standard PRC-006-1, in accordance with WR3. Evidence may include, but is not limited to: 1) documentation that the Reliability Assurer made the required instruction, or 2) Review Group reports or other documentation showing the simulations were conducted no later than November 1 of each year.

WR4. The Reliability Assurer (WECC) shall verify that the Review Group conducts an annual review of the Coordinated Plan (Attachment A) for completion no later than November 1 of each year, to determine whether changes are necessary to the Coordinated Plan.

WM4. The Reliability Assurer shall have and provide upon request, evidence that the Review Group conducted an annual review of the Coordinated Plan (Attachment A) for completion no later than November 1 of each year, to determine whether changes are necessary to the Coordinated Plan, in accordance with WR4. Evidence may include, but is not limited to: 1) documentation that the Reliability Assurer verified that the Review Group completed the required review, or 2) reports or other documentation produced by the Review Group indicating the reviews were done no later than November 1 of each year.

WR5. Each Balancing Authority shall annually allocate its Balancing Authority Area's Peak Demand to its respective Transmission Operator(s) based upon its previous year's actual Balancing Authority Area's Peak Demand, by June 1.

WM5. Each Balancing Authority shall have and provide upon request, evidence that it annually allocated its Balancing Authority Area's Peak Demand to its respective Transmission Operator(s) based upon its previous year's actual Balancing Authority Area's Peak Demand, by June 1, in accordance with WR5. Evidence may include, but is not limited to: a written document illustrating that it has supplied the information to its respective Transmission Operator(s).

WR6. Each Transmission Operator shall identify to the Review Group and to its UFLS Entities, each sub-area Coordinated Plan of the Coordinated Plan it has adopted.

WM6. Each Transmission Operator shall have and provide upon request, evidence that it identified to the Review Group and to its UFLS Entities, each sub-area Coordinated Plan of the Coordinated Plan it has adopted, in accordance with WR6. Evidence shall include, but is not limited to: documentation indicating which sub-area Coordinated Plan(s) of the Coordinated Plan it has adopted, and that the identified sub-area Coordinated Plan(s) were communicated to the Review Group and its UFLS Entities. This documented evidence may be in the form of a copy of documentation provided to the Review Group and the UFLS Entities indicating the sub-area Coordinated Plan(s) it adopted.

WR7. Each Transmission Operator shall coordinate implementation of each adopted sub-area Coordinated Plan contained in the Coordinated Plan with each of its UFLS Entities.

WM7. Each Transmission Operator shall have and provide upon request, evidence that it coordinated implementation of each adopted sub-area Coordinated Plan contained in the Coordinated Plan with each of its UFLS Entities, in accordance with WR7. Evidence may include, but is not limited to evidence of how the adopted sub-area Coordinated Plan of the Coordinated Plan is implemented among the TOP and the UFLS Entities.

WR8. Each UFLS Entity or its designated agent shall coordinate and provide documentation of its responsibilities in meeting the Coordinated Plan to the Review Group. Documentation shall include:

1. A listing of its responsibilities as required under the Coordinated Plan.
2. A designation of the agent responsible for all data submission to demonstrate compliance with the Coordinated Plan

WM8. Each UFLS Entity or its designated agent shall have and provide upon request, evidence that it coordinated and provided documentation of its responsibilities in meeting the Coordinated Plan to the Review Group, in accordance with the criteria set forth in WR8. Evidence may include, but is not limited to a copy of the required documentation and evidence that it was provided to the Review Group.

WR9. Each UFLS Entity or its designated agent shall compile their respective Coordinated Plan data and dynamics file in the WECC-defined format, as listed in the Coordinated Plan – Data Submittals Requirements (Attachment B of this criterion), for its entire load and annually, by July 1, submit Attachment B to the Review Group and to the UFLS Entity’s respective Transmission Operator.

WM9. Each UFLS Entity or its designated agent shall have and provide upon request, evidence that it compiled its respective Coordinated Plan data and dynamics file meeting the criteria establish in WR9.

Evidence may include, but is not limited to, reports or other documentation demonstrating that it has complied with WR9.

WR10. Each UFLS Entity or its designated agent shall implement the Coordinated Plan as documented by the Transmission Operator(s) in WR7.

WM10. Each UFLS Entity or its designated agent shall have and provide upon request, evidence that it implemented the Coordinated Plan as documented by the Transmission Operator(s) in WR7, in accordance with WR10. Evidence may include, but is not limited to, production of reports or other documentation demonstrating that it has complied with WR10.

WR11. Each Generator Owner shall implement the Coordinated Plan.

