Conversion of PSSE data file to ATP format for a study of voltage sags in an aluminum factory

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Abstract-- **An aluminum factory has experienced several load shedding as result of faults in 500 kV overhead lines of the electric grid, external to the plant.**

The load shedding from two of the four potlines of aluminum production, are consequence of the actuation of the protection system against voltages sags installed on the thyristors rectifiers, which under certain conditions considered dangerous, causes the trip of the rectifiers to avoid possible damage to the thyristors due to commutation failure, shedding in this way 360 MW of the total load of the aluminum factory.

In order to assess the sensitivity of the protection system to voltage sags caused by faults in the external network, a comprehensive study of the system was performed through digital simulations of failures in several overhead lines, considering different types of faults, locations, scenarios, etc.

The parameters and topology of the network are available in detail in the PSS/E program power flow files, but since it is necessary to determine the waveform of the voltage at the plant bus bars, the studies must be performed with a program able to calculate electromagnetic transients such as the ATP. A program was developed to make the conversion of the PSS/E power flow data to ATP format.

This paper presents a description of the program, together with the results and conclusions of the study.

Keywords: **ATP, EMTP, Voltage Sags, Thyristor Rectifiers.**

I. Introduction

An aluminum factory has experienced several load shedding as a result of faults in 500 kV overhead lines of the external electric grid of the plant.

Two of the four potlines of aluminum production (180 MW each), are with thyristor rectifiers, and have a protection system against voltages sags, called 'Low Synchronism Voltage Protection' ('LowSync'). Under certain conditions considered dangerous, the protection disconnects the rectifiers to avoid possible damage to the thyristors due to commutation failure, shedding in this way 360 MW of the total load of the plant.

It has been verified in real operation that the protection has tripped the rectifiers with, for example, an asymmetric fault of a 500 kV overhead line, at a distance greater than 350 km from the aluminum factory.

In order to assess the sensitivity of protection 'LowSync' to voltage sags caused by faults in the external network, a comprehensive study of the system through digital simulations of faults in several overhead lines has been performed.

The study considereddifferent types of faults, locations of the faults in the line, scenarios, etc.

The parameters and topology of the Argentinean electric power grid is available in PSS/E power flow files, but since it is necessary to determine the waveform of the voltage at the plant bus bars, the studies must be performed with a program able to calculate electromagnetic transients such as the ATP [1].

Furthermore, the study involves the simulation of many cases that take into consideration single and two-phase faults, with and without ground contact, on several lines in various scenarios of high and low demand, and with different locations of the fault in the line.

Given the large number of cases to be simulated, and in order to construct scenarios with the PSS/E program and then reuse this data with the ATP, an IPLAN program [2] was developed to generate the data files in the required format by the ATP, by converting the PSS/E load flow files.

In this way it was possible to build and run a total of 284 cases with the ATP program, considering one-phase and two-phase faults with and without ground contact in 12 transmission lines (11 of them are 500 kV and one 330 kV), and other bus bars of the grid, using 12 different scenarios.

II. System description

Fig. 1 shows a representative diagram of the connection of the aluminum plant with the network.

The aluminum factory has four potlines with a total load of 720 MW. Two of the potlines rectifiers were recently changed to thyristor technology, while the remaining two still use diode technology.

The plant is supplied by a hydro power plant (4 x 118 MW) interconnected with the aluminum factory through two 330 kV lines. The plant also has an internal generation of approximately 730 MW.

Since 2006 the plant is also interconnected to the main Argentinean transmission system (SADI) thought a 500 kV radial power line of approximately 354 km long.

The replacement of the rectifiers to thyristor technology

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