# A study of the electromagnetic environment in the vicinity of high-voltage lines

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*Abstract*—**The analysis presented in this paper is divided into two main parts. The first part concerns the experimental study of the profile of the electric field and magnetic field generated by the high voltage line transmission at ground level (0 m). While the second part is a simulation study of the profile of the electric field and the magnetic field at different levels above the ground, from 0 m to the level close to the line conductors (20 m above the ground) with the module of electrostatic and magneto-static software COMSOL multi-physics.**

***Keywords-HV line; Electromagnetic Fields; Finite Element Method; Electromagnetic compatibility; Low Frequency***

## I. INTRODUCTION

The electric and magnetic fields present in a high voltage line are a topic that has long worried the crowd's influences on the environment is well known and analyzed in several specialty works [1-3]. Electromagnetic disturbances associated are limited by the general standards on electromagnetic compatibility and Directives 89/336, 92/31et 93/68/EEC of the Council of the European Community. At the recommendation of CIGRE [4] and of the Council of the European Union values of the magnetic induction are limited to 100µT - for public exhibition and 500 µT - for occupational exposure, although the values of the fields power is limited to 5 kV / m applied to the public and 10 kV / m for professionals recommended by Directive 519/1997 of the Council of the European Union [5]. In this work we present a numerical and analytical modeling of the electric and magnetic field generated by a high voltage line The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has established a continuous electric field exposure limit of 5kV/m and a continuous magnetic field exposure limit of 100 µT for general public at 50 Hz frequency [6]. These limit values are sometimes approached exposure is much lower. Away from the power lines field levels are much lower than proposed limits. As we can see, none of regulations are dealing with polarization of electric and magnetic field vectors. So, if low levels of fields have no influence on a human body, could we say the same for polarization of electric and magnetic fields.

## II. MATERIELS AND METHODS

### A. Model description

Measurements have been conducted under two 220KV lines located next to each other (Fig.1).

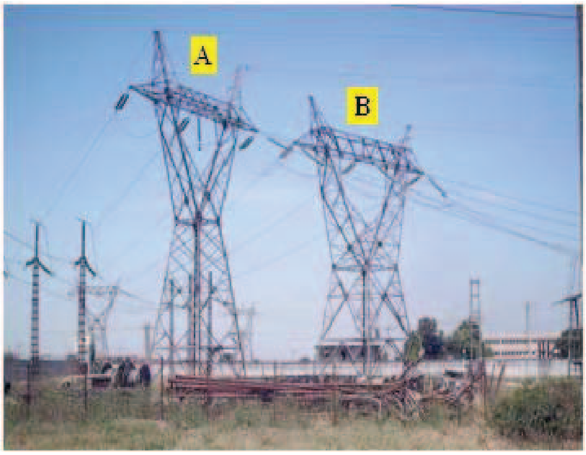


Figure 1. Model studied

The lines A (220KV) and B (220KV) represents respectively ARCELOR-MITTAL and KHARAZA city. The distance between phase lines (7m), the lengths of lines (21m) and the currents in conductors (270A).

### B. Experimental investigation

Measurements of electric and magnetic fields have been conducted in order to achieve an experimental characterization of the electromagnetic environment in the vicinity of the Multi-lines power system chosen, taking into account the inductive and capacitive coupling between the phases. We started our measurements from the center of the tower B chooses as reference (0m) on specific distances to the center of the tower A located at (60m), using an electromagnetic Field Strength Meter PMM8053A (fig.2). The latter is equipped with a low-frequency probe connected to a data acquisition system (EHP50) by means of a fiber optic cable.

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Figure 2. Characteristics of the measuring equipment

## C. *Simulation modeling*

This simulation is solved by COMSOL Multiphysics 3.4 software which uses the Finite Element Method. The profile of the electric field and magnetic field is simulated at several levels above the ground (0m to 20m) using the module electrostatic and magnetic-static.

# III. RESULTS AND DESCUSSION

## A. *Experimental result:*

Figures 3 and 4 show the profile of the electric field and the magnetic flux density detected by the electromagnetic field measuring instrument according to the distance x(m) and at the level 0m (ground).

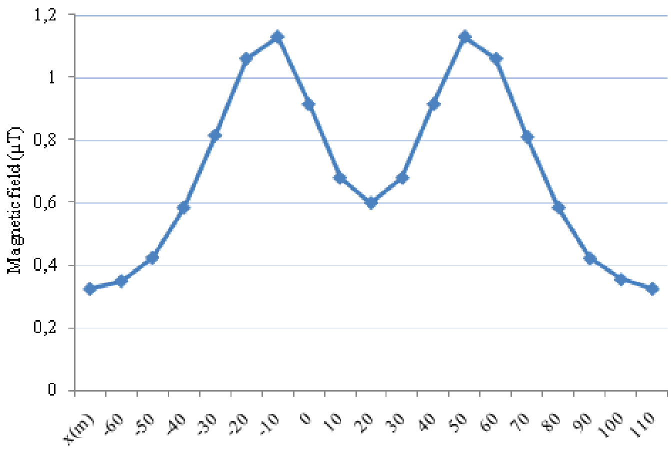


Figure 3. Experimental profile of magnetic field for the level 0m.

