CCJ ONsite
COMBINED CYCLE Journal
User Groups Gas Turbines HRSGs Controls

Align SCR start/stop sequence with GT fast-start requirements

Posted on June 23, 2015 by Team CCJ

The control of critical subsystems must be compatible with today's fast-start peaking gas turbine/generator units capable of remote dispatch. Turlock (Calif) Irrigation District's Almond Plant (Fig 1, sidebar) learned that, while its three new 54.2-MW LM6000PG units were designed for 10-min start capability, the sub-controls for the emissions-reduction systems were not.

1. Turlock Irrigation District's Almond Plant added three fast-start LM6000PG peakers, but had to modify the SCR control logic for compatibility with 10-min start and remote dispatch

"Fortunately," says TID's Jeff Warner, "we were able to make the necessary changes to the controls in the Ovation™ balance-of-plant DCS."

According to Warner, who presented at last year's Ovation Users Group Conference, the control design articulated by the emissions-reduction unit (ERU) vendor and third-party controls specialist was incompatible with the way the plant would operate in at least two respects: It did not account for the units being started and stopped by TID's dispatch SCADA system, and it interfered with the 10-min start capability.

"The SCR controls were handled separately," notes Warner, "though in fairness, these machines were serial numbers 1, 2, and 3 of the PG series." That meant, for one, that temperature profiles and other operating characteristics important to the SCR design changed. And the remote dispatch kind of threw everyone for a loop. What worked on previous models or projects wasn't appropriate for this one.

Almond Plant backgrounder

The three new LM6000PG peaking units were commissioned in July 2012 alongside an existing 2003-vintage, 49-MW LM6000PC with heat-recovery steam generator (HRSG). All four gas turbines have MicroNet™ controls.

The original balance-of-plant (BOP) controls, a Bailey Network 90 (now ABB), were replaced with Ovation™ in 2010 as part of the expansion; this activity took place six months before work on the new turbines began. Importantly, the new controls incorporated the original field terminal modules. Complete replacement took only two weeks, according to TID's Jeff Warner.

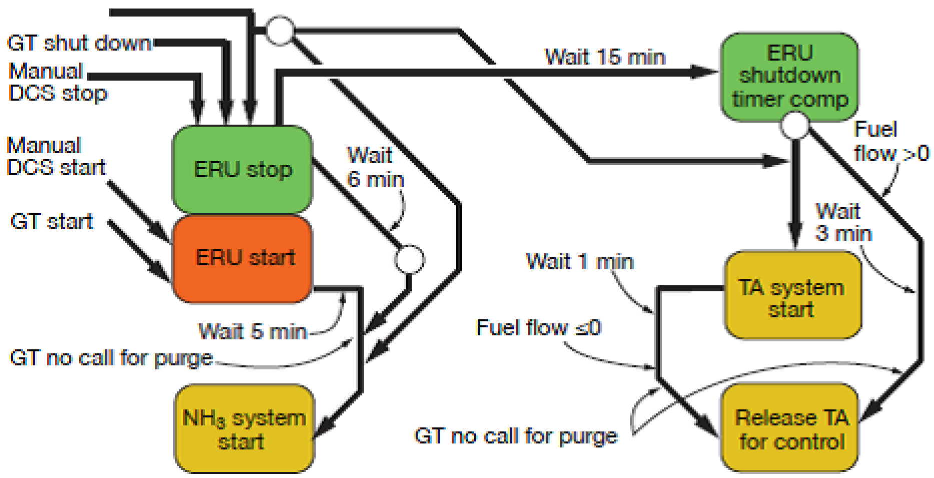
Data links to the Ovation BOP controls include programmable logic controllers (PLC) at the water treatment unit, fuel gas compressors, anti-icing system, absorption chiller, switchyard relays, weather station, and the MicroNet GT controls.

Among other things, the PG model includes a gearbox which allows more power output. It also requires a tempering-air fan system to protect the catalyst.

The new engines are equipped with water injection for NOx control and a downstream selective catalytic reduction (SCR) unit downstream for polishing. Water injection is handled within the MicroNet™ GT controls. Although the SCR is intimately tied to GT operation, the controls were handled by a third-party specialist interpreting the SCR vendor's requirements.

"The 27 pages of SAMA (Scientific Apparatus Makers Assn) and discrete logic from the ERU vendor, used to create 16 pages of control narratives and logic in the BOP software, were confusing and conflicting," Warner said. "Obviously, there's no time to troubleshoot confusing logic within a 10-min start period."

