

GI-2004-11**Transient Stability – No network upgrades. Lamar generator “CTY LAM 14.4” offline. Signal Hill Wind with Low Voltage Ride-through (LVRT)**

The fault scenarios were run to determine system response of the existing system without network upgrades. The second circuit of Boone-Lamar 230 kV, and the second circuit of Boone-Midway 230 kV were not present during these stability cases. In addition, the 25 MW unit at Lamar (CTY LAM 14.4 kV) was offline for this study.

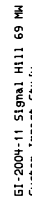
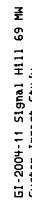
The Lamar DC tie was scheduled to import 210 MW (East to West). Table 1 shows the benchmark case results, while Table 2 illustrates the effect of adding the 69 MW Signal Hill Wind project without the associated network upgrades.

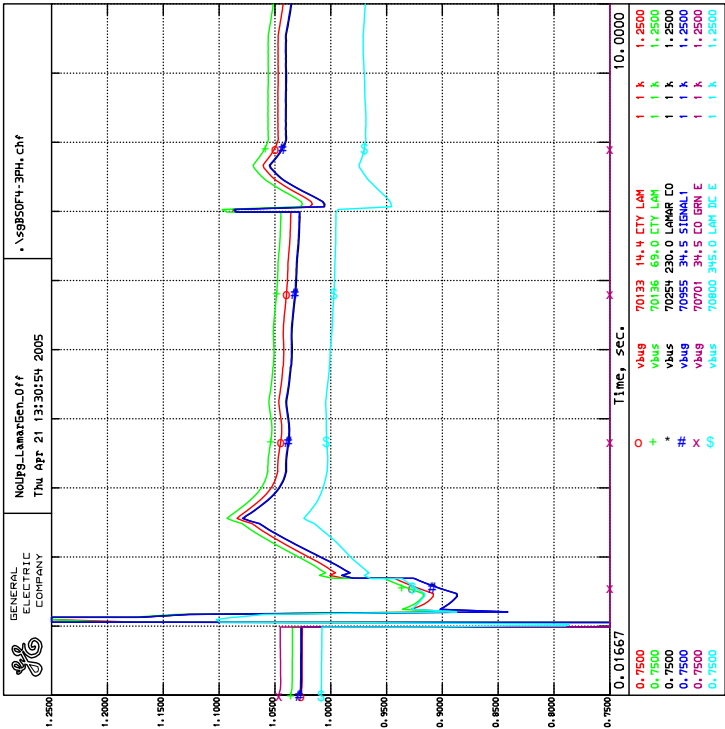
Note that the reliability criteria violations listed in Table 1 are not repeated in Table 2. Table 2 only shows the new or changed violations when compared to the benchmark case.

Table 1 - Transient Stability Results – Existing System with Lamar Generation Offline, Benchmark Case

