

THE EFFECTS OF MICROWAVE RADIATION FROM TELECOMMUNICATION BASE STATIONS

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INTRODUCTION

Network Rail has plans to roll out a GSM communications system throughout their network. Upon the announcement that a GSM base station and transmitter was to be located at Yeoford station, the whole community had deep concerns about the visual impact on the environment and on the possible effects of the transmitter on the health of those living nearby. Several people have asked me to write a discussion of the latest research on health problems associated with base stations. This is of particular concern to Devon people because of the highly publicised cancer clusters around the Orange transmitter in Crediton and the shared transmitter in Pennsylvania, Exeter.

Mobile phones and GSM-mobile phones in particular are relatively new technologies, so there are few long term epidemiological studies that show statistically significant results, that is where results are unlikely to be due to chance. However, there is a growing body of research and anecdotal evidence that should not be ignored.

This is not an exhaustive study. It is a review of some of the published literature on the effects of microwaves, radio waves (RF) and electro-magnetic fields (EMF). Evidence is presented that emissions from microwave base stations do have effects on those living nearby. Studies on animals that demonstrate possible mechanisms for those effects are also discussed. Evidence is also presented that indicates similar effects from long term low level exposure and short term higher level exposure. Most of the papers are from peer reviewed journals, where the work is scrutinised by other academics before being accepted for publication.

THE GSM-R RAILWAY COMMUNICATIONS SYSTEM

The GSM-R system is similar to other GSM microwave systems. It is based on two way radio communication between a mobile handset in the train and the nearest base station. Each base station can serve a line length of up to 4km. in each direction, dependent upon the topography. Information received from Network Rail indicates that the main beam's horizontal dispersion angle is between 25 and 65 degrees, dependent upon local topographic requirements. Commercial GSM base stations may have three transmitters to cover 360 degrees. Several GSM companies may share a particular mast, which increases the total microwave radiation emanating from that mast. There seems to be very little published literature on the effects of mast sharing. Network Rail have indicated that there are no plans to share masts with commercial GSM system providers, but there is evidence that the O2 company has applied for planning permission to share Network Rail masts and that Ultramast, (a subsidiary of Network Rail), is actively promoting the railway network as suitable for shared communications masts. Commercial pressure and current instructions to local councils make planning permission for mast sharing very possible.

The GSM-R system uses a carrier frequency close to 900MHz, with a frame repetition rate of 217Hz. The frames are transmitted in groups of 25, with the 26th frame missing, which results in additional low frequency wave pulsing of 8.34Hz, Hyland (2000). There is an additional pulsing at 2Hz in discontinuous transmission mode when there is no communication between transmitter and receiver. These frequencies correspond to signals within the human brain.

SAFETY LEVELS

In this country the relevant "safety" limit is laid down by the NRPB (National Radiological Protection Board) who have adopted the international (ICNIRP) maximum power standard of 0.4 mW/cm-sq (4W/m-sq) for frequencies in the region of those used by GSM technology. This standard, although international, is not universally adopted. In Australia the limit is 0.2 mW/cm-sq (2W/m-sq), Switzerland 0.0042mW/cm-sq (0.042W/m-sq) and Italy 0.01 mW/cm-sq (0.1W/m-sq) (and regionally enforced standards of 0.0025 mW/cm-sq (0.025W/m-sq)). The UK "safe" level of radiation is therefore 160 times higher (that is less stringent) than the regional Italian level. The NRPB guidelines are based on heating effects only (see below). The Salzburg Resolution (2000) recommended an outdoor exposure level of less than 0.1µW/cm-sq (0.001W/m-sq) in publicly accessible areas around a base station. This is 4000 times lower than the ICNIRP guideline value for 900MHz emissions. The Salzburg Resolution is the intensity below which no health effects have been published. The distance from a mast where this limit is exceeded depends upon the power, height and beam dispersion of the antenna.

The NRPB guidelines for exposure to low frequency electromagnetic fields (for example from high tension power lines) are similarly lax (1600 microtesla) compared with those in Italy (0.2 microtesla), Sweden (0.2 microtesla) and Australia (0.4 microtesla), (Henshaw (2002)).

THE EFFECTS OF MICROWAVE EMISSIONS ON LIVING ORGANISMS

Water based animals (humans, birds, mammals) absorb electromagnetic waves. In doing so minute electric currents can be generated within cells. This is analogous to the effect of radio waves on a crystal radio receiver, generating electrical currents in the aerial. It is these currents that are believed to be responsible for the effects described in the scientific papers discussed below.

The effects are divided into heating and non-heating effects.

Heating Effects

The heating effect is identical to that used in a microwave oven. The microwave energy is absorbed by the water content of food, which is why food gets hot and plates don't. Heating effects become insignificant when distance from a microwave transmitter exceeds a few metres. This is why exclusion zones around mobile phone base stations are relatively small. However a bird perching on a phone transmitter would feel the heating effect very quickly. (It is of interest that the British Trust for Ornithology is investigating the effects of base station emissions on urban bird populations.) The main danger from heating effects is in using a mobile phone receiver. There have been many recent studies on these effects, eg. Frey 1998, who reported on potential causes of headaches associated with mobile phone use. Other studies have reported interrupted sleep, fatigue, warmth behind the ear and burning skin (Coghill (1998) cited by Trower (2001)). Mobile phone use is usually in short bursts of relatively high power emissions. This contrasts with exposure to base stations where emissions are of a much lower intensity but can be continuous.

Non-Heating Effects

Research on the effects of mobile communication technology is in its infancy, but the hazards of microwave, radio frequency (RF) and electromagnetic fields (EMF) emissions on living systems have been known since the Second World War. The use of microwaves as a weapon has been exploited by the Russians and Americans. Simon Best (2001), writing about microwave crowd control weapons: "after 20 years of rumours and speculation the Pentagon has finally confirmed that it has developed a device as part of its joint non-lethal weapons programme ...". He continues, "in the UK many of the women protestors at Greenham Common in the 1980s experienced symptoms that they attributed to being zapped by microwave weapons from the US base". There was a scandal when US Embassy personnel and dependents in Moscow had been irradiated with up to $18 \mu\text{W}/\text{cm}^2$ of microwave radiation for up to 18 h/day as part of an espionage effort. There is evidence that two ambassadors developed leukaemia.

Many laboratory studies have looked at the effect of pulsed microwave radiation on rodents. They are simple to work with and can produce many generations in a short time. Most studies look at the short term effects, some of which have produced negative results (Chagnaud et al. (1999), Heikkinen et al. (2001)). Such studies are worthwhile in that they contribute to our total knowledge of the subject, but they only demonstrate that under a particular experimental regime, no effect was discovered. These should be viewed in the context of the many studies that show a positive result. For example:

Fesenko et al. (1999) reported that irradiation with pulsed microwaves (8.15-18 GHz, [with 1 Hz pulsing], $1 \mu\text{W}/\text{cm}^2$) increases the cytotoxic activity of natural killer cells of rat spleen. In mice exposed for 24-72 h, the activity of natural killer cells increased by 130-150%, the increased level of activity persisting within 24 h after the cessation of treatment.

French et al. (1997) found that 835 MHz radiation at low power density may be affecting a signal transduction pathway involved in cell proliferation.

Changes to thymidine incorporation in rat brains have been induced by exposure to base station levels of GSM type waves (Stagg et al. (1997)).

Imaida et al. (1998) reported significant decreases in melatonin levels in rats when exposed to both 900 MHz and 1.5 GHz microwaves. They postulate that changes of serum melatonin levels may modify the development of preneoplastic lesions in the livers of rats so exposed.

The following article appeared in the New Scientist on 24/10/2002 reporting the effects of low level emissions (only 2.5 times higher than the NRPB safety level) on cancer cells:

Cancer cell study revives cellphone safety fears

The safety of cellphones has been brought into question once again by research that suggests radio waves from the devices could promote the growth of tumours. Paradoxically, the study suggests that the radiation makes tumours grow more aggressively by initially killing off cancer cells.

Cell biologist Fiorenzo Marinelli and his team at the National Research Council in Bologna, Italy, decided to investigate whether radio waves had any effect on leukaemia cells after previous studies indicated that the disease might be more common among mobile phone users. The life cycle of leukaemia cells is well understood, making it relatively easy to spot changes in behaviour.

The team exposed leukaemia cells in the lab to 900-megahertz radio waves at a power level of 1 milliwatt, and then looked at the activity of a gene that triggers cell suicide. Many European mobile networks operate at 900 megahertz, and maximum power outputs are typically 2 watts, although they regularly use only one-tenth of this power.

After 24 hours of continuous exposure to the radio waves, the suicide genes were turned on in far more leukaemia cells than in a control population that had not been exposed. What is more, 20 per cent more exposed cells had died than in the controls.

But after 48 hours exposure, the apparently lethal effect of the radiation went into reverse. Rather than more cells dying, Marinelli found that a survival mechanism kicked in. Three genes that trigger cells to multiply were turned on in a high proportion of the surviving cells, making them replicate ferociously. The cancer, although briefly beaten back, had become more aggressive.

Thus it may be seen that GSM emissions may promote cancerous growth.

The significance of these studies is that there was a biological change to tissue structure or function when exposed to non-heating levels of pulsed microwaves.

Field studies are more disturbing. Most studies before the advent of GSM technology relate to radio frequency (RF) transmitters. It is reasonable to include such studies in this review because GSM900 is close to the RF band and the observed effects are similar. Eg.

Kolodynski and Kolodynska (1996), who presented the results of experiments on school children living in the area of the Skrunda Radio Location Station (RLS) in Latvia, "*Motor function, memory and attention significantly differed between the exposed and control groups. Children living in front of the RLS had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased.*"

Michelozzi et al. (1998) investigated a leukaemia cluster near a radio-transmitter in Rome. The leukaemia mortality within 3.5 km was significantly higher than expected. The risk declined with distance from the transmitter.

Dolk et al. (1997(i)) investigated a reported leukaemia and lymphoma cluster near a high-power FM/TV broadcast antenna at Sutton Coldfield in the UK. They found that the incidence of adult leukaemia and skin cancer was elevated within 2 km of the antenna.

Hocking et al. (1997) and Hocking et al. (2000) in Australia, who reported that "There was an association between proximity to the TV towers and decreased survival, among cases of childhood leukaemia". Close to the towers, in the annulus within 4km, he found childhood leukaemia rates 2.4 times that of children living further from the towers. Hocking used the TV towers as a proxy for cellular phone base-stations since mobile phones have not been around long enough to deliver meaningful statistic on brain tumours and leukaemia (two conditions, often emphasised in the literature) which have relatively long incubation periods.

