NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Lesson Learned

Generator Distributed Control System Impact on Automatic Voltage Regulators

Primary Interest Groups
Reliability Coordinators (RCs)
Transmission Operators (TOPs)
Generator Operators (GOPs)
Generator Owners (GOs)

Problem Statement
The RC and TOP within an RC footprint observed unusual generator reactive output following the switching of a shunt reactor near all of the generators' points of interconnection.

Details
The generators at the plant were operating with their automatic voltage regulators (AVRs) regulating to maintain a constant voltage schedule. The expected change in the generators' reactive output was initially observed when the shunt reactor was switched out of service. Shortly thereafter, the generators' reactive output immediately reduced by approximately the output of the reactor. The resulting transmission voltage was slightly higher than it was prior to the switching of the reactor.

This response initially supported the assumption that the generators' AVRs were functioning properly and automatically regulating to maintain a constant voltage schedule. However, the generators' reactive output began to slowly increase after a few seconds. Over a seven-minute period, the reactive output gradually returned to the same precontingency level it had been prior to the shunt reactor switching. Over this period of time, the transmission system voltage increased proportionally with the reactive output of the generators. The response over this period of time suggested that the generators were not automatically regulating to maintain a constant voltage schedule as had been assumed. This generator response is shown in Figure 1.

A coordinated control review with the GOP was conducted to determine why the plant's reactive output behaved in this manner. It was determined that the AVRs on all of the generators at the plant were operating to maintain a constant voltage schedule. However, the distributed control system (DCS) at the plant introduced a slower control function that would increase or decrease the AVR voltage set point until the plant's DCS reactive output objective was met. The plant's DCS reactive output objective was a megavar value entered into the DCS by the plant operator. The megavar value entered into the DCS was the value needed to meet the transmission system voltage schedule for the existing steady-state conditions. This put the DCS objective in conflict with the required postcontingency AVR response.

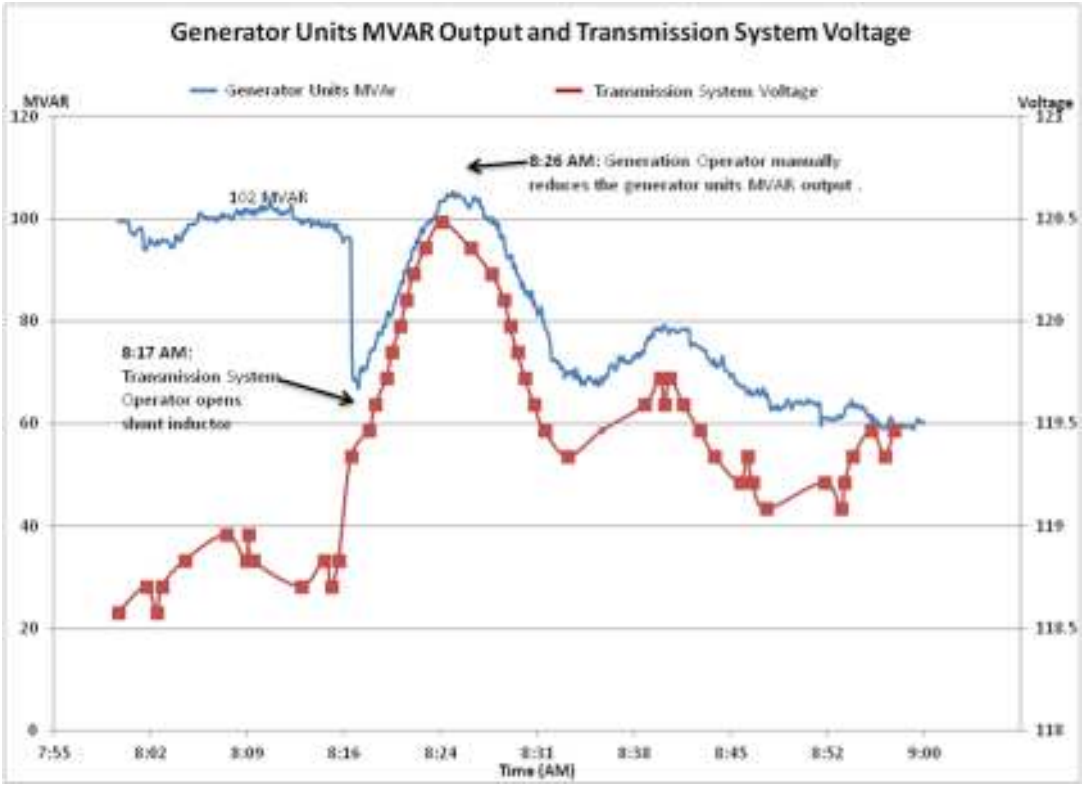

Figure 1: Generator Units MVAR Output and Transmission System Voltage

Corrective Actions

The coordinated control review with the GOP resulted in a modification of the plant's DCS to prevent this behavior. The DCS was modified to have the ability to set the reactive objective to be the transmission system voltage schedule that the plant was directed to control instead of a fixed megavar output. This control change to the DCS system resulted in the desired behavior from the plant following a contingency or a transmission element switching.

After a review of other facilities within the RC's footprint, there were multiple plants found with the same DCS issue. These have been corrected with the same or similar modifications in coordination with the GOP.

Lesson Learned

While a generator AVR may be properly set to control the voltage schedule, other plant control systems may override or counteract the appropriate AVR response. Periodic review of a plant's AVR response to system events must be conducted to determine if this occurs. If a proper AVR response is inhibited, the RC, TOP, and GOP should review the interaction of all related plant control systems to develop a corrective action plan for coordinating the plant control systems to ensure the AVR will have the uninhibited ability to control the desired voltage set point.

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