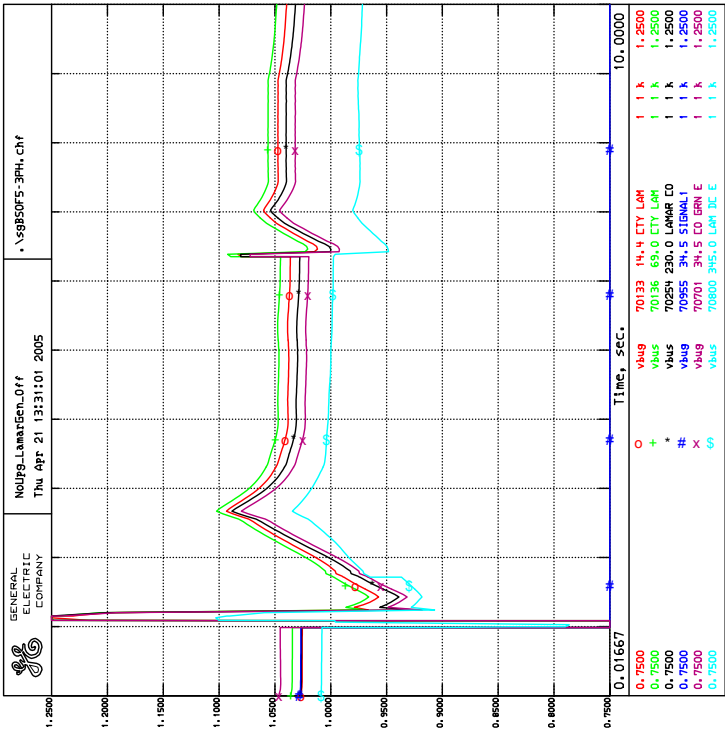
	Fault Location	Action	Result
1	3PH at Lamar 230 kV bus, 4 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips Model diverges at t=1.0667 (4 cycles)
2	3PH at Boone 230 kV bus, 6 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips Model diverges at t=1.33 (20 cycles)
3	3PH at Lamar 115 kV bus; 6 cycles	Trip Lamar 230-115 kV transformer	Colorado Green Trips System Stable Post-transient voltage deviations > 5%: 0.84 to 0.87 pu final voltage at CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, LAMAR CO 115, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 115, 69, WALSH 69, WILLOW CK 115, 69. 0.91 to 0.94 pu final voltage at CTY LAJ 69, 13.8, LA SEPCA 69, LAJ IP 69, LAJUNTAT 115, 69.
4	3PH at Colorado Green 230 kV bus; 4 cycles	Trip Lamar-Colorado Green 230 kV line	Colorado Green Trips System Stable Voltage Violations: Overvoltage spike > 25% at load buses: CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILLOW CK 69
5	3PH at Signal Hill 230 kV bus; 6 cycles	Trip Signal Hill-Lamar 230 kV line	Colorado Green Trips System Stable Voltage Violations: Overvoltage spike > 25% at load buses: CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILLOW CK 69

	Fault Location	Action	Result
6	3PH at Midway 230 kV bus; 6 cycles	Trip Boone-Midway 230 kV line, circuit 2	Colorado Green Trips System Stable Frequency Violations: 62.4 Hz for 11 cycles at CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILOW CK 69. 62.2 Hz for 11 cycles at CO GRN 34.5
7	3PH at Comanche Station 230 kV bus; 6 cycles	Trip Comanche Unit 1	Colorado Green Trips System Stable
8	SLG at Boone 230 kV bus; 20 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips, Lamar DC Tie Trips Voltage Violations: - Overtvoltage spike > 25% at load buses: CHENEY 69, CTY LAJ 69, 13.8, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILOW CK 69 Post-transient voltage deviations > 5%: 0.84 to 0.87 pu final voltage at CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, LAMAR CO 230, 115, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 115, 69, WALSH 69, WILOW CK 115, 69. 0.91 to 0.94 pu final voltage at CTY LAJ 69, 13.8, LA SEPCA 69, LAJ IP 69, LAJUNTAT 115, 69.
9	SLG at Comanche Station 230 kV bus; 20 cycles	Trip Comanche Unit 1	System Stable
10	SLG at Midway 230 kV bus; 20 cycles	Trip Boone-Midway 230 kV line, circuit 2	System Stable
11	SLG at Lamar 230 kV bus; 20 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips, Lamar DC Tie Trips Voltage Violations: - Voltage dip > 25% at load buses: CHENEY 69, CTY LAJ 69, 13.8, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILOW CK 69 - Voltage dip > 30% at VILAS 115
12	3PH at Boone 230 kV bus; 6 cycles	Trip Boone 230-115 kV transformer	Colorado Green Trips Model diverges at t=1.17 (10 cycles)





EL-2004-11 Signal Hill 69 MW
System Impact Study
Fault 4: 3PH Fault at COLO GRN 230 kV Bus
Clearing: 4 cyc, Trip LAMAR CO-COLO GRN 230 kV Line



EL-2004-11 Signal Hill 69 MW
System Impact Study
Fault 5: 3PH Fault at SIGNAL HL 230 kV Bus
Clearing: 6 cyc, Trip SIGNAL HL-LAMAR CO 230 kV Line

