Health Effects of Mobile Phone Transmitter Masts and the Planning Application by Orange plc for a mast in St Michael's Church, Aberystwyth

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Background

In the UK the Radiation Division of the UK Health Protection Agency (formerly the National Radiation Protection Board, NRPB) publishes guidelines on exposure from mobile phones and mobile (cellphone) masts. In addition there is advice from the World Health Organisation's EMF publications, and in the general guidelines offered from time to time by the International Committee on Non-Ionising Radiation Protection (ICNIRP). Since the ICNIRP guidelines are confined only to acute effects, and the issue of masts is inescapably one of chronic exposure, the latter's guidelines are of little use in deciding whether or not to approve these radiation exposures and their chronic effects on populations living close to the masts.

Within these organisations there are only a few individuals competent to give advice. It is a requirement of the European Community's Physical Agents Directive that policy makers take comprehensive note of the entire science, not simply the views of a small and interlinked body of experts. You may be aware that large areas of this planet such as China and the eastern Bloc countries have adopted guidelines, limits and standards which are based on biological and medical rather than merely physical evidence, that they vary considerably from those promoted by NRPB, WHO and ICNIRP, and are substantially more protective of the individual.

The matter of non-ionising radiation (high frequency pulsed electromagnetic radiation (EMR) from mobile phones and transmitters) is one where research is continuing and the scientific jury is still out. In this review we offer an up-to-date assessment of the recent research findings gathered from many separate and reputable laboratories and the state of scientific knowledge in general concerning long-term health risks from such installations.

Overview

The WHO, in formulating its advice regarding EMR, takes into account only properly peer reviewed and published studies, and this is a precept followed in this text. It is therefore instructive at the outset to divide such studies into those reporting biological effects at levels below the guidelines (i.e. at levels generally called "non thermal") and those finding no such effects at those field strengths or power densities.

Some scientists believe that even the published studies show bias depending on the source of funding. This matter has been raised recently in connection with child health in Europe (Busby *et al*. 2006). This view is well illustrated by Table 1 below summarising the results of some 307 studies:

Table 1: Cell Phone Biological Studies

	Effect	**No Effect**	**Total**
Industry-			
Funded	27 (29%)	66 (71%)	93 (30%)
Non-Industry-	147 (69%)	67 (31%)	214(70%)
Funded			
Total	174 (57%)	133 (43%)	307

$\chi 2 = 39.93$ ($p < .001$)

(Source: Prof Henry Lai, University of Washington, Seattle, 3/3/06)

A brief summary of the studies giving rise to concern is presented in Table 2.

Table 2: Studies reporting biological effects of radiofrequency radiation (RFR) at low intensities

(1) Balode (1996)- blood cells from cows from a farm close and in front of a radar showed significantly higher level of severe genetic damage.

(2) Boscol *et al*. (2001)- RFR from radio transmission stations (0.005 mW/cm2) affects immunological system in women.

(3) Chiang *et al.* (1989)- young people who lived and worked near radio antennae and radar installations showed deficits in psychological and short-term memory tests.

(4) de Pomerai *et al*. (2000, 2002) reported an increase in a molecular stress response in cells after exposure to a RFR at a SAR of 0.001 W/kg. This stress response is a basic biological process that is present in almost all animals - including humans.

(5) De Pomerai *et al*. (2003) RFR damages proteins at 0.015-0.02 W/kg.

(6) D'Inzeo *et al.* (1988)- very low intensity RFR (0.002 – 0.004 mW/cm2) affects the operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions.

(7)Dolk *et al.* (1997)- a significant increase in adult leukemias was found in residents who lived near the Sutton Coldfield television (TV) and frequency modulation (FM) radio transmitter in England.

(8) Dutta *et al.* (1989) reported an increase in calcium efflux in cells after exposure to RFR at 0.005 W/kg. Calcium is an important component of normal cellular functions.

(9) Fesenko *et al.* (1999) reported a change in immunological functions in mice after exposure to RFR at a power density of 0.001 mW/cm2.