Selvin et al. (1992) ran a statistical study of exposure to RF from the Sutra Tower (for radio and TV transmission) in the San Francisco City area. There was a large concentration of all childhood cancers, primarily brain tumour, within 1 km of the tower. Outside this there was a ring with low cancer rates and then a ring with higher cancer rates. This study ignored local topography, so the statistical fit between distance from the transmitter and cancer rate was poor.

Cherry (2000) re-analysed Selvin's data to find "*the spatial data when related to actual radial radiation exposure patterns forms significant linear dose-response relationships, with All Cancer and Brain Tumour having extremely significant dose-response relationships.*" This means that exposure was not only related to distance from the tower but also the topography of the land. There was a highly significant correlation between actual exposure to RF and cancer rates. Hillsides facing the tower showed more instance of disease than those facing away. This becomes obvious when viewed in graphical form (Figure 1).

As with laboratory studies, some epidemiological studies have not shown significant results eg. Dolk et al. (1977(ii)). Such papers are publicised by the mobile phone industry to back up their assertion that there is no "conclusive proof" of harmful biological effects from their products. However, in an important paper in The Lancet, Rothman (2000) summarised the difficulties with this type of research:

"individual exposure from base station exposure is difficult to assess..... Buildings reflect and scatter the beam, the intensity of which varies over time according to the telephone traffic. The few studies to date of populations near microwave, radio, and television towers have produced no consistent finding(s)....., but these studies typically exhibit problems with exposure assessment or geography-related confounding. The epidemiological study of base-station exposure is a formidable problem".

Each study must therefore be looked at on its own merits. If a study does not show significant results, it means that evidence of effects was not discovered in that study. It does not mean that evidence from studies that show an effect should be discounted. Further studies, as outlined below, **show that there is evidence** from field studies on RF and GSM type emissions for the threat to the health of those close to the base stations or in the direct path of the beams to be taken seriously. Conclusive proof has been demanded by scientists defending their positions and decisions after they have pronounced the following to be safe: thalidomide; asbestos; BSE; smoking; sheep dip. Is there need to add GSM to the list?

Two studies (Santini and Santini (2001), Santini et al. (2002) and Navarro et al. (2003)) surveyed people living up to 300m from GSM base stations. There were statistically significant correlations between distance from the base stations and health problems. Tiredness up to 300m; headache, sleep disruption, "discomfort" up to 200m; depression, memory loss, dizziness, visual perturbations up to 100m. Women were more susceptible than men. They conclude that base stations should be sited more than 300m from dwellings.

The biological effect of proximity to a base station is reinforced by a study of fecundity in mice near an "antenna park" Magras and Xenos (1997):

"RF power densities between 168 nW/cm² and 1053 nW/cm² were measured. Twelve pairs of mice, divided in two groups, were placed in locations of different power densities and were repeatedly mated five times. One hundred eighteen newborns were collected. They were measured, weighed, and examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. "

Of particular interest is a much cited study of cattle, Löscher & Käs (1998), which when kept close to a base station, recorded reduced milk yields, emaciation, spontaneous abortions, abnormal behaviour patterns, conjunctivitis, heart failure and still births. When cattle were moved away from the base station, their condition and milk yields improved. The severe symptoms reappeared when the cattle were moved back to their original field beside the base station. The symptoms only appeared when microwave transmitters were added to an existing television transmitter. Löscher and Käs also report the profound effects experienced by the farmer and his family since the microwave transmitters were installed. Similar cases of health effects induced by electromagnetic field exposure were cited. Löscher postulates that the effects are connected to changes in melatonin levels.

Other studies have shown the effects of RF and microwaves on melatonin secretion. Abelin (1999) looked at adult sleep disturbance with RF exposure at Schwarzenburg, Switzerland. Alpeter et al. (1995) tested bovine salivary melatonin at the same location. Turning the transmitter off revealed significant rises in bovine melatonin and human sleep quality. The human subjects exposed to a mean RF signal of less than 0.1 microW/cm² experienced highly significant sleep disturbance and reduced melatonin. Human melatonin increased significantly when the tower was turned off permanently. Cherry (2000), cites a further fourteen studies that show that EMR across the spectrum from ELF to RF/microwave reduces melatonin in people.

"It is believed that during the daytime light going through our eyes passes a message to the pineal glands in the brain which slows down the production of melatonin. At night when no light goes through our eyes the production of melatonin is speeded up. Melatonin is believed to scavenge cancer cells and impurities in our bodies and boost the immune system.... microwave radiation is believed to act on the pineal gland and suppress the night-time melatonin to daytime levels; hence the good work of the melatonin at night will be restricted leading to suppression of the immune system", Trower (2001). Its ability to inhibit the promotion of some types of cancer has been shown in animals and it has been shown to suppress the growth of breast cancer cells. So with reduced levels of melatonin, cancer will not be inhibited. Reduced levels of melatonin in the body have also been associated with depression. Similar symptoms have been demonstrated in cases of power frequency EMF exposure, Davis et al. (2001) and Levallois et al. (2001).

Other studies have shown disruption to sleep patterns. Mann and Roschke (1996) found changes to the pattern of rapid eye movement sleep: "...a REM suppressive effect with reduction of duration and percentage of REM sleep was found.

Moreover, spectral analysis revealed qualitative alterations of the EEG signal during REM sleep with an increased spectral power density. Knowing the relevance of REM sleep for adequate information processing in the brain, especially concerning amnesic functions and learning processes, the results emphasize the necessity to carry out further investigations on the interaction of this type of electromagnetic fields and the human organism." This is particularly disturbing because of its potential effect on cognitive response, and may explain the results of Kolodynski and Kolodynska (1996).

One common theme in epidemiological studies on health effects caused by RF and microwaves is headache. There has been a considerable body of research on the effects of emissions on the blood brain barrier (BBB). Headache is consistent with the effects of radiation on the dopamine-opiate system of the brain and permeability of the BBB, Frey (1994) and Frey (1998). The blood brain barrier protects the brain from toxins and allows toxins to be expelled from within the brain. The blood brain barrier is rather like a one way sieve. If the permeability is disrupted, toxins may affect the brain.

Hyland (2000) states that although the monitored field strength in some studies was higher than that which would be expected from a base station, the information content of the base station emissions is the same, and therefore "these results are not irrelevant to any consideration associated with chronic exposure to base station radiation." Indeed there is evidence that RF and microwave effects are cumulative, so that prolonged exposure to low level emissions is as harmful as short term exposure to higher non-heating levels, Grigor'ev et al. (1995), Neshev NN, Kirilova EI (1996).

The papers cited above are just a few examples of the vast body of research on the effects of RF and microwave emissions. Further papers are cited by Hyland (2000) in a much cited paper in The Lancet. Professor Hyland is one of the foremost experts in this field. Of particular concern is the 8.34Hz pulsing of GSM multi-frame carriers which is within the range of human brain alpha waves. Their effect will be greatest in preadolescent children because the absorption of GSM waves is greatest in an object the size of a child's head. Any degradation of the immune system will also be most pronounced in children, where their systems are less robust than in adulthood. Hyland stresses the importance of animal studies where there can be no claim that measured symptoms are psychosomatic.

In 1999, Hyland made a submission to the Select Committee on Science and Technology (Appendix 15), commenting on the paucity of the current safety regulations and explaining some lack of experimental reproducibility: "Attention is drawn to the inadequacy of existing safety guide-lines governing the exposure of the public to radiation of the kind used in mobile telephony, and to the fact that the philosophy underlying the formulation of these guide-lines is fundamentally flawed..... Thereby excluded, however, are possible adverse health effects provoked by the ability of living organisms—and only living ones—to respond in a non-thermal way to aspects of this radiation other than its intensity—specifically its frequency—both the microwave carrier and the lower frequency amplitude modulations that characterise the digital signals employed by the GSM system. The dependence of these effects on the "aliveness" of the organism necessarily means that they cannot enjoy the same degree of reproducibility, as do those that are not so dependent. This does not mean, however, that they do not exist, or that they should be excluded from the formulation of safety guidelines; indeed, the very real possibility that they might trigger adverse health effects must be seriously considered. The empirical fact that such radiation is known to have deleterious effects on both the neurological and immunological functioning of living organisms—including humans—is consistent with this possibility." [In the same way, not all people who smoke will die from cancer, but the risk of doing so is increased.]

Hyland continues with recommendations: "Meanwhile, several courses of action can be identified that would go some way to ameliorating the (unnecessarily) hazardous situation currently obtaining in the case of base stations:

- (i) Ensure that the field strengths to which the public is so indiscriminately and involuntarily exposed are kept well below the threshold values referred to above, which are 1,000 times lower than thermal levels, being of the order of microwatts/cm² (=μW/cm²).

This will, of course, also lower the energy in each pulse, and can be achieved either by locating the antennae on much higher masts, or by introducing an exclusion zone, such as the one of 500 metres recommended (but not legally enforceable) by the Association of Local Governments of New South Wales (NSW), Australia; clearly, mast height can be traded against the extent of any exclusion zone.

It may be noted, in connection with NSW, that the safety limits there recommended (but again not legally enforceable) are the most stringent in the world—being 1,000 times lower than 1μW/cm². By comparison, the NRPB value of 3,300μW/cm² is one million times higher! Furthermore, the NRPB value is more than seven times higher than that (450μW/cm²) of the International Commission on Non-Ionising Radiation Protection (ICNIRP [1]) who advise the World Health Organisation, whilst the EU has recently recommended a value of 10μW/cm².

(ii) Prevent localised areas of unnecessarily high fields by prohibiting the future erection of clusters of masts in the same vicinity, and requiring that existing clusters be replaced by a single tall mast serving the various companies. In considering Planning Applications, attention should be given to the proposed site of a mast in relation to the local topography, so as to ensure that in hilly terrain, for example, there are no homes, schools, hospitals or any other public buildings that are occupied for any appreciable period of time on a level with the emitting antennae. Furthermore, the antennae distribution on the mast should be such that the highest possible emission in any direction (taking into account the maximum call traffic) is, in publicly accessible areas, well below the 1 microwatt/cm² threshold value.

(iii) Remove from the digital signal any low frequency (amplitude) modulations that fall in the range of the human brainwaves.