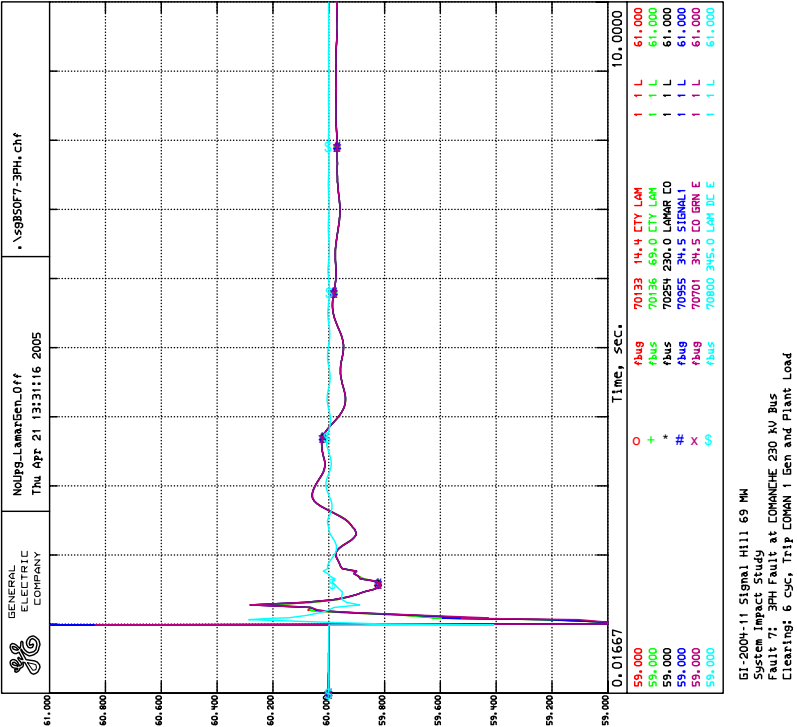


Table 2 - Transient Stability Results – Existing System with Lamar Generation Offline, Signal Hill Wind at 69 MW

	Fault Location	Action	Result
1	3PH at Lamar 230 kV bus, 4 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips, Signal Hill Trips Model diverges at t=1.33 (20 cycles)
2	3PH at Boone 230 kV bus, 6 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips, Signal Hill Trips Model diverges at t=1.13 (8 cycles)
3	3PH at Lamar 115 kV bus; 6 cycles	Trip Lamar 230-115 kV transformer	Colorado Green Trips, Signal Hill Trips System Stable No new violations
4	3PH at Colorado Green 230 kV bus; 4 cycles	Trip Lamar-Colorado Green 230 kV line	Colorado Green Trips, Signal Hill Trips System Stable No new violations
5	3PH at Signal Hill 230 kV bus; 6 cycles	Trip Signal Hill-Lamar 230 kV line	Colorado Green Trips, Signal Hill Trips System Stable New Voltage Violations: Overvoltage spike > 25% at load buses: CTY LAJ 69, 13.8, CTY LAM 25, LA SEPCA 69, LAJ IP 69
6	3PH at Midway 230 kV bus; 6 cycles	Trip Boone-Midway 230 kV line, circuit 2	Colorado Green Trips, Signal Hill Trips System Stable New Voltage Violations: - Overvoltage spikes > 25% at: CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILOW CK 69 Frequency Violations Fixed at: - CHENEY 69, CTY LAM 69, 25, 14.4, 4.2, EADS 69, FT HOLLY 69, FT. LYON 69, GRANADA 69, HILLTOP 69, HOLLY 25, 4.0, PROWERS 69, SPRNGFLD 69, 4.2, T BUTTES 69, VILAS 69, WALSH 69, WILOW CK 69
7	3PH at Comanche Station 230 kV bus; 6 cycles	Trip Comanche Unit 1	Colorado Green Trips, Signal Hill Trips System Stable No violations
8	SLG at Boone 230 kV bus; 20 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips, Signal Hill Trips, Lamar DC Tie Trips New Voltage Violations: Voltage dip > 25% at load buses: CTY LAJ 69, 13.8, LAJ IP 69
9	SLG at Comanche Station 230 kV bus; 20 cycles	Trip Comanche Unit 1	System Stable No violations
10	SLG at Midway 230 kV bus; 20 cycles	Trip Boone-Midway 230 kV line, circuit 2	System Stable No violations
11	SLG at Lamar 230 kV bus; 20 cycles	Trip Boone-Lamar 230 kV line, circuit 2	Colorado Green Trips, Signal Hill Trips, Lamar DC Tie Trips No new violations

	Fault Location	Action	Result
12	3PH at Boone 230 kV bus; 6 cycles	Trip Boone 230-115 kV transformer	Colorado Green Trips, Signal Hill Trips Model diverges at t=1.14 (8 cycles)