WM11. Each Generator Owner shall have and produce upon request, evidence that it implemented the Coordinated Plan. Evidence may include, but is not limited to production of reports or other documentation demonstrating that it has complied with WR11.

WR12. Each Generator Owner shall annually compile and submit to the Review Group, no later than June 1, their respective Coordinated Plan data and dynamics file for its generation, in the format defined in Attachment B of this criterion.

WM12. Each Generator Owner shall have and provide upon request, evidence that it submitted its respective Coordinated Plan data and dynamics file for its generation, in the format defined in Attachment B of this criterion, to the Review Group, meeting the criteria set forth in WR12. Evidence may include, but is not limited to, production of reports or other documentation demonstrating that it has complied with WR12.

WR13. The Reliability Assurer (WECC) shall designate the Review Group to coordinate and perform all post-event analyses associated with the Coordinated Plan.

WM13. The Reliability Assurer shall have and provide upon request, evidence that it designated the Review Group to coordinate and perform all post-event analyses associated with the Coordinated Plan, in accordance with WR13. Evidence may include, but is not limited to, 1) documentation that the Reliability Assurer verified that the Review Group completed the post event analyses, or 2) reports or other documentation produced by the Review Group indicating the post event analyses were completed.

WR14. The Reliability Assurer (WECC) shall instruct the Review Group, or its successor, to review Attachment B, the Coordinated Plan – Data Submittals Requirements, at least once a year, and make changes as deemed necessary by the Review Group.

W**M14.** The Reliability Assurer shall have and provide upon request, evidence that it instructed the Review Group, or its successor, to review Attachment B, the Coordinated Plan – Data Submittals Requirements, at least once a year, and make changes as deemed necessary by the Review Group, in accordance with WR14. Evidence may include, but is not limited to any form of correspondence between the Reliability Assurer and the Review Group containing the prescribed instruction.

Attachment A

The Western Electricity Coordinating Council "Off-Nominal Frequency Load Shedding Plan" is located in the WECC/Library/Document Categorization Files/Polices folder.

Underfrequency Load Shedding Criterion
PRC-006-WECC-CRT-1

Attachment B

Western Electricity Coordinating Council Off-Nominal Frequency Load Shedding Plan - Data Submittals Requirements

The Attachment A Western Electricity Coordinating Council "Off-Nominal Frequency Load Shedding Plan" is located in the WECC/Library/Document Categorization Files/Polices folder.

The Attachment B, PRC-006-WECC-CRT-1 Excel Reporting Form can be found in the Standards/Approved Regional Criteria/All Documents file.

Appendix O: List of Problematic Models

<u>Problematic Generator Models – 2015 Heavy Summer</u>

BUS-NO	NAME1	KV1	ID	PGEN	AREA
15193	C643T_G1	0.48	C3	93.8	14
21015	DPWR#3	13.8	1	50	21
21092	UNIT5L	13.8	1	46	21
22082	BR GEN1	0.21	1	19	22
22172	DIVISION	69	1	34.4	22
22576	NOISLMTR	69	1	42.7	22
22660	POINTLMA	69	1	16.7	22
22660	POINTLMA	69	2	1.6	22
24026	CIMGEN	13.8	D1	25.3	24
24140	SIMPSON	13.8	D1	37	24
27117	WTGCP	0.69	1	40	26
27119	WTGGE	0.57	GE	20	26
27123	WTGGE2	0.57	1	20	26
27358	GRAY_8BC	13.8	8b	42.9	26
29207	BLY1CT1	16	1	170	24
29208	BLY1CT2	16	1	170	24
29209	BLY1ST1	16	1	180	24
31465	WHEELBR1	9.1	2	16	30
31465	WHEELBR1	9.1	3	16	30
31465	WHEELBR1	9.1	1	16	30
31832	SLY.CR.	6.6	1	9.5	30
31906	COLEMAN	6.6	1	10	30
32740	HILLSIDE	115	1	25.5	30
33118	GATEWAY1	18	1	203	30
33119	GATEWAY2	18	1	192.2	30
33120	GATEWAY3	18	1	192.2	30
36413	UNION OL	13.8	1	5.6	30
37581	SPRINGCR	13.8	1	82	30
37581	SPRINGCR	13.8	2	82	30
40361	DWOR 1	13.8	1	91.7	40
42014	ENSERCHL	13.8	L	53	40
43407	PELTON	13.8	1	36.8	40
43407	PELTON	13.8	2	26.6	40
43407	PELTON	13.8	3	26.6	40
44971	LAKESISK	69	1	0.9	40
45026	BIOMASS	13.8	N	8.9	40
45124	COPCO 1	69	1	7.5	40
45485	SLATECRK	4.2	1	0.9	40
47740	CENTR G1	20	1	712	40
47744	CENTR G2	20	2	712	40