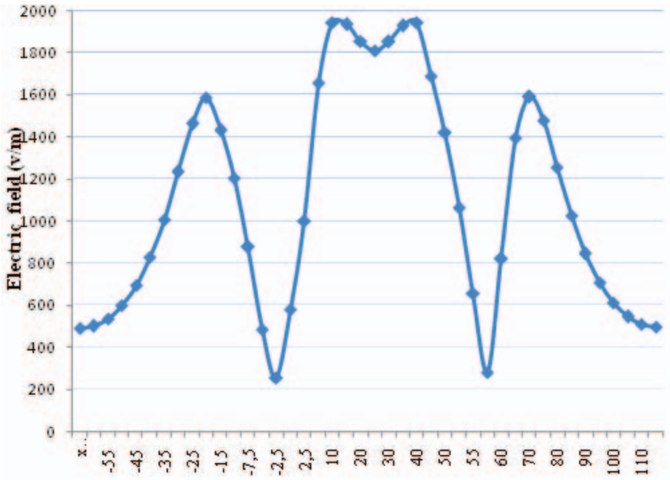


Figure 4. Profile of magnetic field for 4 Level.

## B. *Analytical and simulation results*

- *Behavior of electrical field*

Figures (5, 6 and 7) have the profile of the electric field in the vicinity of the circuit of high voltage line depending on the distance to several levels starting with level (0m) which represents the ground from to the level close to the location of the phases (20m). For good visualization of the results we plotted the results on three curves.

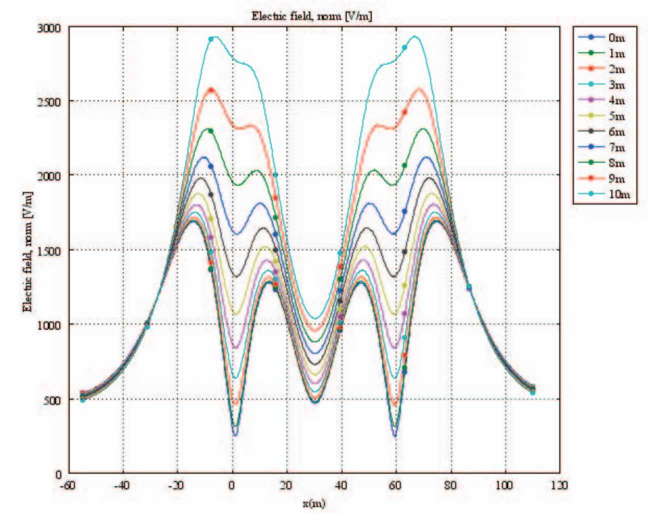


Figure 5. Profile of electrical field for the levels between 0m and 10m

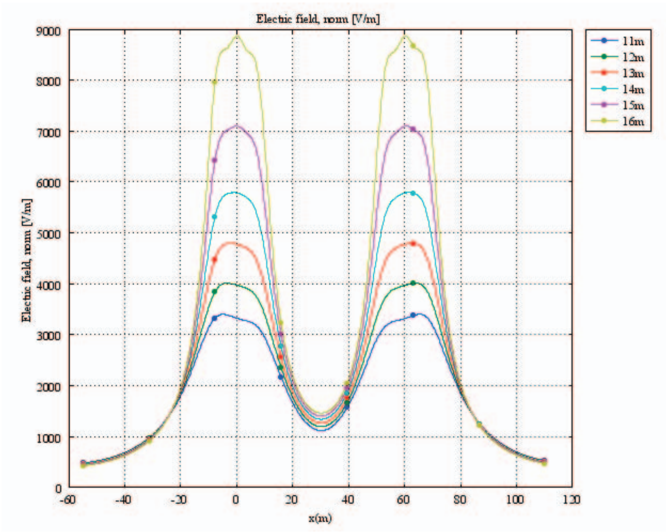


Figure 6. Profile of electrical field for the levels between 11m and 16m

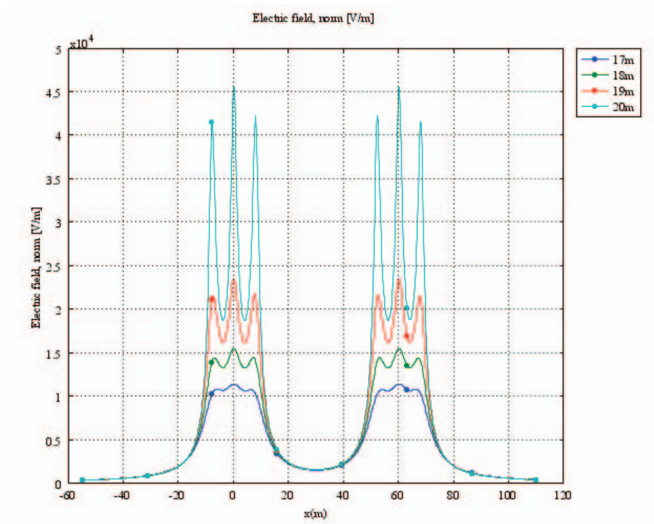


Figure 7. Profile of electrical field for the levels between 17m and 20m

- *Magneticfield*
  The same for the numerical modeling of the magnetic field density has been shown in curves 3 figures (8, 9 and 10) below:

