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 °C difference between the two facial sides compared to 0.8 °C 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 hypersensitivity", 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 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 field
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 differences 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 "electromagnetic 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 methods, 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.

Plastic food container, fields from electric blankets, visual display units, microwave ovens, caffeine	*"Unknown risk"*	**Factor 2**	Fields from large powerlines, pesticides, diagnostic X-rays, nuclear reactors
			Factor 1
Not a "dread" risk			*"Dread risk"*
Power lawn mowers, automobiles, bicycles	*"Known risk"*		Cigarette smoking, large dams, commercial aviation, handguns

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

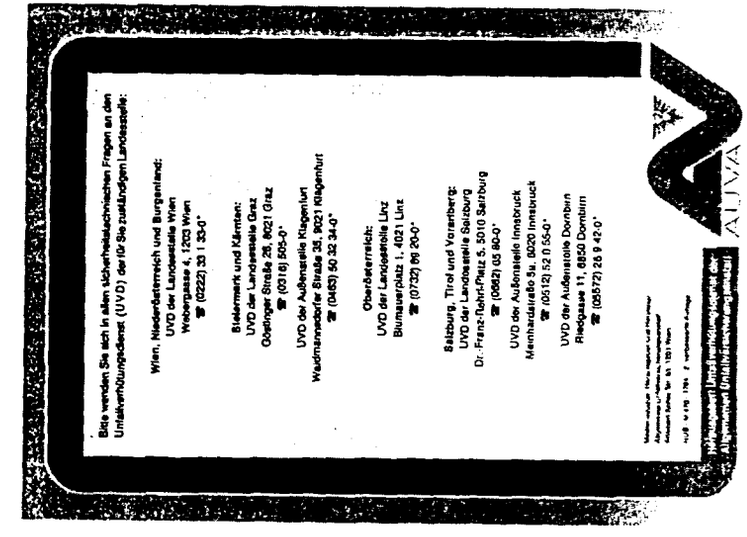
(what type of arguments are used, 1= very much ...4= not at all)
4.a Is content of brochure: an instruction
a warning
a persuasion
a dialogue
objective/subjective
(1= very obj....4=very subj.)
4.b Is there a clear cut between informing and debating:
4.c Are controversies referred to:
e.g.

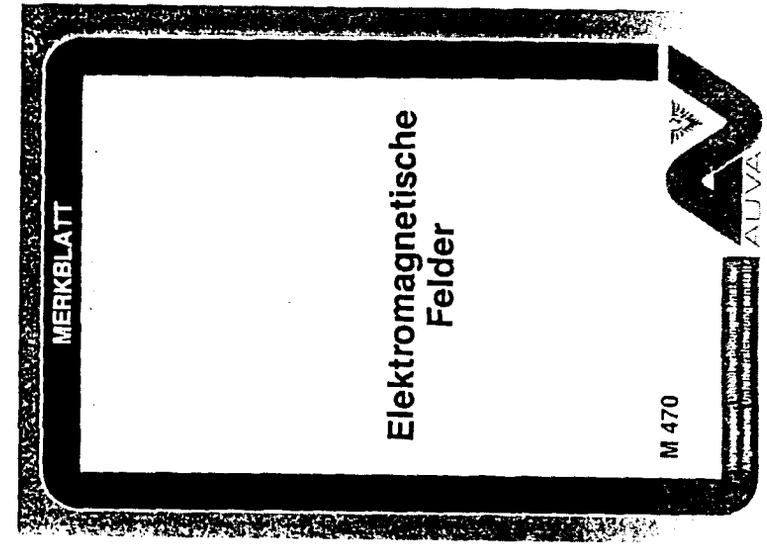
Information brochures from different European countries

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.