50294	VIT 12C1	12.7	1	0	50
50295	VIT 12C2	12.7	2	0	50
50296	VIT 12C3	12.6	3	0	50
50297	VIT 12C4	12.6	4	0	50
50437	KMO 13G1	13.8	1	106.2	50
50438	KMO 13G2	13.8	2	106.2	50
50439	KMO 13G3	13.8	3	106.2	50
50440	KMO 13G4	13.8	4	106.2	50
50441	KMO 13G5	13.8	5	106.2	50
50442	KMO 13G6	13.8	6	106.2	50
50443	KMO 13G7	13.8	7	106.2	50
50444	KMO 13G8	13.8	8	106.2	50
50496	GMS 13G2	13.8	2	260	50
50497	GMS 13G3	13.8	3	260	50
50502	GMS 13G8	13.8	8	280	50
50513	PCN 13G1	13.8	1	160	50
50514	PCN 13G2	13.8	2	160	50
50641	KLY 12C1	12.5	1	0	50
50642	WHN 4G	4.33	1	1.6	50
50918	AKO 25G1	25.2	1	3.5	50
51143	VLG .6G1	0.6	1	1	50
51143	VLG .6G1	0.6	2	1	50
54424	KEEP#2GN	19	2A	392.8	54
56249	LNGLKCG2	13.8	G2	78.3	54
56264	HORUP6	13.8	5	13.5	54
56405	CONKLIN2	13.8	1	71.1	54
56405	CONKLIN2	13.8	1	71.1	54
57249	LNGLKCG1	13.8	G1	78.3	54
57264	HORUP7	13.8	G1	70.7	54
57405	CONKLIN4	13.8	2	71.6	54
57405	CONKLIN4	13.8	2	71.6	54
60032	TUANAGEN	0.69	1	25	60
60417	HIGHMESA	0.6	1	10	60
61293	BTCKWIND	0.6	1	20	60
61811	MINIDOKA	2.4	6	2	60
61811	MINIDOKA	2.4	7	4	60
61812	MINIDOKA	4.16	8	8	60
61812	MINIDOKA	4.16	9	9	60
64131	VALMY G1	22	1	240	64
64132	VALMY G2	18	1	260	64
64150	BEOWAWE	4.16	1	15	64
65021	MAGCORP	13.8	1	10.5	65
65021	MAGCORP	13.8	2	10.5	65

65021	MAGCORP	13.8	3	10.5	65
65191	BONANZA	24	1	488	65
65430	DAVEJON1	13.8	1	104	65
65435	DAVEJON2	13.8	1	104	65
65440	DAVEJON3	13.8	1	228	65
65445	DAVEJON4	22	1	338	65
65625	GEMST G1	13.8	1	10	65
65953	MATHNTON	138	1	0	65
66730	WYODAK 1	22	1	380	65
69020	MTNWD G2	0.6	1	17	65
69022	MTNWD G4	0.6	1	22	65
70503	PONNEQUI	26.1	W1	6.3	70
70723	RDGCREST	34.5	W1	6.3	70
73341	NSS2	13.8	2	93	73
74014	NSS_CT1	13.8	1	28	73
74015	NSS_CT2	13.8	1	40	73
74016	WYGEN	13.8	1	93	73
74017	WYGEN2	13.8	1	100	73
74018	WYGEN3	13.8	1	110	73
74029	LNG_CT1	13.8	1	40	73
76404	DRYFORK	19	1	420	73
79162	CRYSTAL	12.5	1	17	73
80594	FKR G1-3	13.8	2	13.2	50
80594	FKR G1-3	13.8	1	13.2	50
570107	GENCOG7	20	7	0	54
570157	GENCOG57	13.8	57	12	54
570158	GENCOG58	13.8	58	8	54
623541	MONTANA ONE	13.8	1	38	62

List of Problematic Motor Models – 2015 Heavy Summer

BUS-NO	NAME1	KV1	ID	PGEN	AREA
25411	EAGLEMP1	6.9	1	-9.3	24
25411	EAGLEMP1	6.9	2	-9.3	24
25411	EAGLEMP1	6.9	3	-9.3	24
25411	EAGLEMP1	6.9	4	-9.3	24
25412	EAGLEMP2	6.9	6	-9.3	24
25412	EAGLEMP2	6.9	8	-9.3	24
25412	EAGLEMP2	6.9	7	-9.3	24
25412	EAGLEMP2	6.9	5	-9.3	24
25417	IRONMTP1	6.9	4	-3.2	24
25417	IRONMTP1	6.9	3	-3.2	24

