

2009 Power Systems Conference and EXPO

Paper 09PSCE0459

Dynamic Performance of the Next Generation Synchronous Condenser at VELCO

Authors

Paul Marken (GE Energy)
Dean LaForest (VELCO)
Robert D'Aquila (GE Energy)
Dan Wallace (GE Energy)
Erik Kronbeck (GE Energy)
John Skliutas (GE Energy)



Overview

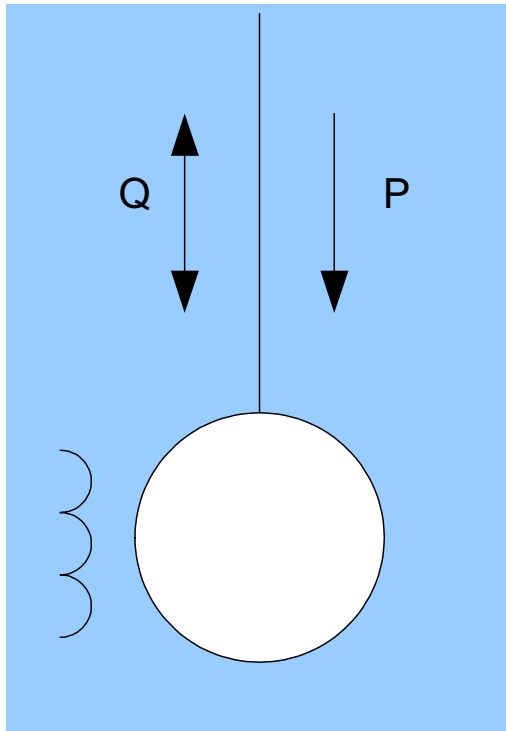
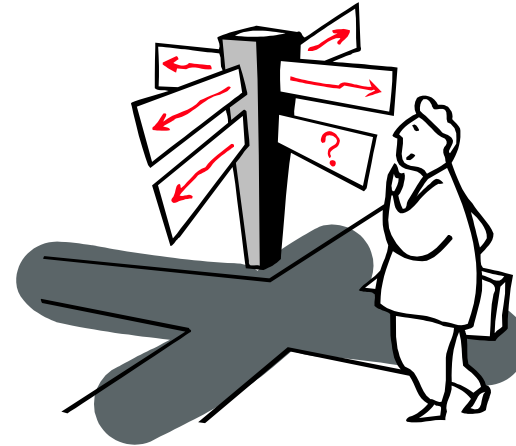
- Background
 - Synchronous Condenser basics
 - VELCO's system
- Dynamic Performance
 - Overload Capability
 - Response Speed
 - Capacitor Switching
 - 345kV Line Trip
- Conclusions
- Questions



Synchronous Condenser Basics

What is it?

Generator without a Prime Mover?
Synchronous Motor without a Load?
Both and Neither!



