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Harmful Effects of Penetrated Electric Field of Mobile Phone Tower Radiations on Skin and Blood Tissues of Human Body

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Abstract:
The radiations from mobile phone tower were exposed to the human body tissues and were penetrated into it where the penetrated electric field was reduced exponentially with depth inside the human body. In this paper we find the harmful distances from the mobile phone tower electromagnetic waves into human skin and blood tissues are studied. These harmful effects are done at frequencies 800, 900, 1800 and 2450 MHz and radiated power of 20 Watts is taken for this study.
Key words: Skin and blood tissues, electromagnetic waves, mobile phone tower.

1 INTRODUCTION

Recently the use of mobile phone is wide spread in our society. Today more than 1.5 billion people are using mobile phones worldwide in which high frequency waves are used and this number is ever increasing. Mainly four frequencies 800, 900, 1800 and 2450 MHz of electromagnetic waves are used for mobile phone communication. These frequencies are known as mobile phone frequencies. The common communication technologies are global system for communications GSM 800, GSM 900, GSM 1800 and GSM 2450. In India most common mobile phone communication technologies are GSM 900 and GSM 1800. Towers have situated to transmit the signals at every corner of city and villages of our country. These towers are essential part of mobile phone communication network. It is necessary to establish connection between mobile phone communication and rest of the network. For transmitting signals numerous towers have been installed in most of the Asian countries e. g, 18000 base stations are operated in India. At 900 MHz frequency, the reference level for exposure of general population is 4.5 W/m^2[1]. Exposure range for general population due to GSM signals is typically between some few hundred mW/m^2. Due to the installation of numerous towers, most population is in direct contact with continuous radiation. This prolonged exposure of mobile phone radiation can increase thermal hazards in many folds. To regulate the balance between heat production and heat loss, the temperature regulation in human beings has evolved with the development of autonomic and behavioral mechanisms but the thermoregulatory mechanism of the human being compensates the effect and reduces the risk at some extent. There occurs a robust growth on a global scale in telecommunication industries. In mid of 1980s, there has been a significant increase in number of mobile phone users and installation of base stations throughout the world. In 2004, statistics from the Multimedia Commission (MC) and Department of Telecommunication (DOT) Delhi reveals that mobile phone radiation penetration rate is 55.90 persons per hundred population or 14.40 million subscribers [2]. Sometimes mobile phone called cellular phone or handset, form an integral part of modern telecommunications and social lifestyle. Only mobile phones are available in some parts of the world, they are the most reliable. In other countries mobile phones become very popular because they allow people to maintain continuous and constant communication without any obstructing their freedom of movement. The individual mobile phone operates by communicating with a fixed installation known as mobile phone base station or telecommunications structure. Since the mobile phone and their base station are two way radios as they produce radiofrequency (RF) radiations by means of communicating and expose the people near them.

About 4.25 lakh mobile phone towers are operated in India to meet the communication demand; these numbers are increasing day by day [3]. The frequency range of mobile phone towers are 869–894 MHz (CDMA), 935– 960 MHz (GSM 900) and 1805 – 1880 MHz (GSM 1800). Also 3G has been deployed in all the cities whose towers transmits frequency range of 2110–2170 MHz. Majority of these towers are mounted near the residential buildings and offices to provide good communication coverage to the users. The transmitting power of mobile phone tower is designed in such a way that it covers distance of few kilometers, so that that a mobile phone handset at that distance should be able to transmit and receive enough signal for proper communication . All of us are aware of the great role that wireless communications has played in bringing the telephony and communications to the Indian people. Mobile phones are now an integral part of modern telecommunications. In many countries, over half of the population is using mobile phone and the market is growing very rapidly. There is an estimation of 6.9 billion subscriptions globally at the end of 2014 [4].

A mobile phone is an important tool for a mankind. No doubt it provides great service in our life. As every goodness is attached with an evil, so the mobile phone. Microwave frequencies are electromagnetic waves, used in mobile phone technology are very high frequencies used as media to carry information from one end to other. Microwave frequencies are harmful if one remains exposed for long period. To grow economy and profit, companies are making sufficient mobile phone users, ultimately society is at risk. Mobile phone markets are becoming more efficient but reality is that a great risk and uncertainty remains with user.

