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Abstract

A project between the Finnish Meteorological Institute and Gasum Oy was started in August, 1998. Aims of the project were (1) deriving a theoretical model for calculating geomagnetically induced currents (GIC) and pipe-to-soil voltages in the Finnish natural gas pipeline, (2) performing measurements of GIC and pipe-to-soil voltages in the pipeline and (3) deriving statistical predictions for the occurrences of GIC and pipe-to-soil voltages at different locations in the pipeline network. Also a brief study of the effects of power transmission lines on pipelines was performed.

The aims of the project were fullfilled as planned. A model based on the transmission line analogy of pipelines was extended to suit for the GIC modelling of the general pipeline network. The main improvements to the previous models were the treatment of branches and the ability to handle the geoelectric field as a general function of position. The theoretical study was a part of the Antti Pulkkinen's M.Sc. Thesis in which the exact derivation of the model is given.

The GIC and pipe-to-soil voltage measurements near the compressor station at Mäntsälä are working well. The only problem has been the effect of the cathodic protection currents, which makes it difficult to identify the current and pipe-to-soil voltage variations related to geomagnetic disturbances. Concerning GIC measurements, the effect of the protection was not critical from the point of view of the study. Measurements are going to last for a few years over the next sunspot maximum.

With the help of the measurements and the theoretical model it is possible to derive statistical predictions for the occurences of GIC and pipe-to-soil voltages at any point in the pipeline network. From the seven points studied here, it is found that the largest pipe-to-soil variations occur at the ends

of the network, while the largest GIC values are found in the middle parts. Especially the region near the Russian border is the most possible site for large GICs.

The effects of power transmission lines were studied as functions of the angle and the distance between the transmission line and the pipeline. As expected, the largest pipe-to-soil voltages and currents are produced in long pipelines parallel to the transmission line.