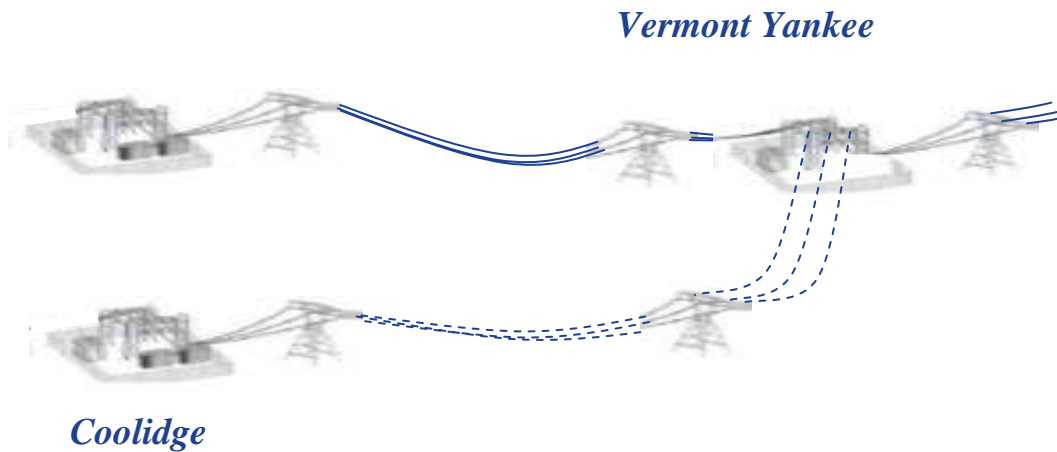
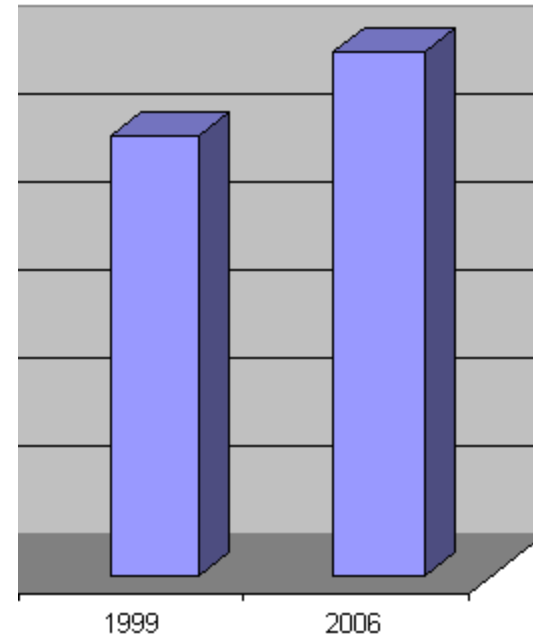
- Can Produce or Absorb Reactive Power
- Absorbs a small amount of Real Power to overcome losses.
- ✓ Good Low Voltage Ride Through Capability
- ✓ Excellent Overload Capability
- ✓ Reasonably Fast

VELCO

VELCO's System

Between 1999 and 2006, Vermont's summer peak electric load has increased ~19%.

Velco Summer Peak Load



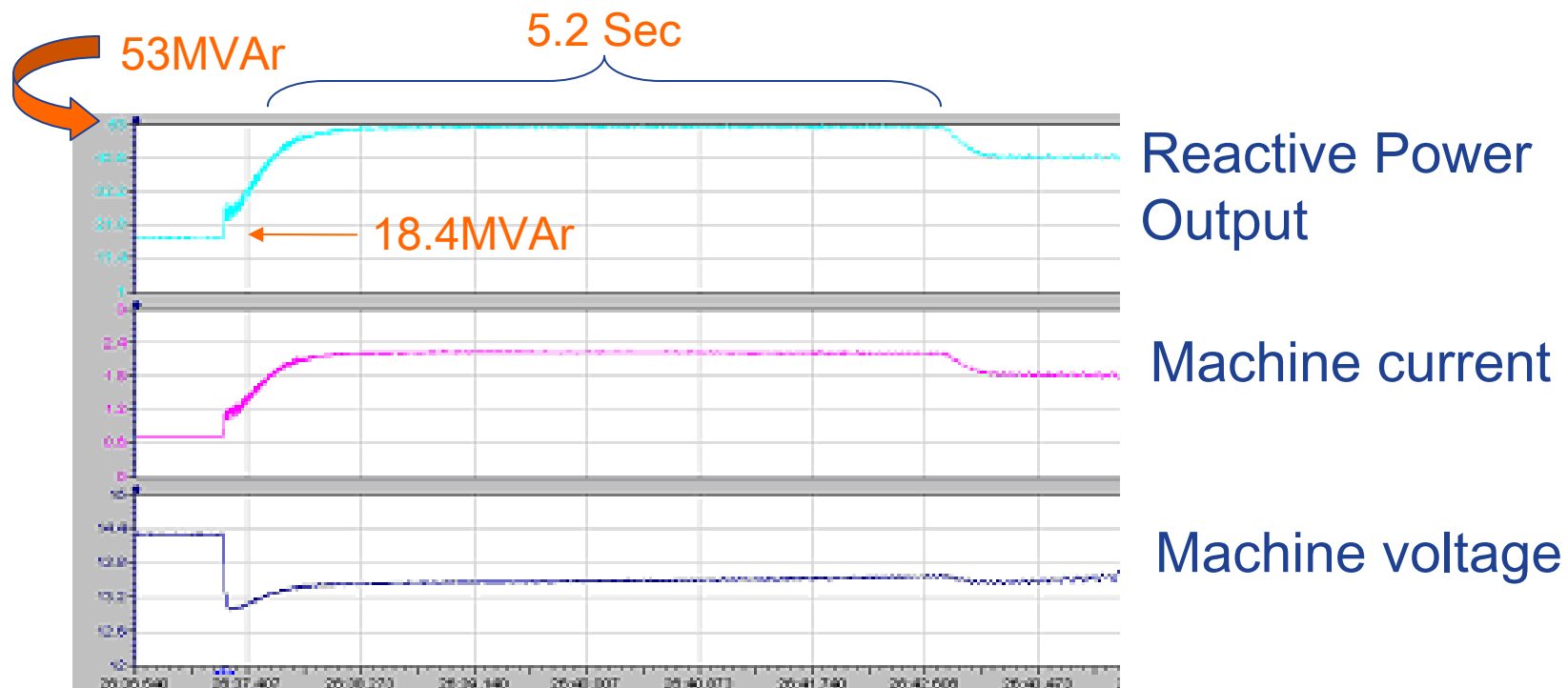
An outage on the Vermont Yankee – Coolidge line required continuous Reactive Power control to prevent voltage collapse.

