Comparison Study of the standards of different levels of power density of radio broadcasts issued by mobile base stations

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Received 20, December, 2012
Accepted 11, March, 2014

Abstract:

Because of the wide spread applications, wireless is the most important application of mobile communication and the wireless internet broad has emerged the need to determine the emission levels wireless transmission towers for these systems in order to determine their impact health users. In Iraq, the Ministry of Environment which is responsible for Establishment radio stations to issue instructions based on the instructions of the **international commission on Non-Ionizing Radiation protection (ICNIRP)**and we studied the comparison between the acceptable levels among several countries with approved level in the country was noted that the approved level High dramatically even higher than neighboring countries such as Kuwait and has noted that New Zealand has the least density capacity between countries world. The study recommended reducing the emission level to maintain the health of citizens and workers.

Key words: GSM, EMF, Power density ICINRP, Safe distance, SRM, base station.

Introduction:

Wireless communication is based on radio wave propagation, similar to other commonly known forms of radio communication such as broadcast radio and television. These systems operate in designated frequency bands within the electromagnetic spectrum and health effects have been extensively studied for over 50 years.

The value of power density radiated from cellular base station antennas in 900 and 1800 MHz, and its effect on the human body is a problem that has been concerning the society, specialist and research institutes for many years.

International organizations like ICNIRP and WHO have published limits for public and occupational exposure levels and many countries use these references for determining if the radiated level is acceptable or not in a given distance from the antenna.

The international scientific committee ICNIRP (International Commission on Non-Ionizing Radiation Protection) has set guidelines for human exposure to EMF [1]. The guidelines include a substantial safety margin to assure that no adverse health effects are experienced when EMF levels are within the established limits.

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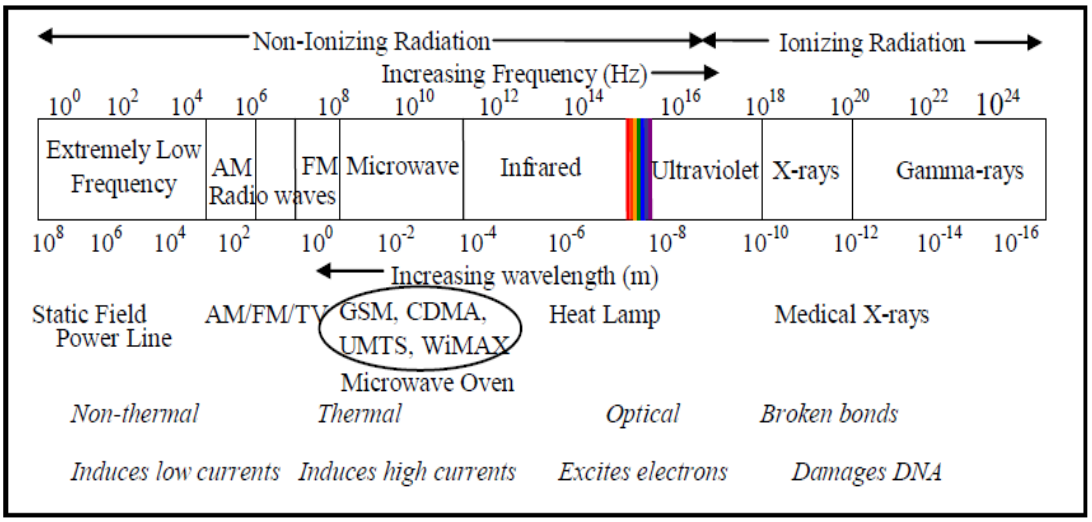


Fig. 1 EM spectrum indicating radiation zones

Analytical methods has been used beside the practical measurements results from the non-ionizing radiation team in the ministry of science and technology for calculating the power density of the radiated power,[2]
In this paper we present an analytic method for estimating the value of radiated power from cellular base station antennas in dual band 900 and 1800 MHZ, antennas.

