Eldorado Series Capacitor Upgrade Project

In September 2004 Siemens PT&D was awarded a turnkey project to replace two old existing series capacitor banks “Lugo and Moenkopi” located at Southern California Edison’s Eldorado (SCE) Substation 45 miles south of Las Vegas, Nevada.

The addition of new generation associated with the Century Project resulted in a significantly higher short circuit duty on the 500 kV bus at SCE’s Eldorado Substation (refer to Figure No.1), LADWP’s McCullough Substation and at Marketplace Substation all located with in 3 miles of each other. Therefore this project represents special design challenges associated with high fault duties, the close proximity of the Mohave Generating Station, the high seismic design requirements, control of parallel line loading by varying the capacitor bank impedance and uncertainty regarding the final steady state bank ratings.

The Moenkopi – Eldorado line is one of five 500kV transmission lines exporting power from Arizona into the Southern California load area served by several utilities (LADWP, SDG&E, etc.) including SCE. And it is one of the transmission lines associated with Southwest Transmission Expansion Project (STEP) lead by California Independent System Operator (CALISO) and scheduled for eventual upgrading with the short term goal to increase path loading by 10,000 MW incl. replacing series capacitors on the existing transmission lines. These complex conditions have required the approval of all stakeholders prior to award of the project.

Figure No.1 Southwest Transmission Expansion Project Map
SCE issued its RFP (Request for Proposal) with options for various ratings and bank configurations and with the scheduled in-service date of March and May 2006. As the preliminary proposal study work proceeded, Siemens’ engineers identified 44 different bank configurations and ratings. Half of the possible alternatives were eliminated due to unreasonable high cost or limitations of available equipment.

Finally, Siemens was able to provide an economic solution for all these special requirements. This, plus the track record of the TPSCs (Thyristor Protected Series Capacitors) already installed on the SCE transmission system at their Vincent and Midway Substations, California, argued for Siemens.

Siemens is the only supplier worldwide providing the innovative TPSC technology, with a post-fault re-insertion time of only a few seconds, compared to an up to multiple hours cool-down time for conventional, Metall Oxide Varistor (MOV) protected capacitor banks.

Previous innovative projects (incl. the first SC with thyristor valves at Lugo Substation 500 kV) were finished on time and are in continuous service with a record of consistent high reliability. The close cooperation between SCE and Siemens is still successful today providing a good foundation for the Eldorado contract.

Regarding the Eldorado Project, SCE ordered a design consisting of two (Lugo) and three (Moenkopi) series capacitor segments which can, if necessary in the future, be upgraded to higher short circuit and line currents and also be upgraded from TPSC to Thyristor Controlled Series Capacitor (TCSC) technology. The advantage of the TCSC is the variable impedance which can provide power oscillation damping, load flow control and sub-synchronous resonance (SSR) mitigation on transmission lines. These features might become important for SCE in the future.

### Technical Data:

**Eldorado-Lugo TPSC-FSC**
- Capacitor Rating: 18.35 Ohm / 199 MVAr
- Compensation Degree: 17.5 %

**Eldorado-Moenkopi TPSC-FSC-FSC**
- Capacitor Rating: 14.97 Ohm / 162 MVAr
- Compensation Degree: 11.7 %

**Lugo TPSC**
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**Moenkopi TPSC**
- Capacitor Rating: 14.97 Ohm / 162 MVAr
- Compensation Degree: 11.7 %

**Moenkopi FSC1 / FSC2**
- Capacitor Rating: 14.97 Ohm / 162 MVAr
- Compensation Degree: 2 x 11.7 %

The digital control & protection system from Siemens “SIMATIC TDC” is used for each substation.

Figure No. 2: Site View Lugo Substation

Figure No. 2 shows the construction progress on the Lugo bank which is completed with valve house and gap enclosures placed on the platforms.