The effects of mobile phone radiations on human health are the subject of recent study and interest, as the enormous increase in mobile phone usage throughout the world [5]. Mobile phone radiations are electromagnetic radiations in the microwave range. Digital wireless system, such as data communication networks, also produce similar radiations.

Health symptoms of mobile phone radiation have been investigated by many scientific studies. These scientific studies are occasionally reviewed by some scientific committees to see overall health risks. The European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published a recent assessment in 2007 to access overall risks [6].

The non ionizing electromagnetic waves affect the human health directly and indirectly. When high frequency radiation is absorbed by human body, then power is absorbed it. The most common complaints due to the power absorption are memory loss, behavior change, headache, sleep disruption, discomfort, depression, nausea, dizziness, irritability, appetite loss, numbness, muscle spasms, tingling, altered reflexes, subjects reported buzzing in the head, light headedness, palpitations of the heart, heat, cardiovascular problems, visual disorders, agitation, nervousness, respiratory problems, etc.

More severe reactions include paralysis, seizures, stroke and psychosis. Mobile phone radiation can damage hair cells whose age is between 18-25 years. These hair cells do not regenerate causing hearing problems in human being. All these changes are related to electrical activity of the human brain.

2 Calculations of Penetrated Electric Field

If mobile phone tower is consider as point source, the radiation is emitted around are as spherical wave front of radius r. Let E_0 be the incident electric field and P is power of radiation around the transmission tower, then radiating power per unit area is represented by.

$$\frac{P}{4\pi r^2} = \frac{1}{2}\varepsilon_0 E_0^2 c$$

$$E_0 = \left[\frac{P}{2\pi r^2 \varepsilon_0 c}\right]^{\frac{1}{2}} = \frac{7.746\sqrt{P}}{r}$$

……………. (1)

Where ε_0 is the permittivity of free space and *c* the velocity of radiation

If the mobile phone tower of power radiates 20W power, the electric field can be calculated by

$$E_0 = 34.641/r \quad \text{……..……….…...…..(2)}$$

Penetrated electric field inside the biological tissues can be calculated by the equation

$$E_z = E_o e^{(-z/\delta)} \quad \text{………………….…..(3)}$$

Where E_z is the field inside the depth z, E_0 is the magnitude of field inside the boundary and δ is skin depth. For biological materials skin depth is given by

$$\delta = \frac{1}{\omega q} \quad \text{…………… (4)}$$

Where σconductivity of biological material and ω is is angular frequency of radiation.

Standard values

At 2450 MHz , σ = 1.5919 W K^{-1} m^{-1} , skin depth δ = 28.808 mm,

At 1800 MHz , σ = 1.232 W K^{-1} m^{-1} , skin depth δ = 28.808 mm,

At 900 MHz , σ = 0.84465 W K^{-1} m^{-1} , of skin depth δ = 43.352 mm

At 800 MHz ,σ = 0.80864 W K^{-1} m^{-1} , skin depth δ = 45.59mm,

z= 0.1mm, 0.2mm, 0.3mm, 0.4mm and 0.5mm

The value of density ρ for blood=1060 kg m^{-3}, for skin=1070 kg m^{-3}

For frequency of EMW of 10 MHz–10 GHz its safe limit =0.4 W/kg [7].

Reference levels for general public exposure to time-varying electric fields with frequency (f) [7].

For frequency f=2450 MHz, E=68.059 V/m

For frequency f=1800 MHz, E=58.33 V/m

For frequency f=900 MHz, E=40.35 V/m

For frequency f=800 MHz, E=38.89 V/m

3 Results and discussion

For the calculation of penetrated electric field inside the body, the distance of mobile phone tower is taken 1 m to 50 cm from the body for the study of skin and blood tissues at frequencies 800, 900, 1800 and 2450 MHz. The computed penetrated electric field around the mobile phone tower at different frequency and at distance of 1 m to 50 m from the human body. The calculation has been made by equation 2.