(10) Hjollund *et al.* (1997)- sperm counts of Danish military personnel who operated mobile ground-to-air missile units that use several RFR emitting radar systems (maximal mean exposure 0.01 mW/cm2) were significantly lower compared to references.

(11) Hocking *et al.* (1996)- an association was found between increased childhood leukaemia incidence and mortality and proximity to TV towers.

(12) Ivaschuk *et al*. (1999)- short-term exposure to cellular phone RFR of very low SAR (26 mW/kg) affected a gene related to cancer.

(13) Kolodynski and Kolodynska (1996)- school children who lived in front of a radio station had less developed memory and attention, their reaction time was slower, and their neuromuscular apparatus endurance was decreased.

(14) Kwee *et al.* (2001)- 20 minutes of cell phone RFR exposure at 0.0021 W/kg increased stress protein in human cells.

(15) Lebedeva *et al.* (2000)- brain wave activation was observed in human subjects exposed to cellular phone RFR at 0.06 mW/cm2.

(16) Magras and Xenos (1999) reported a decrease in reproductive function in mice exposed to RFR at power densities of 0.000168 - 0.001053 mW/cm2.

(17) Mann *et al.* (1998)- a transient increase in blood cortisol was observed in human subjects exposed to cellular phone RFR at 0.02 mW/cm2. Cortisol is a hormone involved in stress reaction.

(18) Marinelli *et al.* (2004)- exposure to 900-MHz RFR at 0.0035 W/kg affected cells' self-defence responses.

(19) Michelozzi *et al.* (1998)- leukaemia mortality within 3.5 km (5,863 inhabitants) near a high power radio-transmitter in a peripheral area of Rome was higher than expected.

(20) Michelozzi *et al.* (2002)- childhood leukaemia higher at a distance up to 6 km from a radio station.

(21) Navakatikian and Tomashevskaya (1994)- RFR at low intensities (0.01 - 0.1 mW/cm2; 0.0027- 0.027 W/kg) induced behavioral and endocrine changes in rats. Decreases in blood concentrations of testosterone and insulin were reported.

(22) Novoselova *et al.* (1999)-low intensity RFR (0.001 mW/cm2) affects functions of the immune system.

(23) Novoselova *et al*. (2004)- chronic exposure to RFR (0.001 mW/cm2) decreased tumor growth rate and enhanced survival in mice.

(24) Park *et al.* (2004) higher mortality rates for all cancers and leukaemia in some age groups in the area near the AM radio broadcasting towers.

(25) Persson *et al.* (1997) reported an increase in the permeability of the blood-brain barrier in mice exposed to RFR at 0.0004 - 0.008 W/kg. The blood-brain barrier envelops the brain and protects it from toxic substances.

(26) Phillips *et al*. (1998) reported DNA damage in cells exposed to RFR at SAR of 0.0024 - 0.024 W/kg.

(27) Polonga-Moraru *et al.* (2002) change in membrane of cells in the retina (eye) after exposure to RFR at 15 mW/cm2.

(28) Pyrpasopoulou *et al*. (2004) exposure to cell phone radiation during early gestation at SAR of 0.0005 W/kg (5 mW/cm2) affected kidney development in rats.

(29) Salford *et al*. (2003)- nerve cell damage in brain of rats exposed for 2 hrs to GSM signal at 0.02 W/kg.

(30) Santini *et al*. (2002)- increase in complaint frequencies for tiredness, headache, sleep disturbance, discomfort, irritability, depression, loss of memory, dizziness, libido decrease, in people who lived within 300 m of mobile phone base stations.

(31) Sarimov *et al.* (2004)- GSM microwaves affect human lymphocyte chromatin similar to stress response at 0.0054 W/kg.

(32) Schwartz *et al.* (1990)- calcium movement in the heart affected by RFR at SAR of 0.00015 W/kg. Calcium is important in muscle contraction. Changes in calcium can affect heart functions.

