

## Time-slot modulated electromagnetic fields of wireless communication systems: Is there a health risk for man?

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The safety guidelines of ICNIRP on bio-effects of low energy fields are based absorption and transformation into thermal effects. These guidelines are much higher than for acute reactions and long time exposure. It is pointed out that the guidelines for cordless telephone and mobile phone should correspond to long time exposure to low energetic electromagnetic fields.

**Keywords:** Acute reaction, Cordless telephone, Low energy electromagnetic fields, Long time exposure, Microwave syndrome, Mobile telephone

The worldwide discussion about bioeffects of low-energetic electromagnetic fields is very controversial. On one side there are safety guidelines postulated by the ICNIRP (International Commission for Non-ionizing Radiation Protection), but these consider only the physical rules of field energy absorption and transformation into thermal effects during exposure. By this well-known effect a temperature increase of 0.5 K (Kelvin) seems a tolerable value for man. These ICNIRP-guidelines are basis in the most European countries.

On the other hand the ICNIRP points out additionally, that the data for a maximal field immission are calculated only for acute effects that means during the time of exposure, limited for 6 min. Not in calculation are the effects by long-time-exposure in low-energetic fields and the fact that bioregulating processes have a delay between influence and detected bioeffect. This time span for a reaction of biosystems reaches from minutes to some hours or days.

For example, an intensive sunlight exposure can induce a melanom tumour. But because not all persons fall ill when exposed to the same sun energy, there is a real problem for the statistical significance of this bioeffect. Or, in other words, which exposure is safe? A corresponding situation is for long-time exposures nearby broadcasting transmitter stations.

The next point of criticism is the fact that for electromagnetic emitters, the characteristic of modulation, was not taken into consideration. At time we know that an amplitude-modulated or time-slot-modulated microwave has obviously another biorelevance than a continuous wave without any modulation (cw-signal).

The microwave effect itself is known for more than four decades. Especially in the Eastern countries the "Microwave Syndrome" was described as a radiofrequency sickness and characterized by debility syndrome (e.g. nausea, headaches, fatigue), cardiovascular and brain dysfunctions. Later on there were reports of a possible carcinogenic effects<sup>1-3</sup>.

The actual worldwide discussion about influences of low energetic microwaves on man is focused on mobile phone-equipments used by GSM-technique.

In 1996 it was demonstrate, that the periodic pulses of electromagnetic waves influence encephalic currents, so-called EEG (electroencephalogram). This phenomenon occurs at exposures by field intensities of less than 1 milliwatt/squaremeter (mW/m<sup>2</sup>). The corresponding safety value of ICNIRP is more than 1000 mW/m<sup>2</sup>. This influence on biosignals demonstrates that there are real effects on the system itself. Besides, there are data, strongly correlated with a long-time exposure for the GSM-signals of transmitters and cordless DECT-telephones in houses.

Repacholi *et al.*<sup>4</sup> reported a significant increase of tumours in mice exposed to electromagnetic fields for a longer time like those from mobile phone equipment. Persson *et al.*<sup>5</sup> and Salford *et al.*<sup>6</sup> found an increased permeability of the blood-brain-barrier

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(BBB) in rats, when exposed to wireless cellular communication systems. The consequence of these experiments is that there is an undesirable transport of harmful substances into brain. Additionally, in this paper the typical non-linear connection between field intensity and bioeffect was also described.

Preece *et al.*<sup>7</sup> reported effects on cognitive functions in man when exposed to simulated phone signals. In a review published by Moulder *et al.*<sup>8</sup> the possible evidence for a connection between cell phones and cancer was discussed. The efficacy of low energetic fields on biosystems is thoroughly more than calculated by results with other exposure data.

One of the scientific topics is the influence of low energetic GSM-fields on neural system of man. There are controversial reports regarding the use of mobile phone and electroencephalogram (EEG). Analysing the present studies the conflict is due to differences in exposure duration. All retrospective studies base on a normal daily use of mobile phones for relatively short time. There is no study regarding the situation nearby a transmitting station or DECT cordless phone in houses. Both systems emit, without interruption, over all the time low frequency modulated electromagnetic fields. But in these areas of continuous exposure there are hints of healthy impairments, mostly beginning with headaches, sleep disturbances difficulties in concentration hearing and visual disruptions, tinnitus, cardiovascular problems and others. More severe are alterations of red blood cells and reduced oxygen transport in peripheral vessels, especially in children.

In this connection the experiments by Pacini *et al.*<sup>10</sup> are important. The authors exposed human skin fibroblasts to GSM cellular phone frequency for about one hour and found alterations in cell morphology. Further, the expression of some mitogenic signal transduction genes and DNA synthesis were increased.

Recently, in Spain an increase in children's leukaemia, was observed when transmitters were operating on school buildings or in its area. The consequence was that the mobile phone towers in these regions were pulled down. Up to now this was the exception because the values of ICNIRP safety guidelines are the markers for telecommunication industry.

How to solve this problem?

By clinical data we know that sensitive persons have health disturbances by long time exposures of low frequency modulated electromagnetic fields of telecommunication equipments. The mode of

Table 1—Effect of electromagnetic fields of wireless communication on exposure

Emitter	ICNIRP-values mW/m <sup>2</sup>	Acute reaction* mW/m <sup>2</sup>	Long-time exposure** mW/m <sup>2</sup>
GSM 900	4,600	< 1	< 0,01
GSM 1800	9,500	< 1	< 0,01
DECT-phone	9,600	< 0,1	< 0,001

\*Exposure: 10 min, \*\*For habitants nearby transmitting stations

bioregulating influence is unknown and therefore we have to look for acceptable immission values.

In laboratory studies test persons were exposed in an absorbance chamber by time-slot modulated electromagnetic fields like those used by mobile phones. In about 70% of these experiments it was observed that after 10 min EEG-signals were altered, especially in the so-called Alpha-band (8-10 Hz). This may be only a phenomenon but obviously the nervous system of man reacts<sup>10</sup>. This acute reaction was induced by an immission of less than 1 mW/m<sup>2</sup> (Table 1). The recovery time after exposure was from minutes to some hours.

On the basis of these data the aim must be a reduction of immission values of some magnitudes. That means, to realize a distance of some hundred meters from transmitters, depending on the antenna characteristic. The safety guidelines of ICNIRP claim only maximal 10 meters. For DECT-telephones in houses we have calculated a distance of minimal 5 meters to the base-station because this system is operating all the time, independently of an actual call.

The actual controversial discussion about the bio-relevance of low energetic electromagnetic fields can only be solved by interdisciplinary scientific research. But at time there is the problem of sponsorship, because the extensive installation of wireless techniques is an immense economic factor.

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