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IMPACT OF GLOBAL EARTHING SYSTEMS ON THE INDUCTIVE INTERFERENCE ON BURIED ISOLATED METALLIC PIPELINES

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INTRODUCTION

Due to focused energy routes, high voltage energy systems (e.g. overhead lines) are located near buried isolated metallic pipelines. Thus, a possible high inductive interference from energy systems may produce hazardous pipeline voltages. High voltage levels can cause personal injuries and material damage. Normally, pipeline voltages are calculated to prevent such unfavourable events. However, conducted measurements on pipelines show much lower voltage levels, than have been calculated for the same pipelines. Investigations on this discrepancy are needed to bring calculations and measurement data closer together to avoid excessive measures.

IMPACT OF CURRENT LOAD AND GLOBAL EARTHING SYSTEMS

For various reasons, calculating worst case scenarios has become a common practice, using maximum operational currents from the influencing energy systems. In reality, these currents rarely occur because of safety regulations and load flow conditions. It seems preferable to use the actually used load currents. This difference is illustrated by an example in Fig. 1, both for railroads and overhead lines.

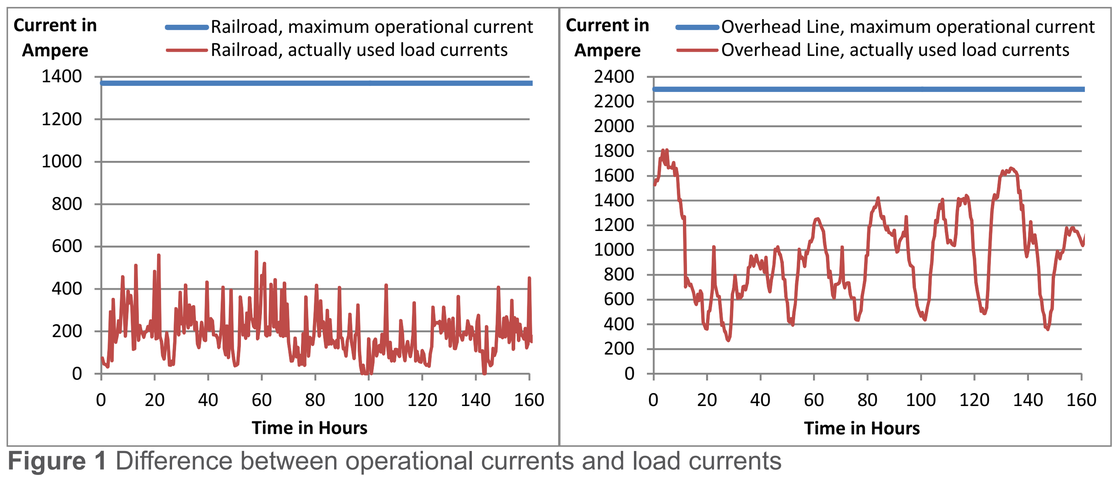

Figure 1 Difference between operational currents and load currents

Still, despite using actual currents, calculated pipeline voltages are often higher than the measured ones. One possible explanation is the voltage reducing effect of global earthing systems (GES). GES consist of linked foundation electrodes and other conductive material within a (sub-)urban area buried in the soil. The advantage of GES is that nearly no dangerous potential differences exist inside the soil. However, some pipelines are made of a similar conducting material and are also buried in the ground. In this case, both are more or less parallel metallic conductors and the inductive influence $\underline{Z}$ from energy systems splits up into the pipeline $\underline{Z}_{pipe}$ and into the GES $\underline{Z}_{earth}$, as Fig.2 shows.

