Radiofrequencies and Microwaves

World Health Organization, Publ. 1981. (ISBN 92-4-154076-1)

HEALTH EFFECTS IN MAN.

The available data concerning the health effects of microwave radiation in man are insufficient, although some surveys of the health status of personnel occupationally exposed to microwaves have been carried out. The main difficulty in the evaluation of such information is the assessment of the relationship between exposure levels and observed effects. As often happens in clinical work, it is difficult to demonstrate a causal relationship between a disease and the influence of environmental factors, at least in individual cases. Large groups must be observed to obtain statistically significant epidemiological data. The problem of adequate control groups is controversial and hinges mostly on what is considered "*adequate*" (Silverman, 1973. Czerki et al. 1974a. NAS/NRC, 1977).

In view of the lack of good instrumentation, especially of personal dosimeters, the quantitation of exposure during work is extremely difficult. This is particularly the case where personnel move around in the course of their duties and are exposed to stationary and non-stationary fields, and both near- and far-field exposures. It is impossible to evaluate within reasonable limits the exposure over a period of several years. Consequently, investigation of the health status of personnel exposed occupationally to microwaves necessitates the examination of large groups of workers exposed for various periods, if any statistically valid results are to be obtained.

Observations on the health status of personnel exposed to microwaves in the USSR have been discussed in detail in monographs edited by Petrov. ed. (1970) and Tjagin (1971).

Effects of Occupational Exposure.

Prior to the establishment of safety standards, it had been observed in some countries that occupational microwave exposure led to the appearance of autonomic and central nervous system disturbances, asthenic syndromes, and other chronic exposure effects (Gordon, 1966. Marha et al., 1971. Dumanski et al., 1975. Serdjuk, 1977). The pathogenesis of these syndromes is controversial, their existence has been reported on a number of occasions but often without the level of exposure. Another problem with earlier reports is that measurement techniques were not properly developed at that time (For a detailed discussion see Baranski & Czerski (1976) pages 153-162). Subjective complaints consisted of headaches, irritability, sleep disturbance, weakness, decrease in sexual activity (libido), pains in the chest, and general poorly defined feelings of ill health. On physical examination, tremor of fingers with extended arms, acrocyanosis, hyperhydrosis, changes in dermographism, and hypotonia were reported in the USSR (Gordon, 1966). Similar syndromes were reported in France by Deroche (1971) and in Israel by Moscovici et al. (1974).

Examination of the circulatory function included determination of the velocity of propagation of the pulse wave. Various coefficients may be calculated and used for the evaluation of vascular tonus and the state of the neurovegetative system. This method is widely used in the USSR, but seldom elsewhere. Disturbances in the functioning of the circulatory system are demonstrable using this method whereas, with the exception of signs of bradycardia, no significant findings are obtained using electro-vecto, and ballistocardiography. Mechanocardiography demonstrated normal or increased systolic and minute heart volume in individuals with hypotonia (Tjagin, 1971).

Gordon (1966) and her colleagues reported studies on occupationally exposed workers who were divided into 3 groups according to levels of exposure to microwave radiation:

(a) Periodic exposure at power densities from 0.1 to 10 mW/cm² (and higher) of maintenance personnel and workers, who had been employed in repair shops since 1953.

(b) Periodic exposure at power densities from 0.01 to 0.1 mW/cm² of technical maintenance workers, some users of microwave devices, and research workers, employed after 1960.

(c) Systematic low-level exposure of personnel using various microwave devices, mainly radar.

Functional changes in the nervous and cardiovascular systems were reported in the first 2 groups. In the first group, a marked disturbance in cardiac rhythm, expressed by variability or pronounced bradycardia was reported. In the third group, similar effects were observed but symptoms were less evident and easily reversed. Only about 1000 individuals were observed over a period of years and some doubts exist regarding the exact exposure received by the workers.

Clinical observations on the health status of 2 groups of workers occupationally exposed to emissions from various types of radio equipment were reported by Sadčikova (1974). The first group consisted of 1000 workers exposed to RF radiation at a few mW/cm², second group, of 180 workers who had been exposed at a few hundredths of a mW/cm² over short periods of time. A control group 200 was matched with respect to sex, age and character of work. The health status of both exposed groups was reported to differ considerably from that of the controls, with a higher incidence of changes in the nervous and cardiovascular systems in the exposed groups.

In Poland (Siekierzynski, 1974. Czerski et al., 1974c. Siekierzynski et al. 1974), a selected group of 841 males, aged 20-40 hours and occupationally exposed to microwaves at power densities ranging from 0.2 to 6 mW/cm², was studied. No relationship was found between the level or length of occupational exposure and the incidence of disorders or functional disturbances such as organic lesions of the nervous system, changes in the translucent media of eye, primary disorders of the blood system, neoplastic diseases or endocrine disorders, neurasthenic syndrome, disturbances of the trointestinal tract, and cardiocirculatory disturbances with abnormal ECG.

A 3-year epidemiological study aimed at determining health risks n microwave exposure in US naval personnel was reported by Robinette & Silverman (1977). Mortality, morbidity, reproductive performance, and health of children were investigated in 20.000 occupationally exposed subjects and 20.000 controls. No significant differences were found between the 2 groups. Cases of whole body or partial body overexposure may occur among personnel operating high-power equipment. Exposure of head and resultant injury to the brain have been reported. Servantie et al., 1978). The person concerned may not realize that exposure is taking place, if there is no sensation of heat. The symptoms may appear later, and a syndrome of meningitis or symptoms similar to those of heat stroke may develop. It has been emphasized by many research workers, including Silverman (1973), that the inadequacies and uncertainties of radio measurements and exposure data from existing, clinical studies, it impossible to determine if, and under what conditions, microwave radiation can induce neural or behavioural changes in. Unfortunately, the same problem exists for other studies led out on human subjects exposed to microwaves, making it difficult to draw conclusions on health status.

Effects on the eyes.