THE STEWART REPORT AND BEYOND

A group of independent experts led by Sir William Stewart has investigated possible health effects posed by mobile phone technology including base stations, on behalf of the Government. The group looked at recent research, took evidence from scientists, and listened to the views of the public at open meetings around the UK. Their report was published in May 2000.

Gaps in scientific knowledge led the Stewart Group to recommend a **precautionary approach** to the use of mobile phones and base stations until more research findings become available. They added that in some cases people's well-being may be adversely affected by insensitive siting of base stations.

Further research is now being set up to keep pace with developments in mobile phone technology. However, the largest experiment is the installation of GSM base stations around the country, using the general population as unwitting experimental subjects. It is clear from the above that evidence for the effects is emerging, but it may be many years before there is enough "proof" to overcome the commercial pressure for mobile communication. By that time it will be too late for many people.

Since the Stewart Report 16 world-class scientists in the field of electromagnetic radiation have signed the Catania Resolution, in which they state their firm conviction that emission levels below ICNIRP guidelines can give rise to ill-health consequences. Also over 1000 medical professionals, mostly doctors and professors of medicine have signed the Freiburger Appeal, in which they identify radiation from telecommunications systems as causing a variety of serious ailments including all of those described above, and call upon governments to take action. The Salzburg Resolution (cited above) was the result of an international conference on health issues connected arising from Base-station emissions. It was signed by 19 scientists and medics from 10 countries.

HOW DOES THIS AFFECT LINE SIDE COMMUNITIES

Evidence is presented above that there are measurable effects from GSM base stations at distances of 300m. John E Moulder (Professor of Radiation Oncology, Medical College of Wisconsin) has stated on his web site that "*the ground level power density does not drop with distance in any regular manner until you get at least several hundred meters away from a base station. Horizontal distance from a base station is less of a factor in ground level power density than antenna height, the antenna power and antenna pattern*". Certainly taller masts create lower emissions at ground level. At many proposed GSM-R base station locations, dwellings will be less than 500m from those base stations (the minimum exclusion zone recommended in Australia) within the 25-65 degree horizontal beam. If Network Rail continues with the plan to allow 3G phone operators to use their masts, the irradiated area becomes an annulus and more dwellings will be irradiated. We need to ensure that any emissions are below the threshold of reported biological effects. Microwaves radiate from transmitters over a wide area: from 3 to 9 miles. However, the radiation drops off quickly after 500-600m., and distance is the ally of safety. If taller masts allow the base stations to be sited further away from habitation, the reduced visual amenity within the landscape is far outweighed by the reduced risk to health.

CONCLUSIONS:

Over the last ten years many dozen peer reviewed studies have shown adverse biological or human health effects specifically from cell phone, base station and RF radiation. It is reasonable to group RF and microwave research because the effects are the similar. These research results to date clearly show that cell phones and cell phone radiation are a strong risk factor for all

of the adverse health effects identified for electromagnetic radiation because they share the same biological mechanisms. Evidence presented above demonstrates that there is a risk from long term low level microwave exposure, as from base stations. These effects include

- **Cancer, especially brain tumour and leukaemia, but all other cancers also.**
- **Cardiovascular problems, fluctuations in blood pressure.**
- **Neurological effects, including sleep disturbance, learning difficulties, depression, headache.**
- **Reproductive effects, especially miscarriage have been shown in rodents and cattle.**
- **Viral and infectious diseases because of reduce immune system competency as associated with reduced melatonin.**

Most of the evidence for adverse effects from mobile phones and base stations circumstantial and statistical. Studies that show reproducible results require a considerable time and scientific training. People (and the government) often don't realise that cause-and-effect aren't necessarily immediate and obvious. Brain tumours and adult leukaemias are rare, and may have very long incubation periods. We have had pulsed (GSM) communication systems for perhaps a fraction of the incubation period and therefore a fraction of the time taken for results significant enough to convince government. Consider the time it took to "prove" the link between cigarettes, lung cancer and heart disease. It is therefore pertinent to look at studies using RF transmitters. This a battle to avoid a future epidemic of the problems described above.

Barry Trower in his report to the Police Federation summarised the effects:

"If you think of a cell in our body, be it a brain cell, bone cell etc, as having a positive and negative charge on the outside and the inside similar to a battery the difference in these charges will draw the chemical into the cell or draw poisonous substances out of the cell. If the charge is changed on the outside of the cell, then necessary chemicals may not go in or poisonous chemicals may not go out. An analogy to that would be – think of your house as a cell in your body. Essential things like food, water and fuel come into the house and poisonous things like waste and gases leave the house. In fact a house is very similar in many ways to a cell in our body. Now, if we had a blockage and waste could not leave the house or sometimes food or electricity did not come into the house, over a short period of time we would survive this, but continual disruption over many years will probably have a knock-on effect on the health of the inhabitants particularly if they are young or frail..... When you suppress the immune system, you tend to have more colds, more coughs, longer colds, longer coughs, longer illnesses, depression, anxiety, or taken to its ultimate – leukaemia."

Professor Lawrie Challis, the new chairman of the expert Stewart Committee, said in a recent interview with the Exeter Express and Echo: *"We cannot say there is no risk. You could never say that. All you can do is take measures to reduce those risks."*

"The Government doesn't want to hear that message. They want us to say that masts are completely safe and aren't dangerous, but we can't say that."

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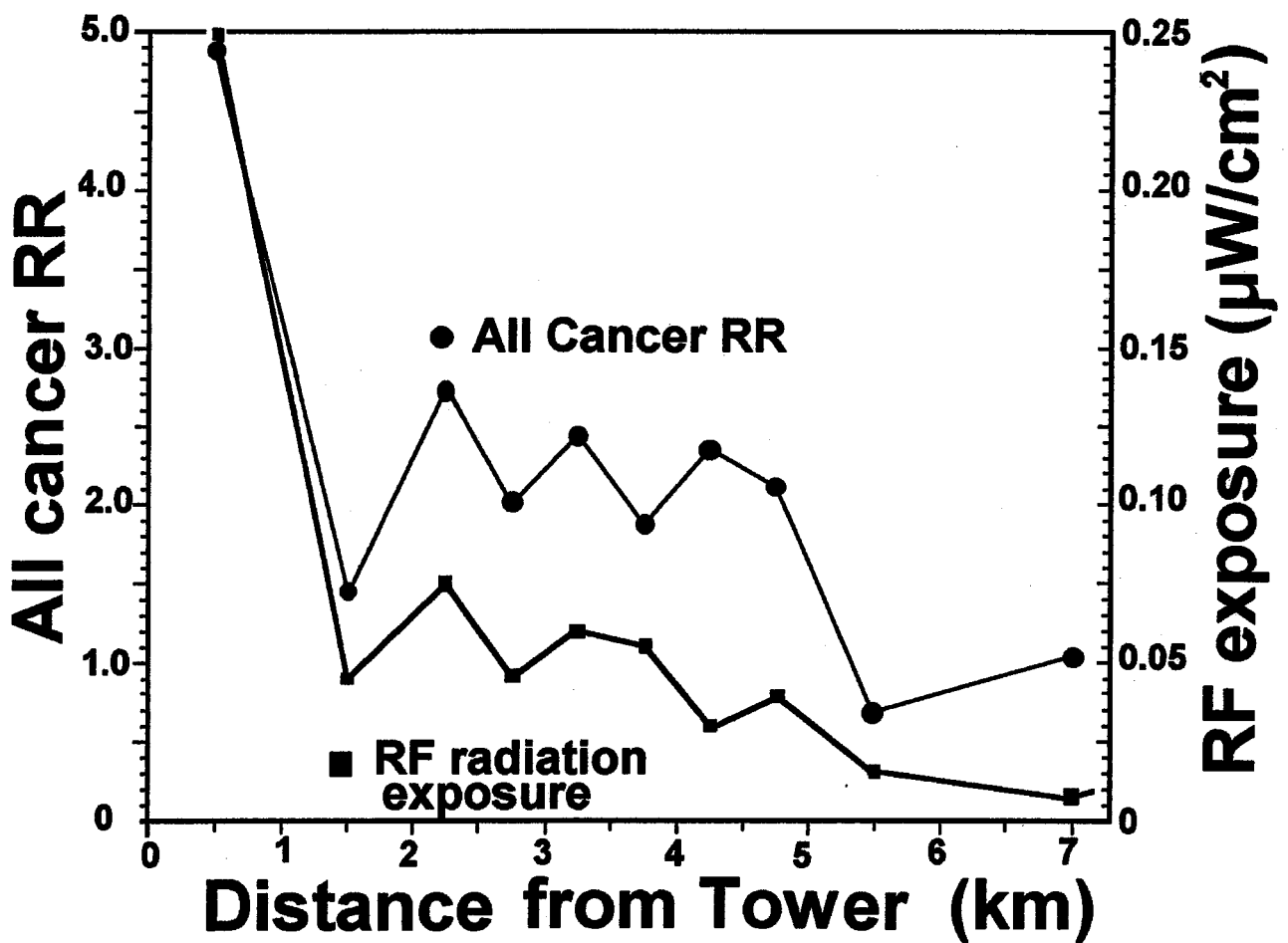
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Figure 1: The radial All Cancer Risk Ratio and the mean residential RF exposure as given in Table 15. Following a complex radial pattern shows a causal effect. (After Cherry 2000)



(English translation)

Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex *

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Summary

A survey study using a questionnaire was conducted on 530 people (270 men, 260 women) living or not in the vicinity of cellular phone base stations, on 18 Non Specific Health Symptoms. Comparisons of complaint frequencies (CHI-SQUARE test with Yates correction) in relation to the distance from base stations and sex show significant ($p < 0.05$) increase as compared to people living > 300 m or not exposed to base stations, up through 300 m for tiredness, 200 m for headache, sleep disruption, discomfort, etc., 100 m for irritability, depression, loss of memory, dizziness, libido decrease, etc. Women significantly more often than men ($p < 0.05$) complained of headache, nausea, loss of appetite, sleep disruption, depression, discomfort and visual disruptions. This first study on symptoms experienced by people living in the vicinity of base stations shows that, in view of radioprotection, the of minimal distance of people from cellular phone base stations should not be < 300 m. © 2002 Editions scientifiques et medicales Elsevier SAS

base station / bioeffects / cellular phone

1. INTRODUCTION

Chronic exposure to high frequency electromagnetic fields or microwaves brings on bioeffects in man such as headaches, fatigue, and sleep and memory disruptions [1, 2]. These biological effects, associated with others (skin problems, nausea, irritability, etc.) constitute what is known in English as "Non Specific Health Symptoms" (NSHS) that characterize radiofrequency sickness. [3] Cellular mobile phone technology uses hyperfrequencies (frequencies of 900 or 1800 MHz) pulsed with extremely low frequencies (frequencies < 300 Hertz) [4]. Even though the biological effects resulting from mobile phone use are relatively well known and bring to mind those described in radiofrequency sickness [5, 6], to our knowledge no study exists on the health of people living in the vicinity of mobile phone base stations.