Dynamic Performance

Overload Capability

During commissioning tests, a Synchronous Condenser was able to produce more than 200% nameplate reactive power for several seconds!

After 5 seconds, shunt capacitors provide assistance.

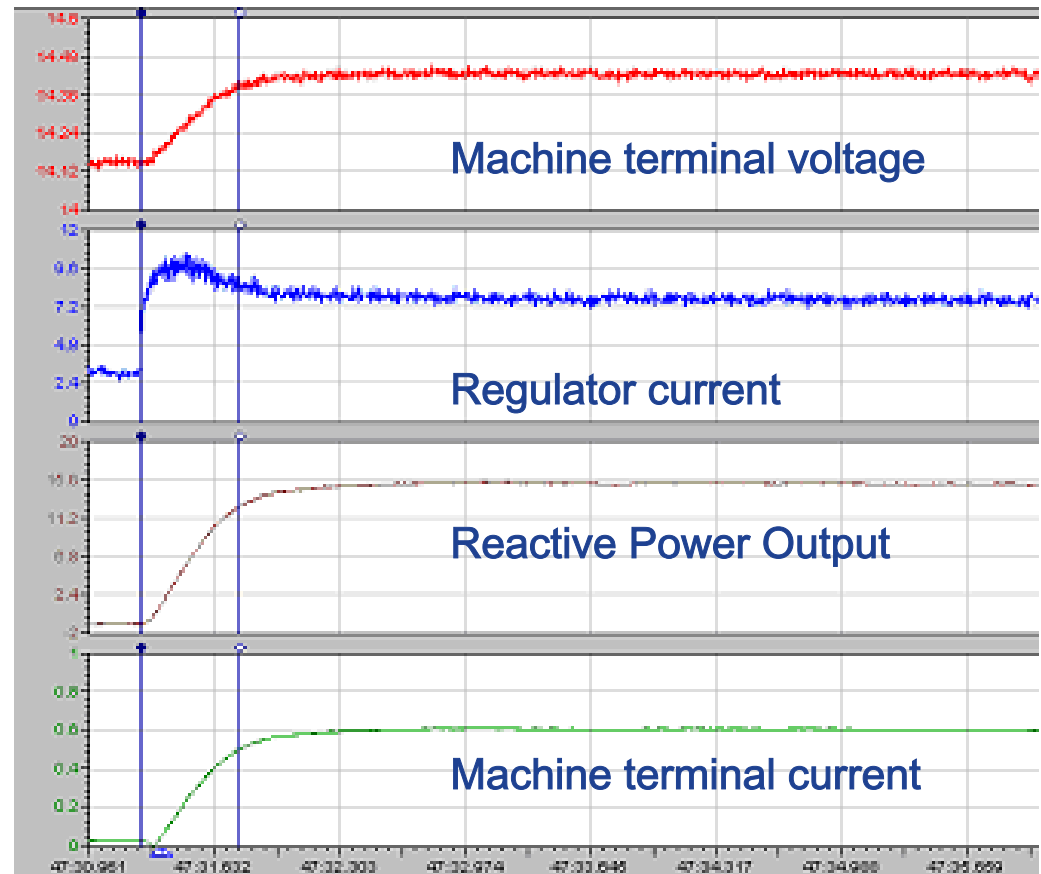


Speed of Response

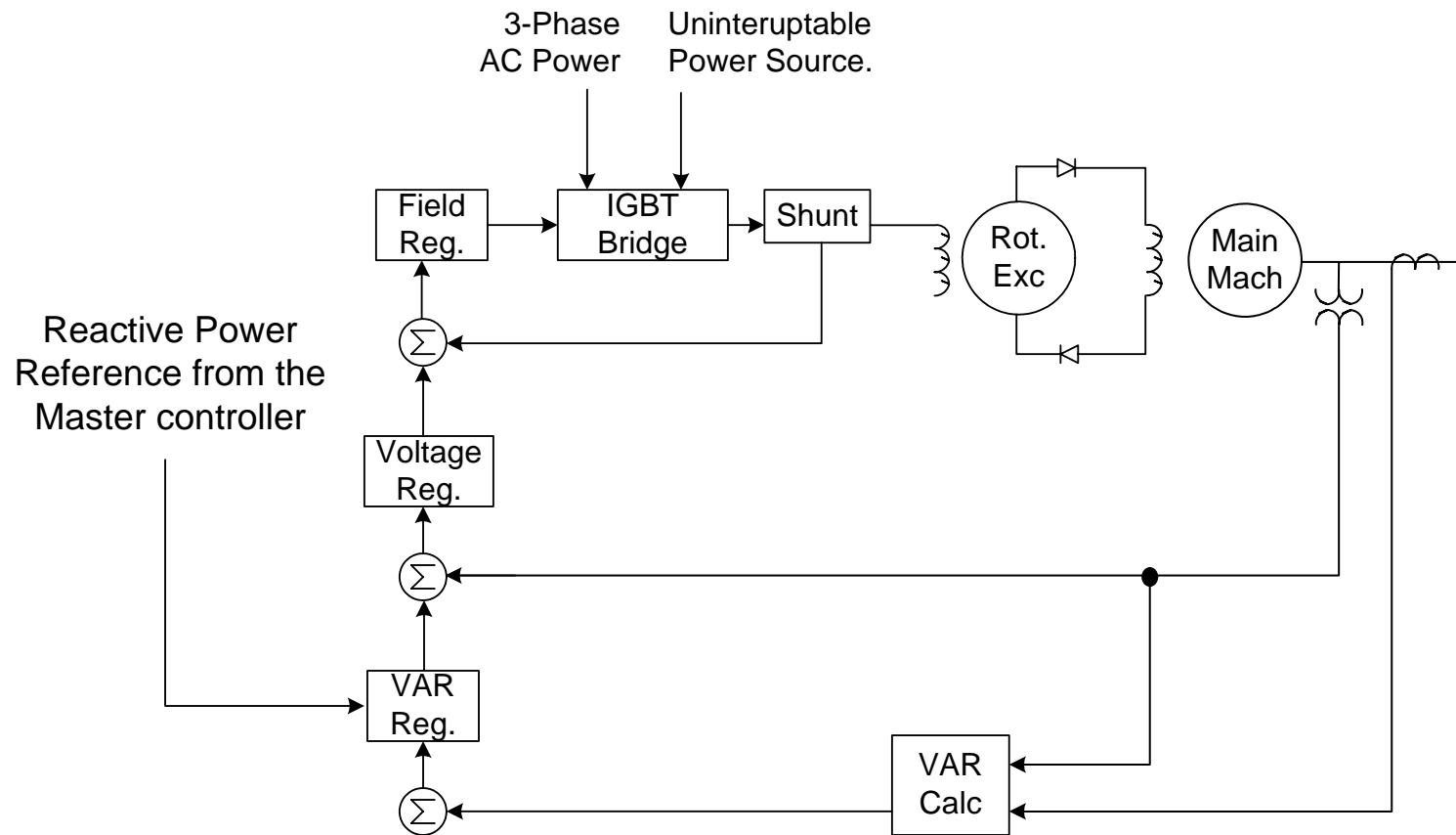
Specification required the regulator response speed to be 90% of a step input within 1.5 seconds.

