SVC for dynamic voltage control of 420 kV submarine cable grid

In 2008, re-commissioning of the Hasle SVC (Static Var Compensator) in Østfold County in south-eastern Norway was performed after thorough rehabilitation and modernization of the installation which had been in operation in the country´s 420 kV power transmission grid since 1981. The SVC, rated at 0-360 Mvar inductive at 420 kV, has the main purpose of controlling the grid voltage adjacent to an oil filled 420 kV submarine cable across the nearby Oslo Fjord. The cable is part of a grid interconnecting the power transmission systems of Norway and neighbouring Sweden. The inter-connector, having an overall transmission capacity of approximately 2.000 MW in either direction, is a key facility for power exchange between the two countries.

The 420 kV line from Hasle to Tveiten consists of an 11.7 km submarine cable across the Oslo Fiord and 35.5 km of overhead line. The reactive power generated in the cable and the connecting overhead line is 355 Mvar.

The SVC increases the power export capacity to Sweden, damps electro-mechanical power oscillations over the inter-connector, and protects the submarine cable from Hasle across the Oslo Fjord to Tveiten against critical over-voltages in conjunction with switching operations or light loading of the cable. And vice versa, since the cable is located in a mostly heavily loaded area, the capacitive generation of the cable can be put to use by supporting the voltage during high load.

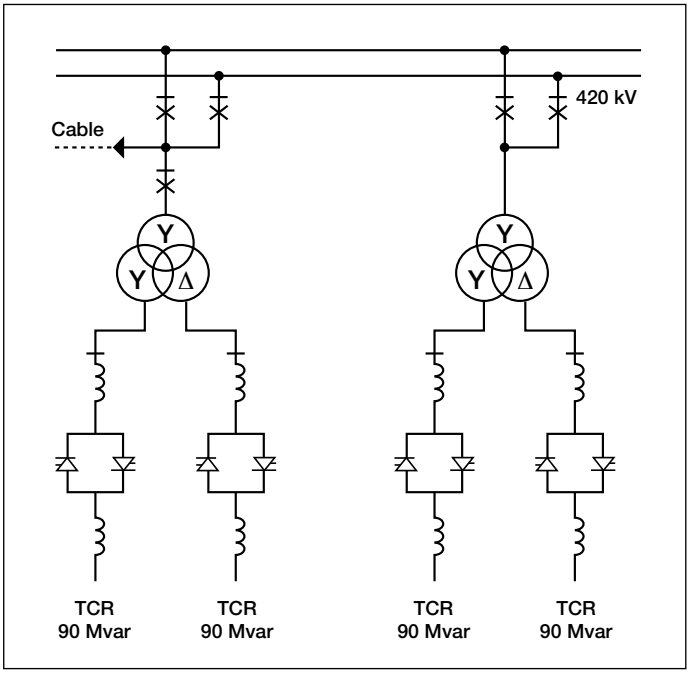
Scope of rehabilitation

The scope of rehabilitation of the existing SVC at Hasle involved replacement of the shunt reactors, thyristor valves, thyristor cooling water pump station, and control and protection system.

Main SVC design

The SVC at Hasle consists of two Thyristor-Controlled Reactors (TCR), each rated at 420 kV, 0-180 Mvar inductive, and each TCR subdivided into two 90 Mvar branches. The branches are 12-pulse connected through a 180 MVA power transformer with its tertiary windings in Y/Δ.

One TCR unit is connected directly to the 420 kV station busbar and the other to the 420 kV line from Hasle across the Oslo Fjord to Tveiten. The units can operate independently, or the two TCRs can be run together.



Single-line diagram

Thyristor valves

The thyristor valves for the TCR each consists of three single-phase units with PCT (Phase Control Thyristor) stacked vertically in two anti-parallel stacks per phase. In parallel with each thyristor, a snubber circuit (series connected resistors and capacitors) is mounted.

Thyristor valve (one 90 Mvar TCR branch)

The thyristors are liquid cooled using a mixture of glycol and de-ionized water with low conductivity as coolant. A dry air cooler placed outdoors provides heat exchange between the cooling medium and the air. Fans are automatically started if the cooling medium temperature exceeds a certain level.

Control system

The SVC is controlled by a microprocessor based control system. The control system is based on the ABB MACH 2 concept, built around an industrial PC with add-in circuit boards and I/O racks connected via standard type field busses. Dedicated voltage and current transformers provide the control system with information of the network parameters, employed in the SVC control.

The control system provides facilities for SVC control either from the Operator Work Station (OWS) in the SVC control room, from a Remote Work Station (RWS) in the Hasle substation control room, or remotely from a dispatch centre via a Gate Way Station (GWS).

The voltage control system is a closed loop system with control of the positive phase sequence voltage at the 420 kV bus.

Power oscillation damping

The most common purpose of an SVC installation is related to voltage control in the power transmission system. However, another useful mode of operation is Power Oscillation Damping (POD), enabling the SVC to act as a damper of electro-mechanical oscillations in the grid. This mode has been utilized in Hasle since 1985, and has successfully acted to damp power oscillations on the heavily utilized Hasle-Borgvik 420 kV inter-connector between Norway and Sweden. The POD mode has been implemented in the rehabilitation and modernisation project commissioned in 2008, as well.

Main technical data

System voltage	420 kV
SVC rating	0-360 Mvar inductive (Two TCR in parallel, each rated at 0-180 Mvar)
SVC connection	12-pulse
Control system	Three-phase voltage control by means of a closed loop system. Power oscillation damping an added feature.
Thyristor valves	PCT type thyristors, water cooled, indirect light firing

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