Hazardous Effects of EM Radiation from Siting Mobile Phone Masts Close to Residential Houses and Schools.

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ABSTRACT

This work looks at the developments in telecommunications in Nigeria and draws from the experience of the other developed countries of the world. It discusses the trends and the effects of electromagnetic radiation in siting base stations close to residential houses and schools in Nigeria and in the developed countries. It gives the highlights of the technical data and calculations of base stations characteristics, such as power density, antenna gain, effective radiated power and electric field strength in about 10 sites visited during this research. The paper also discusses the working principles of cellular mobile phones and summarizes the information obtained from the sites visited. Also presented are suggestions and measures to ensure successful operations of the industry without these dangerous radiations from the base stations, in order to keep the problem under control and limit the consequences of environmental pollution and ill health to people living around the mast.

(Keywords: human health, base stations, electromagnetic frequencies, EMF, power density, environmental pollution, electromagnetic pollution)

INTRODUCTION

Liberalization of the Nigeria telecommunications industry in conjunction with the development of digital radio technology in the 1990s metamorphosed the development of mobile phones resulting in the birth of mobile base stations sites from 2001. The Nigeria Communication Commission (NCC) organized digital mobile license auctions with Communication Investment Ltd., MTN Nigeria Communication Ltd., Econet Wireless, and Nigeria Telecommunication Ltd. (NITEL) emerging as the winners. Later Globacom Mobile Nigeria and Etisalat Nigeria got licenses for operation as well. In effect, there are an increasing number of base stations in the country for effective network coverage. Many of these base stations sites are close to residential houses, schools, and markets, and this, joined with their rapid development, has led to local and international concerns that the electromagnetic frequencies transmitted could be harmful to human health.

This study is from the information gathered from two major cities in Enugu State; Enugu urban and Nsukka town. At Nsukka, the base stations were sited within the distances of 5m to 20m from residential houses, and others were about 10m from primary school fields and also offices and lecture halls within University of Nigeria Nsukka compound. In Enugu urban, many of the base stations were not sited within the compliance distance of NCC, which state at least 50m from residential homes, schools, or markets. Some of the masts are **10m - 30m** away from residential homes or schools.

The selection of sites is inherently biased because they were chosen based on proximity and interest. The aim of this paper is to draw attention more closely to the likely effects of mobile phone masts siting close to homes and schools in Nigeria. The work stated the management of potentially dangerous radiation from mobile masts, suggestions, and measures to be taken here in Nigeria.

SCIENTIFIC REVIEW OF THE EFFECTS ASSOCIATED TO SITING BASE STATIONS CLOSE TO RESIDENTIAL HOUSES AND POPULATED CITY

The human body contains electrolytes and ions that are positively or negatively charged. Water molecules are polar molecules - having positive and negative charges separated by a dipole

length, making them therefore, an electric dipole. Humans are made up of approximately 65-75% water, electrolytes, and ions, (www.equilibrank.com) so it follows that the human body has its own weak electromagnetic field and each of our cells has its own EM field too. It follows that strong and even weak electromagnetic fields emitted from our environment will interact with and affect the human body's own weak electromagnetic fields, and therefore, potentially interfere with the body 's natural processes. This may cause a disease, which can be characterized as a disturbance or interference in the "energy field", the body is forced to produce the mirror-image counter oscillations of the interference field at the same time, by neutralizing them; it succeeds in doing this with the corresponding expenditure of energy. This is referred to as 'holding work' (www.quilibrank.com), which must be performed, because of the constant expenditure of energy in order to neutralize constantly recurring oscillations from the interference field.

If the organism is weak, it can no longer perform the 'holding work' and is no longer able to neutralize the pathological oscillation. "This is the onset of illness and diseases as we know it biologically" (www.quilibrank.com), which occurs when the New Generation (G3/3G) with 2.2GHz and Tetra Masts pulse (phase) (0.9GHz to 1.8GHz) modulate their signals.

It is this modulation or burst repetition rate that seems to have the most damaging effect upon the body because the frequencies generated are very close to the body's natural range of frequencies which range from below 10 to over 10^{15} Hertz. Considering that the body transfers biological information ranging from 1Hz to well above light frequencies, we can see how this type of pollution, may be more harmful than exposure to some pollutant substances. It's a major reason why acute disorders are not common nowadays compared to the increase of chronic disorders in recent years.

According to a report by Dr. R.K Kohli, the Director of the Centre for Environmental Studies, India, "The electromagnetic radiations from the towers generate heat and kill micro organisms present in the soil near it. This in turn harms those organisms that feed on them and it disturbs the ecological cycle". The report from Biolnitiative Working Group, USA, shows scientific evidence raising worries about health impacts including childhood leukemia, brain tumors, and acoustic neuromas from cell phones, cordless phones, and power lines.

