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Lightning Overvoltages on Shield Wire Lines

Alexandre Piantini, Miltom Shigihara
Institute of Energy and Environment
University of São Paulo
São Paulo – SP, Brazil
Piantini@iee.usp.br

José Ezequiel Ramos
Eletrobrás Distribuição Rondônia / Universidade Federal de Rondônia
Porto Velho - RO, Brazil
jer.pvh@gmail.com

***Abstract*—One of the non-conventional technological alternatives for energy supply to small communities located relatively close to transmission lines is the shield wire scheme (SWS). The three phase SWS adopted in the State of Rondônia, Brazil, consists in the energization of the two shield wires of a 230 kV transmission line, being the ground the third phase. The shield wires are energized at 34.5 kV. Lightning has a great impact on the system performance and in this paper an evaluation is presented on the overvoltages induced on shield wire lines (SWL) by indirect strokes.**

Keywords- lightning; overvoltages; power distribution lines; shield wire lines, shield wire scheme.

I. Introduction

In the Amazon region, the existence of small towns and villages located relatively close to transmission lines, but far from the sub-transmission and electricity distribution systems is not uncommon. The use of conventional medium-voltage lines for providing power supply to these communities is sometimes not feasible due to economic reasons.

A non-conventional and low cost alternative conceived by Iliceto [1, 2], namely the shield wire scheme (SWS), has been applied in the State of Rondônia, Brazil, since 1995. Loads greater than 4 MVA can be supplied with the SWS, and the insertion of this technology in the regional scenario enabled energy to be supplied to more than 40.000 people [3].

The Brazilian experience with the SWS is highly positive, but lightning has a great impact on the system operational performance and is responsible for most of the reported power outages. The effect of the overvoltages resulting from direct strikes to the two SWL systems implemented in Rondônia (SMQ and AQJR) was examined in [4]. This paper evaluates the overvoltages induced by nearby strokes on the SWL SMQ.

II. Results

The average conductor height of the SWL SMQ is 21.5 m, more than twice the height of a typical 34.5 kV line. Although the SWLs are located in regions dominated by pastures, there are tall trees close to some line sections. Such trees provide some shielding to the conductors and reduce the line exposure to direct strokes, but on the other hand lightning may occur very close to the line and therefore induced overvoltages can reach sufficiently high levels to cause insulator flashovers. The critical impulse flashover overvoltages of the SWL, referred to the reference atmospheric conditions, are 278 kV and 281 kV for the positive and negative polarities, respectively.

Fig. 1 indicates that, for the conditions considered, the incidence of lightning to distances (d) shorter than about 200 m from the SWL can cause line flashovers. The calculations were carried out assuming a stroke current with triangular waveshape, amplitude of 30 kA, front time of 2 µs, time to zero of 160 µs and propagation velocity equal to 30 % that of light in free space. The soil resistivity and relative permittivity were assumed equal to 4000 Ω.m and 10, respectively.

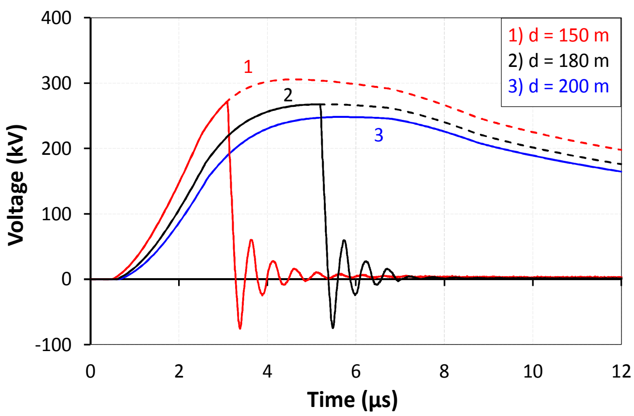

Figure 1. Lightning-induced voltages at the insulator terminals at the point of the SWL closest to the stroke location.

III. Conclusions

Lightning has a significant impact on the performance of SWL systems in regions with high ground flash density.

In comparison with a conventional power distribution line, a SWL is more prone to lightning-caused flashovers. As its conductors are at a higher position, they tend to be struck more times and, additionally, the magnitudes of the lightning-induced voltages by nearby strokes tend to be higher.

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