We are reporting here the results pertaining to 530 people living in France, in the vicinity or not, of base stations, in relation to the distances from these stations and to the sex of the study participants.

2. MATERIALS AND METHODS

2.1. Questionnaire employed:

A questionnaire similar to that developed for the study on mobile phone users [6] was sent to people wishing to participate in the study. General questions pertained to age, sex, estimated distance from base stations (less than 10 m, 10 to 50 m, 50 to 100 m, 100 to 200 m, 200 to 300 m, more than 300 m) and their location in relation to the antennas (facing, beside, behind, beneath in the case of antennas placed on rooftops). The exposure conditions were defined by the length of time living in the neighborhood of base stations, (less than 1 year through more than 5 years), the number of days per week and the number of hours per day (less than 1 hour through 16-24 hours per day).

Participants were asked to indicate the presence or not of electrical transformers (at less than 10 m), high or very high tension electric power lines (at less than 100 m) and radio and television transmitters (at less than 4 km). The questionnaire also sought information on computer use (more than 2 hours per day) and portable telephone use (more than 20 minutes per day).

The level of complaints for the studied symptoms was expressed by the study participants using a scale of: 0 = never, 1 = sometimes, 2 = often, 3 = very often. Of 570 questionnaires received, 40 were not used due to lack of information on the distance from the base stations or on the level of the complaints experienced. For the 530 questionnaires studied, 270 came from males (average age \pm or - variation: 45 years \pm or - 20) and 260 from females (47 years \pm or - 19). 18 symptoms referenced in the "NSHS" were the subject of the questionnaire, one of which, premature menopause, concerned only females.

* The results presented in this study do not involve INSA in Lyon. INSA is the French National Institute of Applied Sciences.

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2.2 Analysis of results:

The results obtained, pertaining to the frequency of the complaints experienced (in comparison to complaints at a level of "0"), were analyzed by the CHI-SQUARE test with Yates correction [7] using a program (STATITCF, 19787, France). We present here the results tallying:

- a) The influence of distance for the base stations on the frequency of reported complaints, by comparison with the reference subjects, exposed at >300 m or not exposed (no existing base stations or non-operating base stations).
- b) The influence of sex on the frequency of reported complaints, and this independent of the age of the subjects.

3. RESULTS

3.1 Influence of distance:

The study subjects are distributed in the following manner: 19.6% are at less than 10 m from base station antennas, 26.2% between 10 and 50 m, 13.8% between 50 and 100 m, 9.6% between 100 and 200 m, 10.1% between 200 and 300 m and 20.7% are at more than 300 m or not exposed (reference group).

In comparison with the reference subject group located at >300 m or not exposed to base stations, the complaints are experienced to a significantly higher degree by the subjects located in the distance zones of <10 m through 300 m from base stations. Certain symptoms are experienced significantly more often ($p < 0.05$) uniquely in the immediate vicinity of base stations (<10 m) and not beyond that: nausea, loss of appetite, visual disruptions, difficulty in moving. Significant differences ($p < 0.05$) are observed up through 100 m from base stations for symptoms such as: irritability, depressive tendencies, difficulties in concentration, loss of memory, dizziness, lowering of libido). In the zone 100 m to 200 m, the symptoms of headaches, sleep disruption, feelings of discomfort, and skin problems are again experienced significantly more often ($p < 0.05$) in comparison with the group of subjects at > 300 m or not exposed. Beyond 200 m, only the symptom of fatigue is reported at a significantly high frequency ($p < 0.05$) (Table 1). By contrast, no significant effect is demonstrated in relation to distance for the symptom of premature menopause. A significant lowering of libido is reported for the distances of less than 10 m, 10 to 50 m and 50 to 100 m from base stations. For fatigue and headaches Figures 1 and 2 present the percentages of complaints expressed as a function of distance from base stations.

3.2 Influence of sex:

Two symptoms were experienced significantly more often in women ($p < 0.05$) as a function of different distance zones: nausea at a distance of less than 10 m, and headaches at distances of 10-50m, 50-100 m, 100-200 m, and 200-300 m. Men complained significantly more often ($p < 0.05$) than women of decrease in libido at a distance of 50 to 100 m from base stations.

When the men/women comparison is made for subjects exposed at a distance of < 300 m, seven symptoms (headaches, nausea, loss of appetite, sleep disruptions, depressive tendencies, feeling of discomfort, and visual disruptions) are experienced significantly more often in women ($p < 0.05$) (Table II). On the contrary, in the group of subjects living beyond 300 m or not exposed to base stations, no significant difference related to sex appears in the frequency of complaints reported for the different symptoms.

4. DISCUSSION

This study gives evidence of the fact that bioeffects are reported by people exposed at up to 300 m from base stations. The significant increase in the frequency of complaints in relation to the reference group (people exposed at > 300 m or not exposed) leads toward the observation found in the Australian governmental report indicating that at 200 m from a base station, some people exposed in their homes are complaining of chronic fatigue and sleep disruption [8].

The number of reported symptoms is higher close to base stations and it decreases with increased distance from them. Some symptoms such as nausea, loss of appetite, visual disturbances, and difficulties in movement are no longer experienced in a significant way beyond 10 m. For symptoms that, like fatigue, headaches, and sleep disruptions, are experienced significantly at considerable distances from base stations, no notable diminishment is observed in the percentages of complaints experienced with increased distance. However, the measurements of electromagnetic fields in the neighborhood of base stations show a reduction in field strength over distance [1,9]. One can expect that human sensitivity to electromagnetic waves is such that increased distance from base stations has no significant effect on certain symptoms up to a distance of 200 to 300 m. It is equally possible that the levels of electromagnetic fields found around base stations would not be the exact representation of the levels of exposure of populations. In fact, different parameters are likely to interfere to modify the levels and in particular fluctuations in emission strengths such as the number of calls handled by the base stations, the reflection of electromagnetic waves, etc. [10].

The results obtained demonstrate the greater sensitivity of women for 7 of the studied NSHS. One earlier study relating to portable phone users demonstrated a greater sensitivity of females to the symptom of sleep disturbance. This sex-related difference is parallel to the particular sensitivity of females to electromagnetic fields [11, 12].

5. CONCLUSION

From these results and in applying the precautionary principle, it is advisable that mobile phone base stations not be sited closer than 300 meters to populations and most significantly because exposed people can have different sensitivities related particularly to their sex.

Table I. Percentages of complaints reported compared to responses of a level of « 0 », by persons living in the vicinity of base stations as a function of their distance away from a base station.

Symptoms	Distances from base stations in meters (m)											
	< 10 m		10 to 50 m		50 to 100 m		100 to 200 m		200 to 300 m		> 300 m ...	
	2	3	2	3	2	3	2	3	2	3	2	3
Fatigue	76 *	72 *	63.5*	50.9*	60.6	56.6*	64.2	41.1	66.6*	43.7	40.7	27.2
Irritability	32.8	23.2*	41.7*	25.7*	47.2*	44.1*	25.8	4.1	25	9	18	3.3
Headaches	51 *	47.8*	40 *	26.1*	40.6*	36.7*	60.7*	31.2*	19.3	0	15.6	1.8
Nausea	14.5*	6.9	8.4	3	5.7	3.8	2.4	4.6	0	2.3	2.1	1.1
Loss of Appetite	20.4*	8.3	8	5.5	5	5	6.9	0	4.2	0	3.3	3.3
Sleep Disruption	41.3*	57.1*	41.4*	57.5*	46.9*	58.5*	45.8*	50*	33.3	35.5	13.8	21.1
Depression	16,9	26.8*	21.6	19.7*	11.6	24 *	16.2	3.1	13.6	2.5	10.3	3.7
Feeling of Discomfort	28 *	45.4*	25.2*	18.9	30.6*	12.8	15.7*	0	9.7	5.1	2.4	8.1
Difficulty in concentration	39.3	28.8*	37.5	16.6	34.2	26.4*	25	12.5	43.3	5.5	26.7	7.1
Memory Loss	27.8	25.4*	29.4	26.6*	37.1*	29 *	25	15.6	17.2	11.1	17.9	5.8
Skin Problems	18.1*	17.1*	6.6	10.8	11.1*	11.1	13.9*	7.5	8.7	0	1.2	4.6
Visual Disruptions	14.5	24.3*	23	13.5	22	7.1	2.5	4.9	15	2.8	13.6	4.1
Hearing Disruptions	33.3*	17.4	17.7*	12	8.3	15.5	7.7	7.7	11.6	9.5	5.6	8.7
Dizziness	10	12.5*	17.3*	7,5*	9.6	9.6*	12.2	2.7	7.7	5.2	6.2	0
Movement Difficulties	5.6	7.7*	8.2	1.7	3	3	0	0	2	0	2.9	1
Cardio-vascular Problems	10.1*	13 *	15.3*	9.6	12.3*	7.4	8.7	0	8.5	6.5	1	3

* Significant difference ($p < 0.05$) in comparison to reference subjects found at > 300 m or not exposed, for the responses 2 = « often » and 3 = « very often ».

Table II. Influence of sex on the frequency of symptoms reported by subjects (205 men, 215 women) living in the vicinity (all distances < 300 m) of mobile phone base stations

Symptoms	Males (%)	Females (%)
Fatigue	41.4	57.5
Irritability	17.9	28.3
Headaches	14.4	45.6 *
Nausea	0	5.9 *
Loss of appetite	1.9	8 *
Sleep disruptions	45.4	61 *
Depressive tendencies	9.8	26.7 *
Feeling of discomfort	15	25.4 *
Difficulties in concentration	18.4	21.6
Memory loss	18	27.7
Skin problems	8	13.1
Visual disruptions	12.2	22 *
Hearing disruptions	9.6	19
Dizziness	6	9.8
Movement difficulties	3.3	2.7
Cardio-vascular problems	8.3	8.8
Lowering of libido	18	12

* $p < 0.05$. Levels of complaints in parentheses.