25417	IRONMTP1	6.9	1	-3.2	24
25417	IRONMTP1	6.9	2	-3.2	24
25418	IRONMTP2	6.9	7	-3.2	24
25418	IRONMTP2	6.9	8	-3.2	24
25418	IRONMTP2	6.9	9	-3.2	24
25418	IRONMTP2	6.9	6	-3.2	24
25419	JHINDSP1	6.9	4	-9.3	24
25419	JHINDSP1	6.9	1	-9.3	24
25419	JHINDSP1	6.9	2	-9.3	24
25419	JHINDSP1	6.9	3	-9.3	24
25420	JHINDSP2	6.9	7	-9.3	24
25420	JHINDSP2	6.9	8	-9.3	24
25420	JHINDSP2	6.9	5	-9.3	24
25420	JHINDSP2	6.9	6	-9.3	24
56941	LONGLK17	13.8	M1	-14.5	54
57259	HORUP8	13.8	1B	-2.1	54
57265	HORUP9	13.8	51	-1.1	54
57438	CAN LIQ8	4.16	5	-7	54
58205	AMOCO R9	4.16	2	-1.5	54
58205	AMOCO R9	4.16	1	-1.5	54
58384	UNION C9	13.8	2	-5.4	54
58384	UNION C9	13.8	1	-7	54
58462	HORUP11	13.8	1A	-2.1	54
58941	LONGLK14	13.8	22	-3.6	54
59241	LONGLK19	4.2	11	-1.2	54
59264	HORUP12	13.8	M1	-2.1	54
59741	LONGLK18	13.8	21	-3.6	54
59841	LONGLK16	4.2	12	-1.2	54
59941	LONGLK15	13.8	M2	-14.5	54
60075	BRDYS011	13.8	1	-0.7	60
60076	BRDYS012	13.8	1	-0.6	60

Problematic Generator Models – 2015 Heavy Spring

BUS-NO	NAME1	KV1	ID	PGEN	AREA
21015	DPWR#3	13.8	1	50	21
21092	UNIT5L	13.8	1	46	21
27119	WTGGE	0.57	GE	34.1	26
27123	WTGGE2	0.57	1	49.2	26
27358	GRAY_8BC	13.8	8b	36.5	26
29207	BLY1CT1	16	1	170	24
29208	BLY1CT2	16	1	170	24

29209	BLY1ST1	16	1	180	24
31460	0105-WD	115	FW	5.5	30
31465	WHEELBR1	9.1	3	16.6	30
31465	WHEELBR1	9.1	1	16.6	30
31465	WHEELBR1	9.1	2	16.6	30
31800	SMPSN-AN	12.47	1	42	30
31824	VOLTA1-2	9.11	2	0.7	30
31824	VOLTA1-2	9.11	1	7	30
31826	SOUTH G	4.16	1	7	30
31906	COLEMAN	6.6	1	11	30
32740	HILLSIDE	115	1	25.7	30
33118	GATEWAY1	18	1	204	30
33119	GATEWAY2	18	1	192.6	30
33120	GATEWAY3	18	1	192.6	30
33171	TRSVQ+NW	9.11	2	8.4	30
33171	TRSVQ+NW	9.11	1	14.7	30
35040	KERNRDGE	9.11	2	1	30
35040	KERNRDGE	9.11	1	40	30
36413	UNION OL	13.8	1	5.3	30
40015	ADAIR	115	1	5.6	40
40361	DWOR 1	13.8	1	91.7	40
43407	PELTON	13.8	2	26.6	40
43407	PELTON	13.8	3	26.6	40
43407	PELTON	13.8	1	36.8	40
44971	LAKESISK	69	1	0.9	40
45026	BIOMASS	13.8	N	8.9	40
45485	SLATECRK	4.2	1	0.9	40
50437	KMO 13G1	13.8	1	106.2	50
50438	KMO 13G2	13.8	2	106.2	50
50439	KMO 13G3	13.8	3	106.2	50
50440	KMO 13G4	13.8	4	106.2	50
50441	KMO 13G5	13.8	5	106.2	50
50442	KMO 13G6	13.8	6	106.2	50
50443	KMO 13G7	13.8	7	106.2	50
50444	KMO 13G8	13.8	8	106.2	50
50641	KLY 12C1	12.5	1	0	50
56249	LNGLKCG2	13.8	G2	67.1	54
56264	HORUP6	13.8	5	13.5	54
56405	CONKLIN2	13.8	1	71.1	54
57249	LNGLKCG1	13.8	G1	67.1	54
57264	HORUP7	13.8	G1	70.7	54
57405	CONKLIN4	13.8	2	71.6	54
60032	TUANAGEN	0.69	1	50	60

