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Possible health implications of subjective symptoms and electromagnetic fields

A report prepared by a European group of experts for the European Commission, DG V

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Summary, conclusions and recommendations

Ulf Bergqvist, Evi Vogel, *et. al*. Possible health implications of subjective symptoms and electromagnetic fields. *Arbete och* Hälsa 1997;19.
The aim of the project was to investigate the occurrence of "electromagnetic hypersensitivity" across Europe. The relevant scientific literature was to be reviewed and the publications and case reports concerning symptoms or adverse health effects were to be analysed in view of a better health protection and prevention. Data on risk perception and communication as well as available public information in connection with this phenomenon and electromagnetic fields were to be evaluated, and specific advice on handling and further recommendations were to be deduced.

The term "electromagnetic hypersensitivity" is used here to designate a phenomenon where individuals experience adverse health effects while using or being in the vicinity of electric, magnetic or electromagnetic field sources and devices (EMF devices). The use of the term "electromagnetic hypersensitivity" does not - by itself - presuppose or indicate any causes of these adverse reactions.

The project was made possible by a grant from DG V of the European Commission.

Description

Certain individuals experience adverse health reactions while using or being in the vicinity of EMF devices. Symptoms vary substantially among different individuals, but in the majority of cases they present mild non-specific symptoms, with objective signs normally absent - unless another disease is present. There are, however, some cases experiencing severe problems with major consequences for work and everyday life. There are no known long-term diseases related to this phenomenon. In the absence of diagnostic criteria, the observed symptoms are attributed to “electromagnetic hypersensitivity”.

Both symptoms and attributions do vary substantially between different afflicted individuals. The occurrence and appearance of this phenomenon also vary considerably throughout Europe. It is possible that the varying use of a term like "electromagnetic hypersensitivity" for many different types of claimed adverse health effects could be one source of this diversity.

Literature review

The scientific literature was evaluated for information on relationships between relevant symptoms and exposure to electromagnetic fields (EMFs), and for

information on possible causal factors for "electromagnetic hypersensitivity". There is a need to differentiate clearly between biological/physiological effects and adverse health reactions. In terms of relationships with EMFs, it should be noted that the report deals with situations where field levels are below accepted international limits. Extrapolation between frequencies is not justified. Some investigations are difficult to interpret because of inadequacies in exposure assessments, absence of clear definitions of medical terms etc.

This review was unable to establish a relationship between low or high frequency fields and "electromagnetic hypersensitivity" or with symptoms typically occurring among such afflicted individuals. The results are often inconsistent and conflicting. Furthermore, the absence of credible mechanisms (both physical and physiological) should be noted. In addition, other possible causal factors were suggested, such as low humidity or flickering light. Among such other factors, the possibility that the risk perception/worry could be a causal factor for certain symptoms must be considered. Like most disorders and illnesses, there were indications of a multifactorial causation of "electromagnetic hypersensitivity".

Two large groups of afflicted individuals have been identified; individuals with mostly neurasthenic symptoms with a general or varied attribution to various sources of electromagnetic fields, and individuals working with visual display units having primarily skin problems. These different groups may require separate descriptions and approaches, as their individual traits, symptoms, attributions and prognoses appear to differ.

Risk perception and risk communication

The concepts of risk perception may be used to describe the reactions of people when using or being in the vicinity of EMF devices. As is the case with any risk, perception varies depending on social background, country and education. Risk perception appear to influence what symptoms are reported by people claiming "electromagnetic hypersensitivity", and would therefore contribute to the heterogeneity of the picture.

Very different perceptions are found among different stakeholders, in particular between experts and the general public. This also has to be taken into account when risk perception is analysed in order to deduce communication concepts. It has to be kept in mind that inadequate communication, such as bias among the communicating parties, selecting wrong target groups or using ill prepared information invariably lead to misunderstandings and problems. In the worst case there is an increased concern, a loss of credibility of the experts and/or an increase of symptoms.

It is acknowledged that public media information is of a transient nature and can change long-term habits only very slowly. However, as public media play an important role, journalists as opinion leaders are an important target group. It is

also necessary that officials or scientists communicating with journalists are capable of presenting their knowledge and the results of studies and research.

Available information

In order to get a better understanding of the information people have about EMFs, information brochures available within different EU states were collected and reviewed. The main finding is that the availability of such leaflets is very non-homogeneous across the EU and the various groups. The leaflets obtained were prepared by different stake holders, such as authorities, industry, scientists, self-aid groups and other organisations. In the reviewed material, information on EMFs was fairly good and comprehensive. However, only a few different target groups were addressed, and "electromagnetic hypersensitivity" was mentioned very rarely or only marginally. For the layout and the preparation of such brochures, it appears that often no professional help, e.g. by communication specialists, was used.

Handling

In some countries and within some organisations, schemes to handle "electromagnetic hypersensitivity" center around:

1. Prevention, mainly concerned with information and mitigation of factors known to give rise to adverse health effects such as indoor air quality or stress conditions.
2. Intervention or early handling of afflicted cases, including medical examination to detect if the individual suffers from a known disease, and investigations of the relevant situations for other factors besides EMF.
3. Treatment, primarily directed towards reducing symptoms and functional handicaps.

Practical experience strongly suggests that early intervention greatly reduces the likelihood of more serious problems.

To reduce the exposure to electromagnetic fields in the relevant situation(s) is a commonly asked for action by individuals claiming "electromagnetic hypersensitivity". There are, however, both advantages and disadvantages of such actions, such as measuring and reducing field emissions or avoiding field exposures. These must be carefully considered, case by case.

Recommendations

This project led to the following recommendations:

The phenomenon known as "electromagnetic hypersensitivity" requires various actions. The extent to which such activities are needed may differ considerably between different European nations and between different organisations.

It is strongly advocated that further information on "electromagnetic hypersensitivity" should be made available. Such information, however, must be based on currently available scientific information, and be carefully tailored to specified target groups. The limited number of seriously afflicted individuals, and the absence of evidence for EMFs as causal factors, do not justify alarmist reports. Well designed information plays a major role in prevention and early handling.

The existence of individuals with severe health problems who claim to be "electromagnetic hypersensitive" is a clear motivation for adequate handling. Such handling would emphasise the need to reach afflicted individuals at an early stage, and to avoid concentrating on single factor explanations. A case-by-case approach within broad recommendations may prove to be effective.

Because of the inability to clearly describe the syndrome and causation of "electromagnetic hypersensitivity", further scientific research is warranted. Research should be centred on the causation of specified symptoms or syndromes, and verification of specific hypotheses. The phenomenon also gives rise to other areas of investigations, such as the role of risk perception and risk communications.

Introduction

General background

In many countries there is increasing concern about reports of cases of various suspected environmental illnesses. One such is that of individuals claiming that the reason for their adverse health symptoms could be exposure to electric, magnetic and electromagnetic fields (EMFs) from nearby electric appliances. This is a major concern in a few countries, where also practical health related work is directed towards this problem. The concern appears to increase in some countries, but it is little noticed in other nations. The fact that the majority of people under similar exposure conditions does not exhibit any reactions - even in countries with major concerns - is assumed to be due to affected persons having an increased sensitivity to such environmental factors. This explanation has been adopted by public media and coined in various terms like “electrosensitivity“, “electric allergy“, “electromagnetic hypersensitivity“ or “sensitivity to electricity“. These terms and their applications are based on the conviction and self classification of individual subjects.

Within this project, the term “electromagnetic hypersensitivity“ is used to describe a phenomenon where individuals experience adverse effects while using or being in the vicinity of devices emitting electric, magnetic or electromagnetic fields (EMF devices). The use of this term does not imply an already established relationship between EMFs and the health reactions. For this reason, the term is - in this document - always within quotation marks (“...”).

Presently the issue of “electromagnetic hypersensitivity” has gained considerable public attention and led to the formation of self aid groups (SAGs) of afflicted persons in different countries in Europe as well as overseas. Although the role of the electromagnetic environment is still unclear, it has to be acknowledged that there are people with health problems of unknown origin that might become so severe that they quit their workplace and even change their entire life and move from their home in cities to rural areas.

It is also recognised that this topic has received different awareness in various European countries: In Sweden, a substantial part of the EMF research and health related efforts is directed towards “electromagnetic hypersensitivity“ primarily in relation to office work situations and visual display units (VDUs). In other countries like Austria and Germany, concerns of people appear to be more concentrated on the exposure at home and focused on power lines and transmitter stations.

In recognition of this problem, DG V of the European Union has supported this project. It was the aim of this project to collect and evaluate the scientific knowledge and practical experience on possible health implications of subjective

symptoms allegedly related to EMFs. The prevalence of the phenomenon within the various member states of the European Union was also to be assessed.

Based on the assumption that information plays a major role, the presentation and dissemination of information material within different European countries was investigated, taking into account risk perception and risk communication. Originally it was also planned to prepare a compendium of information material for use throughout the EU. However, one of the main results of our investigation was that effective information has to be tailored exactly to the situation (target group, country, subject) and therefore ready-made and general information appear to be of limited value.

Organisation of the project work

The project was managed by the National Institute for Working Life (Sweden) and was co-ordinated by U. Bergqvist (Sweden) and E. Vogel (Germany).

The following researchers have participated (in alphabetic order):
Dr Leif ARINGER
National Board of Occupational Safety and Health, Sweden,
Dr Ulf BERGQVIST
National Institute for Working Life, Sweden,
Dr Joe CUNNINGHAM
Electrical Supply Board, Ireland,
Dr Fabriziomaria GOBBA
Department of Biomedical Sciences, University of Modena, Italy,
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Institute for Biomedical Engineering, Austria,
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Centre Hospitalier Universitaire de Nimes, France,
Dipl.-Ing Georg NEUBAUER
Austrian Research Center Seibersdorf, Austria,
Dr Ingeburg RUPPE
Federal Institute for Occupational Safety and Health, Germany,
Dr Paolo VECCHIA
National Institute of Health, Italy,
Dr Evi VOGEL
Federal Institute of Radiation Protection, Germany, and
Ms Cecilia WADMAN, scientific project secretary
National Institute for Working Life, Sweden.

The project was based on:

- three meetings of the participating scientists,
- the elaboration and evaluation of a questionnaire which was sent to official institutions as well as self aid groups,

- the evaluation of information brochures about EMFs, available in different EU countries and
- contributions and talks of invited experts at the second meeting in München, November 1996 and the third meeting in Stockholm, March 1997 (see below).

Invited experts and acknowledgements

The following experts were invited to some project meetings (the titles of their respective talks are also indicated):

Prof Eduard David, Germany
Universität Witten Herdecke, Institut für Physiologie, Witten
"Electrosensitivity and magnetosensitivity - psychosocial aspects",

Mr Lars Grönqvist, Sweden
National Institute for Working Life, Solna (currently at the National Board of Technical Development)
"Electrosensitivity in Sweden - the role of the media",

Ms Renate Harrington, Haltenbek, Germany
"The role of media in the communication of negative and positive news",

Dr Lena Hillert, Sweden
Environmental Illness Research Centre, Huddinge
"Medical approaches to electrosensitivity",

Prof Oswald Jahn, Austria
Abteilung Arbeitmedizin, Universität Wien, AKH, Wien
"Handling of electrosensitive people",

Dr Mike Repacholi, Switzerland
WHO Office of Global and Integrated Environmental Health, Geneva
"The international EMF project",

Dr Turid Vendshol, Norway
Norwegian Board of Health, Oslo
"Project on sensitivity to electric and magnetic fields",

Prof Arne Wennberg, Sweden
Department of Occupational Medicine,
National Institute for Working Life, S-171 84 Solna, and

Dr Peter Wiedemann, Germany
Forschungzentrum Jülich, Gruppe MUT, Jülich
"Risk perception".

We would like to express our gratitude to these invited experts for their valuable contributions to the project. It is also appreciated that due to the additional support by the National Institute for Working Life, Stockholm, Sweden and the Federal Institute of Radiation Protection, Munich, Germany (beyond that included in the project), as well as by their respective affiliations, it was possible to profit from the expertise of all these experts.

Description of “electromagnetic hypersensitivity”

Preamble

According to the plans laid out for this project, the following information of a descriptive nature was to be obtained:

- A description of cases of “electromagnetic hypersensitivity” in the different participating EU member nations - including symptoms, situations where symptoms appear, and allegations as to causes.
- Formal definition(s) of cases (if possible), and a discussion of the extent of the problem - with data (when available) from different countries.

It was quickly apparent that the data basis for responding to several of these questions does not exist. For this reason, a questionnaire was sent out across Europe to overcome this lack of information, and enabling some comparisons between different countries. The information gained by this questionnaire is described below, augmented by some information from other sources.

Two further comments based on the information described here and elsewhere in the report are appropriate. Firstly, no formal definition or diagnosis of “electromagnetic hypersensitivity” is possible, because of a/ the nonspecificity of the symptoms, b/ the apparent heterogeneity of the afflicted individuals and c/ the lack of an established aetiology. (A working definition for the purpose of the study was given in the introduction, see above). Secondly, and for similar reasons, no “typical” cases of “electromagnetic hypersensitivity” could be identified, therefore the case descriptions given below should be seen as examples only, and not as an attempt to establish any typicality.

Questionnaires

In order to assess the appearance of “electromagnetic hypersensitivity”, a questionnaire was designed to solicit responses from certain organisations to questions concerning the awareness of the problem, estimates of the extent, situations where problems appear, symptoms and consequences for the afflicted individuals.

Questionnaires were sent to centres for occupational medicine and other similar organisations (COMs) and self-aid groups (SAGs) in different European nations. The questionnaires were written in English, German, Italian, French and Swedish (see Appendix 2 for the English versions). The numbers of questionnaires sent out and received were as follows (see also Table 1):

- 138 questionnaires to centres of occupational medicine (COM) in the following 18 European countries: Austria, Belgium, Denmark, Faroe Island, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Norway, Portugal, Spain, Sweden, The Netherlands and United Kingdom. The reply rate was 45 %. Non-responding countries were Belgium, Greece, Luxembourg, Portugal and Spain.
- 15 questionnaires to self aid groups (SAG) of "electromagnetic hypersensitive" individuals in the following countries: Denmark, France, Germany, Norway, Sweden and Switzerland. In all we received 10 answers from all of these countries except Switzerland, including answers from 2 SAGs in Ireland.

It should be emphasised that the selection of addresses, the response rates as well as the type of questions asked do not permit detailed and absolute quantitative assessment of the situation across Europe. The intention behind this questionnaire was rather to have a descriptive and - to some degree - a comparative assessment between different countries. Nevertheless, a rough estimate of the extent of the problem could - in our opinion - be obtained.

A detailed description of the responses is given in Appendix 1, and summarised below.

Symptoms

The respondents, both the COMs and the SAGs, were asked to list the five most common symptoms reported in connection with the use of electrical appliances or proximity to EMF sources. The answers may be classified into the following groups - the first two are further specified:

- Skin symptoms; objective, subjective or undefined.
- Nervous system symptoms; sleep disturbances, decreased arousal, neurasthenia, stress, irritation, anxiety and headache.
- Hormonal and metabolic disorders, general body symptoms, cardiovascular symptoms, eye symptoms, ear/nose/throat problems and digestive problems
- Other responses concerned different types of cancer, allergy, reproductive and pregnancy problems and various symptoms attributed to the sick building syndrome.

Overall, the most common symptoms for "electromagnetic hypersensitivity" encountered among the responses were various neurasthenic symptoms, headache and skin symptoms. Other more specific symptoms such as sleep disturbances or anxiety occurred less consistently among these descriptions.

The answers differed considerably between different European nations, however, especially considering the relative importance of nervous system and skin symptoms. In the Nordic countries - with the exception of Denmark - skin symptoms occurred fairly often among the COM responses, while skin symptoms were not so reported from France, Ireland, Italy and United Kingdom. In COM

responses from Austria, Denmark and Germany, some mention of skin symptoms was made, but appeared to be of minor importance compared to nervous system symptoms.

Essentially, all replies from the different countries did suggest a number of various nervous system symptoms in connection with "electromagnetic hypersensitivity". Neurasthenia was the most common among the six different symptom types (except for the COM reply from Ireland) followed by headache, but otherwise no obvious pattern of nervous system symptoms could be found that was consistent among the different European nations. Likewise, it was difficult to discern general patterns among other types of symptoms.

Comparisons of symptom prevalences between individuals with "electromagnetic hypersensitivity" and other individuals that has been made in some Swedish investigations (19, 20) deserve some further comments. It was noted that the symptoms occurring among "electromagnetic hypersensitive" individuals also occurred in other groups of individuals - thus no specificity of symptoms could be discerned. The differences were more directed towards the number of symptoms reported by an individual - "electromagnetic hypersensitive" individuals appeared to report a larger number of symptoms (20). Based on symptoms, it was also indicated that individuals with "electromagnetic hypersensitivity" could be separated into several subgroups (see further below).

Finally, it should be noted that most descriptions were aimed at the identity of different symptoms - not at the severity. The majority of individuals do appear to report mild symptoms, however, there are a smaller number of cases with severe health problems (see further below).

Attribution to sources

"Electromagnetic hypersensitivity" reactions were seen in different situations and have been attributed to different sources - and these appear (again) to differ between different European nations.

In most countries, according to the COMs, problems arose most frequently at the workplace, with the exception of Germany and possibly also Austria, where primarily situations at home were associated with "electromagnetic hypersensitivity". In contrast, outdoor situations in general seem to play a minor role (this was indicated by only a few COMs). The same pattern was reported by the SAGs, except for France and Ireland, where the SAGs emphasised home situations, whereas the COMs pointed towards work situations (note, however, that we do not have SAG replies from all countries).

More pronounced differences between countries were found when the COMs and the SAGs were asked for specific EMF sources being reported in connection with "electromagnetic hypersensitivity". Basically, sources of radiofrequency (RF) fields such as telecommunication masts, broadcasting or TV towers and radar stations were strongly reported by several COMs and SAGs in Denmark, Germany, France, Ireland and Italy, while more localised sources such as

induction heaters, plastic welding or microwave ovens were mentioned in the answers from Denmark, France, Germany, Italy and United Kingdom. Mobile phones were reported by Germany, Ireland, Italy and Sweden. With this last exception, no mention of RF sources as being a common source of problem was made from Sweden, Norway or Finland.

For sources of low frequency EMFs, power lines or transformer stations were emphasised in the replies from a number of countries except Sweden and Finland, while electrical appliances at home were emphasised by Danish, German, Swedish and French COMs or SAGs. Visual display units (VDUs) or fluorescent tubes (thus also sources of light) were reported primarily from the Nordic countries (Denmark, Finland, Norway, Sweden) but also by a few German and Italian COMs.

Thus, these data do suggest some fairly distinct geographical variation, with a "Nordic" scene where use of VDUs (and possible vicinity to fluorescent tubes) predominate, while other countries exhibit a more diverse attribution to various sources of both low and higher frequency fields.

The questions whether individuals who reported "electromagnetic hypersensitivity" also tended to report allergic problems, problems with dental alloys or multiple chemical sensitivity were indicated rather differently by different organisations. The SAGs generally affirmed this, whereas the COMs by and large restricted such correlations to dental alloy attributions or failed to suggest such correlations.

The extent of "electromagnetic hypersensitivity"

In Table 1, the answers to some questions related to the estimated extent of this phenomenon in different European countries are shown (for further details, see Appendix 1).

The results show that the estimates of the total number of cases differ substantially between these countries as well as between the answering groups: SAGs usually give numbers about one order of magnitude higher than COMs.

The countries with the highest estimated occurrence of "electromagnetic hypersensitivity", as estimated by SAGs as well as by COMs appear to be Sweden and Germany, followed by the other Nordic countries. SAGs in Ireland and France also estimate a high number of cases, in contrast to the respective COMs who give very low numbers. From Austria, Italy and the Netherlands, we only received answers from COMs, indicating low numbers of "electromagnetic hypersensitivity". COM replies from United Kingdom do not really suggest the presence of the phenomenon (we had no SAG reply from United Kingdom). No replies were obtained from Belgium, Faroe Island, Greece, Iceland, Luxembourg, Portugal and Spain - which might suggest that in these countries, there is limited occurrence or at least awareness of this phenomenon.

With a few exceptions, the proportion of severe cases to the total number of estimated cases is in the order of 10% throughout the European nations that have provided any estimates; this ratio is the same for both SAGs and COMs.

Table 1. Estimated extent of "electromagnetic hypersensitivity" in some European nations

Country	No of replies	Phone calls/ week a/	Number of members b/	Median no cases c/	Median no severe cases d/
Austria /COM	4	<1/week	-	10-100	<10
Denmark/COM	13	<1/week	-	100-1 000	10-1 000
-"- /SAG	1	-	75	1 000-10 000	100-1 000
Finland/COM	2	<1-4/week	-	10-100 and 100-1 000	10-100
France/COM	6	<1/week	-	10-100	<10
-"- /SAG	2	-	4 + ? e/	1 000-10 000	100-1 000
Germany/COM	8	≥5/week	-	1 000-10 000	1 000-10 000
-"- /SAG	3	-	300	>10 000	>10 000
Ireland/COM	1	no reply	-	10-100	<10
-"- /SAG	2	-	350 f/	>10 000	1000 - 10 000 and >10 000
Italy/COM	4	<1/week	-	10-100	<10
Norway/COM	6	<1/week	-	100-1 000	10-100
-"- /SAG	1	-	90	100-1 000	100-1 000
Sweden/COM	8	<1/week	-	1 000-10 000	100-1 000
-"- /SAG	1	-	1800	>10 000	1 000-10 000
The Netherlands/ COM	1	<1/week	-	10-100	<10
United Kingdom/ COM	7	<1/week	-	<10	<10

Notes for table 1

a/ The "average" number of phone calls received - the question was only asked to COMs. Median of all COM replies indicated.

b/ The number of members in all SAGs who replied (combined).

c/ The estimated number of cases in the country. The median of all COM or SAG replies indicated (unless otherwise indicated).

d/ The estimated number of severely afflicted cases in the country. The median of all COM or SAG replies indicated (unless otherwise indicated).

e/ Not specified by one of the two SAG replies.

f/ Number of "contacts" by one of the SAG. The other reported 3 members.

It should be commented on, that media have often quoted estimates of the prevalence of "electromagnetic hypersensitivity" from a few percent up to 30%, and have argued that "if a third of the general population belonged to the

"electromagnetic hypersensitivity" group, then existing exposure limits appear to be far too high". From Table 1, it can be derived that the prevalence of these estimates - when compared to the total populations of these countries - are far below these figures; ranging from less than a few per million (COM estimates from United Kingdom, Italy and France) to a few tenth of a percent (SAG in Denmark, Ireland and Sweden), and with severe cases - generally - with one order of magnitude lower occurrence. (An obvious uncertainty in this evaluation is due to the fact that some SAGs reported >10 000 cases with no upper limit specified.)

As shown in an Austrian investigation, the number of individuals who believe they are "electromagnetic hypersensitive" but who do not have any actual problems related to EMF sources may be higher (11, 12). In accordance with the working definition (see above), these individuals would then not be considered as cases, as they present no symptoms.

Some case descriptions

In order to further illustrate the findings of the questionnaire and also in order to input experiences of different organisations dealing with this problem, the following descriptions of cases in different stages are given. Cases have occurred in different age and gender groups, as well as in relation to different situations (see above).

In general, health complaints of unclear origin are at the beginning of the problem. In this situation people might look for possible explanations, especially environmental factors. Whether or not "electromagnetic hypersensitivity" develops appears to depend on different circumstances - as is suggested in the variations between different European nations.

In many cases, even mild symptoms may be interpreted by the afflicted persons as warning signals of serious diseases which may lead to avoidance behaviour that may cause inability to work and social isolation. Some patients, however, report intolerable symptoms, most commonly pain or severe paralysing fatigue if they do not avoid the vicinity of EMF sources. As a result, these patients may move from modern society to isolated cottages without any electricity. If the symptoms persist in spite of these measures, as is frequently the case, the patients interpret this by having been exposed for too long a time before or by residual fields which exist even in their new environment.

It should also be noted that the same or similar symptoms occur also in individuals who do not claim to be "electromagnetic hypersensitive", and they can thus presumably be caused by various factors, also those not necessarily occurring in the vicinity of electrical appliances. Of some possible interest in these circumstances are a high working load, poor psychosocial situation, flickering light or low indoor humidity etc. In addition, the observation that - in a given situation - only some individuals develop "electromagnetic hypersensitivity" clearly points to the involvement also of internal factors relating to the individual. For these and other related reasons, the symptoms occurring among

“electromagnetic hypersensitive” individuals should be considered to have a multifactorial aetiology.

In principle, the following different stages can be discerned among reported cases. Some individuals may - during the progression of the problem - undergo all these different stages. The examples given illustrate these stage descriptions and are taken from case series in COMs. It should be emphasised that the symptoms, situations and age information given here are not typical, as there is no typical case of “electromagnetic hypersensitivity”, the examples are only used to describe the stages.

Stage 1

At this stage the patients experience temporary symptoms. Usually, they have heard of the existence of “electromagnetic hypersensitivity” and may consider a possible relationship between the occurrence of these symptoms and exposure to electromagnetic fields. According to some Swedish experiences, cases of “electromagnetic hypersensitivity” start in more than 90% with VDU-related skin problems with generally very good prognosis (9, 20) About 60-70% of the cases show a recovery within 2 to 5 years (5). In this early stage, by providing information and alternative explanations for their problems, in most cases the development of “electromagnetic hypersensitivity” can be avoided or can be treated with a fairly good prognosis and the chance of complete rehabilitation. (As already pointed out above, this predominance on VDU work origin and on skin problems may not, however, be relevant for situations in other countries, though.)

For example, C.N., 32, lived in a newly built house. When the utility built a new power line 50 m away from the house, C.N. began to suffer from headache and sleeplessness. In reaction to C.N.’s complaints, C.N. was informed about the current scientific knowledge concerning interactions between the fields and the body, and the field contribution from the power line was measured. It could be demonstrated that this contribution was much less than the fields from the daily used electric appliances. After some time, C.N. phoned back and told that the symptoms had disappeared.

In another example, an employee, A.K., 42, was told by a colleague that A.K.´s adverse health symptoms like headache, fatigue, anxiety were caused by electromagnetic fields, in particular from a VDU. When having contacted an institute for occupational health, A.K. was informed about the scientific knowledge concerning electromagnetic fields. Furthermore, in a blind experiment, A.K. was exposed to various electromagnetic fields without any reactions. As a result, A.K. accepted that the causes for the symptoms had to be due to other reasons than electromagnetic field exposure.

Stage 2

If the symptoms persist and increase either in intensity, duration and/or number of symptoms, the assumption of a connection between electromagnetic fields exposure and symptoms develops toward certainty and patients may start to look for further confirmation of their "electromagnetic hypersensitivity" hypothesis.

