NEW APPROACH IN THE SYSTEMS AND ELECTRICAL EQUIPMENT MONITORING AND DIAGNOSTIC

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Abstract – **In recent years the subject concerning the human exposure to electric and magnetic fields is very debated. The operation of electrical systems and equipment can affect the electromagnetic conditions in their vicinity. In the same time its have known a large appliance the monitoring and diagnostic systems of the equipment. In this paper it analyses the monitoring and diagnostic with the help of the "electromagnetic map".**

Keywords*: electromagnetic map, monitoring, diagnostic.*

1. INTRODUCTION

Its have highlighted two directions with the applications more numerous in the electrical engineering respectively electromagnetic compatibility and, on the other side, monitoring and diagnostic of the systems and electrical equipment.
In keeping with the definition of the 77-th Committee of IEC, the electromagnetic compatibility (EMC) represent the capability of an apparatus, equipment or system to have a satisfactory operation in its surroundings, without itself intolerably affect the electromagnetic conditions in their vicinity.
A relatively recent and important subject has expressed concern about the effects of the human exposure to electromagnetic fields produced by any type of the power equipment.
In this way, at CIGRE session, one of the favourite subject has been dedicated to the mechanisms of the living body's exposure to electric and magnetic fields and the influence of the power equipment design on the level of their accompanying fields.
Monitoring and diagnostic it applies through the construction of a data base regarding the temporary evolution of the operating parameters on the base of an equipment or installation and the evaluation of their technical state at a given moment.
In this paper it analyses the possibility to realise the monitoring and diagnostic on the base of the magnetic and electric field of low frequency emitted by the equipment and systems.
This creates a spectrum named of us "electromagnetic map".
The modelling and simulation of the magnetic and electrical field it does with the procedures ready used on the large scale in EMC.

2. ELECTRIC AND MAGNETIC FIELDS OF HV POWER TRANSMISSION LINES

In any point M of the space, the electric field represents the operating force on the unit of the electric charge, placed in this point:

$$\overline{F}(M) = q\overline{E}(M) \qquad (1)$$

where $\overline{F}$ is the force, q-electric charge and $\overline{E}$ - electric field strength.
At present, two categories of problems are very important in this way, [2]:

- to estimate, by calculation and measurements, the electric field strength;
- to emphasise his effects, generally on living bodies and, especially, on human persons.

The first there is an electrical question, the second-a biological one [2], [3].
Except the classical methods, which exclusively are applicable for systems with simple geometry, the electric fields and potentials can be computed using one of the next methods: analytical, numerical, Monte Carlo, reduced models. The electric field of a HV overhead transmission line, in any point M(x, y) of his corridor [1], is elliptical (Figure 1).

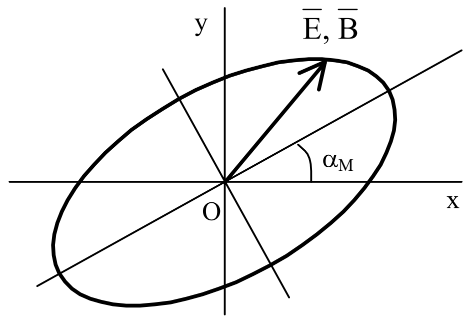

Figure 1: Elliptical electric and magnetic fields.

The magnetic field is generated by conduction, convection, displacement and Roentgen currents, as well by the bodies with residual magnetisation.
The magnetic induction B of a HV charged transmission line could be calculated in any point of his corridor with the Ampere's law given by the relation:

$$B = \mu_0 \frac{i}{2\pi r}, \qquad (2)$$

where i is the current intensity and $\mu_0 = 4\pi 10^{-7}$ H/m - the magnetic permeability in air.

In the case of some tree-phase HV transmission lines it is possible to use the superposed fields theorem, for calculation of the resultant magnetic field being necessary to overlap the partial fields of each conductor.

Similar to electric field, the magnetic field of power transmission lines is also elliptical (Figure 1).

