

## RF radiation from mobile phone towers and their effects on human body

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In the present paper, power density of RF radiation have been measured in close proximity (less than 50 m) to mobile base station Global System for Mobile Communications 900 (GSM 900) at the selected locality in Aizawl (23°44'53.5"N, 92°43'29.4"E), Mizoram, India. The mobile base station was erected in 2006. The study was carried out for the first time ever in the state in the year 2012 after six years of exposure to RF radiation with an aim to study different symptoms of health effects of RF radiation from mobile tower on nearby inhabitants. A survey was conducted on different health problems faced by the inhabitants living near the base station. Absolute power densities have been measured at some selected houses. Frequency spectrum was analysed at different sites. Different symptoms of RF exposure on human body are studied and the result is analysed. The measured power densities have been compared with standard limits given by various authorities, like International Commission on Non Ionizing Radiation Protection (ICNIRP), Bioinitiative 2012 and current National Standards. It has been observed that many inhabitants are having health complaints with different symptoms after the tower had been erected in 2006.

**Keywords:** RF radiation, Non-ionizing radiation, Power density, Mobile base stations, Health hazard

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### 1 Introduction

Cellular wireless telephones have become ubiquitous. Wireless technology is based on extensive networks of base stations that connect the users through radio frequency (RF) signals. Over the last decade, there has been a great deal of concern about possible health consequences caused by human exposure to RF in general and radiations from base stations in particular<sup>1-3</sup>. It is believed that mobile phones produce RF energy of non-ionizing radiation which is too low to heat the body's tissues, and hence is unlikely to have the same impact on human health as those produced by ionizing radiations such as X-rays<sup>4</sup>. Nonetheless, there is still a need to determine the level of health risks caused by RF radiations. Many studies address the impact of mobile phone radiations on human body, only a few consider the effect of human exposure to base stations although such an effect may be greater as more body parts can absorb RF energy<sup>2</sup>.

With the significant increase in mobile phone usage, possible health risks related to RF exposure have become the subject of considerable attention<sup>3,5</sup>. This includes effect from exposure to both cell phones

and base stations. The present paper aims to study different symptoms of health effects of RF radiation from mobile tower on nearby inhabitants. Health concerns can be divided into two main categories: short term and long term effects. The short term effects include brain electrical activity, cognitive function, sleep, heart rate and blood pressure<sup>6</sup>. However, the long term effects include tinnitus, headache, dizziness, fatigue, sensations of warmth, dysesthesia of the scalp, visual symptoms, memory loss and sleep disturbance, muscle problem and epidemiological effects including cancer and brain tumours<sup>7,8</sup>.

In May 2011, International Agency for Research on Cancer (IARC) has classified RF radiation as possibly carcinogenic to human (group 2B) based on increased risk for glioma, a malignant type of brain cancer associated with wireless phone use<sup>9</sup>.

### 2 Materials and Methods

A mobile base station was erected in 2006 in Aizawl (23°44'53.5"N, 92°43'29.4"E), Mizoram, India. The present study was carried out in 2012, which means that inhabitants are exposed to RF radiation for a period of six years.

**2.1 Questionnaire**

A questionnaire survey was conducted at the selected site in Aizawl to study health hazards and problems faced by the inhabitants living close to the base station (within 50 m). The questionnaire was similar to that developed for the study on mobile phone users by Santini *et al.*<sup>10</sup>. The survey was conducted on 38 persons (21 female, 17 male) of 15 different houses on 12 different symptoms. The symptoms include: fatigue, nausea, sleep disruption, discomfort, headache, memory loss, skin problem, hearing problem, dizziness, muscular pain, visual disruption, difficulty in concentration, etc. The level/degree of complaints for the studied symptoms was expressed by the participants using a scale: 0 = never, 1= sometimes, 2 = often, 3 = very often. Health hazards faced by the inhabitants were analysed and compared based on sex.

**2.2 Power density measurement**

Absolute power density measurement was carried out at different houses in close proximity to the base station. No mobile phone was turned on in the vicinity while taking readings. Background radiation was measured to be -50 dBm. At the same time, absolute power (in dBm) was measured at each site. The main purpose of the measurement was to ensure that RF field emission from each site did not exceed the safe public limits and to find whether there was correlation between the health complaints and the measured power densities. The power density  $P_d$  of the RF energy is given by<sup>11</sup>:

$$P_d = \frac{nP_tG}{4\pi D^2}$$

where,  $n$ , is number of transmitters;  $P_t$ , maximum power from each transmitter;  $G$ , antenna gain (decibel);  $D$ , distance of the site from the transmitter. However, power density measurement was done with the instrument HF-60105V4, manufactured by Aaronia, Germany.