What we intend is to compare between the slandered subjected by the ICNIRP and the newly adopted slandered by one the Kuwait estimate, is for the power density that comes from a source that is not a single point but a field radiated from a group of elements connected to each other in a predefined way for increasing the power level radiated in a given direction.

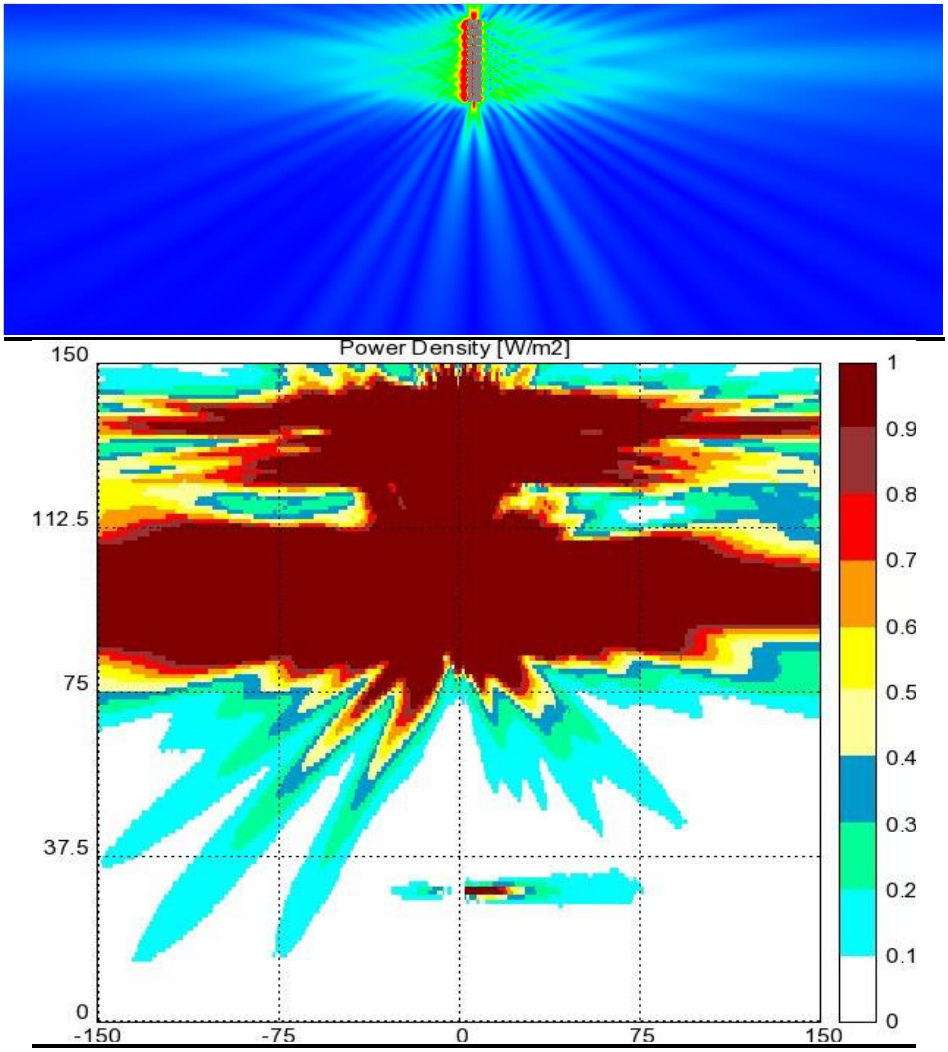
Antennas used in BTS are an array of dipole antennas, known as collinear antennas. For these antennas, which may be directional or Omni-directional, we may use the same theoretical way to estimate the radiation level in a certain distance from the antenna, for public or occupational exposure, comparing to the ICNIRP limits.

