قياس وتحليل شدة المجال الكهرومغناطيسي لمحطات الهاتف النقال في مدينة كركوك

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الملخص :

مع بداية دخول خدمة الهاتف النقال إلى العراقين العام ٢٠٠٤.بدأت شركات الاتصالات بنصب أبراج لتامين عملها بطرق عشوائية وبشكل أهمل تفنيه مراعاة شروط السلامة الصحية والبيئية مما قد يسبب أضرارا صحية وبيئية تهدد الكائنات الحية.تم في هذا البحث قياس كثافة القدرة المنبعثة من بعض محطات الاتصال لشركة آسيا سيل في مدينة كركوك.تم أنجاز البحث بقياس عملي لكثافة القدرة قرب محطات الاتصال الخلوي (بواسطة جهاز قياس شدة الإشعاع الكهرومغناطيسي 480846) بطريقتين: الطريقة الأولى اعتمدت ارتفاع ثابت وهو ٢ متر والمسافة متغيره من صفر الى ٣٠٠ متر.والطريقة الثانية اعتمدت المسافة ثابتة وهي ١٥٠ متر والارتفاع متغير من ٢ إلى ١٥ متر وقد بلغت أعلى كثافة قدره   0.65 ملي وات\ متر مربع .أظهرت النتائج أن كثافة القدرة اقل من المستويات المعتمدة حاليا. هذا يعني انه ليس هناك اثار سلبيةإذا لم تتجاوز هذه المحطات المستويات ا لقياسيةالموضوعة من قبل منظمة الصحة العالمية .

الكلمات الدالة :الهاتف الخلوي ,محطات الاتصال الخلوي , الاشعاعات الكهرومغناطيسية.

List of abbreviations

(RF) : radio frequency

(Who): world health organization

(ICNIRP):.International Commission on Non-Ionizing Radiation Protection

(FCC) :Federal Communications Commission)

(PCS): personal communications systems

Investigate and analyze the Electromagnetic Fields levels Emitted by Cellular Base Stations In Kirkuk City

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Abstract

With the entry of mobile phone in Iraqi 2004,communication companies began to install cellular to worsen random ways but they ignore the safety conditions imposed for the health and environment. This research concern with the risks and damage that may be caused by radiation emitted from Asia cell base stations in Kirkuk city. Research has been conducted by measuring the power density around base stations using a radiation survey meter model (EMF Strength Meter 480846). First way of measurements has been accomplished by using a constant height of 2meters above ground for different distances (0-300 meters)while the second way at a distance of 150 meters for different levels above ground. The maximum measured power density is about (0.65mW/m$^{2)}$). Results indicate that the levels of power density are far below the RF radiation exposure set by (World Health Organization).

Key words: Mobile phone ,cellular base stations, EMF radiations.

