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Biological Effects of Cell Tower Radiation on Human Body

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***Abstract*- Continuous exposure to microwave radiations from Cell phone towers, TV and FM towers cause serious health problems over the years. Microwave radiation effects are classified as - thermal and non-thermal. The current exposure safety standards are mainly based on the thermal effects, which are inadequate. Measurements have been carried out at various places near the cell towers and it has been found that the radiation levels are very high. This paper reviews various epidemiological and experimental studies, which show significant biological effects far below the current standards. Also, the details of Radiation Shield are given, which consists of orthogonally polarized multiple broad band monopole antennas to absorb the undesired radiation.**

***Index Terms*- Biological Effects, Broadband Antennas, Cell Tower Radiation, Microwave Radiation, Radiation Shield**

I. INTRODUCTION

With increase in cell phone communication, number of cell towers getting installed is increasing every day. In India, currently there are nearly 3.75 lakh cell phone towers, and to meet the communication demand, the number will increase to 4.25 lakh towers by 2010. The cell tower transmits in the frequency range of 869 - 894 MHz (CDMA), 935 - 960 MHz (GSM900) and 1805 – 1880 MHz (GSM1800). Also, 3G has been deployed in a few cities, whose tower transmits in the frequency range of 2110 – 2170 MHz. Majority of these towers are mounted near the residential and office buildings to provide good mobile phone coverage to the users. A mobile phone tower and its transmitting power are designed such a way that it covers a distance of at least a few kilometers, implying that a mobile phone at that distance should be able to transmit and receive enough signal for proper communication. A building situated at 10's of meter from the tower will receive 10,000 times stronger signal than required for mobile communication. In cities like Mumbai, Delhi, Bangalore etc, millions of people reside within these high radiation zones.

Not all standards and guidelines throughout the world have recommended the same limits for exposure. For example, some published exposure limits in Russia and some eastern European countries have been generally more restrictive than existing or proposed recommendations for exposure developed in North America and other parts of Europe.

II. MEASURED RADIATED POWER

Radiation level measurements near several cell sites were carried out using broadband monopole antenna of gain = 2 dB and spectrum analyzer. The measurements were done at different locations in front of the transmitting towers at a distance varying from 50m to 150m, at different heights, inside and outside the buildings, and at various angles from the tower (within and off the main beam lobe). For a cell site consisting of transmitting towers of CDMA, GSM900 and GSM1800, signal strengths were measured for each frequency bands. At a distance of 50m, the measured power varied between -20 to -30 dBm inside the rooms but near the window. At a distance of 100 to 150 m and at different angles, the measured power varied between -30 to -50 dBm in the frequency band of 800, 900 and 1800 MHz. These measurements agree with the theoretical calculations.

Power Received P_r by an antenna at a distance R is given by:

$$P_r = \frac{P_t \times G_t \times Area}{4\pi R^2} = P_t \times G_t \times G_r \times \left(\frac{\lambda}{4\pi R}\right)^2$$

For a transmitter power of P_t = 20 W, transmitting antenna gain of G_t = 10 dB, receiving monopole antenna of gain G_t = 2 dB, the received power at R = 50 m is:

At 887 MHz, P_r = -10.2 dBm.
At 945 MHz, P_r = -10.8 dBm.
At 1872 MHz, P_r = -16.7 dBm

The concrete wall provides some attenuation and also these buildings were not directly in the direction of maximum radiation of transmitting antenna, and hence measured power is less than theoretically calculated power.

A mobile phone requires -80 to -100 dBm input power for its proper operation. In comparison with -80 dBm level, the measured power level at R = 50m is at least 50 to 60 dB higher, which translates to 100,000 to 1000,000 times stronger signal than a mobile phone requires. This is not surprising, as one cell tower typically covers a radius of a few kilometers, so at 50 m distance, signal will be very strong as transmitted power varies as $1/R^2$.

