EXTREMELY LOW FREQUENCY MAGNETIC FIELD MEASUREMENTS SURVEY IN DISTRIBUTION SUBSTATION

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ABSTRACT

Many researches were conducted on the adverse health effects of the power frequency magnetic fields. These issues have caused some concern not only with the general public but also to the utilities, and the International agencies which tried to establish guidelines for safe public and occupational Power Frequency Magnetic Field (PFMF) exposure. The measurement of the PFMF was very important to identify magnetic field sources in the distributor and the transformer distribution substations. The main objective of this research is to know the magnetic field emission level inside and outside the distributor, and to evaluate occupational health implications .It is essential to provide employees who work near energized equipment with detailed and accurate information regarding field exposure in their work environment. A modeling and simulation algorithms programs were developed and analyzed to get the calculated values for the magnetic field at different grid points. The calculated and simulated values were compared with the experimental ones and showed to be in good agreement. This indicates that the developed program is an effective tool to assess the magnetic field values.

Keywords: *Power Frequency Magnetic Field, Transformer Distribution station, distributors, Modeling and simulation.*

INTRODUCTION

Distributor Station distributes the loads among power distribution substations. These substations are mostly located in the ground floor of the residential building. Beside that there are technician who live inside the distributors for shifts.

Recently, exposure to man-made electromagnetic fields has been increased due to the increasing demand of electricity, which becomes an integral part of our life. These magnetic fields have been suspected of causing various types of hazard health effects like cancers, leukemia etc. Many scientific authorities believe that the existed data do not support that the power frequency magnetic field is a sufficient factor to cause these health hazards but may be cofactor in causing such abnormalities and cancer disease. On the contrary, some other research centers assure the negative effects. There were limits settled by the International Committee of Non Ionizing Radiation Protection 1998 (ICNIRP), to protect the public and occupational from the Magnetic field emission.

These limits are 500μT for occupational and 100μT for general public.[1-2] which differs much from that of IEEE[3].

MEASUREMENT PROTOCOL

These measurements were performed on a 0.5m×0.5m grid at a height of one meter above the ground finished floor inside the distributor and around the distribution transformer. [4-5] The spot measurements were recorded by the magnetic field meter PMM 8053 which works together with a PMM EHP-50 probe. At the same time the line currents and the neutral current were measured by a precise clamp ammeter for the distribution transformer. [6-8]

CASE STUDY (1): THE DISTRIBUTOR SUBSTATION

Distributor station operates at 11kV, used to distribute the loads among power transformer distribution substations. In Alexandria there are more than 110 distributor stations which are sited in residential and workplace areas, and there are technician who live inside the distributors for shifts.

In order to perform magnetic field experimental measurements, grids covering the whole surface area of the ground substations were set up as mentioned. The measurements were done in two distributor substations between 11am to 1 pm.

Case A:

Distributor Station (A) consisted of a panel board with 12 circuit breakers as shown in Fig (1) and the load at the time of measurement was 400A on each phase. The magnetic field measurements are represented in Fig. (2), and the 3D measurements representation is shown in Fig.(3). The maximum measured magnetic field was found to be 26.38μT, which was reported to be in the back of cubical (cell) that feeds the highest load (of 100 A).This is supported by the idea that the cables are connected to the cubical from its back through the underground trench.

Case B:

Distributor Station B consisted of a panel board having 26circuit breakers and 3cpacitor banks (each one 300 kVAR) as shown in Fig (4) and the load at the time of measurement was about 300A on each phase. The current

magnetic field measurements are represented in Fig. (5) and the 3D measurements representation is shown in Fig.(6). The maximum measured value in case (B) was 12.29μT and it was found to be in back of the cubical maximum loading (which was about 120A).