1. Introduction

The electromagnetic field (EMF) sources include radio and TV broadcasting stations, radar, microwave ovens and microwave communication transmitters. However, radiation from base stations of cellular mobile and personal communications systems (PCS) has got moderately less attention[1].Cellular mobile radio of the first generation operates in the 450 or 900 MHz band. The digital second generation of the mobile phone operates, however, in the 900 MHz, 1800 MHz or 1900 MHz band. The frequency allocation for the third generation is in the 2000 MHz band[2]. In Republic of Iraq, Asia cell mobile antennas operates on the frequency range of (903.4-915)MHz uplink to (948.4-960)MHz downlink with bandwidth of (11.6MHz) that means it works in second generation (GSM900) .Since the mobile devices recently worked in Iraq, few effort has been done in this direction by some local researchers [3].Microcell base stations which are currently used by mobile radio transmit power of about 20 watts per channel are usually mounted on lattice towers 25-50 m in height. Microcells with less than 1-km radius of coverage are mounted on lamp posts and surrounding buildings with average height of about 10 m and transmit between 0.1-1 watt per channel[4].]. The near future personal communications network (PCN) will use Pico cells which are used to provide services for areas with high terminal density and usually deployed for indoor areas with 5-30 m in height. This research presents the results of measurements of electromagnetic power density in the Surrounding area of microcellular radio base stations as a function of distance from the base and height above ground. The base stations are chosen to be located in different areas of Kirkuk city to check the effects of environment nature on the measurements. The results of measurements are compared with the exposure safety standard levels. Many countries have developed RF radiation coverage standards which considered some considerable differences as shown in Figure (1)[5].From the assessment of maximum exposure limits of various standards for general public to RF from base station antennas ranges, the USSR standard is relatively the lowest level(10mW/m$^{2)}$) in the range from (300 MHz to 300 GHz) [6].
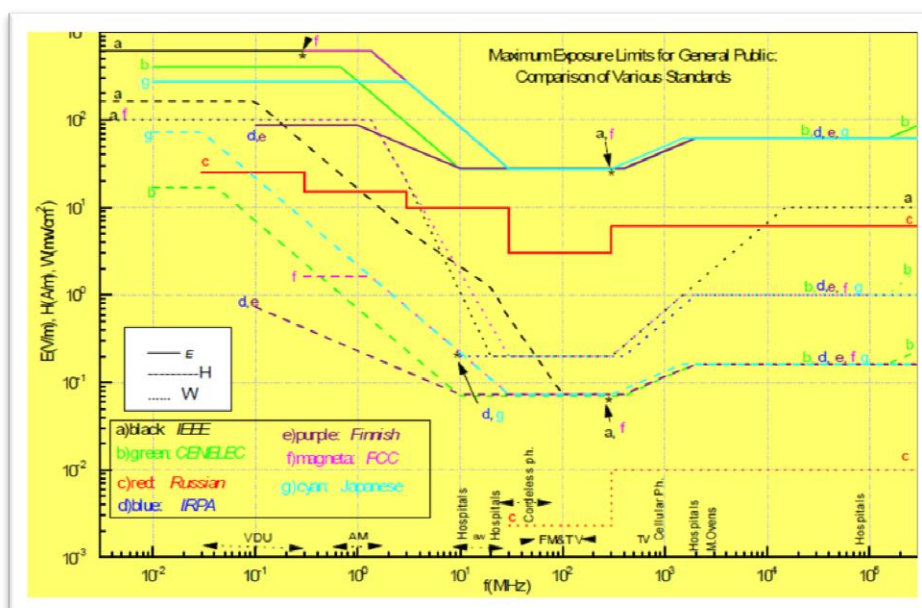
Fig.(1):Evaluation of max .coverage limits of different standards for general public.

1.1- Literature review

The possible health effects resulting from the exposure to low-level electromagnetic fields from communications antennas have received continuing interest and are subject to a great deal of controversy[7]. In particular, magnetic field induced reduction of melatonin and the discovery of magnetic crystals in human tissue are two of the hot research points in this field. The tremendous growth in cellular communication services called for widespread use of cellular techniques which use base stations[8]. Peterson measured the power densities in the region of the base station of cellular mobile radio. The measurements were for a 96-channel system operating at an effective radiated power (ERP) of 100 watt per channel and in the frequency range 869-894 MHz The measured maximal total power density at a level of 2 m above ground was less than $1\mu W/cm^2$[9]. Near-field power density in the mean beam of a root-top mounted antenna transmitting an ERP of 1600 watt at a level of 2 m above the roof level was also measured. The power densities were found to be less than $3\mu W/cm^2$ at

distances greater than 0.7 m from the antenna, less than 100μW/cm^2 at distances greater than 12 m and less than 10μW/cm^2 at Distances greater than 50 m.

2-Theoretical part

The GSM network in Kirkuk divides the city into microcells radio base stations. The base station system comprises a base transceiver station (BTS) and a base station controller (BSC). The transmitting antennas of the base stations are usually installed on the top of either a lattice type tower of heights 25-48 moor the roof-top of a building typically, 35-39 m in height . The antenna system is arranged in three groups at different angles to the azimuth[10]. One Antenna in each sector is utilized for the downlink (BTS to mobile) and the other two are used for Receiving signals from the mobile ,each group consists of three linearly polarized high gain rectangular antennas which are approximately2.3 m long and 0.3 m wide with a total down tilt of 5~10º to the vertical[11].The field strength at ground level depends on the characteristics of the antenna. The main beam is tilted slightly downwards but does not reach ground level until the distance from the tower is at least 50 m (usually 50–200 m)as shown in figure (2).
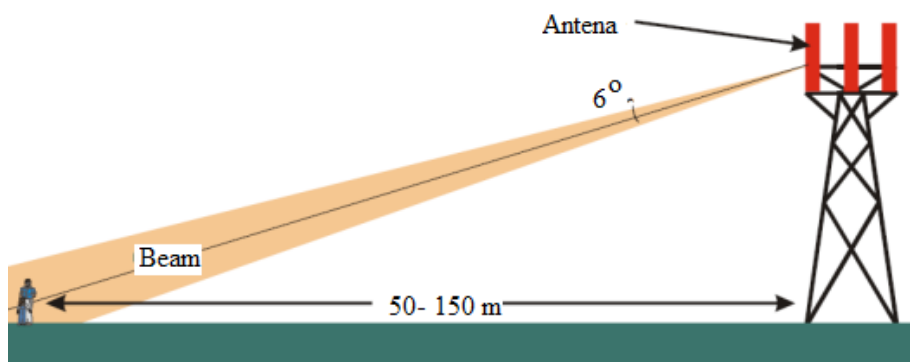

Fig.(2) : Elevation showing the shape of beam formed by a typical antenna used with microcellular base station.