Epidemiological surveys of lenticular effects in workers have been performed in Poland (Siekierz, 1974a, b, Zydecki, 1974), Sweden (Tengroth & Aurall, and the USA (Cleary & Pasternack, 1966. Appleton & McCrossan,. 1972. Shacklett et al., 1975). No statistically significant increases in the number of cataracts in personnel occupationally exposed to microwave radiation were observed in any of the surveys.

Aurell (1974) indicated a statistically significant increase in lenticular defects and retinal lesions in 68 workers in a Swedish (where microwave equipment was tested. These authors of the first to point out possible retinal lesions from microwaves. However, survey data on the intensity were not provided and the control group was not statistically significant differences in lens opacities bet, and control groups were not found in any of the o In cases of confirmed cataracts, there had been reported exposures at densities exceeding 100 mW/cm² indeed, power as 1000 mW/cm² were cited.

Studies on the effects of microwave radiation on the eye were carried out as early as 1948 (Richardson et al., 1978). Most animal studies have been conducted on the New Zealand white rabbit because its eye is similar to the human eye.

Investigations to determine cataractogenic radiation levels and lengths of exposure at various frequencies have been conducted in both the far and near fields. In far-field studies, the whole of the body of the animal is exposed but, in some cases, this results in the animal's death. Near-field techniques involve exposing the eye at some distance from the source and permitting air to circulate against the eye, or exposing the eye by direct contact with a source of microwave energy, so that there is no air circulation. The conditions of exposure have a considerable influence not only on the development of cataracts but also on their location in the eye. When air circulation is permitted, the exposure causes opacities to develop in the posterior subcapsular cortex of the lens. Without an air gap, opacities develop in the anterior subcapsular cortex (Carpenter et al., 1974b).

Guy and his colleagues (1975b) have recently determined threshold power density levels and durations of exposure for cataract formation in rabbit eyes with a single exposure to 2.45 Ghz near field radiation. Their results are in good agreement with earlier data obtained by Carpenter and his co-workers (1974b). At 2.45 Ghz, the maximum temperatures occurred near the posterior surface of the lens, and irreversible changes in the lens took place in the posterior cortical area only. Other changes in the exposed eye were found to be transient in nature and disappeared within two days of irradiation. The minimum power density level at which cataracts were formed appeared to be 150 mW/cm² for 100 minutes corresponding to a maximum specific absorption rate in the vitreous body of 138 W/kg. The threshold temperature in the eye for cataract formation was estimated to be about 41º C (Guy et al., 1975b).

To investigate the mechanism by which microwaves produce cataracts at 2.45 Ghz, rabbits were subjected to general hyperthermia and local heating of the lens (Kramer et al., 1976). Rabbits, under general hyperthermia, were kept at a temperature above 43º C for 35 minutes. After 4-6 months, the only cataracts observed occurred in eyes damaged by insertion of the temperature probes. The authors concluded that basic differences occur when heating by means of microwave energy and by convective hyperthermia. Eyes irradiated with microwaves show a characteristic temperature gradient, with the highest temperature behind the lens, whereas in hot bath experiments, the highest temperature occurs at the surface of the cornea. Further high-level microwave exposure raises the eye temperature within minutes, compared with at least 2 hours in the hot water bath. Thus, a sharp temperature gradient and a high rate of heating rather than gradual, more uniform heating may be necessary to produce cataracts (Kramer et al., 1976).

In studies to investigate the relative cataractogenic effects of exposure to two frequencies, 2.45 and 10 Ghz, a special dielectric lens was used to irradiate the eyes of New Zealand white rabbits, selectively. With a constant power density, exposure to 10 Ghz induced a higher intraocular temperature than exposure to 2.45 Ghz. However, when the animals were exposed to these frequencies for the same length of time, cataracts were induced at lower power densities at 2.45 Ghz than at 10 Ghz. Although opacities formed in the posterior subcapsular cortex of the lens at both frequencies, their initial appearance and subsequent development differed. Radiation at 2.45 Ghz induced posterior cortical banding within 1 or 2 days, followed by the appearance of small granules along or on the horizontal line of the posterior suture. Occasionally small vesicles developed. Some opacities also had a fibrillar, cotton-like appearance, and superficial damage, such as pupillary constriction and hyperaemia of the bulbar and palpebral conjunctiva was observed within 24 hours (Hagan & Carpenter, 1976).

In one of the very few investigations of chronic, low-level exposure of rabbits' eyes (2 mW/cm² for 8 hours per day, 5 days a week, for 8-17 weeks at 2.45 Ghz), ocular changes were not observed up to 3 months after termination of exposure (Ferri & Hagan, 1976).

When the cataractogenic power density levels for continuous wave and pulsed radiation were compared at a few frequencies, no differences in the threshold levels for cataractogenesis were found (Carpenter & Van Urnmersen (1968). Carpenter (1969). Birenbaurn et al. (1969). Williams & Finch (1974). Weiter et al. (1975). The average power density, not the peak power density, appears to be the critical field parameter in cataract induction.

Most authors including Belova (1960), Carpenter et al. (1974b), Paulson (1976), Kramer et al. (1978) and Steward-Dehaan et al. (1979) have tended to relate microwave cataracts to the secondary effects of local temperature increase. The conventional view is that, as the crystalline lens does not have its own blood supply, it is easily overheated with consequent damage to capsular cells and denaturation of the protein in the lens.

Studies have been performed to determine if cataracts can be formed by an accumulation of exposures at subthreshold levels. In one experiment, rabbits eyes were exposed for 3 minutes to 2.45 Ghz radiation at a power density of 280 mW/cm² (5 minutes exposure was required to induce a cataract after a single exposure). When the 3 mm exposure was given once a day for 5 days, the animals developed cataracts. However, if the eyes were exposed under the same conditions, but with a break of 7 days between exposures, cataracts did not develop (Carpenter, 1969). In an earlier study, rabbits eyes were exposed to 2.45 Ghz at a power density of 80 mW/cm² for 60 minutes daily, for 10 or 15 days (Carpenter & Van Ummersen, 1968). Cataracts appeared 1-6 days after treatment. However, the authors later indicated that the power density measurement was inaccurate and that subsequent measurements showed that the actual power density was greater than 80 mW/cm².