After a review of the literature, it became clear that the observation of the thermal effects alone, as was and is still practiced by ICNIRP and WHO is insufficient. The difficulty therein lay in finding studies which could provide evidence for an evaluation based on public health criteria.

The resulting evaluation value of 1 mW/m² (0.1 μW/cm²) applies to the total of the pulsed GSM signals emitted from mobile telecommunications base stations (GSM 900 MHz and GSM 1800 MHz).

The corresponding reference values of the ICNIRP/WHO from April 1998 are 4500 mW/m² for 900 MHz and 9000 mW/m² for 1800 MHz.

Since the applications we selected for calculating the power density of the radiated power from the antenna take place for different frequencies and different power radiated from antennas, we may give for each of them an idea for the range of safety distance from the antenna.as sshown in figure 2,



Fig(2): a) a dipole radiation pattern b)Power density radiated and measured from a base station antenna

Theoretical method for Estimation of power density

In autumn 1998 the compliance with the calculated values was agreed under civil law between the network operator and representatives of the local residents.

Estimation of power density radiated from a collinear antenna is given by equation (1):

$$S=\frac{Pt\ G}{4\pi R2}\text{--------}(1)$$

where:

- S (**w/m2**) is the power density in the distance R
- PT (**w**) is the power radiated by the antenna
- G is the Gain of the antenna
- R (**m**) is the distance from the antenna

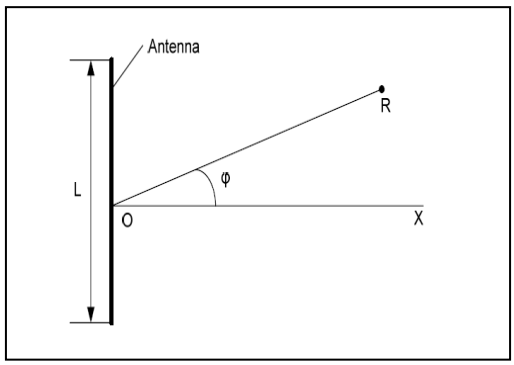


Fig (3): Collinear antenna and the horizontal plan (XOR) where we estimate the peak power density

Maximum values of the radiated power from antenna will be in the XOR plan (O is the center of the antenna and

XOR plan is perpendicular with the antenna considering the down tilt, so if the down tilt is zero the XOR plan is horizontal and if the down tilt is θ the XOR plan has an θ angle with the horizontal plan. So, the OX line is always the axis of the main lobe) and the maximum values in this plan are in OX direction (considering that antenna radiates in this direction).

The calculations showed that in almost all sites, due to the relatively height of the antennas over ground level of about 30-35 m, the type of antenna and the planned transmitting power (17 W with a gain of 18 dBi = 1073 EIRP), the evaluation value of 1 mW/m² was complied with.
The calculation was performed for selected properties in the area surrounding the base stations, for which the highest exposures were expected, for the roof height outdoors without attenuation through walls or roofing barriers.

It is seen from figure (4) and table (I) that the recommended exposure limit to the cell phone networks radiation, which is around 0.9 GHz, is 0.45 mW/cm2. This standard limit, although international, is not universally adopted. Table II shows the the measurement of the safe distance from the base station antenna wich has been adopted by the ICNIRP for the safety evolution

TABLE I
REFERENCE LEVEL SET BY ICNIRP

Type of exposure	Frequency range (f in MHz)	E-field strength (V/m)	H-field strength (A/m)	Power density (W/m^2)
General public	400-2000	$1.375f^{1/2}$	$0.0037f^{1/2}$	$f/200$
	2000-300000	61	0.16	10
Occupational	400-2000	$3f^{1/2}$	$0.008f^{1/2}$	$f/40$
	2000-300000	137	0.36	50