Brochures from Austria





8. Wo gibt es weitere Informationen?

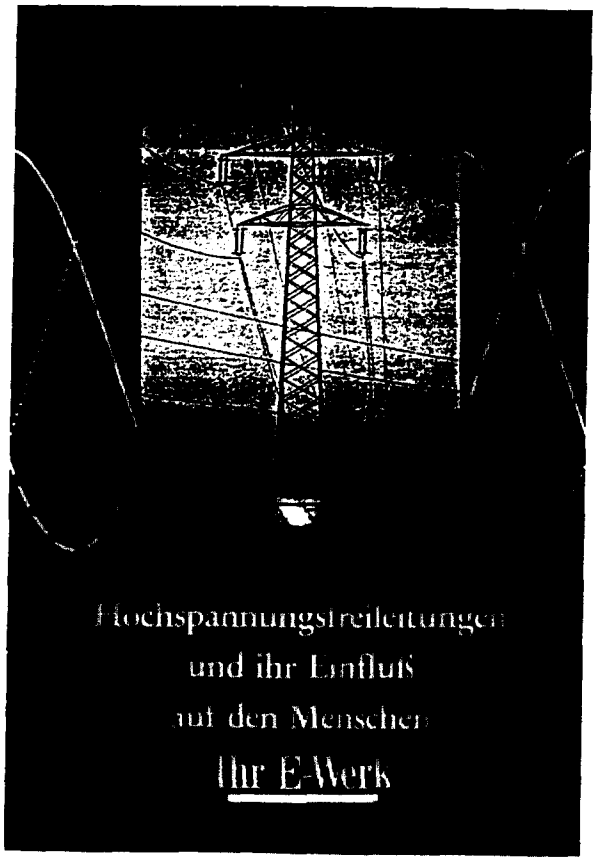
Experteninstruppe
"Elektromagnetische Felder"
p.A.
Verband der
Elektrizitätswerke Österreichs
Postfach 123
1041 Wien

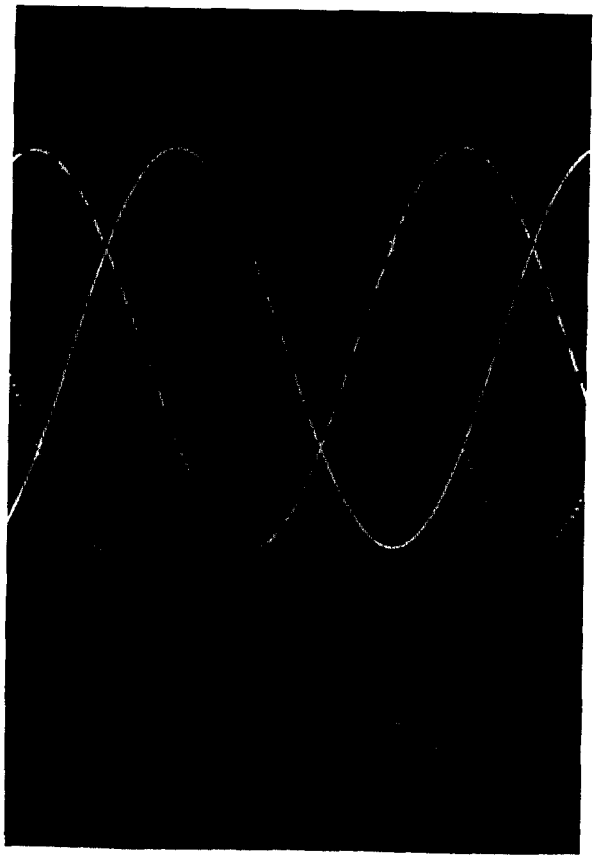
Broschüren und Bücher
★ Broschüre
"Hochspannungsfreileitungen und ihr Einfluß auf den Menschen"
Herausgeber: Verband der Elektrizitätswerke Österreichs, Wien
★ Informationsblatt
"Die Auswirkungen elektromagnetischer Felder von Hochspannungsleitungen auf den Menschen", Herausgeber: Verbundgesellschaft, Wien
★ Buch
"Strahlen, Wellen, Felder: Ursachen und Auswirkungen auf Umwelt und Gesundheit,
von Univ.Prof.Dipl.Ing.Dr. Norbert Leitgeb, Graz. Erschienen im Thieme-Verlag, Stuttgart (1991)
★ Broschüre
"Elektrische und magnetische 50 Hz-Felder", (1991)
Herausgeber: Forschungsstelle für Elektropathologie an der Universität Witten/Herdecke,
Institut für Physiologie, Beckweg 4, D 5804 Herdecke

An dieser Broschüre haben mitgearbeitet:
Dipl.Ing. BACHOFER
Tiroler Wasserkraftwerke AG
Innsbruck
Dipl.Ing. DURDIK
Wiener Stadtwerke
Univ.Prof. Dr. JAHN
Universitätsklinik für Arbeitsmedizin
Wien
Dipl.Ing. NOCKER
Salzburger AG für
Elektrizitätswirtschaft, Salzburg
Univ.Prof.Dipl.Ing. Dr. STIMMER
Techn.Universität Wien
Dipl.Ing. RIPPAR
Verbundgesellschaft, Wien
Dipl.Ing. UMLAUFT, Verband der E-Werke Österreichs, Wien
Gesamtleitung und Koordination:
Ing. NEMETZ,
Tauernkraftwerke AG, Salzburg

