



Interconnection System Impact Study Update Request # GI-2014-7

42 MW Increase to Hydro Pumping Generating Facility
Cabin Creek 230 kV Station, Colorado

Public Service Company of Colorado
Transmission Planning
March 31, 2015

Study Update

Public Service Company of Colorado (PSCo) is providing the interconnection customer a study update regarding stability issues observed for the 42 MW increase in capacity at Cabin Creek pumping hydro generating facility. The following plots show the performance of the generators following a 3-phase fault of the double circuit tower line Cabin Creek – Lookout 230 kV Lines with normal clearing (6 cycles). Also included are several tests of the modeling data to determine where the issue may be occurring.

Figures of plots include:

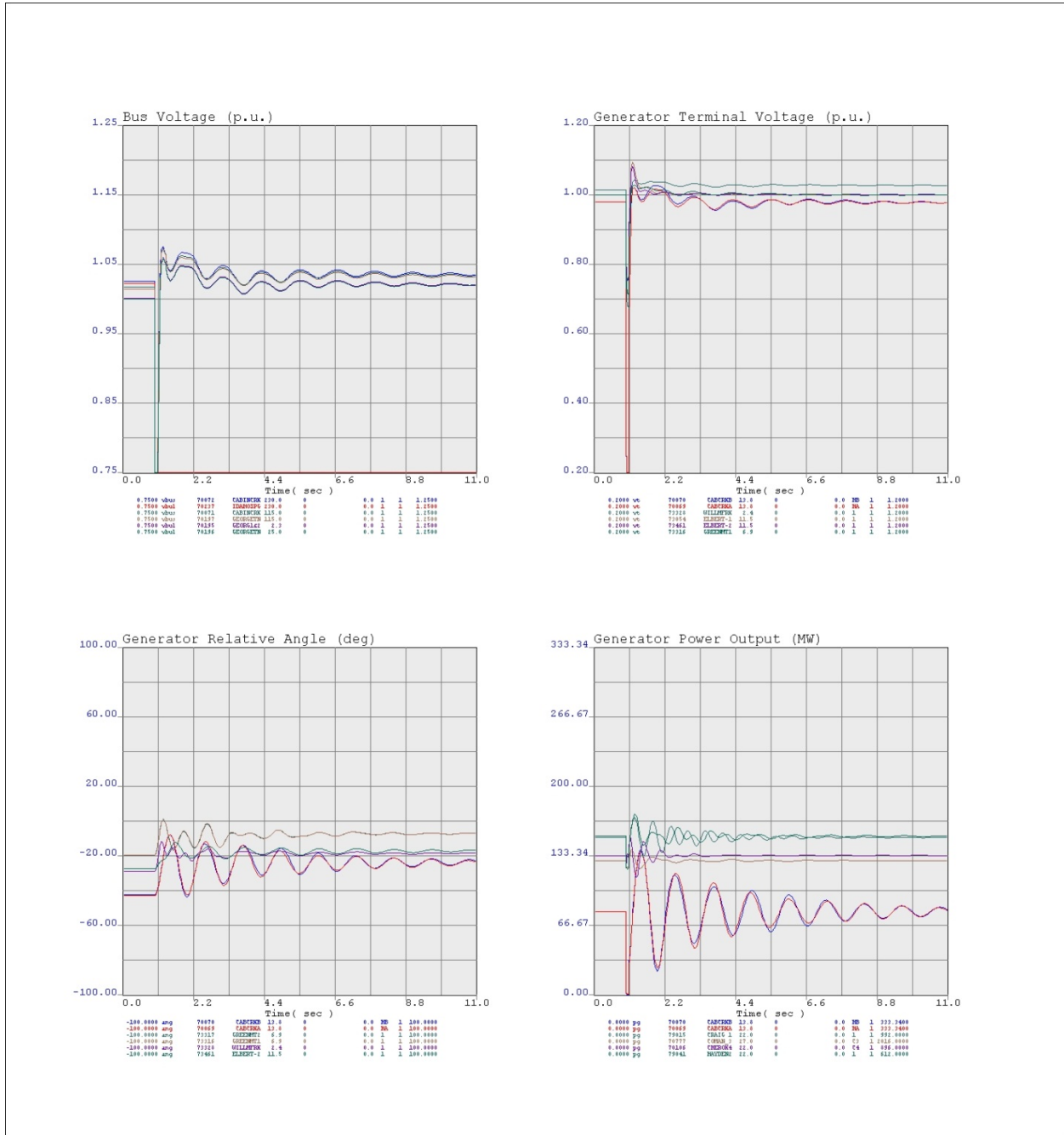
- 1) Benchmark case with Cabin Creek at 160 MW output
- 2) Benchmark case with Cabin Creek at existing full 324 MW output
- 3) Study case with Cabin Creek at requested 366 MW output
- 4) Study case with Cabin Creek exciter models removed
- 5) Study case with Cabin Creek power system stabilizer models removed