In another study reported in the *Sunday Time*s, UK**,** fifteen years ago a 27m cell mast was erected in Cole Shill in the UK and this location hit the headlines in April 2007 when it was discovered that over 30 residents in the immediate vicinity are either battling cancer or had died from it. At a nearby school, the deputy headmaster is well stock with tissues because of the frequency of nosebleeds amongst pupils and at another school out of thirty staff; seven staff developed tumors in recent years.

In another development, the *Trinidad Newsday*, India expressed the view by several professors, researchers and public health scientists during a health symposium at the University of the West Indies, Mt. Hope. Members of the panel found that brain tumors, memory loss, a reduced sperm count, and leukemia were some of the effects caused by constant exposure to cell-tower radiation. It added that towers should not be installing closer than 300 metres to where people live. Also the *Telegraph UK* has it that residents of a Hamlet near a mobile telephone mast have recorded high levels of illness, including seven cases of cancer, raising fresh concerns over the safety of the transmitters.

Among the 50 people living in Wishaw Warwick's, 34 people have reported medical complaints in the past two years. Five women diagnosed with breast cancer and two have tumors. The residence live within a mile were the mast is installed.

In a report from EMF-Omega-New, show that due to the exposure of the radiation from masts, there is large-scale disappearance of the humble honeybees, which threatens agriculture worldwide. The action of pulse-modulated GSM radiation increases regional changes in brain activity and c -Fos expression in cortical and sub cortical areas in a rat model of picrotoxin-induced seizure proneness.

Other studies show ill health effects from mobile phone base station masts, including the document produced by Dr. Grahame Blackwell 21st Feb 2005.

The Netherlands Organization for Applied Scientific Research (TNO) found significant

effects on wellbeing according to a number of internationally recognized criteria (including headaches, muscle fatigue/ pains, dizziness etc) from 3G mast emission well below accepted safety levels (less than 1/25,000th of the International Commission on Non- Ionizing Radiation Protection (ICNIRP) guideline). Thus, those pronounced more ill effects are the people noted as electro hypersensitive and others show significant effects.

Also in the paper presented in an International Conference in Kos, Greece (2004) enumerate the significant ill-health effects in those living close to two GSM mobile phone base stations. They observed that there are depressive tendency of fatigue, sleeping disorder, difficulty in concentration and cardiovascular problems. They advise that the level of indoor exposure value would not be higher than 0.02V/m for sum total, which is equal to a power density of 0.0001W/cm^2 for GSM base stations proposed on empirical evidence by the public health office of the government of Salzburg.

Finally, it is worth noting that it is at nighttime that the body carries out most of it healing work' as it constantly works to restore homeostasis. As these phone masts are fixed structures, it is, therefore, impossible for an individual to avoid these synthetic chaotic energies from interfering with their energy fields and the body's natural ability to restore homeostasis.

EXPERIMENTAL PROCEDURE

A radiation meter of the type 9 E-field probe with a charged–battery powered, was used for the measuring electric field strength and power density in both near-field and far-field measurements. It has a wide frequency range suitable for 10MHz – 18GHz and the field or power density of radiation is displayed on a screen, (LCD) liquid crystal display unit. The device operates in four modes "Instantaneous" and "Max" are for short–term or orientation measurements and the "Average" and "Max average" are for long-term monitoring of exposure to electromagnetic radiation.

The direct reading type 9 E-field probes was fixed in an improved stand which guarantee the measurements isotropy, in a mobile room directed to the radiated dual-band antenna at cell phone base stations. The instrument is switched on and a self-test is performed by the instrument. A zero adjustment is done and the measurement display is read.

In the near-field measurement, the meter is selected to the Default E measurement for the measurement of E-field strength at various close distances from the antenna.

In far-field, the meter was switch to E-field strength in V/m for the data of E-field strength at distances from the radiated antenna. For the power density measurements, it was switch to power density in W/m^2 or mW/cm^2. For any new measurement the meter was reset before taking new readings.

Observations obtained within the distances and the direction of the radiation from the antenna with the range of frequencies shown in Table 2 and 3, respectively. However, several environmental parameters were highly prevented not to influence the results, such as the frequency of other sources, ability to know the distances of far-field or near-field, and the mixed fields from other sources.

RESULTS AND DISCUSSION

Network Coverage

The transmitted signal strength decreases with an increase in distance from mobile phone base stations. Though the GSM base stations in Nigeria communicate up to 30 km, this means that a large number of base stations is needed to provide coverage of the whole of the Nigeria by all five current large networks.

A base station contains a number of radio transmitters whose outputs power is join, fed to an antenna mounted at the top of a mast, and transmits as radio waves. The strength of this waves declines with distance from the antenna according to the inverse square law. It means that the received signal power decreases by ¼(6dB) as the distance doubles. This is due to the R^2 term in the denominator of the equation of main beam antenna power density.