(33) Somosy *et al.* (1991)- RFR at 0.024 W/kg caused molecular and structural changes in cells of mouse embryos.

(34) Stagg *et al.* (1997)- glioma cells exposed to cellular phone RFR at 0.0059 W/kg showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division.

(35) Stark *et al*. (1997)- a two- to seven-fold increase of salivary melatonin concentration was observed in dairy cattle exposed to RFR from a radio transmitter antenna.

(36) Tattersall *et al.* (2001)- low-intensity RFR (0.0016 - 0.0044 W/kg) can modulate the function of a part of the brain called the hippocampus, in the absence of gross thermal effects. The changes in excitability may be consistent with reported behavioral effects of RFR, since the hippocampus is involved in learning and memory.

(37) Vangelova *et al*. (2002)- operators of satellite station exposed to low dose (0.1127 J/kg) of RFR over a 24-hr shift showed an increased excretion of stress hormones.

(38) Velizarov *et al.* (1999) showed a decrease in cell proliferation (division) after exposure to RFR of 0.000021 - 0.0021 W/kg.

(39) Veyret *et al.* (1991)- low intensity RFR at SAR of 0.015 W/kg affects functions of the immune system.

(40) Wolke *et al.* (1996)- RFR at 0.001W/kg affects calcium concentration in heart muscle cells of guinea pigs.

These published studies are a representative sample of those now emerging. Typical of those causing concern among experts is that of Fiorenzo Marinelli (see ref 18 above) from the University of Bologna (where in 1795 Luigi Galvani first observed that a radio wave caused by a simple small spark at one end of his laboratory could demonstrably activate a frog's leg muscle at the other).

Marinelli underlined the potential danger of cellphone base station radiation by research that showed how radio waves from these stations trigger and promote the growth of cancers. Paradoxically, the study suggests that the radiation makes tumours

grow more aggressively after initially killing off cells of all kinds including cancer cells.

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 MHz radio waves at a power level of 1 milliwatt, and then looked at the activity of a gene that triggers apoptosis (cell suicide). Many European mobile networks operate at 900 MHz, and power outputs are typically 2 watts, although at times using only one-tenth of this power (which is still well in excess of 1 milliwatt).

After 24 hours of continuous exposure to the radio waves (this is the kind of exposure experienced by people and especially children, living or schooling near to inappropriately sited base stations), 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 of all cells among those exposed had died than in the non exposed 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 upregulated (turned on) in a high proportion of the surviving cells, making them replicate ferociously. The cancer, although beaten back for a brief spell, had become more aggressive.

Marinelli first presented his results in 2002 at the International Workshop on Biological Effects of Electromagnetic Fields in Rhodes. While these results do not show a direct health threat from intermittently used mobile phones, they do show a direct health threat from mobile phone base stations, and they provide fresh evidence that the low level radiation from all such devices using these frequencies and power levels, play an important role in activating genes that can trigger cancers and help cancer cells multiply aggressively.

"We don't know what the effects are on healthy human cells," says Marinelli. "But in leukaemia cells the response is always the same." Marinelli suspects the radiation initially damages DNA, and that this interferes with the cells' biochemical signals in a way that ultimately triggers a 'defensive' mechanism.

This work supports earlier findings by Lai and Singh that RF/MW radiation can cause single and double strand breaks in DNA.

Some scientists offer the misleading notion that because radiation from cellphones does not have enough energy to break chemical bonds, it cannot damage cells. The only way damage could occur, they argue, is if the radio waves heated tissues up (the notorious “cooking” effect relied on by the former NRPB). But much published research (as shown above) including British research earlier in 2002, by molecular toxicologist David de Pomerai at the University of Nottingham, showed that radio waves can cause biological effects that are not due to heating. He found that nematode

worms exposed to radio waves showed an increase in fertility - the opposite effect from what would be expected from heating.