IMPRESSUM:

Medienhinnaber
Verband der Elektrizitätswerke Österreichs, Wien
Für den Inhalt verantwortlich:
Dr. Hans Zeinhofer
Wien 1991
Best.-Nr. 700/727F4Ö





Vlaamse Instelling voor Technologisch Onderzoek

O LFD

Bronnen, normen en meetmethoden van 50/60 Hz elektrische en magnetische velden

G. Deraet

Verantwoordelijke uitgever :
Walter De Jonghe
Afgevaardigd Bestuurder

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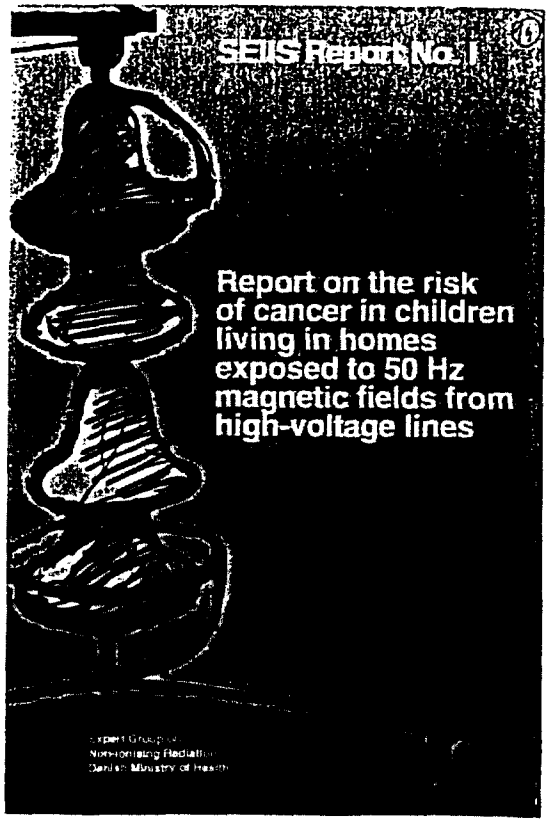
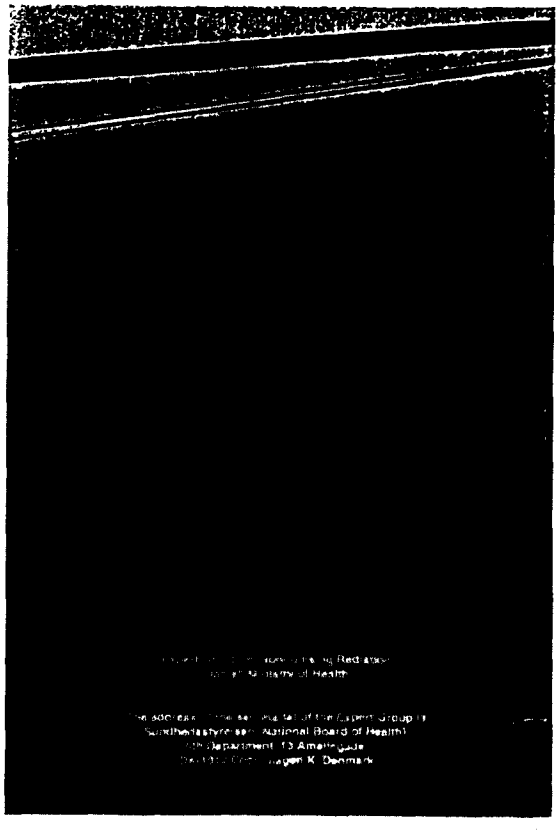
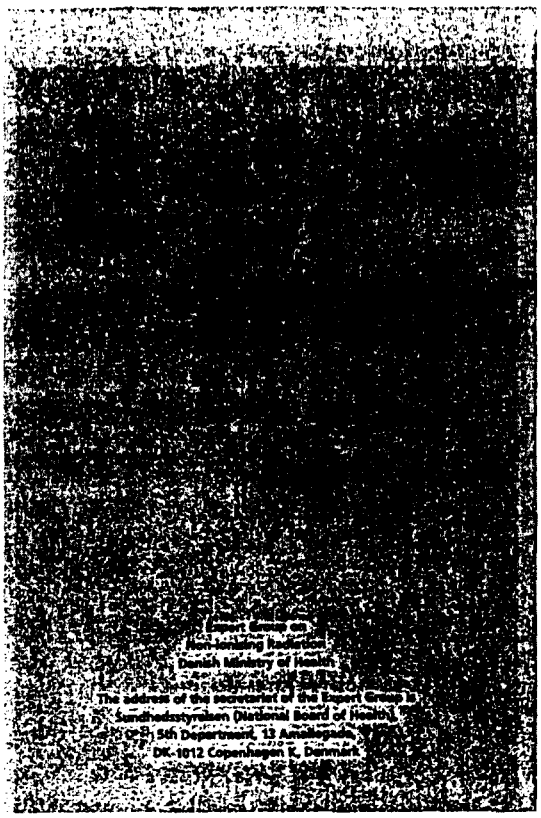
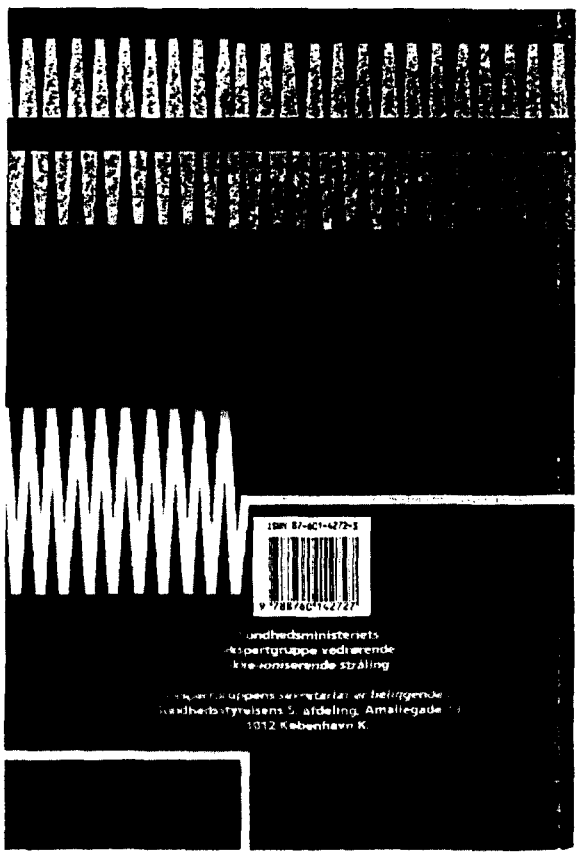