However, the received power available at the antenna terminals is the power density times the effective capture area (A_e) of the receiving antenna.

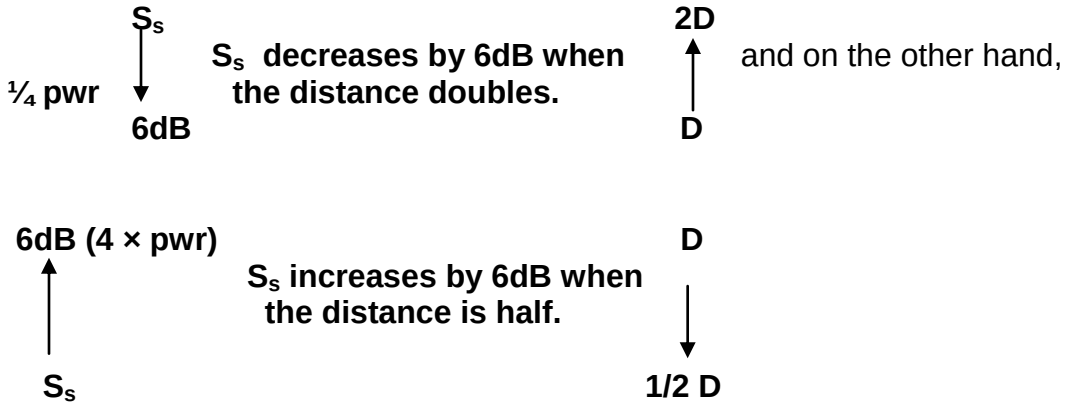


Figure 1: Signal Strength in Relation to Distance.

$$A_e = P_t / p_\rho \quad \textbf{(1)}$$

$$\therefore - \quad A_e = G_t \lambda^2 / 4\pi \quad \textbf{(2)}$$

Therefore, for a given receiver antenna size the capture area is constant no matter how far it is from the transmitter.

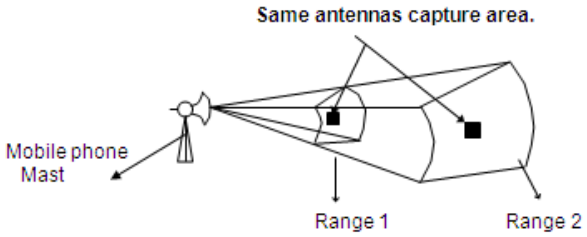


Figure 2: Power Density against Distance Covered.

Range **1** receives more signal than range **2**, which is ¼ of the signal of range **1**.

Table1 below shows various capture areas with respect to the wavelengths of the received signal for GSM 900 and GSM 1800 of the uplink and downlink frequencies.

The Frequency of the Antenna

The frequency used is 824-960 MHz and 1710-2190 MHz. The GSM system in Nigeria is denoted as GSM 900 and GSM 1800MHz. As each GSM radio channel contains uplink and downlink frequency bands, it is separated by 45MHz apart for GSM900 and 95MHz apart for GSM1800.

Table 1: Capture Areas.

Wavelength λ (m)	Capture Area $A_e(m^2)$
0.340	0.92
0.333	0.88
0.326	0.85
0.319	0.81
0.313	0.78
0.306	0.74
0.300	0.72
0.286	0.65
0.273	0.59
0.261	0.54

Antenna

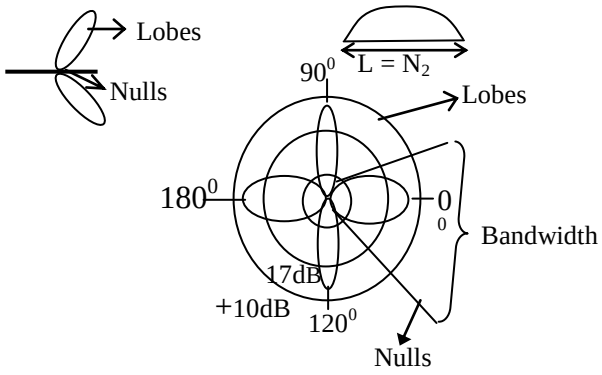
In the sites visited, in a base station, there are sector areas and sets of antennas are mounted on the mast, of which each set gives coverage of 120° arcs about the mast. They are oriented in a way that sector 1,2 and 3 are directed towards grid north,120° east of grid north and 240° east grid north. This gives a pattern of a triangular configuration seen in base station mast in Nigeria.

