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The effect of a floating conductor on the breakdown performance of a non-uniform air gap under HVDC stress at both polarities

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Abstract

A model for predicting the effect of a Floating Conductor (FC) on the breakdown voltage is presented and critically analysed in conjunction with results from laboratory work. Firstly, the scenario of live-line maintenance on HVDC lines is modelled by a FC within a rod-plane gap. The use of a rod-plane gap is to produce a non-uniform field distribution, representing the non-uniform field that would surround the conductor of a transmission line. This test object is then further simplified into simple gap geometries such that the breakdown voltage of the two gaps separated by the FC can be numerically calculated and the breakdown voltage of the entire test object predicted. The DC breakdown voltage of the rod-plane gap is then presented as a function of the position of the FC in the gap. The simulations are performed for both positive and negative DC voltages. The laboratory work uses a similar test object, with the U_{50} breakdown voltage recorded as a function of the position of the FC within the rod-plane gap. The simulation model is then critically analysed by comparing the laboratory and simulation results. It is concluded that although the model predicts the change in the breakdown strength from the starting to the ending points, the developed model has omitted detail that leads to discrepancies in the predicted results when compared to the laboratory results. This omitted detail includes the effect of corona discharge from the FC, additional parameters affecting the potential of the FC, the oversimplification of the gap geometry for numerical calculation, and the lack of a dynamic model for the changing electrostatic scenario as an applied voltage increases towards the breakdown voltage. The results also show that the position of a FC affects the breakdown strength of a non-uniform gap. This effect is due to the polarity dependent nature of breakdown in a non-uniform gap and in particular, the difference in the breakdown strength of a quasi-symmetrical (rod-rod) and asymmetrical (rod-plane) non-uniform gap. The effects of charged particles and their interaction with the floating conductor in the gap is also deemed to have a significant effect on the breakdown strength, with their behaviour also influenced by the sustained electric field that is a result of HVDC stress.