For example, R.G., 44, in a situation when personal conflicts at the workplace coincided with the reorganisation of the work and the introduction of computers, developed adverse symptoms like reduction of concentration ability, nervousness, low blood pressure, tingling sensations and metallic taste in the mouth. These symptoms occurred in particular when working at the visual display unit (VDU). R.G. started to collect publications on the impact of EMFs on health. Gradually the conviction grew that EMFs were responsible for the health problems. This opinion was supported by contacts with other persons claiming to be "electromagnetic hypersensitive". When R.G. contacted a center for occupational health, R.G. was not able to detect electromagnetic fields in a blind exposure situation, but insisted, however, to be affected by electromagnetic fields due to a distant visible VDU even at unmeasurable low intensities. Staying convinced to suffer from "electromagnetic hypersensitivity", R.G. changed the lifestyle and avoided the use and proximity of electrical appliances as far as possible.

Stage 3

This stage is reached by a few people only. At this stage frequently neuro-vegetative symptoms are reported to be triggered by vicinity to most electromagnetic field sources, and the patients are already convinced of a causal relationship between their symptoms and EMF sources. In this stage, the prognosis of a successful treatment is poor, supportive therapy usually only results in some improvement of daily life.

One example that might illustrate this stage is the technician P.S., 37, who experienced the first stinging and burning sensations in the face after several hour's work at the VDU. Within one year, P.S. discovered a reaction also to fluorescent light tubes and other kinds of EMF sources, including the electromagnetic fields of the car. After one more year, P.S. reacted strongly to various electrical environments, and went on sick leaves - but problems appeared also at P.S.'s own house. Therefore P.S. decided first to sleep in the car (with the ignition off) and then to live in an aluminium caravan. P.S. would have had to quit the employment if the company would not have enabled P.S. to work in a ironsheeted (shielded) room.

Possible causal factors for subjective symptoms related to "electromagnetic hypersensitivity”

As described in the introduction, "electromagnetic hypersensitivity” is used to describe a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic or electromagnetic fields (EMFs). Often, these attributions are specifically directed to EMFs from these devices, even if other factors - both physical and others - have also been suggested. This attribution to specific factors must not be confused with a statement of an established causality, however.

In the text below, we describe the results of scientific investigations which have tried to establish or indicate whether there is a link between certain factors (especially exposure to various EMFs) and symptoms typical of those claiming to be "electromagnetic hypersensitive". Studies have been performed both on the general population and on individuals reporting “electromagnetic hypersensitivity”.

A full review based on details in a large number of studies, supplemented by several reviews, is found in Appendix 3 - where also the specific references are listed.

General population-based studies

Studies were reviewed that aim to detect whether the occurrence of certain adverse health reactions are associated with exposure to EMFs. Several adverse health reactions were considered, with main emphasis on neurasthenic symptoms in the general populations, and skin reactions among individuals using visual display units. While considerable concerns are attached to various diseases (notably cancer and possibly also some neurological disorders) and EMFs, scientific investigations of such diseases are not considered in this review as they cannot be included in the given definition of “electromagnetic hypersensitivity”. It should be noted, however, that the worry and concern about such health outcomes may be of relevance for "electromagnetic hypersensitive" persons.

Low frequency fields and neurasthenic or similar endpoints

The most consistent human experimental results appear to come from investigations of EEG activity changes caused by EMFs. While these indications do motivate further investigations, it is worth pointing out that the interpretation of these changes is unclear - they do indicate a biological effect, but not necessarily an adverse effect. EMFs have been shown to reduce pineal melatonin synthesis or

increase the melatonin degradation in four studies on rodents, but failure to find such effects have also been reported in one study. Data on non-rodent mammals are very scarce, and - in the two studies performed - essentially non-positive. A few groups have investigated this possibility in humans, and generally failed to indicate any relationships.

A limited number of epidemiological studies on headaches, depressive or similar symptoms and suicide were also found and reviewed. For depressive symptoms, an association with powerline proximity was suggested in some, but not in other studies. Based on available data, it is, however, difficult to separate (presumed) effects due to the physical presence of the fields from those dependent on psychosomatic mechanisms. For headaches (migraine or non-migraine) and for suicide, no affirmative conclusions or strong indications about associations with electric or magnetic fields could be made. The absence of direct measurements of field levels in most studies, the lack of a well formulated hypothesis of interaction and the varying and in some studies limited scientific quality, all contribute to the inability to make any firm conclusions.

In conclusion, while some results exist that do motivate further research into the possibility of adverse neurasthenic reactions to low frequency fields, current scientific knowledge is unable to prove this possibility.

Radiofrequency fields and neurasthenic or similar endpoints

It is not possible to extrapolate results between different frequencies, so results obtained in subjects exposed to extremely low frequency fields cannot be directly applied to radiofrequency field (RF) situations and vice versa.

For individuals regularly exposed to high levels of RF fields capable of causing substantial thermal effects, or accidentally exposed to very high levels, various neurological and other adverse effects have been demonstrated. The main concern here, however, is with low level RF field exposures - i.e. below those causing thermal interactions with the body, and below the exposure limits set by various national and international guidelines or standards.

Epidemiological and experimental studies that investigate the possibility of neurasthenic effects of such low level RF exposures are very few. Again, it is currently not possible to describe and verify mechanisms that could elicit a biological response of RF exposures below those relevant for known (thermal) interactions. In some contrast, it is possible to formulate a psychosomatic mechanism of interaction - but of course only for situations where the individual is aware of the exposure. In an investigation of sleep problems reported around a Swiss short-wave transmitter, efforts to exclude a psychosomatic mechanism explanation were made, but not fully successful.

A few other studies have also investigated sleep parameters and other outcomes - both biological (EEG changes) and adverse reactions. Overall, the data is at present not sufficient to establish neither the reliance of adverse neurasthenic effects of low RF exposure on mechanisms other than psychosomatic ones nor

indeed their general existence. A few observations and reports are worthy of further investigations, though.

Skin symptoms among VDU users

Skin symptoms are - in some countries - fairly common among those working with visual display units (VDUs). Overall, an excess occurrence of subjectively reported skin complaints or symptoms was found among VDU users, whereas a relationship with objective signs or diagnosed skin disorders appears less clear - a case can probably be made for seborrhoeic eczema, and possibly for non-specific erythema. Most - but perhaps not all - of the cases can be described as mild, and many often appear to improve or disappear even without any remedial action being taken. (The information available on studies from other countries than Sweden and Norway is limited and have produced varied results, even if it can be argued that three out of four available studies have at least indicated an excess of problems among VDU users vs. non-users.)

Some investigations have attempted to find possible causal factors for this phenomenon. The evidence for or indications of an involvement of various electric or magnetic fields on such VDU-related skin problems appear weak to almost non-existent. Some further attention could be given to the possibility that the body's static charges may lead to a higher facial deposition of skin irritants, though.

Generally, a fairly large body of evidence connects indoor air climate or stress factors with skin problems - evidence obtained in other than VDU work situations. Additional VDU-specific studies reviewed here are - in our opinion - sufficient to indicate that such generally accepted factors for skin complaints are operating also in VDU work situations, and to at least suggest that these may actually be major explanatory factors for the noted association between VDU work and skin ailments.

Reactions among individuals with possible special sensitivity

The evidence for the existence of groups with special sensitivity that could be of relevance to "electromagnetic hypersensitivity" was reviewed. Furthermore, investigations into possible causal or contributing factors for symptoms among such individuals with "electromagnetic hypersensitivity" were also summarised and evaluated.

There are indications that "electromagnetic hypersensitive" individuals should not be considered as a homogeneous group. A basic distinction - based primarily on Swedish data - appear to exist between individuals with skin symptoms who attribute them to VDU work situations, and individuals with (primarily) neurasthenic symptoms who attribute them to a variety of situations. Such a distinction can be supported not only on diversity of symptoms and attribution, but also - in a few investigations - on specific findings.

As already outlined before, there is a considerable diversity across different European nations when examining the appearance of "electromagnetic hypersensitivity". Even if the distinction between the skin symptoms and neurasthenic symptoms groups, described above for Sweden, seems valid, the number and the proportion of the subjects included in these groups vary a lot. One possible rationale would be that of a more general occurrence of individuals with neurasthenic symptoms attributed to a variety of sources in several European nations. In addition, observed skin problems among VDU workers would be attributed to "electromagnetic hypersensitivity" in a few countries, while in others, they would be considered as related to other factors and/or called differently.

Individual and possibly predisposing factors

It must be pointed out that further attempts to identify individuals with a special sensitivity of possible relevance to "electromagnetic hypersensitivity" is based on a limited number of investigations, with somewhat varying approaches.

One investigation indicated that individuals with VDU-related skin complaints differed from non-cases in terms of certain hormonal reactions (prolactine and thyroxine) while working with a VDU, and the authors suggested that this could be related to a "stress reactivity". Some investigations have examined relationships between e.g. prolactine levels and EMFs - both in "electromagnetic hypersensitive" and general public individuals - in most cases without finding any such relationships.

Some other results on increased reactivity and other possible predisposing factors among "electromagnetic hypersensitive" individuals consist of observations of increased facial skin temperatures, on different psychological profiles (e.g. concerning socialisation or difficulty in taking initiative), on dermatological or histopathological findings etc. It has been argued that the presence of such or other similar predisposing factors could be involved in transforming a mild and perhaps insignificant reaction (including a reaction within the “normal” physiological range) into a stronger and definitively adverse reaction. Arguments have also been forwarded for a contributing role of risk perception and worry in such processes.

It should be pointed out, however, that while these studies point to an interesting set of descriptors, further work concerning their possible role in the origin of the "electromagnetic hypersensitivity" are warranted before any more definite conclusions should be made.

Electric or magnetic fields and "electromagnetic hypersensitivity"

Provocation studies have been carried out on individuals with skin complaints during VDU work as well as on individuals with ”electromagnetic hypersensitivity”, mostly in Sweden and Norway. In one study, weak indications of reactions to electric/electrostatic fields in terms of tingling or pricking sensations

were reported, while in another, various symptom did appear after exposure to magnetic fields at varying frequencies (0.1 Hz to 5 MHz). (It should be noted that the US study cited above with varying frequencies - together with a UK study - is based on individuals primarily claiming multiple chemical sensitivity, and that the relationship between this syndrome and "electromagnetic hypersensitivity" has not been resolved.) The results in the other 9 of the 11 studies were an inability to a/ detect fields and/or b/ to react to them in terms of symptoms. Individuals with “electromagnetic hypersensitivity” often developed symptoms during these tests, but these symptoms appeared to be independent of the field variation in the studies.

Taken altogether, provocation studies to date have not been able to verify a direct link between (mainly) low frequency fields and problems of "electromagnetic hypersensitivity" that is shown to be independent of awareness of the fields. For fields of higher frequencies, the limited number of studies and the limited number of individuals actually tested enable no conclusions to be made.

Other suggested factors for "electromagnetic hypersensitivity"

A noteworthy observation obtained in a few of these provocation studies was that while the actual fields were not associated with increased discomfort occurrence in the subjects during the test, guessing that the fields were "on", were so related. While this is an interesting observation in terms of the possibility of psychosomatic (worry-driven) mechanisms, the interpretation is far from clear (did discomforts influence the guesses that the fields were on, or did the belief in the fields being on influence the development or perception of symptoms?).

Among some cases of "electromagnetic hypersensitivity", attribution has been to "electrical" appliances that also emit modulated light (VDUs, fluorescent tubes). Based on these observations, a few investigations have indicated that some "electromagnetic hypersensitive" individuals are more sensitive to such light modulations ("flicker") than the controls. At present, the limited amount of data offer no firm conclusions - beyond observing that other physical factors than EMFs might be of interest for at least some subgroups of "electromagnetic hypersensitive" individuals.

Finally, it should be observed that a number of cases of skin problems among VDU operators have been diagnosed as "normal" skin disorders (such as contact dermatitis).

Perception and communication of risks due to electromagnetic fields

Risk perception

Along with ongoing debates, the awareness of possible risks of exposure to electromagnetic fields radiated or emitted by a variety of sources is increasing in all industrialised countries. The way these risks are perceived by different people, however, is not the same.

The personal risk attitude influences the response of individuals, including to some extent subjective health symptoms, which thus might be of psychosomatic nature. This hypothesis is supported by a recent study by McMahan and Meyer (14) on residents living adjacent to power lines. The results indicate that the prevalence of subjective EMF-related health problems (headache, migraine, poor appetite, etc.) is higher in people who are more worried about EMFs (see further discussion in the previous section above). Therefore, understanding the mechanisms of risk perception is of fundamental importance not only to improve the communication between scientists and the general public, but also to evaluate the plausibility and relevance of claimed effects such as “electromagnetic hypersensitivity”.

Factors influencing risk perception

Some general methods of analysis have been developed, which are described in overview papers (e.g., 22). In particular, Covello (3) identified a number of factors which influence the perception of risks in studies concerning nuclear power, toxic substances and environmental pollution (see Table 2). Kunsch (10) also suggested a number of such factors which may be relevant for the perception of risks from EMFs. However, their relevance varies for different sources. The importance of individual factors seems in fact to differ from one kind of EMF to another.

With this regard, it is important to note that, also due to the large use of generic terms in different countries such as “electromagnetic pollution” or “electrosmog”, lay people tend to consider non-ionising radiation as a whole, with no clear idea of the basic differences, for example, between magnetic fields from power lines and high frequency fields radiated by cellular phones.

Table 2. Factors involved in public risk perception, from Covello (3)

Factor	Conditions associated with increased public concern
Accident history	Major and sometimes minor accidents
Benefits	Unclear benefits
Catastrophic potential	Fatalities and injuries grouped in time and space
Controllability	Personally uncontrollable
Dread	Effects dreaded
Effects on children	Children specifically at risk
Effects on future generations	Risk to future generations
Equity	Inequitable distribution of risks and benefits
Familiarity	Unfamiliar
Media attention	Much media attention
Origin	Caused by human activities or failures
Personal stake	Individual personally at risk
Reversibility	Effects irreversible
Scientific evidence	Risk estimates based on human evidence
Trust in institutions	Lack of trust in responsible institutions
Uncertainty	Risks scientifically unknown or uncertain
Understanding	Mechanisms of process not understood
Victim identity	Identifiable victims
Voluntary exposure	Involuntary

As a consequence, factors which are mainly related to a specific source may also influence the attitude of the public towards others. The most evident example is the problem of cancer, connected with several of the factors listed in Table 2: effects on children, effects on future generations, (ir)reversibility etc. There is some evidence, though controversial, of an association between ELF magnetic fields and cancer, but no such evidence exists for high-frequency fields (18). In spite of that, concern is widespread within the public, e.g. for brain tumours from cellular phones. On the other hand, symptoms which were initially reported for VDU operators, such as dermatological effects, are claimed also in the case of

residence near power lines, where an etiological role of EMFs is difficult to substantiate.

The effects of familiarity also seem different for power frequency and high frequency fields. People are generally not familiar with radiofrequency and microwaves, but are familiar with electricity. In the first case, the lack of familiarity may be a cause of concern, as suggested by Covello (3); on the other hand, it has been noted that people tend to strongly react with fear when they discover, or suspect, hazards from agents they are used to live with, and which have been considered safe for a long time, such as electricity.

As shown in the Appendix 4, it may be presumed that most of the factors listed in Table 2 are relevant in the case of electromagnetic fields, the exceptions being limited to catastrophic potential, victim identity and accident history.

The appraisal of risk

Both the overall perception of risks and the relative importance of the factors listed above differ from one individual to another, and among social groups, depending on e.g. education, age, gender, social class etc. Other questions can therefore be addressed by risk research, such as: "How does risk perception differ in different groups?" or "How is risk perception modified by knowledge (on mechanisms, scientific findings, etc.)?". In particular, a question of crucial importance to improve good communication is: "How different is the perception of risks between lay people and experts?". This question has been addressed by Fremling (6) and by the Harvard Center for Risk Analysis (7, 8) who indicated a substantial difference in appraisal, and a large variety in the confidence about the very existence of health risks, even within the scientific community.

The relationship of knowledge and familiarity of risks with their perception has been the object of a study on power lines performed by Morgan and co-workers (16) and more recently by Maerli (13). The main findings of these studies, which are discussed more extensively in Appendix 4, are that the same risk is perceived differently according to voluntarity, and that information about scientific findings generally leads to the perception of risks as more dreadful.

This confirms once again the crucial importance of correct communication, which influences not only the perception of risks, but also its possible modifications, as analysed by Wiedemann and Schütz (22). They identified several factors which might influence the further development of risk perception in the society, and found that the most relevant are science and technology (i.e. the capability of science to prove or disprove the existence of risks, and of technology to mitigate them); societal structure (i.e. possible new social and political conflicts that may limit the attention given to technological risks); and economy (i.e. the economic capability of the society to deal with the problem of health hazards from EMFs).

The future relevance of qualitative factors discussed above, and consequently the development of the EMF controversy, will depend to a large extent on these societal conditions.

Risk communication

The American National Research Council stated that risk communication is "an interactive process of exchange of information and opinion among individuals, groups and institutions; often involves multiple messages about the nature of risk or expressing concerns, opinions or reactions to risks messages or to legal and institutional arrangements for risk management" (17). This definition clearly shows that communication about risks, especially highly uncertain risks is a very intricate and demanding process. The roots of risk communication research date back to the 1980s where the first research activities in the United States where supported e.g. by the Environmental Protection Agency, the National Science Foundation and also the industry. Up to now most groups have been working on questions related to nuclear power, radon or chemical pollution (e.g. 1, 4). Only a few research teams have been studying risk communication with respect to non-ionising electromagnetic fields (e.g. 15, 22).

In the following, the application of risk communication to EMFs, with a glance at the role of the media, will be discussed.

Risk communication about electromagnetic fields

Until recently, EMF risks have not constituted a subject of high involvement by the general public, but the public is currently quite attentive towards this issue as was discussed above. People having very close and/or permanent contact with sources of EMF, e.g. living very close to powerlines, broadcasting or mobile phone towers and particularly sensitive people attribute a high relevance to EMF. Nevertheless, issue research (2) tells us that risk controversies start in small fringe groups, they "name" the risk, as has happened with EMFs, e.g. "electromagnetic pollution" as the term is used in some English speaking countries, or "electrosmog" in German speaking countries. Then the media coverage grows, as has also already happened in this case. The next stages described in issue research have not yet been reached in general through Europe: such as an escalation of media reports and the reaching of a crisis point, where related products or industries face a decisive decrease in acceptance and report dropping sales. Therefore it is necessary to analyse carefully the current debate in order to prevent such a crisis situation and not to enhance apprehensions of people which may lead to a reduced quality of life.

The traditional approach to risk communication has involved conferring with experts to see what people need to know. Subsequently, information material have then been prepared. However, this approach very often encounters cognitive difficulties and does not show the desired result. At Carnegie Mellon University/Pittsburgh, USA, a new approach to risk communication was developed and also applied to low frequency EMF (15). In this approach, expert understanding on EMF was obtained in parallel with investigations on how people frame this problem and what they know or belief about it. Then the decision problems

people face were extracted and a mental model was developed, i.e. a model describing the process of understanding and decision taking. In a further step the ability of this model to support people's decisions was tested and only then was information material designed and communicated to the people. This approach takes into account that people do not process and interpret new information in an isolated way. They process and filter information with reference to existing knowledge understandings and beliefs. The main finding of this study was that lay people do have a variety of incomplete and confused understandings about low frequency EMF, but relatively few beliefs that are outright wrong. However, some of these incomplete and incorrect understandings will pose problems in public policy decision making.

A German study (22), also using interview and discussion group techniques, focused on risk perception and risk assessment in the case of high frequency fields. Additionally, it considered the differences in risk assessment among experts, because risk discussion is also a discussion led by experts, depending very much on the credibility of experts, especially when new technologies such as mobile phones begin to spread. One of the main findings was that among different groups very different communication patterns exist and therefore different strategies have to be used to address them effectively.

The role of the media

The influence of mass media on the communication of positive or negative news is tremendous, even rational people can be influenced quite a bit by the media. Journalists are trained how to spread, control and sell news effectively because this is a big business; some main aspects of which are:

- Facts, background knowledge and any correlations are presented in a very reduced way, so to speak as a black and white picture. However, scientific findings usually do not fit such a picture but have many facets, so when they are forced in such a black and white scheme the content as well as the message could become wrong.
- News may be created from opinions only, however opinions are very variable and public opinions can change in the process as a topic develops.
- News are presented as a kind of entertainment.

Due to the entertainment aspect, bad news or even panics are well received by the people but they are very slow in actually changing the habits of the people permanently. They may however make people want others, officials or industry, to change something. This is a way of passing the responsibility, something which also already happens at the stage when news are consumed but there is an artificial distance between the consumer and the action on the screen or the text in the paper.

Therefore journalists themselves do believe that the influence on the public or the individual is very much overestimated and that people are very well able to

discern between serious news and entertainment (Harrington, R., presented to the project group in München 1996). In order to produce such serious news one does not only need journalists with a special training in e.g. science but one also has to train the researchers: Good journalists do have to discern between results of a single study, which cannot be generalised and replicable results which can be used as a basis for further conclusions. On the other hand, researchers have to present their results in an understandable way, avoiding technical language and complicated descriptions when they appear in the media (Grönqvist, L., presented to the project group in München 1996). They also should learn how to present themselves when asked for an interview. An analysis of how the media treated information about EMFs (21) lead to similar conclusions.

Conclusions

According to the findings of risk perception and risk communication research in general and of studies on electromagnetic fields, as well as due to the key aspects of the use of media, the following conclusions can be drawn:

- The personal attitudes, not only towards one specific risk, influence the response of individuals.
- The perception of risks differs among individuals, social groups, countries, as well as between lay people on one side and experts on the other one.
- Risk perception and risk communication are deeply interrelated: understanding perception is important for communication approaches, whereas communication strongly influences the appraisal of risks.
- For a valuable communication it is essential to find out how much scientific background people of different groups do have on electromagnetic fields and on what kind of mental model they base their decisions. Information programmes should then be based on these models.
- Different approaches are also needed for different countries, because the risk perception, the type of problems and the attitude towards information as well as authority and the administrative structures do vary considerably.
- Risk communication should not be mistaken as just another type of public relations or advertisement. Therefore it is wrong to rely on the usual spreading of information or on the effect of mass media. The interaction between the communicating parties is very important.
- The strategies of risk communication have to be adapted carefully to the focus group to be reached. Different focus groups concerning EMFs are e.g.: the general public, especially vulnerable people, such as pacemaker patients or people showing symptoms due to the use or the proximity to sources of EMFs.
- It has to be taken into account that not only the content of a piece of information is important but also the roles taken by the people communicating and the opinion they have on each other.
- The question of credibility of the experts, i.e. how to remain or become credible has to be addressed.

Information material used in different countries of the EU

There are many stakeholders involved in the communication of possible health effects of electromagnetic fields (EMFs). The ones trying to reach the public or certain groups of the public through written information material are mainly: companies selling technologies which involve EMFs, health authorities, media, scientists and self aid groups. Information materials distributed by some of these groups were collected within the EU - see Appendix 5 for a list of solicited and received material. It should be noted, however, that it was not possible to reach all sources of information material within the time interval given. In addition, new channels for information such as the world-wide web are increasingly used also for this type of information, and the material offered there is changing rapidly. Therefore, the material collected cannot be considered complete, but sufficient material was obtained to draw certain overall conclusions.

In the following, first of all possible aims and means of the stakeholders, as seen from the range of information material obtained, are described. Then a classification of the information material is made according to the target groups. For that reason, layout, content and argumentation space as well as general data of each document were independently evaluated by three members of the project group according to a standard evaluation form (see Appendix 5). Additionally, five non-experts were asked to evaluate one of the leaflets using the same evaluation form. This led to the conclusion that experts tended to evaluate such documents in a more positive way and that the evaluations appeared to depend on the professional education of the reader.

Stakeholders involved in the preparation and dissemination of information material

Companies

Two priorities of public or private companies selling technologies or devices which involve EMFs are to maximise the technical effectiveness of their product and to earn money. In addition, companies have to observe current norms and safety regulations in general. In the case of relatively “old technologies“, such as power lines, the policy of the utilities usually is to deal with any EMF concerns professionally (there already is a background for it) and to ensure that the position of the company is known: Pamphlets are distributed, especially when new sites are proposed, hearings are given, measurements in homes are offered and presentations in schools are made including special written information material

for schools. Concerning relatively new technologies, such as mobile phones, it was shown more clearly that there are groups of different acceptance levels among the public. For example, “yuppies“ like to use handies whereas much protests arise with the public whenever a new mobile phone tower is to be built. The companies, especially the big ones, need to tailor their information strategies much better according to the group addressed. As the market for new technologies is still much more variable compared to the older technologies, more money is likely to be invested in the communication of possible risks and even the help of communication experts is used.

Health authorities

There are international, national and regional health authorities. The international health authorities such as the ICNIRP (the International Commission on Non-Ionising Radiation Protection) or WHO usually write comprehensive reports for scientists and other specialists. These reports are, however, not intended for nor suited to be used directly for the general public. Therefore only national and regional authorities will be dealt with here as sources of information leaflets. They usually give advice to the government, regulatory bodies and to the public. Reports on different aspects are written on request e.g. from the government, sometimes with the help of invited scientists. Information brochures are prepared on subjects of general interest, specific advice may be given by phone or letters. Additionally, press releases on new topics are prepared and sometimes there are telephone help lines with changing information on special subjects.

National health authorities usually choose very careful wording, due to the fact that they try to take into account all different sources of knowledge. However, this is not always appreciated or accepted by the public and by the mass media because they would prefer more definite answers. There are examples where information brochures prepared by local health authorities, e.g. in cities, are rather emotional and subjective. This may be due to the fact that such brochures are used as an instrument of local politics. It is also obvious that the authors often did not have much background knowledge about EMFs.

In general, health authorities do not - as yet - use the latest techniques of risk communication and up to now did not employ such specialists to help them with the information material. Mostly scientists and technicians employed at the authority together with the public relations department will devise the information material.

Depending on different cultural backgrounds etc., information given by authorities is either believed by the public (or even demanded) or it is mistrusted.

Scientists

Scientists are used to describe their results to other scientists, therefore they use many technical terms and intricate descriptions which are difficult to understand for non-experts. Nowadays scientists - involuntarily as well as voluntarily - get

increasingly involved in communicating with the public. They may be asked for interviews in the media or they give presentations of their findings for the press. Scientists may also be asked to assist with official reports on specific subjects, such reports are written e.g. for the government but could be available on request for the public. Then they have to change their wording and streamline their descriptions (compare the section on risk communication above), otherwise their message will not reach the public and may lead to misunderstandings.