Nine, six, or three antennas arranged on some masts in order to provide efficient network coverage. The antenna type is a dual-band panel

that has frequency range 824 – 960 MHz and 1710 – 2180 MHz, which has maximum power per input 500W for 824 – 960 MHz and 250W for 1710 – 2180 MHz with total power of 1000W for 824 – 960 MHz and 500W for 1710 – 2180MHz at 50^{o}C ambient temperature.

Antenna Pattern

The general tools used to show the antenna performance is a polar plot of the relative signal strength of the radiated field versus distance and angle from the antenna.



Figire 3: Typical Radiation Patterns.

The polar plotting is mainly done in a relative scale of which the area of maximum signal strength is 0dB reference, and for every graduation ring nearer to the centre of the plot shows a reduction of signal strength by 2.99 of 9.99dB.

The angle of the signal strength information of the polar plot has its 0^{o} orientation aligned with the major physical axis of the antenna. The angle shows a total sweep of the horizon, in all directions. Thus, this plot shows how the antenna shapes the field strength against distance as it radiates signal energy of which the angles from the antenna have more or less field strength as a result.

The field strength decays with distance from the antenna according to the inverse square law. The antenna pattern used in the sites visited is a directional antenna shown in Figure 4.

Antenna is often described in terms of its principal pattern E and H plane [Electric field and magnetic field]. As they are linearly polarized antenna, The E-plane pattern contains the electric field vector with direction of maximum radiation and the H-plane contains the magnetic field vector and the direction of maximum radiation. The x-z plane is the elevation plane Φ=0; which is the principle-plane and x-y plane, the Azimuthal plane θ=Π/2 that is the principal H- plane. The dual polarization is about +45 and – 45 for the frequency range 824 – 2180 MHz. Thus, the horizontal pattern have half power beam width of 65^{o} for both 824 – 960 MHz and 1700 – 2180 MHz of frequency, the main beam direction at O^{o} between 17dB - 20dB the same frequency. For the vertical pattern, the half power beam width is between the range of 4.69^{o} – 7.5^{0} at the frequency 2180 – 824 MHz; and the adjustable electrical down tilt is 0^{o} - 7^{o} for the frequency 824 - 960MHz and 0^{o} - 6^{o} for the 1700 – 2180MHz .It is tilted either by hand or an optical remote control unit.

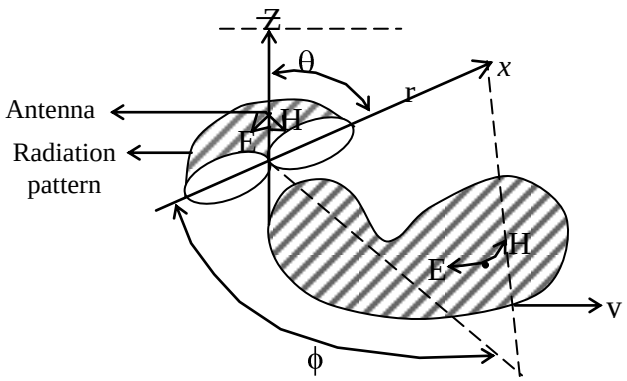


Figure 4: Direction Antenna Pattern.

The field pattern of the signal intensity in directions of the main beam of the antenna, measured relatively far from the antenna, is known as a far field.

The field patterns have lobes-area of very high signal strength and mills-segments of very low signal strength.

$I_{ant} = V/d$ **(3)**

Where $I_{antenna}$ is the intensity of an antenna radiation at a given point in space, V is the root mean square volts and d is the distance in the direction of the electric field.

Table 2: E-Field Strength in Various Frequencies of the Dual Antenna Band Used.

Frequency (MHz)	Electric Field Strength (V/m)
824	39.47
880	40.79
894	41.11
964	42.69
1710	56.85
1850	59.14
1880	59.62
1900	59.93
1990	61.34
2000	61.49

Antenna Gain, G_t

The gain of an antenna is the ratio of the power density in a particular direction of one antenna t o the power density that radiated isotropic. Thus:

$$G_t = \frac{\text{Maximum radiation intensity of actual antenna}}{\text{Radiation intensity of isotropic antenna with same power input.}} \quad \textbf{(4)}$$

However, the maximum antenna gain attainable is proportional to the capture area, A_t (the solid angle subtended by the beam is inversely proportional to the area), is given as:

$$G_t = 4\pi \eta_t A_t / \lambda^2 \quad \textbf{(5)}$$

Where λ is the wavelength and η_t (< 1) is an efficiency parameter.

The directive gain depends on the length of the antenna. Therefore, the gain in decibel is given by:

$$G(dB) = 10 \log_{10} P_{\ell i} / P_{\ell un} \quad \textbf{(6)}$$

Where, $P_{\ell i}$ is the power of reference antenna and $P_{\ell un}$ is the power of unidirectional antenna.