In case of free sight to the antenna, the maximum field Strength can be calculated from the following equations : [12].

$$E_0 = \sqrt{\eta_0 \frac{P_r}{A_{er}}} = \frac{1}{R}\sqrt{120\pi \frac{P_t G_t}{4\pi}} = \frac{\sqrt{30 P_t G_t}}{R} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots(1)$$

Where :

Pr : Power received by antenna.

Aer : Effective area of antenna .

$$SAR = \frac{\sigma |E^2|}{2\rho} \ (W/kg) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots(2)$$

3- Practical part:

The measurement SAR conducted in two ways, the first is the measure of emitted EMF from mobile base station in Kirkuk at a height of(2 m) above the ground and at different distances(0 to300) meters from Asia cell base station as shown in figure (3).

Fig.(3): Distribution of the Asia cell base stations in Kirkuk city

The measurements are carried out using a radiation survey meter model Radio frequency EMF

Strength Meter 480846 as shown in figure (4).

Fig.(4): RF EMF strength meter 480846

The calculation of the power density (Pd) at a distance of d meters from any antenna transmitting a power of Pt with a gain of Gt is given by the following equation[8]:

$$P_d = (P_t * G_t /4\Pi d^2)$$ ....(3)

where is :

Pt : Transmitter power in watt .

Gt : Gain of transmitting antenna .

d : Distance from the antenna in meters .

4-Results and Discussions

Results of the measurements of electric field versus distance in meters from the tower of base station Asia cell 1 in Kirkuk city are shown in table (1) and figures (5,6,7 and 8). This figure shows that Smx increases from about 60 µW/m2 at the base of the tower to about 450 µW/m2 at a distance of about 150m from the tower and a height 2 m above the ground. It is shown that the power is direction-dependent relative to the base station antennas. The variations of measurements of average power density Sav and maximum power Smx with (2m) height above ground level at a difference distances d from the base station of Asia cell towers . These measurements shows the RF field intensity at the ground directly below the antenna is low but its intensity increases slightly as one move away from the base station and then decreases at greater distances from the antenna. Because of the narrow vertical spread of the beam.

From the measurements of the two towers Asia cell 1 and Asia cell 2 (which has height 50m) ,the maximum power density are (0.48mW/m2) , (0.88mW/m2) respectively . While the measurement of towers which has small height like Asia cell 3 and Asia cell 4 (which has height 35m) and the maximum power density are (1.8-3)m W/m2.That mean the more height of tower give less risk to the near human public . All the measurements remain didn't exceed standard for general public exposure .The second way of measurements with constant distance of 150 meters and different levels from 2-15 meters above grounds shown from table (2), the strength of power density increases with increasing the height. We were get the measurements in different heights by climbing the adjacent hills for each height (5, 8, 10, 12, 15) m and we had the high entreasured of 3mW/m2 at a of height (12m).Then the results of measurements are compared with the RF radiation exposure safety standards. Generally, this measured maximum power density is far below the maximum permissible exposure limits of the standards and guidelines for public exposure [9].From it is clear that the Base Station Asia cell (1) and Asia cell (2) are in the inner city area and is closer to downtown but with some low-height and high-density buildings and some fairly open areas. The other two base stations Asia cell (3) and Asia cell (4) are located in an areas where adjacent to the hills which are relatively higher.

The transmitting antenna of base Station Asia cell(4) is installed on the rooftop of a double level house .The measurements in this area is higher because of the low height of towers and the effect of the reflections of radiation from hills .

Table (1):Power density Measurement for a chosen Asia cell base station in Kirkuk city at a height of (2)m above ground.

Cell No.	Height of Tower(m)	Power density for transmitted power (Pt) in $\mu W/m^2$ for each following distance at height of 2 m above ground							
		0 m		٥٠ m		100 m		150 m	
		Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.
cell 1	٤7	0	0	143	174	552	٥٦٠	770	٨٠٠
cell 2	٣٥	٠	٠	75	٨٠	600	٦٥٠	220	240
cell 3	٣٥	٠	٠	80	150	220	٢٤٠	550	٦٠٠
Cell4	٢٥	٠	٠	75	١٠٠	130	١٥٠	450	٥٠٠

