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Risk Assessment of Magnetic Field Pollution in Average Home

Maina Ibrahim [1] Aliyu Ozovehe[2], and Ali Hamdallah[3]
[1]Physics Programme, Abubakar Tafawa Balewa University, Bauchi, Nigeria
[2]Trifield Technology Limited, Abuja, Nigeria
[3]Department of Science and Environmental Education, University of Abuja, Nigeria

ABSTRACT

In our homes and offices, all electrical appliances/devices produce magnetic field, even when they are "off", as long as it is plugged into the electric supply and drawing on the power. These appliances radiate magnetic field that when it exceeds 0.65mG might lead to health hazard in Human being. This paper examined the magnetic field pollution from these appliances and fixtures using Trifield meter in residential area of Bauchi metropolis in Nigeria as a case study. The result showed that most of the appliances examined need to be kept at a distance of around 20cm from human body to avoid health risk.

Keywords: Biological effects, Electromagnetic field pollution**,** Extremely low frequency field, Health hazard

I INTRODUCTION

Electromagnetic (EM) fields are everywhere, so exposure to it is not a new phenomenon. However during the twentieth century, environmental exposure to manmade EM fields has been on steady increase. This EM fields come from everything that uses electricity in our world today. Transformers are among the biggest sources of electromagnetic radiation in our environment. The same is true of lamps, typewriters, photocopiers, fluorescent light fixtures, video display systems, telephones, extension cords and unused electric wires inside walls. Sometimes the difference between "off" and "on" is negligible once plugged in and drawing on the power [1]. If you live in an apartment, the magnetic fields from your neighbors' TV's, computers, appliances, and electric fixtures are right on the other side of your wall. This could even be on the other side of where you sleep, going right through into your living space from above, below and from both sides. When you are in your office sitting at your desk, there could be a fluorescent fixture right above you. Figure 1 shows sources of EM exposure in an average home/office [2].

Therefore, everyone is exposed to a complex mix of electric and magnetic fields both at home and at work. However some are closer than others to the source. In fact, studies have shown that just a few minutes exposure to such kind of field will affect you for more than 24 hours [3].

Although not yet proven, direct and indirect evidence suggests that an EM field increase the risk of certain cancers(such as leukemia and primary brain tumors) and other physiological and psychological abnormalities(some people are reported to lose concentration when exposed to high magnetic field while some studies suggest that fields suppress the production of sleep-inducing melatonin) [4]. Continuous exposure to about one

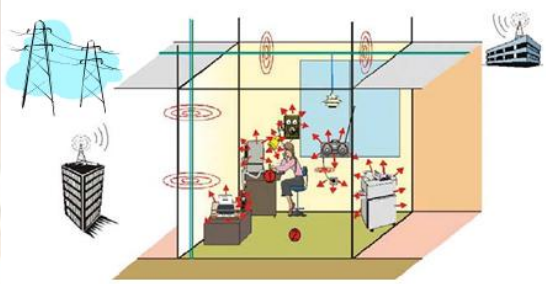

Figure 1: Source of EM field exposure in an average home/office

billionth of an ampere of an alternating current per square centimeter may lead to biological effects in Human beings [5]. Such exposure may also affect the nervous system and the evidence of this is somewhat stronger than that of the cancer effect [6]. More worrisome is that extremely low frequency (ELF) magnetic fields also induce very weak electric fields in the body and we will measure the field someday.

However, experts consider public perception of risk as far-fetched and they recommend communication measures to inform population accurately while ensuring the compliance with national and international standards of magnetic field radiations [7].

II COUPLING TO EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS

Generally, anything electric device you plug in your home and office generates ELF fields and the radiation has two components: weak electric field; and strong magnetic field. The magnetic field travels far from the source compared to the electric field and it virtually passes through all materials and affects us more compared to the electric field [1]. According to generally accepted

usage, the region of electromagnetic spectrum from 30 Hz to 300 Hz is designated as ELF [8].

An EM field can be described by the flux density (B), or intensity of magnetic field (measured in μT or mG). It can equally be measured by the intensity of electric field (E) (measured in V/m) or by the power density (J) (measured in W/m^2). Exposure to EM radiation results in internal body currents and energy absorption in tissues that depend on the coupling mechanisms, the frequency involved and the electrical conductivity of the medium (σ). Ohm's Law relates the internal electric field (E) and current density (J) [9] by

$$J = \sigma E \qquad (1)$$

Also from the law, the current density (J) depends upon the magnetic flux density (B), field frequency (f) derived from Faraday's law of induction and radius of the induction loop [10] and it can be expressed mathematically as

$$J = \pi R f B \qquad (2)$$

There are two types of electric current caused by magnetic field induction [11] a circulating current inside the object (eddy current); and a current entering/leaving the object. These are the current that could affect biological processes in the body.