Self-aid groups and other private organisations

Papers prepared by self aid groups are in general usually highly emotional and often mix science with non-scientific statements. Sound background information for the reader is often missing and the style used is very persuasive. Usually the layout is poor. Often the authors do not have enough background knowledge. However, such information may be widespread, e.g. by Internet.

In some countries, private organisations have appeared, offering "environmental counselling". As they want to sell information, measurements or certain devices, such as "protective material", they tend to offer information brochures with a well prepared layout. These are, however, often found to present biased views and to lack substantial information, due to the fact that the content is intended to support the services offered.

Information material prepared for different target groups

Among the different target groups addressed are: the general public including schools or special fringe groups such as "electromagnetic hypersensitive" individuals, occupationally exposed persons, authorities and medical doctors. In the following, scientific reports, sometimes ordered and/or paid by authorities or the industry or written by international organisations such as the WHO, generally will not be included. Their content usually cannot be used as such for general information.

As most information material obtained is directed to the general public, this part will be discussed more thoroughly than the information material directed to other target groups.

General public, including schools and fringe groups

The contents of the information brochures for the general public range from general information on EMFs to information on special questions only, such as mobile phones. In addition there is quite a variation in length, ranging from a short folder to book format; for schools also posters were prepared. Usually the brochures contain fairly good comprehensive information on the nature of the fields and the possible sources. The results of different studies can only be reported in any details in the somewhat longer brochures, however most of the

brochures did hint at some existing controversies. Only in half of the information material were limits cited, when cited however, mostly national limits are given, although in some cases the values recommended by international organisations such as ICNIRP or WHO were presented. In about half of all brochures obtained some recommendations were given for daily life. Only very rarely did the information material for the general public contain information on the question of ”electromagnetic hypersensitivity”, the only brochures referring to ”electromagnetic hypersensitivity” more clearly, including examples, came from Sweden and Switzerland.

The layout in general relied on the presentation of some pictures or photos, often well chosen, with graphs and tables or lists and inserts used to underline the text. In some cases the graphs and tables seem to be somewhat complicated for the public addressed. The language was usually also well suited for the readers referred to. As was already discussed in the chapter above, the professionally of layout and the type of presentation used differs depending on the type of stakeholder preparing the information.

The argumentation space used was a little more heterogeneous, as here the influence of the authors or editors seemed to have quite some influence. The type of information can in most cases be described as an instruction. The form of a dialogue or a persuasion appeared rarely. In almost no documents were the argumentation written as a clear warning. About the same number of brochures contained either no clear cut between information and debating or such a clear cut. Most documents seem to be fairly objective, but there were some that were very subjective.

Many brochures only gave the address of the authors and thus do not give the interested reader a chance to get a source for further information.

The brochures directed to schools were nor written directly for pupils but they obviously rely on the interpretation of a teacher of natural sciences. However, the information given was usually a good enough background for some hours of teaching, with all the possible criteria discussed above well fulfilled.

We did not find brochures specifically prepared for fringe groups such as ”electromagnetic hypersensitive” people apart from those from the self aid groups themselves. The general layout was then usually very poor, as already discussed in the chapter above, and the content did not cover well either the nature of EMFs, the sources, the results of respective studies or established limits for fields strengths. The argumentation space tended to be very subjective in those cases, with no clear cut between informing and debating; sometimes even the information value was very small.

Occupationally exposed people

Only some brochures obtained were directed at people exposed at the working place. (This is also due to the fact that we asked for information for the public when collecting the brochures.) Information material for working people was usually more technical. The nature of EMFs and their sources as well as studies

were well described. Compared to the information material for the public, limits such as norms or international recommendations were much more emphasised. Possible psychosomatic effects were practically not mentioned. The content of the brochure was mostly instructive and objective, the language was well suited. The photos, tables and graphs used were fairly well laid out, however their number per brochure differed largely.

Two brochures were directed at medical doctors, specialised in working life. They were fairly comprehensive, however the style used was somewhat dry. As they were meant to be used in counselling occupationally exposed people, they used dialogues to explain facts. A clear cut was made between arguing and explaining.

Authorities, such as health authorities, ministries and other decision makers

As was already mentioned above, the relatively large number of scientific or technical reports written for them is excluded from this discussion. There were, however, a few brochures which are well worth a short discussion: They were either directed directly to other decision makers, experts or the industry and contained mainly information on possibilities of risk communication with the public. Therefore they contained almost no background information on the subject of electromagnetic fields, sources and electromagnetic field limits.

Conclusions

Notwithstanding the difficulties in obtaining an objective evaluation of the collected information material and also that the collection of such material was not complete, the following general conclusions and suggestions can be made:

Within the EU countries the distribution of information material on EMFs appears to be quite inhomogenous. The information material obtained appeared in most cases to be fairly suitable for the target groups and did also give quite objective information of today's knowledge. However, the layout and the contribution themselves could be improved with the help of communication experts. Photos, tables and graphs should be selected more carefully according to the respective target group. In addition, different target groups should be identified and the subject of the information material could be more specifically geared towards such target groups (i.e. not only containing information on EMFs in general) in order to improve information flow. It would be helpful to choose target groups which could serve as intermediates, e.g. physicians or labour inspectors. The Internet can be used to advertise such a brochure, e.g. on the home page of the organisation who prepared it.

Handling of individuals claiming "electromagnetic hypersensitivity"

Rationale for handling

A basic premise is that "electromagnetic hypersensitivity" is a real condition in the sense that many afflicted individuals suffer real and - for some - serious health problems. This seriousness, and also the consequences for others around that person (family, work place, etc.) dictate a need for remedial activities and/or help in coping with the situation. Such actions could be taken both in occupational or general public settings as well as by health care (medical) institutions. Close cooperation between these activities is advantageous.

The following recommendations on handling are based on what was elaborated in this report and partly also on some experience gained primarily in Sweden. As this chapter is a very central one in the report, the main findings of this report which was considered useful for determining what actions should be taken, are summarised also here.

On the identity of " electromagnetic hypersensitivity"

- The identification of an "electromagnetic hypersensitive" individual is based on his/her experience of adverse effects while using or being in the vicinity of electric, magnetic or electromagnetic devices (EMF devices). Thus, the individual's appreciation or apprehension of being in the vicinity of some EMF devices is (normally) a precondition for the term "electromagnetic hypersensitivity" to be applied.
- However, situations where individuals in one country or region may attribute their problems to "electromagnetic hypersensitivity", may not lead to such attribution in another area. This is presumably or at least partly due to differences in available information and media attention - major geographical differences occur in these respects.
- "Electromagnetic hypersensitivity" has different appearance and extent in different countries.
- There are currently no methods for identifying individuals with "electromagnetic hypersensitivity" apart from these individuals' attribution of their ill health (symptoms).
- Due to the general non-specificity of the symptoms, the lack of consistent objective findings, the absence of an establish aetiology, and the probable heterogeneity of the problem, the designation "electromagnetic hypersensitivity" should not be confused with a medical diagnosis.

On the causation of "electromagnetic hypersensitivity"

- The causation of "electromagnetic hypersensitivity" is not established. The term, if used, should not be taken as a suggestion that e.g. electric or magnetic fields have been identified as causal factors.
- Manifestations - and presumably also the origin - of "electromagnetic hypersensitivity" are likely due to combinations of different factors, both internal (predisposing factors for the individual) and external (factors present in a specific situation).
- So far, investigations concerning a mechanism by which the vicinity to electrical devices and appliances is involved in the appearance of health problems, have not established a direct physical link between electric or magnetic fields and the health problems, even if further investigations into these and other possible external factors appear warranted.
- There are other external factors which have, at least tentatively, been indicated in the problem, ranging from physical factors such as modulated light ("flicker") to more organisational factors such as various stress conditions.
- Indications exist that psychosomatic reactions may play an important part in the rise and/or maintenance of the syndrome. If so, concern and worry could be important factors for the effect.
- "Electromagnetic hypersensitivity" may be a heterogeneous condition - different afflicted individuals would then not be expected to have the same set of causal factors.

On handling of individuals with "electromagnetic hypersensitivity"

- Upon medical investigations, some individuals claiming to be "electromagnetic hypersensitive" have been found to have other, medically known and often treatable conditions.
- A common experience is that problems - for an afflicted individual - will be less pronounced, and improvements in the situation easier to accomplish, if intervention is made early.
- If the problem of "electromagnetic hypersensitivity" is indeed multifactorial and heterogeneous, then care should be taken not to concentrate efforts on one preconceived type of factor(s) - a broad approach appear better motivated.
- Based on the observation that the occurrence of "electromagnetic hypersensitivity" is sometimes "clustered", and the possibility that concern and worry are at least aggravating factors in "electromagnetic hypersensitivity", careful considerations must be given also to individuals around an afflicted individual, so that remedial actions warranted for one individual do not increase their worry or concern ("they are doing things, so it must be dangerous"). Information efforts should be made in order to explain what is being done and why. This may be especially relevant in occupational settings.

General outline

We have not found any officially sanctioned handling program in any of the European nations that we studied. The Norwegian Board of Health is currently evaluating the possibility of developing a strategy for treatment (Turid Vendshol, presented to the project group in Stockholm 1997). There are, however, several programs used at single medical centers for prevention, intervention and treatment of individuals with "electromagnetic hypersensitivity", and also a number of programs adapted by e.g. several larger companies (Lena Hillert and Oswald Jahn, presented to the project group in München 1996). The majority of such programs - as far as we have found - do emanate from Sweden.

Different approaches to handle "electromagnetic hypersensitive" individuals should be made in different countries, since the approach taken must - in our opinion - be geared to the varying appearances of the phenomena. A balance must also be set between the legitimate need for an individual to receive help, and the problem of increasing concern among others. This balance is most likely different in different countries or regions. The structure of health care systems also varies in different European nations and this variation must be taken into account as well.

Any system or informal way set up to handle the problem of "electromagnetic hypersensitivity", should include means by which early detection of an individual's problem is made. Profound differences in possible such means obviously differ between occupational settings and the general public domain, and between different European countries. This also implies that different strategies should be used for problems attributed to situations in the workplace - where often organisational possibilities for early handling are fairly good - and problems appearing in other situations. In the latter, the general practitioner is most likely a prime candidate for early handling, and thus an important target for information concerning "electromagnetic hypersensitivity".

In principle, the effort undertaken should be structured in accordance with the following normal procedures:

- Prevention of symptom appearance in a population.
- Intervention or early handling of afflicted cases.
- Treatment of individuals with long-lasting symptoms and severe handicap.

As already indicated, these activities would normally be handled by various organisations and professionals; occupational safety officers in workplaces, general practitioners, medical personnel in occupational health centers or special clinics etc. The important role played by information in adequate handling of "electromagnetic hypersensitivity" also suggests that it is important that these professionals do have access to balanced information on the topic - and that they share a common view.

Prevention of symptom appearance in a population

Prevention is used for the situation where no cases of "electromagnetic hypersensitivity" have appeared. Since the symptoms involved are non-specific, they could also be caused by various commonly occurring factors such as skin- and airway irritants, allergens and different stressors such as noise, flickering light, and psychosocial factors. However, increased concerns about such symptoms - regardless of their factual origin - might increase their intensity, causing still more concern etc. in a vicious circle.

Thus, the recommended strategy is to generally reduce excessive exposure to factors known to cause these symptoms or to reduce mental stress (see further Table 3). This should be combined with balanced information on what we know and do not know about suspected health effects from the use of electricity or from exposure to EMFs - in order to interrupt or prevent such viscous circles. This information should be composed of several components such as:

- a better understanding of the fields,
- current understanding of the causes and appearance of "electromagnetic hypersensitivity", and
- current knowledge concerning the possibility of disorders such as cancer being linked to EMF exposure.

Table 3. Some suggestions for actions to be taken for prevention of symptom appearance in a population.

	Workplace	General environment
Information	About EMF, health risks, and national standards. Information about company policy to meet present standards and recommendations.	About EMF, health risks and national standards.
Environmental actions	Optimising the work environment: indoor climate, air pollution, noise, lighting, ergonomic factors, psychosocial factors.	Optimising the general environment including traffic pollution, environmental tobacco smoke, and emissions from factories and houses.
Stakeholders	Government agencies and institutions. Occupational health services. Employers.	Government agencies and institutions. Electricity companies. Mobile phone manufacturers and network providers.

In our opinion, the information must be balanced and avoid the extreme positions of either inflating or neglecting the issues involved. In practice, information activities may often prove to be the main effort at this stage.

Intervention or early handling of afflicted cases

In situations where symptoms and the attribution to "electromagnetic hypersensitivity" has occurred among one or some individuals, early handling of the situation is essential in order to prevent a chronic situation with aggravation of the symptoms (see also Table 4).

Table 4. Some suggestions for actions to be taken for intervention or early handling of afflicted cases.

	Workplace	General environment
Medical actions	Medical investigation motivated by symptoms and signs to identify specific medical illnesses or conditions, but not to identify ”electromagnetic hypersensititvity” - since this latter condition cannot be identified by medical examinations.	Same.
Environmental actions	Work environment investigation to reduce exposure to factors other than EMFs that might be associated with the presented symptomatology. Such factors might be these listed under primary prevention and work place above. Concerning electromagnetic fields see table 6 and the text below.	Environmental investigation to reduce exposure to environmental factors known to give rise to the presented symptomatology. Such factors may be those listed under primary prevention and general environment above. Concerning electromagnetic fields see table 6 and the text below.
Stakeholders	The afflicted individual. Occupational health service. Employers.	The afflicted individual. General health service. Community health and welfare officers. Environmental health agencies.

A fundament in the handling should always be a medical examination performed by a physician. This is to identify if a “known” disease is responsible for the symptom and which should then be subject to appropriate medical handling. The non-specificity of the symptoms involved makes it - in some cases - entirely possible that the symptoms could be manifestations of other disorders, but misinterpreted by the individual or his/her surroundings. It has occasionally been reported that individuals with alleged "electromagnetic hypersensitivity" have been found to suffer from e.g. hypothyreosis, tumours in the nervous system or contact allergy.

The second basic step is a thorough check for possible contributing environmental factors by a hygienist. Examples of such environmental factors are listed

in Table 3 above, and the actions are partly motivated by the same argument as when performing primary prevention, but - here - perhaps with increased priority. Another reason for these actions is to initiate a communication with the patient attempting to find strategies for coping with the situation, i.e. to gain control of environmental factors of possible importance for the symptoms.

It is - in our view - important that whatever action is taken here is done with the following two objective in mind:

- Actions taken should be done in close co-operation with the afflicted individual.
- Actions should preferably have a broad basis. This means that one should avoid all activities and discussion to be focused on only one or a few factors.

This latter point requires some further comments and perhaps justification. The non-specificity of the symptoms, and the possibility that increased concern might aggravate symptoms leads - in our evaluation - to the possibility that concentration on one factor (which might not be justified for that particular case) would then lead to increasing demands for reductions when actions taken are not effective - again increasing the vicious circle problem. It should be pointed out that this argument is - in our opinion - general, not just geared towards EMF.

Finally, correct and balanced information is also an important part at this stage.

Treatment of individuals with long-lasting symptoms and severe handicap

For individuals claiming "electromagnetic hypersensitivity" with long-lasting and severe symptoms, therapy should primarily be directed towards reducing symptoms and functional handicap (see Table 5). We recommend that this should be handled in close co-operation between:

- a physician (for adequate medical handling),
- a hygienist (to exclude or eliminate factors in the environment that are known to cause symptoms or adverse health effects of relevance to those of the patient), and
- a psychotherapist (who would initially focus on the patient’s situation in conjunction with the development of symptoms and consequences brought on by the symptoms).

Table 5. Some suggestions for actions aimed at reducing symptoms and functional handicap.

	Workplace	General environment
Medical actions	Actions to reduce symptoms and functional handicaps.	Same.
Environmental actions	As above. Concerning electromagnetic fields, see Table 6 and the text below.	Same.
Stakeholders	The afflicted individual. Occupational health service in collaboration with other specialists.	The afflicted individual. General health services.

In principle, information activities are relevant at all stages - including this. There is a need here, however, to avoid situations of conflict between e.g. the physician and the patient as to the causes of the disorder - the emphasis here should probably be more on alleviating and assisting in coping, not to change opinions.

Concerning actions directed towards electric, magnetic or electromagnetic field sources

To measure and to reduce the exposure to EMFs in the relevant situation(s) is a commonly asked for action by many of the individuals claiming "electromagnetic hypersensitivity". As illustrated in Table 6, there are, however, both advantages and disadvantages of such actions. Any action taken should balance the need for remedial activity for an afflicted individual with that of avoiding unnecessary worry and concern among others. Again, this balance should be tailored to the varying situation in different countries.

General preventive action to reduce e.g. electric or magnetic fields can not be motivated on the basis of the phenomenon of "electromagnetic hypersensitivity". This is due both to the lack of any solid information that they are indeed involved in the causality, and to the need to avoid the preconception among other individuals that the fields have been shown to have such a relation.

In view of these considerations, companies and other stakeholders involved should consider the various advantages and disadvantages of measuring or reducing electric and magnetic fields - some of which are noted in Table 6 below.

It should be observed that these discussions on field measurements and reductions are relevant to situations where field levels are known to be well below established standards and hygienic limits. If there are grounds to suspect that exposure levels could be in excess of such standards, then of course measurements and - if called for - actions to reduce exposures are warranted,

regardless of reported cases of “electromagnetic hypersensitivity”. In such a situation, relevant guidelines and protocols for measurements do exist.

Table 6. Arguments for and against actions concerning electric or magnetic field exposures in situations where individuals with "electromagnetic hypersensitivity" exist.

	Arguments for	Arguments against
Measuring fields	Ensure that levels of exposure of EMF meet excising standards and recommendations.	A causal relationship has not been proven and taking measurements might be interpreted as an indication that a hazard exists.
	May provide a basis for possible actions to be taken by the individual to reduce exposure.	Lack of knowledge of possible exposure parameter of relevance and consequently lack of relevant guidelines or protocols for measurements of such parameters.
	To respond to the concerns of the individual.	The absence of dose-response relationship.
	If measured levels are low this may have a reassuring effect.	Might draw attention away from other factors that might be more relevant.
	By using dosimeters and symptom records, the hypothesis of an association between symptoms and exposure levels in the individual case might be investigated.	
Reducing fields	As part of a prudent avoidance strategy.	No medical or scientific basis on which to reduce exposure to levels lower than those limits that already exists.
	To respond to the concerns of the individual.	In view of the ubiquitous nature of EMFs, reducing the levels in a particular location may not contribute significantly to a reduction in the individual's total exposure.
	May have a placebo effect in reducing symptoms.	May create unnecessary anxiety among others.

In Sweden, five authorities responsible for activities related to electromagnetic fields under general legislation, have recommended a precautionary principle based primarily on suspected cancer risks in relation to low frequency magnetic fields. It should be noted that that document is not directed to the problem of "electromagnetic hypersensitivity".

Recommendations

This investigation of “electromagnetic hypersensitivity” across Europe included an evaluation of questionnaires to various organisations concerning their appraisal of the situation, descriptions of some case reports, a review of the relevant literature on possible causal factors, a description of the available information for the public on electromagnetic fields and did also take into account the concepts of risk perception and risk communication.

Based on these deliberations, the group has come to certain recommendations. These are presented under three headings; recommendations on how to handle individual with alleged “electromagnetic hypersensitivity”, recommendations on information activities, and recommendations on further scientific research. It is of course recognised that some of these are closely interrelated.

A central observation found when examining descriptions of cases, appraisals by various organisations as well as evaluating the scientific literature is that “electromagnetic hypersensitive” individuals do not appear to form a homogeneous group, but are more likely described best in terms of subgroups - a few of which have been at least tentatively identified. This non-homogeneity of the phenomenon is of major importance also for a variety of the recommendations made.

Handling of individuals with “electromagnetic hypersensitivity”

The existence of individuals with severe health problems is a clear motivation for adequate medical care and situation handling. The fact that most people claiming to be “electromagnetically hypersensitive” only do show very mild symptoms also requires - in our opinion - adequate handling. Such preventive activity would most likely have a major information content (see further below on recommendations concerning information). In any case it is important that “electromagnetic hypersensitive” persons are taken seriously and that their complaints are analysed and taken care of in a proper way.

The main facets of adequate handling can be summarised as follows:

- individual approaches,
- approaches relevant to various stages (prevention, intervention, treatment) of the individual, and
- avoid concentration on single factor explanation.

It should be recognised that handling and medical care have the prime objective of helping an individual, not of providing scientific information. In practice, a decision as to when and how to emphasise scientific information in the handling should be made on a case-to-case basis.

Further elaboration and comments of ways to handle individuals with ”electromagnetic hypersensitivity” are found in a separate section (above).

Information activities

As already stated above, the communication of information on electromagnetic fields in general and on “electromagnetic hypersensitivity” forms an important part of prevention. Such information must of course be balanced, and appropriate for the specific target group and situation. A case could be made for information on electromagnetic fields in general to be available in similar fashion across Europe - keeping the different receivers in mind (general public, various professionals etc.). For specific information on “electromagnetic hypersensitivity”, we would rather advocate a more varied approach, where also the situation in different countries (media attention, current existence of widespread concern or not, etc.) could motivate different activities.

Concerning the general preparation of information material, the following should be kept in mind:

- Proper communication techniques have to be used for public appearance, for private consultation and for written material. Therefore communication and/or layout specialists should be hired and workshops or training for scientists should be offered and used in order to learn effective communication skills.
- For successful written information there should be a definition of the target group, tests of the target group for specific omissions in information and a feedback on trial information.

Concerning general information on electric, magnetic and electromagnetic fields, the following additional recommendations hold:

- The most important target groups to be addressed should be: general practitioners, local health authorities, politicians and other decision makers and schools i.e. intermediators. Journalist may serve as important links to various target groups.
- The information material should be diverse and also specified, i.e. not only on electromagnetic fields in general but there should also be shorter brochures on special questions, e.g. mobile phones, household devices, powerlines etc.

Finally some recommendations concerning information on “electromagnetic hypersensitivity”:

- Here the most important target groups to be reached are: self-aid groups, general practitioners and occupational health physicians.
- There should be a clear statement that there is currently no scientific basis for a connection between “electromagnetic hypersensitivity” and exposure to electromagnetic fields.
- Other factors that could lead to the same symptoms should be included in the information, thus emphasising concepts such as "multifactorial", “broad approaches” etc.

- Depending on target groups, the emphasis between "etiological" information about knowledge on causes, and information on how to handle individuals should be balanced.

Further scientific research

Further scientific investigations are needed because it is not currently possible to either clearly describe the syndrome or definitively identify the cause(s) of “electromagnetic hypersensitivity”. The following aim and comments are appropriate to the situation:

- A better characterisation of the adverse health effect is required. This would include the utilisation and in some cases the development of standard questionnaires as well as standard anamnestic and medical protocols. Asides from its use in research (see below), such improved effect assessments could also assist in the handling of individual cases.
- Standardized assessments of effect could lead to a better development of a data basis. This could also enable comparison between a/ different European nations, b/ different syndromes (see below) and c/ with the general population, and thus more clearly address the specificity or non-specificity of the different symptoms and signs.
- When performing etiological research, specific hypotheses have to be formulated and tested. This applies both to EMF and to other factors that could presumably lead to the adverse health reactions. One problem here is the non-specificity of e.g. some EMF-based hypothesis ("some parameters of the field could be....."), such vague formulations are not easily testable in research. The specificity of hypothesis is also aimed at the effect assessment - we would argue for hypothesis to be geared towards specific effect endpoints rather than “electromagnetic hypersensitivity" - taking cofactors such as higher specific sensitivity into account.
- Research hypothesis should be aimed at both physical and non-physical factors. The possibility of interactions or synergetic effects have also to be taken into account.
- Provocation studies offer one important approach to etiological studies, and should be focused on both EMF as well as on other factors. Careful considerations have, however, to be given to inclusion criteria for testees, as well as the occurrence of various cofactors.
- Possible connections or analogies with other syndromes of (partly) unclear aetiology should be examined, such as multiple chemical sensitivity, amalgam sensitivity, chronic fatigue syndrome, sick building syndrome etc.

In the fields of risk perception and risk communication, certain research issues are also advocated, as their development would greatly contribute to understanding and handling of “electromagnetic hypersensitivity".

- Risk perception as a factor for attribution processes and also as a causal or contributing factor for adverse reactions relevant to “electromagnetic hypersensitivity" should be investigated. Such investigations should take into account

research performed in other areas, and not be limited to “electromagnetic hypersensitivity", however.
- Means to identify possible risk groups and subgroups in terms of variations in risk perception should be identified or developed.
- Research concerning the design and the evaluation of risk communication, in general and for this specific purpose is also required.
- The issue of credibility of opinion leaders has to be taken up as well as the improvement of conflict culture in order to improve communication.

Research activities on these and other relevant topics should be compared and preferentially also co-ordinated between different countries. One important example of such co-ordination efforts is the international WMF project of the WHO.

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Appendix 1. Questionnaire results

Introduction

In the absence of a data base on ”electromagnetic hypersensitivity” covering various European nations, it was decided to solicit some relevant information concerning awareness of the problem, estimates of its extent, situations where it would occur, symptoms and consequences for the individual. Within the framework of the nature of the information required, the time and resources available, a questionnaire sent to various organisations for their appraisals was considered feasible.

In some European nations, self aid groups (SAGs) created around this issue exist, thus constituting one obvious channel of such information. For two reasons, however, this avenue of information was not considered sufficient for our needs; the possibility that they - because of their aims and roles - would forward exaggerated estimates or at least estimates at the upper end of the scales, and the fact that SAGs were only identified in some European nations. Another type of organisation from which information could be solicited were those where medical attention is sought or cases are being referred to. In several or perhaps most European countries, centres for occupational medicine or similar organisations (COMs) would - according to our previous experience - constitute such sources. One alternative would be local physicians or general practitioners, but they would have two serious drawbacks; they would presumably seldom have the overview necessary to be able to estimate the overall extent of the problem, and to reach a sufficient number of them would also become a major practical undertaking. In addition, practical experience from some countries where it was felt that the general environment rather than workplaces provided the majority of cases of ”electromagnetic hypersensitivity”, suggested that a number of such cases were still referred to COMs. Accordingly, we decided to send the questionnaires to SAGs and COMs in the different European countries. Still, in countries where the general environment would provide the majority of the cases of ”electromagnetic hypersensitivity”, we would advocate some caution in the interpretation on two points; 1/ COMs could perhaps tend to underestimate the extent, and 2/ they could also be expected to overestimate the extent of serious cases in proportion to all cases, since the referral system would presumably tend to eliminate a number of non-serious cases.