Paulsson et al. (1979) studied the eyes of rabbits exposed to 3.1 Ghz pulsed (pulse length 1.4 ps, repetition frequency 300 Hz) radiation at an average intensity of 55 mW/cm² (1.3 mW/m² peak) either to single exposures of 1-1½ hours or, after a series of repeated 1 hour exposures, for up to 53 hours during 100 days. Degenerative changes in the retinal neurons and synaptic buttons, and reactive changes in glial cells were observed only following the repeated exposures. No evidence was found of increased permeability of the bloodretina barrier.

Effects of millimetre waves (35 and 107 Ghz) at power densities ranging from 5 to 60 mW/cm² for 15 min-1 h were investigated in rabbit eyes by Rosenthal et al. (1976). Corneal damage and epithelial and stromal injury were observed. Stromal injury appeared at lower power densities (5 mW/cm²) at a frequency of 107 Ghz than at 35 Ghz, but it was concluded that keratitis (inflammation of the cornea) was a useful criterion for ocular response to millimetre radiation. Keratitis occurred at lower power densities than those required to produce other ocular effects such as iritis or lenticular injury. The recovery rate from stromal injury depended on the frequency of the radiation and was faster after exposure to 107 Ghz.

The following conclusions on the effects of microwave radiation on the eye can be drawn from these and other data from literature reviews:

(a) Above 500 Mhz, opacities of the eye may be produced when power densities exceed 150 mW/cm², if the duration of exposure is sufficiently long.

(b) Although ocular injury has not been reported at frequencies below 500 Mhz, its possibility cannot be excluded.

(c) The frequency of the microwave radiation influences the type and location of the injury to the eye.

(d) Exposure conditions, namely whether in the near field or far field, whole body or selective exposure of the eye, eye exposure with or without an air gap (to provide cooling), and the temperature of the animal's body, all influence the power density and duration of exposure needed to produce eye injury.

(c) Injury to the eye from microwaves appears to be predominantly thermal in nature, temperature gradients within the eye and the rate of heating being two major factors in the stress that leads to injury. Non-thermal effects cannot be excluded but they alone do not appear to be sufficient to produce effects in the eye, although they may provide a necessary mechanism of interaction.

(f) The threshold curve of power densities versus time to produce eye cataracts is not linear. Exposure of the eye at each frequency seems to require a threshold microwave power density below which even continuous exposure does not produce eye injury. This would appear to exclude the possibility of cataractogenesis caused by low level chronic exposure, and this was confirmed in a recent experiment (Ferri & Hagan, 1976).

(g) Pulsed and continuous wave radiation with the same average power density level seem to possess the same potential for cataract induction. However, effects from pulsed radiation with a small duty factor and high peak power cannot yet be excluded.

(h) Cataracts can be produced by repeated exposures to subthreshold power density levels. For this cumulative effect to occur, the levels have to be sufficiently high that a slight but persistent injury is not fully repaired before another exposure takes place. However, if the time between exposures is sufficiently long for repair to take place, cumulative damage is not observed.

Effects on reproduction and genetic effects.

There is little information on the effects of microwave radiation on male or female reproductive functions. Reports of sterility or infertility from exposure to microwaves are questionable changes in the fertility of radar workers were found Baraff (1958).

Marha et al. (1971) attributed decreased spermatogenesis (sex ratio of births, menstrual pattern changes, cong in newborn babies, and decreased lactation to the exposure of mothers to RF radiation. According to such effects occurred at power densities exceeding 10 mW/cm².

Cardiovascular effects.

Functional damage to the cardiovascular system, by hypotonus, bradyeardia, delayed auricular and ventricular conductivity, and flattening of ECG waves, has been several USSR clinicians, to result from chronic exposure to RF fields (Gordon, 1966, 1967. Tjagin, 1971. Barans 1976). Decreases in blood pressure from exposure have also been reported. Some authors in the USSR have indicated that the nature and seriousness of cardiovascular reactions to prolonged is related to changes in the nervous system, and the characteristics of the individual. Some patients exhibit only minor asthenic symptoms while others developed marked autonomic vascular dysfunction.

Power density ranges in relation to health effects.

During the 1973 Warsaw International Symposium on biological effects and health hazards of microwave radiation, it was agreed that microwave power densities could be divided into ranges. The following is an abridged version of this agreement:

Microwave densities may be divided into the following 3 ranges:

(a) High power densities generally greater than 10 mW/cm², at which distinct thermal effects (see Glossary) predominate.

(b) Medium power densities, between 1-10 mW/cm², where weak but noticeable thermal effects exist, and

(c) Low power densities, below 1 mW/cm², where thermal effects are improbable, or at least do not predominate.

The boundaries indicated for these ranges are arbitrary and depend on numerous factors, such as animal size, threshold of warmth sensation, frequency, and pulsing. The introduction of the intermediate range of subtle effects calls attention to the need for additional research, aimed at clarification of the underlying mechanisms.

It should be noted that the classification applied to the microwave region (300 Mhz - 300 Ghz). A similar classification was not determined for the RF region (100 Khz - 300 Mhz).

Exposure effects in man.

The meagre evidence available on exposure effects in man has been obtained from incidents of accidental acute over-exposure to microwaves and RF. Not enough attention has been given to the conduct of epidemiological investigations. In some human studies, which have been conducted on people exposed occupationally, subjective symptoms have been reported.

A considerable number of people in many countries have received microwave and RF diathermy treatment at power levels of several tens of watts for a duration of about 20 min daily over a period of some weeks.

Adverse effects have not been adequately investigated among diathermy patients. This is a group of people exposed to microwaves and RF who can be readily identified and such studies should be carried out, as they may yield considerable information concerning exposure effects in man.

