Induced Voltage Of Overhead De-energized Transmission Lines

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Abstract

The utility company may shut off power in the overhead transmission or distribution lines as a preventative measure against wildfire risks and to ensure public safety. However, the de-energized transmission lines can still carry energy due to induced voltage from the electric- and magnetic-fields emitted from nearby energized lines. Despite being intentionally de-energized, these lines can still pose an ignition risk should they fall and contact combustible ground fuels.

This presentation discusses the use of COMSOL (Electrostatics, Boundary Elements and Magnetic Fields interfaces in the AC/DC module) to calculate voltages induced on de-energized lines from nearby energized lines. We started with a simplified model - a 115kV transmission line and a de-energized conductor in the vicinity for the calculation of induced voltage on the de-energized conductor. The induced voltage resulted from the capacitive coupling effective is of orders of magnitude larger than that from the inductive effect. We then used realistic transmission line configurations with two sets of energized and de-energized transmission lines, respectively. Specifically, for conductor geometry, we examined the distance between the energized and de-energized lines, phase configuration, height above ground level, and line angle. The predicted induced voltage can serve as an input to the electrical and thermal arcing models to calculate of the probability of ignition. This work ultimately was used to validate a three-dimensional, grid-scale model of the overhead electric transmission system that was deployed in purpose-built code to quantify ignition probabilities across an entire service territory.

Reference

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2. Allen Taflove, Prediction Method For Buried Pipeline Voltages Due To 60 Hz AC Inductive Couling. IEEE Transaction on Power Apparatus and Systems, Vol. PAS-98, No. 3, 1979.
3. Xuan Wu, et al., Transient Analysis of Inductive Induced Voltage between Power Line and Nearby Pipeline. Electrical Power and Energy Systems. Vol. 84, No. 47-54, 2017.
4. Mazen Abdel-Salam, Abdallah Al-Shehri. Induced Voltages on Fence Wires and Pipelines by AC Power Transmission Lines. Vol. 30, No. 2, 1994.

Figures used in the abstract

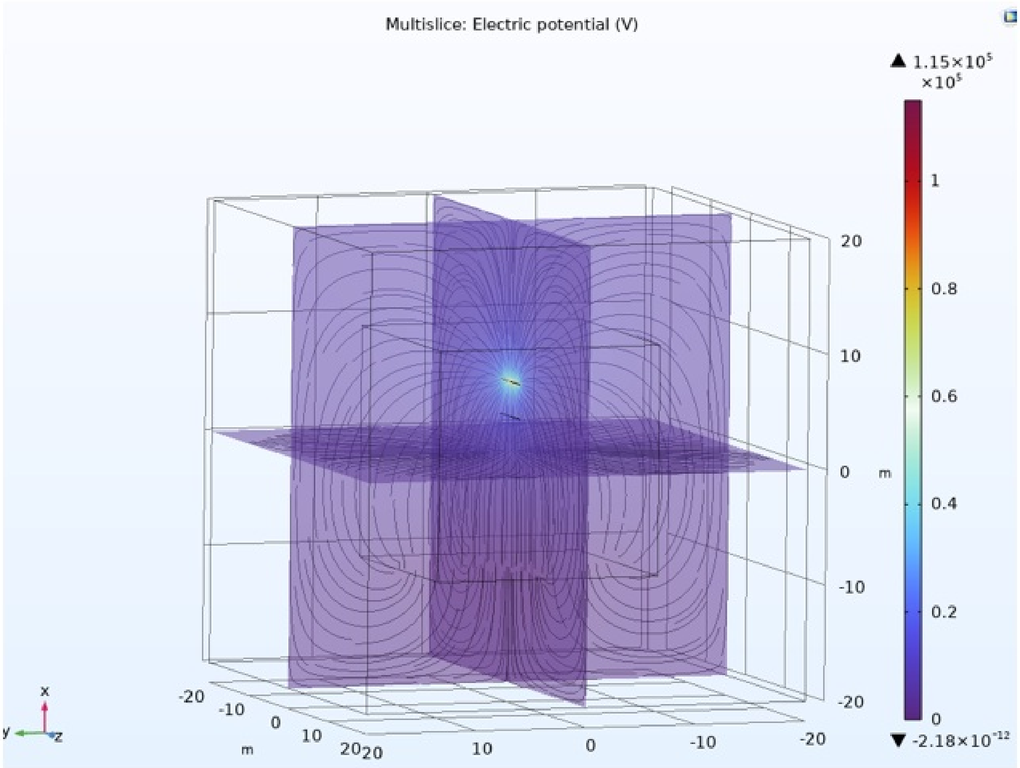

Figure 1. Simplified transmission lines arrangement and visualization of the electric potential.

