



**Point Beach 345 kV and 19 kV  
Worst Case Dynamic Voltage Recovery**

Includes SLG Bus Faults with Delayed Clearing

**October 5, 2007**

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The attached plot includes the worst case dynamic voltage recovery at the Point Beach 345 kV (top, solid blue) and 19 kV (bottom, dashed red) busses under existing system conditions. Planned system improvements are expected to slightly reduce the severity of these voltage swings in the future. After evaluating all POB 3-phase line faults and single phase bus faults with delayed clearing it was found that the worst case dynamic voltage recovery occurs during delayed clearing of a single line-to-ground fault (50 kA) at Point Beach 345 kV Bus 2 when delayed clearing (12.25 cycles) also trips Bus 3. A fault cleared in primary time, even under N-2 contingency conditions (which may require reduced generation to prevent unit tripping), will not produce dynamic voltage swings as severe as produce by delayed clearing during this single line-to-ground bus fault.

All three-phase line and single phase bus faults with delayed clearing were simulated at Point Beach to determine worst case voltage recovery. Three phase faults were modeled on the lines to Kewaunee, Fox River, and the Sheboygan Energy Center. These faults simulated a single phase breaker failing by converting the three phase fault to a single line-to-ground fault (50 kA) for the period between the primary (4 cycle) and breaker failure (9.5 cycle) clearing times. Single line-to-ground bus faults (50 kA) were simulated on all five Point Beach 345 kV bus segments. These faults were cleared in 12.25 cycles and took out the bus next to the faulted bus to represent breaker failure. If there were two busses next to the faulted bus, the one whose outage produced the most severe voltage drop was taken out of service.

### **345 kV Bus Voltage**

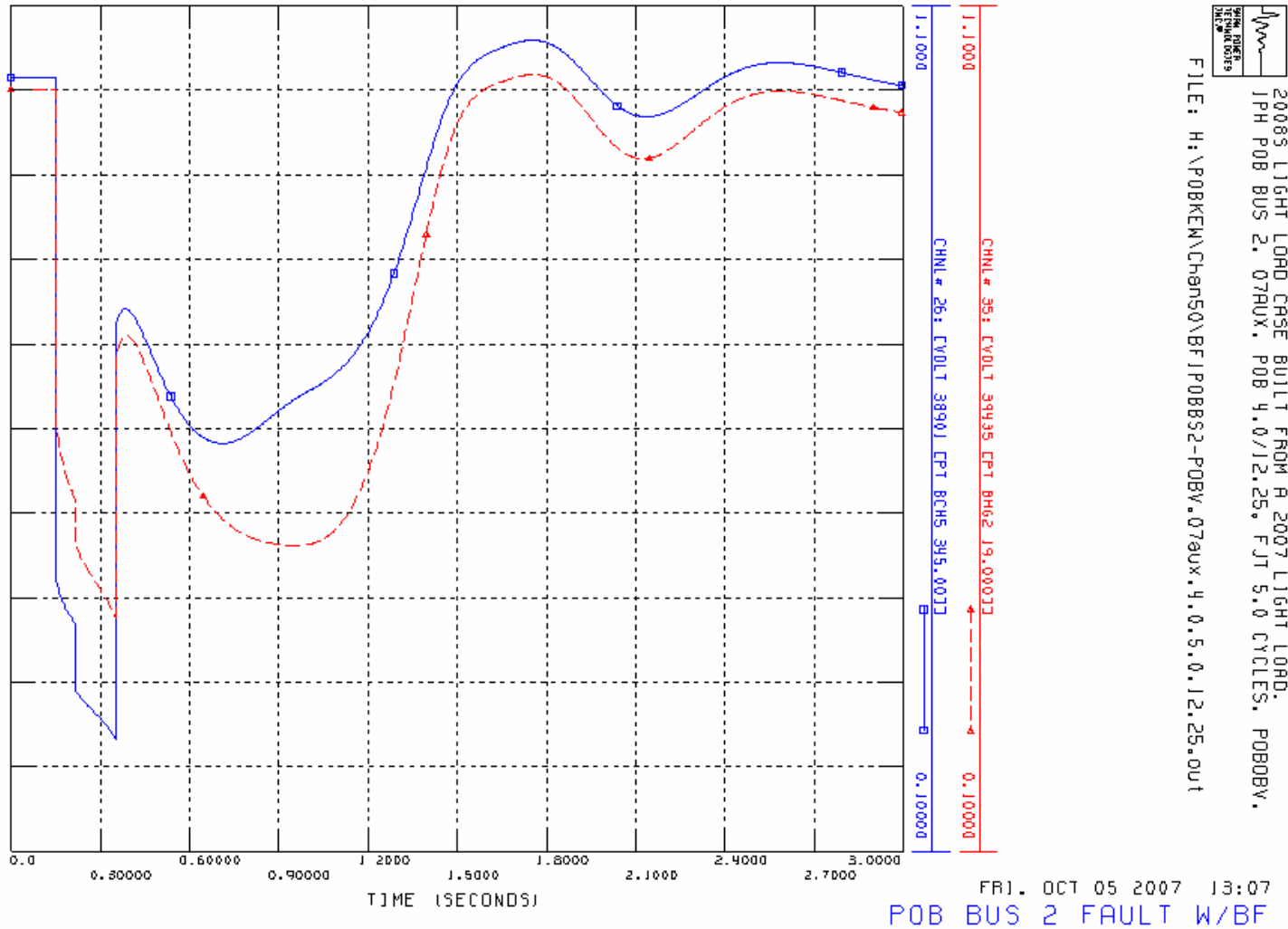
The top (solid blue) line in the attached plot is the worst case Point Beach 345 kV bus voltage simulated during a single line to ground fault (50 kA) on Point Beach Bus 2 with delayed clearing (12.25 cycles). This fault also cleared Bus 3. Bus 2 includes Point Beach Generator #1 and the 345 kV line from Point Beach to Forest Junction (L121). Bus 3 includes the 345 kV line from Point Beach to Kewaunee (Q303). The plot has a voltage scale of 0.1 to 1.1 per unit (0.1 pu/division) and a time scale of 0.0 seconds to 3.0 seconds (0.3 sec./division).

