

OPECST notes

Number 3 - March 2009

Electromagnetic fields (EMF) and health

Our daily environment is subject to various EMF radiations emitted – inter alia – from the Earth's magnetic field or from the myriad applications of electricity. All the same, the interpretations of their possible effects on the health of populations is giving rise to strong controversies. This note fits into the framework of the work by OPECST (Parliamentary Office for Scientific and Technological Assessment) on EMF. In this respect, Mr Daniel Raoul organised on 29 January 2009, at the Senate, a public hearing on the effects on health and the environment of the magnetic fields produced by high voltage and very high voltage lines. Then, on 4 February 2009, OPECST decided to pursue the study entrusted to Mr Alain Gest on the possible consequences on health of mobile telephony.

DÉFINITION ET CARACTÉRISTIQUES DES ONDES ÉLECTROMAGNÉTIQUES

An *electromagnetic wave* transmits energy in the form of an *electric field and a magnetic field*.

The *intensity* of the electric field is measured in Volts per metre (V/m) and that of the magnetic field in amperes per metre (A/m) or in tesla (T).

Electromagnetic waves propagate in a vacuum at the speed of 300,000 km/s. They are characterised by their *frequency* and *length*. Frequency expressed in Hertz (Hz) represents the number of oscillations per second in a given point. Frequency is used to classify waves in the electromagnetic spectrum and determine their technological applications. Length, defined by the distance between two oscillations, is measured in metres. It is inversely proportional to frequency.

There are *electromagnetic fields of natural origin*, such as solar and stellar radiation (including visible light), thunder or those emitted by molecules and living cells. Earth's magnetic field is a static field with a frequency of 0Hz.

Frequency	Range	Examples of applications
0 Hz	Static fields	Magnets, MRI
3-300Hz	Extremely low frequencies (ELF)	Electrical network and electrical household appliances
300 Hz to 30 kHz	Intermediary frequencies	Video screens, induction heating
30 kHz to 300 GHz	Radio frequencies	Radio broadcasting, television broadcasting, mobile telephony, microwave ovens, radars, satellite communications
300 THz to 385 THz	Infrared	Anti-theft detectors, remote controls
385 THz to 750 THz	Visible	Sun, lasers
750 THz to 3 PHz	Ultraviolet	Sun, phototherapy
3 PHz to 30 PHz	X rays	Radiology
Above 30 PHz	Gamma rays	Nuclear physics

Key to the prefixes used : k=kilo= 10^3 , M=Mega= 10^6 , G=Giga= 10^9 , T=Tera= 10^{12} , P=Peta= 10^{15}
Source: *Fondation Santé et radiofréquences*

Artificial electromagnetic fields resulting from human activity have tended to grow in number owing to technological progress: high voltage lines, general public electrical and electronic household appliances (microwave ovens, induction rings, cathode ray tubes, televisions, computers), radars, medical apparatus (radiography, MRI, nuclear medicine), telecommunication networks (mobile telephony, mobile phone masts), computer networks and wireless telephony.

Some consider that these artificial sources are factors of **electromagnetic pollution**.

As shown by the following table, the intensity of EMF varies depending on their type, place and distance between people and the source of exposure.

Electric fields	
In the human body (brain)	5 Volts/m
In the human body (heart)	Up to 50 V/m
Housing (except close to household appliances)	Up to 20 V/m
In an electric train compartment	Up to 300 V/m
Close to high voltage lines	20 V/m
Computer screens (5 cm from them)	From 1 to 10 V/m
In a calm atmosphere	From 100 to 200 V/m
Fitted carpeting (5 mm from it, in a dry atmosphere)	From 200 V/m to 20 kV/m
Field during a storm	Up to 100 kV/m
FM radio programmes A few metres from an FM radio mast	A few tens of V/m
GSM emissions 1 cm from a mobile telephony mast 1 m from a base station antenna More than 5 m from a base station antenna	90 V/m 50 V/m From 0.01 to a few V/m
Magnetic fields	
In apartments: At a distance from an appliance 1 m from household appliances	0.002 micro Tesla Up to 200 microT
Vertically under a high voltage line	20 microT
In a compartment of an Underground train	30 microT
Earth's field (geomagnetic)	Between 30 and 70 microT
In an electric train compartment	50 microT
Metal detectors (airports)	Up to 100 microT
GSM emissions Close to a base station Close to a mobile phone mast	Up to 0.03 microT 0.3 microT
<i>Source: : Rapport Lorrain-Raoul, the possible effect of mobile telephony on health, 2002, p.11</i>	

A joint study by AFSSET (Agence française de sécurité sanitaire de l'environnement et du travail - French Agency for Environmental and Occupational Health Safety) and École supérieure d'électricité (Higher Electricity

School), published in May 2008, also confirms that the exposure of a population to low frequency EMF (50 Hz, which is the frequency of the electrical network) is likely to vary. This study, performed in Champlain in the Essonne *department* and concerning 17 volunteers who were provided with an individual probe for 24 hours, demonstrated that this exposure is around 1 to 2 microtesla for a person living for 24 hours under high voltage lines, and 0.03 microtesla as a 24 hour average for a person living more than 100 metres from such lines. This is the distance after which the influence of the fields is no longer felt. Some household appliances, such as microwaves or hair dryers produce far higher fields, ranging from 5 to 20 microtesla, but the exposure is, per se, short. The values highlighted by this study remain very much lower than the legal limits set at 100 microtesla.

POSSIBLE HEALTH CONSEQUENCES OF EXPOSURE TO EMF

EMF and Cancer

- Exposure to high voltage lines:

Some epidemiological studies show there is a connection between an increased risk of infantile leukaemias and exposure to extremely low frequency magnetic fields (ELF fields) particularly at a level higher than 0.4 microtesla.