Methods

A questionnaire designed to cover the basic information needs given above was created by the project group, with similar but not identical formulations for the two different target groups (COMs and SAGs), in that the questions regarding contact with patients/members were tailored to fit the two groups specifically. Apart from such questions, the questionnaires were essentially the same for both COMs and SAGs. Each questionnaire was written in several language versions; English, German, French, Italian and Swedish - see Appendix 2 for the English versions.

Addresses to COMs were provided by the different project group members in accordance with the structure of such centres in the countries concerned. Some self aid groups addresses were found in the Swedish self aid group monthly magazine, with additional addresses provided by the project participants. We have not approached organisations or SAGs dealing primarily with individuals suffering from some other (ill-defined) conditions such as Multiple Chemical Sensitivity or dental (amalgam) problems.

The questionnaires were sent to 138 different centres of occupational medicine or similar centres in the 15 different EU member countries and also to the Faroe Island, Iceland and Norway, and to self aid groups in Denmark, France, Germany, Italy, Norway, Sweden and Switzerland. In total, we solicited answers from 15 different self aid groups (see Table 1 below). The initial response rates for some countries were very low, necessitating a reminding letter to be sent out, in which we emphasised the importance of replying even if they had no contact with the problem of ”electromagnetic hypersensitivity”.

In all we received 72 answers, of which 10 were from SAGs. Ten questionnaires were sent back to us due to erroneous addresses. We had a response covering 10 of the EU member countries and 3 non-member countries; COMs in Belgium, Luxembourg, Greece, Spain, Portugal and the self aid group in Switzerland did not respond to our questionnaire. We also received replies from some COMs and SAGs that not were on our address list, including two SAGs from Ireland, who had obviously received questionnaires that were passed on from others. Accordingly, a strict response rate can’t be given, nor is indeed called for, as the main emphasis of the interpretation should be qualitative rather than quantitative.

The symptoms reported by the COMs and SAGs were classified into different symptoms groups by the medical doctors of the working group, as were some other conditions reported. Two of the different symptoms groups, the skin and nerve symptom groups, also included a number of subgroups. Apart from this and some other categorisation of answers, the following information is basically presented as received - as we do not consider the material suitable for detailed numerical analysis.

Table 1. Number of distributed and received questionnaires by country.

Country	Questionnaires distributed to			
	COMs		SAGs	
	Sent out	Received	Sent out	Received
Austria	4	4	0	-
Belgium	1	0	0	-
Denmark	15	13	1	1
Faroe Island	1	1	0	-
Finland	5	2	0	-
France	24	6	4	2
Germany	17	8	7	3
Greece	2	0	0	-
Iceland	1	1	0	-
Ireland	2	1	0	2 a/
Italy	28	4	0	-
Luxembourg	1	0	0	-
Norway	9	6	1	1
Portugal	5	0	0	-
Spain	2	0	0	-
Sweden	10	8	1	1
Switzerland	0	-	1	0
The Netherlands	2	1	0	-
United Kingdom	9	7	0	-
Total	138	62	15	10

Notes for Table 1. a/ See text above for comments.

Results

Awareness and contact with the problem

Information was solicited whether the COMs received ”questions or requests etc. related to individuals who consider themselves as ”electromagnetic hyper-sensitive” - i.e. who experience symptoms or other adverse health effects which they attribute to electrical devices or to electric or magnetic fields”. Furthermore, questions were asked whether they knew ”of any (other) organisation that does”. Finally, they were asked to report the number of requests received in a given time period ”in the last year” (this information has been categorised - note that the <1/week category includes some answers from COMs that do not receive calls/ requests at all). In Table 2, the replies to these questions are shown.

Basically, most COMs reported that they received requests and that they knew about other COMs and other authorities, industries, organisations and universities that also received requests concerning ”electromagnetic hypersensitivity”. However, the large number of non-respondents should be kept in mind - it is quite possible that among the non-responders, the awareness of the problem would be

Table 2. Awareness by COMs of ”electromagnetic hypersensitivity” and number of calls received per week.

Country	No of replies a/	Awareness of the problem		Number of calls per week d/		
		Receive calls b/	Know of other centres c/	< 1/week	1-4/week	≥5/week
Austria	4	3	3	1	0	0
Denmark	13	6	5	10	0	0
Faroe Island	1	0	0	0	0	0
Finland	2	2	2	1	1	0
France	6	4	2	5	0	0
Germany	8	7	7	2	1	4
Iceland	1	1	1	0	0	0
Ireland	1	1	1	0	0	0
Italy	4	1	1	3	0	0
Norway	6	4	4	5	0	0
Sweden	8	8	8	6	2	0
The Netherlands	1	0	0	1	0	0
United Kingdom	7	3	3	2	0	0

Notes for Table 2. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of COMs that have received questions or requests. c/ Number of COMs that knew of other centres that do. d/ Number of COMs replying within each category.

less. The number of COMs that received requests appear to vary considerably between countries, though. For Denmark, Italy and United Kingdom, the majority of the COMs that did reply did not receive requests, nor were they aware of other centres that did. The single answers received from COMs in the Faroe Islands and The Netherlands were likewise negative. In some contrasts, most replies from e.g. Austria, France, Germany, Norway and Sweden were affirmative in receiving requests and knowledge about other organisations that did. Similar responses (but based on fewer overall replies) were apparent from the other countries.

Table 3. Number of members of each SAG, and existence of other SAGs in the country.

Country	Number of replies	Only self aid group? a/		No of members
		Yes	No	
Denmark	1	1	0	75
France	2	0	1	4 and ? b/
Germany	3	0	3	20, 120 and 160
Ireland	2	0	2	3 and 350 c/
Norway	1	1	0	90
Sweden	1	1	0	1800

Notes for Table 3. a/ Number of SAGs in each response category. b/ No number given by one SAG. c/ Described as number of ”contacts” by one SAG.

Concerning the SAGs, questions were asked about the number of members and if their group was the only one that they knew of in their country dealing with this problem. The replies are shown in Table 3. Again, the number suggest quite a

variation between different countries - but the limited number of countries for which we have identified SAG groups should be kept in mind.

The extent of the problem

Both COMs and SAGs were asked to give ”your estimate as to the total number of such ”cases” in your country”, and also the ”total number of such cases with severe handicap because of this”. The replies were categorised in the following manner; <10, 10-100, 100-1 000, 1 000-10 000 and >10 000. The number of replies in the two extreme categories as well as the median responses are found in Table 4 and 5.

As seen in the median values presented in Tables 4 and 5, the largest estimated numbers were reported from Germany and Sweden. The proportion between the numbers reported from SAGs and COMs were about one order of magnitude or higher in the SAGs for most countries (except for Norway) with extreme differences noted between COM and SAG replies from Ireland. Considering the number of cases in relation to the populations, the ranking order of all countries were Sweden > Norway and Denmark > Finland > Germany > Ireland > Austria and The Netherlands > Italy and France > United Kingdom according to the median COM answers. For Sweden, the upper limit of the estimate is roughly corresponding to 0.1%. A similar ranking was apparent from the (fewer) SAG answers, with the exception of the ranking of Ireland and Norway; Ireland > Sweden > Denmark > Germany > France and Norway.

Table 4. COM estimates of the number of cases and severe cases of ”electromagnetic hypersensitivity”.

Country	No of	Estimates on no of cases b/			Estimates on no of severe cases b/		
	replies a/	<10	Median b/	>10 000	<10	Median b/	>10 000
Austria	4	1	10-100	0	3	<10	0
Denmark	13	2	100-1 000	0	5	10-1 000	0
Faroe Island	1	-	-	-	-	-	-
Finland	2	0	10-1 000	0	0	10-100	0
France	6	0	10-100	0	3	<10	0
Germany	8	0	1 000-10 000	3	0	1 000-10 000	2
Iceland	1	-	-	-	-	-	-
Ireland	1	0	10-100	0	1	<10	0
Italy	4	0	10-100	0	3	<10	0
Norway	6	0	100-1 000	0	1	10-100	0
Sweden	8	0	1 000-10 000	2	0	100-1 000	0
The Nether-lands	1	0	10-100	0	1	<10	0
United Kingdom	7 d/	1	<10	0	1	<10	0

Notes for Table 4. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of COMs that replied in the two extreme categories, and the median response from all COMs for each country. Note that two of the medians cover two categories (Denmark and Finland). d/ Only on questionnaire responded to these questions.

For the median estimated number of severe cases, similar patterns are seen, with the largest numbers being reported from Germany and Sweden (and from the Irish SAGs), and with more or less similar ranks between the relative number of severe cases in different countries as were seen for the cases. The main difference is that here, Germany has a similar rank as the Nordic countries. The proportions of cases to severe cases are about one order of magnitude or less, for both COMs and SAGs.

Table 5. SAG estimates of the number of cases and severe cases of "electromagnetic hypersensitivity".

Country	No of replies a/	Estimates on no of cases b/ <10	Median b/	>10 000	Estimates on no of severe cases b/ <10	Median b/	>10 000
Denmark	1	0	1 000-10 000	0	0	100-1 000	0
France	2	0	1 000-10 000	1	0	100-1 000	0
Germany	3	0	>10 000	3	0	>10 000	2
Ireland	2	0	>10 000	2	0	1 000-10 000 and >10 000	1
Norway	1	0	100-1 000	0	0	100-1 000	0
Sweden	1	0	>10 000	1	0	1 000-10 000	0

Notes for Table 5. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of SAGs that replied in the two extreme categories, and the median response from all SAGs for each country. Note that one of the medians cover two categories (Ireland).

A general and important caveat for this section is that all numbers are based on estimates from some different organisations, and closer scrutiny of absolute numbers - beyond orders of magnitude - should be avoided. The relative comparisons between different European nations are - in our opinion - presumably more reliable and therefore interesting.

Concerning situations where problems appear

All COMs and SAGs were asked to reply to the question "to your knowledge, do most of the cases experience problems due to exposure at work-places, exposure at home or exposure outdoors or other non-work situations." They were also asked corresponding questions as to where the problems started. The COM replies are given in Table 6.

For the SAGs, the Danish, Norwegian and Swedish SAGs all replied "at work" to both questions, while all German and Irish SAGs specified "at home" being the most common situations where problems started and where they now appear. The French SAG reported both "at home" and "outdoors" as places for current problems to appear. As can be seen when comparing these replies to Table 6, is that while the Scandinavian and German SAG replies corresponded well with the COM replies, discrepancies were seen for the French and the Irish replies.

Table 6. Indications by COMs of the most common situation (work, home or outdoors) where problems appear and where the problems started.

Country	No of replies a/	Problems appear mostly b/			Problems started mostly b/		
		At work	At home	Outdoors	At work	At home	Outdoors
Austria	4	1	2	0	1	2	0
Denmark	13	3	1	2	3	0	2
Faroe Island	1	-	-	-	-	-	-
Finland	2	2	0	0	2	0	0
France	6	4	0	1	3	0	1
Germany	8	1	6	0	1	6	0
Iceland	1	1	1	0	-	-	-
Ireland	1	1	0	0	1	0	0
Italy	4	2	1	1	2	1	1
Norway	6	4	2	1	5	0	0
Sweden	8	7	0	0	8	0	0
The Nether-lands	1	0	0	1	0	0	1
United Kingdom	7	1	1	0	1	0	0

Notes for Table 6. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of COMs that reported the category as ”most common” is given (more than one category were chosen in a few replies).

Again, geographical differences are apparent, with the Nordic countries (Denmark, Finland, Norway and Sweden) emphasising work situations (by both COMs and SAGs), while the German situation is more centred at home (again by both COMs and SAGs). For other countries, the replies appear mixed and somewhat uncertain. Two examples are France and Ireland, where centres of occupational medicine (COMs) favoured workplaces, whereas the SAGs did not.

Attributed sources

Both COMs and SAGs were asked to ”indicate common sources of problems for the cases” - several sources could be given. Below, the replies in the category ”very often” are given.

Among the COMs in countries in the continental part of Europe or the British Isles, there were several that reported various radiofrequency field (RF) equipment or installations as a “very often” reported source of the problems.

- Broadcasting stations, TV towers or telecommunication masts were the most commonly indicated RF sources, reported by COMs from France (2 of 6), Germany (5 of 8), Ireland (1 of 1) and Italy (1 of 4).
- Radar stations reported by France (3 of 6) and Germany (2 of 8).
- Mobile telephones were indicated by 4 of the 8 German COMs and by 1 of the 4 Italian COMs.
- Induction heaters and plastic welding were reported by France (1 of 6) and Italy (2 of 4).
- Microwave ovens were suggested by the reply of 1 of the 7 United Kingdom COMs.

The COMs in the Scandinavian countries did not report any RF equipment as a "very often reported source" except for one Swedish COM that indicated mobile telephones as such.

Among the SAGs, RF equipment or installations were reported to be a "very often reported source" as follows; broadcasting stations, TV towers or telecommunication masts were indicated by the Danish SAG, 2 of the 3 German SAGs and both Irish SAGs. Microwave ovens were reported by the Danish, 1 of the 2 French and 1 of the 3 German SAGs. Both French SAGs reported induction heaters and plastic welding, while mobile phones were indicated by 1 of the 3 German and 1 of the 2 Irish SAGs. Radar stations were reported by 1 of the 2 Irish SAGs. Again, Nordic SAGs (with the Danish exception above) did not report RF sources.

Concerning equipment emanating extremely low frequency (ELF) fields, power lines or transformer stations were the most common to report according to Austrian (3 of 4), Danish (1 of 13), French (2 of 6), German (4 of 8), Irish (1 of 1), Italian (2 of 4), Norwegian (1 of 6) and United Kingdom (1 of 7) COMs. It is noticeable that this source was not reported at all by the Swedish, Finnish and some other COMs. Electrical appliances at home were reported by 3 of 13 Danish, 2 of 8 Swedish and 1 of 8 German COMs. Electric wiring in houses and railways were reported by 3 of 8 and 2 of 8 German COMs, respectively, while electric welding was not reported by any COM. The reporting of ELF sources by SAGs was rather limited; electrical appliances at home were indicated by the Swedish SAG, while the French SAG marked all ELF sources except railways.

Among some "miscellaneous" equipment, light sources (fluorescent tubes and VDUs) were suggested as "very often reported sources" of the problems by primarily the Nordic COMs; VDUs were indicated by 2 of 13 Danish, both Finnish, 2 of 6 Norwegian, and all 8 Swedish COMs. In addition, 1 of the 8 German and 1 of the 4 Italian COMs also indicated VDUs. Fluorescent tubes were suggested by Denmark (1 of 13), Finland (1 of 2), Germany (1 of 8) and Sweden (2 of 8). Medical equipment such as NMR or diathermy was reported by the Irish COM.

The SAGs more generally did suggest both VDUs and fluorescent tubes as a source, apart from the German ones. The SAG from Norway did not report fluorescent tubes as a "very often reported source". Heavy machinery in the industry were reported only by one French SAG.

Commonly occurring symptoms

Each COM and SAG were asked to list the 5 most common symptoms "reported in connection with the use of electrical appliances or proximity to electric or magnetic field sources". The number of COMs and SAGs who reported a symptom in any of the 12 symptom groups are shown in Tables 7-10. These latter numbers should be regarded with some caution, as the number of symptoms from different groups are not readily comparable.

Table 7. Number of COMs reporting different types of symptoms.

Country	No of replies a/	Nervous system symptoms	Skin symp-toms	Hormonal/ metabolic disorders	General body symptoms	Cardio-vascular symptoms	Digestive problems
Austria	4	4	1	0	0	0	0
Denmark	4	3	1	0	1	0	0
Faroe Island	0	-	-	-	-	-	-
Finland	1	1	1	0	1	0	0
France	4	3	0	0	0	0	0
Germany	7	7	2	0	2	0	0
Iceland	1	1	1	0	0	0	0
Ireland	1	1	0	0	0	0	0
Italy	1	1	0	1	0	0	0
Norway	3	3	3	0	0	0	0
Sweden	7	7	7	0	7	3	0
The Nether-lands	0	-	-	-	-	-	-
United Kingdom	1	1	0	0	0	0	0
Total no of symptoms b/	-	73	21	1	8	4	0

Notes for Table 7. The number of COMs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms reported by all COMs - note that a single COM could report more than one symptom in each group.

Table 8. Number of COMs reporting different types of symptoms or conditions.

Country	No of replies a/	Ear, nose, throat problems	Eye symp-toms	Cancer	Allergy	Reproduc-tive or preg-nancy problems	Other problems
Austria	3	0	1	0	0	0	0
Denmark	4	0	0	0	1	0	1
Faroe Island	0	-	-	-	-	-	-
Finland	1	0	0	0	0	0	0
France	4	0	0	2	0	1	0
Germany	7	1	0	1	1	0	0
Iceland	1	1	1	0	0	0	0
Ireland	1	1	0	0	0	1	0
Italy	1	0	1	0	0	0	1
Norway	3	0	0	0	0	0	0
Sweden	7	0	1	0	0	0	0
The Nether-lands	0	-	-	-	-	-	-
United Kingdom	1	0	0	0	0	0	0
Total no of symptoms b/	-	3	4	3	2	2	2

(Notes, see next page)

Notes for Table 8. The number of COMs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms (or equivalent) reported by all COMs - note that one COM could report more than one symptom in each group.

It is readily apparent from a scrutiny of tables 7-10 that most COMs and SAGs have reported nervous system symptoms to be among the most common ones in relation to "electromagnetic hypersensitivity". This is consistently reported from all COMs and SAGs across Europe (with the exception of the Swedish SAG). The second most common group is that of skin problems - but here a rather clear geographical variation is seen; substantial reporting from the COMs of Finland, Iceland, Norway and Sweden, some limited reporting from Austria, Denmark and Germany, and none at all from COMs in other European nations. The limited number of SAG replies offered somewhat different geographical variations, see Table 9.

Table 9. Number of SAGs reporting different types of symptoms.

Country	No of replies a/	Nervous system symptoms	Skin symp-toms	Hormonal/ metabolic disorders	General body symptoms	Cardio-vascular symptoms	Digestive problems
Denmark	1	1	1	1	1	1	1
France	2	2	1	0	1	0	0
Germany	2	2	0	0	0	0	0
Ireland	2	2	1	0	0	0	0
Norway	0	-	-	-	-	-	-
Sweden	1	0	1	0	0	0	0
Total no of symptoms b/	-	22	4	2	2	1	1

Notes for Table 9. The number of SAGs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms reported by all SAGs - note that one SAG could report more than one symptom in each group.

For other types of symptoms or reported conditions, most appear to be isolated reports from a few COMs or SAGs in only a few countries, with the possible exception of eye symptoms, general body symptoms such as overall tiredness or ear/ nose/throat problems which were reported from more than a few of the COMs and SAGs in one or two nations.

Table 10. Number of SAGs reporting different types of symptoms or conditions.

Country	No of replies a/	Ear, nose, throat problems	Eye symptoms	Cancer	Allergy	Repro-ductive or pregnancy problems	Other problems
Denmark	1	0	1	0	0	0	0
France	2	0	0	0	0	0	0
Germany	2	1	0	0	0	0	0
Ireland	2	1	0	0	0	0	0
Norway	0	0	0	0	0	0	0
Sweden	1	0	1	0	0	0	0
Total no of symptoms b/	-	2	2	0	0	0	0

Notes for Table 10. The number of SAGs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms(or equivalent) reported by all SAGs - note that one SAG could report more than one symptom in each group.

Accordingly, the following presentation of data will be centred on nerve system symptoms and skin symptoms. As seen in Table 11, where the types of nerve system symptoms are presented in more details, the most common ones to indicate as being common among cases of ”electromagnetic hyper-sensitivity” are neurasthenic symptoms, followed by headaches - these were reported by a majority of the COMs and SAGs. For the other symptoms, a few additional but less clear observations can be made; Among Austrian and German COMs and SAGs, reports of all these types of nerve system symptoms occurred, with the single exception that no German SAG reported anxiety symptoms. In the Nordic country COMs, the emphasis appeared to be - among nerve system symptoms - on symptoms of neurasthenia, headaches and decreased arousal, whereas the Swedish SAG did not report any nerve system symptoms as being ”very common”. Replies from the other countries were scattered.

Skin problems were differentiated into objective, subjective and undefined. Almost all organisations who reported any skin symptoms, did report either subjective or undefined symptoms, the only exception being one Danish COM and one French SAG.

Table 11. Various nerve system symptoms reported by COMs and SAGs.

Country	No of replies a/	Sleep problems	Decreased arousal	Neuras-thenia	Stress, irritation	Anxiety	Head-aches
Austria/COM	3	2	1	2	2	1	1
Denmark/COM	4	0	2	3	0	0	0
-"- /SAG	1	1	0	1	0	0	0
Finland/COM	1	0	0	1	0	0	1
France/COM	4	0	0	2	0	0	1
-"- /SAG	2	1	0	0	0	0	2
Germany/COM	7	5	3	6	5	2	5
-"- /SAG	3	2	1	2	3	0	1
Iceland/COM	1	0	0	1	0	0	1
Ireland/COM	1	0	1	0	0	0	2
-"- /SAG	2	1	2	3	2	0	0
Italy/COM	1	1	0	2	1	1	1
Norway/COM	3	0	2	2	0	1	2
Sweden/COM	7	1	4	6	0	2	3
-"- /SAG	1	0	0	0	0	0	0
United King-dom/COM	1	0	0	3	0	0	1
Sum	-	14	16	34	13	7	21

Notes for Table 11. The number of symptoms reported by COMs or SAGs in each country is indicated. Note that one COM/SAG could report more than one symptom under each heading. a/ Total number of replies to this part of the questionnaire.

Concerning consequences for the afflicted individuals

Both COMs and SAGs were asked to indicate their appraisal as to the severity of the consequences of "electromagnetic hypersensitivity". Five alternatives could be marked by the notations "most", "several", "few" or "none", the alternatives being:

- Perceive fields or minor symptoms but do not suffer in any consequence in daily life.
- Manage life, but have taken some actions due to the perception of fields or symptoms.
- Show some impairment of well-being.
- Are frequently ill, have to see a doctor more often than common, or have to change work.
- Have had to change life conditions entirely.

Most of the countries replied the middle alternatives ("several" or "few") for all the five alternatives of severity of the problem. The Swedish COMs generally replied "most" on the mild problem alternatives and "few" on the severe problem alternatives. The Norwegian COMs did report "few" for the mild problems, and "none" as to the severe problems. In all, the participating organisations did reply very differently to these questions, differences were found not only between countries but also within countries and between the COMs and between the SAGs.

Correspondence between ”electromagnetic hypersensitivity” and other syndromes

The participating organisations were asked whether ”in your experience, do individuals who suffer from ”electromagnetic hypersensitivity” also report problems with Multiple Chemical Sensitivity. Allergic reactions or Problems with dental alloys?” They were asked to reply with "most do", "some do", "a few do" and "no one does" as appropriate for the three syndromes.

Overall, most of the COMs who did report some correlations at all did suggest such a correlation between ”electromagnetic hypersensitivity” and also reporting dental alloy problems. Allergic reactions were suggested only by one COM in Germany and one in Denmark. The COMs of Austria, Finland, France and United Kingdom did not suggest any correlations at all (by using the response ”no one does”). The COMs from Faroe Island, Iceland and The Netherlands did not reply to these questions.

Most SAGs indicated very strongly that ”electromagnetic hypersensitivity” individuals also reported all three other types of problems - with little variations between countries.

Appendix 2. Questionnaires to centers for occupational medicine and self aid groups

The English version of the questionnaires to the centres of occupational medicine (COMs) and self-aid groups (SAGs) are shown:

- Possible health implications of subjective symptoms and electromagnetic fields. Questionnaires to centers for occupational medicine, page 2-8
- Possible health implications of subjective symptoms and electromagnetic fields. Questionnaires to self aid groups, page 9-15

Questionnaires were also written in French, German, Italian and Swedish (not included here).

Date
96-xx-xx
Your letter date

Our reference
EU/Q-EngOM
Your reference

Arbetslivsinstitutet

Attending to this matter
C Wadman

Possible health implications of subjective symptoms and electromagnetic fields

Questionnaires to centers for occupational medicine

Dear colleague

The European Commission is funding a project named "Possible health implications of subjective symptoms and electromagnetic fields". The aim of this project is to accumulate scientific knowledge and practical experiences regarding individuals who experience symptoms or other health problems related to the use of electrical appliances or proximity to sources of electric or magnetic fields. This phenomena is commonly known as "electrosensitivity" or "hypersensitivity to electricity".

We represent a group of ten scientists in six different European countries (Austria, France, Germany, Ireland, Italy and Sweden) who have been given this task. Our aim is to complete a report on this within one year of the project start (which was May 1996).

In order to obtain an overview of the social prevalence of this problem in different countries, we are sending out this questionnaire to the heads of self aid groups formed around this problem, and also to various occupational health centers or departments. With "social prevalence" we do mean the number of individuals who report health problems and who also report that these health problems are due to electric or magnetic fields - regardless of other peoples evaluation of that claim.

We ask you therefore to fill out this questionnaire and send it back as soon as possible and no later than October 15, 1996 to the following address:

Ms Cecilia Wadman
Dept of Occupational Medicine
National Institute for Working Life
S-171 84 Solna
Sweden

For your convenience, we are including an addressed envelope with stamp already included. (Alternatively, you may use fax, +46 8 82 05 56.)

We do intend to include the answers in an annex to our report. If you do not wish your answer to be included in the annex, please make a note of that on the reply form. After our report is finished and approved by the European Commission, we will send you a copy of the summary.

Sincerely yours

For the Scientific group

Cecilia Wadman

The name of your organisation _____
(institute, clinic or department)

Address _____
_____
_____

Contact person _____
_____
_____

1. Concerning the involvement of your organisation with this problem

1.a Does your organisation receive questions or requests etc related to individuals ("cases") who consider themselves as "electrosensitive" - i.e. who experience symptoms or other adverse health effects which they attribute to electrical devices or to electric or magnetic fields?

0 Yes
0 No
0 I don´t know

1.b Do you know of any (other) organisation that does?

0 Yes
0 No

1.c If "yes", please specify_____
_____
_____

1.d Comments _____
_____
_____
_____
_____

2. Concerning the extent of the problem

2.a How many such requests or questions have you received in the last years? Please specify as to "nn per year".

_____

2.b What is your estimate as to the total number of such "cases" in your country?

- **0** Fewer than 10
- **0** Between 10 and 100
- **0** Between 100 and 1000
- **0** Between 1 000 and 10 000
- **0** More than 10 000

2.c To the best of your knowledge, do such cases occur throughout your country, or in specific areas?

- **0** Overall, no specific area
- **0** In specific area(s)

2.d If specific areas, please describe _____
_____

2.e What is your estimate as to the number of such cases in your country with severe handicap because of this?

