The Possible Harmful Biological Effects of Low Level Electromagnetic Fields of Frequencies up to 300 GHz

IEE Position Statement - May 2002

Summary

The Institution of Electrical Engineers Policy Advisory Group on the Biological Effects of Low Level Electromagnetic Fields has concluded that there is still no convincing scientific evidence that shows harmful effects of low-level electromagnetic fields on humans. This conclusion is the same as that reached in its previous position statements, the last being in May 2000 and has not been changed by the peer-reviewed literature of the past two years. The group has recently produced a FactFile that introduces the subject area and discusses some of the key public concerns (http://www.iee.org/Policy/Areas/BioEffects/emfhealth.pdf)

At low frequencies, the cumulative evidence from the large body of literature built up over the past 20 years suggests that the existence of harmful health effects in general is unlikely. However, recent pooled analyses of epidemiological studies have suggested an association with childhood leukaemia, which warrants further research.

At higher frequencies, fewer data are available. Whilst the existing data do not show harmful effects, the Group is of the opinion that further research, both epidemiological and laboratory based, should be supported. This view is consistent with the conclusions of major reviews published elsewhere, and is based on public concern and the ubiquitous nature of our exposure to such fields rather than a likelihood that harmful effects exist. The UK Mobile Telecommunications and Health Research Programme goes some way to addressing this need for further research with an initial 15 research projects starting in 2002 (http://www.mthr.org.uk/index.htm)

The Group continues to view the replication of studies as important in order to assess and improve the robustness of the existing literature at both low and high frequencies. In view of the difficulties encountered in past replication studies it continues to recommend that isolated reports of biological effects or epidemiological findings should be treated with caution until confirmed by independent groups. In this context, confirmation by a group of the results of their own earlier work, is not viewed by the Group as constituting replication.

The Group noted with concern the continuing trend for some study results to be published in the media before they appear in the peer reviewed scientific literature. The Group supports the 'Guidelines on Science and Health Communication' produced by the Social Issues Research Centre in partnership with the Royal Society and the Royal Institution (http://www.sirc.org/publik/revised_guidelines.shtml). These state that both the journalist and the scientist have a responsibility to state if the work has been peer reviewed and, if not, that the methodology should be carefully checked, preferably by an independent expert, before being reported.

Introduction

The Institution of Electrical Engineers set up the Group in November 1992 to consider the

possible harmful effects of low-level, low frequency electromagnetic fields. The Group first reported in June 1994, and then approximately every two years since that date. Its reports form the basis of the IEE's position on these matters. In January 1998 the terms of reference of the Group were extended to include frequencies up to 300 GHz to reflect public concern over possible health effects of radiofrequency (RF) fields, especially from mobile communications systems.

The Group has continued to use refereed full papers as its source material, retrieved from a broad literature search of a range of electronic databases. The methodology and sources used are described in the attached Appendix.

The literature searches retrieved a total of 798 relevant refereed full papers in 2000 and 2001 combined, of which 65% covered static and low frequencies, primarily relating to 50/60Hz power generation and distribution. 28% of the papers dealt with radiofrequencies, of which 35% were specifically related to mobile phone frequencies (equivalent to 10% of the total literature). Because of the relatively clear distinction between low and high frequency studies, coupled with the different types of sources involved and the likelihood that any mechanisms of interaction are different, the Group has chosen to divide its assessment of the literature into these two frequency bands without attempting to define them rigidly.

The literature can be broadly divided into five areas: epidemiology, human studies, animal studies, cellular studies, and mechanisms of interaction. An additional, and increasing, area of activity is that of reviews by panels of scientists, reporting to governments or other political agencies, and the conclusions of these have also been considered. The points below summarise the views of the Group on the latest literature in all these areas, and on which the conclusions in this statement are based.

Epidemiology

- In recent years a large number of epidemiological studies have been published investigating risks of exposure to low frequency electromagnetic fields from domestic and occupational situations. The diseases investigated included various child and adult cancers, and neurological and psychiatric conditions. Overall no study has confidently suggested any clear links to health effects.