The 345 kV voltage immediately following fault clearing is 0.73 pu. The voltage exceeds 0.80 pu for good 0.95 seconds following fault clearing and 0.90 pu 1.04 seconds following fault clearing. Dynamic voltage recovery will improve slightly as planned systems upgrades, such the Highway 22 lines scheduled to go in service in December 2009, go into service.

### **19 kV Bus Voltage**

The bottom (dashed red) line in the attached plot is the Point Beach Generator 2 19 kV bus voltage simulated during a single line to ground fault (50 kA) on Point Beach Bus 2 with delayed clearing (12.25 cycles) that also clears Bus 3. Bus 2 includes Point Beach Generator #1 and the 345 kV line from Point Beach to Forest Junction (L121). Bus 3 includes the 345 kV line from Point Beach to Kewaunee (Q303). The plot has a voltage scale of 0.1 to 1.1 per unit (0.1 pu/division) and a time scale of 0.0 seconds to 3.0 seconds (0.3 sec./division).

The 19 kV voltage immediately following fault clearing is 0.69 pu. The voltage exceeds 0.80 pu for good 1.03 seconds following fault clearing and 0.90 pu 1.09 seconds following fault clearing. Dynamic voltage recovery will improve slightly as planned systems upgrades, such the Highway 22 lines scheduled to go in service in December 2009, go into service.



Top Line (Solid Blue) Point Beach 345 kV Voltage, Bottom Line (Dashed RED) Point Beach Generator #2 19 kV Voltage (Note: Generator #1 Trips)  
 SLG Fault at Point Beach Bus 2 with Delayed Clearing Bus 3, Voltage 0.1 to 1.1 pu (0.1 pu/division), Time 0.0 to 3.0 sec. (0.3 sec/division)  
 345 kV Voltage Recovery: Instantly: 0.73 pu,, 0.80 pu 0.95 sec after fault cleared, 0.90 pu 1.04 sec after fault cleared  
 19 kV Voltage recovery: Instantly: 0.69 pu,, 0.80 pu 1.03 sec after fault cleared, 0.90 pu 1.09 sec after fault cleared