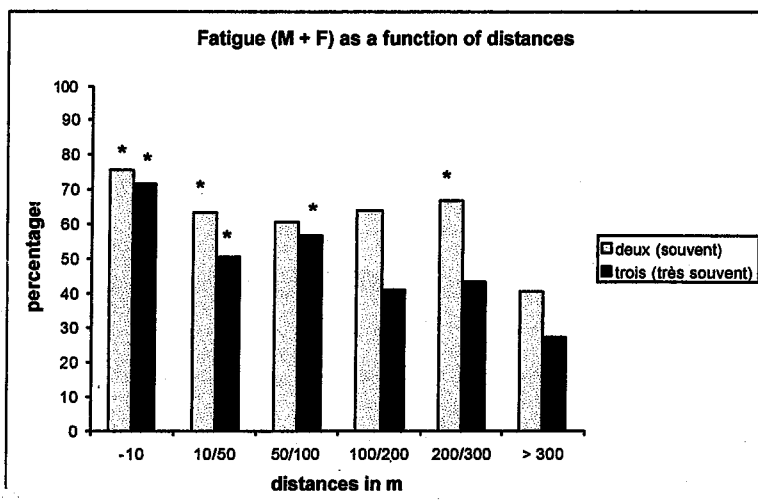


Figure 1. - Frequencies of complaints compared to a response level of « 0 » for the symptom of fatigue, in people living in the vicinity of mobile phone base stations as a function of their distance from base stations.

M = Males, F = Females, m = meters, deux (souvent) = two (often), trois (tres souvent) = three (very often).

* = $p < 0.05$ (comparison with the subjects at a distance > 300 m or not exposed).

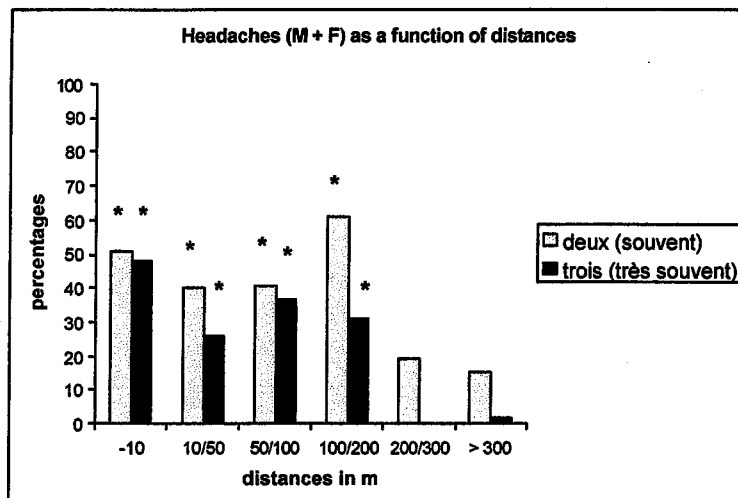


Figure 2. Frequencies of complaints reported in comparison to a response level of « 0 » for the symptom of headaches in people living in the vicinity of base stations as a function of their distance from base stations.

M = Males, F = Females, m = meters, deux (souvent) = two (often), trois (tres souvent) = three (very often),

* = $p < 0.05$ (comparison with the subjects at a distance > 300 m or not exposed).

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Planning Sanity Briefing *Telecommunication Base Stations*

Planning Sanity believes that the time has passed when we can allow the erection of telecommunication masts without proper consideration by the planning authorities. At present the majority of permissions are granted in the form of Permitted Development Rights. This process which is effectively a fast track planning decision making process, is being widely abused, by overworked planning officers (*not always deliberately on the part of officers, but pressure of work means they often take the easy route out*) and operators alike. Planning Sanity totally condemns this, especially when the health implications of these masts is still not fully known or understood, as well as many masts (*despite the recommendation of Sir William Stewart*) still being installed near to schools and other sensitive locations. Far too often we still hear of local planning officers advising that they cannot take health into account despite the clear indications from the courts that they have a legal obligation to take health and health concerns into account.

It should be fully understood here that telecommunication installations cover a wide range of installation types other than those formally looked upon as mobile phone masts, using several different processes some of which totally by-pass the local planning process, with no ability of the public who are forced to live with the consequences having an opportunity for comment. It should also be understood that the UK has four separate planning regimes in as far as telecoms are concerned, that of England, Scotland, Wales and Northern Ireland, albeit that England and Wales are very similar if not identical in nature and practice.

Planning Sanity is calling on members of the public, the media local authorities, Councillors, MPs and MEPs to lobby for a change in the legislation to tighten up the law relating to 'Permitted Development' for telecommunication installations (*In particular a number of loopholes that Operators are using*). A golden opportunity was lost with the introduction of the New PPG 8 in August 2001, which failed to bring in full planning controls. The few improvements brought about were offset by the numerous loopholes as well as not giving clarity to the question of health. We now need to keep up the pressure until we get justice, and a system that allows full participation by those that have to live with the effects of these developments.

Whilst it is accepted that more research is needed on the consequences of irradiation emitted from

these installations, there is genuine concern within the wider community of the health risk from such installations. To allay that fear, and to help lessen the prospect of yet another BSE 'type' health risk being inflicted upon the public Planning Sanity are asking elected representatives and the public to lobby the Government to introduce legislation covering the following points: -

- **Remove permitted development rights from all telecommunications development;**
- **All applications to be brought within the remit of the Town and Country Planning Act (*full planning process*);**
- **Government planning policy guidance should be revised to remove the bias in favour of the telecommunications industry and to include the provision on the need for an environmental impact assessment (*where appropriate*);**
- **The setting up of positive exclusion zones within a given distance of any sensitive existing developments such as schools, hospitals and residential areas, and/or greater powers for local planning authorities to determine inappropriate localities/sites;**
- **An obligation on the part of operators to move existing masts on sites close to sensitive developments such as schools and hospitals;**
- **Telecommunications operators should be obliged to consult the local planning authority on their plans for the ongoing in filling of their network by submitting strategic roll-out information at regular intervals so that it may be organised to minimise environmental impact, and to allow greater integration of services between operators. Such information to be included within the normal local plan process to allow public participation at all stages of the siting of installations;**
- **All applications for planning permission should be subject to a sequential test approach, with a clear obligation on operators to demonstrate the need for any given site over that of others in the same locality. Within that sequential approach the first obligation of operators would be to demonstrate that all existing sites (*including those of other operators*) have been taken into account and demonstrated as not viable before they can move further through the planning process;**
- **The implementation of a planning condition that operators should be required to erect signs warning of the potential danger from the masts. And to take all reasonable precautions to prevent harm to local inhabitants, wildlife, flora or fauna;**
- **A levy to be placed upon phone users to pay for Government backed research into health and other adverse effects of masts and phones;**
- **The blocking of all loopholes that allow for the decisions on the siting of installations to bypass local planning procedures;**
- **A requirement that all installations by non system operators, such as Network Rail come within the same procedures as those for system operators, in order to give consistency to decisions;**
- **That all installations on church property to be determined by the civil planning authorities;**
- **That each local authority be required to take measures to monitor emissions within their areas and to publish the results in both a printed and electronic format;**
- **To re-establish confidence in the planning system a more robust enforcement procedure should be implemented, including policing of emission levels, and ensuring that where masts are unlawfully installed that they are not allowed to operate until enforcement procedures, or retrospective permission has been obtained (*in other words withdrawal of the ability of operators to profit from their unlawful developments*).**

When dealing with health issues, even when the Local Planning Authority (LPA) tell you otherwise you should forget trying to prove an adverse health effect and instead, simply state that you have an abject fear that the base station will potentially affect your health and that of your family, and that this concern is having an adverse effect upon the amenity of the area, making the locality a less desirable place to live. This is a material planning consideration, and must be taken into account. As a consequence of para 29 of PPG8 the local authority have the final say on how much weight to afford to this fear held by the local community, that is they CAN reject an application on health

grounds, but as the courts have said only in the rarest of cases, if they deem sufficient weight should be afforded to the reduction in the amenity of the area. See *Jodie Phillips v First Secretary of State* (*see the Planning Sanity Briefing on Court cases*).

If you want to become involved in the Campaign to Stop the 'Trefid' like spread of these towers then lobby your LPA and elected representative's to adopt the above as their policy, and to ensure they take the matter up at national level to bring about a change in the law relating to Permitted Development Rights and Telecommunication Masts. Also become a member of Planning Sanity, get active and together we can make a real difference. There is also much to be said for the '*precautionary principle*', which gives way to the argument that where a development is likely to have a harmful effect then planning permission should be refused.

The Precautionary Principle

The 'precautionary principle' means that one should not wait for absolute scientific proof that something is dangerous before taking action to head off the potential catastrophe. It is applied in relation to the environment in the Government White Paper "This Common Inheritance", PPG23 "Planning and Pollution Control" and "Sustainable Development - the UK Strategy" as well as being enshrined in the Treaty of European Union (Maastricht, 1992; in force from 1.11.93) which it is worth quoting in more detail. Title XVI: Environment, Article 130r states:

1) Community policy on the environment shall contribute to pursuit of the following objectives:

- o **preserving, protecting and improving the quality of the environment;**
- o **protecting human health;**
- o **prudent and rational utilisation of natural resources;**
- o **Promoting measures at international level to deal with regional or worldwide environmental problems.**

2) Community policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Community. It shall be based on the precautionary principles that preventative action should be taken, that environmental damage should be rectified at source and that the polluter should pay... (p39)

Action on this issue should be priority for many local community groups; if we are not to have yet another BSE type health problem, further information can be obtained from the Planning Sanity help line 0871 750 3992. We simply cannot wait until applications are actually before the local planning department, so we urge as many local groups and individuals as possible to start lobbying local authorities, councillors, MPs, MEPs, Welsh Assembly Members, SMPs and so forth, now today. But in any event to look out for the all important site deemed to be sensitive in your area, and then point the local authority to the regulations (see above), then lobby as furiously as possible to ensure that they take on board the criteria in those regulations. We can supply sample letters of objection. The final point we ask is that you attach this briefing to a media release and circulate it to all your local media outlets.

There are many reports, briefings and letters on our WEB site and that of Mast Sanity which sets out the health issue, and other specialist topic areas in detail, please refer to these, and then phone our helpline for specific advise. Good luck with your campaign.