Table 1 Penetrated (Ez) electric field for skin at frequency 800 MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.53816	34.46248	34.38697	34.31163	34.23645
5	6.9228	6.907632	6.892497	6.877395	6.862326	6.84729
10	3.4614	3.453816	3.446248	3.438697	3.431163	3.423645
15	2.3076	2.302544	2.297499	2.292465	2.287442	2.28243
20	1.7307	1.726908	1.723124	1.719349	1.715582	1.711823
25	1.38456	1.381526	1.378499	1.375479	1.372465	1.369458
30	1.1538	1.151272	1.148749	1.146232	1.143721	1.141215
35	0.9889	0.986733	0.984571	0.982414	0.980261	0.978114
40	0.8653	0.863404	0.861512	0.859625	0.857741	0.855862
45	0.7692	0.767515	0.765833	0.764155	0.762481	0.76081
50	0.6922	0.690683	0.68917	0.68766	0.686153	0.68465

Fig 1 represents variation of penetrated electric field inside the skin with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 800 MHz

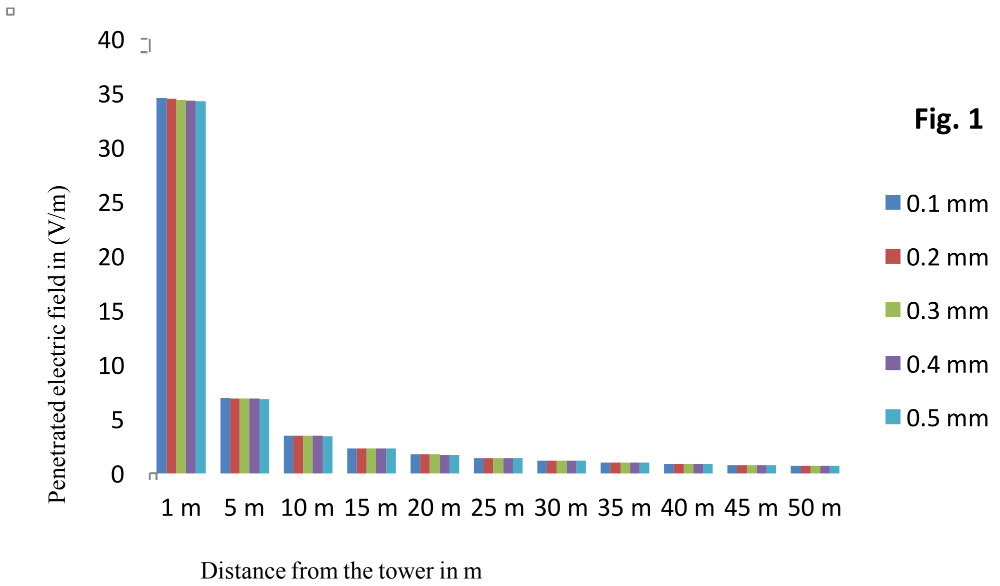


Table 2 Penetrated electric field for skin at frequency 900 MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.53425	34.45468	34.37529	34.29609	34.21707
5	6.9228	6.90685	6.890936	6.875059	6.859219	6.843415
10	3.4614	3.453425	3.445468	3.437529	3.429609	3.421707
15	2.3076	2.302283	2.296979	2.291686	2.286406	2.281138
20	1.7307	1.726712	1.722734	1.718765	1.714805	1.710854
25	1.38456	1.38137	1.378187	1.375012	1.371844	1.368683
30	1.1538	1.151142	1.148489	1.145843	1.143203	1.140569
35	0.9889	0.986622	0.984348	0.98208	0.979818	0.97756
40	0.8653	0.863306	0.861317	0.859333	0.857353	0.855377
45	0.7692	0.767428	0.76566	0.763895	0.762135	0.760379
50	0.6922	0.690605	0.689014	0.687426	0.685843	0.684262

