

Invited Talk 1: Electromagnetic Pollution
Veil Prakash Sandlas
Director General, Amity Institute of Space Science & Technology

Electromagnetic pollution levels are now reaching alarming proportions; highlighted by numerous studies conducted by scientists from all over the world, including many from India. It is very easy to understand water, air or noise pollution or contamination. However, electromagnetic (EM) pollution is very much esoteric; it is not easily seen, tasted, smelled or felt; but it can be more damaging, some thing like a 'silent killer'.

Radio is just 113 years old; impact of related radiations on the environment is now only visible. In May 1895, Sir J C Bose reported his legendary work at 50 GHz to the Asiatic Society of Bengal at Calcutta and demonstrated that 'electric (radio) waves possessed all the characteristic optical properties of light waves'. Subsequently, Marconi commercially exploited radio for long distance communications. Till recently, continuous exposure to radio waves was localized to areas near broadcasting stations, radars, radio communication terminals, etc. – the related radiations were not adversely affecting inhabited areas and general public. The situation has changed significantly during the last few years with the proliferation of cell phones, related base station towers and other EM radiation sources. Several house-hold devices such as microwave ovens, mixers, vacuum cleaners, hair dryers, inverters, cordless phones, WIL, WiFi, WiMAX, Bluetooth, etc. can be significant sources of EM radiation. Other EM radiation sources are Electrical Sub-Stations and Transmission Lines, Electric Traction, Broadband on power lines (BPL), etc.

Common biological effects of Electromagnetic Radiation (EMR) are headache and Migraines; eye irritations and Cataracts; loss of appetite; fatigue and exhaustion; giddiness or dizziness; vomiting sensation; loss of temper and fluctuation in BP; altered concentration and memory loss; anxiety and depression; sleep disruption or Insomnia; reduced REM sleep – altered EEG (brain wave), etc. Serious biological effects are brain tumors, Alzheimer's disease, Parkinson's disease, eye cancer, Epilepsy, Leukemia, stomach pain and digestive disorders; destabilization of the Lymphatic system; disturbances in the nervous system; interruption in the maintenance of hormones; brainwave disturbances in alpha, theta and delta wave signal patterns.

Scientific studies have demonstrated short term and medium term effects of EM radiation on animals and human beings; children, weak or sick persons, pregnant women and small animals are particularly vulnerable. Of course, debates are going on as to whether these effects are temporary or permanent. It is suspected that disappearance of butterflies and sparrows from Delhi and its gardens may be related to the high level of electromagnetic pollution. There is a strong feeling that even 'global warming' may be related to excessive radiation levels. The Indian Council of Medical Research and the World Health Organization have recommended precautionary approach in relation to the use and control of radiations and have also suggested adoption of internationally recommended

acceptance standards and rules and regulations to ensure safety of general public. Dr Abdul Kalam, as President of India, also stressed the urgent need to evolve reasonable standards and legislations for proper use of radio frequencies for telecom operations, including health related restrictions and interference related measures.

It may be noted that radio frequency energy is absorbed more efficiently at resonance. In adults, the resonance frequency is usually about 35 MHz, if the person is grounded, and about 70 MHz, if insulated from ground. Different human body parts may be resonant from 30 to 3000 MHz. Adult head is resonant at around 400 MHz, while a baby's smaller head resonates near 700 MHz. Therefore, children are more vulnerable from exposures at microwave frequencies. Absorption is also dependent upon polarization.

Recently, Govt. of India, Ministry of Communications and Information Technology, Department of Telecommunications (Telecommunication Engineering Centre) have approved the adoption of ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines regarding basic restrictions and reference levels for limiting EMF (Electromagnetic Field) exposure. ICNIRP reference level for exposure of general public is power density of 0.2-1.0 mW/cm² in primary frequencies of interest (10-2000 MHz). The corresponding basic limit for SAR (specific absorption rate – a measure of the rate of energy absorbed by an incremental mass contained in a volume element of dielectric material such as biological tissues) is 0.2 mW/g. It has also been decided to carry out mandatory testing and certification by designated Conformity Assessment Bodies (CABs) to ensure compliance of above limits. Based upon these guidelines, restrictions have been imposed (Jan 10, 08) by the Municipal Corporation of Delhi (MCD) on the installation of Cell Phone Towers in residential areas; consultations with RWA (Resident Welfare Association) made essential. Similar orders have been issued by the Kolkata Govt. (Apr 24, 08) to Municipal Bodies, Zila Parishads and Police, particularly restricting installations near schools, hospitals and narrow lanes. Related restrictions have also been imposed in Chandigarh and Goa; such actions should be extended to all other cities at the earliest. Radiation audit should be done on potential 'hot spots' to assess EMR levels.

Harmful effects of low frequency electromagnetic radiations from power transmission lines on biological systems, particularly human beings, had been of concern for quite some time. Using underground electrical power distribution cables in the cities, or the use of metal conduits for electrical wiring in the buildings, are not just architectural niceties or ethics; these are some of the standard engineering methods to reduce unwanted radiations from power lines. Overhead power distribution lines, particularly high voltage transmission lines near sub stations, are notorious for creating high radio noise, electrical noise and electromagnetic interference. Electric Traction and related power transmission system also creates high level of low frequency EM radiation. While underground metro systems have an inbuilt protection against EM radiation, overhead metro lines through highly populated areas are of concern; they may have to consider 3rd rail for power transmission for reducing EM pollution.

There is very good evidence that exposure to EM fields greater than 16 mG increases the risk by a factor of 5, that a woman may have a spontaneous abortion within the first 10 weeks of pregnancy. Experts recommend that future developments should adopt a safety limit of 2 mG. It should be noted that fields below a 220 kV power transmission line may be as high as 200 mG, a good 100 times more than recommended safe limit. It may be noted that 10-20 mG field is quite common in improperly wired homes.

Some recent studies and arguments emphasize that there no such thing as safe EM radiation level. Generally accepted safe levels vary from $1 \mu\text{W}/\text{m}^2$ for sleeping areas and $10 \mu\text{W}/\text{m}^2$ for other living and working areas to as much as $1000 \mu\text{W}/\text{m}^2$ (as against ICNIRP reference level of $2\text{W}/\text{m}^2$ – which is the upper limit for operations of wireless devices – recommending that significantly less, minimum possible, level should be used for practical applications). However, radiation levels even higher than $5000 \mu\text{W}/\text{m}^2$ have been monitored at busy market places, main road junctions, near hospitals, office complexes, etc. in Delhi, Gurgaon, Jaipur and Mumbai. In fact, a study by Punjab University (Centre for Environment and Vocational Studies, Dept of Botany and Dept of Zoology) of radiations from 199 cell phone towers in the 52 Sectors of Chandigarh, found radiation levels as high as $97,000 \mu\text{W}/\text{m}^2$ in Sector 46 (minimum being $560 \mu\text{W}/\text{m}^2$ in Sector 1).

There is a strong need to initiate public awareness campaign to educate and guide unsuspecting members of our society, so that they can save themselves and their children from the harmful effects of electromagnetic pollution. Adoption of ICNIRP guidelines is good first step; it is also essential that Govt. of India tightens control on unlawful radiations emanating from electrical and electronics devices and other instruments. There is an urgent need to incorporate appropriate amendments to the Indian Telegraph Act and other related laws so as to save the environment and make it suitable for healthy living.

Electromagnetic waves are nature's gift to mankind. It is essential that appropriate steps are taken to protect this natural resource; its equitable and safe utilization is very important for the efficient sharing of the spectrum and for ensuring health of all living things by using minimum possible radiation and controlling resultant pollution level.