Hence, the dual antenna band has the gain of 2 x 16.3dBi – 2 x 17dBi for the 824 – 960 MHz and 2 x 17.8dBi – 2 x 18.29dBi for the 1710 – 2180 MHz.

The beams from the antenna used in the base stations visited are narrow in the plane of elevation and it is the reason why the taller the stack is in relation to the wavelength, the narrower the beam width achieved.

Mathematically, the effective radiated power is given as follows;

$$ERP = P_0 \times G \quad \textbf{(7)}$$

Where P_0 is the power fed to the antenna.

$$ERP\ (dBm) = P_t\ (dBm) + G_t\ (dB) \quad \textbf{(8)}$$

Where P_t is either peak or transmitter power and G_t is the gain of the antenna.

The ERPs used in the sites visited during this work ranged from 47dBm to 61.01 dBm per transmitter and the extrapolate value is about 65dBm.

Power Density

The product of the receiver voltage and the antenna factor in (m^{-1}) can obtain the power density (P_ρ).

$$P_\ell = VF = E \quad \textbf{(9)}$$

Where, E is the Electric field strength of each signal detected with the antennas.

Although, reflections may increase or decrease the power density if the path length traveled by a reflected wave is comparable with the direct distance to an antenna, thus the total power density is increased by a factor of up to four. Therefore, for the main beam antenna:

$$P_\rho = P_t G_t / 4R^2 \quad \textbf{(10)}$$

$$P_\rho = P_t G_t / 4\pi R^2 \quad \textbf{(11)}$$

Where R, is the surface area surrounding the antenna on the direction of radiation from the main beam.

Equation (10) is only valid in the direction of the antenna beam and that of (11) is applicable in spherical regions. In case of isotropic antenna its power density is given as**:**

$$P_\rho = P/A \quad \textbf{(12)}$$

The power density obtained at different distances from the foot of the mast in the direction of the power been radiated by transmitter of the sector antennas is shown in the tables and graph below.

Table 3: Power Density (P_ρ) against different Distances from the Foot of Mobile Mast of Antenna with 4 Transmitters of 20W and Antenna Gain 18dB.

Power density (W/m^2)	Distance (R) (m)	$1/R^2$ (m^{-2})
16.07	5	0.0400
4.02	10	0.0100
1.78	15	0.0044
1.00	20	0.0025
0.64	25	0.0016
0.45	30	0.0011
0.33	35	0.0008
0.25	40	0.0006
0.19	45	0.0005
0.16	50	0.0004

Table 4: Power Density and Various Distances from the Foot of the Mast with Transmitter Power of 20W and Antenna Gain of 20dB.

Power density (W/m^2)	Distance (R) (m)	$1/R^2$ (m^{-2})
25.45	5	0.0400
6.36	10	0.0100
2.83	15	0.0044
1.59	20	0.0025
1.02	25	0.0016
0.71	30	0.0011
0.52	35	0.0008
0.39	40	0.0006
0.31	45	0.0005
0.25	50	0.0004

It show that increase in distance from the foot of the mast, power density decreases. Therefore, the results in this section are, based on realistic technical data that is expected to reproduce typical worst-case conditions. The values are not any way to replace the exclusion zones defined by network operators, and it is only done in the direction of the main beam. Thus, compliance distance would be less in other directions except in an isotropic antenna.

Some Exposure Guidelines and Basic Restrictions

Various researchers and scientists have published guidelines for the protection of people from exposure to electromagnetic fields and radiation. However, it lies on the country's policy makers to determine which set of guidelines should be adopted. In Nigeria, the mobile operators claim to maintain the guidelines and basic restrictions of International Commission on Non–Ionizing Radiation Protection (ICNIRP), which states as follows:

a) Heating can occur because of exposure to electromagnetic field at telecommunications frequencies.

b) The established adverse effects on people's health occur at exposure level where heating would be expected to occur.

c) Exposures should be restricted to avoid the established effects of exposure to electromagnetic fields.

Therefore, the basic restrictions on exposure to electric and magnetic fields in the frequency range 10MHz – 10GHz for occupational and general public specific energy absorption rate (SAR) averaged over the body and over any 6minute period is 0.4W/Kg – 0.08W/Kg,SAR averaged over any 10g in the hard and trunk and over any 6minutes period is 10W/Kg – 2W/Kg and SAR averaged over any10g in the limbs and over any 6minutes period is 29W/Kg -4W/Kg while for frequencies between 10MHz to 300GHz, the basic restrictions of $50W/m^2$ for occupational exposure and $10W/m^2$ for exposure of the general public.