**2.3 Frequency spectrum**

Frequency spectrum of the radiation was analysed at different houses. The frequency peak for each measurement had been recorded. The same instrument HF-60105V4, manufactured by Aaronia, Germany was used to analyse frequency spectrum. The instrument is capable of measuring non-ionizing radiation for frequency in the range of 1 MHz - 9.4 GHz. In the selected site, other than RF radiation, the other electromagnetic signals present were of TV and radio, which lie outside the GSM 900 frequency range. Hence, it has been assumed that the peaks observed were of RF radiation from the tower only.

**3 Results and Discussion**

**3.1 Analysis of questionnaire**

The response of questionnaires from the inhabitants of 15 different houses close to the base station (within 50 m) is analysed and presented in Table 1. Scale number 2 and 3, i.e. health complaint reported often and very often are given more considerations. It is found that from different symptoms studied, females have more complaints than males. On scale 2 (often) out of 12 symptoms, females have more complaints on 10 symptoms than males, on scale 3 (very often), both the sexes have equal number of complaints. The complaints with more frequencies are fatigue, dizziness and muscle pain.

Table 1—Analysis of health symptoms of inhabitants living near the base station (within 50 m)

S No	Symptom	Occurrence, %							
		Never (0)		Sometimes (1)		Often (2)		Very often (3)	
		M	F	M	F	M	F	M	F
1.	Fatigue	41	33	47	29	6	29	6	9
2.	Nausea	67	57	22	19	5	14	6	10
3.	Sleep disruption	65	48	35	19	0	28	0	5
4.	Feeling of discomfort	63	33	16	43	10	14	10	11
5.	Headache	60	28	10	38	15	29	11	5
6.	Difficulty in concentration	35	38	35	43	15	9	15	10
7.	Memory loss	33	34	33	38	17	14	17	14
8.	Skin problem	47	33	29	43	12	14	12	10
9.	Visual disruption	45	52	33	24	11	19	11	5
10.	Hearing problem	63	67	16	14	10	19	11	0
11.	Dizziness	32	29	47	29	10	29	11	13
12.	Muscle pain	38	35	35	14	15	29	12	22

Table 2—Measured values of Power density at different houses (all the houses are of RCC type)

S No	House No	Distance from the tower, m	Exact site of measurement	Power density, mW m <sup>-2</sup>	Power, dBm	% wrt ICNIRP	% wrt Indian Standard	% wrt Bioinitiative Report 2012	Main complaints of inhabitants of the house
1	C-52	25	Bed Room-1	<b>20.6</b>	-5	0.438	4.444	4120	Throat cancer, Fatigue, Muscle pain, Dizziness
			Bed Room-2	<b>31.7</b>	-4	0.674	7.044	6340	
			Bed Room-3	<b>109</b>	-1	2.319	24.22	21800	
2	C-54	27	Bed Room-1	1.6	-19	0.034	0.355	320	Consecutive miscarriage, Muscle pain, Nausea, Fatigue
			Kitchen	1.4	-19	0.029	0.311	280	
3	C-55	29	Living Room	2.2	-18	0.046	0.489	440	Fatigue, Muscle pain
			Kitchen	1.3	-20	0.027	0.289	260	
4	C-55/1	30	Bed Room	1.5	-19	0.032	0.333	300	Breast cancer, Fatigue
			Balcony	<b>10.7</b>	-11	0.227	2.378	2140	
5	C-46	31	Living Room	1.6	-19	0.034	0.355	320	Breast cancer, Fatigue
			Balcony	<b>6.6</b>	-13	0.140	1.467	1320	
6	C-45	39	Living Room	1.2	-20	0.025	0.267	240	Muscle pain
			Balcony	1.2	-20	0.025	0.267	240	
7	C-54/1	42	Balcony	1.2	-20	0.025	0.267	240	Leukemia, Sleep disruption

**3.2 Power density measurement**

Absolute power density of the RF radiation from the selected tower was measured at different selected houses. The measured values of power densities at different houses are given in Table 2 and value more than 5 mW m<sup>-2</sup> are shown in bold. The highest measured value is (109 mW m<sup>-2</sup>). All the measured values are higher than the safe limits recommended by Bioinitiative 2012 (0.5 mW m<sup>-2</sup>) (Ref. 12); Salzburg resolution 2000 (1 mW m<sup>-2</sup>) (Ref. 13); Science and Technology Options Assessment (STOA) 2001 (0.1 mW m<sup>-2</sup>) (Ref. 13). However, all the measured values were well below the current ICNIRP (4700 mW m<sup>-2</sup>) (Ref. 13) and the current Indian Standard (450 mW m<sup>-2</sup>) (Ref. 14)

It has been observed that the power density varies with the distance from the tower and is highest at the shortest distance. The power density also varies from place to place depending on the infrastructure obstructions, like buildings or internal obstructions, like furniture. It is, further, observed that power density is enormously high (109 mW m<sup>-2</sup>) in one of the rooms (BR-3) than other rooms at the same place (C-52). The reason for this may be because the room (BR-3) is on the first floor and facing directly (lying at the same level of height of transmitter) to the transmitter without any obstruction; whereas other rooms are obstructed by internal furniture, like almirah, wardrobe, concrete wall of the house from the tower. Also, the other rooms, being on the ground floor, receive only the secondary radiation from the transmitter. This seems to be true for high values of power density in Balcony of two other houses as these are on first floor.

