

# Western Area Power Authority Kayenta Substation

Service contract gains PLC upgrades and reduces risk of outages

Services for Energy

Western Area Power Administration (WAPA) is an Agency of the US Department of Energy, delivering power and related services within a 15-state region. Comprised of over 50 power plants, WAPA has an installed capacity greater than 10,000 megawatts.

In 1990, Siemens completed a joint project with WAPA for the world's first transmission system with a continuously variable, 3-phase thyristor-controlled series capacitor installation at the Kayenta substation in Arizona.

The series capacitor consists of two 230 kV conventional series capacitor banks, each rated at 165 MVAR with a single-phase impedance of 55 Ohms. One of the two 55-Ohm banks is split into a 40-Ohm and a 15-Ohm segment. This allows the addition of Thyristor-Controlled Reactors (TCR) in parallel with the 15-Ohm segment, providing direct control of the transmission line impedance and offers several advantages to conventional fixed-series capacitors. The Kayenta Advanced Series Compensation (ASC) operates in the following manner: when a controlled reactor is connected in



Siemens field technicians at the Kayenta substation.

parallel with a series capacitor, the net series compensation seen by the transmission line is the impedance that results from the capacitor and reactor. By varying the impedance of the parallel reactor, the total impedance of the compensation is changed. The ASC controls the reactor current as well as the line current, so the ASC can smoothly control the capacitive impedance from 15 Ohms to 60 Ohms.

## Failed analog controller provides an opportunity for increased functionality

Originally, the two conventional series capacitor banks were operated remotely from Phoenix via a RTU link to the bank's control system. The control system utilized four Simadyn D PLC's for protection and control of the banks, and a single Simatic S-5 PLC for RTU interface and clearinghouse functions. The Kayenta control system operated without major problems for over a decade.

**The crisis:** In May of 2007, A processor in the Simatic S-5 programmable logic controller failed. Upon arriving at the site and further inspecting the problem, it was discovered that the archived programming code was no longer viable. Over time, the magnetic disks that were used to store the information had deteriorated and no longer held complete code. Because the failure was in the single, S-5 unit, all communication with the banks were severed. To further complicate the matter, the hard copies related to the existing system wiring were incomplete or unavailable.

**A fork in the road:** WAPA was faced with the dilemma of exhaustingly searching for antiquated parts to repair this particular problem, or finding a solution that would help prevent future failures and reduce the likelihood of having to search for a dwindling supply of parts, service and knowledgeable technicians associated with the dying technology.

**Solution:** Working with our approved contractor, IS International Services LLC (ISI), Siemens was able to replace the Simatic S-5 PLC with current PLC hardware through an engineered code conversion. Prototype lab testing was performed to ensure reliability and functionality, further limiting future risks.

**Enhanced functionality:** To prevent total failure in the future, Siemens engineered two communication channels, allowing independent bank communication and operation, as opposed to the original design which had all communications funneled through one S-5 PLC.

Over the course of a five month project span, Siemens worked closely with WAPA to perform full system integrity testing and put both banks on line ahead of schedule.

## Snapshot: Western Area Power Administration

- Established – 1977
- States Served – 15
- Power plants – 57
- Installed capacity – 10,479 MW
- Substations – 315
- Transmission line miles – 17,107
- Customers – 682
- Employees – 1,417

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