The Stewart report in April 2000 funded by the British Government found no evidence of any health risks from mobile phones, but it still recommended that people take a precautionary approach until further evidence emerged. In particular, it suggested children, whose brains are still developing, should not use mobile phones excessively. Some thirty important studies were curiously omitted from that report, however, which may have been the reason for its lukewarm conclusions

"It's a very confused field," claims Colin Blakemore, a physiologist at the University of Oxford and a member of the British National Radiological Protection Board's advisory group on non-ionising radiation.

But de Pomerai at first insisted that a scientific consensus has emerged that non-ionising radiation indirectly damages DNA by affecting its repair system. If the DNA repair mechanism does not work as well as it should, mutations in cells can accumulate, with disastrous consequences. "Cells with unrepaired DNA damage are likely to be far more aggressively cancerous," he concluded at the time. Since then his funding source (and his opinions) have changed, however.

The issue of chronic versus acute effects

Cellphone handset usage is self-evidently both elective and acute: users can themselves choose how long to accept exposure. By contrast, exposure to cellphone mast radiation is chronic (all day and night, continuously) and the exposed person has no say in the radiation dose, hence the exposure is non-elective and solely within the gift of the planning authority. This predicates the issue of cumulative exposure, a topic which has already raised concerns in relation to handsets, where several studies have found an elevated incidence of acoustic neuroma among those using the instruments over five or so years.

Therefore the researcher faces another problem in evaluating and setting standards, namely the different time periods used to express the values. The listed field intensities of recommended exposure levels must be compared carefully since they refer to different exposure times As stated above the significant factor is the accumulated exposure over a relative short length of time, but the regulatory guidelines and codes do not give any value for a total accumulation as in X-ray exposure standards.

For example, limits given in the Canadian Safety Code 6 (1991) [3] for occupational exposure to radio wave energy are 1 mW/cm² averaged over one hour period and 25 mW/cm² averaged over one minute period. They allow much higher pulse levels than the Swedish Standard [4] which even differentiates for the frequency range and has especially lower limits for the more damaging microwave range 5 mW/cm² 10-300 MHz averaged over 0.1h (=6 min.) 1 mW/cm² 0.3-300 GHz averaged over 0.1h (=6 min.) 25 mW/cm² 10 MHz-300 GHz averaged over 1 second.

Therefore the **cumulative exposure** is not being addressed in the ICNIRP guidelines and similar advice from WHO largely derived from the same scientists. The above limits only make sense in an environment where one is exposed to peaks or pulses of

radiation especially in radar sites or to radiation during the operation of microwave equipment (ovens or heaters), which are switched on and off. Such values do not regulate how long one may be exposed to such electromagnetic fields, not even the maximum levels to which one is exposed.

With a pulse train with a 1:20 on/off ratio, one could be exposed to pulse energies proven to be highly dangerous - e.g. 500 mW/cm²- without violation of the Code. Also one could be exposed for a full second to 1.5 W/cm²over a one minute period. Early studies of cataractogenesis in relation to RF/MW exposure reported that 7% of this value caused eye damage (Paz, 1970s).

To be useful a Code has to give a peak limit **and** a dosage limit. Power from our electricity utilities is measured in Kilowatt-Hours, a unit used to measure accumulated power consumption over a time period. A unit for accumulated exposure to radiofrequency radiation should be established in the same manner, for example mWh/cm². If we use the exposure rates allowed by Safety Code 6 we get as an accumulated dose 1 mWh/cm²for one hour but 0.4 mWh/cm² for a minute allowed by the Swedish Code are for the 10-300 MHz range, and 5m Wh/cm² for the 300 MHz-300 GHz range, the same as the Canadian Code. Only the maximal dose for one second which is equivalent to 7 µWh/cm² may enforce lower peak values of exposure. But in both codes no values for accumulated doses are given and ICNIRP and other regulatory bodies have yet to come up with a dose that can be endured without damage, setting a radiation level that can be considered biologically safe for permanent exposure.