Figure 1 shows the Benchmark case with Cabin Creek at 160 MW output with a well damped oscillation following the loss of the two Cabin Creek-Lookout 230 kV lines. Figure 2 shows the Benchmark case with Cabin Creek at full existing 324 MW output with a slowly damped oscillation.

Figure 3 shows the Study case with Cabin Creek at 366 MW output with a continuous oscillation. The observed oscillation is not damped and therefore continues throughout the study time frame of 60 seconds. The NERC Transmission Planning Standard for system performance following loss of two or more elements (TPL-003-0b) states the system must be stable following loss of any two circuits from a multiple circuit tower line.

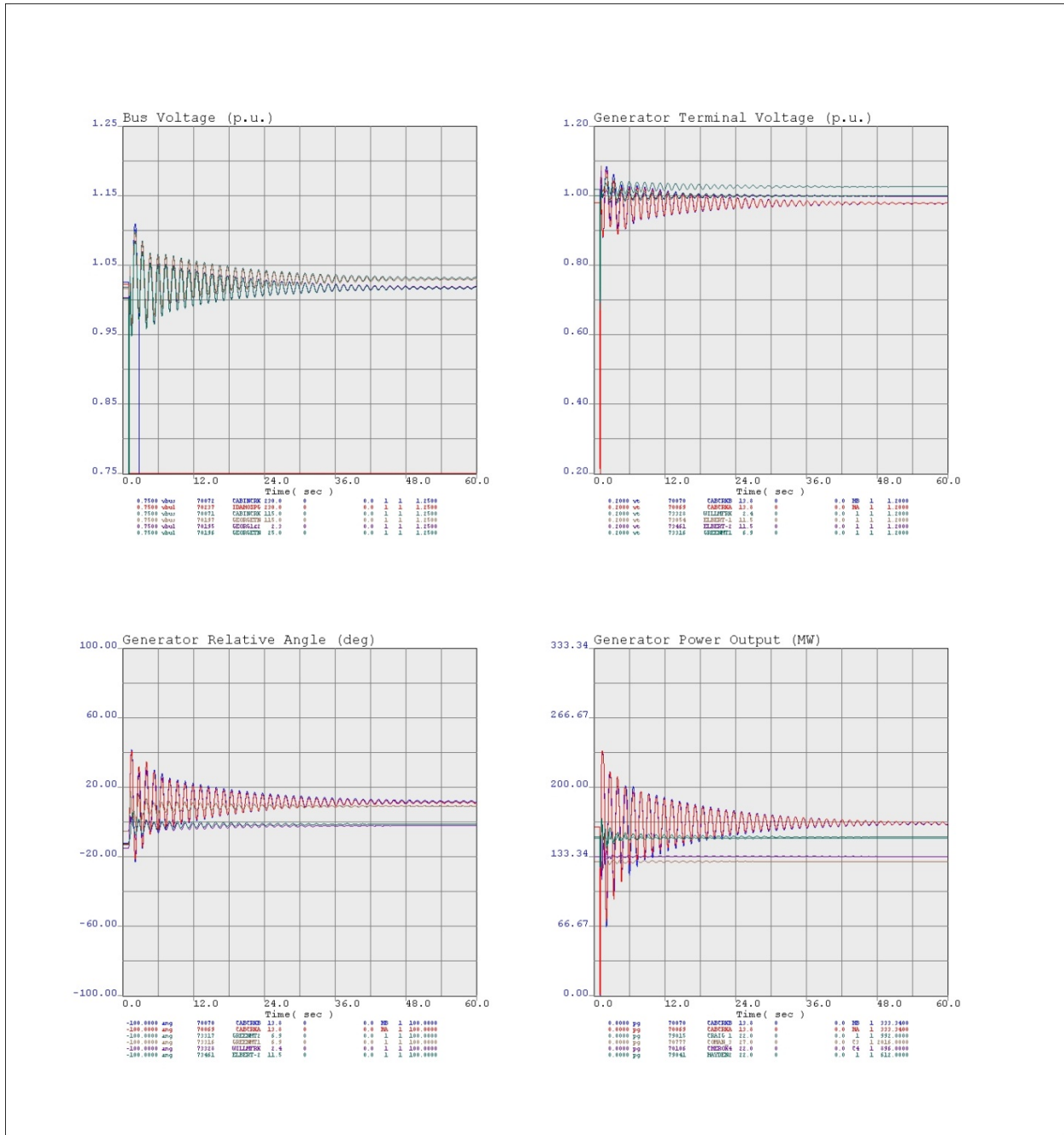
Although the intent of this study does not include isolating the exact cause of the oscillations, an attempt was made to narrow down the issue. In Figure 4 you can see the performance is stable and well damped when the exciter models are removed for both Cabin Creek units. In Figure 5 you can see the oscillation damps very slowly when the power system stabilizers are removed for both units. Hence, the issue may be caused by either model but appears to be more affected by the exciter.

