San Diego Gas and Electric Co. (SDG&E) is operating two series capacitors supplied by ABB in their 500 kV South-West Power Link at Imperial Valley in Southern California. One series capacitor, Imperial Valley East, is rated at 372 Mvar at 500 kV system voltage. The other, Imperial Valley West, is rated at 519 Mvar at 500 kV system voltage. The series capacitors have replaced two older units, supplied by ABB in the 1980s.

The purpose of installing the series capacitors was to increase the power transmission capability of the South-West Power Link bringing power from the Palo Verde power plant up to the customer area of San Diego, thereby taking advantage of the inexpensive remote generation as compared to more expensive local generation in the San Diego area.

Promoting access to renewable energy
In 2012, a third ABB series capacitor, rated at 976 Mvar, went on line at the Suncrest 525 kV s/s, as part of the Sunrise Powerlink Transmission Project. The Sunrise Powerlink transmission line is 120 miles long (190 km) and stretches from the Imperial Valley to San Diego. Its purpose is to provide access to electricity from renewable energy sources such as solar, geothermal and wind located in the Imperial Valley and eastern San Diego County. The line will also help reduce transmission congestion by strengthening the transmission grid and improving access to cheaper energy generated outside the region.

As the series capacitors are located in a seismically active area, an ABB patented mechanical spring damper mechanism is incorporated in the platform design. All the equipment has been designed to meet the High Seismic Qualification level according to IEEE Standard 693.

Main circuit design
The series capacitors are equipped with MOV (ZnO varistors) for primary overvoltage protection, enabling immediate re-insertion of the series capacitors following clearance of external faults of a duration not exceeding 200 msec. For longer durations as well as for internal faults, i.e. faults occurring in line segments containing the series capacitors, the series capacitors are permitted to be by-passed. By-pass is performed by means of a by-pass switch and a current limiting reactor for limiting the inrush current to safe values. After the fault has been cleared, the series capacitor is re-inserted into operation by opening the by-pass switch.
Control system
The control system is based on the MACH 2 concept, which is a system of both hardware and software, specifically developed for power applications. MACH 2 is built around an industrial PC with add-in boards and I/O racks connected through standard type field buses like CAN and TDM.

The series capacitors can be controlled from two different locations. Locally in the series capacitor control room there is an Operator Work Station (OWS) based on a personal computer.

The current measurements for control and protective functions are attained by use of OCTs (Optical Current Transformers). The OCT consists of a current transducer in the high voltage busbar and an optical interface module in the control room. Signal transmission between the transducer and the interface is by an optical fibre system including platform links, high voltage signal columns and fibre optic cables.

Main technical data

<table>
<thead>
<tr>
<th></th>
<th>Imperial Valley West</th>
<th>Imperial Valley East</th>
<th>Suncrest</th>
</tr>
</thead>
<tbody>
<tr>
<td>System voltage</td>
<td>500 kV</td>
<td>500 kV</td>
<td>525 kV</td>
</tr>
<tr>
<td>Rated current</td>
<td>2600 A</td>
<td>2200 A</td>
<td>3000 A</td>
</tr>
<tr>
<td>Rated reactive power</td>
<td>519 Mvar</td>
<td>372 Mvar</td>
<td>976 Mvar</td>
</tr>
<tr>
<td>Rated reactance</td>
<td>25.6 Ω</td>
<td>25.6 Ω</td>
<td>36 Ω</td>
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<tr>
<td>MOV rating (per phase)</td>
<td>41.5 MJ</td>
<td>52.5 MJ</td>
<td>68 MJ</td>
</tr>
<tr>
<td>Seismic design factor (Horizontal acceleration at ground level)</td>
<td>0.7 g</td>
<td>0.7 g</td>
<td>0.5 g</td>
</tr>
</tbody>
</table>

1) The series capacitor is prepared for a future upgrade to 2600 A, in which case the reactive power will be increased to 519 Mvar.

Seismic platform design
The series capacitors are mounted on fully insulated platforms, one platform for each phase. To limit the mechanical stresses on the series capacitors in the event of seismic activity, the platforms are equipped with spring dampers which increase the damping and lower the natural frequencies of the platforms. In this way the natural frequencies of the platforms are decoupled from those of the equipment located on the platforms, thereby avoiding any mechanical resonant conditions.

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