THE BASIC LIMITS FOR RADIOFREQUENCY EMISSIONS

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Abstract: *Mobile telecommunication has boomed in recent years and has acquired an important place in society. Prompted by these developments, society is radically changing. People can, if they wish, be accessible everywhere and at all times (of course, within the capabilities of the telecommunication networks). The advent of technologies allowing for the high-speed transmission of large amounts of data means that it will soon be possible to exchange not only speech and brief messages but also video and other large data files. This will facilitate the use of mobile videophones and mobile access to the Internet. Despite their acknowledged benefits, all these technological developments nonetheless also cause many people concerns. In particular, one common matter of concern is whether increasing exposure to the electromagnetic fields generated during wireless communication could lead to health problems. An argument regularly put forward in this debate is that man's electromagnetic environment is rapidly changing, that the human body is not built for this and cannot adapt quickly enough. Consequently, such changes would have adverse implications for body functioning. It is therefore appropriate to determine whether there is any scientific evidence to support this supposition. From this reason, the conclusions regarding the health effects of exposure to electromagnetic fields must have a scientific base. It considers the existence of an effect, whether a biological effect or an effect on health, only to be scientifically demonstrated in the event of compliance with the some objective requirements.*

Keywords: radiofrequency, mobile phones, basic limits, EU recommendations.

1. Introduction

Mobile telecommunication has boomed in recent years and has acquired an important place in society. Prompted by these developments, society is radically changing. People can, if they wish, be accessible everywhere and at all times (of course, within the capabilities of the

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2. Basic limits

Various national and international organizations have made proposals for exposure limits. In 1997, the Health Council of the Netherlands issued the advisory report Radiofrequency electromagnetic fields (300 Hz-300 GHz), in which limits were proposed for the frequency range in question (HCN97). In 1998, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued guidelines for the 0 Hz-300 GHz frequency range which broadly match the recommendations of the Health Council of the Netherlands (ICN98). Only in the highest frequency range is there a difference. A description of the way in which the limits have been established can be found in the reports indicated. The Committee here gives a short summary of the most important principles.

In their recommendations, both the Health Council of the Netherlands and ICNIRP distinguish between so-called basic restrictions and reference levels (also called derived values). The basic restrictions are maximum values for variables directly relating to a health effect. In the frequency range above around 100 kHz, which covers radio frequencies and thus also the frequencies used for mobile telecommunication, the relevant effect is heat generation. If an organism is exposed to an electromagnetic field, some of the electromagnetic energy is absorbed by the body and converted into heat. Ina microwave oven, the same principle is used to heat food or liquids. Excessive heat generated in the body may, however, result in adverse health effects. On the basis of scientific data obtained from

laboratory animals and volunteers, it has been established that if the increase in body temperature does not exceed 1°C, this does not lead to health problems even in the case of long-term exposure.

The variable used to express absorbed energy per unit time is the specific absorption rate (SAR), expressed in watts per kg. The SAR is defined as the derivation, as a function of time, of the energy W absorbed by a mass *m* in a volume *V* of density ρ:

$$SAR = \frac{\mathrm{d}}{\mathrm{d}t}\frac{dW}{dm} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{dW}{\rho dV}\right), (W/Kg).$$

It is assumed in all the guidelines that, if the average SAR in the body does not exceed 4 W/kg, body temperature does not rise by more than 1°C. As a result of factors such as the extrapolation of experimental animal data to humans, and the existence of human subpopulations who, for various reasons, are more sensitive to heat gain than others (for example young children, frail elderly and sick people), safety margins have been built into the guidelines. A distinction is made between workers and the general population. The term 'workers' does, in this case, not pertain to everyone who works. It refers to healthy adults who, in the course of their professional duties, may be exposed to electromagnetic fields, who are familiar with the risks of such exposure and who know how they should handle these risks. A safety margin of a factor of 10 applies to them, *i.e.* they may be exposed to a maximum SAR of 0.4 W/kg. Everyone else belongs to the general population and is subject to a safety factor of 50. Consequently, the maximum permissible SAR for this group is 0.08 W/kg. These values pertain to total body exposure. When mobile phones are used only part of the body is exposed: the head, especially the side where the telephone is held, and the hand holding the telephone. With respect to partial body exposure both the Health Council of the Netherlands and ICNIRP deem higher SAR values acceptable.

For the general population a SAR of 2 W/kg has been proposed for the head and a value of 4 W/kg for the hand. The corresponding values for workers are a SAR of 10 W/kg for the head and 20 W/kg for the hand. In chapter 4 the Committee elaborates on this subject.

