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Very fast front overvoltage computation in GIL due to switching operations with disconnectors in GIS

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Abstract:

The purpose of this article is to investigate the Very Fast Front Overvoltages, which occur on the 110 kV Gas Insulated Transmission Lines (GIL - line insulated with SF_6/N_2 gas mixture), due to switching a disconnector in GIS. Electrical stresses occur during the switching operation with disconnectors in a GIS to which GIL is connected and they are determined via simulation. The modeling of GIL (directly buried with polymer sheath enclosure), allowed for a series of observations with regard to the parameters of the generated VFTO.

The empirical distribution functions of the VFTO were calculated in [p.u.], depending on polarity, caused by a switching operation with disconnectors in GIS, and on the 110 kV GIL line connected to the station (at both ends and at the middle of the GIL). In the corresponding configurations the switching operations were correlated to the annual probabilities and 500 transients were simulated.

Introduction:

Gas insulated substations have a series of advantages when compared to the classical ones (their characteristics of an insulating medium and gas extinction, high compaction level, modularity). However they have their own problems such as the risk of insulation breakdown under very fast front transients at sparking occurs, and thus are generated traveling waves (reflected and refracted on line discontinuities) with rise times within a few ns and a frequency range within tens...hundreds MHz (the VFTO generated depends on the GIS configuration). When at the end of GIS is connected a GIL (line insulated with $10\%SF_6/90\%N_2$ gas mixture), the VFTO that result are propagated along this, practically maintaining the value of the wave front in the range of hundreds of ns.

The analysis of the propagation of VFTO along these GILs thus becomes interesting, mainly thanks to the use of GIL as an alternative to LEA and LES in places where these are not suitable because of the environment, where the power to be transmitted exceeds the capacity of the cables. However, the electrical stresses, which occur in such cases, cannot be established by means of simple algorithm or model. It is possible to establish them only by making the electromagnetic model of the equipment, by making the numerical simulation [1] and by the statistical data processing.

The basic arrangement of the 110 kV GIS_B (insulated with SF_6 gas and at the gas pressure p = 5,5 bar) and GIL (directly buried line with polymer sheath enclosure, insulated with $10\%SF_6/90\%N_2$ gas mixture and at the gas pressure p = 6 bar) are shown in figure 1. As a working alternative, the case in which line L2 (supply) has 0,8 km in length, has been adopted.