Fig 2 represents variation of penetrated electric field inside the skin with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 900 MHz

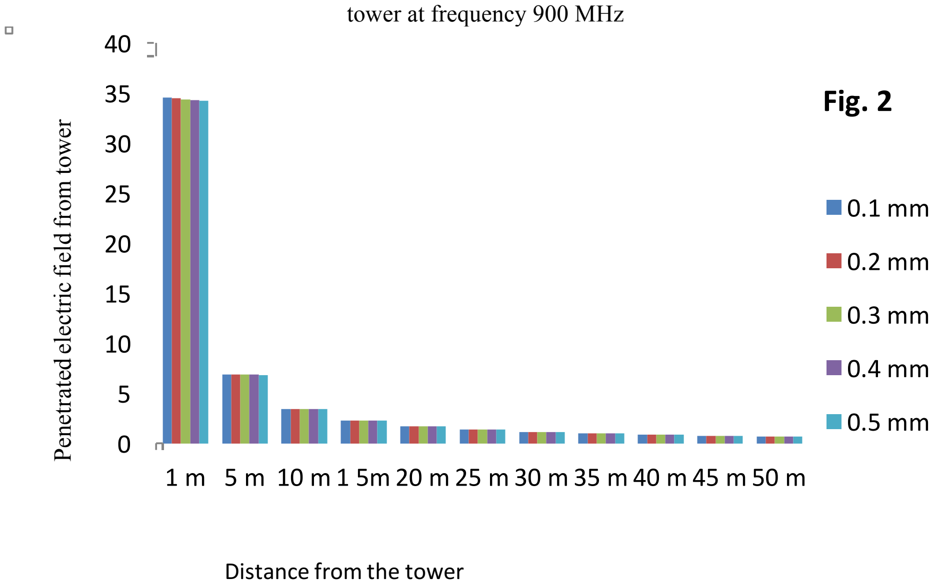


Table 3 Penetrated electric field for skin at frequency 1800MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.49405	34.37452	34.25541	34.1367	34.01841
5	6.9228	6.898811	6.874905	6.851082	6.827341	6.803683
10	3.4614	3.449405	3.437452	3.425541	3.41367	3.401841
15	2.3076	2.299604	2.291635	2.283694	2.27578	2.267894
20	1.7307	1.724703	1.718726	1.71277	1.706835	1.700921
25	1.38456	1.379762	1.374981	1.370216	1.365468	1.360737
30	1.1538	1.149802	1.145817	1.141847	1.13789	1.133947
35	0.9889	0.985473	0.982058	0.978655	0.975264	0.971884
40	0.8653	0.862302	0.859313	0.856336	0.853368	0.850411
45	0.7692	0.766535	0.763878	0.761231	0.758593	0.755965
50	0.6922	0.689801	0.687411	0.685029	0.682655	0.68029

Fig 3 represents variation of penetrated electric field inside the skin with depth of 0.1, 0.2, 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 1800 MHz .