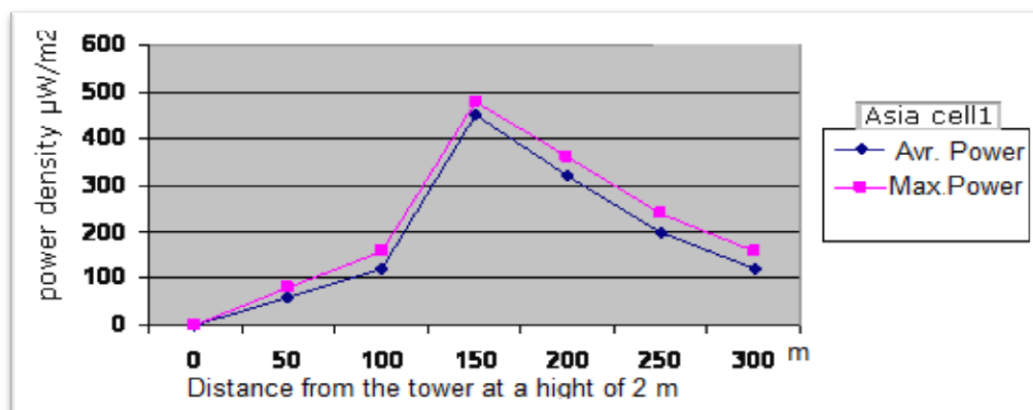**Fig. (5):Shows the variation of *Sav* and *Smx*($\mu W/m^2$) with height 2m above ground and at a different distances from the base of tower (1).**

Figure (6) shows that the power density increases with increasing of distance from the tower; from zero to about 180 $\mu W/m^2$ at a distance of 50 m. Then the power density starts fluctuating around 600 $\mu W/m^2$ as the distance increase from (150) to(200) m. The fluctuation maybe attributed to the effect of multipath

propagation beams from the transmitting antenna on the tower to the receiving probe. After distance of 200m , *Smx* starts to decrease to reach the distance of 300 meters.
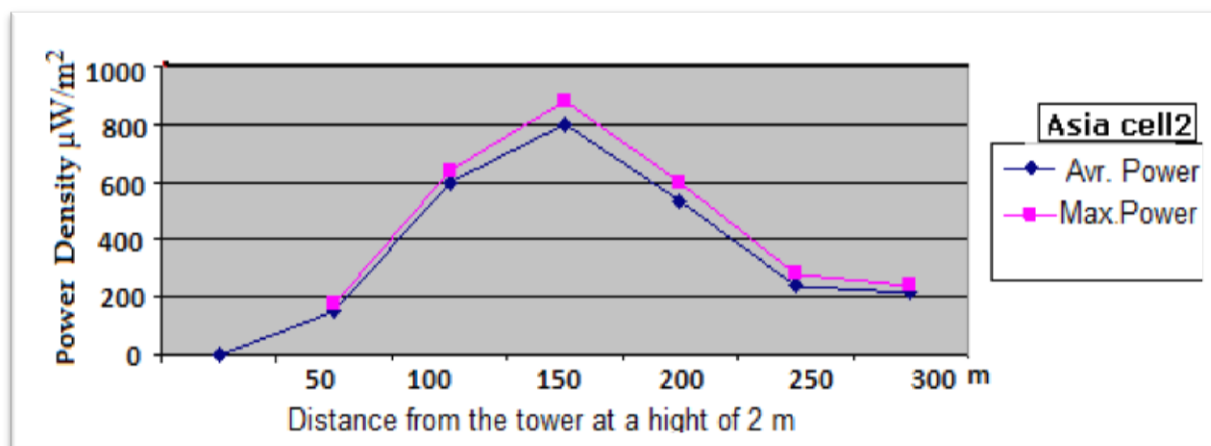

Fig (6): shows the variation of the power density *Sav*(μW/m^2) with distance *d (*dm) from the tower of base Station Asia cell (2).