Actual response to a 2% step change in voltage regulator set point is shown.

Voltage reaches 90% of set point in 0.52 seconds.



Control and Excitation Diagram



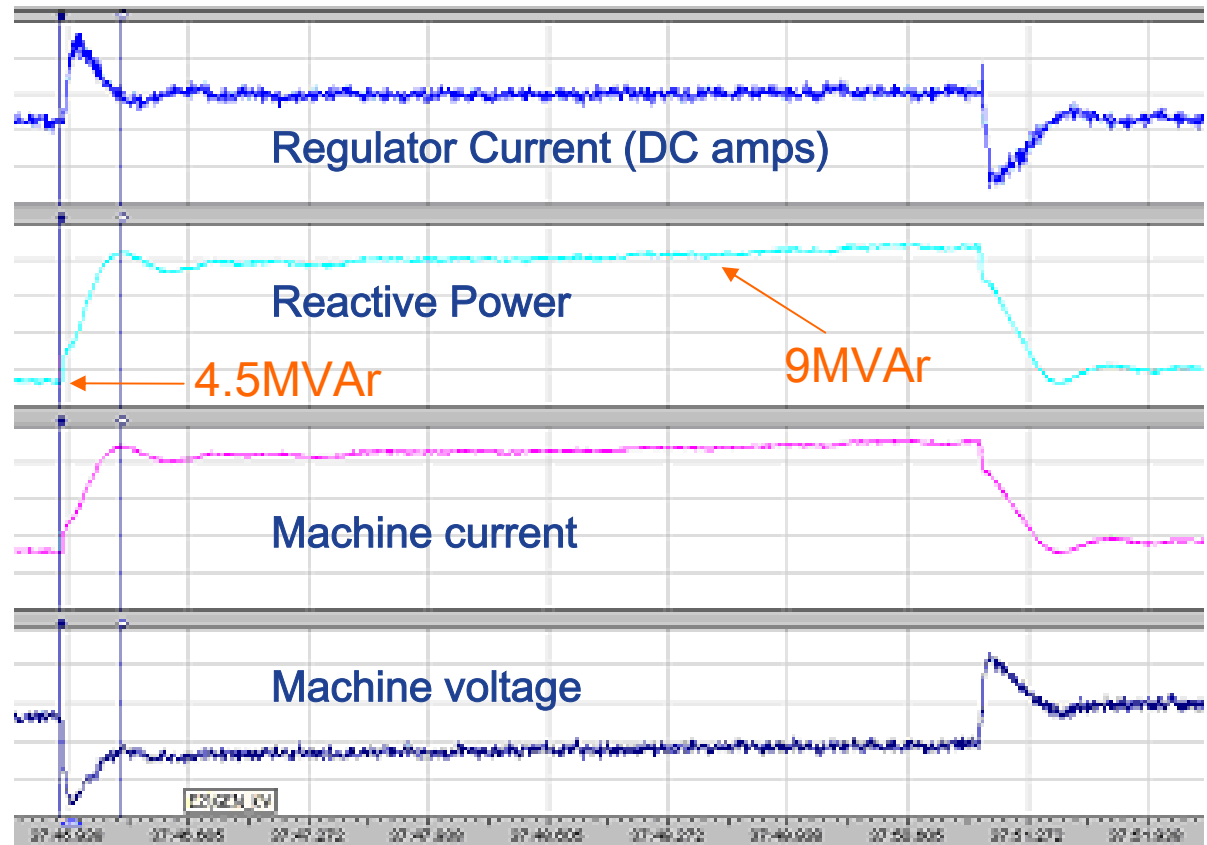
Power Electronics and Digital Controls bring speed and precision.