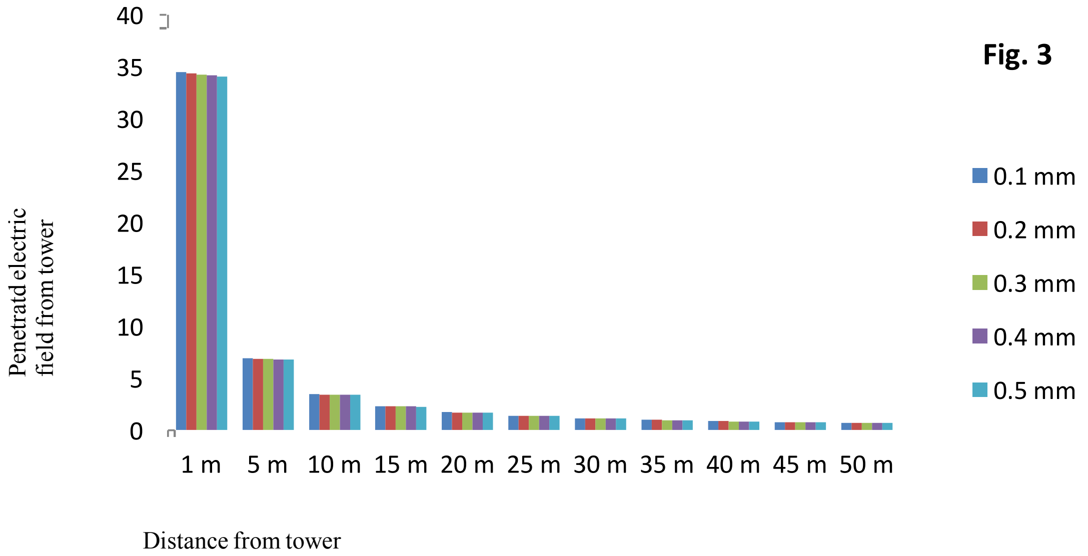


Table 4 Penetrated electric field for skin at frequency (f) =2450 MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.45723	34.30116	34.14581	33.99115	33.8372
5	6.9228	6.891445	6.860233	6.829162	6.798231	6.767441
10	3.4614	3.445723	3.430116	3.414581	3.399115	3.38372
15	2.3076	2.297148	2.286744	2.276387	2.266077	2.255814
20	1.7307	1.722861	1.715058	1.70729	1.699558	1.69186
25	1.38456	1.378289	1.372047	1.365832	1.359646	1.353488
30	1.1538	1.148574	1.143372	1.138194	1.133038	1.127907
35	0.9889	0.984421	0.979962	0.975524	0.971106	0.966707
40	0.8653	0.861381	0.85748	0.853596	0.84973	0.845881
45	0.7692	0.765716	0.762248	0.758796	0.755359	0.751938
50	0.6922	0.689065	0.685944	0.682837	0.679745	0.676666

Fig 4 represents variation of penetrated electric field inside the skin with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 2450 MHz

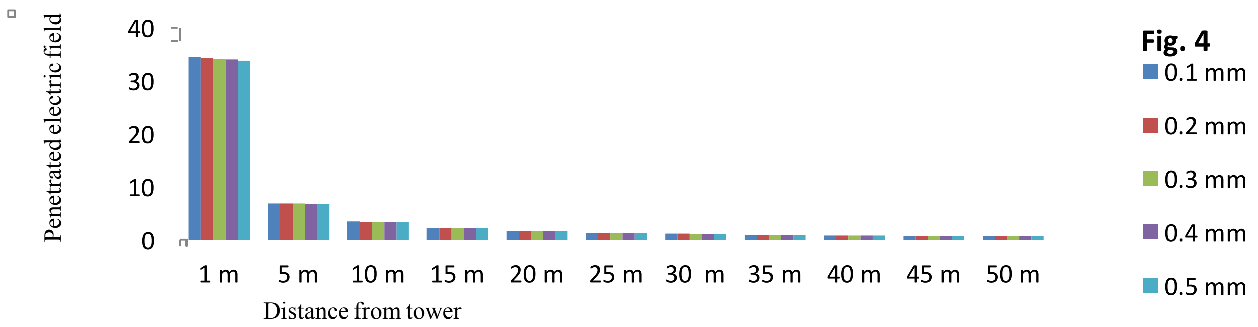


Table 5 Penetrated electric field for blood tissue at frequency (f)= 800MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.49415	34.37472	34.2557	34.1371	34.0189
5	6.9228	6.898831	6.874945	6.851141	6.82742	6.803781
10	3.4614	3.449415	3.437472	3.42557	3.41371	3.40189
15	2.3076	2.29961	2.291648	2.283714	2.275807	2.267927
20	1.7307	1.724708	1.718736	1.712785	1.706855	1.700945
25	1.38456	1.379766	1.374989	1.370228	1.365484	1.360756
30	1.1538	1.149805	1.145824	1.141857	1.137903	1.133963
35	0.9889	0.985476	0.982064	0.978664	0.975275	0.971898
40	0.8653	0.862304	0.859318	0.856343	0.853378	0.850423
45	0.7692	0.766537	0.763883	0.761238	0.758602	0.755976
50	0.6922	0.689803	0.687415	0.685035	0.682663	0.680299