Fig.1 Magnetic Field Measurement at Distributor (A)

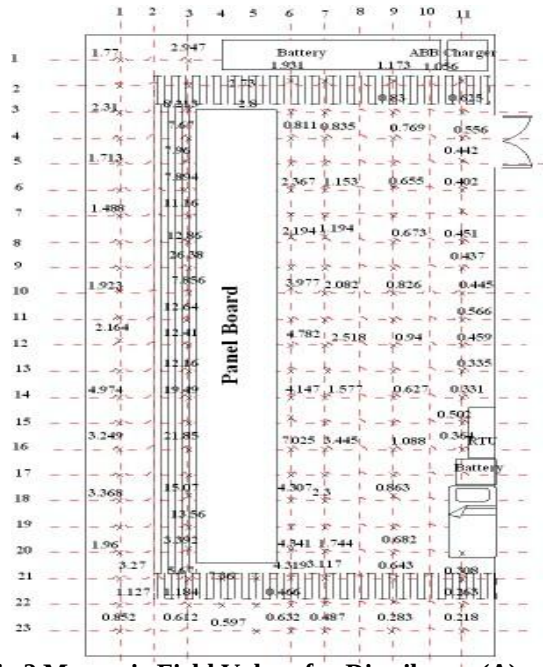

Fig.2 Magnetic Field Values for Distributor (A)

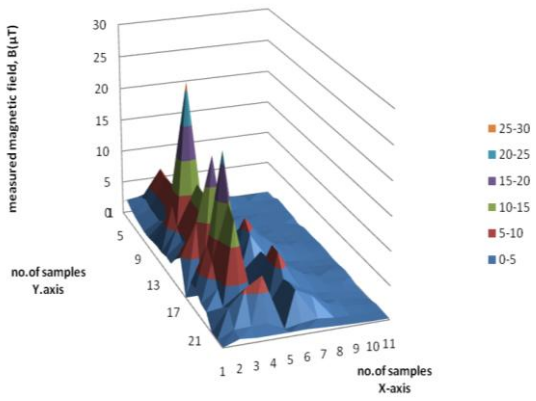

Fig.3 3D plot for the measured values in Distributor (A)

As we mentioned before, this was expected to be found since the connection cable are laid in the back of cubicles in trenches since magnetic file directly related to current.

Fig.4 Magnetic Field Measurement at Distributor (B)

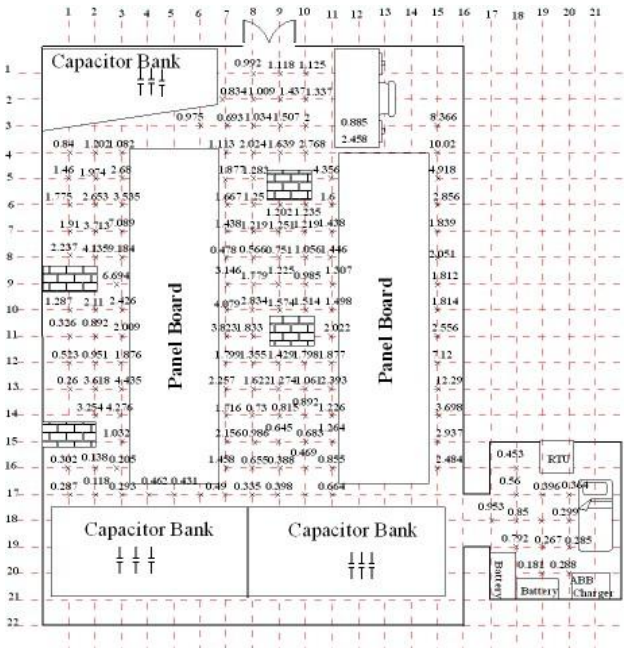

Fig.5 Magnetic Field Values for Distributor (B)