- **0** Fewer than 10
- **0** Between 10 and 100
- **0** Between 100 and 1000
- **0** Between 1 000 and 10 000
- **0** More than 10 000

2.f Comments_____
_____
_____
_____
_____

3. Concerning situations where problems appear

3.a To your knowledge, do most of the cases experience problems due to:

___ exposure at work-places
___ exposure at home
___ exposure outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the least common with "3".)

3.b To your knowledge, for most of the cases, did the problems start at:

___ work-places
___ at home
___ outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the least common with "3".)

3.c In the list below, please indicate common sources of problems for the cases. Mark with "1" if very often a reported source, "2" if rather often, "3" if sometimes, "4" if rather seldom, and "5" if it is very seldom a reported cause.

____ broadcasting stations, TV towers or telecommunication masts
____ electrical appliances at home (electric clocks, hairdryers, vacuum cleaners etc)
____ electric wiring in houses
____ heavy machinery in industry
____ induction heaters and plastic welding
____ light sources (fluorescent tubes or other)
____ medical equipment such as NMR, diathermy
____ microwave ovens
____ mobile phones
____ power lines or transformer stations
____ radar stations
____ railways
____ visual display units or TV sets
____ electric welding
____ (other, please specify)_____
____ (other, please specify)_____

3.d Comments_____
_____
_____
_____

4. Concerning symptoms and related problems

4.a Please list symptoms occurring in cases which are reported in connection with the use of electrical appliances or proximity to electric or magnetic field sources. Then mark with a cross in **0** (up to) the 5 most common symptoms.

_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common

4.b In your experience, do individuals who suffer from "electrosensitivity" also report problems with:

Multiple chemical sensitivity? _____
Allergic reactions? _____
Problems with dental alloys (amalgam)? _____

(Please indicate "most do", "some do", "a few do", "no one does" as appropriate.)

4.c Comments_____
_____
_____

5. Concerning consequences for the individuals

5.a Please indicate - based on your knowledge - the percentage of each category below that:

Perceive fields or minor symptoms but
do not suffer any consequence in daily life _____%
Manage life, but have taken some actions
due to the perception of fields or symptoms _____%
Show some impairment of well-being _____%
Are frequently ill, have to see a doctor more
often than common, or have to change work _____%
Have had to change life conditions entirely _____%

(If you can not give a percentage figure, please give one of the following descriptive terms; "most", "several", "few" or "none".)

5.b Comments_____
_____
_____
_____
_____
_____
_____
_____
_____

Thank you for your help

Date
97-10-02
Your letter date

Our reference
EU/Q-EngSelf
Your reference

Arbetslivsinstitutet

Attending to this matter
C Wadman

Possible health implications of subjective symptoms and electromagnetic fields

Questionnaires to self aid groups

Dear ladies and gentlemen

The European Commission is funding a project named "Possible health implications of subjective symptoms and electromagnetic fields". The aim of this project is to accumulate scientific knowledge and practical experiences regarding individuals who experience symptoms or other health problems related to the use of electrical appliances or proximity to sources of electric or magnetic fields. This phenomena is commonly known as "electrosensitivity" or "hypersensitivity to electricity".

We represent a group of ten scientists in six different European countries (Austria, France, Germany, Ireland, Italy and Sweden) who have been given this task. Our aim is to complete a report on this within one year of the project start (which was May 1996).

In order to obtain an overview of the social prevalence of this problem in different countries, we are sending out this questionnaire to the heads of self aid groups formed around this problem, and also to various occupational health centers or departments. With "social prevalence" we do mean the number of individuals who report health problems and who also report that these health problems are due to electric or magnetic fields - regardless of other peoples evaluation of that claim.

We ask you therefore to fill out this questionnaire and send it back as soon as possible and no later than October 15, 1996 to the following address:

Ms Cecilia Wadman
Dept of Occupational Medicine
National Institute for Working Life
S-171 84 Solna
Sweden

For your convenience, we are including an addressed envelope with stamp already included. (Alternatively, you may use fax, +46 8 82 05 56.)

We do intend to include the answers in an annex to our report. If you do not wish your answer to be included in the annex, please make a note of that on the reply form. After our report is finished and approved by the European Commission, we will send you a copy of the summary.

Sincerely yours

For the Scientific group

Cecilia Wadman

The name of your group _____

Address _____
_____
_____

Contact person _____
_____
_____

Please, send us only one response for each self aid group

1. Concerning self aid group(s)

1.a Is your group the only one dealing with "electrosensitivity" in your conutry?

0 Yes
0 No
0 I don´t know

1.b If "No", how many other groups do you know about? _____

1.c How many members does your group have? _____

1.d Comments _____
_____
_____
_____
_____

2. Concerning the extent of the problem

2.a How many members of your group do experience symptoms or other health problems which are related to the use of electrical appliances or proximity to sources of electric or magnetic field?

_____

2.b What is your estimate as to the total number of such "cases" in your country?

- **0** Fewer than 10
- **0** Between 10 and 100
- **0** Between 100 and 1000
- **0** Between 1 000 and 10 000
- **0** More than 10 000

2.c To the best of your knowledge, do such cases occur throughout your country, or in specific areas?

- **0** Overall, no specific area
- **0** In specific area(s)

2.d If specific areas, please describe _____
_____

2.e What is your estimate as to the number of such cases in your country with severe handicap because of this?

- **0** Fewer than 10
- **0** Between 10 and 100
- **0** Between 100 and 1000
- **0** Between 1 000 and 10 000
- **0** More than 10 000

2.f Comments_____
_____
_____
_____
_____

3. Concerning situations where problems appear

3.a To your knowledge, do most of the cases experience problems due to:

___ exposure at work-places
___ exposure at home
___ exposure outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the least common with "3".)

3.b To your knowledge, for most of the cases, did the problems start at:

___ work-places
___ at home
___ outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the least common with "3".)

3.c In the list below, please indicate common sources of problems for the cases. Mark with "1" if very often a reported source, "2" if rather often, "3" if sometimes, "4" if rather seldom, and "5" if it is very seldom a reported cause.

____ broadcasting stations, TV towers or telecommunication masts
____ electrical appliances at home (electric clocks, hairdryers, vacuum cleaners etc)
____ electric wiring in houses
____ heavy machinery in industry
____ induction heaters and plastic welding
____ light sources (fluorescent tubes or other)
____ medical equipment such as NMR, diathermy
____ microwave ovens
____ mobile phones
____ power lines or transformer stations
____ radar stations
____ railways
____ visual display units or TV sets
____ electric welding
____ (other, please specify)_____
____ (other, please specify)_____

3.d Comments_____
_____
_____
_____

4. Concerning symptoms and related problems

4.a Please list symptoms occurring in cases in your group which are reported in connection with the use of electrical appliances or proximity to electric or magnetic field sources. Then mark with a cross in **0** (up to) the 5 most common symptoms.

_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common

4.b In your experience, do individuals who suffer from "electrosensitivity" also report problems with:

Multiple chemical sensitivity? _____
Allergic reactions? _____
Problems with dental alloys (amalgam)? _____

(Please indicate "most do", "some do", "a few do", "no one does" as appropriate.)

4.c Comments_____
_____
_____

5. Concerning consequences for the individuals

5.a Please indicate - based on your perception as to members of your group - the percentage of each category below that:

Perceive fields or minor symptoms but
do not suffer any consequence in daily life _____%
Manage life, but have taken some actions
due to the perception of fields or symptoms _____%
Show some impairment of well-being _____%
Are frequently ill, have to see a doctor more
often than common, or have to change work _____%
Have had to change life conditions entirely _____%

(If you can not give a percentage figure, please give one of the following descriptive terms; "most", "several", "few" or "none".)

5.b Comments_____
_____
_____
_____
_____
_____
_____
_____
_____

Thank you for your help

Appendix 3. Review of investigations into possible causal factors for subjective symptoms related to "electromagnetic hypersensitivity”

Preamble

As described in the introduction, “electromagnetic hypersensitivity” is a phenomenon where individuals experience adverse effects while using or being in the vicinity of electric, magnetic or electromagnetic devices. Often, these attributions are specifically directed to electric and/or magnetic fields emanating from these appliances, even if other factors - both physical and others - have also been suggested. This attribution to specific factors must not be confused with a statement of an established causality.

In our view, this important caveat is based on both the inability, in single (individual) observations ("case reports"), to identify one out of a number of factors present in a situation as being "responsible" for the reaction, and the difficulty to separate out a direct causal link from that of a psychosomatically mediated link without additional information. This latter difficulty is augmented by the current lack of knowledge concerning a mechanism for interaction between weak electric or magnetic fields and biological systems.

In the text below, we therefore wish to describe the results of such scientific investigations that try to establish or indicate whether there is a link between certain factors (especially exposure to various electric or magnetic fields) and symptoms typical of those claiming to be "electromagnetic hypersensitive".

As discussed elsewhere in this report, there are a number of indications that the designation "electromagnetic hypersensitivity" does not stand for a homogenous group which is distinct from other individuals. This is especially evident when indications from different European countries are compared (see the chapter on description of “electromagnetic hypersensitivity”. Furthermore, even within one country, such as Sweden, indications for heterogeneity of "electromagnetic hypersensitivity" have appeared (14, 51, 111), see further below. Thus, the self-indication by an individual that he or she is "electromagnetic hypersensitive" does not appear to be an optimal definition on which to base deliberations, since a/ it could be a conglomerate of different etiologies, and b/ it may also miss other individuals who share the same etiology for certain symptoms with (some) "electromagnetic hypersensitive" individuals, but who may not be aware of - or have rejected - the "electromagnetic hypersensitivity" label. As will become clear

in the following discussion, a problem is that there are - at present - often no good alternatives to the self-definition of electromagnetic hypersensitivity".

Nevertheless, it was found prudent to separate the discussion of the etiology of the relevant symptoms associated with "electromagnetic hypersensitivity" - and the possible role of electromagnetic phenomena in this etiology - into two parts:

- First, the scientific literature was reviewed for studies relating the relevant symptoms to electric or magnetic fields in the general population. Relevant situations were - as outlined above - neurasthenic or similar symptoms appearing in situations with both low and higher frequencies of electric or magnetic fields. Another situation is that of skin-related symptoms in office workplaces (where use of visual display units, VDUs, occur). This approach was taken in order to cover the possibility that the symptom(s) may be generally related to fields - i.e. in the general or the general working populations, regardless of any specific "sensitivity".
- Secondly, the possibility of a specific "sensitivity" was examined, by way of reviewing efforts to identify groups of such individuals, either by specific reference to an exposure, or by other means such as hormone analyses, personality profiles etc. Attempts to discern factors of importance to symptom development within such groups or in relation to such "sensitivity" are also reviewed.

Scientific investigations appearing in peer reviewed papers, technical reports, conference proceedings etc. were scrutinized for relevant information. Some papers were excluded from the review, for a variety of reasons: the information was not considered to be relevant to the issue of "electromagnetic hypersensitivity or related symptoms"; there was a dearth of information on methods which could not be rectified by contacts with the researcher(s); the study was not based on well formulated hypotheses; and - generally - a low quality of the study or the report.

Throughout this text, it should be observed that a statement such as “an association between.....“ should not be inferred to suggest that a causal link has been established. A verification of a causal link between e.g. an external factor such as a field exposure and an effect is normally considered to require additional data than only a statistical association (see e.g. Hill (46) or Rothman (87) for a general discussion). Basically, such additional data are largely absent in terms of the reviewed associations under scrutiny. Furthermore, the terms “indicated“ or “suggested“ do - in this text - primarily refer to the presence (or absence) of a statistical association, not to a causal link.

General population-based studies

Aim

This part of the section has the following purposes:

- To determine, in studies based on general populations or general working populations, whether relationships exist between exposure to electric or magnetic fields in different frequencies and neurasthenic symptoms.
- To determine, in studies based on general working populations in offices where visual display units are used, whether relationships exist between exposure to electric or magnetic fields as they occur in these situations and skin disorders or symptoms.

The review is not concerned with the possibility that exposure to electric or magnetic fields is related to the development of diseases such as cancer or Alzheimer´s disease, as these are not characteristics of “electromagnetic hypersensitivity“. It should be recognized, however, that an individual´s worry and concern about adverse health effects - including such diseases - may be of relevance to “electromagnetic hypersensitivity“ (see further below).

The term "general" implies (here) that no attempt was made in the design of these studies to *a priori* restrict the study population - or the case group - to individuals with any special sensitivity. Thus, studies performed on groups of individuals specifically selected because of their claim for "electrosenitivity" are excluded here. Likewise, studies based on selected individuals with some (other) defined individual traits of possible relevance to "electrosenitivity" are also excluded. They are treated in a separate part of the text below.

In principle, the review will look at both observational (epidemiological) and experimental studies on humans. It is recognized that a large array of studies have examined animal experimental studies. Where appropriate, brief references to such studies are mentioned, but in general, the readers are referred elsewhere for such information. The motivation for this - beyond the practical fact that this would have extended the review considerably - is that a "human" interpretation of animal data appear problematic, taking into account both the nature of the effects, and the possibility of psychosomatic mechanisms.

Neurasthenic symptoms and exposure to low frequency fields

Epidemiological studies on headaches

Relationships between the occurrence of headaches with proximity to overhead power lines have been investigated in a few epidemiological (observational) studies. Dowson and colleagues (29) observed a significantly higher occurrence

of headaches and migraines among resident living at a moderate distance from the power lines (60-80 m) than among those living closer to or among those living further away from the lines. This study had the advantage of using a validated headaches questionnaire, but suffered from a low response rate (60%) and limited analysis of confounding. Furthermore, the absence of a "dose-response" (if "dose" is implied by distance to the power line) further detracts from the credibility of the association.

In another residential study (82), the study population was chosen among residents in towns adjacent to a powerline, individuals residing close to the powerline as well as petitioners concerned with the powerline. 545 of these were randomly selected and were asked about depressive symptoms, headaches, attitudes and demographic variables - with a 70% response rate. No consistent association between proximity to powerlines and headaches (migrain or non-migraine) were found. In still another paper (70), the investigators failed to indicate differences in migraine or non-migraine headaches in relation to the proximity of a powerline.

In a prospective study (41, hitherto only reported in a conference abstract) on power line workers, no association between the 6 year incidence of headaches and measured levels of magnetic or electric fields were found. Likewise, Broadbent et al. and Gamberale and coworkers (cited by Paneth (78)), failed to find associations between headache and measured field level.

Overall, the amount of support for an association between proximity to power lines and/or field levels and headaches or migraine is very limited, even if the limited number of studies together with the limited methodology in some of the studies precludes any definite conclusion.

Epidemiological studies on depressive, neurasthenic or similar symptoms

It should be observed that the following studies have used varying endpoint defintions such as depressive symptoms, depression, neurasthenic symptoms etc, which makes an overall comparison more difficult.

In the study by Poole and coworkers (82) already referred to, depressive symptoms were ascertained by a validated telephone interview schedule. Subjects were classified as living ”near” or not to a transmission line. An association was noted between proximity to power lines and depressive symptoms, with an odds ratio of 2.8 (1.6-5.1). Although concerns about the transmission line were also associated with depressive symptoms, confounder analysis (adjustments) for this and other variables did not reduce the relationship between depressive symptoms and power line proximity. The study by Dowson et al. (29) also found an association between depression and power line proximity. Likewise, Perry and colleagues reported slightly increased magnetic field levels at the door of houses with cases of depressive symptoms than at houses where non-cases lived (0.23 vs 0.21 μT) (Perry et al. 1989, cf Savitz, Boyle et al. (95)). Few details were given in these latter reports, though, and it should be noted that both studies failed to provide any substantial report on the impact of possible confounding factors.

In contrast, McMahon et al. (69) failed to find such an association - the odds ratio was 0.9 (0.5-1.8), comparing those residing on the power line easement with those one block away. While the reported analysis was based on the proximity measure, measurements at the front of the house of 60 Hz magnetic fields verified a difference between the easement (average 0.49 μT) and one block away (0.07 μT). It should be noted that this study has been criticized for its choice of study population - a well-to-do area - which presumably could have caused too limited contrast within the study population (27). As we see it, however, this objection would be dependent on the (assumed) presence of other necessary factors for the causation of depression - a small contrast (apart from the factor under study) would otherwise be optimal for the study. See further Paneth (78) for a general discussion on the requirements for epidemiological studies within this field.

In a second paper from the same study (70), they also failed to indicate an association between proximity to power lines (or measured magnetic fields) and poor appetite, sleep and concentration problems. Taking these endpoint together (and also including headaches - cf above), the odds ratio between them and proximity to power lines (living on vs off the easement) was 0.85 (0.45-1.62). In some contrast to this, the association between ”worry about the powerline” and the health effects was 2.24 (1.15-4.37).

Savitz and coworkers (95) examined the prevalence of depression among electrical workers. Overall, no real tendency of increased risk for "electrical" vs "non-electrical" workers was found. Among electricians, however, increased odds ratios were noted, especially for "trouble concentrating", where an odds ratio of 2.2 (1.0-5.2) was found when comparing electricians with non-electrical workers. The authors caution against drawing too strong conclusions from the findings, due to a/ the absence of exposure information beyound job title (they note that electricians "are not the group most certain to have elevated EMF exposure" (related to the general problem of using job titles as surrogates for exposure), b/ that other occupational factors (e.g. solvent exposure) were not adjusted for, and should be considered "as an alternative explanation for the associations seen for electricians", and c/ the limited statistical power in the analysis of subgroups of electrical workers.

Another recent study by Chevalier et al. (26) investigated in a nested case-control study at the EDF-GDF (French National Electricity and Gas) company the association between various factors - both occupational and non-occupational - and diagnoses of anxiety or depression. The principal findings of the multivariate analysis revealed an array of statistically significant factors ($p<0.1$):

- For depression: being a woman, being a supervisor, job changes, parental problems, difficulties with children, divorced or separated and having had a serious accident or illness.
- For anxiety: being a woman, being a supervisor, having a job not self-chosen, recent job transfer, job changes, parental problems and being divorced or separated.

In the multivariate analysis, there were no significant influences of performing VDU work or being exposed to "electrical risks".

A study of clinical symptoms in two clusters of individuals living near powerlines in France showed that neurasthenic symptoms appeared in relation to exposure awareness leading to anxiety. Taking into account confounding factors, no consistent association between symptoms and living in the proximity to powerline was found (Luis Miro, personal communication).

Some earlier studies on occupational groups by Knave et al. , Broadbent et al. , Baroncelli et al. and Gamberale et al. (as reported by Paneth (78)) all failed to find associations between measured or estimated levels of electric or magnetic fields and various depressive or anxiety symptoms. In a recent study on workers in the power industry ((41), so far reported only in a conference abstract), the incidences of depression, sleep disturbances, tiredness, tinglings and neuropathy, dizzines or stomach related stress symptoms were not found to be associated with electric nor with magnetic field levels. The 9 year incidence of neurasthenic symptoms (irritation, anxiety, generally worried, fatigued without cause, restlessnes and lack of concentrations) was, however, associated with exposure to magnetic field exposures - even if the final analysis was unable to entirely rule out a confounding effect of solvent exposure and/or workplace worry.

In some contrast to the findings on headaches, there are here some more credible indications of associations between these types of symptoms and field levels or proxies for field level exposures around power lines (but not from occupational settings). On balance, however, there are still too few studies, too limited methodology in some of the studies, and too varied results for any definite conclusions to be made concerning depressive or neurasthenic symptoms (as defined by the various authors).

Epidemiological studies on suicide

Recently, Baris and coworkers reported some indications of an excess risk of suicide being related to exposure among blue collar electrical workers (5). This was further examined in a case-control study (6), where adjustments for some other factors (alcohol consumption, socioeconomic scale, marital status and mental disorders) were also performed. Workers exposed to median levels of accumulated electric field exposures had a risk ratio of 2.8 (0.9-8.1) compared to those with lower exposure. Among highly exposed workers, the risk ratio was lower (1.8; 0.4-8.5). No excess risks were found in association with magnetic fields or pulsed electromagnetic fields, nor with current exposure to any fields. Long term exposure was the parameter primarily indicated by the authors, but results were similar when based on current exposure (for the year in which suicide occurred). The authors caution against drawing any causal conclusions from this study, because of various possible sources of bias within the study (incomplete case ascertainment, exposure misclassification, lack of adjustments for all relevant confounders, and limited sample size). In addition, the lack of a dose-response relationship should be noted.

Earlier studies on suicide in association with field levels, electrical occupations or proximity to power lines have given mixed results. The limited methodology in these other studies should be kept in mind, though. In two different publications, 598 suicide cases were found to have higher estimated (84) or measured (79) electric or magnetic field levels. In contrast, neither Baris and Armstrong (4) nor McDowell (67) found any relationships between suicide and electrical job titles or vicinity to power lines, respectively.

Again, studies are too few, too often with limitations in their methodology and have too varied results - even within the recent and more adequately designed positive study by Baris et al. - for any affirmative conclusions about suicide in relation to electric or magnetic fields to be made.

Experimental studies on melatonin secretion and EMF

In a recent review, Lambrozo and coworkers (60) summarized the current knowledge concerning animal or human experiments with melatonin and EMF exposure regimens:

- Electric 50/60 Hz fields have been shown to reduce pineal melatonin synthesis or increase the melatonin degradation in four studies on rodents, but failure to find such effects have also been reported in one study. Levels varied between 2 and 65 kV/m.
- For magnetic field experiments with rodents, a number of studies have also indicated a decrease in night time melatonin in rodents, after various exposure regimens using levels from 0.02 to 100 μT. In a few studies, a lack of such responses was reported. In both the electric and magnetic field studies, lack of dose-response relationships (with dose = exposure level) were noted in some of the positive studies.
- Data on non-rodent mammals are very scarce, and - in the two studies performed - essentially non-positive.
- Human data are, again, very limited. Two groups have investigated this possibility, with mixed results (see however further below).

In addition and subsequent to this review, Graham and coworkers (39, 40) and Selmaoui et al. (96) reported failures to find overall changes in nocturnal melatonin related to night time magnetic field exposures among both women and men. (Part of the first of these studies was previously reported, but then as partly positive. This was included in the review by Lambrozo above.) These studies all examined nightime exposure and its possible effect on nightime melatonin changes. David and coworkers (unpublished, presented to the group in München, November 1996) investigated also the effect of daytime exposure during day - and could find no effect of magnetic field exposure on melatonin regardless of the time of the day.

Another study investigated effects on circadian rhythm of electric field exposure among human volunteer isolated from any cues as to the diurnal light variations. Small (up to 5%) variations in the circadian rhythm were noted in this

isolated situation (Sulzman et al., cited by Paneth (78)). The clinical or health implication of this finding is however unclear.

Other experimental studies on neurological and related functions and low frequency fields

A number of other endpoints such as EEG, ECG and reaction times have been studied in the laboratory, both with animal and human subjects. Experiments on humans are briefly reviewed here - the briefness is motivated by the difficulty in interpreting the findings in terms of adverse health outcomes. For a review of animal experimental studies, we refer to other reviews.

Bell and coworkers (7) exposed patients and volunteers to 7.8 μT static and 60 Hz magnetic fields, and recorded increased EEG (electroencephalogram) activity in the frequency range 1-18.5 Hz. The static and 60 Hz fields appeared to act independently. Similar results were noted by Lyskov et al. (65). who found an increased α (7.6-13.9 Hz) and β (14.2-20 Hz) but decreased δ (1.5-3.9 Hz) activity after exposure to continuous or intermittent 45 Hz, 1260 μT magnetic fields. Cook and coworkers (28) found changes in auditory (but not visually) evoked potential after 9 kV/m and 20 μT 60 Hz electric and magnetic field exposures. In a series of experiments by Ruppe and coworkers (88), volunteers were exposed to strong 50 Hz magnetic field levels of up to 2 mT for 10 minute durations. No effects on EEG readings were noted.

In three studies, effects on electrocardiograms and pulse rates were investigated. In the study by Cook et al. (28) already referred to, a decrease in heart rates was noted. An interaction with the order of expoure/sham sessions was also observed; the heart rate decrease was only found if the first and the last session was "exposed", not when exposure occurred in the intermediate sessions. Closer scrutiny also revealed that the difference in heart rate was due to changes primarily in the sham sessions; in the morning, a decrease in the heart rate over the three hours was noted in both exposed and sham situations, while in the afternoon, this pattern was again observed for the exposed, but not for the sham subjects. In our opinion, these results lead themelves to various interpretations - and it is not clear whether there is in fact only an order effect or an order + exposure effect, or - if an exposure effect exist - if it should be considered harmful or beneficial.

Using somewhat lower exposure levels (3-4 kV/m and 1-7 μT), Korpinen and Partanen (56) failed to note any changes in the pulse rate due to exposure. Some autonomic function tests being related to the cardiovasvular system (orthostatic tests, Valsalva maneuver and deep breathing) were also evaluated by the same authors (57), again without observing an effect related to EMF. However, some weakness in the protocol and execution of the study were identified. In the experiments by Ruppe and coworkers (88) (see above), no effects on ECG, pulse rates or changes in body temperatures were noted.

Reduced number of errors but similar reaction times in tests performed during exposure vs sham were noted in the study by Cook and coworkers (28). In

contrast, neither Lyskov et al. (65) nor Podd and coworkers (81) reported effects of strong magnetic fields (1260 μT, 1100 μT) on reaction times. It should be noted, however, that Podd et al. used quasi-static frequencies (0.1-0.2 Hz) and very short exposure durations. Cook et al. (28) also summarized earlier studies on reaction time, they describe the results as "inconsistent". After strong but short exposure regiments (2 mT, 10 minutes), some psychological tests indicated a reduction of mental performance (88), although the statistical significance of the results were unclear.

Summary - low frequency fields

Overall, the hypothesis of increased risks of various neurasthenic symptoms being related to environmental or occupational exposure to low frequency electric or magnetic fields is - at present - not supported by strong or consistent epidemiological findings. This lack of overall support is partly due to the inconsistency of the findings, the limited methodology in some of the studies and also to the limited number of studies performed. The best case - primarily in terms of need of future research - appear to be made by environmental exposure to fields from power lines and depressive disorders. For this situation, however, it is - based on available data - difficult to separate (presumed) effects due to the physical presence of the fields from those dependent on psychosomatic mechanisms.