60036	BLISS 1	13.8	1	24	60
60037	BLISS 2	13.8	1	16	60
60160	HUNT	138	1	45	60
60201	L SAMN 1	13.8	1	16	60
60202	L SAMN 2	13.8	1	16	60
60246	MILNER	13.8	2	9	60
60246	MILNER	13.8	1	14	60
60353	TWINFALS	13.8	1	19	60
60417	HIGHMESA	0.6	1	10	60
61293	BTCKWIND	0.6	1	20	60
61811	MINIDOKA	2.4	6	2	60
61811	MINIDOKA	2.4	7	4	60
61812	MINIDOKA	4.16	8	8	60
61812	MINIDOKA	4.16	9	9	60
64131	VALMY G1	22	1	240	64
64132	VALMY G2	18	1	260	64
64150	BEOWAWE	4.16	1	15	64
65021	MAGCORP	13.8	2	10.5	65
65021	MAGCORP	13.8	3	10.5	65
65021	MAGCORP	13.8	1	10.5	65
65393	CURRNTS1	18	1	245	65
65625	GEMST G1	13.8	1	10	65
65953	MATHNTON	138	1	0	65
66730	WYODAK 1	22	1	380	65
69020	MTNWD G2	0.6	1	17	65
69022	MTNWD G4	0.6	1	22	65
70503	PONNEQUI	26.1	W1	6.3	70
70723	RDGCREST	34.5	W1	6.3	70
74014	NSS_CT1	13.8	1	28	73
74015	NSS_CT2	13.8	1	40	73
74016	WYGEN	13.8	1	93	73
74017	WYGEN2	13.8	1	100	73
74018	WYGEN3	13.8	1	110	73
74029	LNG_CT1	13.8	1	40	73
76404	DRYFORK	19	1	420	73
79162	CRYSTAL	12.5	1	15	73
80416	DSQ 7G	6.9	1	0.4	50
80594	FKR G1-3	13.8	1	13.1	50
80594	FKR G1-3	13.8	2	13.1	50
570107	GENCOG7	20	7	0	54
570157	GENCOG57	13.8	57	12	54
570158	GENCOG58	13.8	58	8	54
622531	RYAN GEN1-3	6.6	3	9	62

622531	RYAN GEN1-3	6.6	1	9	62
622531	RYAN GEN1-3	6.6	2	9	62
622532	RYAN GEN4-6	6.6	5	9	62
622532	RYAN GEN4-6	6.6	4	9	62
622532	RYAN GEN4-6	6.6	6	9	62
623541	MONTANA ONE	13.8	1	40	62

List of Problematic Motor Models – 2015 Heavy Spring

BUS-NO	NAME1	KV1	ID	PGEN	AREA
25411	EAGLEMP1	6.9	1	-9.3	24
25411	EAGLEMP1	6.9	2	-9.3	24
25411	EAGLEMP1	6.9	3	-9.3	24
25411	EAGLEMP1	6.9	4	-9.3	24
25412	EAGLEMP2	6.9	6	-9.3	24
25412	EAGLEMP2	6.9	8	-9.3	24
25412	EAGLEMP2	6.9	7	-9.3	24
25412	EAGLEMP2	6.9	5	-9.3	24
25413	GENE P1	6.9	1	-6.7	24
25413	GENE P1	6.9	2	-6.7	24
25413	GENE P1	6.9	3	-6.7	24
25413	GENE P1	6.9	4	-6.7	24
25417	IRONMTP1	6.9	4	-3.2	24
25417	IRONMTP1	6.9	3	-3.2	24
25417	IRONMTP1	6.9	1	-3.2	24
25417	IRONMTP1	6.9	2	-3.2	24
25418	IRONMTP2	6.9	7	-3.2	24
25418	IRONMTP2	6.9	8	-3.2	24
25418	IRONMTP2	6.9	9	-3.2	24
25418	IRONMTP2	6.9	6	-3.2	24
25419	JHINDSP1	6.9	4	-9.3	24
25419	JHINDSP1	6.9	1	-9.3	24
25419	JHINDSP1	6.9	2	-9.3	24
25419	JHINDSP1	6.9	3	-9.3	24
25420	JHINDSP2	6.9	7	-9.3	24
25420	JHINDSP2	6.9	8	-9.3	24
25420	JHINDSP2	6.9	5	-9.3	24
25420	JHINDSP2	6.9	6	-9.3	24
56941	LONGLK17	13.8	M1	-14.5	54
57259	HORUP8	13.8	1B	-2.1	54
57265	HORUP9	13.8	51	-1.1	54
57438	CAN LIQ8	4.16	5	-7	54