Appendix 5:16



Appendix 5:17

ST-ohje
ST-direktiv 9.2
ST-guide

Pulssitutkien säteilyturvallisuus

Säteilyturvakeskus
Strålsäkerhetscentralen
Finnish Centre for Radiation and Nuclear Safety
PL. P.O.BOX 268, SF-00101 Helsinki, Finland
P. (90) 708 21, Tel. +358 0 70821

Valtion painatuskeskus
Kampan VALTIMO
Helsinki 1992

ST-ohje
ST-direktiv 9.3
ST-guide

ULA- ja TV-asemien mastotöiden säteilyturvallisuus

Säteilyturvakeskus
Strålsäkerhetscentralen
Finnish Centre for Radiation and Nuclear Safety
PL. P.O.BOX 268, SF-00101 Helsinki, Finland
P. (90) 708 21, Tel. +358 0 70821

Valtion painatuskeskus
Kampan VALTIMO
Helsinki 1992

Appendix 5:20

les écrans de visualisation

guide méthodologique pour le médecin du travail

INRS

Réalisé en liaison avec des médecins du travail et des ophtalmologistes, ce guide tente de faire la synthèse des connaissances et des méthodes nécessaires à la mise en pratique, par les médecins du travail, des textes réglementaires qui s'appliquent plus spécifiquement aux activités sur écran de visualisation.

Les nouvelles conditions de travail créées par le développement de l'informatique peuvent être à l'origine, chez les usagers, de problèmes liés à la charge visuelle, à l'aménagement du poste, au contenu et à l'organisation des tâches. Le médecin du travail doit donc disposer d'un maximum d'éléments pour prévenir ou remédier à des situations susceptibles de porter atteinte à la santé physique ou mentale des opérateurs et fonder sa décision d'aptitude.