The use of such surrogates for EMF exposure as proximity to power lines etc. has been critizised, as several unidentified confounders (such as traffic density, urban location of houses etc.) may interfere with the interpretation of the results (Valberg 1996). In some of the more recent studies, measurements of EMF exposures have been conducted. It can be observed, however, that the inclusion of data based on measurements have generally not resulted in stronger associations with the effects. This lack of further substantiation of the association when better exposure assessments are made, can be interpreted in several ways, though, among them;

- a lack of a “true“ relationships with the fields, where some other factor(s) (“confounders“) may be responsible for the association seen.
- the choice of an inappropriate exposure parameter or field desriptor - which again points to the absence of information on a possible causal mechanism

Considerable attention has been given the possibility that psychosomatic mechanisms may be involved here. Some supporting data from the reviewed studies were found by Poole et al. (82), by McMahan (70) and the cluster investigation reported by Miro, as already described and briefly discussed above. It should be noted, however, that - again - a causal link between EMF worry and e.g. depressive symptoms can not be considered as established, it remains a possibility in these cross-sectional studies that the effect may have caused increased concern and worry. As a general remark, the current inability to formulate a relevant mechanism or pathway for a "direct" effect tends to favour the credibility of a psychosomatic mechanism. It may be counter-argued,

however, that the results of the study by Poole et al. (82), where adjustments were made for attitudes and anxiety, would speak against the psychosomatic mechanism. Better knowledge about socioeconomic variations close to and further away from powerlines as well as further investigations into the impact of attitudes etc. appear warranted.

The most consistent human experimental results appear to come from investigations of EEG activity changes caused by EMF´s. While these indications do motivate further investigations, a few points are worth mentioning; a/ the exposure levels were high (8 - 1260 μT), b/ the interpretation of these changes appear unclear - in our opinion, they indicate a biological effect, but not necessarily an adverse effect and c/ effects have not been consistently found by all investigators. This latter point is augmented by the observation that while effects on brain potentials were noted in a few studies, they did apparently not result in reduced reaction times - as measured in two of them. Few other reliable effects were noted in the reviewed experimental studies on humans. The key issue of whether melatonin secretion or circadian rhythms are influenced by EMF´s can not be answered by current data, studies on rodent give some support for the idea, but data from non-rodent or from human subjects have hirtherto failed to do so.

For both observational and experimental studies on possible effects of low frequency, low level electric or magnetic fields, this area suffers from the general inability to describe possible mechanisms or biological pathways linking an exposure parameter to the investigated effect(s), and the concommitant uncertainity as to the correct exposure index (average, peak, short or long term exposure, electric or magnetic field component etc.). Several hypothetical biological pathways have been proposed, but none have been firmly established. As discussed by e.g. Paneth (78), Savitz et al. (95), Sobel and coworkers (100) and others, two primary contenders for such a role of interest to these outcomes are calcium efflux across the cell membrane, and changes in melatonin secretion. As further argued by Paneth (78), the latter hypothesized pathway (decreased secretion of melatonin caused by electric or magnetic field exposure) would have the advantage of a/ being more selective toward the types of effects reported here, and b/ being directly testable on whole animal or human subjects. (It should be noted that such a pathway (EMF -> melatonin secretion changes -> disorders), does not describe a "mechanism" in the sense that the "dose" can be identified. In our opinion, the term "mechanism" should refer to knowledge about the physical interaction process. Nevertheless, a firm indication of such a pathway may enhance the design of further studies where a relevant definition of "dose" could be achieved.)

In conclusion, while results exist that clearly motivate further research into the possibility of adverse neurasthenic or neurological reactions to low frequency fields, current knowledge is unable to strongly support this possibility. This is in part due to the inconsistent and partly contradictory result obtained, and in part due to the current inability to determine the relevant exposure parameters (if any).

Neurasthenic symptoms and exposure to radiofrequency fields

In a limited number of studies, neurasthenic or similar symptoms were investigated in relation to radiofrequency field exposures. Both observational (epidemiological) studies in occupational and general public/residential settings have been performed, as well as some experimental studies on humans. (For a review of experimental studies on animals, see WHO (118), or McKinlay, Andersen et al. (68).

Occupational studies

In the 1960-ies and 70-ies, various neurasthenic symptoms and symptoms of functional disturbances of the nervous and the cardiovascular systems were reported in Soviet and Eastern European literature among military personnel and other workers chronically exposed to RF. In some studies, ECG or EEG abnormalities were also observed (38, 106, 117, 118). Based on this, the term ”microwave sickness” or ”neurotic syndrome” was coined. The exposures were rarely estimated - with exception of one study (99), where exposure levels were given from dozens to hundreds of V/m. These studies are, however, not easily evaluated because of several drawbacks (vague description of cases, lack of adequate control groups, poor statistical analyses etc., 118). Some other earlier epidemiological studies reported failure in finding - in exposed groups or groups assumed to be exposed - any significant excess of "neurotic syndrome" (97), ECG (97), hospital admission rates due to mental, psychoneurotic or personality disorders (86) and clinical neurological or psychometric findings (73). For further review, see Bergqvist (17).

Among plastic welders with high documented exposures to RF, increased occurrences of paresthesia (numbness) of the hands were found (22, 54). Both studies were small, and adjustments for possible confounders were generally not performed, nevertheless the results should be regarded with some interest, as these two studies are at least partly based on actual measurements, and these clearly indicated excessive exposure levels - well above those recommended e.g. by IRPA (30). In one of these studies (54), a non-significant excess of neurasthenic symptoms was found, whereas headaches or tiredness were not reported more often by the exposed. The other study by Bini et al. (22) found no significant associations between central nervous system findings and exposure (no details given, though).

An excess of self-reported heart problems was in another study found among male physiotherapists using RF (shortwave or microwave) diathermy equipment (42). Self-reports of both disease and exposure (use vs non-use) as well as a low participation rate (58%) do detract from the credibility of the association, though.

In an unpublished study (Luis Miro, personal communication), 105 exposed microwave workers and 62 controls were been examined. The exposure was reported as chronic occupational exposure (exposed all day to about 0.1 W/m^2), No clinical problems nor subjective complaints were noted among the controls. In contrast, some 63% of the exposed workers had some complaint, which was

identified as neurasthenic syndrome (headache, fatigue, heart palpation, vertigo, thermoregulatory disorder, nausea and behaviour modifications) in 30%. In 8.6%, this condition was serious enough to justify treatment. Furthermore, after investigating hematological functions, most (87%) of the exposed but only 3% of the unexposed presented a significant increase in osmotic globular resistance.

Residential exposure to RF fields

Various adverse health outcomes were investigated - in response to resident´s petitions - in the vicinity of a shortwave transmitter based in Schwarzenburg near Berne, Switzerland (1). The broadcast consists of active periods with shorter (15 min) inactive periods for direction changes. Three zones (A, B and C) were defined around the transmitter at increasing distances, C being several km away. Exposure to RF signals (6-22 MHz) was measured, and indicated increasing levels in the C - B - A series. At C, levels were similar to background level (0.08 mA/m), while at A, the median level during broadcast was 1.6 mA/m (but still considerably lower than the IRPA guidelines of 73 mA/m). 100-150 individuals from each zone took part in at least one of the several investigations. Socioeconomic status or attitudes varied across the zones, and were accordingly adjusted for in the analysis.

Difficulty in sleeping was more prevalent closer to the transmitter, and did exhibit a relationship with measured field levels: Increasing field levels from 1 to 10 mA/m was related to an odds ratio of 3.2 (1.8-5.5). Weakness, nervosity etc were apparently secondary to this difficulty in maintaining sleep. Experiments were performed, with changes in the transmitter (shut down or directional changes); individual´s diary notation of sleeping difficulty correlated with these changes. However, attempts to indicate a melatonin mechanism for this relationship failed. The authors were - in their own conclusions - not able to fully differentiate between a direct biophysical relationship, a stress-mediated one or a psychosomatic relationship.

These results do - in our opinion - merit further study. There are some aspects of the study, that makes it difficult to evaluate the outcome, though:

- This study was based on a petition - presumably because of an existing problem. Thus, it can be seen as a cluster investigation. This comment is primarily relevant for the cross-sectional part of the study, where it will decrease the generalizability of the results. The experimental part is presumably less affected, unless the selection process (choosing this particular site) have resulted in a particularly sensitive population being studied. Then, while conclusions about the experimental observations *per se* may still be valid, inference as to the commonality of such reactions should perhaps not be made.
- Some design aspects are not clear, such as the impact of a rather limited response rate, some details of the analysis, and the full confirmation of experimental blindness.
- The use of melatonin levels as a possible intermediate in the pathway between RF exposure and sleep problem appear - to us - not well based in the literature.

It should preferably have been used as a possible confounder - but then that would have made it necessary to evaluate all participants for melatonin levels.

Notwithstanding these limitations, further investigations into this possibility appear warranted. Currently, it is - in our opinion - not posible to draw any general conclusions from this single study.

The US Embassy in Moscow was intermittently irradiated between 1963 and 1975 by an RF source of a few GHz, resulting in exposure levels of some 0.05-0.2 W/m^2. An extensive survey of adverse health problems among the Embassy personnel and dependents living at the Embassy. Although various health outcomes among individuals were detected, including some with neurasthenic symptoms, no health outcomes was, in the final analysis, judged to be linked to the exposure (64).

Mobile phone users

In some countries, anecdotal reports have appeared that describe various symptoms such as headaches, feeling of warmth etc in some individuals when using mobile phones. Results of studies on this phenomenon have - so far - been very limited (47), but some research activities on this are currently ongoing. Another general concern being expressed is that of exposure due to mobile tele-communication base stations. To our knowledge, studies related to these latter situations have not been performed.

It should be noted that while public exposure to base stations appear negligible, thermal exposure from hand-held mobile phones ("cellular phones") could in some extreme circumstances be of the same order as - or possibly also exceed - current basic limits or safety standards. Major difficulties exist, however, in the ascertainment of the exposure in these situations, because of uncertainties in measuring and/or calculating the relevant dosimetric quantity . See further Kuster and Balzano (58).

Other observations in humans

Cutaneous perception (primarily as heat or pain) is possible at high exposure levels to frequencies in the order of a few GHz; auditory effects (”microwave hearing”), and effects of contact or induced currents, exceeding stimulating thresholds of excitable tissues, have been experimentally observed (118). Some of these effects can be considered ”physiological” rather than ”adverse”, and furthermore, they appear as a consequence of short term exposure to RF levels much higher than commonly occurring occupational or environmental levels. Ten cases of complaints allegedly associated with RF field exposures have been collected in a French data base, but without possibility to establish a link with RF exposure (Miro, personal communication).

An overexposure to high levels of RF of a few GHz frequency can apparently induce neurasthenic symptoms and also EEG abnormalities (106, 118). Headache, fatigue, heart palpations anxiety, memory loss, insomnia, hyperhydrosis and other subjective symptoms were reported, mainly in subjects overexposed during

maintenance of radar or military systems; in a few subjects EEG abnormalities were also found (106). Even if in some cases the exposure was not estimated, it can be concluded that in most instances, such effects have been reported from exposure situations where the levels are a few to several orders of magnitude higher than current guidelines (e.g. by ICNIRP), and are considered to be due to thermal interactions of RF fields with the body (118). As a consequence, these observations can not be applied to chronic low level RF exposure, which is under scrutiny here.

In two recent experimental studies, some effects on EEG pattern and on sleep parameters (shortened sleep latency, decreased REM sleep) (66) and on the EEG alpha activity (110) have been reported after exposure to pulsed fields from mobile phones or similar sources. The exposure ranged from 0.5 W/m^2 (900 MHz pulse-modulated at 217 Hz (66)) to less than 0.01 W/m^2 (150 MHz pulse-modulated at 217 Hz; (110). In another experiment, exposure to 1 W/m^2 of 2.45 Ghz continuous fields did not result in any noticeable effects on nervous system functions, where exposure to 10 W/m^2 did influence some perception test results (71).

Summary - radiofrequency fields

For high RF exposures after accidental overexposures (capable of causing substantial thermal effects), various neurological and neurasthenic effects have been described, as well as other medically well defined conditions. Numbness of the hands does also appear to be a reasonably well documented effect of moderately high RF exposures - appearing among plastic welders exposed to levels above current guidelines. No other neurological or neurasthenic effects of RF exposures at moderately high levels could be verified.

The main concern here, however, is with low level RF exposures - i.e. below those causing thermal interactions with the body, and below the expoure limits set by various national and international guidelines or standards. Epidemiological and experimental studies that investigate the possibility of neurasthenic effects of such low level RF exposures are limited. The sleep problems reported around a Swiss shortwave transmitter motivates some further comments here, however, as the investigators made considerable efforts to exclude a psychosomatic mechanism. This report - as well as some indications from the study reported by Miro (see above) motivates further research, but the data is at present not sufficient to establish neither the reliance of the adverse effect (neurasthenic symptom or difficulty in sleeping) on mechanisms other than psychosomatic ones nor indeed its general existence. The various problems anecdotally reported by mobile phone users (headaches etc.) and the few experimental studies on nerve system functions, sleep effect etc. do also point to the need for further scientific investigations.

At the same time, the paucity of studies with good exposure assessment and sophisticated analyses does at the same time make it impossible to fully dismiss the suggestion of neurasthenic effects of low level RF exposures on the basis of these studies. The plausibility of the hypothesis is also partly reduced due to the

inability - at present - to describe and verify mechanisms that could elicit a biological response of RF exposures below those relevant for thermal interactions. In some contrast, it is possible to formulate a psychosomatic mechanism of interaction - but of course then only for situations where the individual is aware of the exposure.

As was the case for low frequency fields, the current (limited) scientific knowledge is unable to strongly support the suggestion that low level RF fields would cause neurasthenic effects. A few observations and reports are worthy of further investigations, though.

Skin symptoms among VDU users

Description of skin complaints or disorders among VDU users

The first reports of facial, throat or hand skin problems among VDU users appeared - to our knowledge - from the UK (Rycroft 1984 cf Stenberg 102), followed by some Norwegian reports (25, 72, 107). The first Swedish reports were published in the middle or late eighties (9, 63, 113), although unpublished case descriptions had appeared earlier. Since then, most published studies have been performed in Sweden, even if case reports have also appeared in other countries, e.g. USA (36, 37) and Japan (Matsunaga et al. 1988, cf Stenberg 102). It should be noted, however, that reports have also appeared that indicate a lack of ”VDU-related dermatoses” or ”VDU-related dermatological problems in some countries; e.g. from Italy, where 736 VDU workers seen at the Institute of Occupational Medicine in Milano, without reporting any such cases (80).

Descriptions of these cases often emphasized unspecific symptoms similar to those of various skin disorders such as rosacea (pain, itching, burning), with mild objective signs (rashes, redness, sometimes describable as a non-specific erythema) but with more pronounced or intense symptoms (16) (9). It is also noteworthy that in the cohort study by Bergqvist and Wahlberg (20), 25% were given a diagnosis of a skin disorder, while only 19% of the same cohort did report skin symptoms at the same day - but prior to visiting the dermatologist. (And, as indicated below, with only a minor overlap.) A major reason for these discrepancies probably lies in the observations that most (86%) of the diagnosed skin disorders were judged to be mild, with the remainder of moderate severity (20).

Generally, these skin symptoms appear transient, often being reduced after work or over weekends (16). In a 5 year follow-up study by Eriksson and co-workers (33), 63% of the skin problems present at the onset disappeared during the study time. The occurrence of changes in work situations or the "electrical environment" were more common among those who remained as cases than among those who recovered - the full interpretation of this is, however, unclear; both ineffective measures and measures directed to more severe (but less responsive) cases could be involved. Of 201 cases examined by Berg (9), 75% were followed up 8 months later. For 14% the problems had ceased, while 52%

reported less severe problems and 28% had similar skin complaints. For 6%, the problems had increased. Most (87%) had continued their work at the VDUs.

It must be emphasized, however, that this description of mild skin problems that often resolve without remedial actions - while common - does not apply to all individuals concerned. A smaller group describe their health problems as intense and with major social consequences, and their problems are also described as increasing if remedial actions are not taken. For example, in the study by Berg (9) on referred patients, 5 individuals (3% of the follow up) had markedly different symptoms (but few objective signs), and had declared themselves as "hypersensitive to electricity" - had quit the VDU work and described serious consequences in their daily life.

The research experience gained on such more severely afflicted individuals are discussed in a separate section below.

Comparisons of self-reported symptoms and objective signs or diagnosed skin disorders have given varied results. According to Berg (10), a fairly good correlation was noted between self-reported skin complaints amd clinical diagnoses (depending on both signs and symptoms) - about 87% of the skin complaint statuses were confirmed by the diagnoses. However, the correlation was rather poor between skin complaints and current signs (46% confirmation). In another cohort study by Bergqvist and Wahlberg (20), the correspondence between skin symptoms and diagnoses was rather poor, with only 33% of those reporting symptom were given a diagnosis. (It should be noted that the clinical criteria for rosacea was different in these two studies, Berg et al. used a much broader definition.)

From case reports, a high degree of one-sidedness of symptoms (at the side of the face turned to the VDU) have often been noted (9). When examining this in a cohort (i.e. when individuals were not self-selected), no such unilaterality was observed (13); while many had unilateral rashes, they were at least as common on the side not turned towards the VDU. A reasonable explanation for the unilaterality towards the VDU in case reports appears to be that of a selection process, individuals with mild/modest skin rashes at the "wrong" side of the face will perhaps not approach a dermatologist for "VDU-related skin problems".

Epidemiological investigation into relationships with VDU work

In Sweden, a number of epidemiological studies have been performed concerning skin problems and VDU work. In most of these studies, skin symptoms and complaints were more common among those performing VDU work than among those who did not (13, 20, 52, 74, 103). Most but not all of these studies also performed some adjustment analysis for confounding factors. For example, comparing those working at least 20 hrs/week for at least 5 years resulted in a risk ratio of 3.0 (1.2-7.1) according to Berg and coworkers (13). Similar results - an odds ratio of 2.5 (1.1-5.6) for those having worked at least 2.5 man-years - were noted by Bergqvist and Wahlberg (20). Both studies used both a retrospective definition of exposure ("at least 5 years" or "man-years" of VDU work), and a retrospective recall of skin rashes (in the last 2 years, in the last 12 months,

respectively). When asking about current symptoms, only individuals with shorter VDU work duration (<2.5 man-years) indicated a (non-significant) excess odds ratio (2.0; 0.7-5.5) (20). A possible - but in no way definite - interpretation could be that this reflect a transient effect of VDU work, problems appear most commonly at the beginning of VDU work, and then partly disappear. (Compare the description above.) In a longitudinal study, the incidence of reporting skin symptom did not correlate with VDU use vs no VDU use (the risk ratio was 1.2; 0.6-2.3), but did weakly correlate with the intensity of VDU use (>30 hrs/week vs <20 hrs/week, risk ratio=1.9; 0.9-3.8) (19). (The study by Bergqvist and Wahlberg is a cross-sectional part of this longitudinal study.) In a third cross-sectional study by Stenberg and coworkers (101) on office workers in northern Sweden, VDU work was associated with skin symptoms in a dose-response manner (dose = daily VDU work duration); for 0-1 hr/day, the odds ratio was 1.2 (1.0-1.5), for 1-4 hr/day, the odds ratio was 1.9 (1.6-2.2) and for >4 hr/day, the odds ratio was 2.4 (2.0-2.9). These odds ratios were adjusted for other factors (gender, asthma and psychosocial conditions). This large questionnaire study formed the basis for additional investigations, see further below.

In other countries, a few similar studies have been performed as well, with varied results. In some early questionnaire studies from the US with low response rates and limited analysis, one reported an association between symptoms and VDU use (Murray 1981, cf Bergqvist (16) and Stenberg (102), while the other did not (Frank 1983, cf Bergqvist (16) and Stenberg (102). A more recent UK study (23) failed to find a statistically significant association; The odds ratio (calculated by us) comparing VDU and non-VDU users where 1.3 (0.9-1.9). For more specific symptoms or signs, odds ratios varied between 1.1 and 1.7 - none being significant. The low response rate (41%) and the limited analysis should be taken into account.

In a large Italian study (24), both women and men reported significantly higher prevalences of skin disorders and facial rashes when the duration of VDU work exceed 2 hours/day. The odds ratio (calculated by us) was 2.2 (1.6-2.9) for skin disorders and 2.7 (2.3-3.2) for facial rashes. These associations varied somewhat with both age and gender. For example, among women, the odds ratio for facial rash was reduced to 1.4 (1.1-1.7). If a symptom frequency score was used, the associations decreased somewhat, which the authors interpreted as a failure to verify the association between VDU work and facial skin "as have other epidemiological studies...in norther European countries". It may conceivably also reflect the mild type of skin reactions presumably involved. Furthermore, it was noticable that the prevalences of skin rashes and disorders were generally much lower in this Italian study (0.5 - 7%) than among the Swedish studies (see above). To what degree this reflects reality or different manner of ascertainment is not possible to determine. For further discussions of international comparisons of this issue, see also a review by Stenberg (102).

As already indicated, evaluations of skin symptoms, signs and diagnosed skin disorders can be seen as more or less independent processes. For skin signs, Berg

et al. (13) reported a small nonsignificant association with VDU work. Bergqvist and Wahlberg (20) found subtantial increases in the occurrence of non-specific erythema with VDU work, but the limited number of cases again resulted in this excess being statistically non-significant (see further below).

For diagnosed skin disorders overall, the results have been varied, with Berg and coworkers (13) finding an excess (the relative risk was reported to be 1.4; 1.1-1.8 for those working at least 20 hrs/week at a VDU for at least 5 years). In contrast, Bergqvist and Wahlberg (20) did not find such excesses (their odds ratio was 0.9; 0.4-2.2 for those having worked at least 2.5 man-years). For specific diagnoses, however, the correspondence appear greater, both studies noted an increased occurrence of seborrhoeic eczema with increaed VDU use. This is consistent also with the results of some other Swedish studies (63, 104) (Note that the study by Lidén and Wahlberg is based on the same study population as Bergqvist and Wahlberg (20), but 6 years previously.)

Overall, an excess occurrence of subjectively reported skin symptoms or complaints is apparently found among VDU users, whereas a relationship with objective signs or diagnosed skin disorders appear less clear - a case can probably be made for seborrhoeic eczema, and possibly for non-specific erythema. Most - but perhaps not all - of the cases can be described as mild, and many often appear to improve or disappear even without any remedial action being taken. It should be noted that most of the evidence and indications on which these conclusions are based come from Swedish and some Norwegian studies. The information available on studies from other countries than Sweden and Norway appear limited and have produced varied results, even if it can be argued that three out of four studies have at least indicated an excess of problems among VDU users vs non-users. The limited number of non-Swedish publications are perhaps attributable to the more limited attention given this topic in other countries. For example, in the conference series Work With Display Units, which has been held four times (1986, 1989, 1992 and 1994), the dominant presentation on this topic has generally been Swedish).

Relationships between skin problems and electrostatic or low frequency electric or magnetic fields

These fields have been in the center of interest ever since the discussion concerning skin complaints during VDU work commenced at around 1980.

Several investigations have explicitly or implicitly studied the possibility that electrostatic charges on the VDU and/or the operator might influence the occurrence of skin problems. As originally proposed by Cato Olsen (25), the hypothesis would be that increases in the electrostatic field at the VDU work station, or increases in the electrostatic charge of the operators, would increase the facial deposition of small air particles, which in turn might lead to adverse reactions. In an early Swedish study (63), some limited additional support for this hypothesis appeared, but with the emphasis on the operator´s charge, not the electrostatic charge of the VDU. Subsequent Swedish studies did not, however, substantiate this; In the study by Sandström et al. the odds ratios for various body

potentials varied between 1.2 (0.6-2.8) and 1.4 (0.7-3.1) (93), while the study by Bergqvist and Wahlberg resulted in an odds ratio of 0.6 (0.3-1.2) for highly charged operators. Neither could the use of grounded filters be shown to reduce the skin problems (21). More recently, two Norwegian intervention studies have, however, somewhat reopened this hypotheses, by indicating a/ that changes in the grounding of an external filter (which affects both electrostatic and low frequency electric fields from the VDU) affected the frequency of tinglings of the skin (77), and b/ efforts to reduce low frequency electric fields as well as electrostatic charges on both the operator and the VDU did reduce the occurrence of skin symptoms - but only in locales with high airborne dust levels (98).

In two Swedish studies, explicit measurements of exposure to low frequency electric or magnetic fields at the VDU work station have been performed - without finding any definite relationship between these fields and the skin complaints (21, 91, 93, 101) after adjustment for other factors, nor with objective signs or diagnosed skin disorders (20, 21). While some excess odds ratios were found between the accumulated exposure (over the years) to line frequency electric and magnetic field, these excesses were shown to be related primarily to the duration of VDU work, not the field levels involved (21). Likewise, an excess odds ratio for ELF magnetic fields (2.7; 1.0-6.9) (93) was reduced after adjustments for other factors (101).

A firmer statistical association was found, however, between electric fields in other parts of the office and the skin complaints in the study by Sandström and colleagues (91, 93, 101). The interpretation of this finding is not straightforward, though. If cases of skin problems increase with increasing VDU work (thus, presumably, staying at the VDU work station), then what mechanism(s) relate this to fields in other parts of the room, but not to those at the VDU work station? One way would be the recognition that measurements of electric fields are extremely difficult and give quite variable results, and that the two parameters measured (VDU vs other places in the room) should be seen as samples of the general level only, and not predictive of specific sites. On balance, this finding is interesting, but can not - in our opinion - be seen as definitive.

Koh and coworkers compared users of CRT (cathode ray tube) and PD (plasma display) VDU users, where the former are generally assumed to cause higher exposure levels - no significant difference was found (53). Likewise, Berg et al. failed to associate their increased VDU work skin rashes with any VDU type or use of filters etc (13).

In summary, the evidence for or indications of an involvement of various electric or magnetic fields on VDU-related skin problems appear weak to almost non-existent. The possible exception is - in our view - actually the first formulated hypothesis, where increased electrostatic charge on (primarily) the operator would increase the deposition of airborne particles, with possible skin-related consequences. If this is indeed the case, then it appears difficult to study, since it would be very situation specific and due to a/ the composition (chemically) of the airborne dust, and b/ the sensitivity of the individual to this dust. This might

explain the failure in some major studies - which did find excess VDU-related skin problems - to find any support for this hypothesis. However, it may then also be argued whether such a situation-specific hypothesis - even if true - is capable of explaining more than a smaller part of the VDU-related skin problems.

Relationships between VDU-related skin problems and some other factors
In the study by Bergqvist and Wahlberg (20), a low relative humidity and skin type were together associated with seborrhoeic eczema; individuals with skin type 1 and 2 who had worked with an average relative humidity below 30% during the preceeding week had an odds ratio of 8.3 (2.5-28) of being given the diagnosis seborrhoeic eczema. This finding appeared to be independent of VDU work, but the occurrence of a low relative humidity was more common in locales where VDUs were placed. The authors tentatively ascribed the earlier reported findings of associations between seborrhoeic eczema and VDU work (20, 63) to low relative humidity as an alternative explanation.

In an intervention study, a high air temperature (above some 23 ºC) increased the reporting of various skin symptoms (especially among men) (49). Further limited support for such associations can be found in the seasonality of some skin problems, e.g. for seborrhoeic eczema (104). In contrast, no real associations with humidity or air temperature was found by Sandström and coworkers (91, 93), but the fact that the climate factors and skin problems were not ascertained in the same time periods may be a possible explanation for this non-positive finding.