Health risk evaluation as a basis for exposure limits.

Theoretical considerations, experimental animal studies, and limited human occupational exposure data constitute the basis for the establishment of health protection standards. It should be noted that, in some countries, microwave and RF health protection standards have recently been changed and that there is a tendency to adopt less divergent exposure limits in comparison with those proposed two decades ago.

In establishing health protection standards, different approaches and philosophies have been adopted.

A highly conservative approach would be to keep exposure limits close to natural background levels. However, this is not technically feasible. A reasonable risk-benefit analysis has to be considered.

More data on the relationship between biological and health effects and the frequency and mode of generation of the radiation, particularly in complex modulations, are needed.

In the case of pulse modulation, peak power density may be a factor which should be considered in setting exposure limits. However, it is not possible to propose a limit of peak power density from the information available at present.

Biological investigations.

Reports of experimental work should contain sufficient information describing the exposure conditions to allow an estimation not only of the total absorbed energy but also, as far as possible, of the distribution of the energy deposited within the irradiated biological system.

Systematic investigation of the effects of microwave/RF exposure at all levels of biological organization are to be encouraged. This includes effects at the molecular level on subcellular components, cells, viruses, and bacteria, organs and tissues, and whole animals. Particular attention should be paid to: (a) long-term, low level exposures and possible delayed effects (b) the possibility of differences in sensitivity of various body organs and systems, where specific effects in various animal species are being considered and (c) the influence of microwave/RF exposure on the course of various diseases, including any possible increase in sensitivity to microwaves/RF that may result because of the disease state.

Epidemiological investigations.

Epidemiological studies should be carried out in a careful manner, paying attention to the relationship between exposure to microwaves/RF and other environmental factors occurring in the place of work and to the health status of the investigated group. Specific biological endpoints should be selected and adequate examination methods used for such studies. Conventional medical examinations will not provide sufficient information.

Studies should be carried out on (a) workers occupationally exposed to microwave/RF sources; (b) patients treated with microwave and RF diathermy and (c) groups within the general population living near high-power microwave/RF sources.

A distinction should be made between occupational and public health protection standards.

MAGNITUDE OF EXPOSURE TO MICROWAVE AND RF RADIATION AND SOURCES OF CONCERN.

Electromagnetic fields and RF radiation occur naturally over a very wide range of frequencies. The ionosphere very effectively shields the earth's biosphere from radiations of this type originating in space. Electromagnetic fields and radiation of high intensity may be generated by natural electrical phenomena such as those accompanying thunderstorms.

However, in the frequency range of 100 Khz to 300 Ghz, the intensity of natural fields and radiation is low. Exposure of the urban population in the USA to man-made microwave sources was found by Janes (1979,) to vary from a very low value to as high as 100 $\mu W/cm^2$. The median exposure to the total microwave flux from external sources for this population was calculated to be 0.005 $\mu W/cm^2$. Osepchuk (1979) has calculated the background exposure from the sun, integrated up to 300 Ghz to be 1.4 X 10^{-5} $\mu W/cm^2$. These values can be put in better perspective by noting that the integrated microwave /RF flux emitted from the human body has been calculated by Justesen (1979) to be up to 0.5 $\mu W/cm^2$.

The proliferation of man-made sources of energy in the 100 Khz - 300 Ghz range has only occurred over the last few decades. From the point of view of biological evolution, this energy constitutes a very recent physical factor in the environment. Observations of biological effects from exposure to microwaves gave rise to concern in the early 1940s. On the basis of special research programmes, radiation protection guides recommending exposure limits were developed in the 1950's in the USSR and the USA. Thereafter, several industrialized countries introduced recommendations and/or legislation on microwave and RIP health protection. It should be noted, however, that exposure limits vary widely, and are the subject of many discussions and much controversy.

Although concern about microwave and RF effects and possible hazards arose first in highly developed countries, the problem is universal. Developing countries are rapidly establishing telecommunications, broadcasting systems, and other sources of electromagnetic energy. Electromagnetic waves emitted in particular countries may propagate around the globe. A report from the USA (Office of Telecommunications Policy, 1974) states: "**Unless adequate monitoring programs and methods of control are instituted in the near future, man may soon enter an era of energy pollution comparable to that of chemical pollution of today**".

The urgent need for international agreement on maximum exposure limits and international programmes for the containment of electromagnetic pollution has been stressed at international meetings (Czerski et al., 1974a). Prevention of potential hazards is a more efficient and economical way of achieving control than belated efforts to reduce existing levels.

MICROWAVE AND RF ENERGY ABSORPTION IN BIOLOGICAL SYSTEMS.

Electric and magnetic fields are induced within a biological system exposed to microwave or RF energy. To understand the resulting biological effects, it is necessary to determine the induced field strength at various internal points of the system. Knowing the electrical and geometrical characteristics of the irradiated object and the external exposure conditions, it is possible, in principle to calculate the rate at which energy is absorbed throughout the interior of the irradiated object.

The magnitude of interior and exterior scattered and reflected fields depends on many factors: the frequency and configuration of the incident field; the electrical properties of the various layers (tissues) of which the irradiated system is composed; the shape, the size relative to wavelength, and the relative orientation of the system. Biological systems are usually of complex exterior and interior geometry, and consist of several layers with various elect cal properties (complex permitivity). As a result, the interior energy deposition in biological systems will be non-uniform. Depending on the thermal properties and blood flow of tissues, there can be marked differences in the magnitude and rate of increase in temperature, and thermal gradients can result. A review on the interaction of microwave and RF radiation with living systems has recently been completed by Stuchley (1979).

Energy Absorption.

Biological systems are lossy dielectrics characterized by limited conductivity. The losses originate from the movement of free ions (conduction loss) and molecular rotation (dielectric loss). Thus, electromagnetic waves, propagating 'through a biological medium, interact with it, and energy transfer occurs. This results in attenuation of the field and an increase in the kinetic energy of the molecules of the medium, i.e., in heating. The degree of attenuation of the field depends on the dielectric properties of the medium, and these change with the frequency of the incident field. The real and imaginary parts of the complex permitivity generally decrease with increasing frequency.

