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ELECTROMAGNETIC FIELDS AND HEALTH

According to THE PRECAUTIONARY PRINCIPLE¹, **authorities should focus on protecting citizens from the risk of damage caused by EMF² exposure.** The scientific literature proves that the studies which have been done are too recent to exactly define the long term effects caused by electromagnetic radiation exposure. While the short-term effects have been identified, the scientific community is still far from disclosing the long-term effects. Experiments in specialized laboratories have already revealed some possible consequences caused by long EMF exposure but it is still too early to settle the matter.

Introduction

Electromagnetic fields are created every time electricity is produced, transported and consumed. EMFs are invisible lines of force that surround any electrical device. An electromagnetic field is a combination of two fields: an electric one and a magnetic one. Power lines, electrical wiring, and appliances all produce electrical and magnetic fields.

Electrical and magnetic fields have different properties and possibly different ways of causing biological effects. Note that while electric fields are easily shielded or weakened by conducting objects (e.g., trees, buildings, and human skin), magnetic fields weaken with increasing distance from the source.

Both electric and magnetic fields are present around appliances and power lines. Recent interest and research has focused on potential health effects of magnetic field exposure.

Human exposure levels to electromagnetic radiation are measured by testing the Specific Absorption Rate, referred to as SAR. The SAR measures how much energy is absorbed by the body and it is usually expressed in Watts per Kilogram (W/Kg).

1. - Sources Of Exposure

The main EMF sources of exposure are shortlisted below. However, all apparatus which uses electricity as a power source produces electromagnetic fields such as an electric razor, vacuum cleaner, hair dryer, radio, iron, copier, fridge, recorder, TV, microwave oven, etc.

1.1. - Mobile Phones And Base Stations

The main sources of exposure are mobile phones and base stations, which emit RF³ radiation⁴. In both cases, levels of exposure are generally reduced with increasing distance from the source. For mobile phones, exposure will be principally to the side of the head for hand-held use, or to the parts of the body closest to the phone during hands-free use. For base station emissions, exposures of the general population will be to the whole body but normally at levels of intensity many times less than those from handsets.

1.2. - Overhead Lines And Ions⁵

There has been some alarm recently about the role that ions or charged particles may play in increasing the risk of cancer for people living near high voltage overhead lines. In fact, these lines create charged particles, which become attached to particulate pollutants in the air, which in turn, become attached to people. The pollutant will then stick to the skin or be breathed in, where, because it is charged, it will stick to the lungs. The high voltage overhead line is not itself harmful, but its presence will attract and concentrate pollutants from car exhausts etc.

1.3. - Substations

There have been many scare stories published in the media and on TV about families who live near substations becoming ill. This is a surprising outcome because substations are not the large sources of electric or magnetic fields that some people imagine. Indeed there are many larger sources of EMFs within every home.

¹ Treaty of Maastricht - THE PRECAUTIONARY PRINCIPLE requires society to take "prudent action when there is sufficient scientific evidence (but not necessarily absolute proof) and that inaction could lead to harm."

² EMF: ElectroMagnetic Field. A location where the electromagnetic energy from a source exerts an influence on an object.

³ RF: Radio Frequency. Electromagnetic radiation at frequencies used for Radio. mobile phones. This term is usually applied to frequencies between 300 Hz and 300 GHz.

⁴ Radiation simply means the process of emitting energy in the form of waves or particles.

⁵ Ion: electrically charged atom or group of atoms.

1.4. - Cables

Wherever there is a flow of electrical current a magnetic field is produced. This basic principle means that all cables will create fields when they are in use.

Most concern is often focussed on underground power cables as they carry large current. These cables are buried under the footpath or roadway and have a current rating of typically 100 to 550 Amps. This variation is due to the many types of cable in use. Generally, it does not matter what voltage the cables are working at. A cable working at 230 volts can produce the same magnetic field as one operating at 11.000 volts if the current is the same.

At even higher voltages there are some other differences. For some cables operating at 33.000 volts, and almost all the cables that operate above this voltage level, it is normal practice for there to be 3 individual cables grouped as one cable. The cables are normally laid with a gap between them. The gap however causes greater magnetic fields to be produced than would have resulted from them being laid together.

1.5. - Transport

Transport is not free from electric and magnetic fields. This is because electricity is used both as a power source and as a controlling mechanism. Trains and trams powered from overhead wires will create electric and magnetic fields along the length of the wire. Similarly, where power is provided by electrified track, electric and magnetic fields will exist along the length of the track.

2. - What Damage Can EMFs Cause?