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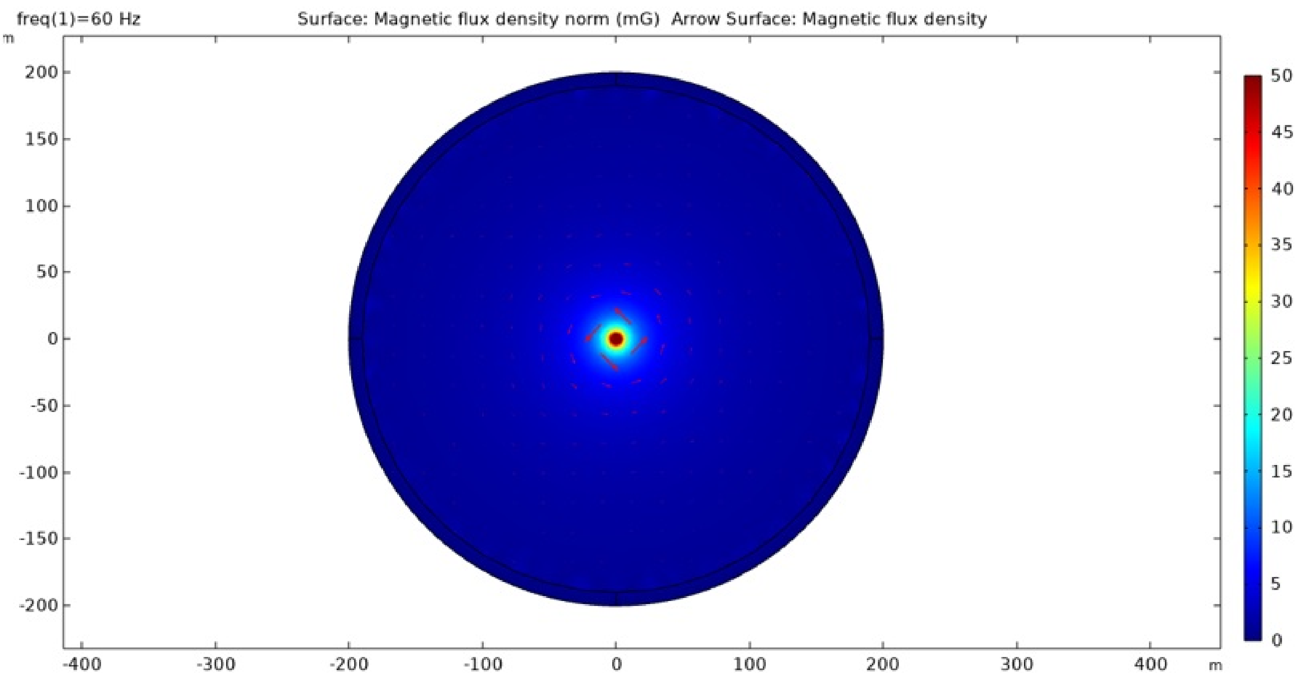

Figure 2. Visualization of the magnetic flux density around the energized line.

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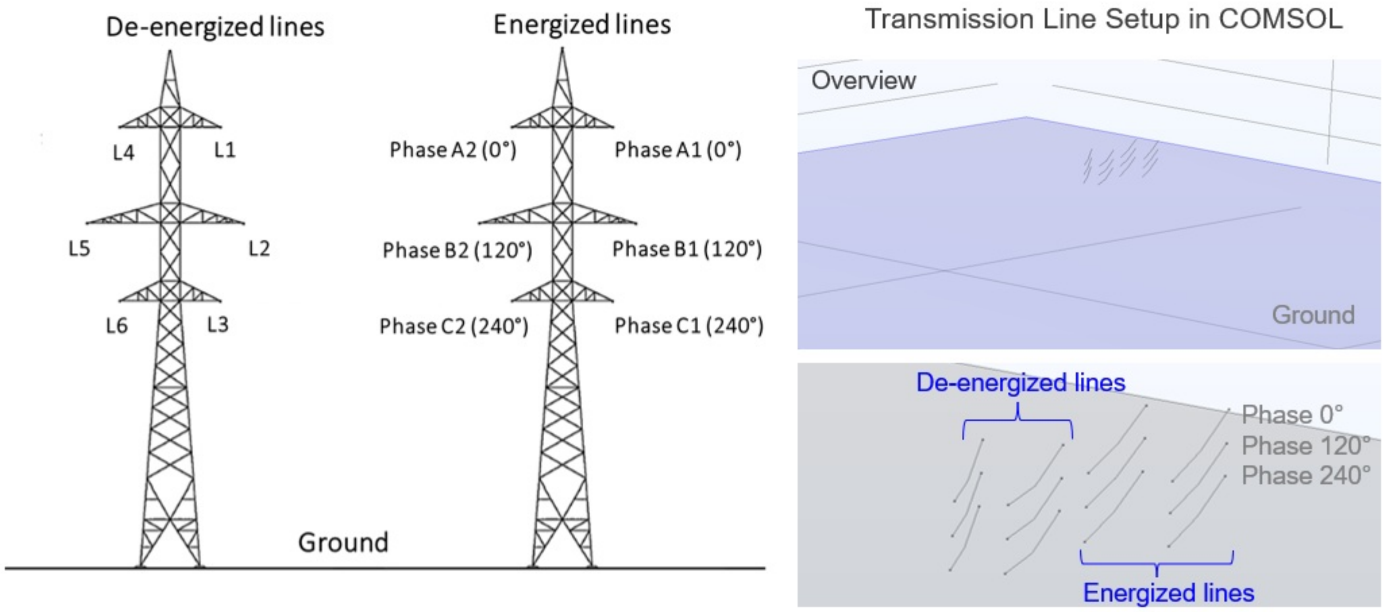