The power density at R = 50m is equal to 6.366 mW/m^2 = 6366 $\mu W/m^2$. According to the Soviet Union standard, the safe radiation limit is $0.1W/m^2 = 0.01mW/cm^2 = 100{,}000\mu W/m^2$ for 2 hours of exposure per day. This limit was established several decades back in Soviet Union, which has cold weather. For tropical countries, such as, India, which is hot and humid, the acceptable maximum radiated power density should be much lower. Also, the above limit is for a maximum exposure of 2 hours/day, whereas some of the people (especially older people, house wives, small children) living near the towers are exposed to this radiation 24 hours a day. In a more recent study in Germany, a threshold of 1,000 $\mu W/m^2$ was pointed out for non-thermal biological effects, and a further safety factor of 10 was recommended for pulsed radiation sources as cellular phone base stations for long-term exposure, reporting that the power densities should not exceed 100 $\mu W/m^2$ [1].

At many places, cell phone towers are mounted on the roof top of the residential /commercial buildings. Even though antenna radiates less power vertically down but the distance between the antenna and top floor is usually a few meters, so the radiation level in the top two floors remain very high.

III. BIOLOGICAL EFFECTS

When a human body is exposed to the electromagnetic radiation, it absorbs radiation, because human body contains 70% of liquid. It is similar to that of cooking in the microwave oven. The human height is much greater than the wavelength of the cell tower transmitting frequencies, so there will be multiple resonances in the body, which creates localized heating inside the body. This results in boils, drying up the fluids around eyes, brain, joints, heart, abdomen, etc

The current international standards (based on ICNIRP recommendations) are purely based on the thermal effects of radiation where as various epidemiological and experimental studies have shown to have significant biological effects far below these standards. Non-thermal effects of Radio frequency radiation accumulate over time and the risks are more pronounced after 8 to 10 years of exposure [2]. The effects are not observed in the initial years of exposure as the body has certain defense mechanisms and the pressure is on the stress proteins of the body, namely the heat shock proteins [3]. This means that the body recognizes these electromagnetic radiations as a potential harm. An additional concern is that if the stress goes on too long, there is a reduced response, and the cells are less protected against the damage. This is why prolonged or chronic exposures may be quite harmful, even at very low intensities.

Radiation from cell phone towers has been associated with greater increase in brain tumor [2]. This is due to the damage in the blood brain barrier and the cells in the brain which are

concerned with learning, memory and movement. Studies by Carl Blackman have shown that weak electromagnetic fields release calcium ions from cell membranes [4]. Leakage of calcium ions into the cytosol acts as a metabolic stimulant, which accelerates growth and healing, but it also promotes the growth of tumors. Loss of calcium ions causes leaks in the membranes of lysosomes releasing DNAase that causes DNA damage. Another possibility of DNA damage is via increased free radical formation inside cells [5, 6], which further causes cellular damage in the mitochondria. Irreversible infertility has been reported in mice [7] and continuous exposure has been associated with reduction in sperm viability and mobility by around 25 percent in men [8]. Children are more vulnerable to radio frequency radiation emissions as their skulls are thinner, their nervous system still developing and myelin sheath is yet not developed. A pregnant woman and the fetus both are vulnerable because of the fact that these RF radiations continuously react with the developing embryo and increasing cells. Microwave radiation damages the placental barrier, implying that pregnant woman should not use cell phone [9]. The RF Exposure can adversely affect the heart pace maker, implantable cardiovascular defibrillators and impulse generators [10]. These radiations may stop Pace Maker from delivering pulses in a regular way or may generate some kind of external controlling pulse putting the patient to death. Studies of people who are exposed in their work (occupational exposure), have shown to have elevated levels of health risks. Another study reveals that workers who are in the highest 10% category for EMF exposure are twice as likely to die of prostate cancer as those exposed at lower levels [11]. Exposure to electromagnetic fields has shown to be in connection with Alzheimer's disease, motor neuron disease and Parkinson's disease [12]. All these diseases are involved with the death of specific neurons and are classified as neurodegenerative diseases. Inhabitants living near mobile phone base stations are also at risk for developing neuropsychiatric problems as headache, memory loss, nausea, dizziness, tremors, muscle spasms, numbness, tingling, altered reflexes, muscle and joint paint, leg/foot pain, depression, and sleep disturbance [13]. More severe reactions include seizures, paralysis, psychosis and stroke. All point to the fact that the current exposure standards for microwaves are not safe for long-term exposure.