Fig 5 represents variation of penetrated electric field inside the blood with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 800 MHz

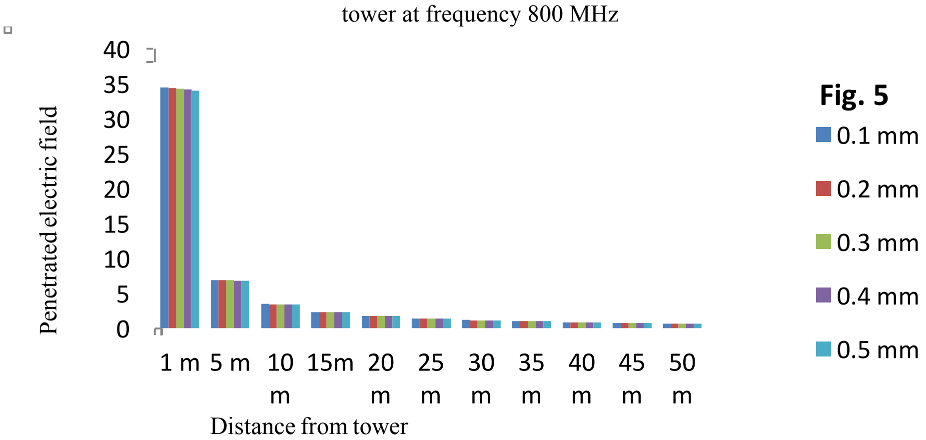


Table 6 Penetrated electric field for blood at frequency 900 MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.48984	34.36612	34.24285	34.12002	33.99763
5	6.9228	6.897968	6.873224	6.84857	6.824003	6.799525
10	3.4614	3.448984	3.436612	3.424285	3.412002	3.399763
15	2.3076	2.299323	2.291075	2.282857	2.274668	2.266508
20	1.7307	1.724492	1.718306	1.712142	1.706001	1.699881
25	1.38456	1.379594	1.374645	1.369714	1.364801	1.359905
30	1.1538	1.149661	1.145537	1.141428	1.137334	1.133254
35	0.9889	0.985353	0.981818	0.978296	0.974787	0.971291
40	0.8653	0.862196	0.859103	0.856022	0.852951	0.849892
45	0.7692	0.766441	0.763692	0.760952	0.758223	0.755503
50	0.6922	0.689717	0.687243	0.684778	0.682321	0.679874

Fig 6 represents variation of penetrated electric field inside the blood with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 900 MHz