Ce guide, au caractère multidisciplinaire, aidera le médecin du travail à être un partenaire efficace des instances responsables de l'informatisation des postes de travail.

INRS

INSTITUT NATIONAL DE RECHERCHE ET DE SECURITE
30, rue Olivier-Noyer
75680 PARIS CEDEX 14

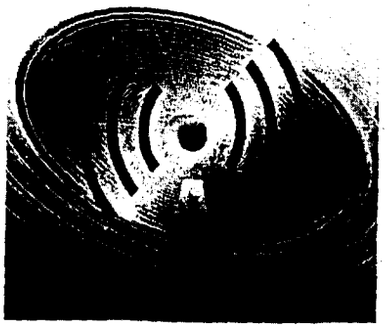
Edition INRS ED 666 . 3e édition (1993) réimpression mars 1995 . 8 000 ex.
ISBN 2-85599-477-2

Appendix 5:21

INRS

Champs électriques
Champs magnétiques
Ondes électromagnétiques

Guide à l'usage du médecin du travail et du préventeur



LA LIGNE PREVENTION

Le bilan des effets physiques et biologiques des rayonnements électromagnétiques non ionisants ainsi que l'aspect médical de la question sont traités au regard de la situation actuelle de la recherche scientifique dans le domaine. Ce guide, initialement prévu à destination des médecins du travail, a été complété de nombreuses considérations techniques pour élargir son impact.

Les champs électriques et magnétiques statiques, les rayonnements d'extrêmement basses fréquences de la nature de ceux qui sont générés par les lignes de distribution de l'électricité et les ondes électromagnétiques de 10 kHz à 300 GHz développées par les générateurs de radiofréquences et d'hyperfréquences font l'objet d'un examen systématique incluant les principes de fonctionnement, les valeurs limites d'exposition admises dans la plupart des pays industrialisés et de considérations propres à aider le médecin du travail pour le suivi médical des salariés exposés et favoriser sa mission de prévention.

Ce guide, assorti de deux lexiques, l'un médical et l'autre technique, ainsi que de nombreuses données bibliographiques, est illustré par une application particulière relevant de l'usage récent de la résonance magnétique nucléaire (RMN). Il constitue ainsi la synthèse actualisée de données pratiques dans un secteur qui préoccupe de plus en plus la population et, plus particulièrement, les salariés.

INRS

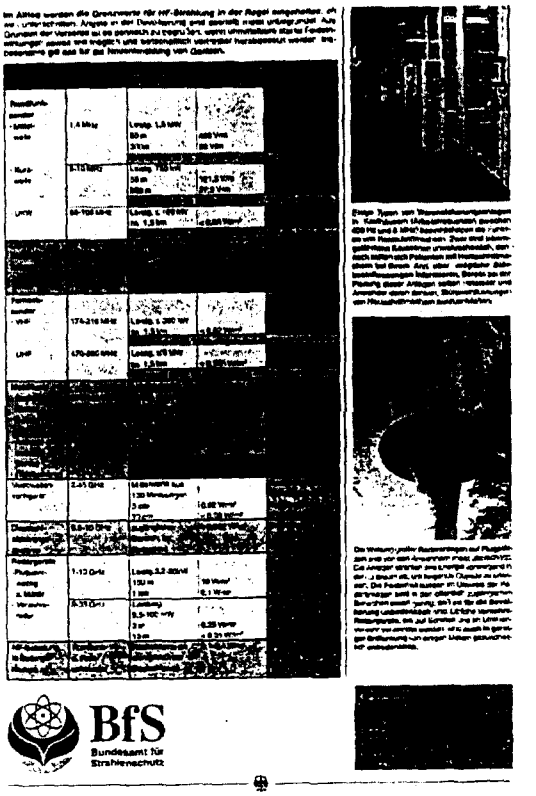
INSTITUT NATIONAL DE RECHERCHE ET DE SECURITE
30 rue Olivier-Noyer 75680 Paris cedex 14
Edition INRS ED 785
1ère édition : août 1995 10 000 ex. ISBN 2-7389-0368-1

BfS Bundesamt für Strahlenschutz

STRAHLEN THEMEN

November 1994

Radio- und Mikrowellen



BfS Bundesamt für Strahlenschutz

Appendix 5:22

BfS Bundesamt für Strahlenschutz

STRAHLEN THEMEN

2. Auflage April 1995

Elektrische und magnetische Felder im Haushalt

BfS Bundesamt für Strahlenschutz

Appendix 5:23

BfS Bundesamt für Strahlenschutz

STRAHLEN THEMEN

November 1991

Mobilfunk und Sendetürme

Weltweit und jederzeit erreichbar sein – diese Forderung moderner Menschen erfüllt die drahtlose Telefonie.

