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ANALYSIS OF ELECTROMAGNETIC RADIATION FOR FOUR DIFFERENT TRANSMISSION POWER STATIONS AREAS OF NIGERIA

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ABSTRACT

Exposure to electric field and magnetic field can result in serious health effect which is our major concern in this research work. The measurement of electromagnetic field strength required for the evaluation of electromagnetic pollution from power lines has been recommended by International Radiation Protection Association (IRPA). In this research work, the study of electromagnetic radiation emanated from high tension transmission lines and 330 KV from Osogbo power transmission station, Egbin power station, Jebba power station and Kaduna power transmission stations were considered as case study. This research work was evaluated on the platform of the safety limits recommended by International Committee on Non-ionizing Radiation Protection. The electric field and the magnetic field within the power transmission stations with distance varying between 10m and 100m were measured using electro smog meter. It was observe that the electric field and the magnetic field are higher within 10m to 70m but become greatly attenuated beyond the 80m.The lowest electric field strength measured for power stations are 6.178 V/m, 8.212 V/m, 5.11 V/m and 4.000 V/m from Jebba high tension line, Egbin power stations, Osogbo and Kaduna power lines. The highest electric field strength measured for each power stations are 12.001 V/m, 11.041V/m, 10.941 V/m and 11.00 V/m for Egbin power station, Jebba power station, Osogbo power station and Kaduna power station respectively. The highest magnetic field strength, the measured from each stations are 9.146 A/m, 9.000 A/m, 8.912 A/m and 8.003 A/m respectively while the lowest measurements are 6.112 A/m, 4.341 A/m, 6.421 A/m and 4.002 A/m respectively.

Keywords: *Safety distance, Electromagnetic pollution, Electric field, Magnetic field, ICNIRP*

INTRODUCTION

When electricity is generated and transmitted, electric and magnetic fields (electromagnetic field) are produced due to the motion of electric charges. Electromagnetic radiation is a form of energy that is found everywhere. Electromagnetic fields are emitted by power lines, transformers, electrical panels and electrical appliances. Electromotive force (EMF) is produced when an atomic particle such as an electron is accelerated in the presence of electric field which causes it to migrate. This movement generates oscillating electric and magnetic fields which travel in a bundle of light energy called a photon (Aliyu et al, 2011).

Electricity produced from electromagnetic field has been used for some years without society being aware of any negative health effect, other than thermal injury and electrocution. Electromagnetic radiation is associated with two major potential hazards both electrical and biological. This study therefore examines the radiation being exposed to people living close to Power lines. The radiation exposure is quantified using parameters such as electric field, magnetic field and power density which were measured using an electrosmog meter. The obtained values are compared with the ICNRIP data to confirm if they are prone to danger or not. This is because people are not expected to be exposed to radiation with intensity above the ICNRIP standard (ICNIRP1998 and1999). This research work therefore helps to examine the level of hazard faced by people living close to or far from different sources of electromagnetic radiation that are unavoidable. In 1972, Soviet researchers linked electromagnetic fields with low grade health problems such as fatigue and headaches. In 1977, Robert Becker, physician and biophysicist Andrew Marino testified before the New York State Public Service Commission about the results of their experiment that showed negative health effects due to exposure to Extremely Low Frequency (ELF) fields (Iovine, 993).

By the virtue of increasing population of the world, towns are expanding, many buildings construct near high voltage overhead power transmission lines. Large transmission lines configurations with high voltage and current levels generate large values of electric and magnetic fields stresses which affect the human being (Aliyu et al, 2011). The effect of electromagnetic fields near the transmission lines on human health therefore need to be investigated. Human body system seems to be acting like an energy wave broadcaster and receiver system which incorporate and respond to electromagnetic fields. Various Scientific researchers have demonstrated that every cell in the human body may have its own electromagnetic field which may help to regulate significant functions and keep body healthy. Strong artificial electromagnetic field such as the one from power lines can interfere and scramble the body natural electromagnetic field, harming and damaging the functioning body tissues and cells and lower the immunity of the body system. Wertheimer and Leeper reported in 1979 that children living around power lines had a risk to develop some diseases such as cancer (Wertheimer and Leeper, 1979). Exposures to electromagnetic fields are on the increase due to advancement and production of more electromagnetic devices which therefore