- A pooled analysis of 9 childhood leukaemia studies suggests an increased risk associated with average household fields of greater than 400 nT. The findings are based on small numbers (largely from North America) and work is underway to investigate these results further.

- Epidemiological studies of occupational exposure to RF fields from various sources have been published over a span of many years. No studies have been able to deal satisfactorily with dosimetry issues. None of the studies are readily interpretable and although some suggest increased risks, they are low and generally inconsistent.

- Studies so far published on health effects of mobile phone handsets have lacked the power to yield firm conclusions. Major international studies investigating the use of mobile phones and the possible risk of developing brain tumours or acoustic neuromas have started and results will be available in the next few years.

- Mobile phone base stations produce very low fields compared to handsets but remain a cause of public concern. No major epidemiological studies appear to have been published on base stations.

Human studies

- There is no obvious pattern to reported effects and especially no convincing evidence to suggest the existence of adverse health effects following low level exposure at any frequency.

- The evidence continues to grow that exposure to low frequency magnetic fields in laboratories does not disturb melatonin levels, although some limited evidence suggests that occupational exposure may affect levels in males, but not females.

- The possibility that low frequency magnetic fields may affect heart rate variability now seems less likely, even in a sensitive sub-population. Previous positive results using exposure to intermittent fields have been attributed to experimental artefacts.

- The existence of the phenomenon of electrical hypersensitivity has not been confirmed in controlled, laboratory tests, although subtle cognitive changes have been reported using power frequency magnetic fields.

- The possibility continues that exposure to mobile phone signals may cause subtle functional changes on the brain and nervous system, measured using endpoints such as attention and reaction time, sleep quality and the EEG. However other studies have reported null effects. There is some evidence that the likelihood of demonstrating a cognitive effect seems to increase when the demands of the test are high.

- With the exception of the sensation of warmth on the face, laboratory-based studies have failed to confirm the existence of symptoms such as headaches reported by users of mobile phones.

- The limited evidence available suggests that melatonin levels are not affected by RF fields.

Animal studies

- Research into possible cancer-related endpoints has continued. An increasing number of well conducted studies clearly indicate that exposure to power frequency magnetic fields do not cause or affect the development of various cancers in either normal or transgenic animals. Previous positive findings have not proved possible to replicate.

- Studies of the effects of low frequencies on the brain and behaviour have also continued and the possibility of subtle effects still exists. For example, field-dependent changes to the endogenous opioid systems continue to be suggested by some studies.

- A growing number of independent studies all suggest that the fields associated with mobile phones do not cause or affect the development of brain cancer or other forms of cancer.

- Studies of possible effects of RF fields on the brain and behaviour have continued. A few studies have reported subtle effects, although in general they do not show field-dependent effects in the absence of heating. In particular, two independent studies failed to confirm any field-effect on spatial memory using mobile phone signals.

- Earlier suggestions that exposure to low level RF fields may harm the eyes and impair normal retinal function have not been confirmed.

Cellular studies

- These continue to use a wide range of models, exposure criteria, and biological end points and they have a poor record of reproducibility.

- Publication of the results of the1994-1998 $41 million USA EMF-RAPID programme is now complete. One of the priorities of the programme was to replicate published effects with emphasis on well-controlled and blinded study design. Studies included gene expression, intracellular calcium, colony growth and ornithine decarboxylase. No effects of magnetic field exposure were found.

- Approximately 30% of low frequency cellular papers were devoted to potential medical uses, most claim positive effects, however the quality of these papers in general remains poor.

- Only approximately 15% of the papers studied RF fields. There are a few contradictory findings on human lymphocytes, however most studies (-70%) showed no genetic effects. Replication studies have yet to be published.

Mechanisms

- The two most popular hypotheses used to explain possible biological effects of low-level low frequency electromagnetic fields remain those of magnetic field effects on free radical reactions and the effects of electric fields on airborne aerosol particles contaminated with a variety of pollutants.

- Both hypotheses are based on well-established scientific principles and are the subject of ongoing research. However neither has been shown to have effects on health and the magnitude of the phenomena involved makes it unlikely that the mechanisms could result in significant health consequences.