A different way of reviewing the RF/MW literature was provided by Dr Cindy Sage of Sage Associates Inc, a Montecito, California based consultancy. She showed that the ratio of studies reporting positive results far outweighed those reporting no biological effects (see Charts 1 and 2). Furthermore in confining the studies to those reporting chronic exposure effects it becomes evident that these too are far more likely to show effects than otherwise (Chart 3). Finally, the ratio of studies most likely to mimic cellphone or cellphone mast radiation levels also weighs heavily in favour of results reporting biological effects than those reporting none (Chart 4).

Chart 1: Radiofrequency Radiation Studies 1990 - 2003

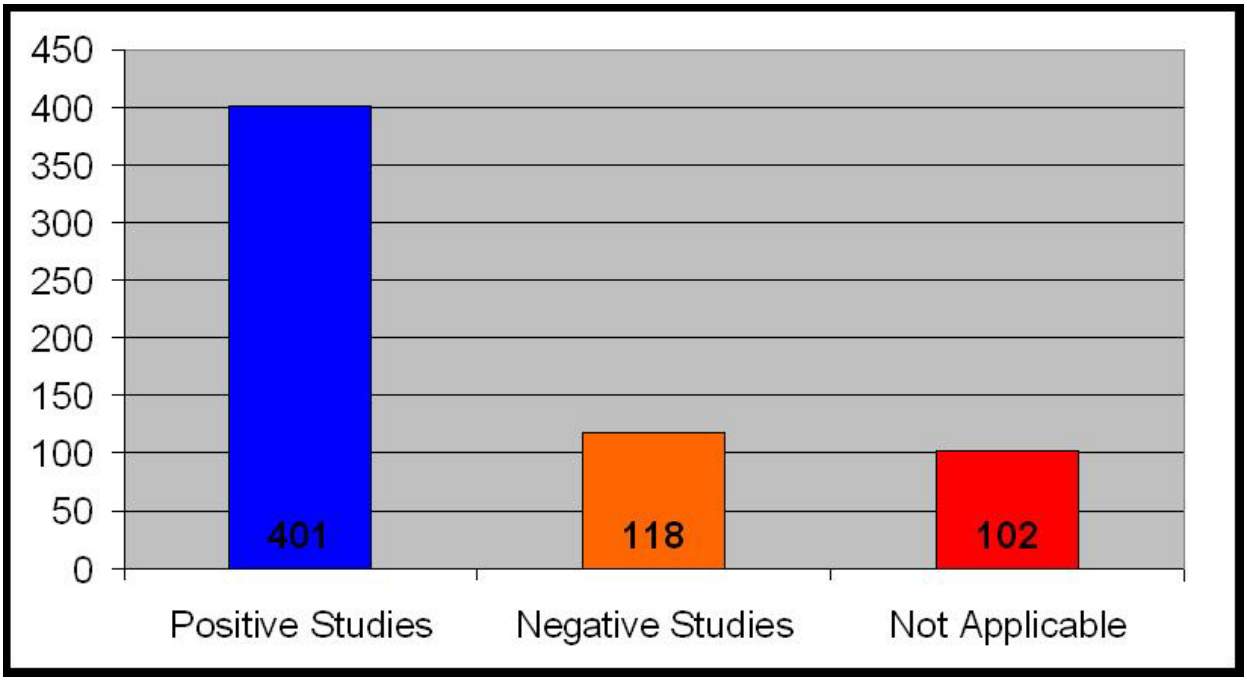
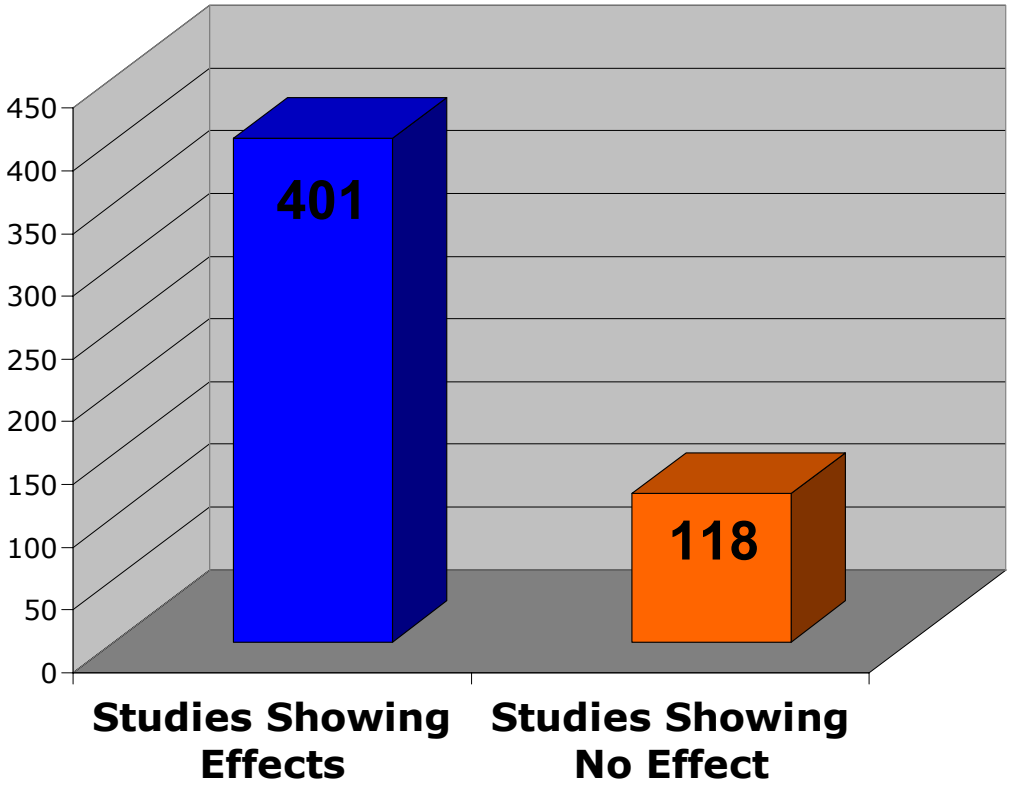


