Series Capacitor for increased hydro power transmission over a 230 kV grid

A series capacitor rated at 108 Mvar is in operation in the 230 kV power transmission grid of Hydro-Québec at Des Hêtres 230/120/69 kV substation in Québec, Canada. The series capacitor, supplied by ABB as a turnkey commitment, has the task of increasing the power transmission capacity over an existing inter-connector bringing power from several hydro power plants down to the consumer areas.

Main circuit design

The series capacitor requires control, protection and supervision to enable it to perform as an integrated part of the power system. Also, as the series capacitor is working at the same voltage level as the rest of the system, it is located on fully insulated steel platforms, one per phase.

The series capacitor protective scheme consists of a Metal Oxide Varistor (MOV), Current Limiting Damping Equipment (CLDE), a Fast Protective Device (FPD), and a Bypass Switch. The CLDE consists of a current limiting reactor, plus a resistor and a varistor in parallel with the reactor. The purpose of the resistor is to add damping to the capacitor discharge current, and thus quickly reduce the voltage across the capacitor after a bypass operation. The purpose of the varistor is to avoid fundamental frequency losses in the damping resistor during steady state operation.

The FPD scheme is based on a hermetically sealed and very fast high power switch, CapThor™, which replaces conventional spark gaps. The FPD works in combination with the MOV, and allows bypassing in a very controlled way in order to reduce the energy dissipation in the MOV. The FPD scheme has advantages over previous, conventional schemes with spark gaps such as:

- More compact
- Unaffected by the environment.
Control and protection system

The control system is based on the ABB 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 busses.

The Series Capacitor 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 Series Capacitor can also be controlled via a Remote Terminal Unit (RTU) interface from a remote control center.

The operator’s interface in the Series Capacitor control room is an InTouch application running on the OWS/SER computer. This computer using a SQL database also performs event handling. All event, alarm and fault lists are displayed on the OWS. The OWS/SER computer is connected to the Main computer through a TCP/IP Ethernet LAN via a network switch.

The following are some of the available protective functions for the Series Capacitor:

- Capacitor unbalance protection
- Capacitor overload protection
- Flashover to platform protection
- MOV overload protection
- MOV failure protection
- Pole disagreement protection
- Bypass switch failure protection
- CapThor protection

Main technical data

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated system voltage</td>
<td>230 kV</td>
</tr>
<tr>
<td>Rated reactive power</td>
<td>108 Mvar</td>
</tr>
<tr>
<td>Rated current per phase</td>
<td>1000 A</td>
</tr>
<tr>
<td>Overload current, 30 min</td>
<td>1350 A</td>
</tr>
<tr>
<td>Rated phase reactance</td>
<td>36 Ω</td>
</tr>
<tr>
<td>Rated ZnO varistor energy</td>
<td>32.1 MJ/3-phase</td>
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For more information please contact:

ABB AB
FACTS
SE-721 64 Västerås, SWEDEN
Phone: +46 (0)21 32 50 00
Fax: +46 (0)21 32 48 10
www.abb.com

1) SER = Sequence of Event Recorder
   SQL = Standard Query Language
   TCP/IP = Transport Communication Protocol / Internet Protocol
   LAN = Local Area network