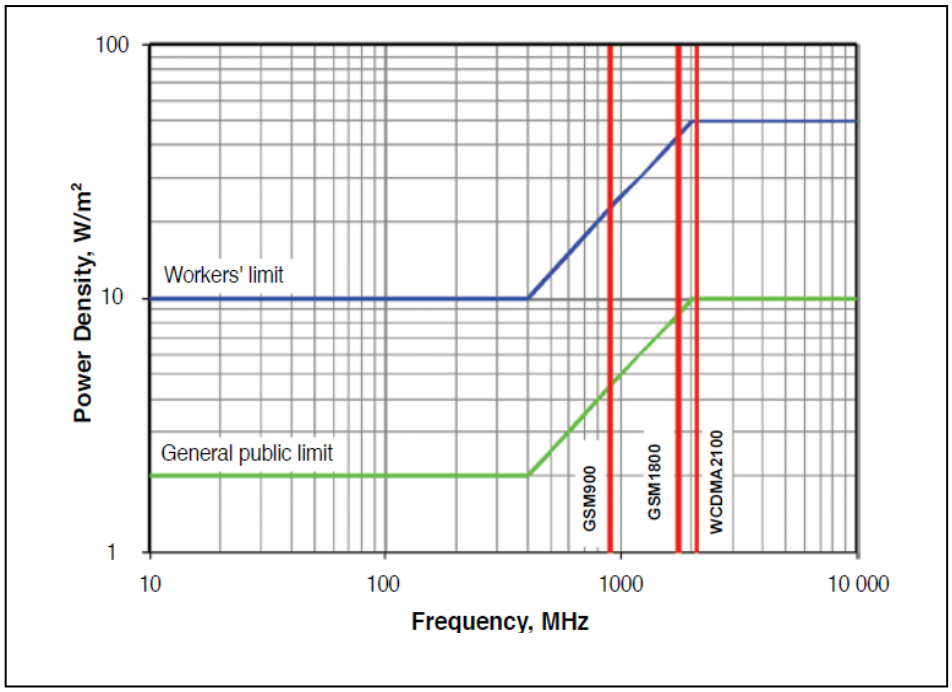
Fig(4): recommended exposure limit Power density limits

TABLE II
COMPLIANCE DISTANCES FROM BASE STATION ANTENNA

Type of exposure	Frequency range (f in MHz)	Compliance distance (meter)
General public	400-2000	$6.38(eirp/f)^{1/2} \approx 8.16(erp/f)^{1/2}$
	2000-300000	$0.143(eirp)^{1/2} \approx 0.184(erp)^{1/2}$
Occupational	400-2000	$2.92(eirp/f)^{1/2} \approx 3.74(erp/f)^{1/2}$
	2000-300000	$0.0638(eirp)^{1/2} \approx 0.0184(erp)^{1/2}$

Output from base stations

The base station antennas serving macro cells are either mounted on free-standing towers, typically 10–35 m high, on short towers on top of buildings, or attached to the side of buildings.
In a typical arrangement, each tower supports three antennas, each transmitting into a 120° sector.A large proportion of the power is focused into an approximately horizontal beam typically about6° wide in the vertical direction and the rest goes into a series of weak beams (called side lobes)either side of the main beam.
The main beam is tilted slightly downwards Figure (5) but does not reach ground level until the distance from the tower is at least 50 m (usually 50–200 m).The base station antennas transmit appreciably greater power than the phones. The limit to the power is formally set by the need to avoid RF interference and defined by a license issued by the Radio communications

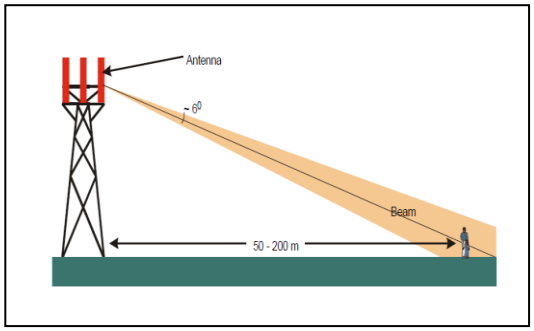


Agency. This does not directly limit the total power emitted but does so indirectly by fixing the maximum intensity that an antenna can transmit into the main beam.

