

# ENEL Geothermal Plants Stillwater & Salt Wells, Nevada, USA

Systems Integrator—CSE Engineering, Concord, California

Application—Woodward 505 Enhanced Control on 14 MW Turbo/Expanders



## Plant Information

ENEL North America, Inc. is a leading owner and operator of renewable energy projects in North America, with a presence in 20 US states and three Canadian provinces.

ENEL fully commissioned their Stillwater II and Salt Wells geothermal plants in April, 2009. The two plants have a total gross installed capacity of 65 MW, which will generate over 400 million kWh of electricity a year, enough to meet the needs of 40 000 households and avoid the emission of over 300 000 tons of CO<sub>2</sub>.

Geothermal resources are underground reservoirs of hot water or steam created by heat from the earth. Geothermal steam and hot water can reach the surface of the earth in the form of hot springs, geysers, mud pots, or steam vents. These resources also can be accessed by wells, and the heat energy can be used for generating electricity or for other direct uses, such as heating greenhouses and aquaculture operations or for dehydrating vegetables.

Stillwater and Salt Wells are medium-enthalpy plants, meaning that they operate at temperatures between 130–150 °C (266–302 °F), using binary cycle technology

that employs two fluids: hot water is extracted from the ground and brought into contact with a working fluid (in this case, isobutane) contained in a closed circuit. The working fluid, which is rapidly heated to a high temperature and pressure, drives the turbines to generate electricity. The geothermal water is returned below ground, and the secondary liquid remains within the closed circuit, ensuring no emissions of greenhouse gases or other negative impacts on the local resources.

## Plant Problem/Concern

Due to the remote location of the Stillwater and Salt Wells plants with regard to the utility feeder line, they often are affected by loss-of-full-load events due to utility tie line issues. It is extremely difficult to respond to these events, and, depending on system delays, may result in turbine generator overspeed trips, and related complete plant shutdowns. Since the time to recover from a complete plant shutdown can take several hours or even days, ENEL was very concerned with the capability of the new turbine generator control systems to respond to the loss of full load and quickly convert to an island mode operation to provide power for parasitic plant loads and maintain plant frequency control.

## Reason for Choosing Woodward

ENEL's system response requirements drove CSE Engineering Inc. (the selected systems integrator) to select the new Woodward 505 Enhanced controller for this project due to its fast scan rates and loss-of-load anticipation logic. The 505 controller senses the rate of change of the turbine generator and anticipates that load has been lost, then uses its fast scan rates to step the turbine steam valve to the correct position. A related reason for the selection of this controller was its capability to automatically switch from load control to frequency control (island mode) upon sensing a utility tie breaker open condition.

## System Description

Each Mafi-Trench turbo expander is controlled by a 505 Enhanced controller, with Woodward Servo Position Controllers (SPCs) used to drive/position the high pressure (2000 psi) hydraulic actuators. Woodward ProTech® 203 overspeed protection devices were also used on each unit to protect the turbine generator set from overspeed events (no overspeed trip bolt was used). The 505 Enhanced controller's breaker opening anticipation logic is enabled to ensure that the system is able to respond to a utility breaker open event and not overspeed. The ProTech 203's two-out-of-three voting architecture is used to protect each turbine generator from overspeeding, but not subject the system to nuisance trips.

### Turbo/Expanders

- 6 Mafi-Trench Corp. 14 MW turbo/expanders
- 4 units at Stillwater, 2 units at Salt Wells

### Woodward Equipment per Application

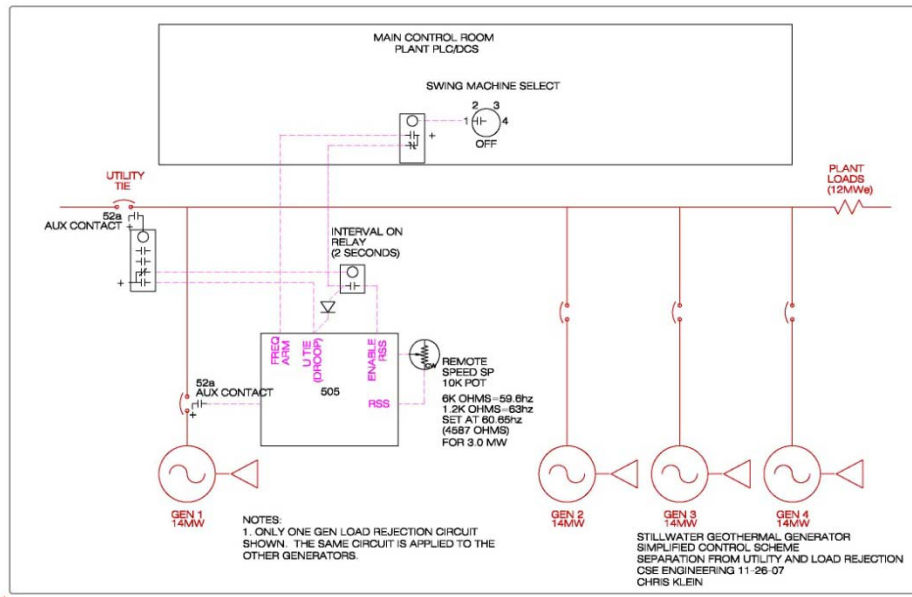
- 505 Enhanced Controller
- Servo Position Controller (SPC)
- ProTech® 203 Overspeed Protection Device

## Application Challenge

With multiple turbine generators online, a challenge was to configure the plant's drooped turbine generators (non-swing machine units) to step back to min load levels when islanded from the utility.

## Plant Results

Loss-of-utility testing verified that the 505 Enhanced control and fast-acting high-pressure actuator could both respond fast enough to catch and control each turbine generator upon a sudden loss of load when the utility tie was opened at all load levels tested.



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