The above statements present, in a simplified form, the classical theory of microwave and RF energy absorption, which was developed by Schwan and his school (Schwan & Piersol, 1954, 1955; Schwan, 1971, 1976). The latest restatement of this approach (Schwan, 1978) may be summarized as follows: "Among the established effects in biological systems the most important is heat development but direct field interactions with membranes, biopolymers, and biological fluids are all possible". All energy deposition, however, takes place because of conduction losses, molecular movements, and biopolymer rotation.

During the last few years, the concept of the specific absorption rate (SAR) has been developed for quantifying microwave and RF effects.

As mentioned earlier, the specific absorption rate is defined as the rate of energy absorption per unit mass of an exposed object. For steady-state sinusoidal fields, the SAR is directly proportional to the tissue conductivity, the square of the electric field, and inversely proportional to the mass density. The relationship is more complex in pulsed or modulated fields, if the intrinsic properties of the medium are non-linear. However, since the SAR is related to the intensity of the internal electric field, this concept can be used independently of the nature of the interaction mechanism responsible for biological effects. This stems from the fact that it is the internal electric field intensity that quantitatively describes the interaction. Nevertheless, it may not be the only factor, e.g., frequency and/or modulation of the radiation field may strongly affect biological effects. Consequently, the nature of the radiation fields should always be considered in addition to the SAR.

The SAR is a measure of the absorbed energy which may or may not all be dissipated as heat. The temperature is a function of the SAR, but it is also a function of the thermal characteristics of the absorber (i.e., the size, shape, thermal conductivity).

The values of the SAR averaged over the whole body and the distribution of the SAR have been estimated theoretically and measured experimentally in models and experimental animals for various exposure conditions. For human subjects, the average SAR for exposures in the far field may reach a peak in the frequency range of 30-200 Mhz, depending on various factors associated with the specific exposure situation (Johnson et al., 1976. Durney et al., 1978, 1980). Average SAR in man and experimental animal models at an incident power density of 1 mW/cm² in free space (far-field) conditions. The graphs in Fig. 11 (page 46) show the importance of size, frequency, and orientation, while values of average SAR at the resonant frequency for several exposure conditions for models of man and 2 sizes of rats. This mathematical modelling is only possible for greatly simplified models.

In addition to the average SAR, the SAR distribution in many models has been calculated. Much of this work can be found in reports by Shapiro et al. (1971), Lin (1976), Gandhi et al. (1979), Kritikos & Schwan (1979), and is summarized in the latest edition of the Dosirnetry Handbook (Durney et al., 19,80).

In the absence of adequate knowledge concerning the mechanisms of interactions between microwave energy and biological systems, and in the light of the limitations inherent in the SAR, the following conclusions can be drawn.

(a) SAR alone cannot be used for the extrapolation of effects from one biological system to another, or for the extrapolation of biological effects from one frequency to another.

(b) Curves for exposure which produce equivalent SAR for a given body over the microwave/RF energy spectrum may be used to predict equivalent average heating, provided data concerning heat dissipation indicates equivalent heat dissipation dynamics. Such curves cannot, however, be used as the only basis for predicting biological effects or health risks over the microwave/RF spectrum, since from current knowledge, it is not possible to state that equivalent average energy absorption rate for given radiation frequencies is associated with equivalent biological effects.

Molecular Absorption.

Despite the photon energies, some recent theoretical explanations of experimental observations strongly indicate the possibility of interactions at the molecular level. Proton tunnelling, changes in the conformation of molecules, and cooperative mechanisms have been envisaged (Fröhlich, 1968. Illinger, 1971, 1974. Cleary, 1973, 1978. Rabinowitz, 1973. Grodsky, 1975. Keilmann, 1977).

It has been postulated (Fröhlich, 1968. Rabinowitz, 1973) that microwaves in the frequency region of 60-120 Ghz may influence macromolecules in biological systems, altering such functions as cell division, and virus inactivation or activation. Effects on enzyme systems, DNA-protein structures (chromosomes), and cell membranes are possible (Grundler & Keilmann, 1978. Pilla, 1979. USSR Academy of Sciences, 1973). Physical experimental techniques need developing and further studies on biological effects are necessary. Similar mechanisms may be operative at lower frequency ranges (Kaczmarek & Adey, 1974. Adey, 1975. Grodsky, 1975. Bawin & Adey, 1976) and the present status of knowledge about the molecular absorption of microwaves and RF in biological systems has been summarized by Straub (1978) who states:

"Absorption of non-lonizing electromagnetic (EM) radiation by biologically important molecules can occur by many different mechanisms over the frequency range from several hertz through the millimeter microwave region. The absorption of EM radiation is determined by the bulk dielectric properties of living tissues, cells and biomolecules in solution. However, the existence of diverse and complex molecular structures characteristic of biological systems makes it necessary to consider the details of absorption and dissipation of EM energy. In addition, the biological function of the molecular species absorbing energy needs to be studied to understand the significance of the EM absorption. Among many possible examples the following five are given: (1) The network of membranous lipid-containing structures within and at the outside limit of cells poses a series of barriers to thermalization of the absorbed radiation. Thus, adiabatic conditions may be maintained in small membrane bound volumes for much longer periods of time than in simple solution. Large thermal gradients and temperature elevations can result. (2) Subsequent temperature elevation may cause membrane structures or complex protein assemblies to pass through phase transitions, altering their properties. (3) Spatial anisotrophy in the arrangement of large molecular assemblies, as found in mitochondria and ribosomes, results in specialised functions which can be completely changed if some of the molecules are rotated or translated by EM radiation. (4) Quanturn effects such as proton tunnelling with resulting isomerization of DNA base pairs may also be influenced by EM radiation. (5) Otherwise random motion of "gates" in excitable channels of nerve membranes may be brought into forced oscillation by EM radiation, with resultant membrane depolarization. Detailed knowledge of structure and function of the biological system thus reveals many perturbations which might be induced by EM absorption, and, conversely, EM radiation can be used to probe biological structures and function".