Planning Sanity working towards greater local community involvement in adverse development decisions - with practical help, advice and planning resource base

Help Line 0871 750 3992
email: info@planningsanity.co.uk

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FUNDRAISING SECTION

Mobile-phone masts

Once an expensive novelty, mobile phones are now considered a necessity. The staggering fact is that more people in the UK now own mobile phones than a landline-connected telephone.

But a mobile phone only works if it's transmitted through radio signals beamed from a phone mast. Each of the four main mobile-phone companies in the UK has its own antennae. So far, the four have installed about 40,000 antennae across the nation, with only the remotest rural parts still without coverage. Indeed, some communities have as many as 16 phone masts on one site.

This figure is set to double in the near future with the advent of the third-generation (3G) mobiles, offering video and Internet access as well as voice transmissions. UK phone companies recently paid the government £22.5 billion for the 3G system, so there are huge commercial and political interests in not rocking the boat of mobile technology. In practice, this means that the UK government and even the UK judiciary would prefer not to put up legal obstacles to the erection of mobile masts or admit to any possible health risks.

Indeed, in a recent test case, a British judge overruled the objections of parents, the local council, government planning inspectors and even the office of the Deputy Prime Minister, and cleared the way for an 81-foot 3G mast to be erected near three Yorkshire schools. Now under appeal, the decision—where the judge

claimed that all safety considerations had been met—was seen to provide a clear path for mobile-phone companies to erect phone masts near schools. It is at variance with government policy, which says that schools should have the right to veto masts planned to be built near their buildings.

The scientists who advise governments on the safety of mobile-phone technology tend to come from the nuclear and microwave industries and, thus, have a particular view of what constitutes a health risk. In Britain, the government advisory body is the National Radiological Protection Board (NRPB), and these experts place mobile technology in the same category as microwave dishes and radar.

The principal danger from microwaves and radar has always been thought to be thermal—in crude layman's terms, can these forms of 'non-ionising radiation' cook people? But, as the thermal radiation from mobile-phone transmissions is considered too weak to break chemical bonds or heat up tissue, the NRPB gave an all-clear to the technology as soon as it appeared in the 1980s. In this view, electromagnetic fields (EMFs) are just a kind of external toxin and, in the case of mobiles and masts, too little of one to have any effect.

However, a growing number of scientists are now questioning officialdom's complacency as to the health risks associated with mobile technology. Many of these critics are experts in a field of science called 'bioelectromagnetics'.

Is there a mast near you?

Mobile-mast radiation is everywhere. The source may be obvious—such as on the sides of buildings—but antennae are increasingly being hidden from view.

To find out if you live near a source of radiation, you can check out the mobile-phone companies' antennae sites at www.sitefinder.radio.gov.uk (in the US, www.emrnetwork.org/index.htm). If you zoom in on your town, it will show you exactly where the mobile-phone masts are, whose they are and how powerful. However, some of these data may be incorrect or out of date.

Instead, consider buying or renting a device that either displays mobile-phone radiation in V/m or translates it into an audible sound—COM Environmental Microwave Monitors or AcustiCOMs, respectively. These are obtainable from Perspective Scientific (100 Baker St, London W1U 6WB; tel: 020 7486 6837).

If you find significant levels of radiation in your

home, you don't have to move house. Protect yourself by installing a domestic version of a Faraday cage—a metal structure that blocks all radiowaves. A good one is a see-through copper-mesh 'curtain' that can be hung up like a mosquito net around the bed (from Powerwatch, tel: 01353 778 919). A cheaper alternative is to wallpaper your bedroom with a layer of metal kitchen foil.

But perhaps the best move of all is the preemptive strike. Get together with other members of your community and your planning department, and discuss where to put the masts so that they are at a maximum distance from residents' homes and schools.

If no one is prepared to listen to reason, get your entire community to put pressure on the council and mobile-phone companies. No mast provider is interested in adverse publicity. Many communities have resorted to picketing or tearing the masts down.

UK biologist Dr Robert Becker, the late French biologist Jacques Benveniste and German physicist Fritz-Albert Popp are just a few of the prestigious scientists who have experimentally demonstrated that all living things—humans, animals and plants—generate EMFs and that EM signalling is the primary means of communication between cells.

The new science of bioelectromagnetics has clearly established that we are fundamentally electromagnetic beings. In this view of the human body, the fundamental nature of our being is frequency and exposure to external frequencies from the entire transmission infrastructure of, say, mobile-phone technology, can cause us to pulse to the wrong beat.

Microcells and macrocells

The mobile phone transmission system works in separate side-by-side zones, each with its own transmitter. The zones resemble body cells, which is why, in the US, mobiles are called 'cellphones'. Each cell has its own base station, which both receives and transmits radiowaves. However, a base station can only handle about 100 calls at the same time, so large cities may have many cells per square mile whereas less-populated, rural areas may have single cells covering several square miles.

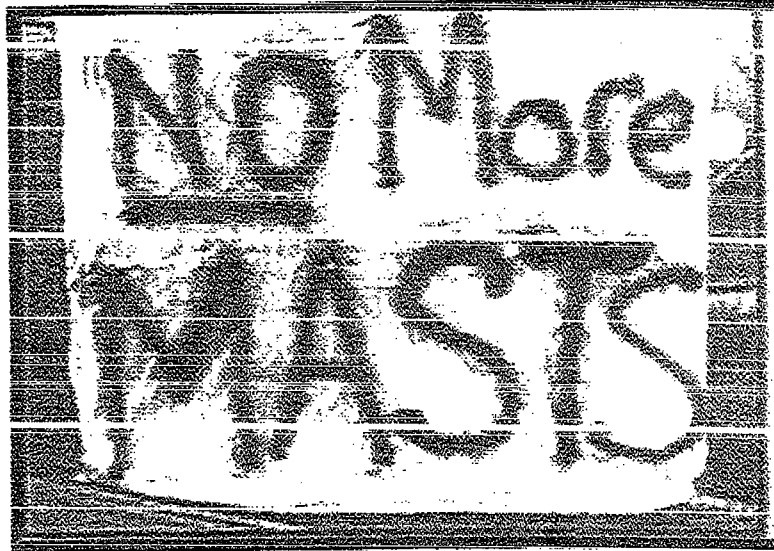
There are three types of mobile-phone transmitters/receivers. Base stations with 'macrocell' antennae have the biggest ranges—up to 22 miles—and are usually attached to tall masts or buildings. 'Microcell' and 'picocell' antennae have much shorter ranges—down to as little as 100 yards—and are used to boost coverage in towns and cities. These antennae are difficult to spot as they are burglar alarm-sized boxes that tend to be sited high on walls, lampposts and flagpoles, or in chimneys and ceiling cavities.

Are masts a danger to health?

This was one of the questions asked by Professor William Stewart, chairman of the UK government's official investigation four years ago [The Report of the UK Independent Expert Group on Mobile Phones (The Stewart Report), 11 May 2000].

His committee was probably not taken by both government and mobile phone companies as a 'no'. Yet, the small print of the report acknowledged that it is impossible to assess the long-term health consequences of mobile technology after just a few years of experience. And health effects are already showing up.

The earliest warning signs in Europe came from cattle grazing in fields near mobile masts. In Germany, university vets were called to a farm where a dairy herd was experiencing problems after the installation of macrocell antennae. Milk yields were way down,



spontaneous abortions were up, older cows were dying and the rest of the herd was behaving strangely.

The problems started when antennae were attached to a TV mast. The vets also discovered that the power output of the antennae was well below official German government limits. The evaluation of possible factors which could explain the abnormalities in the livestock did not disclose any factors other than the measurable high-frequency electromagnetic fields, the vets reported (Fract Vet Surg, 1998; 79: 107-11).

This suggests something unique about mobile-phone transmissions that sets them apart from the usual EMFs.

One scientist specialising in mobile technology is physicist Dr Gerald Hyland, of Warwick University and the International Institute of Biophysics in Neuss, Germany, an international group of scientists like Popp working on the biophysics of biological radiation. He believes that an unrecognised hazard of mobiles is that, in the more modern systems, the EM signals are not sent out continuously like radiowaves, but in pulses. This pulsed transmission is a particular feature of the latest GSM (global system for mobiles) technology, rapidly becoming the standard in Europe.

These pulse rates, says Dr Hyland, can have serious biological effects. "The pulses happen to be close to some of the brain's own electrical and electrochemical rhythms. Since these are involved in the control and regulation of biological processes essential to well-being, it is reasonable to anticipate that the functionality of the body will be impaired" (Lancet, 2000; 356: 1833-6).

Primary effects noted by Hyland were based on Russian research on the brain and behaviour (Vest Novy Med Tekhnol, 1999; VI: 24-6, 40-2). The former Soviet Union is in the vanguard of studies of EMFs and human health. "Particularly

disturbing is that the low frequencies [of] GSM pulsing are close to those at which it is known that human mood and behaviour can be influenced . . . ranging from depression and docility to rage," he says.

In one study, pulsed radio-frequency waves significantly increased calcium in brain cells. Calcium is involved in the release of neurotransmitters, and any disturbance in the usual ratio could disturb the balance of chemicals in the brain, with repercussions on the nervous and immune systems (Merritt JH, in Klauenberg BJ et al., *NATO ASI Series*. New York: Plenum Press, 1995).

A recent Dutch study exposed 36 volunteers to radiation as emitted by mobile masts. Most of them reported "detrimental effects on well-being", including nausea, tingling and headaches, on top of impaired memory, reaction time and alertness. The researchers were surprised as the radiation levels used were well within government limits [Netherlands Organisation for Applied Scientific Research (TNO). FEL-03-C148, 2003].

This ties in well with French research that has uncovered more serious neurological effects from mobile-phone masts. A team from France's National Institute of Applied Science surveyed more than 500 people living near mobile masts, and found a significant increase in headaches, sleep disturbances and tiredness up to 300 metres away from the base station.

The problems were worse the nearer the mast. Many of those living within 100 metres experienced irritability, depression, loss of memory, dizziness, lowered libido, loss of appetite and nausea (Pathol Biol [Paris]. 2002; 50: 369-73).

In Australia, doctors have reported the case of a man accidentally exposed to high levels of base-station radiation for less than two hours. He suffered from headaches, blurred vision, pupil constriction and other abnormalities of the trigeminal ophthalmic nerve—which took six months to clear up (Occup Med [Lond]. 2001; 51: 410-3).

These sorts of problems are consistent with the recent discovery that mobile-phone radiation can make the brain—at least in rats—more vulnerable to external toxins.

