# Lesson Learned

## Generator Trip While Performing Frequency Response

**Primary Interest Groups**
Generator Operators (GOPs)
Generator Owners (GOs)
Balancing Authorities (BAs)
Reliability Coordinators (RCs)

**Problem Statement**
Two generating units were responding to a large frequency excursion when they tripped off-line on low boiler furnace pressure.

**Details**
Two units (units 1 and 3) of a three-unit coal plant were operating at about half load when 1500 MW of generation tripped off elsewhere. The interconnection frequency dropped to 59.79 Hz (see Figure 1 below).

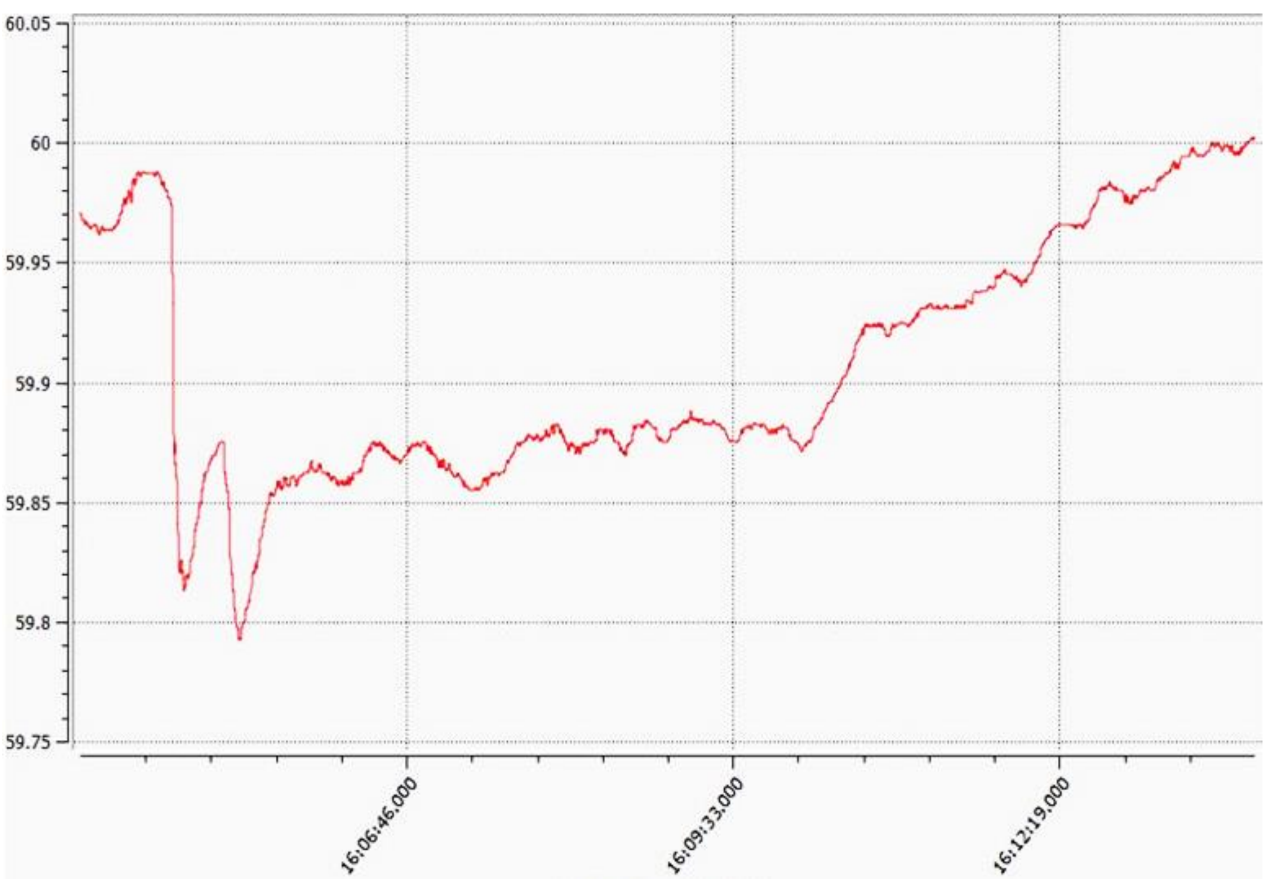


**Figure 1: Interconnection Frequency**

In response to the dip in frequency, both operating coal units rapidly increased their output. Unit 1 responded with a 205 MW/minute ramp rate while unit 3 responded with a 169 MW/minute ramp rate. The induced draft (ID) and forced draft (FD) fans did not respond in an appropriately coordinated manner with the increased load demand, resulting in low furnace pressure. In less than 15 seconds after the frequency dip, both of these units tripped offline due to low boiler furnace pressure (see Figure 2 below).