Chart 2: Radiofrequency Radiation Studies (1990-2004)



From this background one can now separate out the chronic studies. These show just how likely it could be that adverse health effects may only appear after some time, perhaps only after several years.

Chart3: Radiofrequency Radiation Studies with Chronic Exposures (1990-2004)

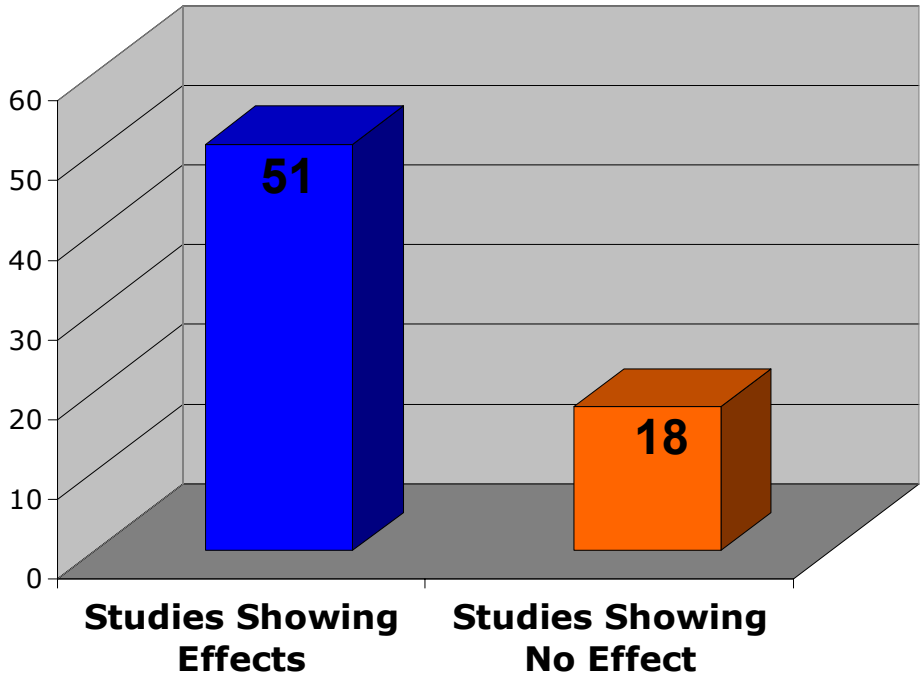
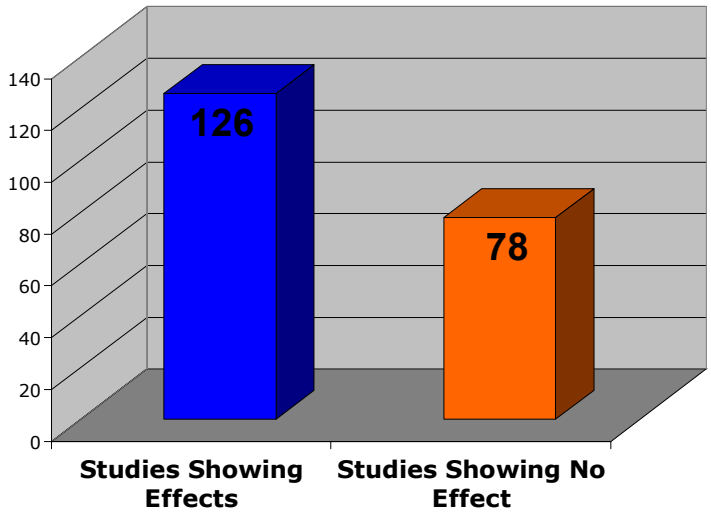


Chart 4: Studies Reporting Effects Similar to Cell Phone or Mast-Related Radiofrequency Radiation (1990-2004)



Melatonin Reduction

One fundamental issue emerging from the present literature is the effect of both power and radiofrequency on melatonin synthesis. This indoleamine is synthesised in several parts of the body as a defence against free radicals, particularly at night, when essential processes of cell repair and restoration via mitosis (cell division) take place. The adult human being repairs some half a billion cells in this way each night, and the energy essential for such repair is derived largely from oxidative phosphorylation. This in turn inevitably gives rise to free radicals, so evolution has arranged for the nocturnal synthesis of melatonin, which appears to bring about reduction in free radicals. Unfortunately it appears from studies at several laboratories that electric fields successfully inhibit melatonin synthesis. In consequence the potential damage to DNA from these free radicals is increased, thereby elevating the risk of cancer. Women with breast cancer have only one tenth the normal level of melatonin, and men with prostate cancer less than half compared with the normal population.

- Fourteen studies show that EMFs across the spectrum from ELF to RF/MW reduces melatonin in people.

- Wang (1989) found that workers who were more highly exposed to RF/MW had a dose-response increase in serotonin, which indicates a reduction in melatonin. Abelin (1999) reported significant reductions from SW radio exposure, Burch *et al*. (1997) with a combination of 60 Hz fields and cell phone use and Arnetz *et al*. (1996) with VDTs.

- ELF exposure reduced melatonin in Wilson *et al.* (1990), Graham *et al.*(1994), Wood *et al.* (1998), Karasek *et al*. (1998), and Burch *et al*. (1997, 1998, 1999a), Juutilainen *et al.* (2000) and Graham *et al*. (2000); Pfluger *et al.* (1996)[16.7 Hz] and geomagnetic activity, Burch *et al.* (1999b).

Thus the possibility that exposure to RF/MW from cellphone masts causes a chronic reduction in melatonin cannot be ruled out.

In a relatively short letter such as this one cannot attempt a complete review of the literature, though competent and fairly recent attempts have been made by the late Prof. Neil Cherry of Lincoln University New Zealand (2002) and by the late Dr. Ross Adey, formerly of Loma Linda Veterans' Medical Center, (2005) and these are commended for further reading.