Funkwellen bringen dieses „Wunder" zustande. Mit ihnen wird die Information zum nächstgelegenen Funkturm oder Antennenmast gesendet. Dort werden die Signale verstärkt und weitervermittelt bis sie schließlich beim Empfänger landen. Ein ganzes Netz von Funktürmen und Antennenmasten ist dazu erforderlich: es überzieht inzwischen das Land und wird weiter ausgebaut.

Ist drahtloser Telefonieren jedoch tatsächlich so unbedenklich, wie es scheint? Was ist zu beachten, damit die Gesundheit der Menschen nicht beeinträchtigt wird?

Das BfS fordert: Soll der Mensch vor schädlichen Wirkungen dieser Strahlung geschützt werden, muß die hochfrequente Energie begrenzt werden, die den Körper belastet. Bei Mobilfunkgeräten und Sendetürmen müssen deshalb entsprechende Grenzwerte eingehalten werden.

Bereits im Frühjahr 1991, als der vorläufige Ausbau der Mobilfunknetze begann, bestätigte noch das BfS damit: Mögliche gesundheitliche Risiken dieser Technik seien nachhaltig aufgeklärt worden. Die Ergebnisse ausführlicher Fachgespräche übernahm die deutsche Strahlenschutzkommission 1991 in ihre Empfehlung „Schutz vor elektromagnetischer Strahlung beim Mobilfunk". Dort empfiehlt sie Begrenzungen, die sich auf weltweit anerkannte Grenzwerte stützen – beispielsweise der internationalen Strahlenschutzkommission für nichtionisierende Strahlung (ICNIRP) und der Weltgesundheitsorganisation.

Bei mobilen Mobilfunkgeräten wird nicht mehr von vornherein, die mögliche geringere Sendeleistung ausgenutzt werden. Dennoch ist die Einstrahlung der HF-Energie in den Kopf sehr unterschiedlich. Das hängt auch von der Bauart des jeweiligen Gerätes und der Art der Benutzung ab: vom Typ der Antenne und ihrer Position zum Kopf, von der verwendeten Frequenz und der Ausgangsleistung sowie von der Dauer des Gespräches.

Übermäßige Erwärmung sind zu vermeiden, wenn die Grenzwerte eingehalten werden. Werden bei Handies (Nie. D-Netz: Ausgangsleistung bis zu 2 Watt [Spitzenleistung]) statt Stabantennen und im E-Netz bis zu 1 Watt es gibt es keine gesundheitlichen – Bedenken. Die empfohlenen Grenzwerte sind sicher dann eingehalten, wenn das Gerät direkt ans Ohr gehalten wird. Im C-Netz ist das [illegible] bis 8,8 Watt der Fall.

Zur Antenne

Autotelefone und transportable Geräte (sogenannte „Portables") werden in der Regel mit höheren Sendeleistungen betrieben. Hier müssen die Grenzwerte durch eine entsprechende Konstruktion des Gerätes eingehalten werden: Zwischen Kopf und Antenne ist ein Abstand einzuhalten. Bei Einbauantennen von Fahrzeugen wird dadurch die Antenne meist auf dem Dach oder Heck des Fahrzeugs montiert. Fährt der Mobilfunk, das beim Betrieb die Neugrenzwerte nicht überschreiten werden, so empfiehlt die SSK für gebräuchliche Autotelefone und Portables: Im C-Netz (16 W) eine eine rauer Abstand zur Antenne nimmt, also ca. 30 cm; im D-Netz (6W) genügt bereits eine mindestens Abstand – eines 6 cm.

Werden die empfohlenen Grenzwerte eingehalten, so sind sowohl akute Schäden, als auch langfristige gesundheitliche Beeinträchtigungen durch Mobilfunkgeräte ausgeschlossen. Das gilt auch für Krebserkrankungen.