A study in Australia found that children living near TV and FM broadcast towers had more than twice the rate of leukemia as children living more than seven miles away from these towers [14]. In another study, TV signal exposed workers were observed to have increased Immunoglobulin G and A and decreased lymphocytes and T8 cells, resulting in a decrease in immune response [15].

In a German study, it was found that proportion of newly developed cancer cases was three times higher among those who had lived during the past ten years at a distance of up to 400m from the cellular transmitter site, compared to those living further away. Also, patients fell ill on average 8 years earlier. It is recommended that the safe limit of radiations for human beings is up to 50 $\mu W/m^2$ and the upper limit is 100 $\mu W/m^2$.

IV. RADIATION SHIELD

Since antennas are used for transmitting and receiving signals. A "Radiation Shield" consisting of multiple orthogonally polarized broadband monopole antennas, has been developed. The antennas are broadband planar circular monopole antennas and are designed to cover the frequency range from 800 to 4000 MHz. The antennas are terminated in matched load to absorb the harmful radiation to produce a safe radiation free environment. The details of these antennas and other measurements will be presented at the symposium.

V. CONCLUSIONS

In addition to the continuous radiation from cell towers, there is radiation from cell phones, wireless phones, computers, laptops, TV towers, FM towers, microwave ovens, etc. We are

exposed to all these radiations, which are additive in nature. Stricter radiation norms must be enforced by the policy makers across the globe.

This does not mean that we have to stop living near these towers. We all know that automobiles create air pollution – have we stopped using them? Instead solutions were found such as unleaded petrol, CNG driven vehicle, hybrid vehicles, etc. Similarly, the solution to avoid excess radiation is to use radiation shield, which absorbs 10% to 50% of radiation depending upon its placement and direction of source of radiation. Multiple units can absorb radiation up to 80% to 90%. Mobile companies should not be in the denial mode, and accept that radiation causes serious health problems, only then people all over the world will carry out research to come out with solutions.

REFERENCES

[1] Haumann Thomas, et al, " HF-Radiation levels of GSM cellular phone towers in residential areas",http://nocelltower.com/German%20RF%20Research%20Article.pdf

[2] Hardell Lennart et al, "Epidemiological evidence for an association between use of wireless phones and tumor diseases", Pathophysiology, PATPHY-595, 2009

[3] Leszczynski D et al, "Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer- and blood-brain barrier-related effects", Differentiation, 70(2-3), 120-9, 2002

[4] Blackman CF et al , "Effects of ELF fields on calcium-ion efflux from brain tissue in vitro", Radiation Research, 92, 510-520, 1982

[5] Lai, H, Singh, NP, "Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells", Bioelectromagnetics, 18, 446-454, 1997a

[6] Simkó M, "Cell type specific redox status is responsible for diverse electromagnetic field effects", Current Medicinal Chemistry, 14, 1141-1152, 2007.

[7] Magras IN, Xenos TD, "RF radiation-induced changes in the prenatal development of mice", Bioelectromagnetics, 18, 455-461, 1997

[8] Agarwal A et al, "Relationship between cell phone use and human fertility: an observational study", Oasis, The Online Abstract Submission System, 2006

[9] Allan H. Frey, Evolution and Results of Biological Research with Low-Intensity Nonionizing Radiation, Modern Bioelectricity, 785–837, 1988

[10] Altamura G et al, "Influence of digital and analogue cellular telephones on implanted pacemakers", European Heart Journal, 18(10), 1632-4161, 1997

[11] Charles L E et al, "Electromagnetic fields, polychlorinated biphenyls and prostate cancer mortality in electric utility Workers", American Journal of Epidemiology 157, 683-691, 2003

[12] World Health Organization, ELF Health Criteria Monograph. Neurodegenerative Disorders, p187, 2007

[13] Abdel-Rassoul G, et al, "Neurobehavioral effects among inhabitants around mobile phone base stations", Neurotoxicology, 28(2), 434-40, 2006

[14] Hocking, B., et al, "Cancer incidence and mortality and proximity to TV towers, Medical Journal of Australia", 165, 601-605, 1996

[15] Moszczynski, P, et al, "The effect of various occupational exposures to microwave radiation on the concentrations of immunoglobulins and T lymphocyte subsets", Wiad Lek, 52, 30-34, 1999