However, these studies are the subject of discussions among scientists, mainly because of potential biases introduced by the absence of

any measurement of electromagnetic fields and of the exposure of the population to these fields.

The study by Draper, published in June 2005, was aimed at comparing ill individuals with healthy controls, and was performed on the basis of 20,000 children under 15 years old between 1962 and 1965. The results show a higher risk of a rare form of leukaemia for those



Exploded view of a mobile phone
Source - CNRS

living between 100 and 600 metres whereas the field is almost nil and there is paradoxically no increase in the risk between 0 and 100 metres. Therefore scientists question the reliability of this study.

Also, no biological mechanism explaining cumulative or long term

effects of electromagnetic fields has been documented in animals.

Therefore CIRC (International Research Centre on Cancer) considers that at present there is no convincing proof of a health risk for long duration exposures at low level fields, nor any causal connection between the closeness of high voltage lines and the appearance of leukaemias. However, in 2002, CIRC classified electromagnetic waves – of extremely low frequencies – as category B possible carcinogens for man, like coffee.

For these reasons, WHO felt in 2007 that the evidence was not sufficiently solid to be considered as establishing a causal connection, but was sufficiently so to remain worrisome.

Exposure to radio frequencies

The *epidemiological studies* that have examined the effects of the radio frequencies of mobile phones have mainly focused on cancers occurring in the head: gliomas (brain tissue tumour), acoustic neurinomas (benign tumour of the acoustic nerve), meningiomas (benign tumour located at the level of the hard meninge) or a tumour of the parotid gland (located between the ear and the jaw).

A study conducted as part of the Interphone¹ international study suggests the possibility of an increased risk of gliomas in the event of the intensive use of a mobile phone for more than

ten years. This result is however controversial as it could be caused artificially by the division of the studied population into sub-groups or by memorisation biases.

Laboratory studies performed on *animals* aim at examining the capacity of radio frequency fields to cause cancer, worsen the effects of carcinogenic substances or accelerate the development of tumours.

Laboratory studies on *cell cultures* have addressed the possible effects of radio frequencies on DNA, the cell cycle, and cell proliferation and differentiation.

– Electrohypersensitivity:

Some people exposed to electromagnetic fields, especially those emitted by high voltage lines, mobile phone masts, and wireless local networks - Wifi² for instance – complain in particular about fatigue, sleep disorders or else headaches.

The question arises as to whether these symptoms are not of a subjective nature.



View of a mobile phone mast

REGULATIONS ON PROTECTION AGAINST EXPOSURE TO EMF

Protection of people

Recommendation 1999/59/EC of 12 July 1999 of the Council of the European Union proposed limit exposure values for the public. Covering all the range of non-ionising radiations (from 0 to 300 GHz), this recommendation is based on the risk assessments published under the aegis of WHO and ICNIRP³.

¹ Interphone is a study directed and coordinated by CIRC. Conducted in 13 countries - including France - it examined 6,600 patients to determine whether the use of mobile phones increases the risk of cancer.

² WiFi (Wireless Fidelity): a wireless data-processing network technique set in place to operate in an internal network. It is also a means of accessing high-speed Internet.

³ International Commission on Non-Ionizing Radiation Protection

It fixes the intensity:

✓ For a 50 Hz alternating current, at 5,000 V/m for the electric field (10,000 V/m for workers); and at 100 microtesla for the magnetic field.

✓ For radio frequencies at 41 V/m for GSM 900, 58 V/m for GSM 1800 and 61 V/m for UMTS (2110-2170 MHz).

These limits values are based on the sole *proven and known* effects of EMF and cannot therefore take account of risks so far non demonstrated nor measured.

They have been fixed at levels 50 times lower than those having led to the slightest observable health effects in animals, to introduce an additional element of safety.

France has taken up the Council's recommendations regarding the limit values applying to extremely low frequencies and to mobile phone masts whereas these provisions have been applied in an uncoordinated manner in the European Union.

Directive 2004/40/EC defines limit values governing the *protection of workers*.

Taking up the ICNIRP's recommendations, the directive aims at a harmonisation of protection in the working environment against the effects of non-ionising radiations.

The last date for its transposition was set initially as 30 April 2008, but has been postponed till 30 April 2012. This postponement is aimed, according to the Commission, at preparing a substantial amendment of the directive with a view to guaranteeing that the exposure limits will not jeopardise the practice of magnetic resonance imagery (MRI), while ensuring appropriate protection for the personnel.

Protection of equipment

In order to allow various pieces of electric and electronic equipment to coexist, Community legislation has defined standards aimed at ensuring the *electromagnetic compatibility* of this equipment. This notion designates the aptitude of a piece of equipment to operate in its electromagnetic environment in a satisfactory manner without itself producing *electromagnetic disturbances* for said environment, in other words without degrading the performance of a piece of equipment or adversely affecting living or inert matter.

The correlative aim is to preserve the *electromagnetic immunity* of equipment, in other words its aptitude to operate in the presence of electromagnetic disturbances.

The regulations applying in this field result from Directive 2004/108/EC, which entered into force on 20 July 2007.

This directive lays down that equipment must be designed and manufactured so as to guarantee that:

-Electromagnetic disturbances do not exceed the level beyond which hertzian equipment and telecommunications cannot perform as intended;

-It possesses a level of immunity to electromagnetic disturbances allowing it to operate without unacceptable degradation within the framework of the intended use.

Directive 2004/108/EC therefore repeals Directive 89/336/EEC, within the framework of which CENELEC (European Committee for Electrotechnical Standardization) had set at 3V/m the level of immunity for any piece of electrical equipment – except for vital medical devices and other sensitive systems.



Reverberating chamber allowing the electromagnetic immunity of components to be tested as part of electromagnetic compatibility tests.
Source CNRS