ANALYSIS OF THREE DIFFERENT THEORIES FOR CALCULATION OF INDUCED VOLTAGES ON DISTRIBUTION LINES DUE TO NEARBY STRIKES

Alexandre Piantini
Institute of Electrotechnique and Energy (IEE/USP CED) -
University of São Paulo, Brazil

Jorge M. Janiszewski
Escola Politécnica (EPUSP-PEE) - CED

ABSTRACT

This paper presents the results of a comparative study of three important theories concerning lightning induced voltages on overhead lines due to nearby strokes.

By means of theoretical analysis and digital simulations, it is shown that both Chowdhuri - Gross and Liew - Mar models are not suitable for predicting induced voltage waveforms, because of the inadequate treatment given to the charges induced on the line during the stepped leader process. The influence of several parameters on induced voltages are also discussed.

Lightning is responsible for a great number of damages and outages on overhead lines. Although the overvoltages caused by direct lightning discharges have higher amplitudes, the voltages induced by discharges in the vicinity of the line usually represent a more serious problem due to their higher frequency of occurrence.
So, several researches have been carried out searching for a simple and reliable model that can be used for the analysis of the line performance concerning nearby lightning discharges.
However, the existing theories diverge in many aspects due to the complexity of the phenomenon.

In this paper, three important theories are analysed, with a special interest towards discharges that occur relatively close to the distribution line and could cause supply interruptions.

This paper showed that the divergencies among the studied theories are very significant. Chowdhuri's explanations for the induced voltage behaviour are inconsistent, as concluded by the analysis and the figures presented.

The modification proposed by Liew and Mar in his theory, including the Jakubowski's treatment to the magnetic component of the induced voltage, do not either justify the obtained results.

Apparently, the fact of not taking into account the effect of the charges induced on the line in the stepped leader phase is the main cause of the large differences in relation to Rusck's model. This effect must not be disregarded, because the stepped leader average speed is small enough to allow for positive charges of the ground to migrate to the line, keeping it at ground potential till the beginning of the return stroke phase.

On the other hand, Rusck's model leads to coherent results, that can be justified from the electromagnetic fields of the phenomenon under study.

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