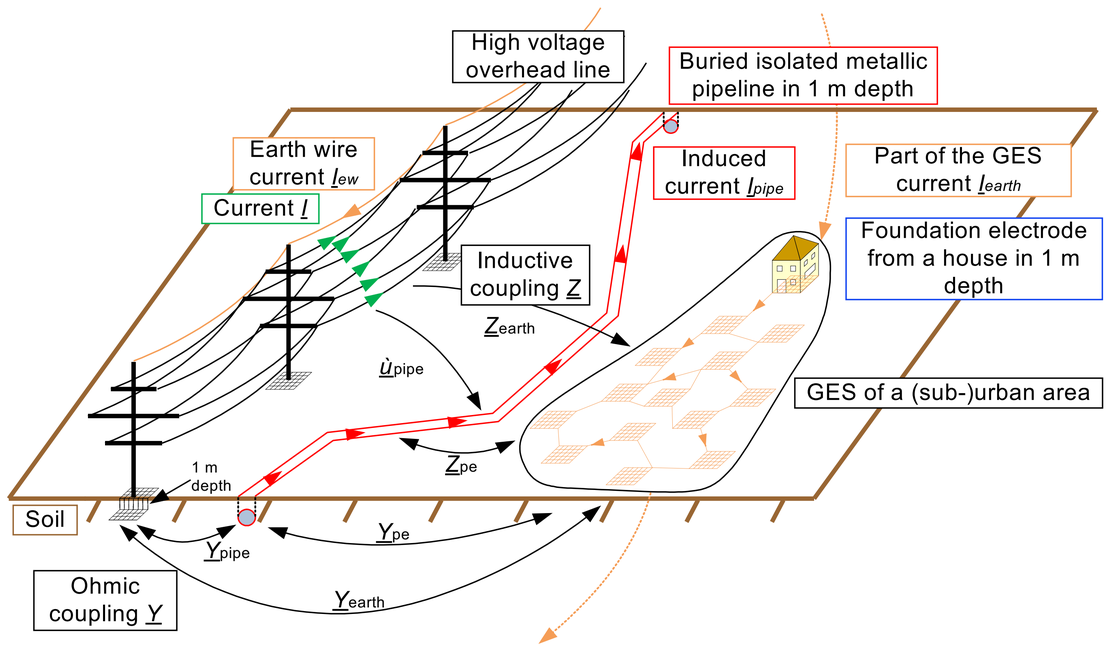

Figure 2 The complex situation between all three interfering components

A side effect of GES is, their conductive material reduces the soil resistivity in the area which further lowers pipeline interference voltage levels ($\underline{Y}$ in Fig. 2). In conclusion, depending on the geographical location and dimensions of GES, pipelines and energy systems, only part of the inductive interference reaches the pipeline, causing reduced pipeline interference voltages.

RESULTS

The following Figures show different examples of calculations using the actually used load currents, with and without GES, comparing them to measurements during a measurement period of 140 to 160 hours at different pipeline locations. As can be seen from Fig. 3 to 5, calculations which consider GES reduce the voltages by as much as a factor up to nearly 5, comparing to calculations without considering the reduction effect of GES. In Fig. 3 and 4, the voltage progressions are very similar which indicate the immediate closeness to GES. However, Fig. 5 shows that the calculation including GES still differ in a remarkable ammount from the measurement. The reason could be unknown metallic systems in the soil, e.g. grounding rods, medium voltage or low voltage power cables or water pipelines. More research is necessary to understand this impact and to investigate whether there are other crucial factors.

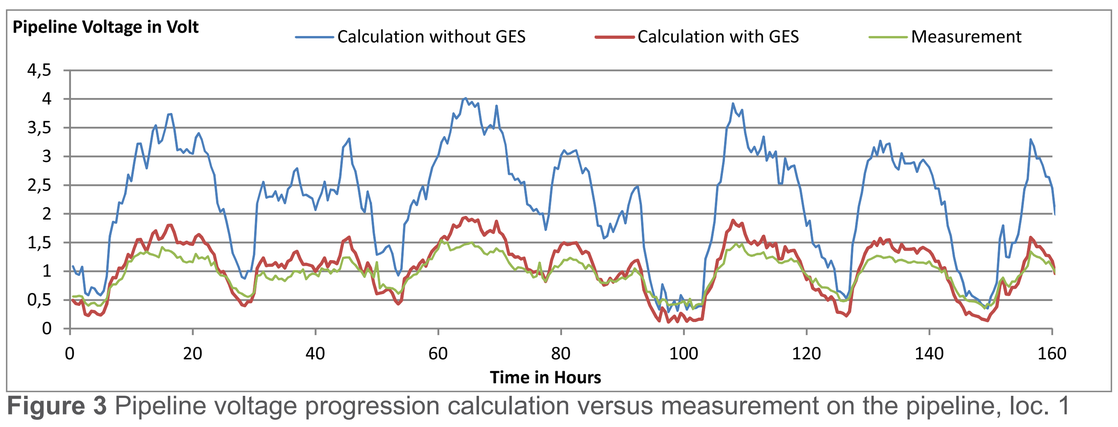

Figure 3 Pipeline voltage progression calculation versus measurement on the pipeline, loc. 1