This work focuses on the risk assessment due to magnetic field pollution only from some electric devices and appliances that we work with at home or office.

III MEASUREMENT METHODS

The strength of the magnetic field from equipment depends on equipment design and current flow not on its size, complexity, or voltage. Though some electric equipment produces EM fields of other frequencies, most health research has considered only frequencies near 60 Hz. In this work measurements were made at alternating current frequency of 50Hz. Furthermore, any measurements of EM pollution should be frequency weighted (that is the product of magnetic field strength times frequency) if the measurement are to gauge whether the current inside the body exceeds a threshold level. Here the magnetic field from the electrical appliances was measured using Trifield meter (model 100XE). The meter is a gaussmeter, electric field meter, radio field strength meter in a single until. The meter combines all features needed for fast, accurate measurements of EM pollution. It independently measures electric and magnetic field and is properly scaled for both, to indicate the full magnitude of the currents produced by each type of field inside the human body. Depending on where the knob is set, it detects either frequency-weighted magnetic fields or frequency-weighted electric fields in the ELF [12].

When measuring electromagnetic fields, the primary concern is usually magnetic fields, which can be tricky to measure. This 3-axis Trifield meter solves the problem by measuring the true strength of the field regardless of which way it is oriented.

IV RESULTS

Electromagnetic radiation exists around electrically driven home and office appliances. The field extends several centimeters around the appliance. In this work, the magnetic field from most commonly utilized appliances (which operate on mains supply of 240V, 50Hz) at home and offices were examined by measuring their magnetic fields at different distances from the appliances as shown in Figures 2 to 11.

Figure 2 shows the variation of magnetic field with distance from a 14" screen hp nx6325 model laptop. The solid- line shows when the system is being used in the normal mode while the

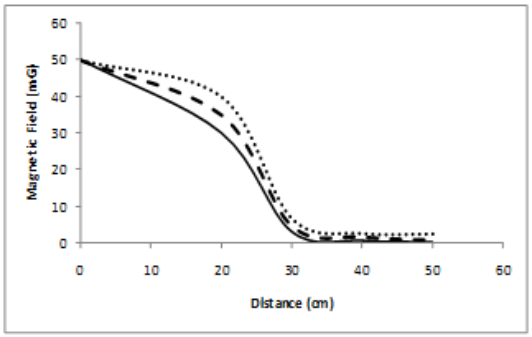

Figure 2: Magnetic field at different point close to14''screen laptop

dotted-line and broken-line is when video and audio are being played on the system respectively. The magnetic field from 61W standing and table Fan are shown in Figure 3; the broken-line shows the field from the standing Fan and the solid-line from the table Fan. In Figure 4, the variation of

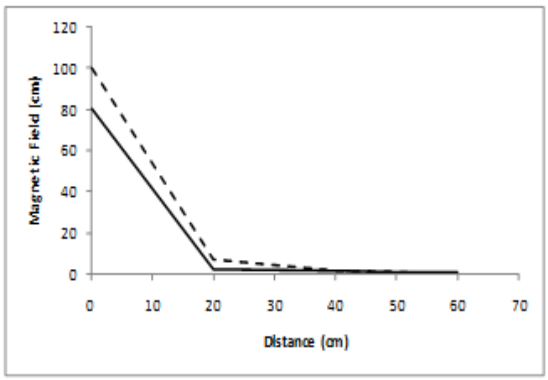

Figure 3: Magnetic field at different point close to floor type standing and table fan.

magnetic field with distance in 14" 61W color TV (broken-line) and 110W, 21"color TV (solid-line) are shown. Also, magnetic field variations with distance for 1000W and 2000W room heater are shown in Figures 5 and 6. The broken-line gives the variation with distance when measurement is taken from the back of the heater while the solid line is for measurement taken from its frontage. On spot result for some electrical points is shown in Figure 7. Note that SOC1 refers to 13amp socket,

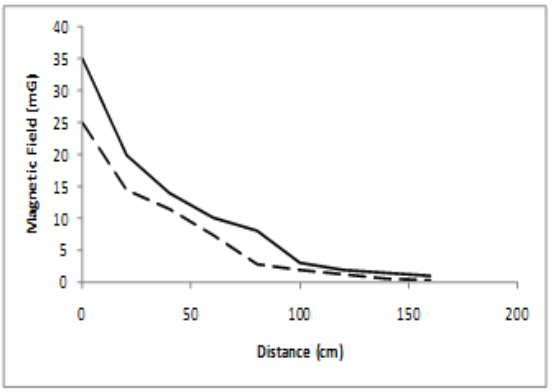

Figure 4: Magnetic field at different point close to a 14" and 21" coloured television.

