



# The European Commission's non-food Scientific Committees



**DG SANCO - Health Information Unit**



# Potential health effects of exposure to electromagnetic fields (EMF)

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# Background

- SCENIHR has a *standing mandate* on EMF issues.
- Previous opinion(s) issued in 2009. It was based on material available until September 2008. Since then, a sufficient number of new scientific publications have appeared to warrant a new analysis of the scientific evidence on possible effects on human health of exposure to EMF.
- The development of new technologies using EMF in the THz range called for new assessments.
- A meeting organized by the European Commission in Brussels under the auspices of the SCENIHR in November 2011 (the International Conference on EMF and Health) provided an overview of the most recent scientific developments in this area as a first preparation for a future scientific opinion.

# Terms of Reference

1. To **update** the opinions of 2009 in the light of newly available information.
2. To give **particular attention to** issues affected by important gaps in knowledge in the previous opinions, especially:
  - the potential adverse effects of EMF on the nervous system, including neuro-behavioural disorders and on the risk of neo-plastic diseases;
  - the understanding of biophysical mechanisms that could explain observed biological effects and epidemiological associations; and
  - the potential role of co-exposures with other environmental stressors in biological effects attributed to EMF.

## Terms of Reference (cont'd)

3. To review the scientific evidence available to understand the potential adverse health effects of EMF in the **THz range**.
4. To develop a set of **prioritized research recommendations** updating previous efforts in this area (in particular by the SCENIHR and the WHO). These recommendations should include methodological guidance on the experimental design and minimum requirements to ensure data quality and usability for risk assessment.

# Structure of the opinion

## Scientific rationale

- **Exposure** to EMF
- **Health effects** overview according to **frequency bands**
- **Health effects** overview according to **special cases**
- **Research recommendations**
- **Guidance on research methods**

## Opinion

# Structure of the opinion

## Scientific rationale

- **Exposure** to EMF → Wireless communication technologies
- **Health effects** over Industrial applications
- **Health effects** over Medical applications
- **Research recomme** Security applications
- **Guidance on resear** Power generation and transmission

## Opinion

Transportation  
Household appliances  
THz technologies



# Structure of the opinion

## Scientific rationale

- Exposure to EMF
- **Health effects** overview according to **frequency bands** →
- **Health effects** THz technologies 0.3 – 20 THz
- **Research** Radiofrequency 100 kHz – 300 GHz
- **Guidance** Intermediate frequency 300 Hz – 100 kHz  
Extremely low frequency 1 – 300 Hz

## Opinion

Static magnetic fields (0Hz)

# Structure of the opinion

## Scientific rationale

- Exposure to EMF
- Health effects overview according to frequency bands
- **Health effects** overview according to **special cases**
- **Research** Combined exposure to different EMF
- **Guidance** Co-exposure to other stressors  
EMF effects on implanted medical devices

## Opinion

# Structure of the opinion

## Scientific rationale

- Exposure to EMF
- Health effects overview according to frequency bands
- Health effects overview according to special cases
- **Research recommendations**
- **Guidance on research methods**

## Opinion

# Structure of the opinion

**For each section on health effects:**

- **All lines of evidence discussed (human, in vivo, in vitro)**
- **Primary conclusions on line of evidence and outcome level**
- **Where appropriate, special consideration (as in mandate) of**
  - neoplastic diseases,
  - nervous system effects,
  - neurobehavioural disorders,
  - symptoms and other effects

# Structure of the opinion

## Scientific rationale

- Exposure to EMF
- Health effects overview according to frequency bands
- Health effects overview according to special cases
- Research recommendations
- Guidance on research methods

**Opinion** → response to the terms of reference

# Considerations

- Primarily English language material published in international peer-reviewed scientific journals
- Occasional, limited, input from other sources (expert judgment)
- Mainly publications published between 2009 and early 2013
- Inclusion and evaluation criteria according to the SCENIHR Memorandum „Use of the scientific literature for risk assessment purposes – weight of evidence approach“ plus criteria given in section 3.2 Methodology
- About 540 references cited in the text
- Additional papers were identified but not cited



# Opinion

## **1. To update its opinions of 2009 in the light of newly available information**

In most of the sections of the Scientific Rationale in the current opinion, reports appearing in the literature after 2009, i.e., after the publication of the previous opinions, have been considered.