Transportable Mobilfunkgeräte (sogenannte „Portables") arbeiten mit höheren Sendeleistungen als Handies. Um den Strahlenschutz zu gewährleisten, befindet sich die Antenne bei diesen Geräten am Grundgerät in sicherer Entfernung von Kopf und Auge.

Längst aber direkte Wirkungen auf die Gesundheit eintreten können, möglicherweise [illegible] Berlin benutzt empfindlich auf hochfrequente Strahlung, bedeutend empfindlicher als bei niederfrequenter Strahlung. Körper Kreisen ist vor allem die pulsartig Betriebsweise von Mobilfunkgeräten. Sie stört elektronen stark die normale Funktion anderer elektronischer Geräte. Zwar kann dadurch beispielsweise die Qualität des Radio- oder Fernsehempfangs gestört werden, besonders wenn diese Geräte schlecht entstört sind oder in sicheren Winkel-längenbereich Verstärkungsanlagen aufweisen. Mit schädlichen Gesundheitswirkungen hat das in der Regel jedoch nichts zu tun.

Dennoch gibt es indirekte Wirkungen auf die Gesundheit, wenn elektronische Körperhilfen betroffen werden. Die Gesundheit und das Wohlbefinden vieler Menschen hängen, z.B. von Herzschrittmachern, Insulinpumpen und Hörgeräten ab.

Die Taktfrequenz beim Mobilfunk (217 Hertz) nehmen viele Hörgeräteträger als Brummen im Ohr wahr. Störungen ergeben eine Stromentnahmeung durch D-Netz Handies bei etwa 70 cm Entfernung vom Gerät, bei D-Netz Portables mit 3 Watt Ausgangsleistung sogar bis zu 1,30 Meter.

Probleme können bei [illegible] auftreten, wenn empfindliche medizinische Geräte beeinflußt werden. Die Störfeldstärken medizinisch-technischer Geräte werden bereits in etwa 1 bis 2 Meter Abstand erreicht.

Unsere Empfehlungen:

- Träger von [illegible] sollten darauf achten, entsprechendes Handies nicht unmittelbar am Oberkörper zu tragen, da sonst Störungen nicht in jedem Fall auszuschließen sind.
- Träger von Hörgeräten können in der Nähe von Mobilfunkgeräten durch Störgeräusche belästigt werden; hier die Empfehlung: Abstand halten oder Hörgerät abschalten!
- In Flugzeugen sind die Anordnungen des Bordpersonals zu befolgen, um Beeinflussungen der Elektronik zu vermeiden.
- In Kraftfahrzeugen sollten nur einige dauer, vom Hersteller zugelassene Geräte verwendet werden.

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BfS Bundesamt für Strahlenschutz

STRAHLEN THEMEN

Oktober 1994

Elektrische und magnetische Felder der Stromversorgung

Sogar extra scharf Strom aus der Steckdose. Sicher: wenn, weil er einen langen Weg zurückzulegen im Kraftwerk wird er erzeugt, in Transformatorenstationen auf geringeren Übertragungsspannungen gebracht. Über verzweigtere Verteilernetze wird er in niederspannungsleitungen auf die Reise zum Verbraucher geschickt. Transformatoren verbinden die unterschiedlichen Netze miteinander. Über sie gelangt der Strom schließlich zum Verbraucher. In Haushalten werden dann die gegenüber 50 Hz-Wechselspannungen von 220V oder 380V verwendet. Damit wurde das [illegible] Licht, werden Haushaltsgeräte betrieben oder bleichen in Gang gesetzt.

Stets treten beim Transport der elektrischen Energie auch elektrische und magnetische Felder in der Umgebung von Hochspannungsleitungen auf, ebenso sind Trafohäuschen und elektrische Geräte davon umgeben.

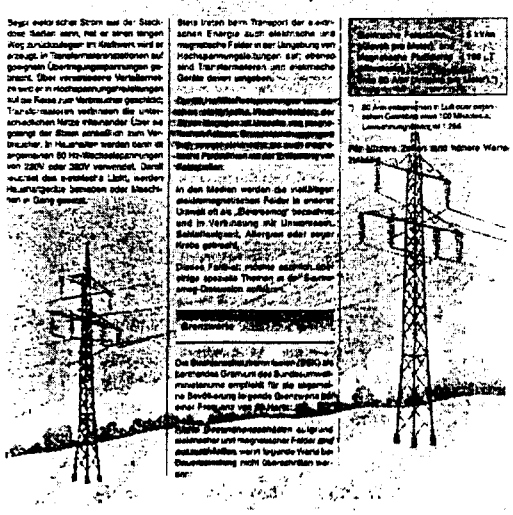
[illegible]

In den Medien werden die vielfältigen elektromagnetischen Felder in unserer Umwelt oft als „Bedrohung" bezeichnet und in Verbindung mit Unwohlsein, Schlaflosigkeit, Allergien oder sogar Krebs gebracht.