Much of the incompatibility centered on (1) the tempering-air subsystem necessary to keep the GT exhaust to the SCR catalyst within a prescribed temperature range and (2) the ammonia (NH3) purge requirements for the SCR (Fig 2). More specifically, following an emergency shutdown of the ERU (mostly for personnel protection during an upset), Almond engineers realized that the tempering-air (TA) fans would turn off, overheating the catalyst.



2. Old SCR control logic allowed hundreds of state combinations and was not "deterministic"

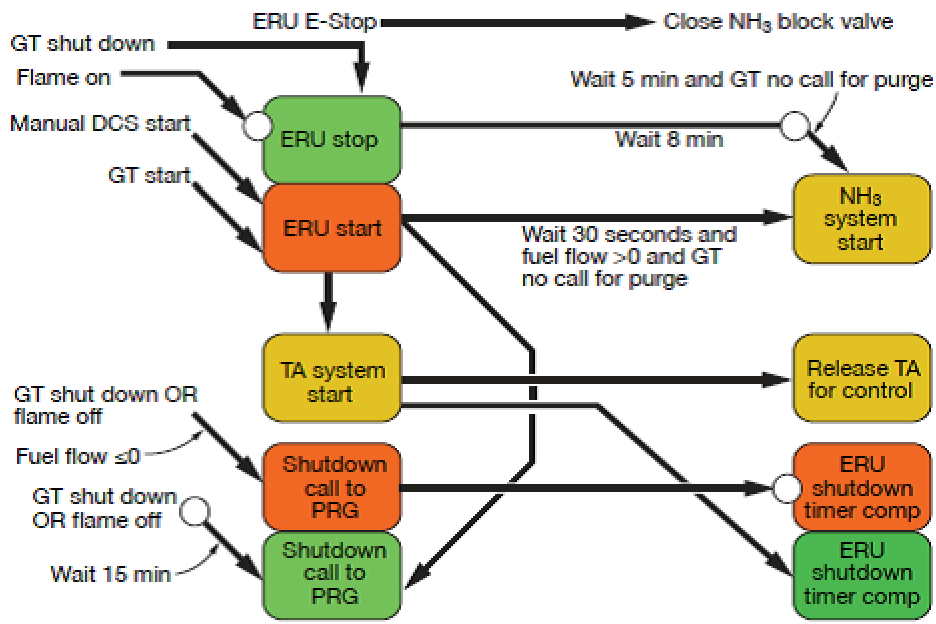
Abbreviations: Prg, purge; GT, gas turbine/generator; ERU, energy-recovery unit; TA, tempering air; DCS, distributed control system; Comp, completed; Man, manual

"There were over 250 combinations of transition 'states' in the logic, which is unmanageable," notes Warner. In other words, the logic was not deterministic." However, the ERU control philosophy still needs to protect personnel first and equipment second, from chemical exposure (NH3 leakage), explosion (loss of proper purge), and electrical and mechanical failures.

In addition, the ammonia purge cycle times were incompatible with a dispatch-driven plant startup and shutdown, especially in the event of a restart after only a few minutes. "While this is a situation we expect to occur only occasionally, we still have to be prepared for it," stresses Warner. In other words, start/restart within a few minutes is something to avoid but the dispatcher has authority to do so in an emergency.

Although the gas turbine would eventually shutdown on high GT exhaust temperature with the tempering-air fans inoperable, "the catalyst could still be fried" by this time, cautioned Warner.

The solution (Fig 3) proved to be modifying the state transition logic so that the emergency stop also signals the DCS (BOP controls) to close the NH3 flow stop valve. Energy hazards in the ERU are mitigated in the lockout/tagout procedures, explosion hazards are handled with proper purge and hardware interlocks in the turbine controls, and the possibility of NH3 leakage is managed with detectors around each ERU. "If ammonia is detected," Warner stressed, "we initiate an ammonia shutdown from the control room."



3. New state transition logic in Ovation is compatible with fast start/stop and remote dispatch, is far easier to troubleshoot, and allows testing and validation of logic mods online

The new logic sequences are much easier for the plant to follow. According to Warner, the modifications have performed flawlessly. "The most important attribute is that the new logic is so much easier to troubleshoot. That's critical when time is of the essence." Ease of troubleshooting stems from the ability to create new logic in Ovation and run it in parallel with the existing logic. "We can test new logic and run it while the plant is running with the existing logic to validate it before making the actual tie-ins."

Running "what if" scenarios have been touted for several years as a key benefit of the latest Ovation platform. TID's Almond Plant is reaping those benefits. "The old logic took hours to troubleshoot," said Warner. In addition, the "state" of the plant is always visible to the operators in the HMI (control room computer screen).