ELECTRICAL STUDIES PERFORMED TO INSERT LONG AC CABLES IN THE FRENCH GRID – FIRST CONCLUSIONS

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ABSTRACT

EHV cables are more and more considered as an alternative solution to develop the network. The solution is particularly relevant when the public opposition is too strong to build new overhead lines or when there is a need to connect a new power generation plant in a short time. In the next years RTE, the French TSO, plans to install several long HVAC cables. The insertion of a cable in the grid often requires additional devices to control the voltage and the load flow. EMTP studies are required to assess electrical transients generated by those new components. This paper describes the methodology adopted at RTE for those studies and the first conclusions with the example of a 65km long 225kV cable installation in the south east of France.

KEYWORDS

Long HVAC cable, EMTP-RV, network modeling, frequency scans studies, electromagnetic transient studies.

INTRODUCTION

With the difficulties to build new overhead lines, HVAC cables are now considered as an attractive alternative solution to develop the network. However HV cables have different electric properties from overhead lines and to operate the network properly, installation of additional HV devices are often required. First of them, shunt reactors are often needed at one or both ends of the cable in order to counterbalance the reactive power generated by the cable. Moreover in a meshed network, the low series impedance of a HVAC cable link also implies the installation of series reactor or phase shifting transformers in series with the cable in order to balance the load sharing with the different overhead lines in the vicinity.

Since 2008, the French TSO RTE (Réseau de Transport d'Electricité) has decided to install several long HVAC cables on its grid. The first example consists of a 65km long 225kV AC cable between the substations of Boutre and Trans which is meant to reinforce the 225kV grid in the South East of France. In steady state, this cable will generate 260 MVAR on the grid. Therefore, in order to obtain acceptable voltage variations during energization, it has been chosen to compensate the Boutre-Trans cable with one 80 MVAR shunt reactor connected at each end. Although the compensation rate is only around 60%, these shunt reactors are required to be mechanically controlled so they can be switched off with the cable in service in order to take advantage of the reactive power of the cable to support the voltage in heavy load situations. However this flexibility brings new situations to look at.

Long HVAC cables with their associated devices have to be considered as new components inside the grid since their impact in terms of electromagnetic transients have to be checked. At first, frequency scan studies are conducted to detect potential adverse resonance with the existing network components. These studies aim to detect any configuration which may lead to temporary overvoltages following the energization of a saturable device. Even though a frequency domain program would have been sufficient, frequency scan studies are made with the EMTP-RV program, since they are followed by time domain studies to evaluate the duty of the HV equipment when switching-on the cable or when clearing a fault on the cable or on a line.

Protection relays have also to operate safely with no false operation during cable transients. For that reason, protection relay studies are also performed with EMTP-RV using frequency dependant parameters for the cables. The calculated current and voltage waveforms can then be injected in the relay in order to check its behavior.

With the increase of innovative solutions in the transmission grid, transient studies take a growing part alongside system planning studies. A methodology has to be developed to perform these studies in the most efficient way to meet the deadlines requirements for the projects. Modeling of the network is a particular sensitive point in terms of time consuming for EMTP studies. The questions which arise are the size of the network to model, the initial load flow, generation and load conditions, the validation of the network model …

This paper shows the first conclusions of the EMTP studies performed at RTE for the Boutre Trans cable in 2010.

ELECTRICAL STUDIES

The electrical studies realized to design a cable and its insertion are described in Fig. 1.

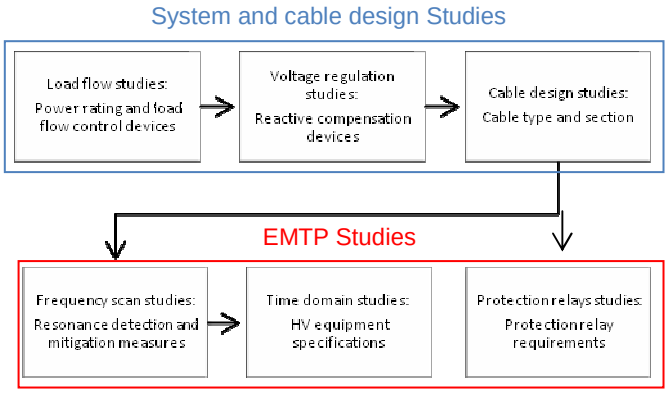

Fig. 1: Electrical studies for HVAC cable insertion

The load flow studies are the first studies to realize for the design of a long HVAC cable. The expected outputs are its connection points to the grid, the active power to be transmitted and the characteristics of the series devices to implement to ensure a good load sharing with the other parallel lines. This can lead to the installation of series reactor or phase shifting transformer together with the cable to limit the current in the cable in steady state due to its low series impedance.