Therefore, the present opinion covers studies that were published between 2009 and the beginning of 2013. However, certain sections of the Scientific Rationale were not covered in the previous opinions.

In such cases, reports published before 2009 have also been taken into account for the risk assessment.

# Opinion

## 2. To give particular attention to issues affected by important gaps in knowledge in the previous opinions, especially:

2a. the potential adverse effects of EMF on the nervous system, including neurobehavioural disorders and on the risk of neo-plastic diseases

### **RF fields**

Conclusions regarding:

- changes in the EEG
- symptoms
- neurological diseases and symptoms (incl. child development and behavioural problems)
- epidemiological studies and brain tumours
- in vivo studies and carcinogenesis
- in vitro studies pertaining both to genotoxic as well as non-genotoxic endpoints

### **IF fields**

No definitive conclusions can be drawn

### **ELF fields**

Conclusions regarding:

- waking EEG
- behavioural outcomes and cortical excitability
- neurodegenerative diseases
- symptoms
- childhood leukemia





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# Opinion

## **2. To give particular attention to issues affected by important gaps in knowledge in the previous opinions, especially:**

2b. the understanding of biophysical mechanisms that could explain observed biological effects and epidemiological associations

Despite a number of studies continuing to report candidate mechanisms, particularly 48 regarding effects on reactive oxygen species, lipid peroxidation and antioxidant defense, no mechanism that operates at levels of exposure found in the everyday environment has been firmly identified and experimentally validated. It is important to stress here the difficulties of demonstrating small changes in gene expression that may occur following in vivo exposure to EMF which are due to inherent variability of biological responses and the technical limitations in the sensitivity of existing technologies.



# Opinion

## **2. To give particular attention to issues affected by important gaps in knowledge in the previous opinions, especially:**

2c. the potential role of co-exposures with other environmental stressors in biological effects attributed to EMF

The opinion of 2009 concluded that there was some evidence from in vivo studies to suggest that co-exposure with ELF fields may act as a co-carcinogen, while there was no evidence that RF fields could act in a similar way. The results reported since then indicate that exposure to ELF or RF can interact with several chemical or physical agents resulting in either an increase or a decrease in their effect. Nevertheless, due to the small number of available investigations and the large variety of protocols adopted (different chemical or physical treatments and different EMF exposure conditions), it is not possible to draw definitive conclusions. The effects lack consistency and are not linked to specific experimental conditions. Therefore, their relevance to human carcinogenicity under real life exposure conditions remains unclear.



# Opinion

## **3. To review the scientific evidence available to understand the potential adverse health effects of EMF in the THz range.**

A risk assessment on health effects from THz exposures is difficult to perform since no suitable evidence is available, due to the small number of scientific studies that have been carried out. Most of the studies were performed in the last decade, mainly in the frequency range of 0.1-1 THz. Only very few studies are available at higher frequencies. In vivo studies indicate mainly beneficial effects on disorders of intravascular components of microcirculation in rats under immobilization stress, but do not address acute and chronic toxicity or carcinogenesis. In vitro studies on mammalian cells differ greatly with respect to irradiation conditions and endpoints under investigation. Studies suggesting effects of exposure have not been replicated in independent laboratories. Some theoretical mechanisms have been proposed, but no conclusive experimental support is available. Therefore, this evidence does not challenge existing knowledge.



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# Opinion

**4. To develop a set of prioritized research recommendations taking updating previous efforts in this area (in particular by the SCENIHR and the WHO). These recommendations should include methodological guidance on the experimental design and minimum requirements to ensure data quality and usability for risk assessment.**

A set of prioritized research recommendations and methodological guidance on the experimental design and minimum requirements to ensure data quality and usability for risk assessment are provided in sections 3.13 and 3.14 of the opinion.