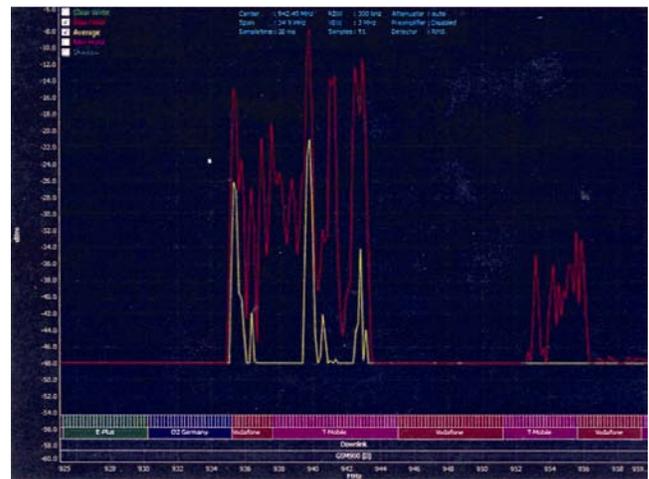


Fig. 1—Frequency spectrum of RF radiation (GSM 900) at a distance of 25 m (House No C-52) from the tower [Frequency peak observed around 940 MHz]

It is further observed from Table 2 that most of the inhabitants (at < 50 m distance from the tower) complain of fatigue and muscle pain. The inhabitants of the houses, where power density is above 5 mW m<sup>-2</sup>, are suffering from breast cancer or throat cancer. Further discussion with the inhabitant having consecutive miscarriages pointed out that her bed room is facing towards the transmitter but is obstructed partly by a building under construction.

**3.3 Analysis of Frequency spectrum**

Frequency spectrum of the mobile tower was determined at different places and shown in Figs 1 and 2. It has been observed that the peak frequency changes at different places over time. This change in peak may be due to time varying nature of the wave.

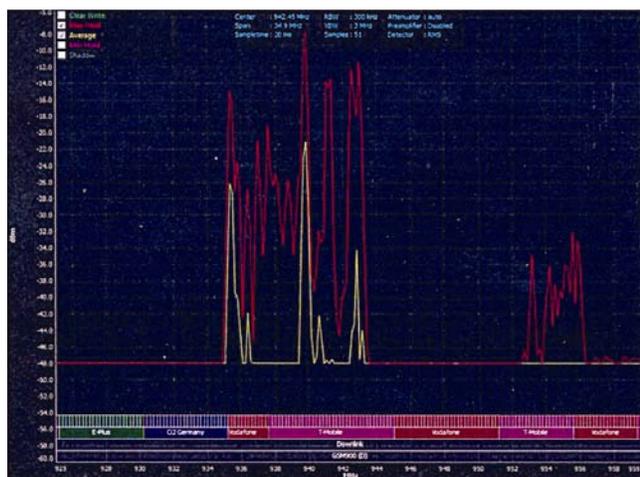


Fig. 2—Frequency spectrum of RF radiation (GSM 900) at a distance of 31 m (House No C-46) from the tower [Frequency peak observed around 936 MHz]

Many frequency peaks are observed at each site with peak frequencies at around 936 and 942 MHz. In the selected site, other than RF radiation, the other electromagnetic signals present were of TV and radio, which lie outside the GSM 900 frequency range. Hence, it has been assumed that the peaks observed were of RF radiation only.

#### 4 Conclusions

It has been observed that the measured values of power densities at all the sites are higher than that of the safety recommendation of Bioinitiative 2012<sup>12</sup>, Salzburg resolution 2000<sup>13</sup> and EU (STOA) 2001<sup>13</sup>, but well below the safety limit recommended by ICNIRP<sup>13</sup> and the Department of Telecommunications, Govt of India<sup>14</sup>. However, it has been observed that many inhabitants are having health complaints on different symptoms although the tower had been erected in 2006. It has been observed that females are having more health complaints than males. As a whole, the residents living within 50 metres from the tower are having more health complaints than those living outside 50 metres. It is concluded and suggested that mobile phone towers should not be located within 50 metres distance from the residential houses.

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