BIOLOGICAL EFFECTS IN EXPERIMENTAL ANIMALS.

During the past thirty years, research has been devoted to various aspects of the interactions between microwave and radiofrequency radiation and biological materials. Unfortunately, most experiments have tended to report biological effects as phenomena rather than attempting to establish whether such radiation presents a health risk to man and other biota. In Czechoslovakia, Poland, and the USSR, a continuous research effort made over the last 25-30 years has resulted in numerous research reports and reviews (Presman, 1968. Marha et al., 1971. Baranski & Czerski, 1976). In the past 20-25 years, interest in this field of studies has increased in the USA, first with the establishment of the Triservice Programme in 1956 and then other programmes in later years.

It is impossible to review the numerous studies (see bibliographies by Glazer et al., 1976. Glazer & Brown, 1976. Glazer et al., 1977) related to the biological effects of microwave radiation and only those most pertinent to the evaluation of potential biological hazards have been cited. Potentially beneficial effects of microwave radiation are outside the scope of this document.

Only limited information is available from studies of human subjects directly exposed occupationally or experimentally to microwave radiation. Most of the data on possible harmful effects are based on studies of separate cells, simple organisms, animals, and models, making it difficult to extrapolate such experimental results to man.

Radiant energy absorption in the living system followed by direct interaction with biophysical or biochemical processes, may be defined as the primary interaction. Changes in the structure and function of a biological system as a result of the primary interaction are considered to be biological effects. Immediate biological effects arising at the site of the primary interaction may induce further indirect changes, both acute and chronic.

The analysis of data on effects requires the consideration of a sequence of events: the physical interaction followed by physiological reactions, local and generalized, and immediate and delayed biological effects. In addition, frequent activation of adaptive mechanisms may lead to their exhaustion via the classical sequence of events of stress-adaptation-fatigue. Consequently, the effects of single and repeated exposures should be considered separately, even when exposures take place under identical conditions.

For many years, the primary interaction of microwave and RF radiation with living systems was considered almost exclusively in terms of electromagnetic field theory (Schwan, 1976, 1978). It was concluded that the conversion of the absorbed energy into kinetic energy of molecules (i.e., heat) was the only significant mechanism involved. However, there are discrepancies between some empirical observations and the theoretical explanations available (Cleary, 1973. Baranski & Czerski, 1976. Dodge & Glaser, 1977), which indicate that "non-thermal" effects may play some role. Direct interference with bioelectric phenomena (as seen on the electroencephalogram and the electromyogram) and the role of electromagnetic fields in the transmission of biological information was suggested by Presman (1968), but these hypotheses need experimental verification.

Interaction of microwave energy at the molecular level has been postulated to explain the primary interaction between microwaves and parts of living systems such as membranes

(Fröhlich, 1968. Adey, 1975. Bawin et al., 1975. Grodsky, 1975. Bawin & Adey, 1976. Grundler & Keilman, 1978. Pilla, 1979).

Neuroendocrine Effects.

Interaction between the endocrine and nervous systems is very important to the functioning of the human body. The hypothalamus within the brain is a control centre involved in the regulation of the autonomic nervous system, including such visceral functions as temperature control within the whole body. This gland, coordinated by the central nervous system (CNS), releases specific factors into the pituitary portal system, which regulate hormones released by the endocrine organs. The endocrine system can be considered as a feedback control system where the hypothalamus, via the pituitary causes hormones to be secreted by endocrine glands. Once the (endocrine hormones have reached a certain level, this information is fed back to the pituitary and hypothalamus, causing a reduction or cessation in hormone secretion, The system's actions are modified by direct neural inputs from higher brain centres and peripheral nerves.

Descriptions of the biochemical and neuroendocrine aspect of exposure to microwaves can be found in recent reviews by Michaelson et al. (1975) and Cleary (1977).

Dogs exposed to 3 Ghz microwaves at 10 mW/cm² showed substantial increase (100%-150%) in corticosteroid levels, a d(crease in blood potassium, and an increase in blood sodium contei (Petrov & Syngajevskaja, 1970). The increase in the corticosteroid levels during and after irradiation may have been an adapted reaction, since in some animals the adrenocortical function becomes inhibited and sensitivity to microwave radiation increases because of insufficient release of adrenocortico tropic hormone (ACTH).

Dumanskij & Sandala (1974) found that chronic low-level exposure of rats and rabbits to 3 cm, 12 cm, and 6 minutes microwaves at 10 μW/cm² and below, for 8-12 hours per day, for 120 days, reduced cholinesterase and increased 17 ketosteroid levels in the urine during the 60 days following irradiation. A reduced amount of ascorbic acid in the adrenal glands and reduced adrenal gland weight were also observed. Syngajevskaja et al. (1962) exposeddogs and rabbits (162 animals) to decimeter waves at 70 mW/cm² for 30 min and reported increases in the ascorbic acid concentration in the adrenals, while exposure at 5 mW/cm² for 30 minutes caused it to decrease. Changes in glucose levels in the blood and variations in liver glycogen content were observed; lactic acid levels were also affected. It has been suggested that a whole body rise in temperature caused by microwave exposure suppresses the hormone-producing functions of the anterior pituitary and adrenals, while exposures not resulting in an increased rectal temperature enhance hormone production (Petrov & Syngajevskaja, 1970).

No significant alterations were observed in growth hormone or thyroxine levels in barbiturate-anaesthetized dogs, cranially exposed to 2.45 Ghz microwaves at various power densities (20-80 mW/cm²) for 1 hour (Michaelson et al., 1975). When rats were exposed (whole body) for 1 hour to 2.45 Ghz microwaves at 9 mW/cm² an increase in growth hormones was observed, but at 36 mW/cm² exposure, a significant decrease was noted (Syngajevskaja et al., 1962).