Figure 1 Benchmark Case – Cabin Creek 160 MW



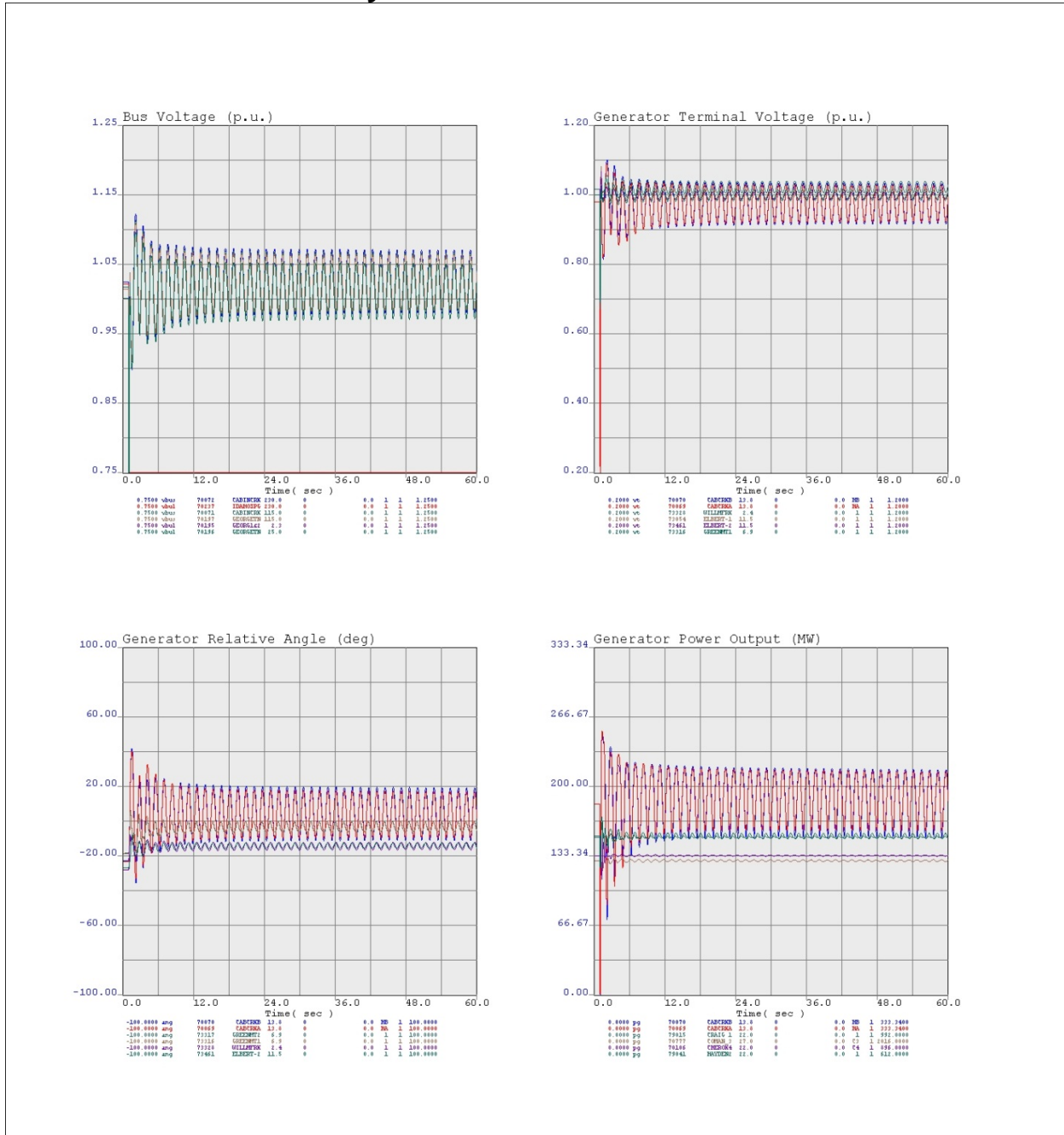
20hs2 BASE CASE
 Benchmark case
 GI-2014-7 stability analysis
 Fault on Cabin Creek 230 kV bus - clear in 6 cycles
 Element removed: Cabin Creek - Lookout #1 & #2 DCTL 230 kV
 COMMENTS DUE TO AREA COORDINATORS BY JULY 31, 2014
 COMMENTS FROM AREA COORDINATORS TO STAFF BY AUGUST 7, 2014

