OVERHEAD TRANSMISSION LINES IMPACT EVALUATION ON HUMAN PRESENCE

Tatiana Damatopoulou[1, a] and Antonios Kladas[1,b]

[1]*School of Electrical and Computer Engineering, National Technical University of Athens,*
9 Iroon Polytechneiou Street, 15780 Athens, Greece
E-mails: [a]damatat5@yahoo.gr, [b]kladasel@central.ntua.gr

Abstract. The paper presents an investigation of the impact on humans present in the vicinity of overhead transmission lines by the low frequency electric and magnetic fields generated. In particular the modeling procedures proposed in standards are reviewed and the precision obtained under the assumptions adopted are checked. The main interest is focused on electric field which is substantially distorted by the human presence.

Keywords: Low frequency electric and magnetic fields, finite element method, environmental impact, permissible limits.

1. Introduction

Electric and magnetic field analysis generated by overhead transmission lines are of great concern regarding the aspects of health, safety and environment. A large number of studies has been developed providing reference values of permissible limits for human activity in the vicinity of low frequency power equipment concerning both general public and working personnel [1]. Moreover, specific modeling procedures have been proposed in standards enabling efficient evaluation of these fields under human presence in the proximity of the respective power installations [2]. To that respect particular software techniques have been developed for the calculation of the fields and their impact on human organism undertaking appropriate compromises between computational speed and acceptable precision of the obtained results [3-5]. In the present paper an investigation is undertaken on the precision achieved by specific approximations proposed (Figs. 1-4).

2. Permissible limits of electric and magnetic fields

The permissible limits of low frequency electric and magnetic field intensities for human activities have been already extensively studied and specific values proposed by ICNIRP [1] have received international acceptance. In general, the electric and magnetic field intensity permissible limits at power frequencies are determined differently for general public and working personnel, due to unequal potential health sensitivities and duration of exposure. The generally accepted guidelines, which are actually adopted equally in EU concerning the maximal limits of acceptable human exposure to field intensities at the frequency of 50 Hz, are as follows:

- Electric field intensity of 5 kV/m for general public and 10 kV/m for working personnel, respectively.
- Magnetic field density of 200 μT for general public and 1000 μT for working personnel, respectively.

3. Modelling procedures proposed

The distributions of electric and magnetic field near the ground created by the overhead transmission lines can be easily evaluated by using appropriate analytical formulae. It may be noted however, that the consideration of objects such as towers or even the human presence may importantly affect mainly the electric field distribution thus necessitating introduction of numerical approaches [3-4]; to that respect appropriate modeling requires a trade off concerning 2D and 3D configurations and alternative methodologies depending on the effects to be accounted for. The developed techniques have been assessed and evaluated and particular guidelines for the modeling procedures to follow have been proposed by international standards [2]. As far as human presence is concerned a typical configuration of a man body has been adopted while 2D axisymmetric analysis by using the finite element method has been proposed providing accurate representation of the electric field distribution (Fig. 3). The present paper undertakes the assessment of deviations of such an approximation with respect to the more realistic 3D representation of the human body. To that respect a 400 kV rectilinear conductor case at a distance of 11 meters from a perfectly smooth planar ground surface has been considered in conjunction of the typical man body presence just below the conductor (Fig. 1). A 3D finite element model has been implemented for the simulation of this problem and the discretization adopted is shown in Fig. 2. The maximum electric field intensity generated has been calculated along two lines at the level of the head positioned in parallel and orthogonal directions with respect to the conductor, as illustrated in Fig. 2. The obtained distributions of electric field intensity are shown in Fig. 4, indicating that the 2D axisymmetric representation provides the same results as the 3D one along the parallel direction of the conductor; in counterparts, it overestimates the electric field along the orthogonal direction with respect to the conductor, in particular at points situated distant to the man. A detailed investigation of the distance from the man that the 2D analysis provides sufficient accuracy will be presented in the extended paper.

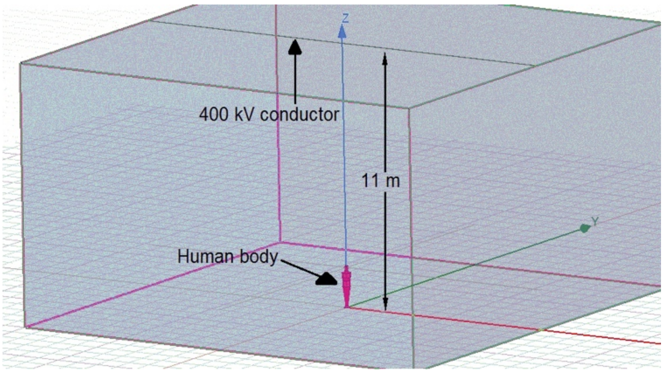

Fig.1. Considered position of the human body with respect to a 400 kV linear conductor.

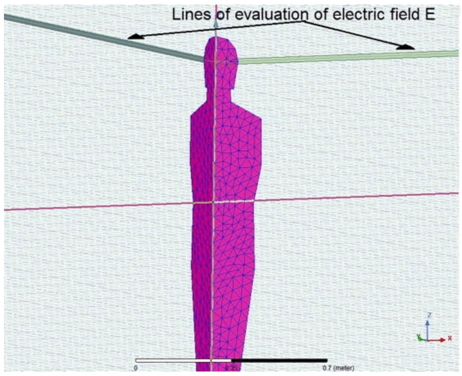

Fig.2. Finite element discretization of the human body in 3D representation.

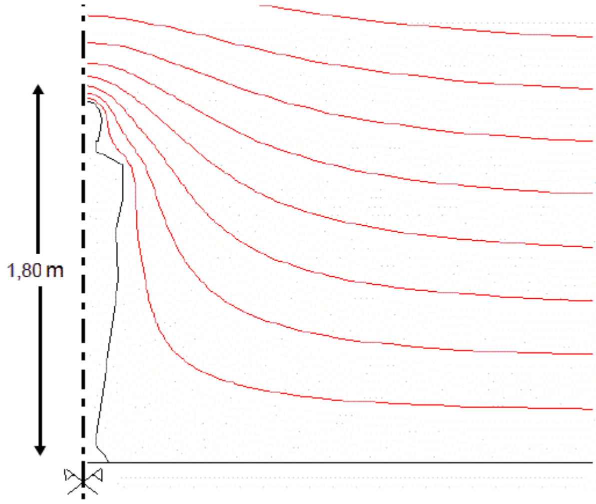

Fig.3. Axisymmetric 2D representation of the typical man body proposed in [2] and local electric field distortion.

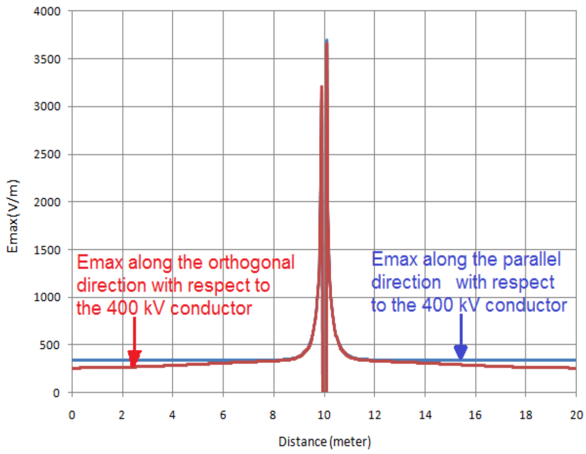

Fig.4. Electric field intensity E_{max} variations at the level of the human head along parallel and orthogonal directions with respect to the 400 kV conductor, respectively.

References

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