Interference and electro-magnetic field analysis

Studies for the calculation and evaluation of electromagnetic fields and the interference of secondary equipment and metallic pipelines

At a glance

Siemens Power Technologies International (Siemens PTI) can support operators of high-voltage systems with the following services:

- analysis of the compliance to limits for time-varying electric and magnetic fields in the vicinity of conductors, transmission line routes, switchgears and power plants
- calculation of the inductive interference between high-voltage overhead lines and secondary equipment or pipelines
- proposal of measures to ensure electromagnetic compatibility of high-voltage switchgears

The challenge

Electromagnetic fields (EMF)
Current-carrying conductors generate a magnetic field in their vicinity, and energized conductors generate an electrical field.

These electromagnetic fields (EMF) can produce adverse health effects if they exceed certain limits. Exposure limits are described in many scientific studies and are discussed politically all around the world. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields. Nevertheless, some countries demand compliance to much lower exposure limits than those required by ICNIRP. The operators of electrical systems are committed to verifying compliance with the guidelines, providing a documented evidence of conformity to the respective exposure limit values.

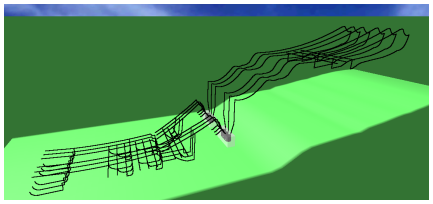

Figure 1: EMF-calculation model of a high voltage station.

Power frequency interference
Power frequency electromagnetic fields from overhead lines and cables can induce voltages on secondary cables or metallic pipelines situated in parallel. On the one hand, these voltages can be a risk for people working on the equipment, and on the other hand, the equipment itself can be damaged. Therefore companies should comply with the limiting values.

Transient overvoltages in secondary equipment
High frequency electromagnetic fields like those that appear during switching of circuit breakers or disconnectors can generate high transient overvoltages in secondary equipment. The secondary equipment can be disturbed or even damaged due to high voltage peaks.

Our solution

Electromagnetic fields (EMF)
High performance software allows Siemens PTI to calculate the EMF in the proximity of single conductors, substations or power plants.

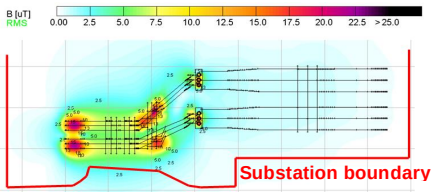

Figure 2: Calculated magnetic flux density in the proximity of a high voltage station.

With these programs, magnetic fields are calculated according to the Biot-Savarts law. The evaluation of electrical fields is realized considering the charge simulation method.

For the optimization of single electrical equipment, and within the scope of fault investigations, detailed EMF simulations can be realized with the finite element method.

For existing installations, the proof of compliance with reference levels can also be provided by measurements on site.

If the simulations or the measurements show that the limit values are exceeded, Siemens PTI can propose corrective measures.

Power frequency interference

For the simulation of the electromagnetic interference in secondary equipment and in pipelines due to high voltage overhead lines, Siemens PTI can rely on high-performance calculation programs.

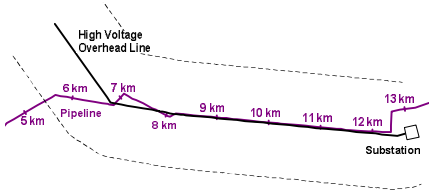

Figure 3: Interference analysis model of overhead line and induced pipeline.

Not only parallel courses between high-voltage overhead-and secondary conductors or pipelines can be modeled, but also oblique exposures and crossings.

The interference analysis takes into account the maximum load as well as the short-circuit currents in the overhead line.

Transient overvoltages in secondary equipment

The occurrence of inadmissible, high-transient overvoltages in secondary equipment during switching operations can be avoided with an EMC-(Electromagnetic Compatibility) compliant design. For this purpose Siemens PTI can plan EMC-compliant measures.

The effectiveness can be tested with EMC measurements according to EN60694.

Application example 1

Magnetic field calculation

For a newly constructed 380/110 kV substation, the conformity to the reference levels of the German 26.BImSchV was required. A three-dimensional model of the station was built (Figure 1) and the power frequency electric and magnetic fields were calculated. Figure 2 shows that the magnetic flux density in the publicly accessible area outside of the station is significantly below the reference level of 100 µT. The electric field strength is below the reference level of 5 kV/m.

Application example 2

Pipeline interference

A gas pipeline was constructed parallel to an existing 380 kV overhead line (Fig. 3). The inductive interference of the pipeline due to maximum load and short-circuit currents in the overhead line was analyzed. The calculations demonstrated that in case of an earth fault, the limit value of 1000 V would be exceeded significantly. Corrective measures were planned and coordinated with the cathodic protection of the pipeline to meet the demanded interference standards (Figure 4).

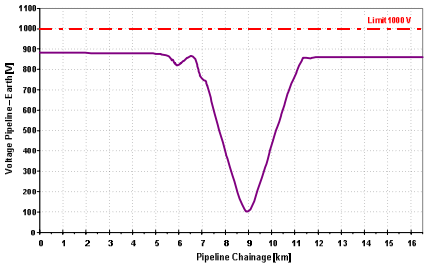

Figure 4: Calculated interference voltage pipeline – earth

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