Figure(7) shows that the Smx increases from about 0.06mW/m2 to about 0.08mW/m2 at a distance of about 150m from the tower and a height 2 m above the ground. Then, it starts to decrease until the distance increases beyond 200 m where Smx starts to fluctuate. Also the measurements did not exceed the allowed limited standard of 10mW/m2.
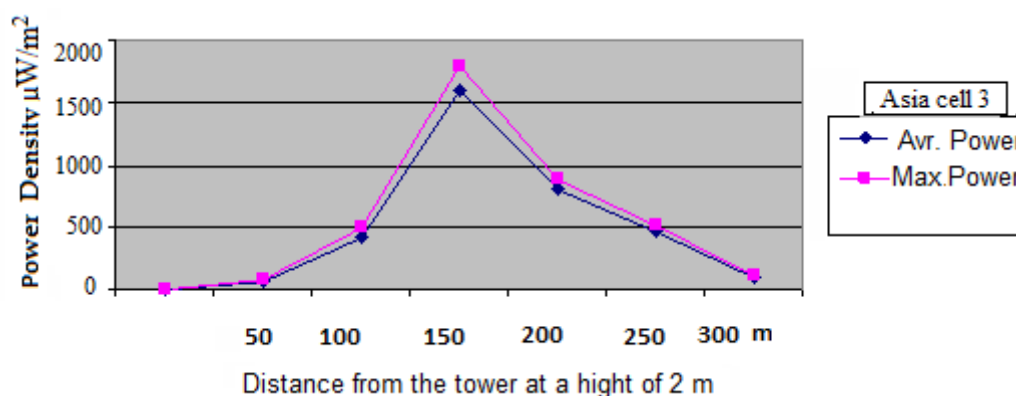

Fig.(7): shows the results of the maximum and average power density versus distance *d* from the tower of base Station Asia cell (3).

The variation of max. and average power density versus the distance from the tower of base station is shown in figure (8). In this case, the antennas are installed on a height of 38 m.

Figure (8) shows that, the power density at the first measurement remains constant until reaching the distance of 100m .Then the EMF radiation start rapidly increasing until reaches the max. value of about (0.65mW/m2) at distance of (150m) .Then the power density start to decrease after a distance of (200-300m) . However, again the measurements are far below the

USSR standard of the power density which is evident in the figure. The increasing in measurements because of environment area of the tower place and also due to the effect of the presence hills and building on EMF radiation because of multiple reflections.
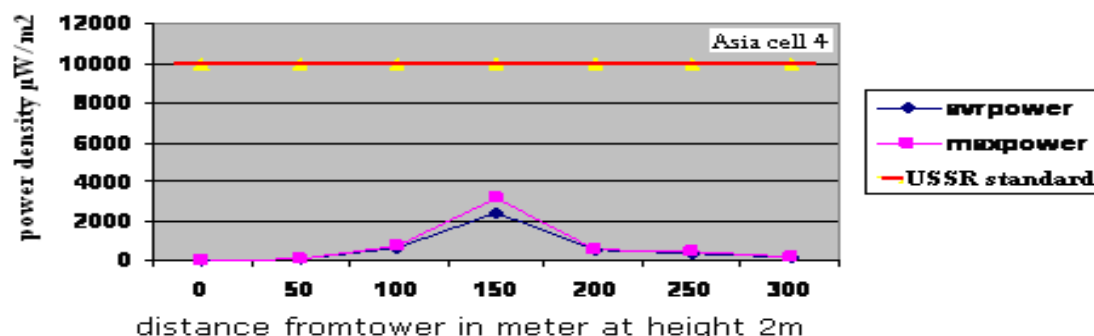

Fig.(8): Variation of maximum and average power density *Sav*(μW/m^2) with distance *d* (m) from of base Station Asia cell (4).

Fig. 9 and 10 shows that the maximum power density may reach 0.6mW/m2 at a height of 15 m above the ground; and 150 m distance from the base of the tower. The linear model can represent the increase of power density with height increase h (in meters) at d = 150 mass :Smx(μW/m2) = 0.73 h (m) - 0.47 and Sav(μW/m2) = 0.44 h (m)

5- Conclusions

The EMF radiation from the antennas of base stations of Asia cell cellular mobile radio company in Iraq operate at a frequency range of (903.4-915)MHz to(948.4-960)MHz with a Band width of 11.6MHz in second generation(GSM900) . The chosen case study base stations were located in different areas of a small place in Kirkuk city. The measurements shows that the max. power density at a distance of 150m at 2m height above the ground level was about 3mW/m^2. The variation of power density with height of (2-15m) above the ground level is linear. The result obtained is far below the maximum permissible exposure limits of the safety standards which ranges from 0.2-1.2 µW/cm2Generally, for the Asia cell base stations, it is found that the power densities are relatively low at the foot of base station tower ($d \leq 50$ m) is ≤ 0.06 m .W/ m^2, and increase with increasing of the distance from the tower. The maximum measured power density at150 m distance from the base stations, at 2 m height above the ground, is about (1.5mW/m$^{2)}$ but it increases with the height increasing to about (3mW/m$^{2)}$ at 12 m above the ground at a distance of(150 m)from the tower. so, this measured max. power density seem to be far below the maximum permissible exposure limits of the standards . It is about 0.65% of the FCC or the ANSI/IEEE or the Japanese standards, 0.87% of the CENELEC or IRPA or Finnish standards, and about 30% of the Russian standard.

6 - **References**

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