Nature has endowed the brain with a kind of Berlin Wall known as the 'blood-brain barrier'. This prevents dangerous molecules from entering the brain and causing damage. However, Swedish researchers have shown that mobile-phone radiation was able to cause brain-cell damage in these animals (Environ Health Perspect, 2003; 111: 881-3).

Even more worrying is the finding that mobile-mast radiation can affect DNA. Lab tests using human cells have shown that mobile-phone radiation is 'genotoxic'—able to interfere with cellular chromosomes and DNA (Bioelectromagnetics, 2002; 23: 7-13).

This has serious implications as genotoxicity is a known risk factor for cancer.

According to Hyland, pulsed frequencies have further worrying effects. They increase levels of the brain enzyme ornithine decarboxylase (ODC), high levels of which can promote tumours (Cancer Res, 1998; 48: 422-6). They also cause overexpression of heat shock proteins (HSPs). These stress proteins are called upon when the body undergoes an environmental stress; they also act like traffic cops in each cell, making sure that proteins are where they should be and that old proteins are disposed of. Most significantly, they help the immune system recognise the diseased cells for disposal.

When overexpressed, these proteins are believed to block apoptosis, or programmed cell death. This could also have the effect of promoting cancer (Differentiation, 2001; 67: 93-7; Differentiation, 2002; 70: 120-9).

When laboratory animals were exposed to mobile-phone radiation, cancer-promoting effects have been found. Among the first of such studies was one from an Australian medical team which used exactly the same kind of pulsed EMFs as radiated by mobile base stations. After directing the EMFs at cancer-prone mice for just one hour a day for 18 months, these scientists found a significantly

Mast emissions: a movable feast

Most experts don't think of mobile-mast radiation as a problem, so you'd expect international regulations to be broadly in line with each other. However, radiation limits vary widely from one country to another.

Perhaps as a reflection of political-commercial pressures, Britain has the least stringent limits in the world.

Radiation is measured in volts per metre (V/m), which vary according to the frequency—measured in megahertz (MHz). Mobile phones operate on two frequencies: 900 MHz and 1800 MHz.

	900 Mhz	1800 MHz
Britain	41 V/m (was 112 V/m)	58 V/m (was 194 V/m)
Switzerland	4 V/m	6 V/m
Russia	6 V/m	6 V/m
Italy	6 V/m	6 V/m
Luxembourg	3 V/m	6V/m

Radiation levels from a 15-m mast are at their maximum at a distance of about 100 m, falling away to near-zero at 300 m. A 60-m mast has a radiation peak at a distance of about 200 m, falling away at 800 m.

Here come the G3s

The major health problems with networks of mobile-phone masts could worsen as the G3 masts start appearing.

One example of this advanced technology is the TETRA mobile network, which is being introduced to all 53 of the UK's police forces. It is an advanced digital network that should be fully operational by next spring, at a cost of £2.9 billion to the UK government.

As usual, the network has been introduced with all the standard scientific platitudes that it is perfectly safe. But early reports back 'from the field' suggest otherwise.

Six people based at one police station in Norfolk have all reported sick with a debilitating health condition since a TETRA mast was installed just yards from them. The police staff has suffered bouts of dizziness and severe headaches, and it's been as bad for the 25 local residents who also happen to live near the mast. Repeated nosebleeds, disturbed sleep and skin problems, especially among the children, have been reported.

The police staff has been warned not to make public their health concerns. A similar ban was imposed on one policeman, Neil Dring, who died from cancer of the oesophagus, which developed after he had been using his TETRA handset.

These incidents are not isolated examples. Some reports suggest that hundreds of policemen and women have complained of deterioration in their health since TETRA was introduced in their area (*The Daily Telegraph*, 14 August 2004).

of the bedrooms. A three-year-old girl who had lived with this radiation all her life developed lymphoblastic leukaemia; there have been two other cases of leukaemia and four cases of cancer in the same area.

- ◆ In Wishaw, Warwickshire, of the 50 people living within 500 metres of a base station, 34 have reported medical problems—sleeplessness, skin irritation, low blood-cell counts and seven cases of cancer. Local residents have since torn down the mast.
- ◆ Gainsborough, Lincolnshire, has reported 10 cancer cases among those living within 100 metres of a base station.

- ◆ In Saintfield, Northern Ireland, 12 children developed leukaemia and seven adults developed cancer—all residing within half a mile of a base station.
- ◆ Near Dunganon, Northern Ireland, in the five homes below the Cranlome Hill mast, six people got cancer, three of whom died. Again, local residents have since felled the mast, which bristled with 35 antennae.
- ◆ In Paris, the mobile-phone company Orange itself dismantled a mast after eight schoolchildren contracted cancer. The company had put the antennae on the schoolhouse roof.
- ◆ In Valladolid, Spain, four young children were diagnosed with cancer in a school of 450 children after a mobile base station was installed 50 metres away—seven times the average national incidence. "In 32 years, there had never been a case of childhood cancer here," said local doctor Luis Martin.

In October 2002, thousands of German doctors put their names to the Freiburger Appeal, which blamed mobile-phone technology for the "dramatic in rise in severe and chronic diseases among our patients". The document cited symptoms such as headaches, behavioural problems, sleeplessness, chronic exhaustion and infections, heart attacks, cancer, leukaemia and brain tumours, and pleaded for a halt to mobile-phone expansion.

Nevertheless, the technology appears to be unstoppable. There are already over a billion users of mobile phones worldwide, a figure that is expected to triple within a decade—mainly because the technology is so much cheaper than landlines and, hence, more attractive to developing countries. But with more mobiles come more masts.

It could be said that we are all participants in the biggest epidemiological experimental study in history.

The mobile-phone companies have tried to insure themselves against future health claims, but no insurance company in the world will take on the liability.

03 November 2006

Dear States Member

The harmful health effects of mobile phone masts

Please find enclosed a paper providing details on the **seriously harmful effects** to health from mobile phone masts and concerns about current safety limit guidelines.

This paper has been sent to every states member and to head teachers at all Islands school.

We are very concerned about more mobile masts going up in Jersey.

We ask you seriously consider the information and supporting evidence documented in this paper, and undertake personal research yourself to validate this information if necessary.

Thank you

Jersey Mobile Mast Concern Group.

(English translation)

Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex *

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Summary

A survey study using a questionnaire was conducted on 530 people (270 men, 260 women) living or not in the vicinity of cellular phone base stations, on 18 Non Specific Health Symptoms. Comparisons of complaint frequencies (CHI-SQUARE test with Yates correction) in relation to the distance from base stations and sex show significant ($p < 0.05$) increase as compared to people living > 300 m or not exposed to base stations, up through 300 m for tiredness, 200 m for headache, sleep disruption, discomfort, etc., 100 m for irritability, depression, loss of memory, dizziness, libido decrease, etc. Women significantly more often than men ($p < 0.05$) complained of headache, nausea, loss of appetite, sleep disruption, depression, discomfort and visual disruptions. This first study on symptoms experienced by people living in the vicinity of base stations shows that, in view of radioprotection, the of minimal distance of people from cellular phone base stations should not be < 300 m. © 2002 Editions scientifiques et medicales Elsevier SAS

base station / bioeffects / cellular phone

1. INTRODUCTION

Chronic exposure to high frequency electromagnetic fields or microwaves brings on bioeffects in man such as headaches, fatigue, and sleep and memory disruptions [1, 2]. These biological effects, associated with others (skin problems, nausea, irritability, etc.) constitute what is known in English as "Non Specific Health Symptoms" (NSHS) that characterize radiofrequency sickness. [3] Cellular mobile phone technology uses hyperfrequencies (frequencies of 900 or 1800 MHz) pulsed with extremely low frequencies (frequencies < 300 Hertz) [4]. Even though the biological effects resulting from mobile phone use are relatively well known and bring to mind those described in radiofrequency sickness [5, 6], to our knowledge no study exists on the health of people living in the vicinity of mobile phone base stations.

We are reporting here the results pertaining to 530 people living in France, in the vicinity or not, of base stations, in relation to the distances from these stations and to the sex of the study participants.

2. MATERIALS AND METHODS

2.1. Questionnaire employed:

A questionnaire similar to that developed for the study on mobile phone users [6] was sent to people wishing to participate in the study. General questions pertained to age, sex, estimated distance from base stations (less than 10 m, 10 to 50 m, 50 to 100 m, 100 to 200 m, 200 to 300 m, more than 300 m) and their location in relation to the antennas (facing, beside, behind, beneath in the case of antennas placed on rooftops). The exposure conditions were defined by the length of time living in the neighborhood of base stations, (less than 1 year through more than 5 years), the number of days per week and the number of hours per day (less than 1 hour through 16-24 hours per day).

Participants were asked to indicate the presence or not of electrical transformers (at less than 10 m), high or very high tension electric power lines (at less than 100 m) and radio and television transmitters (at less than 4 km). The questionnaire also sought information on computer use (more than 2 hours per day) and portable telephone use (more than 20 minutes per day).

The level of complaints for the studied symptoms was expressed by the study participants using a scale of: 0 = never, 1 = sometimes, 2 = often, 3 = very often. Of 570 questionnaires received, 40 were not used due to lack of information on the distance from the base stations or on the level of the complaints experienced. For the 530 questionnaires studied, 270 came from males (average age \pm or - variation: 45 years \pm or - 20) and 260 from females (47 years \pm or - 19). 18 symptoms referenced in the "NSHS" were the subject of the questionnaire, one of which, premature menopause, concerned only females.

* The results presented in this study do not involve INSA in Lyon. INSA is the French National Institute of Applied Sciences.

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2.2 Analysis of results:

The results obtained, pertaining to the frequency of the complaints experienced (in comparison to complaints at a level of "0"), were analyzed by the CHI-SQUARE test with Yates correction [7] using a program (STATITCF, 19787, France). We present here the results tallying:

- a) The influence of distance for the base stations on the frequency of reported complaints, by comparison with the reference subjects, exposed at >300 m or not exposed (no existing base stations or non-operating base stations).
- b) The influence of sex on the frequency of reported complaints, and this independent of the age of the subjects.

3. RESULTS

3.1 Influence of distance:

The study subjects are distributed in the following manner: 19.6% are at less than 10 m from base station antennas, 26.2% between 10 and 50 m, 13.8% between 50 and 100 m, 9.6% between 100 and 200 m, 10.1% between 200 and 300 m and 20.7% are at more than 300 m or not exposed (reference group).

