Lightning response of distribution lines equipped with shield wires and surge arrester

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Abstract— Lightning-originated overvoltages are a major cause of outages in distribution lines. In medium-voltage distribution lines equipped with a periodically grounded shield wire and surge arresters, lightning outages associated with indirect lightning are less frequent than those associated with direct ones. Recent analysis concerning medium voltage lines equipped with a shield wire shows that the electromagnetic pulse radiated from the channel may enhance the overvoltage across insulators during direct strikes. This contribution is aimed at further discussing this aspect.

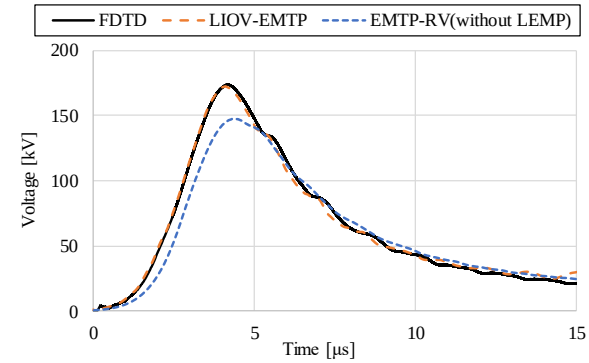
Keywords – LEMP lightning electro-magnetic pulse, distribution lines; lightning protection; direct lightning, grounding

I. INTRODUCTION

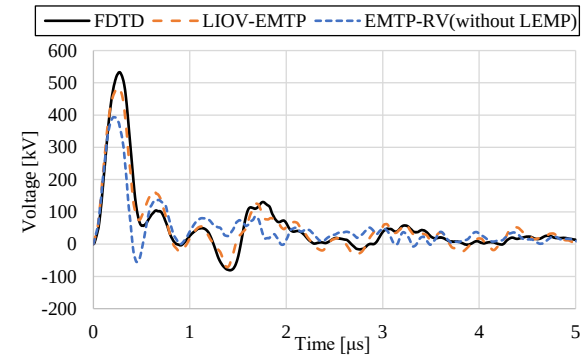
Flashovers on medium-voltage distribution lines due to lightning activity are caused by indirect and direct strikes. For the assessment of the direct lightning performance, circuit-theory-based electromagnetic transient programs, such as EMTP or ATP, are widely used. In these calculations, a direct lightning strike on a distribution line is typically represented by a lumped-current source in parallel with a resistance, and the influence of electromagnetic field associated with the return-stroke current, namely the lightning electromagnetic pulse LEMP, is typically disregarded. However, according to recent studies, e.g. [1], overvoltages induced by the LEMP may significantly affect the direct lightning performance of some type of MV distribution lines, with specific reference to those equipped with a shield wire. The conclusions of the analysis are supported by the close agreement between the results obtained by means of two different approaches: the three-dimensional finite difference time domain (3D-FDTD) method [2] and the LIOV-EMTP code [3].

II. CONTENT OF THE PAPER

Figure 1 shows the overvoltages due to a first stroke in a line equipped with surge arrester installed every 200 m calculated with the 3D-FDTD and with the LIOV EMTP, with and without considering the LEMP contribution. The results are reported for both the cases of a first and a subsequent stroke channel base current waveform. Further results will be presented in the contribution that show how important can be for some cases the effect of the LEMP coupling on the amplitude of induced voltages even for the cases of direct strikes.



(a) First stroke



(b) Subsequent stroke

Figure 1. Voltages across insulators at lightning struck pole.

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