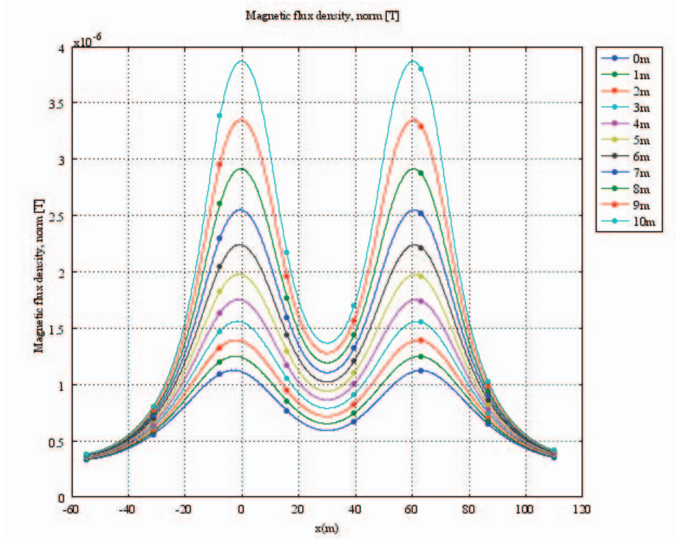


Figure 8. Profile of Magnetic flux density for the levels between 0m and 10m

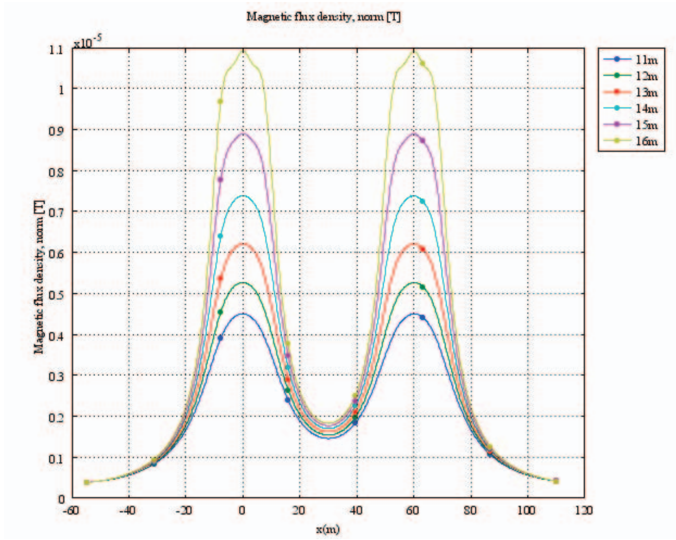


Figure 9. Profile of Magnetic flux density for the levels between 11m and 16m

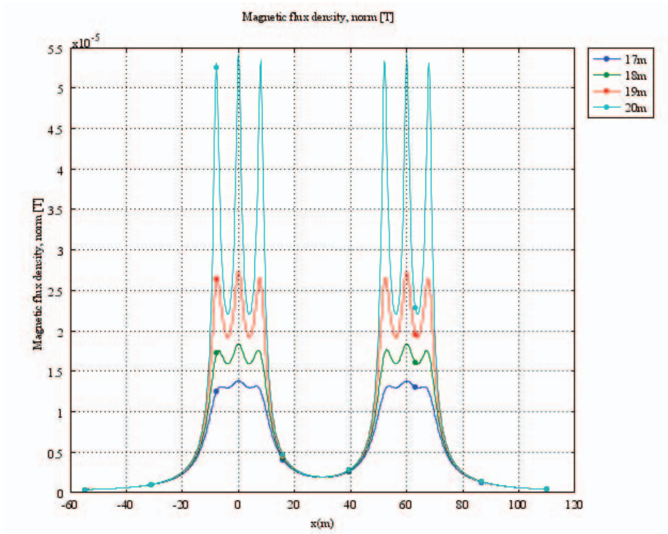


Figure 10. Profile of Magnetic flux density for the levels between 17m and 20m

## IV. Discussion And Conclusion.

The analysis of the results presented in this work shows that the profile of the electric and magnetic fields obtained by digitally is comparable with these obtained experimentally for the first level curve (0m). Consequently, the finite element analysis using the software COMSOL Multiphysics is-a numerical process that can be recommended for the analysis of complex configurations including lines to levels close to different drivers. Experimental measurements for the other levels will be 1m-20m in the framework of a research project in collaboration with the PNR Company producing electricity SNALGAZ Algeria. The intensities of the electric and magnetic field readings are well below the limits set by international standards (5KV/m for the electric field and 100 µT for the magnetic field).

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