58205	AMOCO R9	4.16	2	-1.5	54
58205	AMOCO R9	4.16	1	-1.5	54
58384	UNION C9	13.8	1	-7	54
58384	UNION C9	13.8	2	-5.4	54
58462	HORUP11	13.8	1A	-2.1	54
58941	LONGLK14	13.8	22	-3.6	54
59241	LONGLK19	4.2	11	-1.2	54
59264	HORUP12	13.8	M1	-2.1	54
59741	LONGLK18	13.8	21	-3.6	54
59841	LONGLK16	4.2	12	-1.2	54
59941	LONGLK15	13.8	M2	-14.5	54

List of Changes Made to DYD Files For Both Base Cases – TLIN models not acting correctly

```
# Block 1 59.3 Hz
lsdt9    42637 "PEASLY  " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42657 "W.AUBURN" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42599 "FALCON  " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42592 "EARLGTON" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42605 "HAZELWD " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42452 "SOMERSET" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42450 "SMERCER " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42614 "LIQ. AIR" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42591 "E.VALLEY" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42630 "NORPAC  " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42656 "VICTORIA" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42753 "EDGEWOOD" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42747 "CEDARHST" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42778 "STEWART " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42950 "LONG LK " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42942 "FRAGARIA" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
#tlin1    42701 "WHITE RV" 115.00 "1 "    42595 "ELLNGTAP" 115.00 "1 "  1 : #9 0 0 0 42504 59.3000 0.233333 0.100000
#tlin1    42504 "OBRIEN  " 115.00 "1 "    42657 "W.AUBURN" 115.00 "1 "  1 : #9 0 0 0 42701 59.3000 0.233333 0.100000
#tlin1    42513 "OBRIEN N" 115.00 "1 "    42599 "FALCON  " 115.00 "1 "  1 : #9 0 0 0 42525 59.3000 0.233333 0.100000
#tlin1    42525 "SHUF115 " 115.00 "1 "    42592 "EARLGTON" 115.00 "1 "  1 : #9 0 0 0 42504 59.3000 0.233333 0.100000
#tlin1    42525 "SHUF115 " 115.00 "1 "    42622 "MER.IS.T" 115.00 "1 "  1 : #9 0 0 0 42303 59.3000 0.233333 0.100000
#tlin1    42303 "LAKESIDE" 115.00 "1 "    42452 "SOMERSET" 115.00 "1 "  1 : #9 0 0 0 42525 59.3000 0.233333 0.100000
#tlin1    42504 "OBRIEN  " 115.00 "1 "    42614 "LIQ. AIR" 115.00 "1 "  1 : #9 0 0 0 42502 59.3000 0.233333 0.100000
#tlin1    42502 "TALBOT  " 115.00 "1 "    42656 "VICTORIA" 115.00 "1 "  1 : #9 0 0 0 42504 59.3000 0.233333 0.100000
#tlin1    42701 "WHITE RV" 115.00 "1 "    42753 "EDGEWOOD" 115.00 "1 "  1 : #9 0 0 0 42704 59.3000 0.233333 0.10000
#tlin1    42704 "ALDERTON" 115.00 "1 "    42778 "STEWART " 115.00 "1 "  1 : #9 0 0 0 42701 59.3000 0.233333 0.100000
#tlin1    42514 "OBRIEN S" 115.00 "1 "    42645 "S.DMOINE" 115.00 "1 "  1 : #9 0 0 0 42645 59.3000 0.233333 0.100000
#tlin1    42950 "LONG LK " 115.00 "1 "    42942 "FRAGARIA" 115.00 "1 "  1 : #9 0 0 0 42504 59.3000 0.233333 0.100000
lsdt9    42184 "SUMMITPK" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000
lsdt9    42054 "LAUREL P" 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 0.900000
lsdt9    42763 "KNOBLEP " 115.00 "1 " : #9 0.000000 0.400000  59.3000 0.233333 0.100000 1.000000

# Block 2 59.2 Hz
lsdt9    42649 "SHERWD  " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42626 "MSTREET " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42613 "LEAHILL " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42647 "SEQUOIA " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42651 "SOOSCRK " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42643 "ROLLHLS " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
