

# Calculations and Measurements of the Electromagnetic Radiation from Mobile Phone Base Stations in Tripoli

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**Abstract**— The aim from this work is to investigate the radiation power from mobile base stations by measuring the power density of selected base station on schools of local communication networks in Tripoli, The measurement of radiated power density from mobile phone base station antennas conducted on which mobile phone base stations installed; and then compare the measured data with Specific Absorption Rate (SAR) guidelines, to ensure power radiation level radiated by base station antennas over these schools is within the level of SAR.

**Keywords**— EM radiation, base station radiations, Specific Absorption Rate, standard levels, SAR.

## I. INTRODUCTION

The radiation of electromagnetic waves is very important in science and technology, but its effects on health and environment are very important subjects that had been studied by specialized persons as many people are concerned about the health effects of electromagnetic radiation. The main objective was the useful use of electromagnetic radiations, as well as, minimizing the possible effects which following the exposing to these radiations. Therefore, there is a great attention to study these possible effects, to know what is the best use of electromagnetic radiation without any health concerns[1]. Many studies has been conducted which are concerned about the possibility of adverse health effects arising from exposure to radiation from mobile base stations. Due to the expanding of mobile phone networks in Libya many mobile base station antennas has been installed on roof of many schools where students spend some times, and other places where people live for the whole day long. The question rise out of this is the radiation level of the power radiated by base stations over schools; are within the level of radiation permitted by the international health organization or not?. Therefore, it is necessary to measure the level of radiated power from these stations. Many measurements in many developed countries have been conducted to verify that the power radiated by base station antennas complies with international guidelines[1,2, 4].

## II. MAXIMUM EXPOSURE LIMITS

the maximum exposure levels for both RF and microwave exposed workers (including occupationally exposed persons) and other individuals (including the general public) are shown in Table I, Table II respectively . These levels shall not be exceeded. The basic limits which shall not be exceeded are given in terms of the currents in the body, either by induction or contact with energized metallic objects, or in terms of the rate at which RF electromagnetic energy is absorbed in the body. The latter is expressed, more precisely, as the SAR , i.e., the rate of RF energy absorption per unit mass in the body. SAR has unit watts per kilogram (W/kg). In practice, direct measurements of SAR are feasible only under laboratory conditions. Recommended maximum exposure levels in terms of unperturbed electric and magnetic field strength as well as power density are therefore given in addition to the SAR limits. These maximum field intensities are at levels which would generate a SAR or induced body current no greater than the basic limit [3.4, 6, 8].

TABLE I  
 EXPOSURE LIMITS FOR RF AND MICROWAVE EXPOSED WORKERS

Frequency Range (MHZ)	Power Density(w/m <sup>2</sup> )	Averaging Time (min)
0.003-1		6
1-10		6
10-30		6
30-300	10	6
300-1500	f/30	6
1 500-15 000	50	6
15 000-150 000	50	616 000/f <sup>1.2</sup>
150 000-300 000	3.33 X10 <sup>-4</sup> f	616 000/f <sup>1.2</sup>

Frequency, f, is in MHz.

TABLE II  
 EXPOSURE LIMITS FOR RF AND MICROWAVE EXPOSED PERSONS  
 (INCLUDING THE GENERAL PUBLIC)

Frequency Range(MHZ)	Power Density( $w/m^2$ )	Averaging Time (min)
0.003-1		6
1-10		6
10-30		6
30-300	2	6
300-1 500	$f/150$	6
1 500-15 000	10	6
15 000-150 000	10	$616\ 000/f^{1.2}$
150 000-300 000	$6.67 \times 10^{-5}f$	$616\ 000/f^{1.2}$

Frequency, f, is in MHz.

### III. METHODOLOGY OF MEASUREMENTS

To assure the validity of the measurements in this work using the EM power density is carefully designed and controlled, the elements of this methodology include the following:

1. Measurements have been made at a number of different locations and positions in base stations.
2. Distances, that were required in the measurements, has been taken using laser meter.
3. Radio Frequency Electromagnetic Field (RF EMF) strength meter used to measure the radiation power density ( $w/m^2$ ).
4. To make sure that the results of measurements for distances and radiation power density are correct, they have been repeated at each point two times.

### IV. INSTRUMENTATION

To measure the radiation power density from base stations, RF EMF strength meter (This meter monitor high frequency radiation in the 50MHZ to 3.5GHZ frequency range, Non-directional measurement with triaxial measurement probe, measurement optimized for 900MHZ-1800MHZ-2.7GHZ), has been used [4].

### V. SITE SELECTION

Measurements were made at sites where people live, work, or has frequent access. The sites were selected which has the highest number of antennas on rooftop. People are rarely exposed to the main beam, because of close proximity to the mobile phone mast in question, or due to shielding by buildings. The base stations have been chosen according to:

1. Location.
2. Frequency.
3. Gain.
4. Power.
5. Company (Libyana-Almadar).

### VI. TECHNICAL DATA OF THE BASE STATIONS

The base station antennas that were installed by the two only mobile phone operators in Libya AL-Madar and Libyana companies, over the selected sites consist of sector dipoles antennas each cover an angle of 120°. Operators have provided us with the technical data of macrocellular base stations at the seven sites [5,7, 9,10].

### VII. MEASUREMENT RESULTS AND ASSESSMENT

The measurements of power density is carried out in the period between 10/01/2016 to 30/06/2016.

In these measurements, RF EMF Strength Meter is used to measure the radiation power density, to know the amount of radiation emitted by base stations and then compare the measured data with (SAR), to ensure the power radiation level radiated by base stations is within the SAR.

#### Note:

- SAR values depends on the base stations frequency as illustrated in TABLE I, TABLE II.
- All next calculations use Exposure Limits for RF and Microwave Exposed Persons (Including the General Public) TABEL II.

#### A. AL-MADAR Company.

TABEL III shows the power density level for six Base Stations, and it can be noted that power density levels are less than the SAR.

TABLE III  
POWER DENSITY LEVEL FOR SIX BASE STATIONS  
(AL-MADAR COMPANY)

Site address	Frequency (MHZ)	SAR ( $w/m^2$ )	Power density ( $w/m^2$ )
AL-shomok	875	5.83	4.7
Hyder alsaatti	900	6	5.2
Al-noflyen	925	6.16	5.9
Shohada AL-shat	1775	10	7.6
Om-Salma	1800	10	7.9
Jamela	1825	10	8.4

#### B. LIBYANA Company.

TABEL IV shows the power density level for six Base Stations, and it can be noted that power density levels are less than the SAR.

TABLE IV  
POWER DENSITY LEVEL FOR SIX BASE STATIONS

(LIBYANA COMPANY)

Site address	Frequency (MHZ)	SAR (w/m <sup>2</sup> )	Power density (w/m <sup>2</sup> )
<i>Masoud Ben-zedan</i>	875	5.83	5.1
<i>Eben-ALhitem</i>	900	6	5.7
<i>Salah Alden</i>	925	6.16	6.2
<i>Yahya Ben-yahya</i>	1775	10	7.1
<i>Al-salam</i>	1800	10	7.5
<i>Al-manar</i>	1825	10	8.1

### VIII. CONCLUSION

The organizations of concern should pay attention to radiation levels for having a direct effect on the human health and Formation of special working teams concerned with measuring the radiation levels emitted by radio jamming devices and withdrawing those of higher radiation, It can be noted from conducted measurements and from all results that all values obtained of power densities was less than the SAR.

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