The thyroid activity in rats exposed to 2.45 GHz microwaves at 1 mW/cm² for 8 hours per day for 8 weeks was studied by Milroy & Michaelson (1972). No structural or functional changes were detected, other than those that could be attributed to microwave-induced thermal stress. In contrast, Baranski et al. (1973) reported that rabbits exposed to 10 cm microwaves at 5 mW/cm² showed increased thyroid activity. Mikolajczyk (1977) suggested that these differences in results were due to the experimental procedure and conditions rather than the differences in species.

When rats were exposed to 2.45 Ghz microwaves at 10, 15, 20, and 25 mW/cm² for 4, 16, and 60 hours (i.e., 64 hours with two 2 hours breaks), Parker (1973) found that the iodine-concentrating ability of the thyroid serum, protein-bound iodine levels, and thyroxine increased slightly at 10 mW/cm², but decreased at 20 and 25 mW/cm² during the 16 hours exposure.

Exposure at 15 mW/cm² for 60 hours resulted in a decrease in protein-bound iodine and thyroxine, and a decrease in the ability to concentrate iodine.

When male rats were exposed to 2.87 Ghz radiation at 10 mW/cm² for 6 hours per day, 6 days per week for 6 weeks, there were no significant differences between the average body and organ weights Of irradiated and control animals (Mikolajczyk, 1977). Although the levels of growth hormone in the anterior pituitary were the same in both groups of rats, a significantly higher level of luteinizing hormone (LH) was found in the irradiated animals. It was suggested that changes in the LH activity might be due to the influence of microwave exposure on the pituitary, or on hypothalarnic function or on both.

Various animal studies in which neuroendocrine effects have been reported following exposure to low intensity fields are summarized. Baranski & Czerski (1976) state in their review of endocrine effects that it is extremely difficult to sum up the evidence. All aspects of microwave interactions reported need further investigation concerning both the cause and dose dependence of the effects described and the mechanisms involved. However, it could be stated that:

(a) Microwave radiation induces endocrinological changes that may be due to stimulation of the hypothalamic-hypophyseal system, through thermal interaction at the hypothalamus, or immediately adjacent levels of organization, the pituitary, the particular endocrine gland, or the end-organ.

(b) Since the neuroendocrine system is homeostatic, transient neuroendocrinological changes should not be equated with pathological alterations.

(c) Sufficient data are available to indicate that the response of the neuroendocrine system to microwaves depends on the frequency, power density, the duration of exposure, and the part of the body exposed.

(d) The non uniform distribution of microwave energy within the body seems to be an important factor affecting the response of the neuroendocrine system.

(e) Several components of the neuroendocrine system are critically sensitive to environmental temperature, thus low-power density, microwave-induced effects could result from sensitivity to small changes in temperature.

(f) From available data, it would seem that direct interaction of microwaves with components of the neuroendocrine system cannot be excluded.

Nervous System and Behavioural Effects.

Microwave radiation effects on the central nervous system and behaviour have been the subject of most controversy in the whole field of bioeffects. Czechoslovak, Polish, and Soviet investigations on this subject commenced in the early fifties and have been the source of most of the reports on the effects of microwaves on man. Animal studies and clinical and industrial surveys in Czechoslovakia, Poland, and the USSR have been summarized by Marha et al.: (1971), Baranski & Czerski (1976), and Presman (19,68), respectively. The basic assertion is that exposure to microwaves at low power densities results in neurasthenic disorders in man. Subjective complaints such as headache, fatigue, weakness, dizziness, moodiness, confusion, and nocturnal insommia have been reported. In small experimental animals, chronic and repeated exposures at incident power densities of 10 mW/cm² or less have been reported to lead to disturbances in conditioned reflexes and to behavioural changes (Kholodov, 1966. Presman, 1968. Petrov et al., 1970. Frey, 1971, 1977.

Marha, 1971. Lobonova, 1974. Galoway, 1975. Hunt et al., 1975. Serdjuk, 1977. Cleary, 1978). Studies of microwave/RF exposure effects on conditioned and normal reflexes, as well as on behaviour, were carried out on mice, rats, guineapigs, rabbits, dogs, monkeys and in some instances on birds (Romero-Sierra et al., 1974. Bigudel-Blanco et al., 1975. Bliss &

Heppner, 1977).

Numerous reports of the sensitivity of the human CNS to low level microwave exposure have stimulated interest in the subject with a consequent increase in studies on microwave effects on the animal CNS (Cleary, 1977). Investigations have been conducted at various levels of CNS organization and range from studies of isolated nerves (McRee & Wachtel, 1977) to behavioural studies in primates (De Lorge, 1976, 1979). These studies were established to determine if the effects were thermally-induced or were the result of the direction of microwave-energy on the CNS. The results of many studies can be explained by the non uniform distribution of thermal energy and/or thermal gradients, but the results of others such as the increase in calcium efflux from cerebral tissue, due to specific amplitude modulation are difficult to explain on the basis of heating.

Disturbances in the bioelectric function of the chick forebrain with calcium efflux were observed following in vivo exposure to 147 MHz radiation, amplitude modulated at 9-20 Hz (Bawin et al., 1975). These effects could not be obtained when the frequency of amplitude modulation was between 6 and 9 Hz or between 210 and 35 Hz. A 20% increase in calcium was also observed by Kaczmarek & Adey (1974) in the cat brain after in vivo exposure to 10 ms pulsed radiation at 200 Hz, 20-5O mV/cm². Further research is needed since these effects may depend on a direct interaction of electromagnetic fields with the cellular membrane (Grodsky, 1975. Straub, 1978. Kolmitkin et al., 1979).

Blackman et al. (1979) recently confirmed the work of tawin and Adey and their coworkers, in finding that calcium efflux from brain tissue depended on amplitude modulation frequency and power levels. Increased calcium efflux appeared at amplitude modulation frequencies around 9 Hz, peaked from 11-16 Hz, and disappeared above 20 Hz. It can be said that a "frequency window" exists for this phenomenon. Calcium efflux appears at 0.5 mW/g, reaches higher values at 0.75 mW/g and decreases at 1.0 mW/g. Thus, it can be said that "power windows" also exist. These may shift with frequency (Blackman et al., 1979).