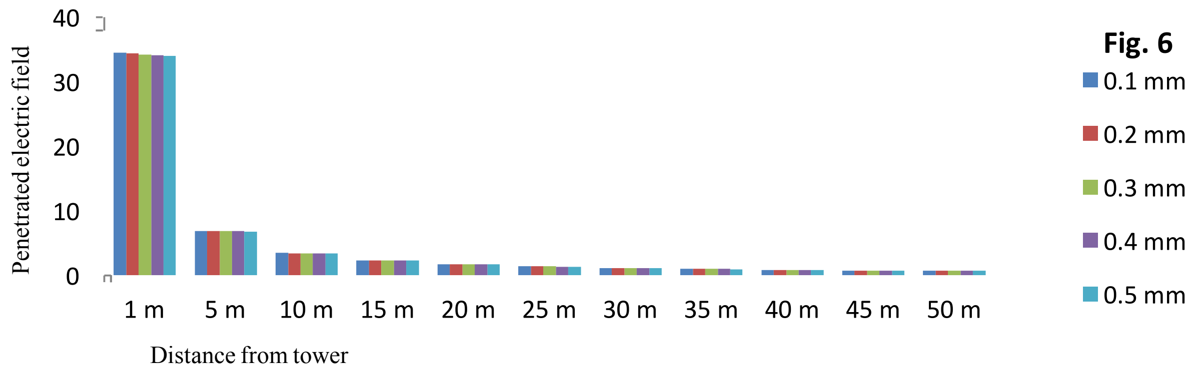


Table 7 Penetrated electric field for blood at frequency 1800 MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.44393	34.2747	34.1063	33.93873	33.77198
5	6.9228	6.888786	6.85494	6.82126	6.787745	6.754395
10	3.4614	3.444393	3.42747	3.41063	3.393873	3.377198
15	2.3076	2.296262	2.28498	2.273753	2.262582	2.251465
20	1.7307	1.722197	1.713735	1.705315	1.696936	1.688599
25	1.38456	1.377757	1.370988	1.364252	1.357549	1.350879
30	1.1538	1.148131	1.14249	1.136877	1.131291	1.125733
35	0.9889	0.984041	0.979206	0.974395	0.969608	0.964844
40	0.8653	0.861049	0.856818	0.852608	0.848419	0.844251
45	0.7692	0.765421	0.76166	0.757918	0.754194	0.750488
50	0.6922	0.688799	0.685415	0.682047	0.678696	0.675361

Fig 7 represents variation of penetrated electric field inside the blood with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 1800 MHz

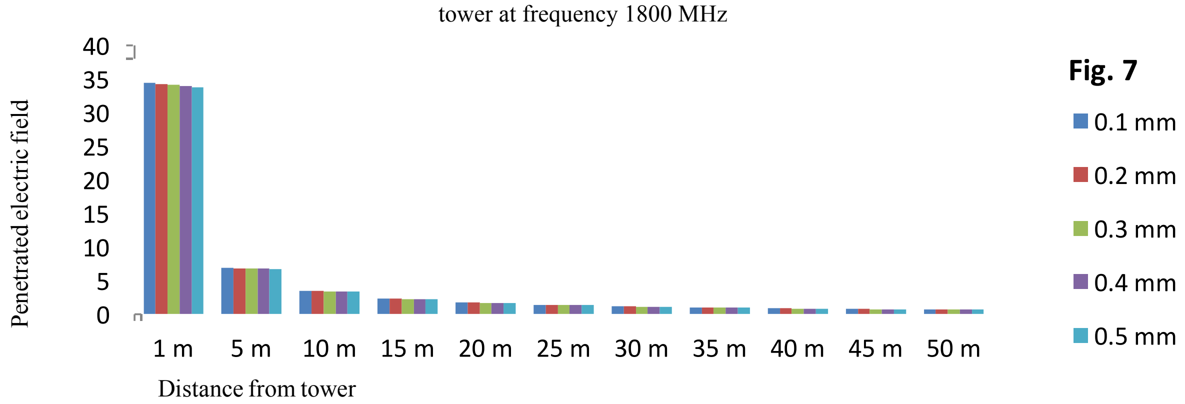
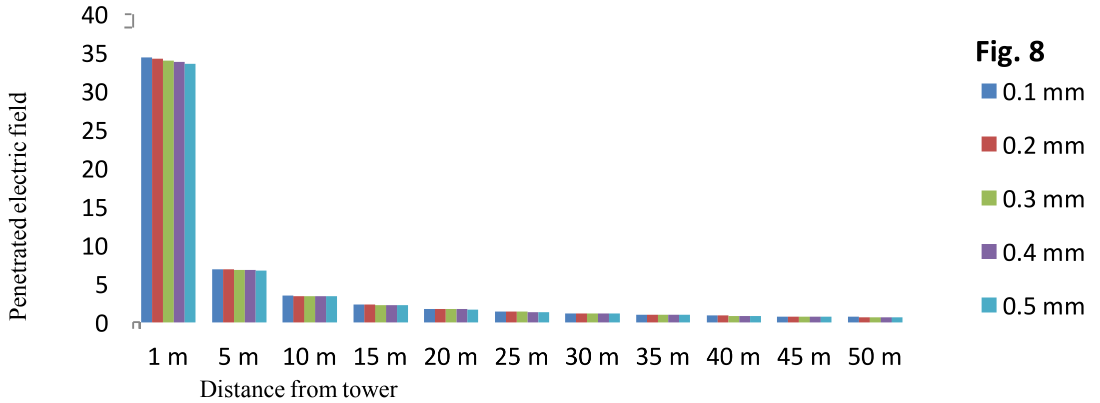