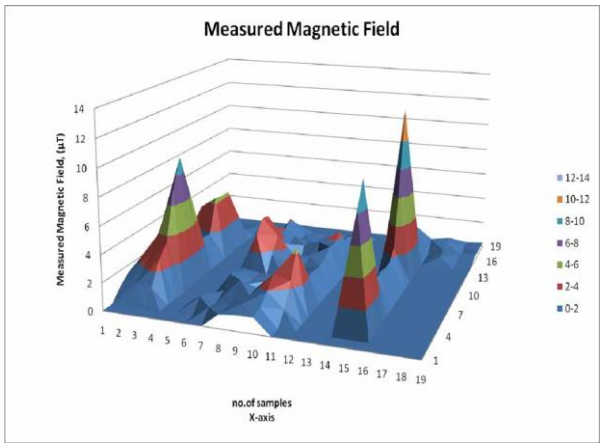

Fig.6 3D plot for the measured values in Distributor (B)

CASE STUDY (2): POWER TRANSFORMER DISTRIBUTION SUBSTATION

A typical distribution substation for residential area consisted of a building which houses two transformers (delta/star connected) rated at 1000kVA and 500kVA with their associated 11kV circuit breakers and the 3phase, 4 wire 380/220 V distribution panel as shown in Fig.7. The magnetic field measurements were carried out at this substation and the results are indicated in the measuring grid as (0.5m×0.5 m) shown in Fig.8. The 3D representation as illustrated in Fig.9.The average currents measured during the magnetic field measurement for the transformer 1000kVA was 200A, and the neutral current was30.7 Amp. For the second transformer, the average current was 80 A, and neutral current 20 A. The measurements were made from 11:30 am to 2pm .

MAGNETIC FIELD SIMULATION

SUBCALC Magnetic Field Modelling Program was developed to model, simulate and calculate the magnetic field at any point on the grid. The program models the power frequency magnetic fields from a user specified array of primary distribution lines, and substation conductors. The program is based on the Biot- Savart law in calculating and modelling the magnetic fields. In this research, the program is used to model the magnetic fields in 11/0.4 kV distribution substation.[5] The magnetic field output of the simulation program for the same measured substations and for the same loading conditions is also presented in 3D format for the simulated output of the substation model as shown in Fig.10.