Figure 2 Benchmark Case – Cabin Creek 324 MW



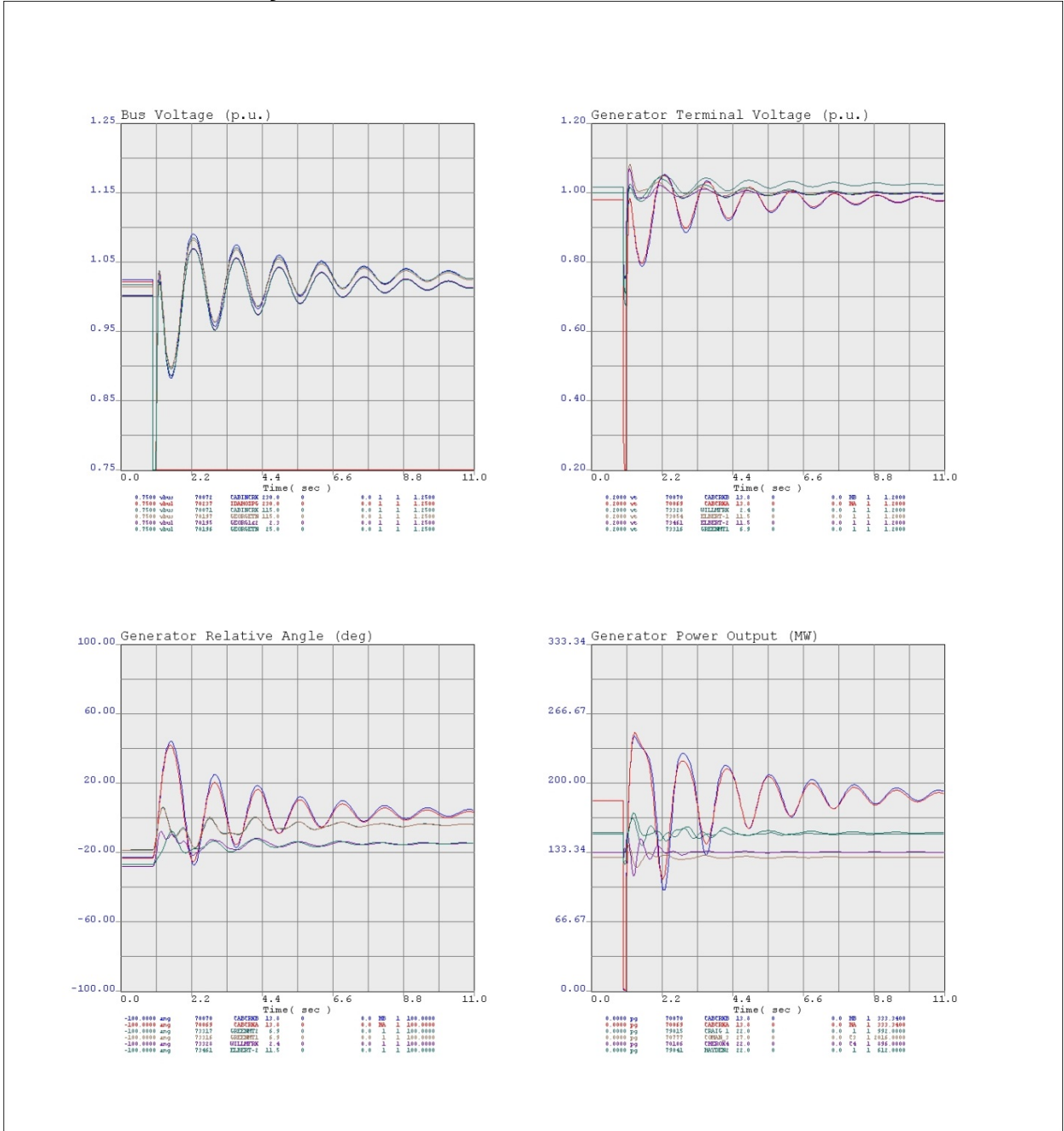
20hs2 BASE CASE
 Benchmark case
 GI-2014-7 stability analysis
 Fault on Cabin Creek 230 kV bus - clear in 6 cycles
 Element removed: Cabin Creek - Lookout #1 & #2 DCTL 230 kV
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Figure 3 Study Case – Cabin Creek 366 MW