Table 8 Penetrated electric field for blood at frequency 2450 MHz

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.39996	34.18725	33.97585	33.76576	33.55697
5	6.9228	6.879993	6.83745	6.795171	6.753153	6.711395
10	3.4614	3.439996	3.418725	3.397585	3.376576	3.355697
15	2.3076	2.293331	2.27915	2.265057	2.251051	2.237132
20	1.7307	1.719998	1.709363	1.698793	1.688288	1.677849
25	1.38456	1.375999	1.36749	1.359034	1.350631	1.342279
30	1.1538	1.146665	1.139575	1.132528	1.125525	1.118566
35	0.9889	0.982785	0.976708	0.970669	0.964666	0.958701
40	0.8653	0.859949	0.854632	0.849347	0.844095	0.838876
45	0.7692	0.764444	0.759717	0.755019	0.75035	0.745711
50	0.6922	0.68792	0.683666	0.679439	0.675237	0.671062

Fig 8 represents variation of penetrated electric field inside the blood with depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from mobile phone tower at frequency 2450 MHz



4 Conclusion

The penetrated electric field inside the body of human beings due to the radiation of mobile phone is calculated. These penetrated electric fields are compared with the international standard safety limits of ICNRP, WHO, NRPB etc. Generally mobile phone tower radiates power in the range of 20 watts to 60 watts and mobile phone handset radiates 2 watts (peak value). For the calculation of penetrated electric field the power of the mobile phone tower, the power is taken 20 watts. The calculation has been made around the mobile phone hand set from 1 m to 50 m is given in table 1. Tables from 2 to 9 represent penetrated electric field (V/m) at 0.1mm to 0.5mm depth inside the skin and blood due to the electromagnetic wave of frequencies 800, 900, 1800, 2450 MHz from 1 m to 50 m distance from the mobile phone tower. The calculated electric field given in this table decreases as the distance from the tower increases. 98.00 % penetrated electric field increases at different depth inside the body when we move from 50 m to 1 m towards the tower. Figure 2 to 9 represent the variation of penetrated electric field inside selected tissues the skin and blood with depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from mobile phone tower at frequencies 800, 900, 1800, 2450 MHz.

The electromagnetic wave of frequencies 800 MHz, 900 MHz, 1800 MHz and 2450 MHz of mobile phone tower are not harmful for skin and blood, tissues of human body up to 1m distance

References

[1] Panda, "Audiologic disturbances in long-term mobile phone users," J Otolaryngol Head Neck Surg, *Chandigarh,* vol.1, no.9, pp.5-11. 2014.

[2] Annual report ,"Department of Telecommunication Ministry of Communication & Information Technology Government of India New Delhi", 2004-2005.

[3] Annual report, "Department of Telecommunication Ministry of Communication & Information Technology Government of India New Delhi",2010-2011.

[4] Annual report, "Department of Telecommunication Ministry of Communication & Information Technology Government of India New Delhi", 2013-2014.

[5] L. Stefan, Ahlbom, A. Hall and F. Maria, "Long-Term Mobile Phone Use and Brain Tumor Risk", *American Journal of Epidemiology*, vol. 161, no. 6pp.526–35, 2005.

[6] L. Anna, A. Anssi, R , Jani, Schoemaker, j. M. Christensen, C. Helle, F. Maria; J. Christoffer, K. Lars "Mobile phone use and risk of glioma in 5 North European countries". *International Journal of Cancer*, vol. 120, no.8, pp.1769–75, 2007.

[7] ICNIRP www. icnirp. Org / documents / emfgdl.pdf, 2010.