This is done by defining the maximum "equivalent is otropically radiated power" (EIRP) that can be transmitted. The EIRP is the power that would have to be emitted equally in all directions to produce a particular intensity. In fact, as already noted, the antennas used are very far from isotropic, with most of the power being emitted into the main beam, and the ratio of the EIRP to

the total power output is called the gain of the antenna. For a 120□□sector antenna the gain is usually between about 40 and 60

Fig. (5): Identification of zones around a base station antenna



Fig(6): main beam from antenna mounted on a tower .the beam is in fact less well define than that shown here and there is a series of weak side lobes either side of it

Results and discussion:

In UK the limit is set to 0.4 mW/cm2, Australia 0.2 mW/cm2, Switzerland 0.0042 mW/cm2and Italy 0.01

mW/cm2 newzeland and Cuba has set there limits to 0.001.

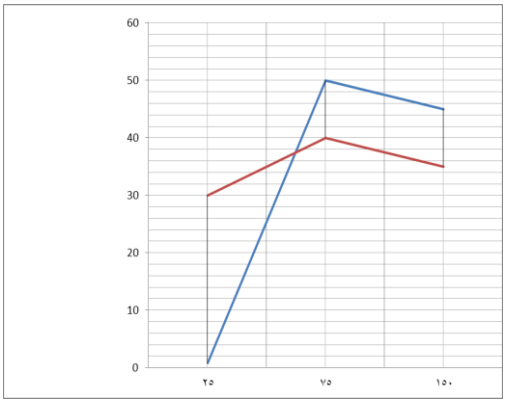
The Salzburg Resolution recommended an outdoor exposure level of less than 0.1 μW/cm2 in publicly accessible areas around a base station. This is 4500 times lower than the FCC guideline value for900MHz emissions.[6]

Using the above mentioned theoretical method, we have estimated the peak power density over the distance and the distance where Power Density is equal to the limit for GSM900, GSM1800 and WiFi applications.

In table 1, you will find the results from estimations for each application. The values of **(S)** are selected as random from values of the total sites where the estimations are done.

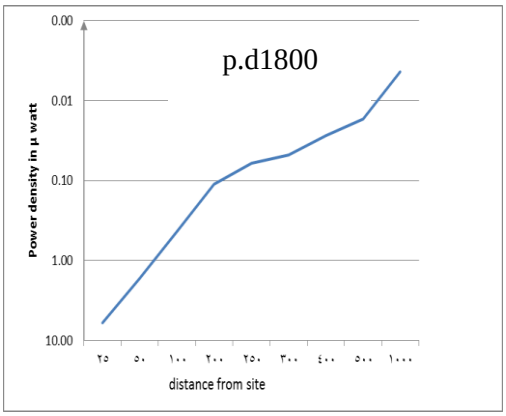
Table III: practical measured Values of (power density) for different application using the SRM3006 for GSM 900,1800

frequency	ICNIRP value for **occupational**	ICNIRP value for **public**	power density(s) (nw/cm^2) (distance (m))		
			D=25m	D=75m	D=150m
900 MHz	$4.5watt/m^2$	$22.5watt/m^2$	0.8	50	45
1800 MHz	$9\ watt/m^2$	$45\ watt/m^2$	30	40	30



Fig(7): Power density of GSM900 & GSM 1800 with respect to distance measured by the SRM 3006