However, there is a contrary view about the ICNIRP exposure levels by many of the world's foremost independent scientists. Dr Neil Cherry (2000) recommended risk reduction targets for the mean chronic public exposure to be $10nW/cm^2$. Also, Koivisto et al.(2000) and Krause et al.(2000) reports that for a 2 minutes exposure, the SAR is 0.013W/Kg and 10minutes,SAR is 0.0025W/Kg and weakens the blood brain barrier,($P<0.0001$) with a dose above 1.5J/Kg. In 1995, New Zealand Environmental court (as the planning tribunal) in a case of MacIntyre vs. Bellsouth set a level of ($2\mu W/cm^2$) $0.002W/m^2$ as a precautionary approach.

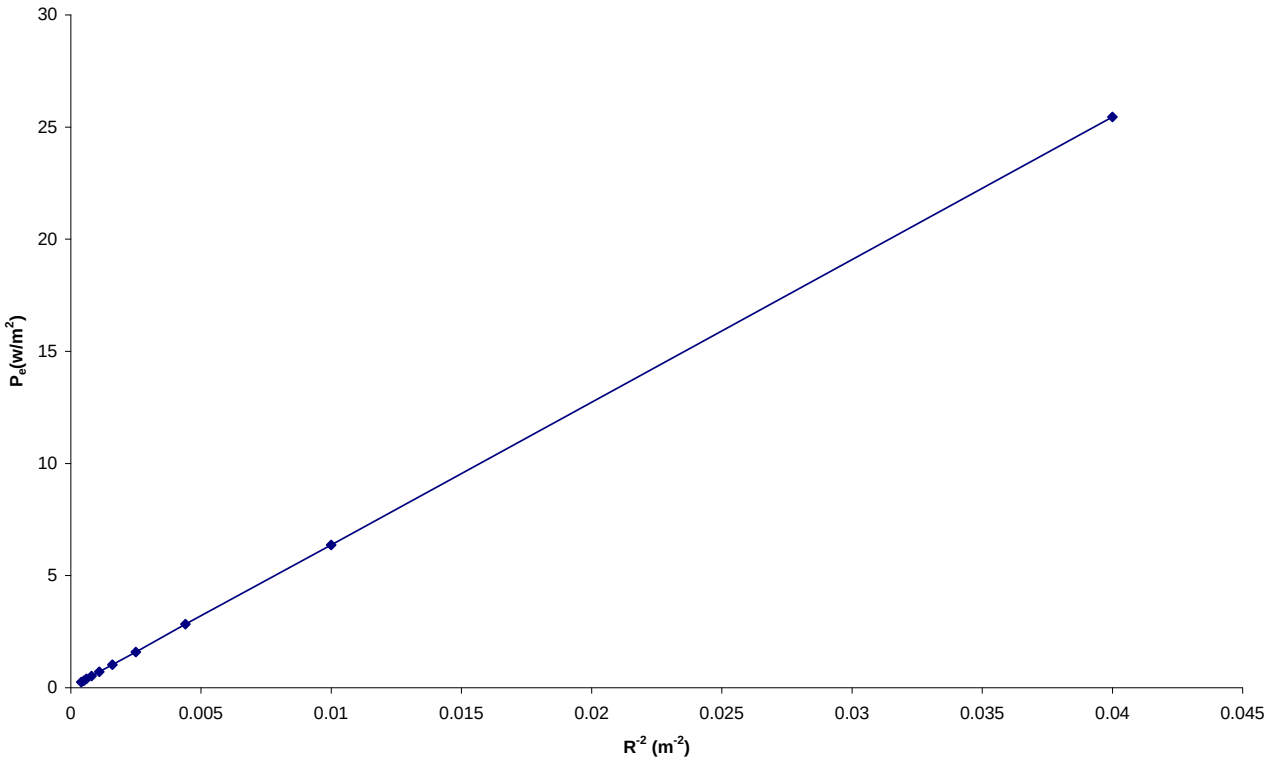


Figure 5: The Graph of Power Density against the Square of the Reciprocal of the Distance from the Foot of the Mast.

A report by Altpeter et al. (1995) shows that people living close to a mast show a significant effect of RF exposure on sleep disturbance and reduced bovine melatonin at power density of 0.0004W/cm^2 and even when expose to a mean RF signal of less than 0.1mμ/cm^2,the people involved experienced.

MANAGEMENT OF ELECTROMAGNETIC RADIATIONS FROM MOBILE PHONE MASTS CLOSE HOMES, SCHOOLS, Etc.