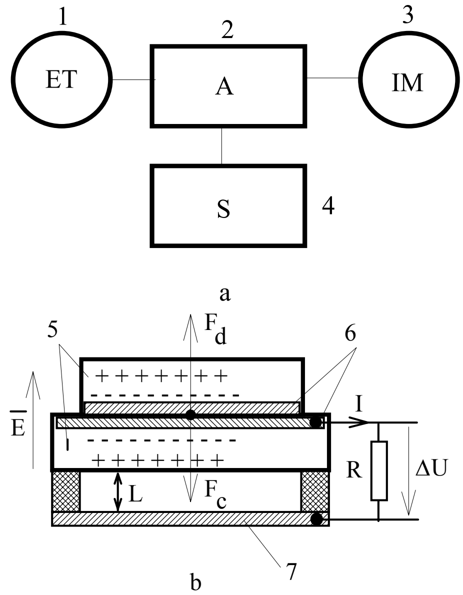

Figure 2: Electret sensor: a-block diagram: 1-electret sensor, 2-amplifier, 3-indicating meter, 4-source; b-electret sensor: 5-double sheet electret, 6, 7-electrodes.

In Figure 2 an original electric field strength meter [4], [5], for alternating electric field is presented.

The voltage ΔU, generated by the electret sensor, is processed in electronic block 2 (preamplifier, low-pass filter, amplifier), otherwise output signal of diagram, resulting proportional to measured electric field strength, can be displayed on a final indicating meter 3.

3. NUMERICAL TREATMENT AND RESULTS IN EMC

The computation results [5], of electric and magnetic fields, produced near ground by a 110 kV overhead double circuit transmission line with 100 A load current are graphically presented in Figure 3.

The used mathematical model correspond to [1], [2]. This situation corresponds simply to 110 kV voltage level.

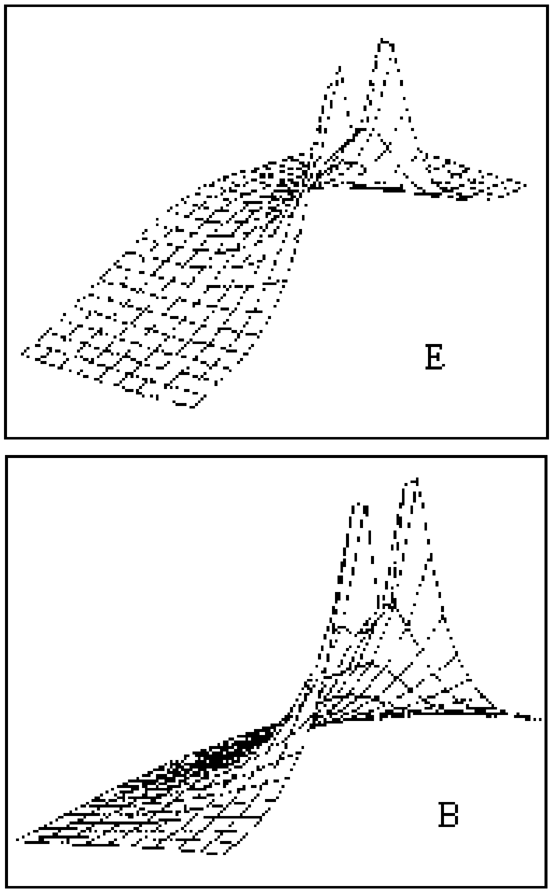

Figure 3: Electric (E) and magnetic (B) fields of a transmission line.

If the voltage of the electric line are higher, the strength of electric field may be touch upper values. For example the electric field at earth level from centre of a line at 400 kV voltage level is up to 5 kV/m and, for 765 kV (single circuit-lines), at 20..30 m distance from centre of line, the strength of this field is 8...10 kV/m.

The strength at soil of magnetic field (Fig.5b), depending to load current, touch the specific values to electrical appliances frequently used (TV sets, portable heaters, vacuum cleaners etc.), produced at distances up to 0,3 m from their surfaces, [5].