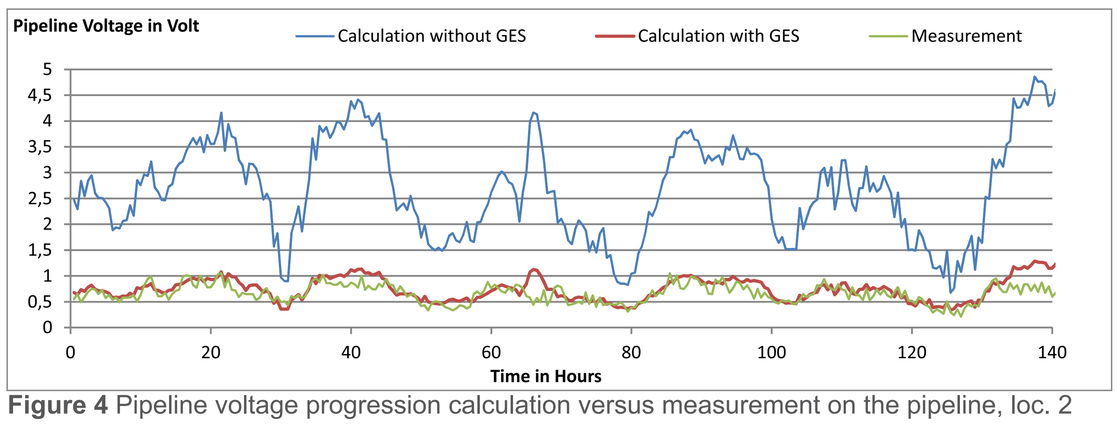

Figure 4 Pipeline voltage progression calculation versus measurement on the pipeline, loc. 2

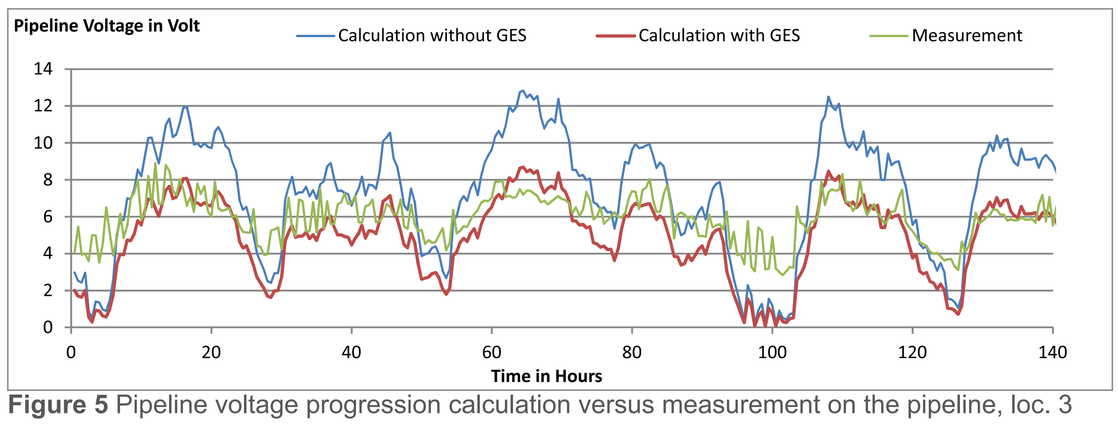

Figure 5 Pipeline voltage progression calculation versus measurement on the pipeline, loc. 3

CONCLUSION

In the case of inductive interference from energy systems on pipelines, the calculation results indicate a strong impact of global earthing systems buried nearby. When GES influence pipelines, the pipeline interference voltage is reduced significantly up to a factor of 5 or higher. How high this factor is, appears to depend strongly on the geographical location. However, certain cases indicate other sources of interferences, still left to be investigated.