Scientific evidence reporting adverse health effects from weak chronic non-thermal exposure to RF/MW radiation continues to emerge, such as the recently published REFLEX report, a joint project of some dozen European laboratories who confirmed that weak RF/MW exposure can cause DNA damage, thereby confirming the earlier results of Lai and Singh. Such studies are to be found in the proceedings of Conferences (usually before they are later published in peer reviewed journals or in preprint format on the internet). Recent Conferences include the Bioelectromagnetics Societies annual meeting in Cancun, Mexico and the EHE06 Conference in Madeira Portugal (at both of which one of the present authors made presentations). New Conferences are shortly forthcoming in France (EBEA) and Crete.

Conclusions

Against this background it must be obvious that simply to rely upon the short term (acute) exposure guidelines offered by ICNIRP, which is evaporating in the plethora of non-thermal effects now being reported, is inadequate for any planning authority. Heed must be paid to the overwhelming evidence that long term exposure to vanishingly weak RF/MW radiation will ultimately carry with it adverse on effects on the health of exposed people nearby. In dealing prudently and applying the mandated precautionary approach advocated by the European Community's directives, planning authorities should seek to locate mast installations as distant as possible from human habitations.

Planning Application in Aberystwyth

The proposed Aberystwyth Mast has a children's playground within 100 metres of the antenna. In the vicinity also is the Castle Park, the main Tourist Amenity. The existence of the mast will represent a health threat to the children, and if it becomes well known that the mast is there (for instance, if a danger notice were to be put up close by) , fewer people will use the playground and the park since they will be loath to allow their children to play near the radiation; tourism may be affected.

In addition, the children's playground has a number of resonant array scattering structures which will reflect the radiation in such a way as to produce very high field intensities at hot spots in the playground. Resonant devices for the 5.9 inch wavelength radiation being used are metal railings, and metal playground apparatus and metal studded netting for climbing frames. This aspect of the radiation intensity near a antenna has not been adequately researched and the field intensities generated by masts are merely calculated as if the mast was on a flat plane with no reflectors.

The further issue of effects on pets, livestock and breeding birds and other fauna has not been raised in any detail in this brief review but this must also be a consideration. In this regard it is instructive to note that a recent Italian study reported how white storks nesting near cellphone masts produced significantly fewer fertile embryos than those residing further away, and there are similar studies reporting disruption of homing, flock scattering, and other adverse effects on avian wildlife near radio masts. Similar studies on cattle found lowered melatonin levels with exposure to short wave RF.

Of course arguably the most famous effects after those reported by Volta and Galvani on biological tissues and muscle were the high levels of cancer experienced among the US Moscow Embassy staff in the 1950s, where deliberate irradiation from Soviet monitoring devices was as low as 4 microWatts/cm2.

We hope this somewhat brief account will serve to alert Ceredigion planning authorities to the emerging concerns being expressed in the scientific community that too little attention is being paid to the long term effects of radiofrequency radiation exposure and too much focused on the acute thermal effects as a basis for decisions. In the opinion of these authors, planning consent for the St Michael's mast in Aberystwyth where the proposed additional electric fields due to multiple scattering are superpositive to the original installation, should be refused. The Orange signal in the area where the mast is proposed is already adequate. It would be

counterproductive if, given that our present state of scientific knowledge no longer provides a state-of-the-art defence, a future class action not only led to the removal of the mast installation but also to punitive damages awarded to those suffering ill health from the radiation effects so clearly described in the many studies cited above.

References:

Van den Hazel P, Zuurbier M, Bistrup ML, Busby C, Fucic A, Koppe JG et al (2006) Policy and Science in children's health and environment: Recommendations from the PINCHE project. *Acta Paediatrica* 2006; 95 Suppl 453: 114_119

The other references may be downloaded from the website of Coghill Research laboratories www.cogreslab.co.uk or will be supplied on request by Green Audit (admin@greenaudit.org).