Overall, VDU-specific studies have given some limited indications that a low relative humidity and/or a high indoor air temperature is conducive to certain skin ailments. If so, and if some observations are correct that put these findings as basically independent of VDU work (but mixed because of common occurrence of these problems in VDU localities), then some of the skin problems ascribed to VDU work situations may in actuality be involved in the "indoor air problems" also discussed.

A high workload was shown in two studies (20, 101) to be associated with skin symptoms. In e.g. the former, an odds ratio of 3.7 (1.3-10.3) was found, after adjustments for other factors. In the latter, a relationship was also noted between workload and the objective sign of nonspecific erythema. This latter relationship was noted among VDU users only, though (20). Likewise, Norbäck and coworkers (74) also noted some fairly strong - but uncertain - relationships between dermal problems and various psychosocial factors.

In this part of the review, no effort was made to describe the totality of scientific evidence connecting indoor air climate or stress factors with skin problems - the review is limited to studies which specifically have investigated these associations in VDU situations. Generally, a fairly large body of evidence connect these factors with skin problems - evidence obtained in other situations. The studies reviewed here are - in our opinion - sufficient to indicate that generally accepted factors for skin complaints such as low relative humidity/high indoor air temperature or stress are operating also in VDU work situations, and to

at least suggest that these may actually be major explanatory factors for the noted association between VDU work and skin ailments.

Summary - VDU work and skin problems
In summary, while skin symptoms appear to be associated with VDU work, this appears less certain for skin disorders. Regarding objective signs, no conclusion appear possible. Some results suggest that "normal" explanations for these problems such as a low relative humidity or a high air temperature, as well as stress situations, may be major explanatory facors for these skin problems also in VDU work situations. In contrast, suggestions of electric or magnetic field involvement are very scant to nonexistant. One possibility could, however, be static charges leading to a higher facial deposition of skin irritants.

These conclusions are almost exclusively derived from Swedish and a few Norwegian studies. The degree by which they are applicable to skin problems among VDU users also in other countries is not clear - nor is indeed the occurrence of the problem there. It is conceivable that major effect modifiers such as the prevalence of low relative humidity situations or differences in skin types etc. may play a role in causing large scale regional differences.

Finally, it should be reemphasized that these skin problems - often of mild and transient character - should not be mixed with the less common occurrence of individuals with more severe health problem being attributed to various "electrical sources". See further next section.

Reactions among individuals with possible special sensitivity

In the section above, data concerning associations between various but often rather common symptoms and electric or magnetic fields were examined. It was found that the evidence for such associations - although some indications needing further investigations do exist - was rather meagre. For these studies, study populations were normally recruited among the general population, and the evaluation was based on statistical methods. It is thus conceivable, that if a higher sensitivity to a specific factor exist among a small group of individuals, then these studies reviewed above may be incapable of detecting associations between the factor such as field exposure and symptom in such (hypothetically) few sensitive individuals. To overcome this possible problem, studies are warranted that specifically look at such sensitive individuals, but in order to do so, they must of course first be identified.

Aim

This section examines the evidence for the existence of groups with special sensitivity that could be of relevance to "electrical sensitivity". Such sensitivity could be defined around a self-declaration of sensitivity, an explicitly measured sensitivity to an external factor, a type of reaction, an individual/constitutional

factor or a personal trait. When reviewing such different bases for "sensitivity", other data pertinent for the particular type of sensitivity (if any) are also discussed.

Groups defined by self-definition, symptoms and/or attribution

The simplest and ostensibly most straightforward approach would be to identify an individual as "electromagnetic hypersensitive" based on his/ her own appraisal. It can be shown, however, that this approach does have serious drawbacks in terms of scientifically valid methodology: Such a definition of effect will involve also an appreciation of the exposure - and if that is related to the real exposure, false positive results may be obtained when examining the possible association between "electromagnetic hypersensitivity" and the exposure. However, in the absence of the individual being able to determine his/her "exposure" situation, this self-definition approach may still be valid.

Several attempts have been made to describe typical symptoms of individuals claiming to be "electromagnetic hypersensitive". Symptoms have also - in a few instances - been used to define possible subgroups. In an early case series description of 32 seriously afflicted individuals (51), they were differentiated as to:

- Individuals with symptoms dominated by skin problems. This subgroup reported their problems primarily in terms of VDUs or VDU work, and could be described as having a fairly good prognosis - various efforts to improve the situation appeared to work for many of them.
- Individuals with symptoms dominated by neurasthenic problem (but often also with skin problems). This subgroup attributed their problems to a range of electrical appliances (including VDUs), and their situation did not seem to respond as well to remedial actions.

Bergdahl and coworkers (14) differentiated a group of 20 individuals according to their own attribution of their problems; a/ the "VG" group - only to VDUs and fluorescent tubes or b/ the "EG" group - to a wide range of electrical devices. When symptoms were ascertained, the results were found to be similar to those given by Knave et al. above, as the VG group reported primarily skin symptoms, while the EG group also reported a number of neurasthenic symptoms (dizziness, headaches, concentration problems, heart palpitations etc.). (See further below for a psychological profile of these individuals.)

In another recent study based on questionnaires (111), 111 individuals who were all still actively employed (although some were on sick-leave for various reasons) declared themselves as "electromagnetic hypersensitive". Based on their symptoms, they were divided into four groups:

- 67 individuals (60% of the case group) who considered themselves "electromagnetic hypersensitive", each individual reported, however, few if any skin or neurasthenic symptoms,

- 26 cases (24%) reported several skin symptoms,
- 9 cases (8%) reported several neurasthenic symptoms, while
- 9 cases (8%) reported both several skin and neurasthenic symptoms.

It should be noted that a number of individuals who did not consider themselves as "electromagnetic hypersensitive" were also found in all subgroups. One obvious possibility is to use symptom-based groups as the basis for further investigations, regardless of self-declaration of "electromagnetic hypersensitivity". A few cautionary comments are warranted, though. First, this might miss - as previously argued - a (hypothetical) special groups which otherwise might be "drowned" in others. Possibly reinforcing this, it was noticed that - within this study - there were differences between e.g. the skin subgroup derived from the cases and from the non-cases (111). Furthermore, this strictly symptom based approach has actually already been reviewed (see the section on skin problems above).

Eriksson (32), reporting on the same study as Sandström, Stenberg and coworkers, noted that during the 5-year follow-up period, individuals who, in addition to having skin symptoms, also reported other symptoms (general or mucosal) had a higher risk of still having skin symptoms five years later. This finding appear to be consistent with the retrospective information obtained from Knave et al. (above) - a better prognosis for individuals with (primarily or only) skin symptoms.

Thus, care should be taken for the heterogeneity of those calling themselves "electromagnetic hypersensitive". Data above, which are all from Sweden, do clearly indicate this - at least for the Swedish situation. Tentatively, a VDU/skin oriented group could be differentiated from other group(s) with a more diverse attribution and with a higher occurrence of (also) neurasthenic symptoms. It should be emphasized that this more diverse attribution (at least in Sweden) still includes VDUs. For example, in a study reported in 1988 by Berg on 201 referred patients for suspected VDU-related skin problems (9), 5 individuals (2.5%) declared themselves sensitive to electricity ("electric allergy"), they were described as having different symptoms, and reported limitations of their daily life. (See further below.)

Individual and possibly predisposing factors

Hormonal levels and stress mediated reactions

Arnetz and coworkers (3, 11) examined 47 office workers with VDU associated skin symptoms (19 cases) or 28 healthy controls, and found that the cases differed from the controls during actual work with VDUs but not during leisure days (both situations were apparently in the same locales, so as to keep the "electromagnetic environment" constant). The following differences were found:

- Higher hormone levels (prolactin and thyroxine) among the cases than the controls, but only during a working day. A similar decrease was found for

testosterone. These changes were also associated with increased levels of stress among the cases.

- Higher levels of estradiol among the cases than controls, both during work and leisure periods. This was, according to the authors, possibly related to itching behaviour, and could presumably be explained by the effect of estradiol on vasodilation.
- No differences in adrenalin, noradrenalin, cortisol or growth hormone levels.

The authors concluded that "physiological differences" were found between subjects with and without VDU-related skin complaints, and they discussed these findings primarily in consequences in terms of occupational stress reactions, not as a reaction the EMF levels - as they were the same or similar for both situations. In the provocation study of Andersson et al. (2), no relationships between prolactin or cortisol and the electric or magnetic field exposures were found. Two studies (briefly reported in conference abstracts) on general populations offer some further comments: (109) could not find any association between ELF electric or magnetic field exposures and cortisol or prolactin levels in men, while Graham and coworkers (39) noted changes in estradiol and prolactin, but not in cortisol levels in women (neither report give details, however).

Another noteworthy observation obtained in a few provocation studies (see below) is that while guessing that the fields were on were related to increased discomfort occurrence in the subjects, the actual fields were not (2, 45). One difficulty in interpreting these observations is that it is unclear whether the discomforts then influenced the guesses that the fields were on, or whether the belief in the fields being on influenced the perception of symptoms. A possibility in this is some sort of "vicious circle", where such processes may reinforce each other.

Based on these findings, Arnetz and colleagues suggested that "many employees working with computers suffer from occupational strain. This results in physiological changes characterized by elevated metabolism and increased dermal blood-flow. This response acts as an unconditioned stimulus. Once the conditioned response has been learned, the psychophysiological response is elicited purely by the conditioned stimulus, i.e. the VDU-environment." (3). Similar arguments for the amplification of an early (physiological) effect have also been forwarded by Leitgeb (61), who investigated the possibility that a physical factor (electric current perception) could trigger a situation (see below), and also suggested a role for e.g. media-driven awareness in this process. Further arguments for this have been forwarded by David and colleagues (34, 85). The reader is also referred to the section on risk perception, as well as to the earlier comments on a possible (psychosomatic) link between worry and adverse health effects in the vicinity of powerlines.

For a few investigations into melatonin levels, see below.

Personality inventories and psychological profiles

In the study by Bergdahl and coworkers (14), where cases were separated into a "VDU" (VG) and an "electrical appliances" (EG) group depending on their attribution of their problems (see above), both groups were compared to a control/healthy group as to various psychological profiles. While the VG group only deviated from the control group in terms of higher somatic anxiety and muscular tension, the EG group deviated in several scores from the Karolinska Scale of Personality (socialization, somatic anxiety, muscular tension, psychasthenia), and various psychological function scales (e.g. difficulty in taking initiative) as well as items best described as symptoms (e.g. difficulty in concentration). (Similar observations have been made by Ruppe, personal communication.)

In another (unpublished) report by Edvardsson (31), job satisfaction among a group of individuals with VDU work related skin problems was ascertained, and was found to be slighty higher than an external control group. Most (83%) described themselves having active but not stressful jobs. Disease behaviour in this group was characterized as excessive disease conviction, emphasis on somatic perception of the disease and denial of family or economic problems, but also low levels of anxiety - all in comparison with a primary care patient group.

Although interesting, it must be pointed out that a/ both of these studies are small, b/ that they are both cross-sectional in design, and c/ that the study by Edvardsson did not report any analysis of confounder factors. In the study by Bergdahl et al. , some items describing differences between the EG and the control group appear to us to be akin to neurasthenic symptoms. Thus, if a group is defined by symptoms, then finding an excess of such symptoms should not be interpreted as an item describing possible causality. Other items in the Bergdahl study are of more central interest, especially social behaviour, lack of initiative and feeling of inferiority. Again, however, conclusions are difficult, since it could also be argued that such behaviour could be a result of the problem, not necessarily a cause of them. On balance, these studies point to an interesting set of descriptors, but further work concerning their possible role in the origin of the "electromagnetic hypersensitivity" are warranted before any such conclusions should be made.

Dermatological or histopathological findings

Skin biopsies were taken on three early cases of skin problems during VDU work (two men 25 years old and one woman 50 years old), and revealed increased vasculation of the skin, signs of inflammatory processes and - in microscopic examination - signs of actinic elastosis. The author discussed these findings in terms of ultraviolet radiation, ionizing radiation and "unknown factors" (59). The hypothetical connection to UV or ionizing radiation was rebutted in a comment from the Swedish National Radiation Protection Institute, as these factors have been measured in VDU work situations in general and around the VDU units used by one of the three cases referred to above, and found to be negligible (8). The influence of an operator´s electrostatic charge on radon daughter deposition was

also investigated, and was found to be slightly increased in one study (35) but not in another (15). Even in the positive finding, the increase in normal office situations was too small to be considered relevant (8). Also the interpretation of the actinic elastosis finding as unusual has been challenged: it was pointed out that in other investigations of normal individuals in these age groups, such findings were not uncommon. In one early study, 87% of the 20-29 year old and 100% of the 50-59 year old individuals examined exhibited such changes (50).

Subsequently, a histopathological investigation of 83 VDU users with skin complaints and 51 gender and age-matched dermatological out-patients without VDU work has been published (12). The occurrences were similar for 'telangiectases', 'degenerative changes in elastic fibres' and 'sebaceous glands' and (non-significantly) less common among the VDU workers for 'inflammatory infiltrates', 'hydropic egeneration of basal cells' and 'occurrence of demodex folliculorum'. When separating the subjects into subgroups depending on whether objective signs were present or not, it was found that the VDU workers with skin complaints and objective signs had significantly fewer findings of marked telangiectases than non-VDU workers with objective signs ($p<0.001$). VDU workers with skin complaints had more mast cells (moderate and marked degree) than the non-VDU workers - but the differences, which was found both among those with and without objective signs, failed to be statistically significant. Two out of a total of four individuals who reported themselves as "electromagnetic hypersensitive" were among those with a marked increase in mast cells (12).

Examining in two patients with self-defined "electromagnetic hypersensitivity" the possible effects of a TV set session, a high proportion of mast cells were found prior to the open-field exposure, and they were also found to have a high number of somastostatin immunoreactive dendritic cells. After the TV sessions, the number of mast cells were unchanged, but no somastostatin immunoreactive dendritic cells could be found (48). The authors emphasized that this should be further examined, but also stressed the extremely small number of individuals examined. In summary, this material is at present too small and unclear for any conclusions to be made.

Overall, limited evidence is currently available concerning possible dermatological or histopathological differences between VDU users with skin problems and other individuals. The finding of an increased number of mast cells is interesting, but a/ this has only (so far) been examined in one study, where chance was not ruled out as an explanation, b/ it did not appear to be specific for those with a more serious symptomatology who had declared themselves "electromagnetic hypersensitive", and c/ it is not clear whether this change - if substantiated by more investigations - should be regarded as an individual trait possibly enabling certain reactions, as a consequence of exposure or as a finding of no specific etiological interest by itself.

Skin temperature readings

In one provocation study (116), cases of "electromagnetic hypersensitive" individuals had a much more varied facial skin temperature than controls (cases:

1.4 ºC difference between the two facial sides compared to 0.8 ºC in controls - neither being related to the electric field exposure tested in the study). They discussed this in terms of "differences in vegetative system function" with possible consequences in terms of skin blood flow and sweat secretion.

Reactions in terms of skin temperature and some other physiological parameters were also investigated in some other provocation studies, e.g. the study by Hamnerius and coworkers (43), without finding any relationships.

Sensitivity and reactions to external factors

Sensitivity to electromagnetic fields or currents

The observation that "electromagnetic hypersensitive" individuals report their symptoms in situations where modest exposure to electric or magnetic fields occur, while other individuals do not report such reactions, motivates a closer look at the possibility of special sensitivity to these fields.

In the literature, the degree of sensitivity to electric fields and induced currents has been fairly well documented. An external field of some 10-15 kV/m is considered normally sufficient for perception, while about 5% of the population may perceive fields at some 3-5 kV/m (75, 118). Annoyance reactions in terms of tinglings etc may require slightly higher levels of normally some 20 kV/m. (30, 75). Calculations by Korniewicz (55) have suggested somewhat lower perception threshold levels (1.6 kV/m) - presumably under "ideal" conditions. For contact currents, i.e. currents mediated by a metallic object in the ambient electric field, threshold values are substantially lower, the WHO document (118) presents data from Chatterjee et al. (1986) where field levels in the order of 10-100 V/m were sufficient for perception (at 10 kHz), rising about one order of magnitude for higher frequency fields. Data are also presented that suggest a large individual variability, the 0.5% most sensitive population may react to currents half to one magnitude lower than the "average" person (118).

Considering the levels of electric fields in some relevant situations, and the large degree of individual variability that exist in perception, it is not inconceivable that this perception phenomenon might occur in some situations in a smaller part of the population, e.g. around high voltage power lines (75). Such perception phenomena in office situations around VDUs appear more questionable, however, where electric field levels are often found to be in the 10 to 100 V/m range (21, 92).

In a series of experiments, Leitgeb and coworkers (61, 62) have investigated the variation in electric current sensitivity, and indicated that the distribution of this measurable sensitivity in the population is bimodal, and with women having a threshold some 30% lower than men. It can also be seen clearly that there is a certain percentage of persons with a considerably lower threshold which may be interpreted as a prerequisite for - but not as a sign of “electromagnetic hypersensitivity”. Additionally the tested persons have been asked before the test

to grade their “sensibility”. It turned out that for the men being tested, there was not a very good correlation between their subjective evaluation of “sensibility” with the measurements, but that this correlation was better among the women.

Provocation studies with EMF´s

Provocation studies have been carried out on individuals with skin complaints during VDU work as well as on individuals with “electromagnetic hyper-sensitivity”, mostly in Sweden and Norway (2, 43-45, 77, 94, 115-116) but with a few studies also from other countries (83, 114). A tabulation of their basic design and outcome is given in table 1. A few additional studies are ongoing. Furthermore, provocation studies have in some instances been used as part of the medical handling of individuals, see e.g. Hellbom (45), Sandström, Stenberg et al. (94) or Toomingas (108). This latter aspect is not covered here, though.

In addition to the studies listed in table 1, unpublished data from an ongoing study by David and coworkers was reported to the project group in München in November 1996: 9 individuals with "electromagnetic hypersensitivity" were not able to guess more than random whether they were exposed or not - and the same was true for a control group.

In the way of an example, the study by Andersson and coworkers (2) is described in more detail. The inclusion criteria (substantial symptoms, reacted in an open challenge within 30 minutes to the actual VDU, etc) were met by 17 of 35 candidate, 16 of whom participated in the study. The double blind sessions in from of a VDU (4-8 sessions, each being either "on" or "off") had a 30 minute duration. Guesses if the fields were "on" or "off", a VAS scale symptom ascertainment, and blood hormonal levels were endpoint under study. The following results were obtained:

- Participants could not guess better than random whether the fields (the VDU) were "on" or "off".
- No relationships were found between hormonal levels such as prolactin and cortisol)and the "on"/"off" status.
- Symptoms changes were related to the guesses as to whether the fields were "on", not the actual fields.

The overall evaluation by the authors of these studies were that these studies fail to demonstrate an ability by these individuals - as a group - to detect fields, and an association between symptoms developing during the test sessions and the fields involved. In some studies, e.g. the ones by Hamnerius, Agrup et al. (43), Sandström et al. (94) and Wennberg et al. (115, 116), some individuals were able to guess correctly in one session, but were generally unable to verify this when retested.

Table 1. Provocation studies with EMF´s and selected individuals

Study	Recruitment 1)	Exposure situation	Outcome parameter	Results
Recruited among patients with VDU work related skin problems				
Hamnerius et al. (43)	30 skin/VDU patients	Fields created (ELF, VLF, RF), 1 h/ session	Field detection, skin measures and symptom reporting	Inability to detect fields. Symptoms or measurements not related to fields
Oftedal et al. (77)	20 skin/VDU cases 1)	Real work situ-a-tions, VDUs and grounded filters (on/off)	Reporting of skin problems when using these VDUs	Weak association with filter being grounded vs not
Sandström et al. (94)	22 skin/VDU patients (1 non-VDU case)	Fields created (ELF, VLF). Varying durations	Reporting of facial skin problems	8 cases reacted more for certain fields, but not reproducibly
Swanbeck et al. (105)	30 skin/VDU patients	Different VDUs (electrostatic and VLF magnetic fields) 3 h/ session	Reported skin problems	No differences between these VDUs. Reactions also when VDUs switched off
Recruited among cases of declared "electromagnetic hypersensitivity"				
Andersson et al. (2)	16 cases of "electromagnetic hypersensitivity" . Positive open challenge	Real VDU (on/ off), 30 min/ session	Field detection and symptom reporting	Inability to detect fields. Symptoms not related to fields
Hamnerius et al. (44)	7 cases of "electromagnetic hypersensitivity"	Shielded VDUs => magnetic field changes, 1 h/session	Field detection, skin measures and symptom reporting	No secure differen-ces exposure vs shield situations
Hellbom, (45)	6 cases of "electromagnetic hypersensitivity" . Positive open challenge	Real VDU (on/ off), 30 min/ session	Field detection and symptom reporting	Inability to detect fields. Symptoms not related to fields
Wennberg et al. (115, 116)	25 cases of "electromagnetic hypersensitivity"	Fields created (ELF, VLF). Short re-curring exposures	Field detection, symptom reporting	No relation symp-tom and fields. 3 cases detected fields, but not reproducibly

Table 1. (continued)

Study	Recruitment 1)	Exposure situation	Outcome parameter	Results
Recruited among individuals with multiple chemical sensitivity who also reported sensitivity to EMF´s				
Rea, et al. (83)	100 MCS and "electromagnetic hypersensitivity" cases 2)	Magnetic fields created by coil, several chal-lenges	Symptoms and physiological parameters	16 individuals did reproducible react to certain frequen-cies
Wang et al. (114).	19 MCS and "electromagnetic hypersensitivity" cases 2)	Magnetic fields created by coil, several challenges	Symptoms and physiological parameters	No relation symptoms and fields when challenged

Notes for table 1:

1) These are based on best available information - but categories are difficult to separate (at least in the Swedish studies) and may have changed over time. In some studies, control groups were also included.

2) MCS=multiple chemical sensitivity. These individuals reported both MCS and "electromagnetic hypersensitivity". The study by Wang et al. also included individuals with MCS but not with "electromagnetic hypersensitivity".

In two studies, positive findings were obtained. In the first, a provocation/ intervention study by Oftedal and collagues (77), grounding - in a double blind manner - an external filter (with conductive coating) did significantly reduce the severity of the skin symptom "tingling or pricking sensation" ($p=0.03$). The effect on other symptoms were negligible. The mere presence of an ungrounded filter did reduce the electrostatic fields only - and this was also associated with a reduction in the same symptom. Thus, the authors discuss whether the observed effects were related to the static field or the time-dependent (ELF or VLF) fields, but were unable - due to the small number of individuals involved - to clarify this. In conclusion, they summarize by noting that the "results weakly support the hypothesis that skin symptoms can be reduced by a reduction of electric fields", but also that "relatively weak tendencies were shown in this study, and few persons were participating. Therefore, more studies are required to confirm or deny the role of electric fields". Recently, in a conference abstract, the same investigators reported a failure to replicate these findings, though (76).

In the other study by Rea et al. (83), 100 subjects apparently recruited among individuals with MCS (multiple chemical sensitivity) who complained of being sensitive to EMF were challenged by 21 active challenges (magnetic fields at varying frequences between 0.1 Hz and 5 MHz) and 5 sham challenges. 25 individuals reported at least a 20% change in the number or intensity of symptoms were retested, and 16 (64%) of these again reported positive reactions. The symptoms and the frequency at which these individuals reacted differed. For neurological/neurasthenic symptoms, essentially all frequences were found to be positive for several of the 16 successful subjects. Subsequent to the appearance of this report, critique has been levelled at the experimental procedures (field levels

reported, assurance of blindness etc.; (18)). The authors reply corrected some but not all of these questions. Other aspects of this study has also been discussed, including the variability in the responses (different symptoms etc). It should be noted that another study aimed at reproducing these findings, but under "more realistic non-controlled environments" (114) failed to do so.

The ability of all these studies to be able to detect sensitive individuals has also been discussed, and therefore the non-positive studies ability to really indicate an absence of an effect has been questioned. This discussion has centered around a/ recruitment of testees, b/ correct test situations and c/ disturbances by other factors.

It has been argued that by indavertently choosing the wrong individuals (individuals not able to react under these conditions or in the often short duration of the session), the tests might be unable to find a positive effect (even if there is one) and/or make it difficult to generalize the findings. Thus, inclusion criteria are critical. Most studies have been based on individuals who themselves claim to react quickly (within the prescribed test sxession duration). Furthermore, a few studies have verified this by actually testing the individuals in an "open" session, i.e. by requiring that the individuals report a reaction under the experimental conditions when they are aware of the fields/VDU being "on". The failure - in these two studies (2, 45) - to detect the fields in the subsequent double blind session among individuals who reported reactions when knowing the exposure diminish, in our opinion, this counterargument of using the wrong individuals. The same argument is valid against the second objection - that of incorrect test situation (wrong fields etc). It does remain a possibility that a psychosomatically mediated reaction is so strong that it overwhelms any reaction "directly" due to the fields.

In table 1, all provocation studies are separated according to the source population from which the testees were derived, as we think this is important in terms of the discussed inhomogeneity of "electromagnetic hypersensitivity". It should be noted, however, that the delineation between skin/VDU cases and "electromagnetic hypersensitive" individuals (in the Swedish studies) is difficult, in part due to limited information, and in part due to the possible variations over the years in these designations. In general, cases of both skin/VDU problems and "electromagnetic hypersensitivity" were obtained through sources that - in our opinion - would ensure that the testees had severe problems, this being used here as a proxy for "electromagnetic hypersensitivity" or "individuals with a special sensitivity". Severity of problems were also included as a specific inclusion criteria in some of the studies, e.g. the one by Andersson et al. (2). The study by Oftedal and coworkers (77) is not clear on this point, however, since the primary selection was by questionnaire, and there is no information on subsequent restrictions based on severity - severity was an investigated variable in the analysis. Thus, it might be arguable that this study should in actuality be placed in the previous section - i.e. being considered together with other information on normal skin reaction in VDU work situations.

An overall evaluation of these provocation studies does - in our opinion -result in a general inability to demonstrate an effect, in that

- "electromagnetic hypersensitive" individuals have not been shown to be able to detect electric or magnetic fields at levels consistent with those situations where they do react, and
- "electromagnetic hypersensitive" individuals do react in these provocation studies, but these reactions have not been shown to be related to the fields. In a few studies, they do appear to be related to the belief that the field is "on".

In reference to radiofrequency fields - and to mobile phone use situations - a brief mention should be made of one study, where one of 7 individuals could identify whether a mobile phone was ”on” or not (47). The author did however state that these results do not at present allow any conclusions - the indication needs to be followed up. So far, we are not aware of any larger study that has examined this possibility.