In the developed nations where concerns over the effect of electromagnetic radiations from mobile base station originated, strategies for the management of the radiation from masts have been devised. Such measures include:

a) The use of deluxe screened bed canopy that reflects high frequency electromagnetic waves (200MHz - 3.3GHz) with attenuation of 32 to 13dB. It is not externally conductive and needs not to be grounded. It acts as a Faraday cage and no electronic device is used inside it. Table 5 and Figure 6 show Attenuation against Frequency.

b) Application of a transparent screening solution (a silver-plated (non-allergenic) bobbinet material), which is woven for durability and stops over 99% of in-coming microwave radiation energy (300-3000MHz). In addition, is the electrosmog lining paper that is the most effective protection. This lining paper is ideal for both the public living in high electromagnetic field areas, and for those who already known they are electro sensitive (ES). It is hung like a normal lining paper and can be painted.

c) The use of Elanra MKII- Therapeutic Ionizer with variable frequency settings: This helps to counteract the risks to health posed by microwave radiation emitted from mobile phone masts. It works by carefully choosing the right frequency setting on the machine and setting the intensity that is based upon the number of masts nearby, levels of

radiation etc, that it is possible to alleviate some of the debilitating. It helped to diffuse, and reduce the adverse effects the radiation had upon our body especially at nighttime when the body carries out most of its repair work.

Table 5: Attenuation (dB) 99.99% and Frequency (GHz).

Attenuation (dB)	Electric Field Strength (V/m)
5	10.00
10	4.00
15	2.40
20	1.40
25	0.70
30	0.35
35	0.02

Nigeria could follow the above measures for the control of these ELFs radiations from base stations. While the industry is new, we should not wait until we start experiencing the negative side effects of these radiations. Rather, measures should be taken to keep health risks under control. The following strategies should help:

1) Creation of massive awareness campaign to enlighten the populace on the dangers of siting mobile phone masts close to residential houses, schools, etc.; and regular health checks on those living close to masts.

2) Enforcement of the policies and guidelines by Nigerian Communication Commission (NCC), Consumer Protection Council (CPC), Federal Environmental Protection Agency (FEPA), etc. for the mobile operators in Nigeria to maintain the precautionary level and compliance distance of at least 50m away from residential houses, schools, and markets. In addition, authorities should maintain the development plan, ensure that statutory consultations are made, and have evidence of public responses of those living where the mast will be sited.

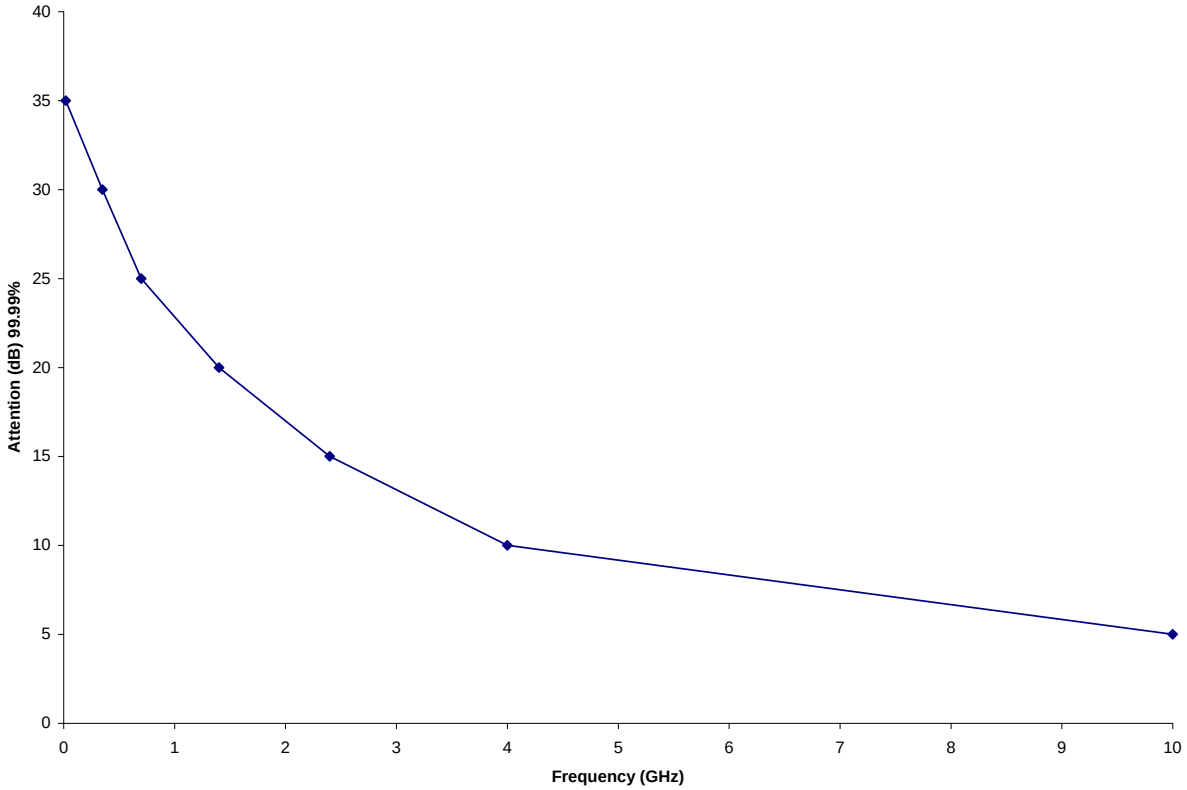


Figure 6: Attenuation (dB) 99.99% versus Frequency (GHz).