Owing to the differing electromagnetic properties of tissues in the body, local differences in temperature increase will occur. However, as a result of the removal of heat by blood circulation, these are partially nullified. Consequently, a thermal equilibrium will eventually be achieved, where the supply of heat through exposure to the electromagnetic field and

the removal of heat through blood circulation and heat transfer to the environment through radiation, convection and sweating are in balance. For this reason, the aforementioned SAR maxima are intended as an average over any 6-minute period. These are the basic restrictions that must be met at all times.

3. EU recommendations

When a mobile telephone is in use, the antenna of the device is near the user's body, generally near the head. Part of the emitted power is absorbed by the body. The latter is composed of different tissues with widely varying and frequency-dependent electromagnetic characteristics (Gab96, Pey01). The amount of energy that a body can extract from an electromagnetic field is highly dependent on the frequency of the field, the size and dimensions of the body and the tissues in the exposed parts of the body.

Absorption of electromagnetic energy leads to warming of body tissues. Owing to the differing electromagnetic characteristics of the tissues, local differences in temperature gain will arise which are in turn partly cancelled out by heat dissipation through blood circulation. Eventually, thermal equilibrium will be achieved. This means that the supply of heat through exposure to the electromagnetic field and the removal of heat through blood circulation and heat emission to the environment through radiation, convection and sweating are in balance with each other. Once exposure is stopped, body temperature will gradually return to the preexposure level. Calculations and experiments with volunteers show that, in resting individuals, it takes about an hour for the body to return to the starting temperature.

In case of exposure to pulsed fields, the maximum achievable temperature is roughly equal to the temperature that would be caused by exposure to a continuous field with the same average SAR.

Various guidelines and recommendations for exposure limits that have been developed over the last few years provide a maximum SAR for local exposure. In Western European standards, this represents a mean for a volume of 10 g tissue and in the most important US standard a mean for 1 g tissue 30 Mobile telephones. SAR values are known for a number of types of mobile telephone. With few exceptions, these do not exceed the standard values at maximum transmission power.

The EU Committee would point out that the electromagnetic field generated by the antenna of a mobile telephone behaves randomly in the near field (a region within a radius of about 30 cm from the telephone.

Values determined on the basis of measurements and calculations are highly dependent on the defined set-up or configuration. This is because the presence of the head and hand, for example, has a major impact. It is not possible to extrapolate SAR values determined under far-field conditions to a situation in the near field. It is therefore important to have a harmonized standard to unambiguously determine the local SAR in the near field. In Europe, the basic standard EN50361 and product standard EN50360, drawn up by CENELEC.

The basic standard regulates which emission requirements products must meet (in this case, the values from the ICNIRP guideline), while the product standard regulates how the emission level must be determined. This represents a major step towards an unambiguous definition of the measuements for determining the SAR values associated with the use of mobile and wireless telephones. There is no simple rule of thumb that can enable results obtained by another measurement procedure to be compared with or extrapolated to values obtained with this new standard. Significant amounts of electromagnetic energy are only absorbed in the head when making calls on a mobile phone, during which time it is held against the head. This does not occur in any other situation. If the telephone is in use, but is not held to the head (when using a handsfree set, for example) the level of electromagnetic energy absorbed by the body and the region of the body affected will depend on the position of the device relative to the body. When sending or receiving SMS messages, energy absorption is negligible. Composition or reading of a message takes place in standby mode, and sending or receiving a message takes no more than a few seconds. In addition, in this situation the telephone is held at some distance from the body. The concerns expresed in this regard by the British Medical Association in a recent report (BMA01) are therefore unjustified. If the telephone is on standby, it regularly emits short (1-2s) pulses for the purpose of position-finding within the network. The intervals between such pulses vary – depending on the network settings – from 20 minutes to several hours. The pulse is initially broadcasted at full power, but the power is then reduced. This reduction will depend on the phone's position relative to the nearest base station and the setting of that base station. This determines the maximum transmission power of the GSM telephone. If a call takes place, a link is established and the telephone transmits continuously. Here, too, this process takes place initially for a very short time on full power, with the power then being reduced to the minimum level required for a good link. During the call, the telephone transmits as indicated earlier in this chapter.

4. Conclusions

The EU Committee finds no reason in the scientific data concerning non-thermal effects to apply the precautionary principle and lower the SAR limits for partial body exposure. So, until scientific reports will demonstrate that the lower levels of electromagnetic field could have health effects on the human body, the exposure limitations will remain unchanged.

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