The literature concerning EMFs often uses terms such as **interaction, biological effect, risk, damage.**

When a biological entity is exposed to an EMF, an **interaction** takes place between the field strength and the electrical current and charges of the body tissue. The result of the interaction produce the so called **biological effect**. A biological effect is not necessarily **damage**. Damage occurs when the biological effect outgrows the biological compensation properties of the body. **Risk** is the underlying likelihood of damage. Effects caused by exposure to EMF's can be classified as **acute** and **chronic**. Acute effects are always associated with a specific threshold value. Up to this value, immediate and objective effects are caused. Because the chronic effects are not immediate and not objective we can refer to long term effects.

2.1. - Mechanism Of Interaction

EMFs induce torques on molecules, which can result in displacement of ions from unperturbed positions, vibrations in bound charges, and rotation and reorientation of dipolar molecules such as water. These mechanisms are not capable of producing observable effects from exposure to low-level EMFs, because they are overwhelmed by random thermal agitation. Moreover, the response time of the system must be fast enough to allow it to respond within the time period of the interaction. Both considerations imply that there

should be a threshold (below which no observable response occurs) and a cut-off frequency (above which no response is observed).

In general, exposure to electromagnetic fields results in a highly non-uniform deposition and distribution of energy within the body. For absorption of energy by the human body, electromagnetic fields can be divided into four ranges:

- frequencies from about 100 KHz to less than about 20MHz, where absorption in the trunk decreases rapidly with decreasing frequency, and significant absorption may occur in the neck and legs;
- frequencies in the range from about 20 MHz to 300 MHz, at which relatively high absorption can occur in the whole body, and to even higher values if partial body resonances are considered;
- frequencies from about 300 MHz to several GHz, at which significant local, non-uniform absorption occurs;
- frequencies above about 10 GHz, at which energy absorption occurs primarily at the body surface.

2.1.1. - Cellular Function

The cells of living organisms naturally maintain an electrical charge across their membranes that is essential to the normal functioning of human tissues. This is extremely sensitive to very weak electromagnetic fields. Radiation of unnatural frequencies can rearrange and damage molecules and alter metabolism. A process of a chain-like reaction will firstly alter the organism's electrical stability and affect cell polarisation. The resulting disharmony may eventually lead to changes in hormonal activity, affect the synthesis of genetic material, interfere with the flow of substances in and out of cells, and change the behaviour of cancer cells.

2.1.2. - Creating Free Radicals¹

The basic mechanism for damage involves FREE RADICALS. These damage proteins and cellular membranes, mutilate genes and DNA, reduce levels of antioxidant hormones, such as melatonin, affect enzymatic and biochemical processes essential to normal function, and disrupt patterns of electromagnetic energy in muscles.

2.1.3. - Promoting Histamine Release

Mast cells (which secrete histamine and other substances) are destabilised by free radicals. When exposed to radiofrequency radiation, studies have shown a doubling of histamine release.

2.1.4. - Upsetting Calcium Levels

Radio waves and their destructive agents, the free radicals, upset calcium levels in the body, especially in the central nervous system, the brain and the heart. It is thought that calcium (and possibly magnesium) levels diminish within the cells. This affect the growth, reproduction and division of cells and the communication

¹ Free Radical: a group of atoms that normally cluster with other atoms. They can exist by their own, but usually only for a fraction of a second. They are though capable of damaging other cells

of signals between the outside of the cell and the nucleus inside the cell.

3. - Public Perception Of EMF Risks

Technological progress in the broadest sense of the word has always been associated with various hazards and risks, both perceived and real. The industrial, commercial and household application of electromagnetic fields (EMF) is no exception.

Throughout the world, the general public is concerned that exposure to EMF from such sources as high voltage power lines, radars, mobile telephones and their base stations could lead to adverse health consequences, especially in children. As a result, the construction of new power lines and mobile telephone networks has met with considerable opposition in some countries.

Recent history has shown that lack of knowledge about health consequences of technological advances may not be the sole reason for social opposition to innovations. Disregard for differences in risk perception that are not adequately reflected in communications among scientists, governments, industry and the public, is also to blame.

3.1. - Health Hazard and Risk.

In trying to understand people's perception of risk, it is important to distinguish between a health hazard and a health risk. A **hazard** can be an object or a set of circumstances that can potentially harm a person's health. **Risk** is the likelihood (or probability) that a person will be harmed by a particular hazard. EMF can be potentially hazardous, and the risk to a person's health depends on the level of exposure.

3.2. - Perception Of Risk.