In comparison with the reference subject group located at >300 m or not exposed to base stations, the complaints are experienced to a significantly higher degree by the subjects located in the distance zones of <10 m through 300 m from base stations. Certain symptoms are experienced significantly more often ($p < 0.05$) uniquely in the immediate vicinity of base stations (<10 m) and not beyond that: nausea, loss of appetite, visual disruptions, difficulty in moving. Significant differences ($p < 0.05$) are observed up through 100 m from base stations for symptoms such as: irritability, depressive tendencies, difficulties in concentration, loss of memory, dizziness, lowering of libido). In the zone 100 m to 200 m, the symptoms of headaches, sleep disruption, feelings of discomfort, and skin problems are again experienced significantly more often ($p < 0.05$) in comparison with the group of subjects at > 300 m or not exposed. Beyond 200 m, only the symptom of fatigue is reported at a significantly high frequency ($p < 0.05$) (Table 1). By contrast, no significant effect is demonstrated in relation to distance for the symptom of premature menopause. A significant lowering of libido is reported for the distances of less than 10 m, 10 to 50 m and 50 to 100 m from base stations. For fatigue and headaches Figures 1 and 2 present the percentages of complaints expressed as a function of distance from base stations.

3.2 Influence of sex:

Two symptoms were experienced significantly more often in women ($p < 0.05$) as a function of different distance zones: nausea at a distance of less than 10 m, and headaches at distances of 10-50m, 50-100 m, 100-200 m, and 200-300 m. Men complained significantly more often ($p < 0.05$) than women of decrease in libido at a distance of 50 to 100 m from base stations.

When the men/women comparison is made for subjects exposed at a distance of < 300 m, seven symptoms (headaches, nausea, loss of appetite, sleep disruptions, depressive tendencies, feeling of discomfort, and visual disruptions) are experienced significantly more often in women ($p < 0.05$) (Table II). On the contrary, in the group of subjects living beyond 300 m or not exposed to base stations, no significant difference related to sex appears in the frequency of complaints reported for the different symptoms.

4. DISCUSSION

This study gives evidence of the fact that bioeffects are reported by people exposed at up to 300 m from base stations. The significant increase in the frequency of complaints in relation to the reference group (people exposed at >300 m or not exposed) leads toward the observation found in the Australian governmental report indicating that at 200 m from a base station, some people exposed in their homes are complaining of chronic fatigue and sleep disruption [8].

The number of reported symptoms is higher close to base stations and it decreases with increased distance from them. Some symptoms such as nausea, loss of appetite, visual disturbances, and difficulties in movement are no longer experienced in a significant way beyond 10 m. For symptoms that, like fatigue, headaches, and sleep disruptions, are experienced significantly at considerable distances from base stations, no notable diminishment is observed in the percentages of complaints experienced with increased distance. However, the measurements of electromagnetic fields in the neighborhood of base stations show a reduction in field strength over distance [1,9]. One can expect that human sensitivity to electromagnetic waves is such that increased distance from base stations has no significant effect on certain symptoms up to a distance of 200 to 300 m. It is equally possible that the levels of electromagnetic fields found around base stations would not be the exact representation of the levels of exposure of populations. In fact, different parameters are likely to interfere to modify the levels and in particular fluctuations in emission strengths such as the number of calls handled by the base stations, the reflection of electromagnetic waves, etc. [10].

The results obtained demonstrate the greater sensitivity of women for 7 of the studied NSHS. One earlier study relating to portable phone users demonstrated a greater sensitivity of females to the symptom of sleep disturbance. This sex-related difference is parallel to the particular sensitivity of females to electromagnetic fields [11, 12].

5. CONCLUSION

From these results and in applying the precautionary principle, it is advisable that mobile phone base stations not be sited closer than 300 meters to populations and most significantly because exposed people can have different sensitivities related particularly to their sex.

Table I. Percentages of complaints reported compared to responses of a level of « 0 », by persons living in the vicinity of base stations as a function of their distance away from a base station.

Symptoms	Distances from base stations in meters (m)											
	< 10 m		10 to 50 m		50 to 100 m		100 to 200 m		200 to 300 m		> 300 m ...	
	2	3	2	3	2	3	2	3	2	3	2	3
Fatigue	76 *	72 *	63.5*	50.9*	60.6	56.6*	64.2	41.1	66.6*	43.7	40.7	27.2
Irritability	32.8	23.2*	41.7*	25.7*	47.2*	44.1*	25.8	4.1	25	9	18	3.3
Headaches	51 *	47.8*	40 *	26.1*	40.6*	36.7*	60.7*	31.2*	19.3	0	15.6	1.8
Nausea	14.5*	6.9	8.4	3	5.7	3.8	2.4	4.6	0	2.3	2.1	1.1
Loss of Appetite	20.4*	8.3	8	5.5	5	5	6.9	0	4.2	0	3.3	3.3
Sleep Disruption	41.3*	57.1*	41.4*	57.5*	46.9*	58.5*	45.8*	50*	33.3	35.5	13.8	21.1
Depression	16.9	26.8*	21.6	19.7*	11.6	24 *	16.2	3.1	13.6	2.5	10.3	3.7
Feeling of Discomfort	28 *	45.4*	25.2*	18.9	30.6*	12.8	15.7*	0	9.7	5.1	2.4	8.1
Difficulty in concentration	39.3	28.8*	37.5	16.6	34.2	26.4*	25	12.5	43.3	5.5	26.7	7.1
Memory Loss	27.8	25.4*	29.4	26.6*	37.1*	29 *	25	15.6	17.2	11.1	17.9	5.8
Skin Problems	18.1*	17.1*	6.6	10.8	11.1*	11.1	13.9*	7.5	8.7	0	1.2	4.6
Visual Disruptions	14.5	24.3*	23	13.5	22	7.1	2.5	4.9	15	2.8	13.6	4.1
Hearing Disruptions	33.3*	17.4	17.7*	12	8.3	15.5	7.7	7.7	11.6	9.5	5.6	8.7
Dizziness	10	12.5*	17.3*	7.5*	9.6	9.6*	12.2	2.7	7.7	5.2	6.2	0
Movement Difficulties	5.6	7.7*	8.2	1.7	3	3	0	0	2	0	2.9	1
Cardio-vascular Problems	10.1*	13 *	15.3*	9.6	12.3*	7.4	8.7	0	8.5	6.5	1	3

* Significant difference ($p < 0.05$) in comparison to reference subjects found at > 300 m or not exposed, for the responses 2 = « often » and 3 = « very often ».

Table II. Influence of sex on the frequency of symptoms reported by subjects (205 men, 215 women) living in the vicinity (all distances < 300 m) of mobile phone base stations

Symptoms	Males (%)	Females (%)
Fatigue	41.4	57.5
Irritability	17.9	28.3
Headaches	14.4	45.6 *
Nausea	0	5.9 *
Loss of appetite	1.9	8 *
Sleep disruptions	45.4	61 *
Depressive tendencies	9.8	26.7 *
Feeling of discomfort	15	25.4 *
Difficulties in concentration	18.4	21.6
Memory loss	18	27.7
Skin problems	8	13.1
Visual disruptions	12.2	22 *
Hearing disruptions	9.6	19
Dizziness	6	9.8
Movement difficulties	3.3	2.7
Cardio-vascular problems	8.3	8.8
Lowering of libido	18	12

* $p < 0.05$. Levels of complaints in parentheses.

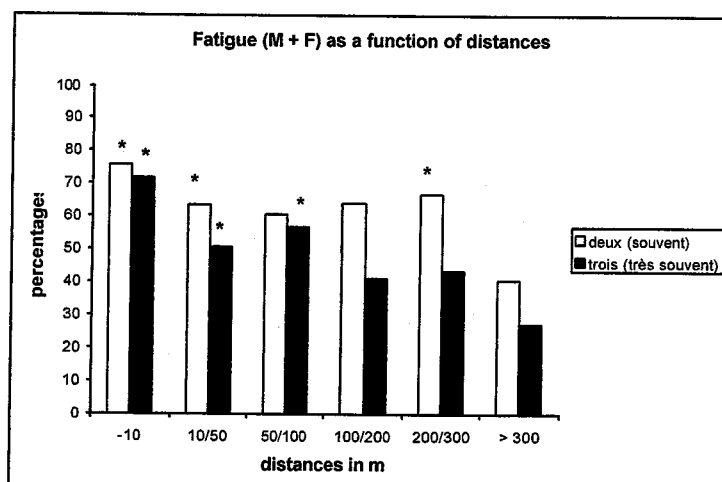


Figure 1.- Frequencies of complaints compared to a response level of « 0 » for the symptom of fatigue, in people living in the vicinity of mobile phone base stations as a function of their distance from base stations.

M = Males, F = Females, m = meters, deux (souvent) = two (often), trois (tres souvent) = three (very often).

* = $p < 0.05$ (comparison with the subjects at a distance > 300 m or not exposed).

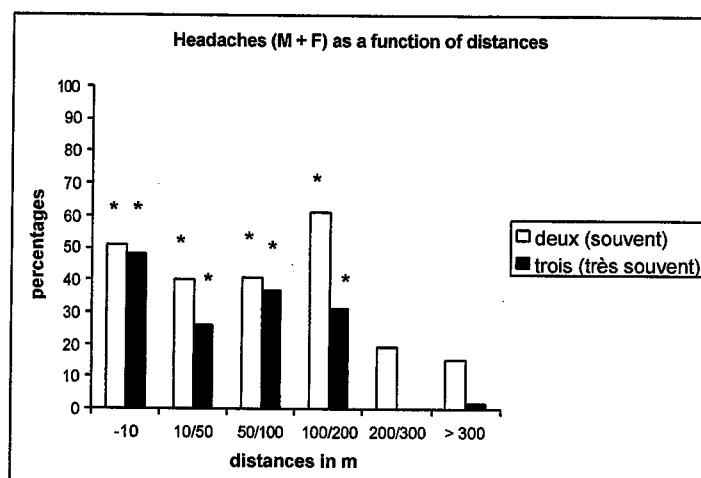


Figure 2. Frequencies of complaints reported in comparison to a response level of « 0 » for the symptom of headaches in people living in the vicinity of base stations as a function of their distance from base stations.

M = Males, F = Females, m = meters, deux (souvent) = two (often), trois (tres souvent) = three (very often),

* = $p < 0.05$ (comparison with the subjects at a distance > 300 m or not exposed).

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