increase the emission of electromagnetic radiation to the environment. Nearly everybody is being exposed to a complex mix of electromagnetic field of different frequencies that permeate our environment. In the past two decades the general public has become increasingly concerned about potential adverse health effects of exposure to electric and magnetic fields at extremely low frequencies (ELF). Such exposures arise mainly from the transmission and use of electrical energy at the power frequencies of 50Hz (Akinyemi, 2010).
As a result of thermo molecular agitation, exposure of the public to power line generates internal body currents and energy absorption in tissues. This depends on the coupling mechanisms, the frequency and the electrical conductivity of the medium. Permeability connects magnetic field intensity to magnetic flux density in magnetic media by (Aliyu et al, 2012),

$$B = \mu H \quad , \tag{1}$$

where μ is the permeability, H is the magnetic field strength and B is the magnetic flux density.

It was proposed by Power Holding Company of Nigeria (PHCN) that any building constructed along the high voltage lines must give a right-of-way (RoW) of 10m for 11KV and 33KV, 15m for 132 KV and 25m for 330KV lines (Ibrahim, 2011). Therefore this research work was set to investigate the PHCN RoW compliance as well as the effects of electromagnetic radiations on non- compliance cases and proffer possible solutions. Attempt was therefore made in this research work based on this guideline to measure the electric field and magnetic field within this specified distance and beyond.

METHOD OF ANALYSIS

This research work was carried out in four different high voltage power stations transmission lines. Site 1 is Osogbo power station transmission line, site 2 is Kaduna power station transmission line, site 3 is Jebba power station transmission line and site 4 is Egbin power station transmission line. The method adopted in this study includes calibration of equipment and data collection from different power-lines sites. The instrument used for this research work is Electrosmog Meter (Model TES-92) shown in figure 1.

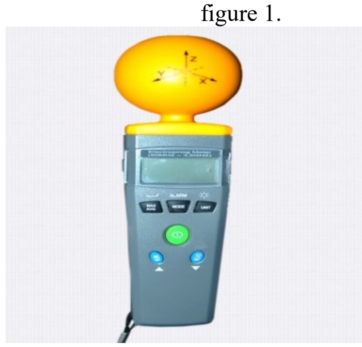

Figure 1*: Electrosmog Meter (Model TES-92)*

The device used for the measurement is a broadband device designed for monitoring high frequency radiation in the range between 50MHZ to 3.5GHZ. Electrosmog is designed to measure electric and magnetic field strengths with specified frequency of 900MHZ, 1800MHZ and 2.7GHZ. In this research work, measurements were taken at 10m, 20m, 30m, 40m, 50m, 60m, 70m, 80m, 90m, and 100m away from the source of electromagnetic field. The initial measurement was taken 10m away from the transmission line.

The meter was mounted on a tripod stand 1m above the ground level. Since the study focuses on the protection and safety of the public who live or spend a lot of their time around power-line, we felt it is necessary to start our measurement 10m away from the power transmission line. Measurements were taken at ten different points. At each of this point, the value of electric field strength and magnetic field strength were measured and power density was determined using equation 2. The equipment was set to be in maximum mode.

$$S = E \times H \tag{2}$$

where E is the electric field strength, S is the power density and H magnetic field strength.

RESULTS AND DISCUSSIONS

The results obtained for electric field, magnetic fields and power density from different power lines with locations in Jebba, Egbin, Osogbo and Kaduna metropolis are depicted in the Tables 1-3 below. Jebba power station and Egbin power station are power generating stations where power is transmitted to substations such as Osogbo transmission station. Kaduna power station is known to be a power transmission sub-station where power is being supplied or transmitted from Kanji dam through high voltage power lines. The measurements were carried out from the high tension line just to ascertain the effect of the electromagnetic field emanated from the power lines on the people living around it. The electric and magnetic field strengths were measured within the range of10 m and 100 m from different High Voltage.