A number of factors influence a person's decision to take a risk or reject it. People usually perceive risks as negligible, acceptable, tolerable, or unacceptable, and compare them with the benefits, which should outweigh the risk by a significant margin. These perceptions can **depend on people's age, sex, cultural and educational backgrounds**.

The **nature of the risk** can lead to different perceptions. Surveys have found that the following pairs of characteristics of a situation generally affect risk perception. The first member of the pair tends to increase while the second one decreases the magnitude of the perceived risk.

3.2.1. - Involuntary Vs. Voluntary Exposure.

This is an important factor in risk perception, especially for EMF-emitting sources. People who do not use mobile telephones perceive the risk as **high** from the relatively low radio-frequency (RF) fields emitted from mobile telephone base stations. However, mobile telephone users generally perceive as **low** the risk from the much more intense RF fields from their voluntarily-chosen handsets.

3.2.2. - Lack Of Personal Control Vs. Feeling Of Control Over A Situation.

If people do not have any say about installation of power lines and mobile telephone base stations, especially near their homes, schools or play areas, they tend to perceive the risk from such EMF facilities as being high.

3.2.3. - Familiar Vs. Unfamiliar.

Familiarity with the situation, or a feeling of understanding of the technology, helps reduce the level of the perceived risk. The perceived risk increases when the situation or technology, such as the EMF technology, is new, unfamiliar, or hard-to-comprehend. Perception about the level of risk can be significantly increased if there is an incomplete scientific understanding about potential health effects from a particular situation or technology.

3.2.4. - Dreaded vs. not Dreaded.

Some diseases and health conditions, such as cancer, severe and lingering pain and disability, are more feared than others. Thus, even a small possibility of cancer, especially in children, from EMF exposure receives significant public attention.

3.2.5. - Unfairness Vs. Fairness.

If people are exposed to RF fields from mobile telephone base stations, but do not have a mobile telephone, or if they are exposed to the electric and magnetic fields from a high voltage transmission line that does not provide power to their community, they consider it unfair and are less likely to accept any associated risk.

In the case of people who do not own a mobile telephone, for example, exposure to RF fields from mobile telephone base stations may be perceived as a high risk for the following reasons:

- people are faced with an **involuntary** exposure to RF fields;
- it is **unfair** because the installation of these base stations exposes the whole community to RF fields while only the few mobile telephone users benefit;
- there is a **lack of control** over expansion of such networks into communities;
- mobile telephone technology is **unfamiliar** and incomprehensible to most people;
- there is **insufficient scientific information** to precisely assess health risks; and
- there is a likelihood that this technology could cause a **dreaded** disease such as cancer.

4. - Self Protection

EMF exposure is cumulative. Our bodies may withstand a certain amount of radiation from wiring and electrical and electronic equipment in the home. An extra geopathic stress, such as that from radio-frequencies or high tension power lines or underground running water may tip us over the edge. Indeed, any other toxic source will add to the burden and destabilise the body. Nothing can be separated out. So, we need to do all we can to

reduce the overall burden, while improving the body's vitality and its immune health.

4.1. - Building The Body's Defences Through Nutrition

An anti-oxidant, detoxifying low fat diet is important. High levels of saturated fats increase free radical activity and fried foods should be avoided. Include pectin (found in apples) and kelp, both of which help protect the body by binding with toxins. Eat plenty of broccoli, Brussels sprouts, cabbage, cauliflower and watercress (preferably organic). Use oils such as sunflower, safflower, olive and canola. Use soured milk products such as yogurt and buttermilk which contain lactobacillus and other bacteria which protect the gastrointestinal tract.

Supplement the diet with antioxidants such as vitamins A, C and E, plus calcium and magnesium, the trace elements selenium, germanium and vanadium, in order to inhibit free radical formation.

4.2. - Specific Action To Protect Yourself

The first thing is to be conscious of the risks and take them seriously. It is difficult because electromagnetic waves are odourless, tasteless, silent, colourless, and risk does not appear to exist until we think about it. We can minimise our exposure by:

- cutting back on our use of cordless phones and cellphones.
- Keep away from the microwave oven when it is not necessary to be close to it.
- Stop the children from sitting close to the television set or the VDU¹.
- Sleep on the other side of the house from overhead wires, radio beams, etc.
- Do not have a TV or computer on the other side of a wall from your bed.
- Sit well back from the TV.
- Avoid equipment which relies on radio beams or emits radiation of any kind.
- Unplug all the electrical equipment when not in use.

5. - Video Display Units (VDUs) And Your Health

A VDU is essentially a television-type monitor that displays information received from a computer rather than from a broadcast signal for television.