3) The introduction of co-location and sharing of masts should be adopted and enforced by NCC to avoid too many masts in one particular locality. Just as in the case of electronic wastes where limits are set on the levels of toxic materials allowed in electronic products, limits should be set on the exposure level of electromagnetic radiation from base stations. Imagine a locality where MTN, GLO, Zain, and Etisalat have their different base stations which generate radio waves and in each base station, at least one generator that supplies power to the cells which generate heat that adds to the radio waves from the antennas. The exposure rate may exceed safe levels for the people living in the locality.

4) Finally, the central Government should construct some houses were these masts are not installed so that those people already living with these structures permanently fixed for some years could migrate to these estates while those living in other locations could exchange for an exposure dilution of these radiations. Therefore, let us be our brothers' keeper, especially for those in power corridors so that Nigeria limit the risks already identified in developed countries, for the good of us and generations to come. If not, we may be wide-open to litigation in the future.

CONCLUSION

The total power radiated by antennas used with macro cellular mobile phone masts in Nigeria is in the range of 100W – 80W and exposures in the beam in close proximity of the antennas can exceed regulatory guidelines. The NCC technical standard for locating base stations is not less than 50m from residential houses. The power density at this distance is 0.25W/m^2 of antenna gain of 20dB and 0.16W/m^2 of a gain 18dB. These are for beams in spherical region, but for the main beam with antenna gain 18dB is 0.51W/m^2 and that of 20dB gives 0.8W/m^2.

However, in most sites visited during this research, siting distances of masts are within the range of 5m – 30m with the corresponding power density for 18dB at 16.07W/m^2 – 0.45W/m^2 and 20dB in the range 25.45W/m^2 – 0.71W/m^2 in cylindrical antenna beams. For the main beam, it is 50.47W/m^2 -1.40W/m^2 for 18dB and 80W/m^2 – 2.22W/m^2 for 20dB.

Note that in the main beam power density is less in the direction where it is not focused. Therefore, when considering the exposure level of people living in the immediate vicinity, the safe level may exceed this result. Additionally generators are attached to a base station for power supply and these generate additional heat and emit carbon. It is the conclusion of the authors that the NCC and other agencies must adopt serious measures towards the possible hazards from electromagnetic radiation from base stations. There is a strong indication that health hazards may be manifest after 10 or more years of latency with people living close with static mobile phone masts.

RECOMMENDATION

The Nigeria Communication Commission (NCC), the Federal Environmental Protection Agency (FEPA), and the Legislature should back with full significance enforcement of the policies that guide the telecommunication operators in erecting their masts/tower in the country. The authors recommend the implementation of the measures given above so that Nigeria will not experience deleterious effects of EMF radiation from mobile phone masts.

REFERENCES

1. Lowe, A.J., R.P. Blackwell, S.M. Mann, S.G Allen, and T.G. Cooper. 2000 "Exposure to Radio Waves Near Mobile Phone Base Stations". National Radiological Protection Board: Oxon, UK.

2. Abelin, T. 1999. "Sleep Disruption and Melatonin Reduction from Exposure to a Short-Wave Radio Signal". Seminar at Canterbury Regional Council: Canterbury, New Zealand. August 1999.

3. Alberts, E.N. 1978. "Reversibility of Microwave Induced Blood Barrier Permeability". *Radio Science Supplement*.

4. Alberts, E.N. 1977. "Light and Electron Microscopic Observations on the Blood-Brain Barrier after Microwave Irradiation". Symposium on Biological Effects and Measurement of Radio Frequency/Microwaves. HEW Publication (FDA) 77-8026: 294-309.

5. Altpeter, E.S; Krebs, Th., Pfluger, D.H., Von kanel, J., Blattmann, R., et al. 1995. "Study of Health Effects of Short Wave Transmitter Station of

Schwarzenburg, Berne, Switzerland". University of Berne, Institute for Social and Preventative Medicine: Berne, Switzerland. August 1995.

6. Ash, D. 1996. *The New Science of (the work of Viktor Schanberger)*. Gateway Books: Bath, UK.

7. McTaggart, L. 2001. *The Field*. Harper Collins Publishers: New York, NY.

8. Cherry, N. 2000. *Probable Health Effects Associated with Mobile Base Stations in Communities: The Need for Health Studies. 8th Edition*. Lincoln University: Canterbury, New Zealand.

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