Power density according to different distances for GSM 900



Fig(8):Theoretical power density with respect to distance

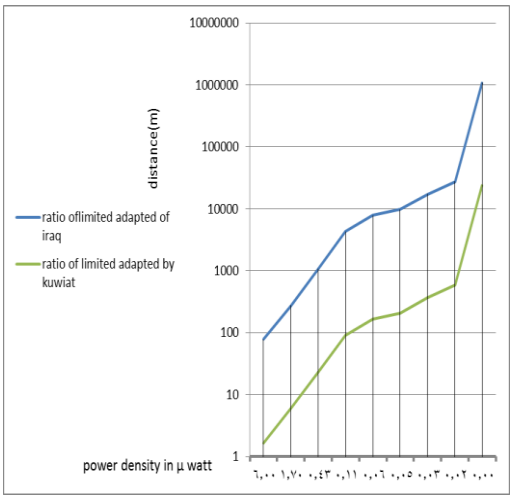


Fig (9): Comparisons between ICRNIP, Iraq and Kuwait adaptation

Conclusion and Recommendation

The standards adopted by Iraqi authorities are very high in comparison with some standards used by neighbor's countries.

The 0.4 standards for GSM 900 is no longer valid since it is too far from the real values measured on the ground , so we recommend to change the standards for safety

Many effects are recognized in the trends of effecting of the radiation from the cell phone base stations but because of the very high slandered

These effects has been neglected for that purpose a clear view must be submitted to the public for changing these standards which are being old (issued in 1998) and ites not following the advancing in technology and safety of people especially after the announcement of the WHO that the base station and cell phone are carcinogenic factor.

References:

[1]S. Miclaus, P. Bechet, Estimated and measured values of the radiofrequency radiation power densityaround cellular base station, 7th International Balkan Workshop on Applied Physics, 5 - 7 July 2006, Romania ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics 74 (4): 494 – 522, 1998

[2] ICNIRPGuidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics 74 (4): 494 – 522, 1998A.

[3] Faraone, R. Yew-SiowTay, K. H. Joyner, Q. Balzano, Estimation of the Average Power Density in the Vicinity of Cellular Base-Station Collinear Array Antennas, IEEE Trans. On Vehicular Technology, 49(3):984–996, May 2000

[4] Muhammed Abdelati The Islamic University of Gaza Electromagnetic Radiation From Mobile Phone Base Stations At Gaza Journal of The Islamic University of Gaza (Natural Sciences Series) 13(2):129-146 ,2005 ISSN 1726-6807,

[5]R. Cicchetti, A. Faraone, Estimation of the Peak Power Density in the Vicinity of Cellular and Radio Base Station Antennas, IEEE Trans. on Electromagnetic Compatibility, 46(2): 275 – 290,May 2004

[6]R. Cicchetti, A. Faraone, Q. Balzano, A Uniform Asymptotic Evaluation of the Field Radiated from Collinear Array Antennas, IEEE Trans. on Antennas and Propagation, 51(1): 89–102, Jan. 2003

دراسة مقارنة للمستويات القياسية لكثافة القدرة المختلفة الصادرة من بث محطات الهاتف النقال

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الخلاصة:

نتيجة للانتشار الواسع للتطبيقات اللاسلكية ومن أهمها تطبيق الاتصال المحمول وانتشار شبكة الانترنت اللاسلكية الواسعة فقد ظهرت الحاجة إلى تحديد مستويات الانبعاث اللاسلكي من أبراج البث الخاصة بهذه المنظومات وذلك لتحديد تأثيرها الصحي على المستخدمين وفي العراق قامت وزارة البيئة المسئولة عن ملف نصب المحطات اللاسلكية بإصدار تعليمات النصب استنادا إلى تعليمات الهيئة العالمية للحماية من الأشعة الغير مؤينة (ICNIRP) وقمنا بدراسة بالمقارنة بين المستويات المقبولة بين عدة دول مع المستوى المعتمد في البلد ولوحظ ان المستوى المعتمد عالي بشكل كبير حتى أعلى من دول مجاورة مثل الكويت وتمت ملاحظة إن نيوزلندا تتمتع بأوطأ كثافة قدرة بين دول العالم.أوصت الدراسة بتخفيض مستوى الانبعاث للحفاظ على صحة المواطنين والعاملين.