When first introduced into the workplace, VDUs were suggested as the cause of many health complaints, for example headaches, dizziness, tiredness, cataracts, adverse pregnancy outcomes and skin rashes. Many scientific studies have been conducted to determine whether electromagnetic fields could have any health consequence. WHO² and other agencies have reviewed factors, including indoor air quality, job-related stress and ergonomic issues, such as posture and seating while using a VDU. These studies (see below) have suggested that the work environment, and not EMF emissions from VDUs, may be a determining factor of possible health

effects associated with VDU use. A brief review of scientific findings follows:

- **Adverse Pregnancy Outcomes.** Studies have failed to demonstrate any effect on reproductive processes due to EMF emitted from VDUs. Studies have suggested however, that if there are effects on reproduction, they may be related to other work factors, such as job stress.
- **Effects on the eye.** Cataracts and other eye diseases were not found to have any link with VDU work. Glare and reflections from VDU screens have been identified as a source of eye strain and headaches in extreme circumstances.
- **Effects on the Skin.** An excess of symptoms such as skin rashes or itching has been studied. They could not link these symptoms to EMF emission from VDUs. Laboratory tests conducted on people with these symptoms showed their symptoms were not a result of any EMF exposure.

5.1. - Protective Measures

Fear of adverse health effects from EMF emitted by VDUs has led to a proliferation of products supposedly offering protection from any adverse effects of these fields and radiation. These include special aprons, screen shield or "radiation absorbing" devices for use with VDUs.

Except for screens that reduce glare (causing eyestrain), protective devices are not recommended by WHO, since the EMFs and radiation are only a very small fraction of exposure limits permitted in international standard. However, some useful advice should be given in order to prevent temporary and long term effects. Considering that eye stress increases as the distance from the VDU decreases, most experts advice to conduct some minutes of break every hour of activity with the VDU. Particular attention should also be paid to illumination (both natural and artificial). When using a VDU, always make sure that all the sources of light be at 90° with respect to the screen in order to prevent adverse reflection on it and consequently eye stress.

6. - Mobile Phones And Your Health

Mobile phones are low power radio devices that transmit and receive microwave radiation at frequencies of about 900 MHz and 1800 MHz. Some of the energy in the radio waves emitted by mobile phones is absorbed in the head of the user, mostly in superficial tissues. Exposure guidelines relevant to mobile phones are therefore expressed in terms of absorbed energy in a small mass of tissue in the head. Setting SAR guidelines is useful to indicate to public what level of radio or other electromagnetic waves emitted by electrical appliances, is safe.

ICNIRP³ set the SAR limit for the general public at **2 Watts per Kilogram (W/Kg)**. Recent SAR research has been carried out by EMC Technologies in Australia,

³ International Commission On Non-Ionising Radiation Protection is an independent scientific organisation responsible for providing and advice on the health hazard of non-ionising radiation exposure.

¹ VDU: Video Display Unit.

² WHO: World Health Organization

(commissioned by K-Tip magazine, Zurich). The findings were quoted in The Sunday Times, 3rd December 2000. EMC Technologies research reported the following SAR levels:

Mobile Phone Handset	SAR in W/Kg
Benefon Twin Dual	1.01
Bosch GSM 909	0.81
Ericsson A2618s	0.79
Ericsson R310s	0.94
Ericsson R320s	0.94
Ericsson T18s	0.61
Ericsson T28s	1.27
Motorola T2288	0.54
Motorola P7389	0.83
Motorola V3690	1.13
NEC db 4000	1.23
Nokia 3210	0.81
Nokia 3310	0.75
Nokia 6150	0.71
Nokia 6210	1.19
Nokia 7110	0.76
Nokia 8210	0.72
Nokia 8850	0.22
Nokia 8890	0.53
Panasonic EB GD92	1.07
Philips Ozeo	0.61
Samsung GSH 2400	1.17
Siemens S35I	0.99
Siemens M35I	1.14
Siemens C35I	1.19
Sony CMD-Z5	1.06
Swisscom Trend G366	1.05
Trium Aria	0.48

SAR is measured as Watts of radiation energy where the SAR limit is an absorption threshold as measured thermally over any one gram of brain tissue. Many scientists believe SAR standards should not be used

- SAR only measures the thermal effects (heating) of tissue. (Simulated)
- SAR calculations can be inaccurate.
- SAR is measured on synthetic models and simulations, not on real tissue inside the head.
- SAR simulation test procedures do not depict the actual biological effects of radiation upon the body.
- SAR has no worldwide common standard.
- SAR is measured by the manufacturers and self policing.
- SAR is measured at ear level, a lower SAR does not mean a cell phone is safer than another. It could mean the radiation hot spot (transmitter) is moved further round the head. It only takes a small change in distance to effect a large change in SAR.
- SAR is an average over a time period, Some analog and virtually all digital phones can emit more than 2 Watts per kilogram into head tissue, but are considered compliant with SAR standards because the signals are averaged over a time period. For phones used in GSM (Digital) networks, there are hundreds of pulses of radiated energy per minute entering the head. This has

been shown to be more biologically active than continuous radiation of the same power level and frequency.