“This is not your father’s Synchronous Condenser.”

Response to Capacitor Switching

Response to a 25MVAR shunt bank tripped off line and then placed back into service.

- Long tail-in is the master controller slowly raising the system voltage.
- Voltage dips to 98.8% at 0.059 seconds.
- Voltage returns to 99.5% at 0.271 seconds.



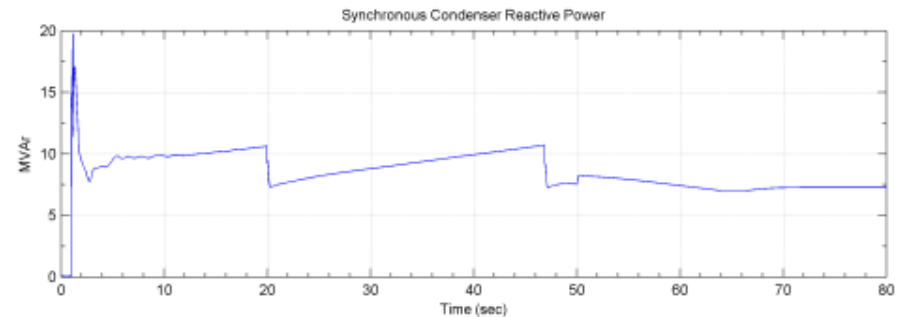
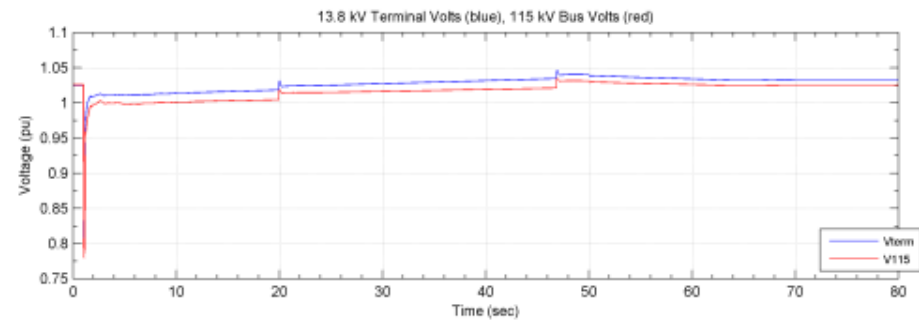
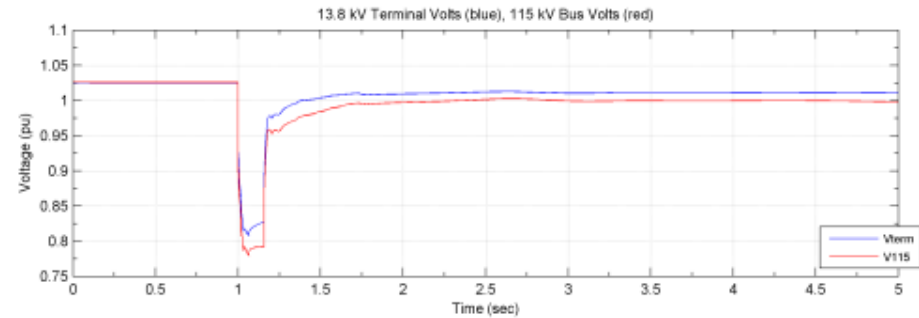
Response time to reactive power peak is 0.339 seconds.

345kV Line Trip

Simulation of stuck
breaker fault – loss of
two 345kV Lines

Capacitors provide the steady state
reactive power needs.

Synchronous Condensers provide
fast response until the capacitors
are switched.



SC speed of response is fast enough to prevent voltage
collapse. Overload capability provides greater dynamic range.

Conclusions

Next Generation Synchronous Condenser

Power Electronics and Digital Controls

+

Proven reliability and durability of heavy metal

=

- ✓ **Excellent Overload Capability**
- ✓ **Fast speed of response**
- ✓ **Stable Dynamic Support**
- ✓ **Economical**

Thanks for Your Attention

Questions?