- No plausible mechanisms have yet to emerge by which high frequency electromagnetic fields can have biological effects at levels below those that cause heating to occur. Free radical reactions are being investigated, but experimental evidence to support this mechanism in biological systems has yet to be found.

Reviews by scientific bodies

- In the past two years several national and international bodies reviewed the scientific evidence on low frequency electromagnetic fields. In March 2001, an Advisory Group of the National Radiological Protection Board published a review on cancer, which concluded that, although the evidence is not strong enough to justify firm conclusions, the possibility remains that magnetic fields can increase the risk of leukaemia in children.

- A similar conclusion was reached in June by the International Agency for Research on Cancer, who classified low frequency magnetic fields as "possibly carcinogenic". This was based on "limited" epidemiological evidence for childhood leukaemia, but "inadequate" epidemiological evidence for all other cancers, "inadequate" evidence from animal studies,

and "inadequate" evidence for electric fields. In December, a review by the International Commission on Non-Ionizing Radiation Protection reached very similar conclusions for cancer, and also looked at various other diseases, concluding that there is no disease for which electromagnetic fields can be regarded as an established cause.

- In California, the Department of Health Services issued a draft review concluding that there is a significant chance, in several cases over 50%, that low frequency fields cause a number of different diseases. This conclusion is clearly out of line with the other reviews mentioned above, and appears to be unjustified by the balance of scientific evidence.

- The Zmirou report to the French Health General Directorate considered the health effects from mobile phones and base stations. It reviewed the main reviews including the U.K. Stewart report and the report of the Royal Society of Canada. It also reviewed the scientific literature and heard evidence from a number of experts from the scientific and industrial sectors. Their main conclusions agree with those of the Stewart report with respect to the state of knowledge, the adequacy of current standards and the need for a well-planned research programme. The report also concluded that children are not a high-risk category but parents should use common sense and advise their children accordingly.

- A report by the Health Council of the Netherlands entitled "Mobile telephones - An evaluation of health effects", was published in January 2002. It agrees with previous reviews on the state of knowledge and the adequacy of standards. In a significant departure from the conclusions of the Stewart report it does not recommend the application of the precautionary principle concerning non-thermal effects and sees no justification to recommend restriction in the use of mobile phones by children.

Appendix

Search Criteria

The Policy Advisory Group concentrates on peer reviewed literature retrieved by broad category, computerised, monthly searches of three major databases: INSPEC, MEDLINE, and BIOSIS.

INSPEC is a database maintained by the Institution of Electrical Engineers (IEE). Coverage is centred on four main subject areas: physics; electrical engineering; electronics and communications; computers, computing and information technology.

MEDLINE is the database maintained by the US National Library of Medicine (NLM). It provides access to articles published in more than 3,900 biomedical journals published around the world.

BIOSIS is an American `not-for-profit organisation' that publishes biological abstracts and zoological records. It provides access to 6000 periodicals covering biological and biomedical sciences.

Group Reports

1. 'The Possible Biological Effects of Low-frequency Electromagnetic Fields' (Public Affairs Board Report No 10 - July 1991)

2. 'The Possible Biological Effects of Low-frequency Electromagnetic Fields' (Supplement to PAB Report No 10 - June 1994)

3. 'Possible Harmful Biological Effects of Low-level, Low-frequency, Electromagnetic Fields' (IEE Position Statement - November 1996)

4. 'Possible Harmful Biological Effects of Low-level, Low-frequency, Electromagnetic fields' (IEE Position Statement - May 1998)

5. 'The Possible Harmful Biological Effects of Low Level Electromagnetic Fields of Frequencies up to 300 GHz' (IEE Position Statement - May 2000)

Group Membership

Professor Anthony T Barker (Chairman)
Professor Raymond A Cartwright (to December 2001)
Dr Leslie A Coulton
Dr Camelia Gabriel
Dr Patricia A McKinney (from December 2001)
Dr Zenon J Sienkiewicz
Dr John Swanson