[illegible]

Die Bundesregierung hat [illegible] das beratende Gremium des Bundesumweltministeriums empfiehlt für die magnetische Bevölkerung langende Grenzwerte [illegible] Frequenzen von 50 Hertz [illegible]

[illegible] Grenzwerte [illegible] elektrischen und magnetischen Felder sind [illegible] wenn bestimmte Werte bei Dauerbelastung nicht überschritten werden.



Für höhere Zahlen sind höhere Werte zulässig.

BfS empfiehlt: Grenzwerte nicht ausschöpfen

Die Forschungsergebnisse reichen eine ausreichende Basis, um die empfohlenen Grenzwerte weiter abzusenken. Zu diesem Schluß kam im Mai 1992 die internationale Strahlenschutzkommission auf dem Gebiet der nichtionisierenden Strahlung (ICNIRP). Die Grenzwerte für die allgemeine Bevölkerung von 5 kV/m und eine Meter und 100 Microtesla bei Dauerbelastung werden erneut bestätigt.

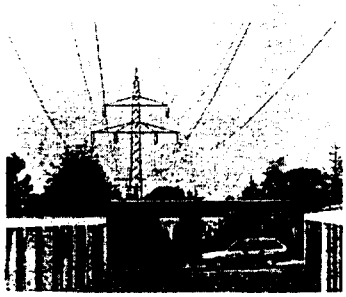
Offene Fragen aus den wissenschaftlichen Untersuchungen jedoch reicht Anlaß über Vorsorge nachzudenken. Auch die geringe Wahrnehmungsschwelle und die Beeinflussung von Herzschrittmachern sprechen dafür, vorhandene Grenzwerte nicht voll auszuschöpfen.

Deshalb empfiehlt das BfS: Auf den Neubau von Kindergarten, Schulen und Wohnanlagen direkt unter Hochspannungsleitungen sollte verzichtet werden. Dann vermeiden man von vornherein eine Belastung von empfindlichen Personengruppen.

Größenordnung der elektrischen und magnetischen Feldstärken in der Stromversorgung

	elektrische Feldstärke in kV/m	magnetische Feldstärke (mit 1 µT) in Microtesla
direkt unter Hochspannungsleitungen ohne Überbauung		
380 kV-Leitung	2 - 7	5 - 15
220 kV-Leitung	1 - 5	5 - 14
110 kV-Leitung	1 - 2	5 - 20
direkt über Niederspannungs-Erdkabeln		10 - 30
Haushaltsstationen	0,001 - 0,01	sehr inhomogen
95% aller Haushalte		0,01 - 0,3
Mittelwerte bei Fußbodenflächenheizung		0 - 12
Nachtstand-arbeiten 30 cm Abstand		0,15 - 5

Bei Haushaltsstationen treten weder elektrische noch magnetische Feldstärken auf, die den Grenzwerten nahe kommen. Netzrückwirkungen sind deshalb aus strahlenhygienischer Sicht nicht erforderlich.



Nach Möglichkeit sollten Maßnahmen zur Verringerung der Exposition an den Feldquellen selbst erfolgen. Ein Beispiel ist die optimale Phasenbelegung der Leiter bei der Stromübertragung.

Im Zweifelsfall: Messen

Ist eine Bebauung in der Nähe großer Hochspannungsleitungen unumgänglich bzw. bereits vorhanden, kann man sich anhand von Feldstärkemessungen darüber vergewissern, ob die empfohlenen Grenzwerte eingehalten, noch Mögliches tun noch nicht ausgeschöpft werden. Meist werden die Grenzwerte bereits in unmittelbarer Nähe der Leitungen unterschritten.

Messungen in Haushalten führt das BfS nicht durch; Hochschulinstitute, TÜV oder Sachverständige sind dafür die richtigen Ansprechpartner.

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Bildnachweis: Grafik: BfS
Druck: Druckerei Braunschweiger Presse AG
(Gedruckt auf 100% Altpapier-Pulpe)