Table 1: Comparison of electric field strength obtained from different sites.

D (m)	E1(V/m)	E2 (V/m)	E3 (V/m)	E4 (V/m)
10	10.941	11.000	11.004	12.001
20	10.955	9.812	11.213	12.000
30	10.891	9.888	12.132	12.142
40	10.911	9.921	12.291	12.421
50	9.746	8.922	11.924	12.000
60	9.481	8.771	12.111	12.121
70	8.746	6.733	10.812	11.451
80	8.100	5.904	8.500	11.000
90	6.982	5.171	8.231	8.146
100	5.110	4.000	6.178	8.212

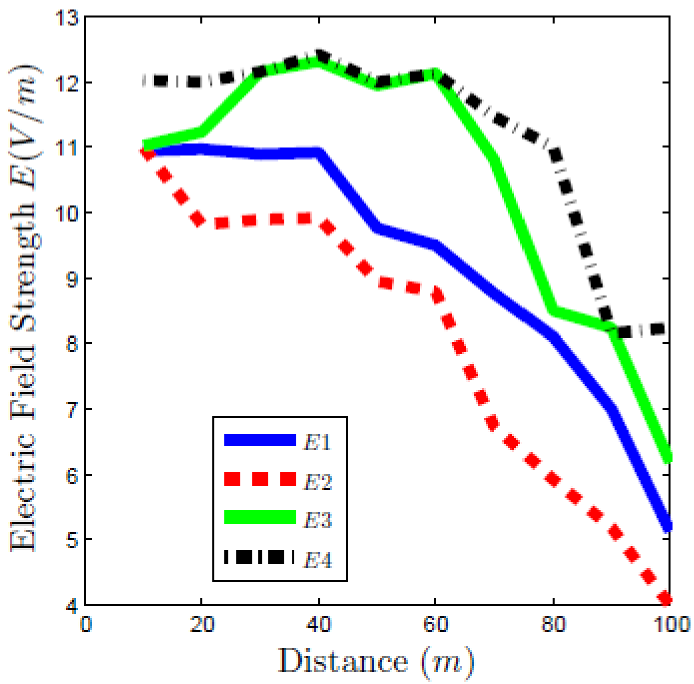

Figure 2*: Electric field strength E (V/m) for from different sites*

Table 2: Comparison of magnetic field strength obtained from different sites.

D (m)	H1(A/m)	H2 (A/m)	H3 (A/m)	H4 (A/m)
10	8.713	9.000	6.721	9.300
20	8.811	9.212	7.001	9.121
30	8.846	8.900	7.211	9.400
40	8.122	9.321	9.230	9.000
50	8.000	7.813	8.421	8.789
60	7.711	7.211	6.890	8.433
70	7.312	5.009	5.932	5.000
80	6.000	5.000	5.711	4.890
90	5.214	4.876	4.901	4.711
100	5.000	4.341	4.002	4.101