6.1. - Protective Measures

The most frequently reported symptoms made by mobile phone users is the occurrence of **unexplained headaches, ear and eye sight problems, feeling of nausea or dizziness, a tingling sensation on the skin and a numbness or redness to the face and neck**. While there is no scientific proof that phone radiation can be harmful, neither is there proof that it is safe. If it turns out that there is a problem with electromagnetic emissions at mobile frequency ranges, then using a device that operated so close to your head is an obvious reason for concern. There are a number of practical things that mobile phone users can do if they are concerned about the potential health risk:

- do not use your mobile phone when a normal phone is handy;
- always extend the antenna;
- consider installing a car kit;
- if you have a digital phone try and use it in open space as much as possible so that the phone can transmit at a lower power level;
- limit the number and duration of calls.

Many concerns are also shown from pacemakers users and person wearing a hearing aid. What should they do?

Brands and models of cardiac pacemakers have a wide range of immunity levels to GSM signals. People who wear cardiac pacemakers and who want to use a GSM phone should seek the advice of their cardiologist or a physician - who will be able to:

- refer to your pacemaker product literature for information on your particular device;
- refer to your phone product literature for the technical parameters of your phone.

Hearing aid interference comes from many sources, such as fluorescent lights, computers and other electronic devices including mobile phones. Interference varies greatly with the type of hearing aid. In general, older larger types suffer more interference. Some hearing aids on the market today are already immune to mobile phone interference and new compatibility standards and hearing aid products are continually being developed.

If a person wear a hearing aid and is concerned there are several things that can be done:

- if possible use the mobile phone at the non aided ear;
- use a different, more immune hearing aid. In general, smaller aids worn in the ear have higher immunity than those worn behind the ear. It is important for the user to try a new aid with a mobile phone to confirm that it is compatible. It is also important to remember that the power level of the phone's transmitter changes with geographic location;
- use a hands free accessory. Different accessories can be coupled to the hearing aid by either using the Microphone or T- Coil position;

- seek the advice of your hearing specialist.
- Until there is more conclusive evidence about possible health risks, we should be cautious about mobile phones and their use.

7. - The Power Of Information

Suppose wireless phone radiation were shown conclusively to cause cancer. Just to delay the news by six months could be worth a lot of money. As the tobacco, BSE and global warming debates show, corporations are not inclined to passively accept the findings of science when it hurts their bottom line. What is good for the balance sheet is not always good for public health.

Let us take the example of the work of two scientists, funded by a European telecom company. Their first experiment yielded important results and made waves among wireless industry insiders. But few people had access to the original study. The public was excluded, as was the scientific community at large. Only the telecom company had access to the data, and they shared it with few others.

A year and a half has been lost, in which other researchers could have used this knowledge to sharpen their own investigations. And clearly, the question of EMF health effects is too complex to be resolved by one lab working alone.

But when industry has advanced knowledge of research results, it has more power to define what comes next. This in turn affects political decisions about the pace and funding of research. The inevitable consequence is that journalists and the public are not sure when company statements can be trusted.

An account of the conflicts of interests in this case would not be complete without mentioning the role of a famous consultant. The journal to which the above study was submitted is *Radiation Research*, one of the principal journals for RF/MW health studies, and the consultant is the associate editor with primary responsibility for non-ionising radiation. Yet the consultant is also paid by the wireless industry in several different countries.

This, obviously, results in a conflict of interests. It is bad enough that the consultant gets payments from the mobile phone industry while acting as a gatekeeper of scientific information. Cellular phone companies and their consultant should not have advance knowledge of research results. We need a level playing field in access to information. Until we have it, private interests will continue to have an unhealthy advantage.

Communities feel they have a right to know what is proposed and planned with respect to the construction of EMF facilities that might affect their health. They want to have some control and be part of the decision-making process. Unless an effective system of public information and communications among scientists, governments, the industry and the public is established, new EMF technologies will be mistrusted and feared.

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Statements made in this STOA Briefing do not necessarily reflect the view of the European Parliament

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