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Static Var Technology steadies Power Supply to Northeastern New Mexico

In order to keep up with voltage levels along distribution lines, many electric utilities are starting to make the change from manually switched capacitor banks to volt-amperes reactive (VAR) management systems. Tri-State Generation and Transmission is employing the unique technology to its transmission infrastructure with the commissioning a new static VAR system at its Clapham Substation in northeastern New Mexico.

Headquartered in Westminster, Colorado, Tri-State is the power supplier to 44 member systems in Colorado, Nebraska, New Mexico, and Wyoming, serving nearly 1.2 million people in the region. The driving force behind the G&T's nearly $6-million installation of the static VAR system is to ensure quality power is supplied to members – both that of Tri-State's member systems and the member consumers at the end of the line.

Consumers of two of Tri-State's member co-ops – Clayton, N.M.-based Southwestern Electric Cooperative and Springer Electric Cooperation in Springer. N.M. – have been experiencing power quality problems since the early 1980s when Occidental Petroleum Corp., started up its Bravo Dome carbon dioxide processing facility outside the town of Clayton. The large motor load added stress to an already overloaded power system, resulting in voltage excursions and flickering lights for area residences and business.

The Bravo Dome Carbon Dioxide Field has the world's largest and purest natural deposits of carbon dioxide gas, which is used in dry ice production and to enhance oil recovery. The facility demands up to 44 megawatts of power through its use of more than nine gascompressor motors. Bravo Dome is the largest, single industrial load served by a Tri-State member system.

The voltage problem caused by Bravo Dome's massive load was addressed on the 1980s by the previous power supplier, Plains Electric Generation and Transmission Cooperative, which merged with Tri-State in 2000. In 1984, Plains Electric installed a +/- 25 megavolt-amperes reactive (MVAR) compensator at Clapham Substation. Construction of a second power line to serve the Bravo Dome load could not be justified because of the remote location of the facility. A MVAR system proved the best option to improve power quality in the area.

Static VAR system are electrical devices used to provide fast-acting reactive power in high-voltage transient operating conditions, such as a series of gas-compressor motors that draw power intermittently.

While a static VAR system is unique, the technology has been around for nearly three decades. Static VAR compensators often are found at steel mills – arc furnaces used to melt scrap metal are culprits in causing flicker to a power system. The static VAR technology at Tri-State's Clapham Substation is the only one operated by the G&T within its 250,000 square-mile member service territory.

Paired VAR systems boost reliability

Continuing in the same format that has been used to address the power voltage issue northeast New Mexico for 21 years, the static VAR system being installed this year by Tri-State will run parallel to the 1980s vintage system built by Plains Electric. Having two static VAR compensators affords Tri-State the ability to perform maintenance on either of the crucial facilities without compromising power quality. Additionally, in the event that one of the systems experiences an outage, the other will serve as a back-up.

ELECTRIC ENERGY issue 1, 2006
Steadies Power Supply to
Northeastern New Mexico

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Photo:
115 kV circuit breaker and transformer.

A member of Tri-State's safety personnel conducts testing of the new system.

Jeff Selman and two Tri-State substation technicians discuss the testing of the new static VAR system.

Thyristor control reactors.

The new thyristors and cooling system.

The G&T will have two, redundant systems, but there are differences between the old and the new. While the older unit is still running, it didn't completely address light flicker issues and it progressively requires more maintenance.
Nokian Capacitors Ltd., with headquarters and production facilities in Tampere, Finland, built the new static VAR compensator system installed at Clapham Substation. Employing microcomputers and the latest thyristor technology, Nokian's system handles more capacity, faster and more efficiently.

The thyristors are at the core of the technology. The thyristor controls sense the drop in voltage before it is even visible and instantly switch the balance between the reactors and the capacitors to keep the lights steady. The technology functions in milliseconds – monitoring the substation bus, thyristors can automatically raise or lower voltage every one-fortieth of a second.

Clapham Substation's older unit has 144 thyristors. The new unit has only 60, yet they can carry more current because of the advances in the technology in the last 20 years. The valve hall that houses the thyristors from the original static VAR compensator is 2.5 times larger than the new valve hall. While the newer technology is more compact, it has the same rating of +/- 25 MVARs.

In both the new and old systems, the thyristors are water cooled. The cooling water is piped in from a series of plastic tubes. Each time a thyristor is replaced, the water purification system has to be opened, resulting in potential ethylene glycol and propylene glycol leaks and the system has to run for a few hours before starting it up again. To perform maintenance on the older system, it takes nearly 10 hours before it can be put back in to service, meanwhile consumers experience power quality issues.

In addition to more reliable water tubes, the new system has tubes that are made of flexible plastic and the coolant used is strictly propyleneglycol, which is more environmentally sound. An individual thyristor can be replaced without opening up the water loop. Total time to replace the thyristor water tubes in the new system is one hour.

The other key component of a static VAR system is the filter bank. Because of the harmonics caused by thyristor switching, the power system voltage can be distorted. The filters suppress the harmonics, distorting the 60-cycle voltage wave. The filters actually have two functions, in addition to blocking out harmonics; they also serve as the fixed capacitors to raise the voltage.

The benefit of using the latest technology is the ability to easily monitoring the system. At the time it was installed, Clapham Substation's older static VAR unit had a Westinghouse analog computer with only small lamps to indicate performance levels. Ten years later, it was upgraded to a Siemens digital computer, which was advances at the time, but doesn't even begin to compare to today's computers.

Improving electricity

As Tri-State's purpose of installing new technology is to improve power quality, it is important that the old and new systems work in unison to stabilize the power flow. Making sure that the original static VAR system and the new system complement each other, a real-time digital simulator was used to test the potential issue and corrected the control system before installation.

Clapham Substation's original static VAR system has stabilized power delivery to northeastern New Mexico for more than 20 years. Now with the pairing of a new, technologically advanced system and a reliable workhorse, Tri-State will continue to deliver dependable power to its member systems.

EN-RF08-04/2007

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