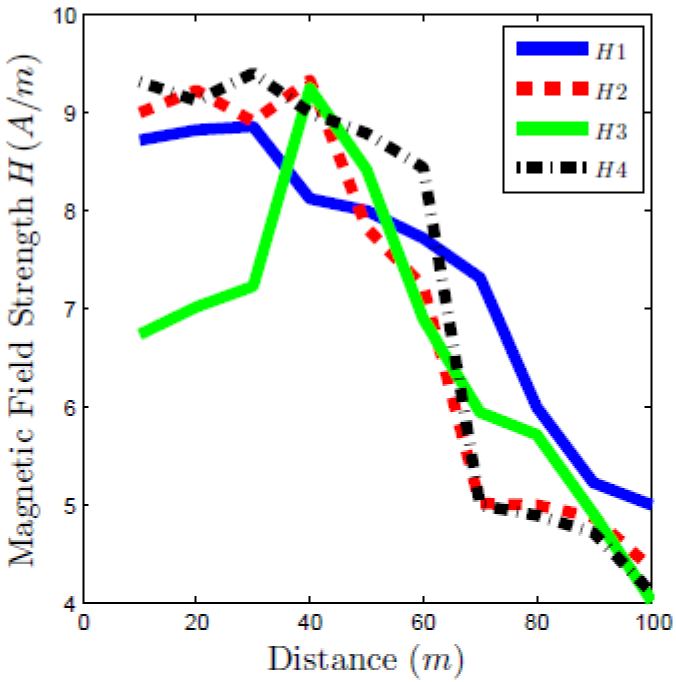

***Figure 3**: Magnetic field strength H (A/m) obtained from different sites.*

Table 3: Comparison of power density obtained from different sites.

D (m)	S1(W/m²)	S2 (W/m²)	S3 (W/m²)	S4 (W/m²)
10	95.329	99.000	74.206	111.609
20	96.524	90.388	78.502	109.452
30	96.341	88.003	87.483	114.134
40	88.619	92.473	113.445	111.789
50	77.968	69.707	100.412	105.468
60	73.108	63.247	83.445	102.216
70	63.951	33.725	64.136	57.255
80	48.600	29.52	48.543	53.790
90	36.404	25.231	40.340	38.375
100	25.550	17.364	24.724	33.677

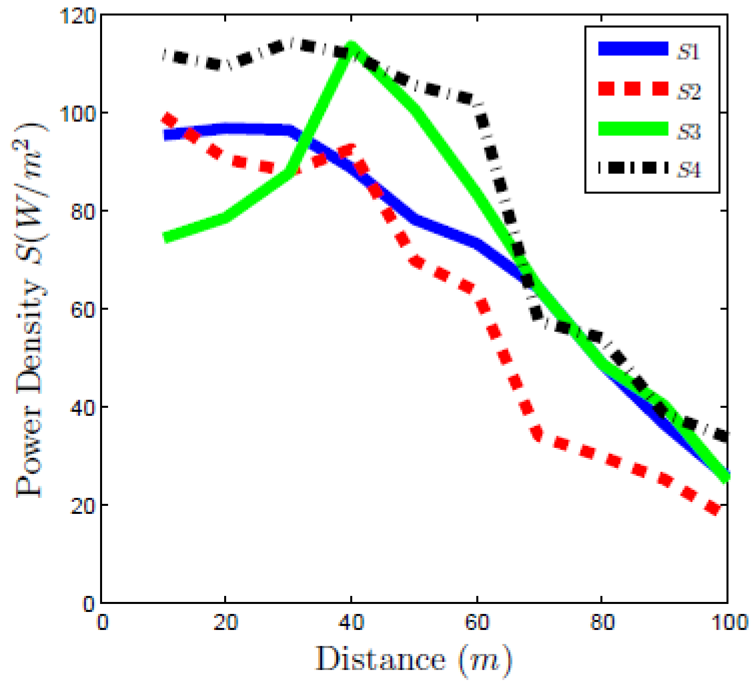

Figure 4: *Power Density S (A/m²) for four different sites.*

Table 1 represents the electric field strength data obtained from site 1, 2, 3 and 4. The lowest and highest electric field measured is 5.11 V/m and 10.941 V/m in site 1, 4.00 V/m and 11.00 V/m in site 2, 6.178 V/m and 11.004 V/m in site 3 and 8.212 V/m and 12.001 V/m in site 4. These correspond to 0.32%, 0.31%, 0.30% and 0.31% for 330 KV line of the ICNIRP 1999 exposure limit for the general public. Thus there is no health risk to human activities under the lines or close to the lines. Also the electric field measured within 25m of the recommended distance by PHCN is about 10.923 V/m, 9.85 V/m, 11.672 V/m and 12.071 V/m respectively. These correspond to 0.31 %, 0.29 %, 0.34 % and 0.31 % of the ICNRIP, 1998 exposure limit for the general public. However, the data was represented with Figure 1 which shows the variation in electric field with change in distance for four different sites. The electric field measured in site 3 within the distance 10 m and 20 m is lower compared to electric field measured within 30 m, 40 m, 50m, and 60 m. This could be due to a lot of activities taking place within these distances. There is electric field attenuation which could be due to the cluster of building structures and more environmental structures which were erected or thick vegetation within the range. The attenuation could be due to scattering or absorption of the radiation by the structures. The maximum electric field was observed at the shortest distance from the various sites showing that site 1 has the highest electric field strength and site 2 has the lowest electric field strength. The least electric field strength obtained from site 3 is more than that of site 2 and the least electric field obtained from site 4 is more than that of site 2 and 3. This explains the effect of the location where the power line is situated on the amount of electric field strength exposed to people living in the area. Though, people living in site 4 are more exposed to the danger of electric field strength than those of site 1 and 2. In general, there is decay in the electric field strength as the distance increases.