4. ELECTROMAGNETIC MAP. EMT PROGRAM SIMULATION

The spectrums of the magnetic and electrical fields of the low frequency systems and electrical equipment, obtained for certain spatial structures and certain behaviour states it considers that creates “electromagnetic map”.

In the case of the systems of industrial frequency, it can talk of an electric map and a magnetic map, respectively.

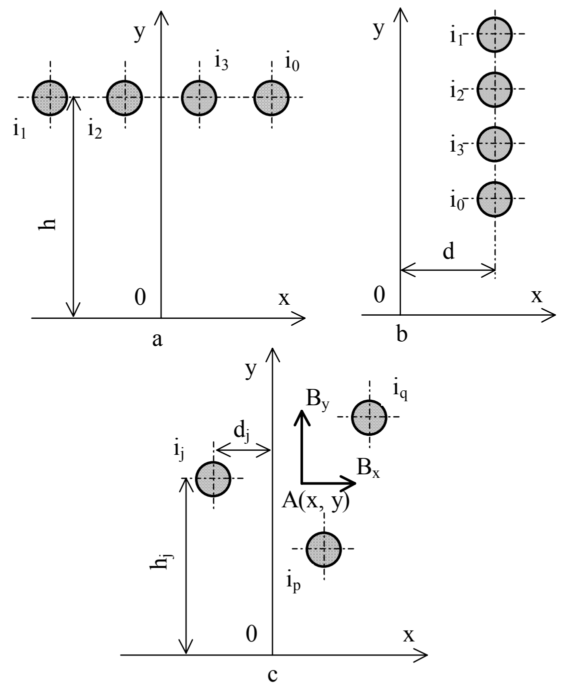

Figure 4: Three-phase system: a- horizontal plan conductors; b- vertical plan conductors; c- magnetic map calculus model.

This can be obtained through analytical modelling or through the artificial intelligence procedures.
The modifications intervened in the technical state of the systems and equipment, in their geometrical structure or in their electromagnetic behaviour state leads to modifications of the electromagnetic map.

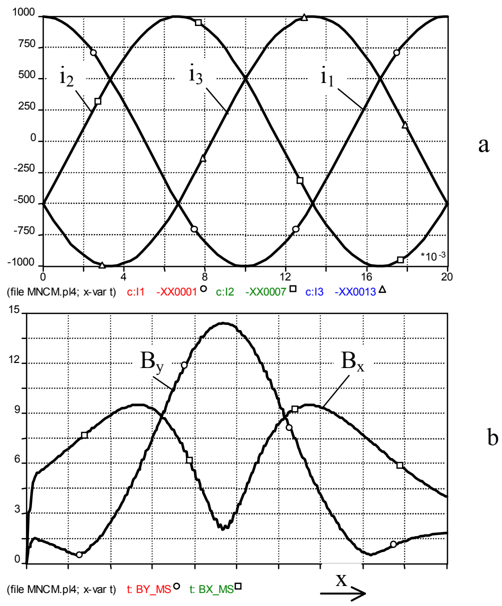

Figure 5: Horizontal plan conductors, equilibrated state: a-currents; b-µT magnetic induction.

This allows the identification of the modifications appeared and, in finally, the system diagnostic.
It exemplifies the proposed principle through the analyse of the “magnetic map” of a LV three-phase installation, having the conductors placed as in Figure 4a,b. For the calculus model Figure 4c is useful.
In Figure 5 are graphical represented the numerical results of the calculus for the magnetic field in the equilibrated state, in points situated at 2 m high referenced to ground and between ±6 m referenced to the vertical axe. (Figure 4a).