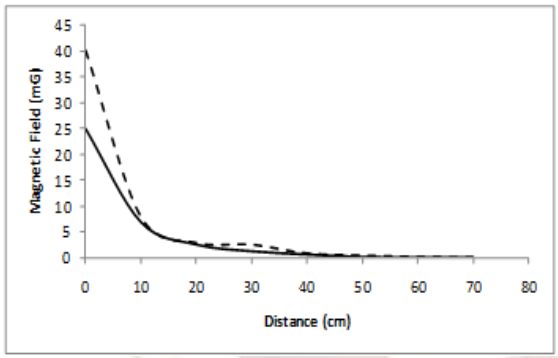

Figure 5: Magnetic field at different point close to 1000W room heater.

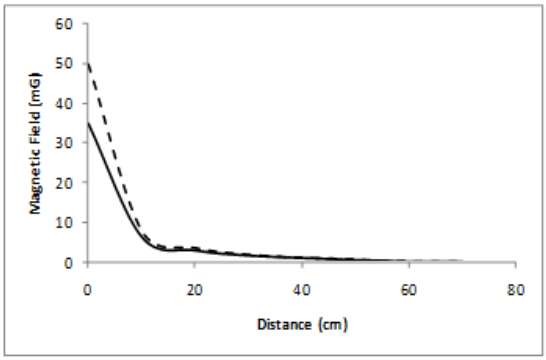

Figure 6: Magnetic field at different point close to 2000W room heater.

SOC2 electric cooker socket, SOC3 "Newclime" ceiling fan regulator and SOC4 1000W electric iron. Electric motor which is commonly use as pump or driver in grinders, compressors etc. is examined as shown Figure 8 with the broken-line and solid-line showing the variation of magnetic field with distance from 1Hp and 2Hp motors respectively. Figures 9 and 10 are the results for 1000W electric stove and refrigerator respectively.

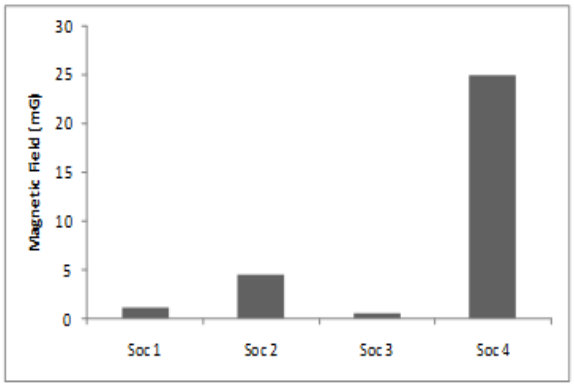

Figure 7: Magnetic field from different electrical points.

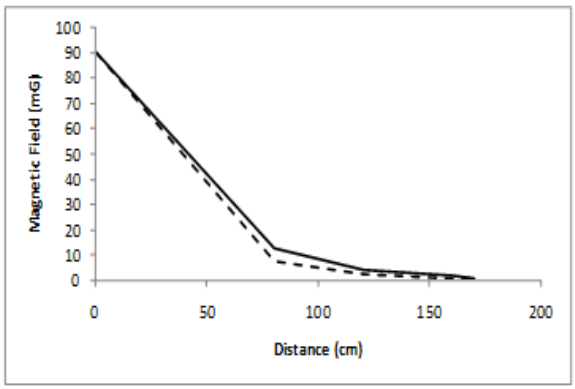

Figure 8: Magnetic field at different point close to 1HP and 2Hp water pump.

Portable transistor radio receiver has found wide usage in most part of Nigeria. People usually keep it close to the ear while listening. Two of the most popular brands (Sony ICF-SW and Kchibo KK-9609) were examined as shown in Figure 11. R1 shows Sony on low volume, R2 Kchibo on low volume, R3 Sony on medium volume, R4 Kchibo on medium volume, R5 Sony on high volume and R6 Kchibo on high volume.

It should be noted that care was taken to minimize other sources of magnetic field when making the measurement. However, the exposure level depends on several factors like the power of the equipment, sensitivity of field-detecting coils inside the metre, the ability of the metre to combine the three coil outputs nonlinearly to give a true magnitude of the environmental factors. The level of risk to adverse magnetic field in an average home that may result in biological effect to human being is shown in Table 1[1].

Table 1: Risk level for time varying magnetic field pollution in average home.

LEVEL OF RISK	*MAGNETIC FIELD (NANOTESLA (nT))*	*MAGNETIC FIELD (MILLIGAUSS (mG))*
NORMAL	*0 - 64*	*0 - 0.64*
THRESHOLD	*65*	*0.65*
DANGEROUS	*66 - 99*	*0.66 - 0.99*
VERY DANGEROUS	*100 - 249*	*1 - 2.49*
EXTREMELY DANGEROUS	*250+*	*2.5+*

V DISCUSSION

The variations of the measured field are presented in Figures 2 to 11. It can be observed that apart from the on-spot measurements, the field decays with increasing distance away from the appliances. The highest value for each appliance was recorded at a distance of zero (where the metre is in contact with the appliance) and almost all exceeds the threshold value of 0.65mG set for home/office appliances.