Table 2 represents the magnetic field strength (H) data obtained from sites 1, 2, 3 and 4. The highest and lowest magnetic field strength measured is 8.713 A/m and 5.00 A/m in site 1, 9.00 A/m and 4.341 A/m in site 2, 6.721 A/m and 4.002 A/m in site 3, 9.302 A/m and 4.101 A/m in site 4. It corresponds to 0.82 %, 0.85%, 0.63% and 0.87% of the ICNRIP, 1998 exposure limit for the general public. Also the magnetic field measured within 25m of the recommended distance by PHCN is about 8.828 A/m, 9.056 A/m, 7.106 A/m and 9.261 A/m respectively. These correspond to 0.83 %, 0.86 %, 0.65 % and 0.88% of the ICNRIP, 1998 exposure limit for the general public. Thus human activities like farming are safe under the lines. Hence, there is no risk to PHCN maintenance personnel working under the line. However, the data in table 2 was represented in Figure 3 which explains the variation in magnetic field strength with respect to the type of location. Site 4 gives the highest value of magnetic field strength and site 3 gives the least magnetic field strength. It was observed that the least magnetic field strength in site 1 is more than the least magnetic field strength in site 2 despite the fact that the highest magnetic field in site 2 is more than the highest magnetic field in site 1. The highest magnetic field strength in site 2 is more than that of the highest magnetic field strength in site 1. Therefore people living in site 4 are prone to higher magnetic field strength than those living in site 3 which produce the least magnetic field strength. People living in site 3 are prone to higher magnetic field strength than those in site 2. Though those living at the longest distance to power transmission lines are prone to higher magnetic field strength than those living in the least distance and longest distance to the power line in site 2 whereas those living at the least distance are exposed to higher magnetic field strength than those living at the same distance in site 1. The electric field measured in site 3 within the distance 10 m, 20 m and 30 m is lower compared to manetic field measured within 40 m and 50 m which could be due to several activities taking place within these covered distances. There is electric field attenuation which could be due to the cluster of building structures and more environmental structures which were erected or thick vegetation within the range. The attenuation could be due to scattering or absorption of the radiation by the structures.

Table 3 represents the power density data obtained from sites 1, 2, 3 and 4. The power density (S) varies from 95.329 to 25.550 w/m^2 in site 1, S varies from 99.00 to 17.364 w/m^2 in site 2, 74.206 to 24.724 w/m^2 in site 3 and 111.609 to 33.677 w/m^2 in site 4. However, the data in table 3 was represented in Figure 4 which explains the variation in power density with respect to the type of location. Site 4 gives the highest value of power density and site 2 gives the least power density at distance 100 m. The power density from site 3 initially increases up to the distance 40 m and latter decreases to the least value of 24.724 w/m^2.

CONCLUSION

In this research work, the electric and magnetic fields emanating from power- lines were established and critically studied. The electromagnetic radiations from these power-lines fall within the exposure limits set by ICNIRP standard. The work also showed that no measurable ionizing radiation components are associated with low frequency radiations. This research has also revealed that most people living in close proximity to power-lines may be at more risk than those staying very far. Due to the cluster of building structures and distribution of environmental structures, the amount of radiation exposed to the people living in some of the areas is not above the ICNIRP standard.

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