Issues embedding Series compensation in Interconnection Central System (SIC) of Chile

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In 2005, the Chilean trunk system had to be expanded to allow that the big (relatively) hydro plant was able to deliver its power from the south of the country to the central load located 500km at north. The special characteristic of the Chilean transmission system is this has two main generation zones, one of them located around of 100km to the north-west of the central load, which main combustible is Gas, Coal or even Diesel, and the other generation zone is located around 600 km at south of the central load.
The central and main load of the system is Santiago Metropolitan Area (SMA) whose peak demand is 2200 MW and the total peak demand is around 6200 MW, it means more than 30% of the total peak is concentrated in SMA.
The other and important characteristic of the Chilean electrical system is that the south generation is almost 100% hydro, and all of north generation is thermal. So, there are two well clear extremes of operating the system: high power flow from the south, (around of 1400 MW in the mentioned corridor) and the other is very low transmission from south and high dispatch of central generation.
The trunk system had important changes with this project converting three 220kV in to two 500kV lines becoming into a 500 km of four 500kV lines.

Additionally, the project had to include 500 kV Series Compensation which was between 45% and 55% of the line impedance; all of this installed in a same substation (Ancoa), as the figure 1 shows.

One of the primary concerns was the protection system performance in this new trunk system considering that the previous installed 500kV lines had old protection relays, ones distance protection, and others, phase comparison, all of them commissioned in service by 1985.

To check the correct performance the protocol was developed which consisted in the following sequence:

1. Make static electrical studies. (Permanent Short circuit analysis). These studied showed up cases where the performance of relays was doubtful and had to be checked in detail.
2. Make some dynamic studies. (Transient analysis). These studies showed up cases where the performance of relays still was doubtful and had to be checked in more detail. From these studies were got COMTRADE files with sample frequency enough to test the relay.
3. Make some field test. (Testing relays). These tests confirm not enough performance of some relays and give the direction to solve the problems detected in other relays.

These tests also allowed checking the pilot scheme proposed and its eventual changes to improve the response.

Among the problem detected were:

1. Not enough voltage memory in old distance protection.
2. Unfeasibility of using classical pilot scheme and as a result was needed to use a special pilot scheme used only in this part of the electrical system.
3. Need to change setting of the relays protection of the neighboring lines and in some cases need of change of complete system.

This protocol was also used to check the most recent expansion of the system (2008), extending the 500kV additional 70 km to the north.

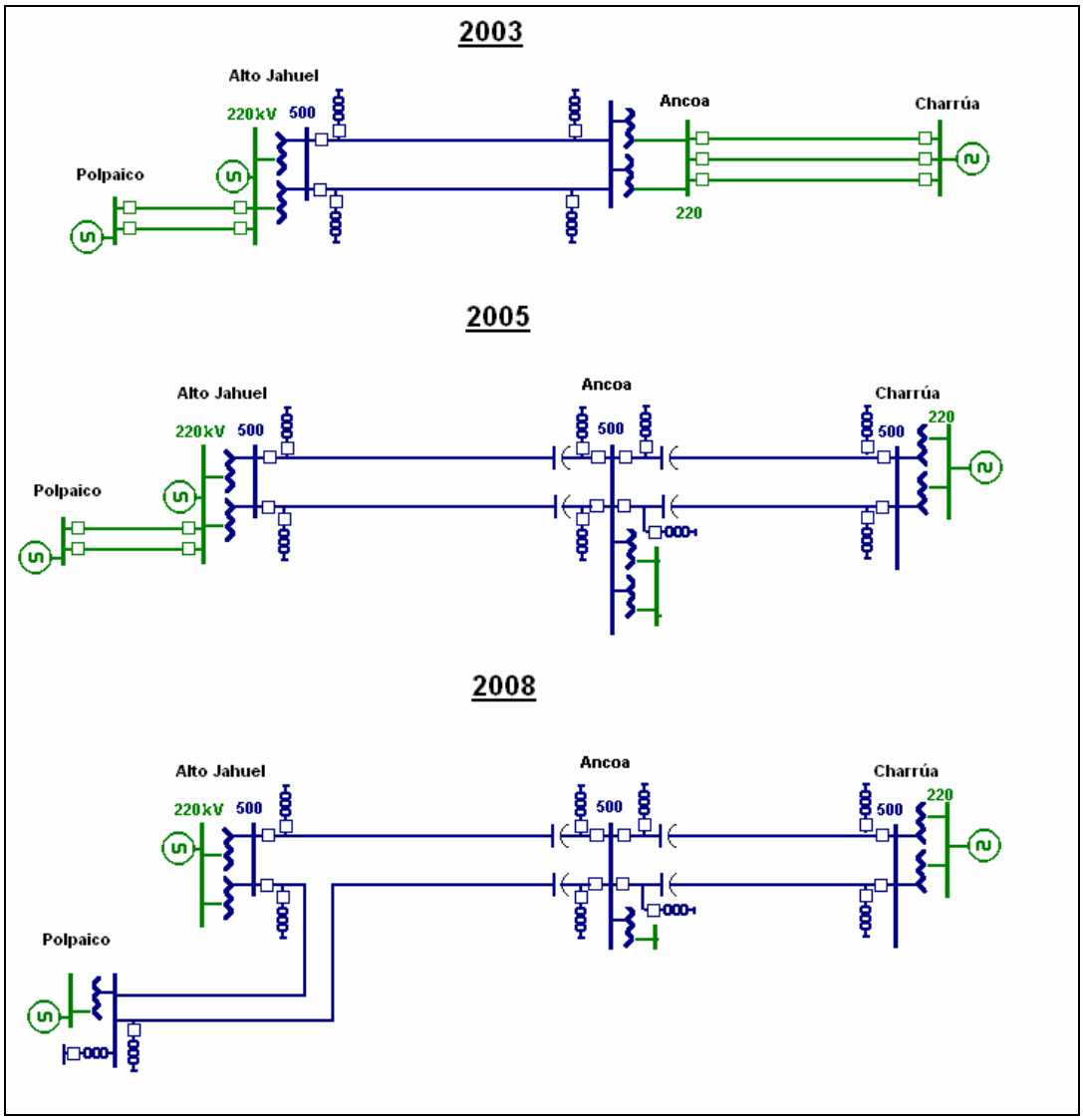

Figure 1. Expansion of the 500 kV system and its series compensation