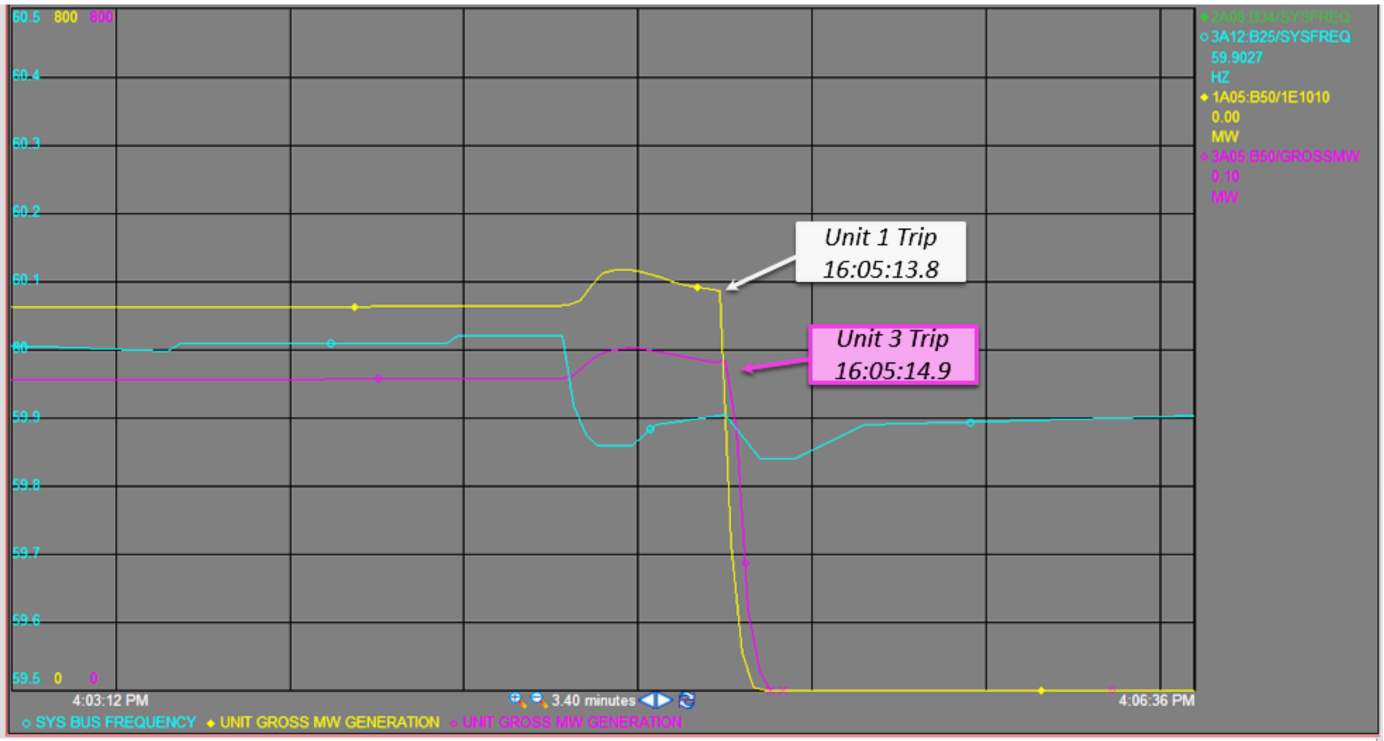


**Figure 2: Low Boiler Furnace Pressure Trips**

The Generator Operator thought the units should have been able to ride through this frequency event without tripping and instead assist the system in recovering frequency as they have done in the past. In investigating the unit trips with the original design engineer and distributed control system (DCS) vendor, it was determined that the accumulation of plant modifications and incremental tuning (addressing many isolated issues over time) changes during the past fifteen years had altered plant response. The DCS was no longer "in tune" with the physical plant.

This was a configuration management issue. Configuration management involves keeping the physical system (what is *really* there), the documented system (what is *said* to be there), and the requirements of the system (what is *supposed* to be there) in sync at all times (see Figure 3).

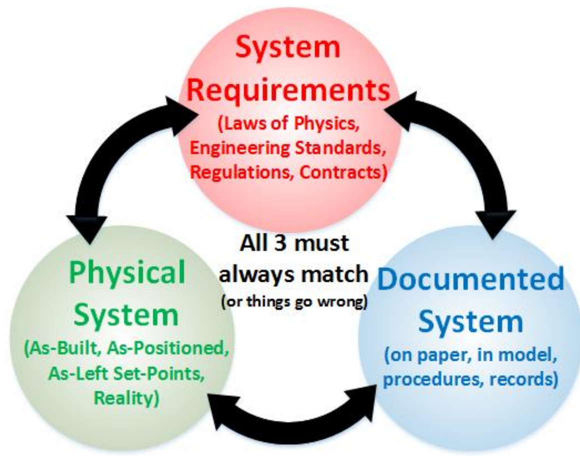


**Figure 3: Configuration Management**

“Physical” refers to the actual equipment, the actual settings, positions, and conditions. “Documentation” refers to the design drawings, operation and maintenance procedures, and records. “Requirements” may be engineering standards, the laws of nature, contracts, or regulatory requirements. When a change is made to the requirements, the documentation and the physical aspects must be adjusted to match. If the physical does not match the requirements, equipment failures, performance issues, or legal issues are likely to emerge. If the documentation does not match the physical, operators may run into problems with procedures and drawings, maintenance may go awry, and engineers may make wrong assumptions when attempting to design a new modification.

## Corrective Actions

The Generator Owner consulted with the vendor and original design engineer to establish whether or not the unit trips were appropriate.

The stroke times on FD and ID fans were captured. It was found that their control curves needed to be modified to align with the physical system changes that had occurred over time to improve stability.

The GO worked with the DCS vendor to schedule load ramps and testing to further tune control curves for the fans and other equipment. This was similar to performing an initial control system commissioning. The DCS tuning cost was less than the startup fuel costs that would have been realized as a result of each of the unnecessary unit trips. This provides a reasonable cost/benefit case for the tuning.

## Lesson Learned

Accumulated effects of plant modifications and incremental tuning changes may significantly alter plant response over time. Eventually, the digital model in a DCS may no longer correspond to physical reality or system requirements.

It is cost effective to obtain unit load data and perform baseline “re-tuning” every 5-10 years (depending on frequency of modifications) or as part of any major modification project.

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