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lsdt9    42636 "PANTHRLK" 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42602 "GLENCARN" 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42617 "LKMERIDI" 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42877 "MOTTMAN " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42869 "GRIFFIN " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42866 "ELDINLET" 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
#tlin1    42701 "WHITE RV" 115.00 "1 "    42650 "SHERWD T" 115.00 "1 "  1 : #9 0 0 0 42508 59.2000 0.233333 0.100000
#tlin1    42508 "BERRYDAL" 115.00 "1 "    42651 "SOOSCRK " 115.00 "1 "  1 : #9 0 0 0 42701 59.2000 0.233333 0.100000
#tlin1    42511 "TALBOT N" 115.00 "1 "    42643 "ROLLHLS " 115.00 "1 "  1 : #9 0 0 0 42508 59.2000 0.233333 0.100000
#tlin1    42508 "BERRYDAL" 115.00 "1 "    42617 "LKMERIDI" 115.00 "1 "  1 : #9 0 0 0 42502 59.2000 0.233333 0.100000
lsdt9    42153 "GAGES   " 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
#tlin1    42809 "OLY P N " 115.00 "1 "    42877 "MOTTMAN " 115.00 "1 "  1 : #9 0 0 0 42815 59.2000 0.233333 0.100000
#tlin1    42815 "WEST OLY" 115.00 "1 "    42866 "ELDINLET" 115.00 "1 "  1 : #9 0 0 0 42800 59.2000 0.233333 0.100000
lsdt9    42894 "FR.GROVE" 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000
lsdt9    42948 "KINGSTON" 115.00 "1 " : #9 0.000000 0.400000  59.2000 0.233333 0.100000 1.000000

# Block 3 59.0 Hz
lsdt9    42765 "LK.TAPPS" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42579 "WABASH  " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42578 "W.R.MILL" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42570 "CLAY CRK" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42574 "GREENWTR" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42746 "BUCKLEY " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42786 "WILKNSON" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42440 "PINELAKE" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42474 "PLATEAU " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42446 "SAHALEE " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42380 "AMES LAK" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42618 "LKWILDR " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42608 "HOBART  " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42424 "MIRRORNT" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42876 "MCKINLY " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42870 "JOHNS HL" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42871 "LACEY   " 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
lsdt9    42885 "TANGLEWD" 115.00 "1 " : #9 0.000000 0.400000  59.0000 0.233333 0.100000 1.000000
#tlin1    42702 "WHITE RV"  57.50 "1 "    42765 "LK.TAPPS"  57.50 "1 "  1 : #9 0 0 0 42510 59.0000 0.233333 0.100000
#tlin1    42510 "KRAINCOR"  57.50 "1 "    42579 "WABASH  "  57.50 "1 "  1 : #9 0 0 0 42702 59.0000 0.233333 0.100000
#tlin1    42510 "KRAINCOR"  57.50 "1 "    42532 "STEVNSON"  57.50 "1 "  1 : #9 0 0 0 42706 59.0000 0.233333 0.100000
#tlin1    42706 "ELECTHTS"  57.50 "1 "    42786 "WILKNSON"  57.50 "1 "  1 : #9 0 0 0 42510 59.0000 0.233333 0.100000
#tlin1    42307 "LKTRAD  " 115.00 "1 "    42440 "PINELAKE" 115.00 "1 "  1 : #9 0 0 0 42305 59.0000 0.233333 0.100000
#tlin1    42305 "NOVELTY " 115.00 "1 "    42381 "AMESLKTP" 115.00 "1 "  1 : #9 0 0 0 42307 59.0000 0.233333 0.100000
#tlin1    42508 "BERRYDAL" 115.00 "1 "    42618 "LKWILDR " 115.00 "1 "  1 : #9 0 0 0 42307 59.0000 0.233333 0.100000
```