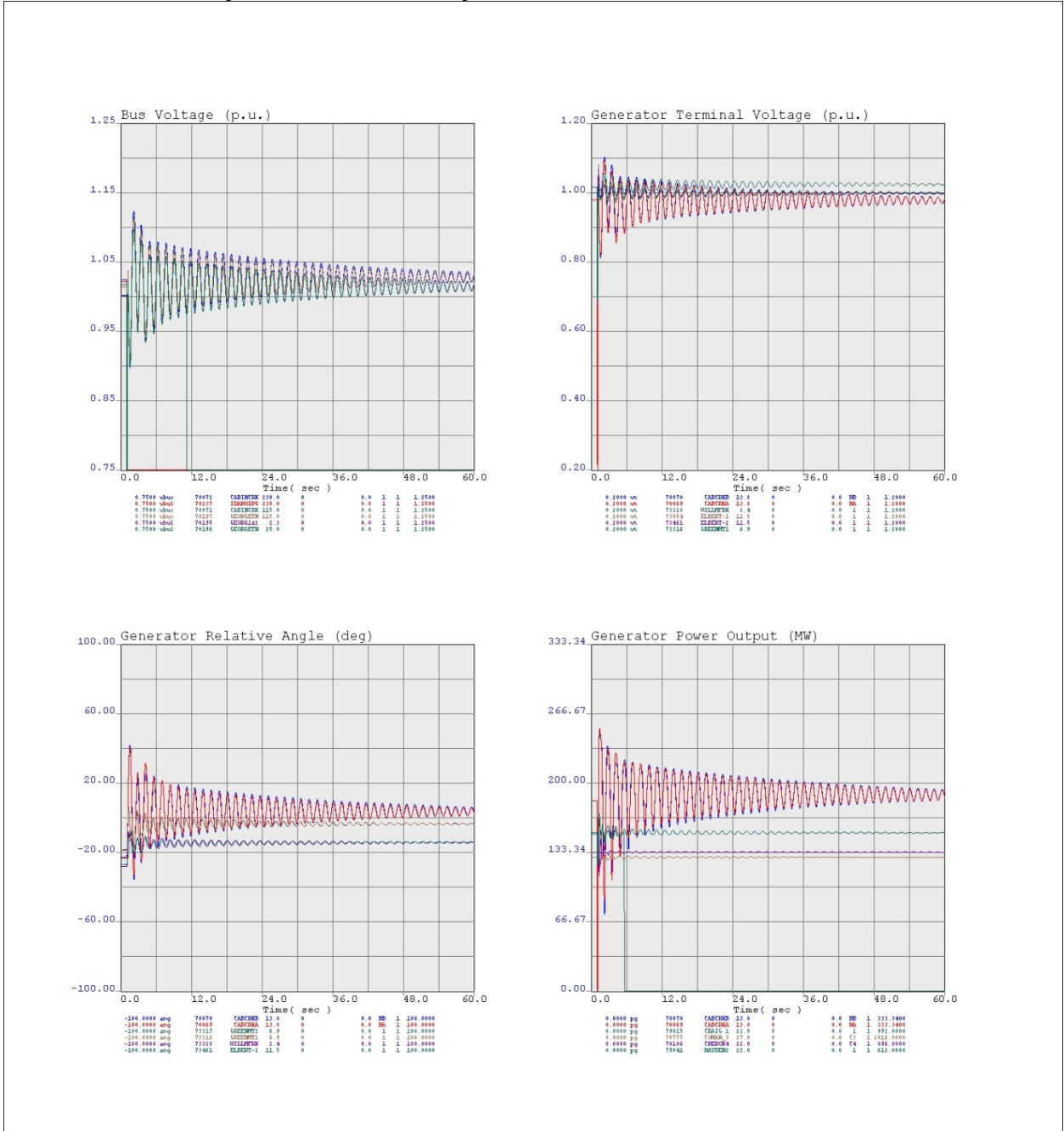
20hs2 BASE CASE
 Study case with Cabin Creek
 GI-2014-7 stability analysis
 Fault on Cabin Creek 230 kV bus - clear in 6 cycles
 Element removed: Cabin Creek - Lookout #1 & #2 DCTL 230 kV
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Figure 4 Study Case with Exciter Models Removed



20hs2 BASE CASE
 Study case with Cabin Creek exciter models removed
 GI-2014-7 stability analysis
 Fault on Cabin Creek 230 kV bus - clear in 6 cycles
 Element removed: Cabin Creek - Lookout #1 & #2 DCTL 230 kV
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Figure 5 Study Case Power System Stabilizers Removed



20hs2 BASE CASE
 Study case with Cabin Creek PSS removed
 GI-2014-7 stability analysis
 Fault on Cabin Creek 230 kV bus - clear in 6 cycles
 Element removed: Cabin Creek - Lookout #1 & #2 DCTL 230 kV
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