Société Le Nickel (SLN) is a nickel plant situated at Nouméa, New Caledonia. The plant smelter facility comprises three submerged arc reduction furnaces, rated totally at 130 MW. The smelter takes its power partly from a small regional power distribution grid, and partly from a local, steam based power supply. The submerged arc furnaces introduce considerable phase imbalance on the three-phase power supply. They are also a source of harmonics. At the same time, the local alternators have limited endurance to phase imbalance, lest they suffer added heating and consequent derating of life span.

To limit the impact of phase imbalance as well as reduce the amount of harmonic distortion entering into the power grid, an ABB Static Var Compensator (SVC) has been installed in the smelter, rated at 2 Mvar (inductive) to 66 Mvar (capacitive) at 63 kV. The SVC has been designed to limit the negative phase sequence current in the local generators to about 8%, and to improve the displacement power factor (DPF) to ≥ 0.95. Special precautions were taken to avoid harmful interference between the SVC and the existing harmonic filters, as well as between the SVC and the thyristor controlled furnaces.

**Nickel smelting furnaces: some main features**

Some specific features of the nickel smelting furnaces:

- The furnace is equipped with three pairs of electrodes. Each pair is connected to a single phase transformer with an On Line Tap Changer (OLTC) and an electronic device for current control (Fig. 1).

- The mechanism of power to heat conversion and heat transfer to the furnace charge can be said to be something between submerged electrode and shielded arc. That means near the electrodes, the voltage ranges from 200 V to 1500 V, and the current between 10 kA and 35 kA.

- Furnace operation requires specific power adjustments for each pair of electrodes. Therefore, they produce variable amounts of imbalance.

- The physical properties of the ore, such as resistivity, can change over time.
The SLN plant is located in an island with a weak network supplying the plant, as well as the public grid. Up till now, the furnace load constitutes the main part of the electricity consumption, as well as occupying the main part of the generation capacity available on the island (Fig. 2).

The three electric furnaces are fed from a 63 kV network. The latter is based on a 63 kV indoor substation, interconnected to 4 x 40 MW alternators driven by steam turbines and to 4 x 16 MW alternators driven by hydro turbines. Other hydro and thermal generators are connected to the grid to supply public users. These latter are located far away from the plant and connected by a 150 kV overhead line.

A 3rd Harmonic Filter is directly connected to each furnace. This kind of arrangement has the benefit that with a furnace out of service, the Harmonic Filter is also out, eliminating possible overcompensation.

**SVC: some main design features**

The SVC comprises the following main building blocks (Fig. 2):

- One TCR (Thyristor Controlled Reactor), rated at 64 Mvar
- One 2nd Harmonic Filter, rated at 15 Mvar
- One 5th Harmonic Filter, rated at 15 Mvar.

Together with the three existing 3rd Harmonic Filters in the plant, the overall dynamic range of the SVC reaches 2 Mvar (inductive) to 66 Mvar (capacitive).

A basic feature of the SVC is its direct connection to the 63 kV furnace bus, i.e. the need for an intermediate power transformer has been eliminated altogether. This, of course, represents a considerable simplification of the SVC scheme, plus a saving of installation costs, site space, as well as transportation weight and volume. Moreover, transformer losses are eliminated in this case. Also, fire hazard, always associated with large amounts of oil in one place, is eliminated. And last but not least, the absence of a transformer makes harmonic filtering more efficient, as the path from furnaces to filters gets more direct from an electric point of view.

The thyristor valve is of BCT type, i.e. it is equipped with Bi-directionally Conducting Thyristors. In such devices, two thyristors are integrated into one wafer with separate gate contacts. As the SVC is directly connected to the point of common connection (P.C.C), the thyristor valve has been rated to accommodate the full 63 kV plant voltage.

Furthermore, the SLN SVC is installed 100% indoors, against a more common practice of placing part of the equipment outdoors. The reason is protecting the SVC from severe, regularly occurring tropical storms.

**SVC Benefits**

Tests performed with the SVC in operation have confirmed the following benefits of the SVC:

- The voltage imbalance of the plant is more than halved, from max 1.25% to below 0.5%.
- Harmonic voltages are reduced considerably, all located below contractual guarantee values.
- The displacement power factor is improved to DPF ≥ 0.98 in normal operation.

**Main technical data, SVC**

<table>
<thead>
<tr>
<th>Controlled voltage</th>
<th>63 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVC rating</td>
<td>2 Mvar inductive to 66 Mvar capacitive (-2/+66 Mvar)</td>
</tr>
<tr>
<td>Control system</td>
<td>- Negative-phase sequence control</td>
</tr>
<tr>
<td></td>
<td>- Closed loop reactive power control</td>
</tr>
<tr>
<td>Thyristor valve</td>
<td>Directly connected to 63 kV, BCT (Bi-directionally Conducting Thyristors) equipped, water cooled, indirect light firing</td>
</tr>
</tbody>
</table>

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