Expoure to light or light modulation ("flickering light") and melatonin findings
The observation that a common attribution in at least the VDU related cases of "electric sensitivity" in Northern Europe is to sources of light and especially modulated ("flickering") light such a VDUs and fluorescent tubes, have motivated some groups to examine the possibility of an increased sensitivity to light modulation among these individuals.

Both Wibom et al. (119) and Sandström and coworkers (89, 90) recruited individuals claiming to be "electromagnetic hypersensitive" as well as healthy controls, and exposed them to variations in light modulation. Whereas Sandström used an artificial situation mimicking the light modulation of a VDU, Wibom used variations in light modulations from fluorescent tubes. Both noted an increased sensitivity among those claiming to be "electromagnetic hypersensitive" compared to the controls. These differences were noted both subjectively and according to EEG and VEP measurements (EEG=electroencephalogram, VEP= visually evoked potentials.) For the study by Wibom et al. , subject were recruited based on their subjective attribution of their problems also to fluorescent tubes.

In a recent conference proceeding, Wadman and coworkers (112) did not find any differences in night urine melatonin between those claiming "electromagnetic hypersensitivity" and those who did not. They found, however, an increased level of melatonin - and a strong light influence on it - in a small subgroup of individuals with both skin and neurasthenic symptoms (112). Preliminary data on urine melatonin levels from David and coworkers (presented to the group in November 1996), suggested a/ that there was no difference among healthy individuals in field free and in a 100 μT 50 Hz magnetic field, and b/ that there was no difference between healthy individuals and individuals with "electromagnetic hypersensitivity" when both were tested in a field-free environment. The preliminary presentations of these data, together with the small number of individuals involved in the "positive" subgroup (above) warrant caution in interpretation, though.

A few studies have thus suggested that selected groups of individuals who claim to be "electromagnetic hypersensitive" are more sensitive to light modulations ("flickering light") than normal subjects. Two preliminary reports have also appeared that suggest that "electromagnetic hypersensitive" individuals - as a group - do not have urinary melatonin levels that differ from healthy controls. In one of them, however, a difference was found in a subgroup defined by having both skin and neurasthenic symptoms. It could be argued that further investigations into light, light modulation and/or melatonin levels should consider specific subgroups of "electromagnetic hypersensitives". At present, the limited amount of data offer no firm conclusions - beyond observing that other physical factors than EMFs might be of interest.

Summary - individuals with possible special sensitivity

Attempts to identify individuals with a special sensitivity of possible relevance to "electromagnetic hypersensitivity" appear rather fragmented. Likewise, successful and definite identification of causal factors for symptoms among such individuals have not been made. Some preliminary and detailed observations are available, though:

On identification and terminology
To identify individuals on their claim for "electromagnetic hypersensitivity", while a cause of some problems in etiological research, would have utility in handling situations. There are indications, however, that "electromagnetic hypersensitive" individuals should not be treated as a homogenous group. Thus, subsequent identification of subgroups - currently based on symptoms and/or attributions - appear valid for both research efforts and for medical handling. A basic distinction appear to be relevant between individuals with skin symptoms who attribute them to VDU work situations, and individuals with (primarily) neurasthenic symptoms who attribute them to a variety of situations. It is possible that the first of these two groups (the skin/VDU) is found also in other countries than Sweden, but is not described there as "electromagnetic hypersensitivity".

Throughout this document, the term "electromagnetic hypersensitivity" (when placed within citation marks) is used in the current, loosely defined way. Further discussions on an international or at least inter-European level on this topic would, however, benefit from a common and perhaps more strict terminology. We therefore suggest that the skin/VDU situation is described as such (e.g. "skin symptoms occurring in VDU work situations") and that the term "electromagnetic hypersensitivity" is not used to cover these situations and these individuals. In principle, we would prefer a similar restraint also for the second situation - calling it e.g. "neurasthenic symptoms in the vicinity of electrical appliances" (although we recognize that this could be difficult in some countries). If so, then the term electromagnetic hypersensitivity could be restricted to situations - and investigations - that specifically address a sensitivity to electric or magnetic fields or electric currents.

On individual, predisposing factors

In one study, certain hormone levels differed between individuals with "electromagnetic hypersensitivity" and others, both constitutionally (for estradiol) and during VDU work (for prolactin and thyroxine) - but not in relation to EMF levels. A few other investigations have reported differences between "electro-magnetic hypersensitives" and others in terms of personality or disease behaviour.

These and some other indications suggest that "electromagnetic hypersensitive" individuals may react differently (more intensively(?)) to various stress situations, including concern for fields. These limited observations do, however, require further support before a definite involvement of stress sensitivity in the causation of "electromagnetic hypersensitivity" can be considered established. The main importance of such further investigations is likely to be the connection between the results (if verified) and confirmation - or not - of a psychosomatic part in the causal mecha-nism for "electromagnetic hypersensitivity".

Another individual trait that has been suggested is that of signs of a higher skin reactivity, both in terms of skin temperature variations between "electromagnetic hypersensitives" and others, and in terms of increased occurrence of mast cells in skin biopsies. Again, these results are however found only in single studies, and do require further study.

On sensitivity to external physical factors

A large variation in individual sensitivity to induced or contact electric current is well established. Some indications that extreme groups exist in this sense have been forwarded. Its involvement in the process by which some individuals claim to be "electromagnetic hypersensitive" has not been established, however.

Among some cases of "electromagnetic hypersensitivity", attribution has been to "electrical" appliances that also emit modulated light (VDUs, fluorescent tubes). Following up on this, a few investigations have indi-cated that some "electromagnetic hypersensitivity" individuals are more sensitive to such light modulations ("flicker") than healthy controls. Further investigations are in progress, but whether and to what degree such sensitivity could explain some subgroups of "electromagnetic hypersensitivity" is currently unknown.

On reactions to electric and magnetic fields

In some countries (Germany, Norway, Sweden, the UK and the US), provocations studies of various electric or magnetic field exposures have been conducted with individuals claiming "electromagnetic hypersensitivity". The recruitment met-hods, inclusion criteria, provocation design and endpoint under study have all varied in these 12 studies - covering totally 284 "electromagnetic hypersensitive" individuals as well as control persons in some of them. In one study, weak indications of reactions to electric/electrostatic fields in terms of tingling or pricking sensations were made, while in another, various symptom did appear after exposure to magnetic fields at varying frequencies (0.1 Hz to 5 MHz). The results in the other 9 of these 11 studies were an inability to a/ detect fields and/or b/ to react to them in terms of symptoms. Taken overall, provocation studies to

date have not been able to verify a direct link between (mainly) low frequency fields and problems of "electromagnetic hypersensitivity" that is independent of awareness of the fields. For fields of higher frequencies, the limited number of studies performed enable no conclusions to be made.

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Appendix 4. Risk perception and communication

As stated in the main text of this report, Kunsch (5) listed a number of factors, within those listed in Table 1 in the main text, which may have relevance in the case of electromagnetic fields. Here we discuss in more detail these factors, whose relative importance of each depends on the source, on the exposure conditions, and mainly on the perception of an individual person. Therefore, no ranking of the factors is possible, and their order in the following is completely arbitrary.

The catastrophic potential should be of minor relevance. No possibility of accidents is foreseen even by the general public. However, distorted messages such as “electrical Chernobyl” in the case of clusters of broadcasting antennas, or of power lines, could create attitudes similar to catastrophic fear.

The different role of familiarity has already been discussed. In addition, it may be noted that even if people are familiar with electricity, they are not with electric and magnetic fields in se. The fields cannot be seen, on perceived by senses, apart from special cases (e.g. hair stimulation by intense electric fields), and this “hidden” nature increases the concern, also because of the similarity with ionizing radiation.

The uncertainty and the lack of understanding of mechanisms and effects are the focus of public debates and controversies, and consequently are likely to have a great impact also on individual perception of risks.

Whereas the biological and health effects of high intensity fields are well known and understood, not even the basic interaction mechanisms underlying hypothesized effects of low-level exposures have been clearly identified. The possibility of such effects is still a matter of controversy among scientists, with physicists in general being more skeptical than biologists and epidemiologists (see e.g. the statement of the American Physical Society (1)). That induces large uncertainties in the evaluation of risks, further increased by inconsistencies and contradictions in the scientific findings of biological effects.

People are confused by controversial results and diverging opinions of experts, and that results in a general lack of credibility in science.

The risk is absolutely uncontrollable by individuals, who in most cases are not even aware of the exposure. When awareness is possible, as in the case of VDUs or cellular phones, that does not imply a control of actual exposure and, even more, of risks. People in fact do not know “how much” they risk, due to the absence not only of any indication of dose-effect relationships, but also of a clear concept of “dose”.

Exposure to electromagnetic fields is in most cases involuntary. Significant exceptions are the use of home computers and cellular phones. The perception of risks in this cases, with respect to other similar exposures, would warrant further

investigation. In the absence of ad hoc research, the empirical observation of users of cellular phones, who are concerned with radiation from base stations more than from the portable set (whose exposure is much higher), suggests a relevant role of the perception of risks, at least for this source.

As already discussed, effects on children and on future generations play a significant role in determining the perception of risks from electromagnetic fields, mainly due to the cancer issue. Also epidemiological and biological findings on pregnancy disturbances and teratogenic effects probably influence people's attitude. That holds true in particular for VDUs and this attitude seems not modified by most recent studies which do not support the hypothesis of miscarriages or other effects on pregnancy for such exposures. It has been observed in fact (5) that the initial information is essential for the attitude of the public towards new sources of risk, whereas later on the human mind tends to select the information which supports one's previously formed opinions.

The importance of coverage by the media is obvious and will be discussed in more detail in the paragraph on risk communication.

The benefits of most technologies involving exposure to electromagnetic fields (electricity, broadcasting, telecommunications) are generally well recognized. The distribution of risks, on the contrary, may be a matter of controversy. That seems quite clear for the siting of power lines and base stations for cellular phones. The attitude is the same which is exhibited in completely different cases, where a NIMB ("not in my backyard") logic prevails. This factor therefore interferes with personal stake, in the sense that risks are perceived as higher risks by people personally exposed.

It may be presumed that the human origin of most electromagnetic pollution is a cause for increased concern. In addition, sources with high visual and environmental impact, such as power lines and broadcasting towers, are perceived as "hard technologies", and that is generally an additional reason for fear.

In conclusion, most of the factors identified in previous research on different agents, activities and habits are likely to contribute to some extent to the perception of risks for electromagnetic fields.

Other subjective attitudes may however be relevant for risk perception. It is likely in fact that anxiety and discomfort related to inconscious causes (e.g. psychosocial factors) are projected onto an external, visible source such as an antenna, a power line, or a VDU at the workplace.

The question of the different perception of risks by lay people and by experts has been addressed by Fremlin(2).

Table 1 shows the different ranking of a number of different activities by four different groups. The comparison indicates very large differences in risk perception, in both directions. Nuclear power is considered a threat by the general public much more than by experts, who on the contrary appreciate the risks of X-rays more than lay people.

Table 1. Ordering of perceived risk, by experts and by three lay groups, for a selected number out of 30 activities and technologies in the USA (2).

	15 experts	40 women	30 students	25 active club members
Motor vehicles	1	2	5	3
Smoking	2	4	3	4
Alcohol	3	6	7	5
X-rays	7	22	17	24
Police work	17	8	8	7
Nuclear power	20	1	1	8

Electromagnetic fields are not included in the study; however, empirical experience clearly indicates a big difference, the risks is perceived as a more likely and severe risk by the public as compared to scientists.

The matter is being investigated by the Harvard Center for Risk Analysis. They reported (4) on the interview of 1,000 Americans about a variety of alleged hazards in the daily life that had been covered by the media. Interestingly, respondents were less confident that electromagnetic fields were a hazard than they were about nearly all the agents covered by the survey (Table 2). The striking coincidence of findings on X-rays and electromagnetic fields is suggestive of a tendency by the public to associate (or even confound) the two sources, as pointed out above.

Table 2. Hazard confidence score within the public in the USA adopted from the Harvard Center for Risk Analysis (4)

ITEM	Percent Top Score[1]	Mean Score[2]
Heavy smoking	90.0	9.1
Environmental tobacco smoke	71.9	7.7
Ozone Depletion	63.2	7.1
Global Warming	51.4	6.4
Radon	46.7	6.2
Medical X-rays	38.8	5.6
Electric and Magnetic Fields	38.3	5.5

[1]Percentage of responses equal to 7 or more on a 10-point scale.

[2]Mean score of the 1,000 respondents.

Further research is in progress to investigate how much difference there is between the public and the scientific community in their perception of risks from electromagnetic fields. It has already been reported (3) that also within scientists the confidence on the existence of health risks from such sources spans over a wide range.

The relationship of knowledge and familiarity of risks with their perception has been the object of a study on power lines performed by Granger Morgan, Slovic and coworkers (7). They reported a comparison of risk perception for 16 known or potential hazards through a psychometric representation, i.e. a two dimensional diagram (Figure 1) where factors 1 and 2 are made up of a combination of factors (see Table 1 in the main text) that seem to go together. Factor 1 “dread risk”

stands for: uncontrollable, dread, consequences fatal, not equitable, catastrophic, high risk to future generations, not easily reduced, risk increasing, involuntary. Factor 2 "unknown risk" represents: not observable, unknown to those exposed, effect delayed, new risk, risks unknown to science. The negative axes denote the respective opposite characteristics.

It is not surprising that risks from power lines, although equally unknown as those for electric blankets and not far from VDUs and microwave ovens, are perceived as "dread", probably due to involuntarity. In the same study, the authors found that exposure from power lines and electric blankets were ranked by lay people among the least risky of the hazards considered. However, the provision of information on scientific findings on ELF fields, that was initially very limited, produced a significant shift in the perception of the respondents towards more "dread risk". This point is very important for the connection between risk communication and risk perception. The debates on electromagnetic fields have in fact increased over the more than one decade that has passed after the study, and it is likely that information disseminated by the media has produced a similar shift in the appraisal of risk by the public in general.

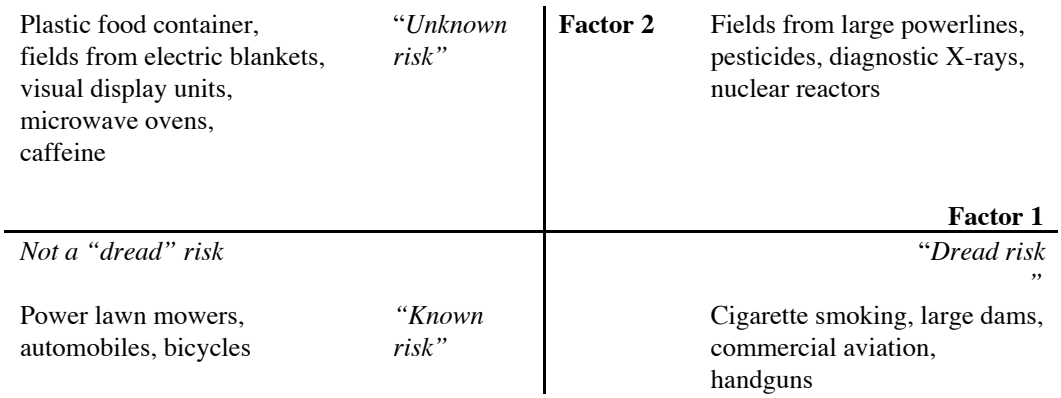

Figure 1. Location of hazards on two risk-dimensions for 16 known or perceived hazards Data from Morgan et al. (7)

These findings are fairly consistent with a recent study in Norway (6), where a survey on about 1,000 people shows that approximately two thirds of the sample consider health effects to be probably due to exposure, and three quarters regard the fields being more dangerous than they formerly believed.

The Norvegian survey also confirms the importance of voluntarity. Even though the Norvegian public is well aware of the electromagnetic fields generated by domestic appliances, the concern is much lower than for power lines (Table 3).

Table 3. Reported anxiety for different sources of radiation and fields in Norway. Percentage of respondents (adapted from Maerli (6).

Source	Very frightened	Rather frightened	A bit frightened	Not frightened	Don't know
Radioactive fallout	57	24	13	5	1
Power lines	10	19	34	34	3
UV	8	20	42	27	3
X rays	5	9	33	51	2
Computer screens	3	7	27	59	4
Electric devices	3	5	26	64	2
Microwave ovens	3	5	23	64	5

References

1. APS. *Statement on "Power Line Fields and Public Health*. American Physical Society, 1995
2. Fremling JH. *Power production, what are the risks?* (2nd ed.) Adam Hilgar, Bristol, New York, 1989.
3. HCRA. *Workers, EMFs, and cancer*. Report vol 3 no 2, Harvard Center for Risk Analysis, Boston, Mass, 1995.
4. HCRA. *EMFs and childhood cancer*. Report vol 4 no 2, Harvard Center for Risk Analysis, Boston, Mass, 1996.
5. Kunsch B. Electromagnetic fields and risk perception. In: Simunic D, ed. *COST 244 meeting on Electromagnetic Hypersensitivity. Graz:* COST 244, 1994: 58-67.
6. Maerli MB. The Norwegian public´s perception of risk from electromagnetic fields. *Radiat Prot Dosim* 1996;68:235-238.
7. Morgan MG, Slovic P, Nair I, et al. Powerline frequency electric and magnetic fields: A pilot study of risk perception. *Risk Anal* 1985;5:139-149.

Appendix 5. Information material

In the following, the addresses contacted in order to ask for information material as well as the contact letter are included. Furthermore the evaluation sheet used to get a somewhat uniform description of the different information brochures is presented. Finally, the first and the back page of each evaluated brochure is included in the appendix.

Address list of organisations and institutions asked for information material on electromagnetic fields

The following list contains addresses of institutions and organizations in various European nations. It should be noted that sometimes information is used in neighboring states as well as in the country of origin. Some organisations also sent information material prepared by other organisations. In the documentary part of this report the first and last page of each brochure received and evaluated is to be found. As is evident from the list below, not all institutions replied by sending information brochures.

Austria

Total number of brochures received and evaluated: 3
Addresses referred to:

Verband der Elektrizitätswerke Österreichs
Brahmsplatz 3
1040 Wien

Unfallverhütungsdienst der Allgemeinen Unfallversicherungsanstalt
Adalbert-Stifter Str.65
1201 Wien

Belgium

Total number of brochures received and evaluated: 1
Addresses referred to:

Begacom D5
Service MOB
Rue des Palais 42
1210 Bruxelles

Vlaamse Instelling vor Technologisch Onderzoek
Boerentang 200
2400 Mol

Denmark

Total number of brochures received and evaluated: 3
Addresses referred to:

The National Board of Health
Amaliegade 13
PB 2020
Kopenhagen K
Denmark 1012

Finland

Total number of brochures received and evaluated: 2
Addresses referred to:

Finnish Center for Radiation and Nuclear Safety
POB 14
00881 Helsinki

France

Total number of brochures received and evaluated: 3
Addresses referred to:

Institut National de Recherche et de Securite
30 rue Olivier-Noyer
75680 Paris Cedex 14

Unipede
28 rue Jacques Ibert
75888 Paris Cedex 17

Germany

Total number of brochures received and evaluated: 14
Addresses referred to:

Berufsgenossenschaft der Feinmechanik und Elektrotechnik
Gustav Heinemann Ufer 130
50968 Köln

Bundesamt für Strahlenschutz, Institut für Strahlenhygiene
Ingolstädter Landstraße 1
85764 Oberschleißheim

Forschungsgemeinschaft Funk e.V.
Bonn Center, HI 305
53115 Bonn

Informationszentrale der Elektrizitätswirtschaft e.V.
Postfach 7005 61
60555 Frankfurt Main

Umweltschutzreferat München
Rindermarkt 10
80331 München

Verbraucherzentrale Niedersachsen e.V.
Herrenstr.14
30159 Hannover

Greece

Total number of brochures received and evaluated: 0
Addresses referred to:

National Center for Scientific Research "Democritos"
153 1D AG. Paraskevi Attikis
POB 60228
Athens

Ireland

Total number of brochures received and evaluated: 2
Addresses referred to:

Electrical Supply Board
Lower Fitzwilliam Street
Dublin 2

Italy

Total number of brochures received and evaluated: 0
Addresses referred to:

Istituto di ricerca sulle onde elettromagnetiche
del Consiglio Nazionale delle Ricerche
Via Panciatichi 64
0127 Firenze

Luxembourg

Total number of brochures received and evaluated: 0
Addresses referred to:

Ministere de la sante de la securite sociale de
l'education physique et des sports de la jeunesse
Division de la Radioprotection

Portugal

Total number of brochures received and evaluated: 0
Addresses referred to:

Instituto das Communicationes de Portugal
Av. Jose Malhoa
Lote 1683
1000 Lisboa

Higiene e Seguance do Trabalho
Gen. Dir.
Av. da Republica 84
1000 Lisboa

Spain

Total number of brochures received and evaluated: 0
Addresses referred to:

Direccion General de Telecommunicaciones
Ministerio de Obras Publicas, Transportes y Medio Ambiente
Placio de Cibeles, s/n 5 a Planta
28014 Madrid

Institudo de Seguridad e Hygiene en el Trabajo
Torrelaguna 73
28027 Madrid

Ministerio de Industria y Energia
Avda Complutense 22
28040 Madrid

Sweden

Total number of brochures received and evaluated: 6
Addresses referred to:

National Board of Occupational Safety and Health
171 84 Solna

Elsäkerhetsverket
Box 1371
11193 Stockholm

Forskningsrådsnämnden
Box 6710
113 85 Stockholm

Föreningen för El- och Bildskärmsskadade
Box 151 26
104 65 Stockholm

Switzerland

Total number of brochures received and evaluated: 2
Addresses referred to:

Bundesamt für Umwelt, Wald und Landschaft
3003 Bern

Schweizer Bundesam fŸr Gesundheitswesen
Abteilung Strahlenschutz
Bollwerk 27, Postfach
3003 Bern

SUVA Schweizerische Unfallversicherungsanstalt
Postfach
Fluhmattenstr. 1
CH 6002 Luzern

The Netherlands

Total number of brochures received and evaluated: 0
Addresses referred to:

Ministry of Welfare, Health and Cultural Affairs
Directorate for Food and Product Safety
PO BOX 3008

United Kingdom

Total number of brochures received and evaluated: 4
Addresses referred to:

National Radiological Protection Board
Chilton Didcot
Oxon OX11 OQR

Electricity Association Services Limited
30 Milllbank
London SW1P 4RD

Contact letter

The following letter was sent to these organisations.

Dr. Evi Vogel
Institute for Radiation Hygiene
Federal Office of Radiation Protection
85764 Obercleissheim
Germany

8 Aug 1996

Dear ladies and gentlemen,

the European Commission is funding a project on “Possible health implications of subjective symptoms and electromagnetic fields”. Ten scientists of six different European countries are about to collect, evaluate, and coordinate knowledge and practical experiences on persons showing symptoms due to the fields of electric or magnetic devices or the proximity of other such sources. Within a year a status report will be prepared and recommendations on actions to be taken will be included. We expect that information on electric, magnetic, and electromagnetic fields in general will play a major role. Therefore we intend to include in our status report also a review on what different kinds of such information is circulated in different countries. It would be very helpful if you could send us your information leaflets, if you have any, and also tell us how videly they are spread.
Thank you very much

Yours sincerely

(Dr Evi Vogel)

Evaluation checklist

1. General

1.a Titel of brochure:
in English:
1.b Editor/Organisation:
1.c Country/Language:
1.d Number of pages:
1.e Year:
1.f Written for whom**:**

2. Layout

2.a Is type of language used appropriate for the readers referred to:
(1=very much... 4= not at all)
2.b Are comparisons given to explain things?
few several many
interesting examples:
2.c Pictures/photos : x/y pages
(1= very good,....4=very bad, 0= none):
mostly amusing
2.d Graphs x/per y pages
(1= very good,....4=very bad, 0= none):
2.e Tables/lists x/y pages
or text inserts (1= very good,....4=very bad, 0= none):

3. Content

3.a Compared with length of paper:
1= very good,....4=very bad, 0= none
3.b Is information given on:
nature of EMF:
sources:
results of studies (state of the art):
limits:
which limits (international, national, self made)

3.c Is information given on individuals with “electromagnetic hypersensitivity” or on psychological effects:
e.g.:
e.g. recommendations:
(interesting examples on back side)

3.d Addresses for further information:

4. Argumentation space

(what type of arguments are used, 1= very much ...4= not at all)

4.a Is content of brochure:
- an instruction
- a warning
- a persuasion
- a dialogue
- objective/subjective
- (1= very obj....4=very subj.)

4.b Is there a clear cut between informing and debating:

4.c Are controversies referred to:
e.g.

Information brochures from different European countries

The front and back page of brochures from the following nations and organisations are reproduced on the following pages:

- Austria:
  - Unfallverhütungsdienst (UVD) der Allgemeinen Unfallversicherungsanstalt (AUVA), page App 5:11;
  - Verband der Elektrizitätswerke Österreichs, page App 5:12-13,
- Belgium: Vlaamse Instelling voor Technologisch Onderzoek (VITO), page App 5:14,
- Denmark: Sundhedsstyrelsen, page App 5:15-17,
- Finland: Säteilyturvakeskus (STUK), page App 5:18-19,
- France: Institut National de Recherche et de Sécurité (INRS), page App 5:20-21,
- Germany:
  - Bundesamt für Strahlenschutz (BfS), page App 5:22-25;
  - Umweltschutzreferat der Landeshaupstadt München, page App 5:26;
  - Informationszentrale der Elektrizitätswirtschaft e. V. (IZE), page App 5:27-29;
  - Arbeitskreis Schulinformation Energie, page App 5:30;
  - Forschungsgemeinschaft FUNK, page App 5:31;
  - Berufsgenossenschaft der Feinmechanik und Elektrotechnik, page App 5:32;
  - Verbraucher-Zentrale Niedersachsen e.V., page App 5:33;
  - Wulf-Dietrich Rose/KiWi, page App 5:34;
  - Info-Blatt ELEKTROSMOG, page App 5:35,
- Ireland: Electricity Supply Board, page App 5:36-37,
- Sweden:
  - Arbetarskyddsstyrelsen and other authorities, page App 5:38;
  - Boverket and other authorities, page App 5:39;
  - Forskningsrådsnämnden, page App 5:40;
  - Elsäkerhetsverket, page App 5:41;
  - El- och Bildskärmsskadades Förening, page App 5:42-43,
- Switzerland: Bundesamt für Umwelt, Wald und Landschaft (BUWAL), page App 5:44-45,
- United Kingdom:
  - Electricity Association, page App 5:46-47;
  - National Radiological Protection Board, page App 5:48-49,
- Unipede: Permanent Group on Medical Matters, page App 5:50.