Figure 3. Phase configuration and spatial arrangement of the realistic transmission lines and their 3D setup in COMSOL.

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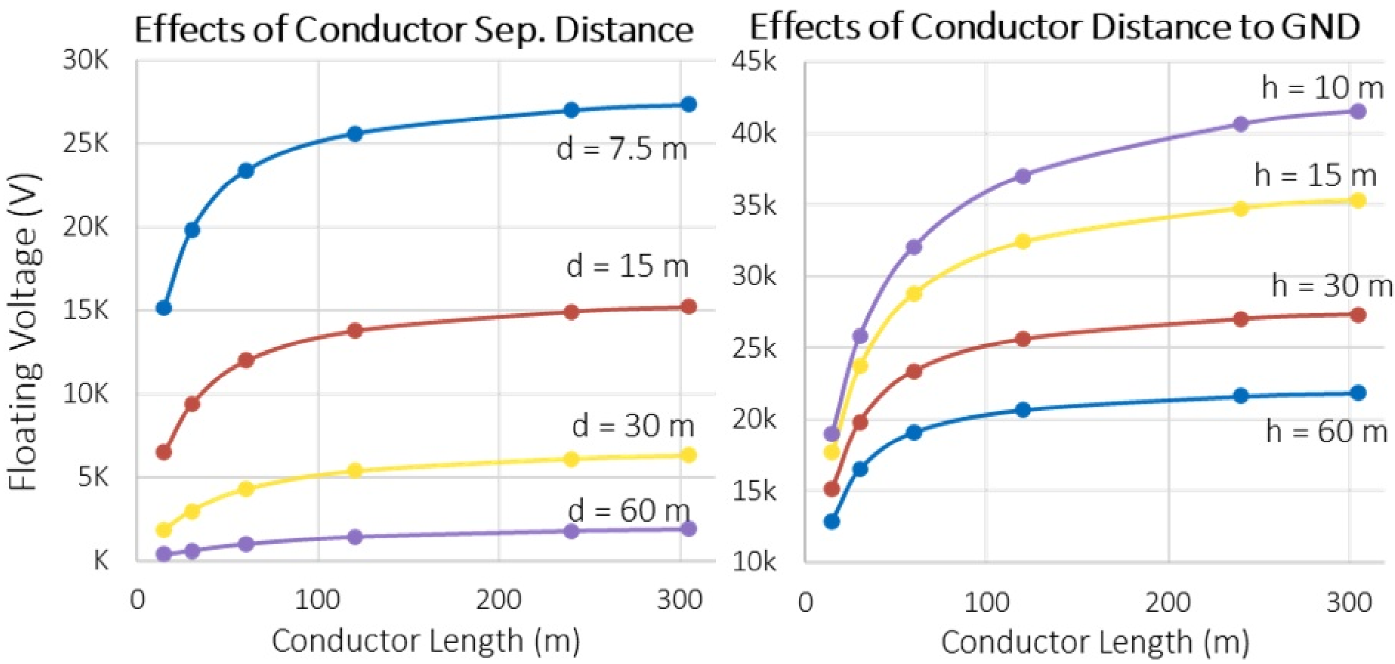

Figure 4. Floating voltage induced on a de-energized straight transmission line parallel with another transmission line energized to 115 kV. Various factors were investigated.

Figure 4 : Floating voltage induced on a de-energized straight transmission line parallel with another transmission line energized to 115 kV.