Steam Turbine Generator Retrofit

Elk Basin, Wyoming, USA

"Right now both the turbines are running probably the best I have ever seen them run …" —Nolan Keeler (has maintained these machines for 30 years), Encore Energy Partners Operating, LLC

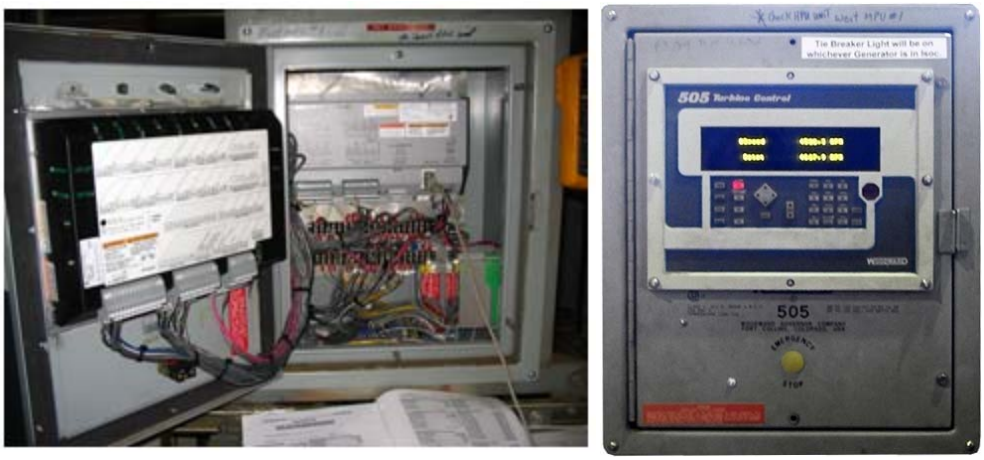
The Problem

- Unstable turbine operation and turbine trips caused by unstable valve position control
- Performance was poor according to operator Dusty Franklin
- Frequency variations of ±1 Hz were common
- Load shed trips often occurred: ≤59 Hz for >2 seconds

The Solution

- Upgrade to Woodward enhanced 505 Steam Turbine Control
- Installed Woodward EHPS Electrohydraulic Power Servo
- Added Woodward SPC Servo Position Controller
- Removed existing actuator and linkages
- Disabled original pilot amplifier
- Added actuator position sensor (LVDT), Accumulator, Filter

"[The retrofit] eliminated a whole lot of linkage, probably 6 joints, and wherever you have a joint you have problems." —Nolan Keeler



New 505 and SPC Installation in the Original 505 Housing

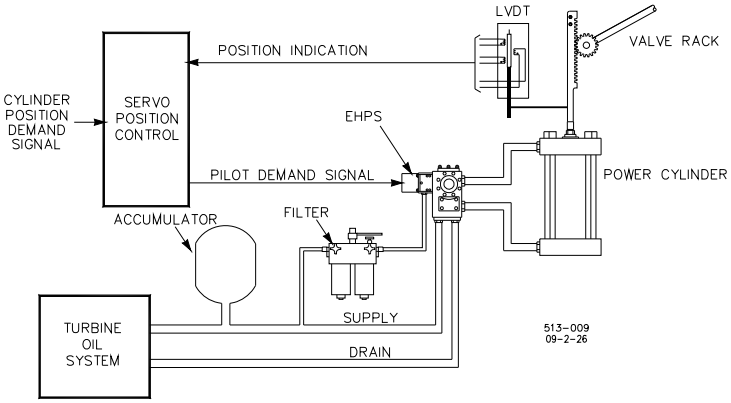
- Enhanced 505 Steam Turbine Control
- EHPS Electrohydraulic Power Servo
- SPC Servo Position Controller
- Reduced linkage
- Improved performance

EHPS Electrohydraulic Power Servo

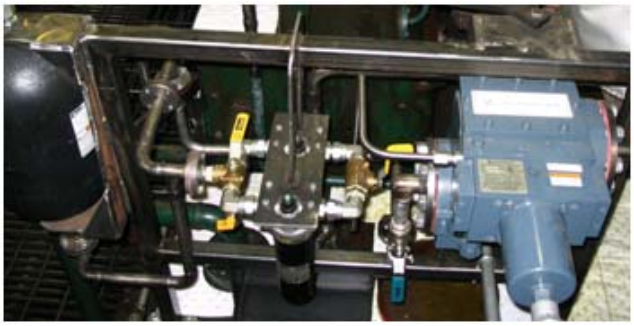
- Replaces hydraulic portion of the turbine's hydraulic pilot amplifier and servo system
- Designed to work with turbine lube oil (oil is often too dirty for precision hydraulic controls)
- 2 Stages—
  - Stage 1—Precision pilot positioner (requires highly filtered oil but at a low flow)
  - Stage 2—Takes unfiltered oil and ports it to the power cylinder that requires high flow
- Design Enhancement:
  At the site, both stages were initially connected through the filters, and the filters became plugged within 4 hours of operation. With just stage 1 filtered, no problems have been seen in last 6 months of operation.
  —Virgil Hobbs, Winn-Marion Barber, LLP

SPC Servo Position Controller

- Replaces all of the mechanical position feedback linkages
- Electronically closes the position loop between the valve position and servo valve
- Supports variety of servo currents (Including bi-polar and unipolar drives up to ±250 mA)
- Supports single or redundant AC and DC position transducers in a variety of configurations
- With LVDT or RVDT transducers:
  - Can monitor both secondary voltages and detect failures of excitation or any wire loss in any position
  - Polarity of the wires is ***not*** important
  - Excitation does not need to be synchronous with the feedback
- Takes position demands as a 4–20 mA current signal or via a DeviceNet digital communication link
- Redundant combinations of these demand signals are supported



EHPS Schematic



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