#tlin1 42307 "LKTRAD " 115.00 "1 " 42424 "MIRRORNT" 115.00 "1 " 1 : #9 0 0 0 42508 59.0000 0.233333 0.100000
#tlin1 42809 "OLY P N " 115.00 "1 " 42876 "MCKINLY " 115.00 "1 " 1 : #9 0 0 0 42803 59.0000 0.233333 0.100000
#tlin1 42805 "ST CLR E" 115.00 "1 " 42885 "TANGLEWD" 115.00 "1 " 1 : #9 0 0 0 42800 59.0000 0.233333 0.100000
lsdt9 42781 "SUNRISEP" 115.00 "1 " : #9 0.000000 0.400000 59.0000 0.233333 0.100000 1.000000
lsdt9 42892 "RAINR VW" 115.00 "1 " : #9 0.000000 0.400000 59.0000 0.233333 0.100000 1.000000
lsdt9 42051 "SEMIAHMO" 115.00 "1 " : #9 0.000000 0.400000 59.0000 0.233333 0.100000 0.770000
lsdt9 42397 "FACTORIA" 115.00 "1 " : #9 0.000000 0.400000 59.0000 0.233333 0.100000 1.000000

tlin1 20065 "CIP-115 " 115.00 "1 " 20073 "EMND-115" 115.0 "1 " 1 : #9 0.0 0.05000 1.0 20068 58.5000 0.100000 0.066667 20065 0.0
#tlin1 20065 "CIP-115 " 115.00 "1 " 20074 "MND-115 " 115.00 "1 " 1 : #9 0.0 0.050000 1.0 20075 58.5000 0.100000 0.066667 20065 0.0
tlin1 20065 "CIP-115 " 115.00 "1 " 20075 "KON-115 " 115.0 "1 " 1 : #9 0.0 0.05000 0.0 20068 58.5000 0.100000 0.066667 20065 0.0
#tlin1 20065 "CIP-115 " 115.00 "1 " 20075 "KON-115 " 115.0 "1 " 1 : #9 0.0 0.05000 1.0 20075 58.5000 0.100000 0.066667 20065 0.0
tlin1 20075 "KON-115 " 115.00 "1 " 20076 "SQN-115 " 115.0 "1 " 1 : #9 0.0 0.05000 2.0 20077 58.5000 0.100000 0.066667 20065 0.0
#tlin1 20075 "KON-115 " 115.00 "1 " 20076 "SQN-115 " 115.0 "1 " 1 : #9 0.0 0.05000 1.0 20077 58.5000 0.100000 0.066667 20065 0.0
tlin1 20075 "KON-115 " 115.00 "1 " 20078 "TRI-115 " 115.0 "1 " 1 : #9 0.0 0.05000 2 .0 20081 58.5000 0.100000 0.066667 20065 0.0
#tlin1 20075 "KON-115 " 115.00 "1 " 20078 "TRI-115 " 115.0 "1 " 1 : #9 0.0 0.05000 1.0 20081 58.5000 0.100000 0.066667 20065 0.0

tlin1 11011 "ANTHONY " 115 "1 " 11031 "BORDER " 115 "1 " 1 : #1 0 0.05 2 11031 58.500 0.1 0.1 11011 2
tlin1 11075 "FELIPE " 69 "1 " 11005 "ALAMO_R " 69 "1 " 1 : #1 0 0.05 2 11074 58.300 0.1 0.1 11075 2
#tlin1 11011 "ANTHONY " 115 "1 " 11031 "BORDER " 115 "1 " 1 : #1 0 0.05 0 11031 58.500 0.1 0.1 11011 2
#tlin1 11075 "FELIPE " 69 "1 " 11005 "ALAMO_R " 69 "1 " 1 : #1 0 0.05 2 11005 58.300 0.1 0.1 11075 2

tlin1 12020 "CLAPHAM" 115 "1 " 12062 "ROSEBUD" 115 "1 " 1 : #9 0 0 2 12063 58.5 0.1 0.183 12020 1 81
tlin1 12100 "GLADSTON" 115 "1 " 12115 "HESSBDW" 115 "1 " 1 : #9 0 0 2 12116 58.9 0.1 0.15 12100 1 81
#tlin1 12020 "CLAPHAM" 115 "1 " 12062 "ROSEBUD" 115 "1 " 1 : #9 0 0 1 12063 58.5 0.1 0.183 12020 1 81
#tlin1 12100 "GLADSTON" 115 "1 " 12115 "HESSBDW" 115 "1 " 1 : #9 0 0 1 12116 58.9 0.1 0.15 12100 1 81
tlin1 40611 "KITSAP " 115.0 "1 " 40077 "BANGOR " 115.0 "1 " 1 : #9 0 0.0500 1 42904 58.600 0.050 0.050
#tlin1 40611 "KITSAP " 115.0 "1 " 40077 "BANGOR " 115.0 "1 " 1 : #9 0 0.0500 2 42982 58.600 0.050 0.050

tlin1 70453 "VILAS " 69 "1 " 70223 "HLTP_TP " 69 "1 " 1 : #9 0 0 2 70403 59.1 0.1 0.183 70453 1 81
tlin1 70453 "VILAS " 69 "1 " 70460 "WALSH " 69 "1 " 1 : #9 0 0 1 70473 59.1 0.1 0.183 70453 1 81
tlin1 70473 "WILLOW_CK" 69 "1 " 70203 "GRANTAP " 69 "1 " 1 : #9 0 0 1 70453 59.1 0.1 0.183 70473 1 81
#tlin1 70467 "WAVERLY " 115 "1 " 72480 "CARMEL " 115 "1 " 1 : #9 0 0 1 70477 58.7 0.1 0.183 70467 1 81