Fig.7. Magnetic field measurement at distribution substation

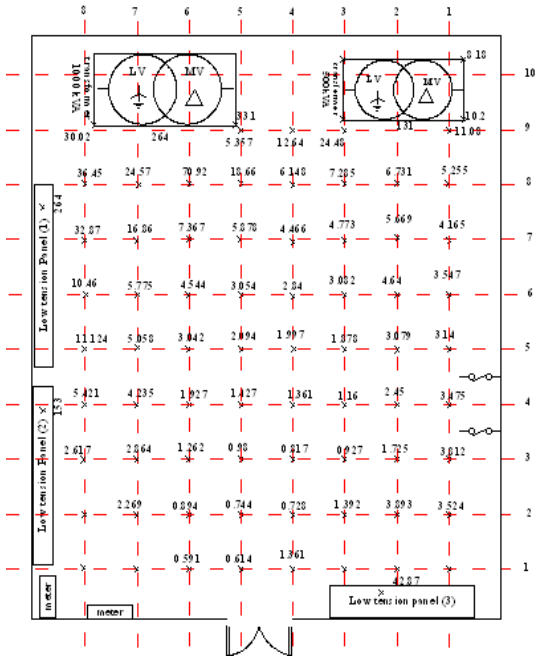

Fig 8. Magnetic Field Measured values

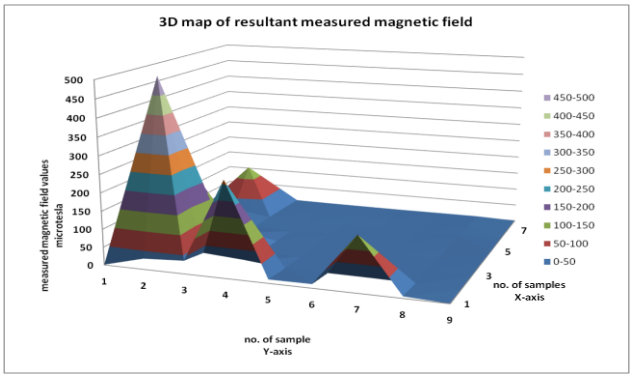

Fig 9. 3D plot for the measured values in substation

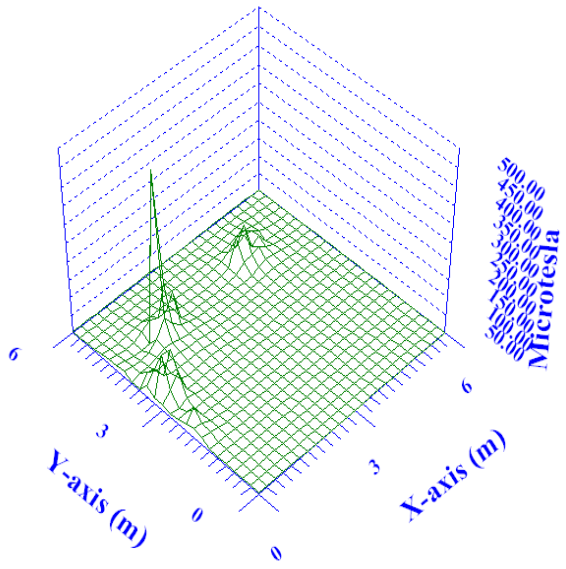

Fig.10. 3D Simulated magnetic field

COMPARING THE MEASUREMENTS RESULTS AND THE SIMULATION RESULTS

The simulation program and the measuring techniques are used to provide closer look at the variation of magnetic field density within some specified location inside the substation with direct comparison between measured and calculated magnetic fields at that defined location inside substation.Fig.11. shows the field profile inside the substation at Y=8meter, while varying the X-axis.

It can be observed that the simulation profile agrees with the measurements profile on the overall distribution of the magnetic field. This indicates the effectiveness of the developed program.

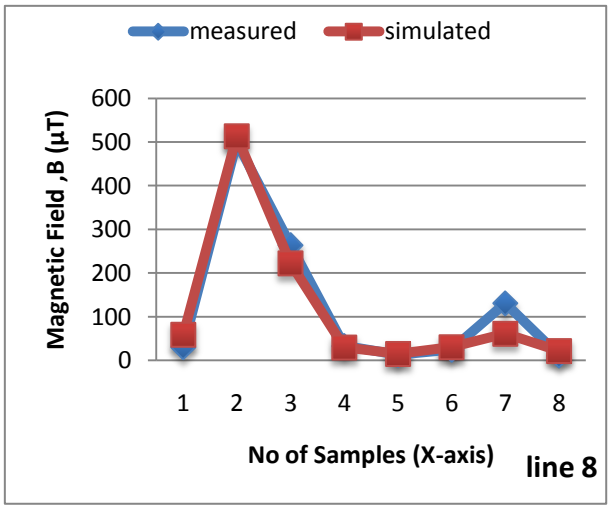

Fig.11 Simulated and measured magnetic field Profiles at Y=8

CONCLUSION AND RECOMMENDATIONS

It is noticed that the measured magnetic field level didn't exceed the magnetic field occupational limits in the International standards. But, it may be dangerous for long time exposure in distributors especially for case B. The magnetic field value was about 8µT at technician's desk. So it was recommended to replace their desk to another place with lower magnetic field values as in front of the distributor door. Also, it is observed that the measured magnetic field values at the back of the circuit panel were higher than in front of it, because the MV cables are connected at the back of the circuit breaker panel.

For the transformer distribution substation, the highest measured magnetic field value was 330µT at the outage of the low voltage cables from the transformer.

The attainable measured and modelling results were coordinated and showed almost full agreements. This may conclude that the modelling and simulation program is capable to determine the magnetic field distribution inside and outside the distribution substations. This would have a great benefit to electrical utilities in choosing the substation location and to take the proper measures in designing these substations.

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