Effect of magnetic field on the body is independent of the direction of the field. Only the magnitude matters and biological activities begin to occur in the body when exposed to magnetic field above threshold of 0.65mG for long period of time [1]. From the results, it can be observed that table Fan has the shortest safe distance (where the field strength is 0.65mG) of 20cm while that for 2Hp pump was measured at a distance of 150cm which is the longest for all the appliances under

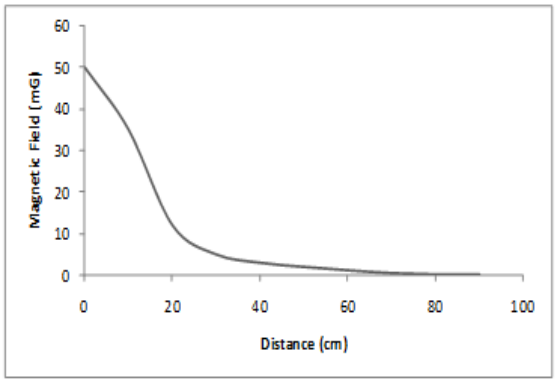

Figure 9: Magnetic field at different point 1000W electric stove.

consideration. For the brands of portable transistor Radio considered, the result revealed unhealthy situation associated with the mode of usage described earlier, which should be discouraged completely as the pollution exceed the threshold. For electric sockets, some were found to be unfriendly producing field in the dangerous region of Table 1.

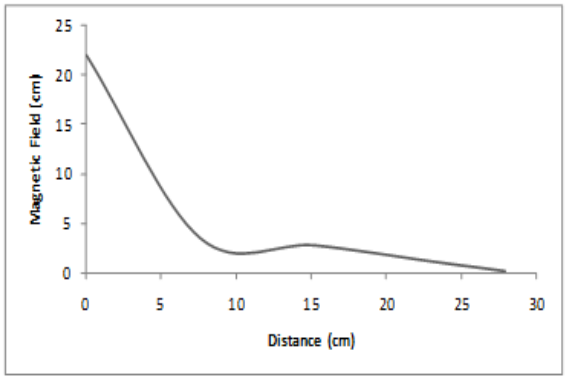

Figure 10: Magnetic field at different point close 1000W refrigerator

The safest distance for other appliances can be established from the graphs. Therefore staying less than these distances (where 0.65mG is observed) in any case for a long period of time might result to health hazard. From these non-uniform safe distances observed, it becomes very important to minimize magnetic field

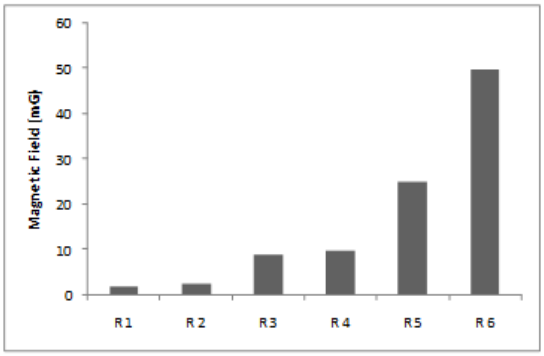

Figure 11: Magnetic field from transistor radio at variable volume levels.

pollution at all-time where possible. This can be done by removing appliances that are not in use from power supply as stray currents and radiating fields can still be emitted from electric wires even if appliances are switched off. Hence live wires must be kept away from the body.

VI CONCLUSION

Using Trifield meter magnetic field from some selected electric driven home/office appliances has been assessed. It was observed that the distance for biological effect to take place varies from appliance to appliance - 20cm for table Fan and 150cm for 2Hp pump. It is therefore very necessary for the authorities charged with pollution control in Nigeria to launch measurement campaign to classify the safe distance for most commonly used appliances at home/office.

While research continues, general public and occupational workers might consider the following simple, inexpensive measures for reducing magnetic field exposure:

- Maintain a distance of 25cm from electrical appliances considered in this paper during their use;
- The general public and occupational workers should be enlightened about the possible health hazards of magnetic fields from home/office electric driven appliances; and
- Reduce time of exposure to magnetic field considerably.

In the same vain, the need to sensitize Nigerian Authorities about potential harmful effects of electromagnetic field (EMF) pollution to health have prompted series of practical measurement of exposure level from cellular network [13], high voltage power lines [14,15 and 16]. We hope to extend the research to Radio and TV Stations in Nigeria for comprehensive risk assessment and huge data base for further research and comparative studies.

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