Transient studies of power cable sections in 380 kV transmission system

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Today is more than a decade since 380- kV XLPE cables have been installed for relatively long distances in the network. Expansion of this technology is reasonable particularly in the urban areas, where underground transmission or distribution is appropriate. 380 kV cables were installed in the long tunnels in big European capitals. Coming years many kilometers of new high voltage transmission lines will be erected. Alone in Germany 3500 kilometers of new extra high voltage lines are required for the transmission of wind power from North to South. Geographical constrains and dense settlement areas may change the structure of the grids in near feature. Even connection between two substations may consist of many cable and overhead line sections along a short distance. The differences between the overhead lines and cables are not only in their design, costs and impact on the environment. Their behavior in electrical grid is not similar. The paper presents modeling and simulation results for a 380 kV transmission line concatenated by several overhead line and cable sections.

The number of mixed lines consisting of several OHL and cable sections at EHV level may rise in near future. Energization of the cable with OHL simultaneously can cause critical transient surges. Moreover shunt reactor connected directly to a line can interact with the cable. Shunt reactor compensate produced by power reactive power. Especially interesting is their interaction during switching transients in the power system. This paper has described development of the EMTP model of a 380 kV mixed line consisting of cable and OHL sections compensated by shunt reactors. Switching overvoltages of the 380 kV mixed line are studied by means of digital simulations. For better understanding some theoretical background is provided, before problem and countermeasures are discussed. Two phenomena can occur during energizing a mixed line namely switching overvoltages and delayed current zero-crossing phenomena. This paper investigates the electrical behavior of mixed cable/OHL lines with shunt reactors in a 380 kV transmission system regarding these phenomena. Comprehensive description and investigation of all phenomena would exceed the size of this paper. With the help of models of 380- kV mixed lines major issues with respect to switching computations are investigated. The simulation studies were performed using electromagnetic transient program. Transmission system components require an insulation level to withstand the switching surge overvoltages. It is therefore important to estimate accurately the switching overvoltage amplitudes and define all hazardous dangers. Furthermore some guidelines regarding secure closing sequences and countermeasures are presented.

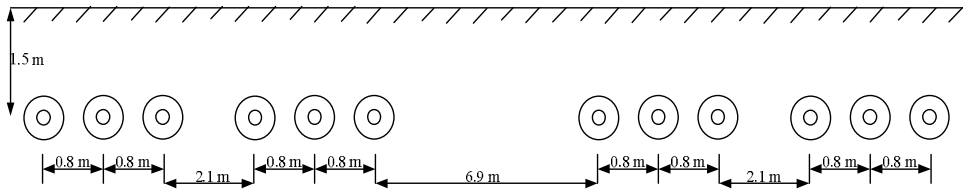

Fig. 1:. Cross-sectional layout of the cable section. The line consists of two parallel three-phase systems