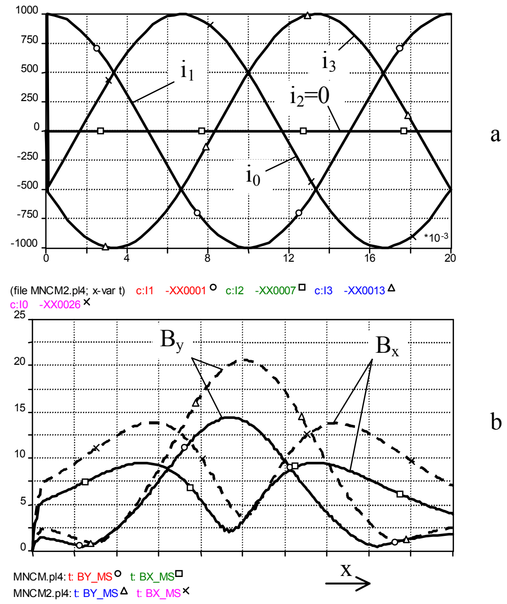

Figure 6: Horizontal plan conductors, non-equilibrated state: a-currents; b-µT magnetic induction.

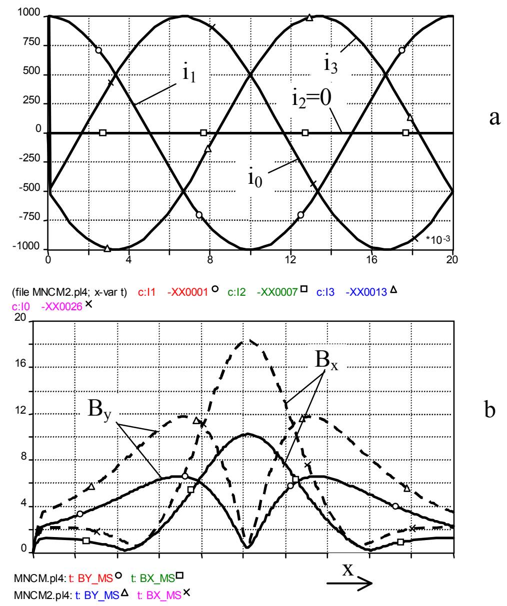

Figure 7: Vertical plan conductors, non-equilibrated state: a-currents; b-magnetic induction, in µT.

In the case of a non-equilibrium (Figure 6a), intervened through the current switching on a phase, appears modifications in the magnetic map, which can be seen, marked with breaking line, in Figure 6b.
Similar results it obtains and in the case of the conductors placed in the vertical plan (Figure 4b). At the switching of the current i_2 (Figure 7a), the magnetic map modifies (Figure 7b), from the curves drawn with continue line (equilibrated state) to those with breaking line (switched phase conductor).

5. A POSSIBLE ARTIFICIAL NEURAL NETWORK APPROACH

An artificial neural network (ANN) can be considered as a matrix function that provides an approximate model of a system.
A three-layer ANN (shown in Figure 8), which consists of input, a hidden and an output layer, is adapted to implement the proposed application, [7].

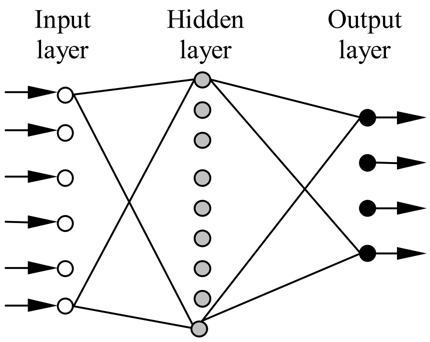

Figure 8: ANN architecture

The capability accuracy in the estimation depends on the number of input nodes, hidden nodes and output nodes.
Starting from the computation results, an ANN can be trained to analysis the possibility to realise the monitoring and diagnostic on the base of the magnetic and electric field of low frequency emitted by the equipment and systems.

6. CONCLUSIONS

Using a proper EMTP soft application, is computed the electric and magnetic fields, produced in his corridor by a HV power transmission line in operating state.
It models and numeric simulates the magnetic map for a LV three-phase installation, having the conductors placed on horizontal, respective vertical plan.
It observes some the modifications in the magnetic map in the case of some non-equilibrium states.
The errors appeared in the shape of the magnetic map can be explained with the help of the artificial intelligence procedures, so that the results obtained are susceptible of applications in the field of monitoring and diagnostic of the systems and electrical equipment.

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