The electrical activity of the brain, measured by means of an EEG, may be influenced by a wide variety of exposure regimes. Acute single exposures to 40 mW/cm² or more, induce transient changes in EEG patterns. Early experimentation in this area has been summed up by Kholodov (1966). Long-term, repeated exposures of dogs, cats, rabbits, rats, frogs, and mice at power densitie as the desynchronization of basal rhythms and later a flattening in EEG tracings (Baranski & Edelwejn, 1968. Bychkov & Dronov, 1974. Bychkov et al., 1974. Gillard et al., 1976). However, these earlier reported effects are questionable since experiments were carried out using EEG electrodes or wires that significantly perturbed the field.

Mice, rats, and rabbits subjected to long-term, low or medium level (about 1-5 mW/cm²) exposure were reported to show an increased susceptibility to convulsant drugs (Baranski & Edelwe Jn, 1968. Servantie et al., 1974, 1975. Krupp, 1977). Detailed analyses of EEG data and results of pharmacological studies indicate that the reticular formation of the midbrain is the structure in which exposure to microwaves and RF may induce effects at, low incident power density levels.

The mechanism of changed susceptibility to drugs acting on the nervous system, particularly convulsant drugs, after repeated microwave exposures is unclear. On the other hand, as the action of many drugs is well understood, the phenomenon may serve to

clarify mechanisms of action of microwave and RF radiation on the nervous system (Czerski, 1975). The phenomenon has practical implications in the case of the medication of microwave workers.

Structural changes in the nervous tissue of rabbits and hamsters which were demonstrable by electron and light microscopy, were reported following single exposures to 2.450 Mhz microwaves at power densities of 25-50 mW/cm² (Baranski, 1967. Baranski & Edelwejn, 1979. Albert & De Santis, 1975. Albert, 1979). In their study on rabbits subjected to single or repeated exposures to continuous or pulsed microwaves (2.950 Mhz), Baranski & Edelwejn (1974) did not find any effects on acety cholinesterase activity after long-term exposure (2 hours/day for 3-4 months to 3.5, 5 mW/cm²).

Brain hyperaemia, pyknosis, and vacuolization of nerve cells were observed in rats repeatedly exposed for 75 days to 3 and 10 cms microwaves at high power densities (40-100 mW/cm²) (Tolgaskaya et al., 1962. Tolgaskaya & Gordon, 1973). These effects were less pronounced following exposures at 10-20 mW/cm² and with exposure to 3 cms microwaves compared with 10-cm microwaves at the same power density. The effects were reversible, several days after termination of the experiment.

The blood-brain barrier of rats may be affected by pulsed and continuous wave microwave radiation at 1.2 Ghz, (Frey et al., 1975). A single exposure of 30 min at an average power density of 0.2 mW/cm² pulsed and 2.4 mW/cm² continuous wave radiation led to an increase in permeability. In another study on rats, Oscar & Hawkins (1977) found temporary alterations in permeability following single 20 minutes exposures to 1.3 Ghz radiation at power densities of about 1 mW/cm² pulsed and 3 mW/cm². Many other investigators including Merrit (1977) and Sutton & Carrell (1979) were unable to reproduce these experimental results.

In studies by Wachtel et al. (1975), exposure of individual neurons to 1.5 Ghz and 2.45 Ghz microwave radiation at a dose rate of approximately 10 mW/g had a marked effect on the firing pattern of Aplysia neurons. Although heating may have been partially responsible, the authors suggest that other factors are needed to explain the effect. Rectification of the applied field in nerve tissue could explain the observed effects.

The threshold power density required to evoke potentials in the brain stem of cats using nonperturbing electrodes was found to be approximately 0.03 mW/cm² with a peak of 60 mW/cm² for frequencies between 1.2 - 1.5 Ghz (Frey, 1967).

Stverak et al. (1974) found that rats having an inherent predisposition to epileptic seizure after sound stimulation showed reduced sensitivity of this phenomenon following long-term (4 hours/day for 10 weeks) exposure to 2.850 Mhz radiation, pulsed for 10 us, repetition frequency 769.2 Hz, at an average power density of 30 mW/cm².

Behavioural perturbations in rats in the form of work stoppage have been reported by Justesen & King,(1970) and Lin et al. (1979). Exposure of hungry unrestrained rats to 2.45 GHz microwaves at a dose rate of approximately 9 mW/g caused stoppage of work for food after 20 minutes of exposure in a multimode cavity (Justesen & King, 1970). With restrained rats irradiated with near-field radiation at 918 Mhz, the threshold dose rate for the effect was 8 mW/g (Lin et al., 1979). It was calculated by Justesen (1978) that an integral dose between 8 and 10 J/g was required for work stoppage in hungry rats, e.g., 23 min exposure to an average power density of 20 mW/cm² at 600 Mhz (resonant frequency for the rat) or 46 minutes exposure to the same power density at 400 Mhz. The work stoppage was found to be related to the specific absorption rate, suggesting a thermal basis for the effect.

In studies by Moe et al. (1977), rats exposed for 210 hours to 918 Mhz radiation at 10 mW/cm² showed decreased locomotor activity and food intake. This behavioural change could be attributed to thermal loading, even though the animals were not under hyperthermic stress.

The effects on exploratory activity, swimming, and discrimination involving a vigilance task were studied in rats exposed to 2.45 Ghz pulsed radiation (Hunt et al., 1975). A dose rate of 6 mW/g caused a moderate decrease in the level of exploratory activity and swimming speed. The results were attributed to fatigue from thermal overexposure, since the effect on vigilance discrimination was observed to be directly related to induction of and recovery from hyperthermia. Nearly lethal radiation (11 mW/g) initially produced a marked degradation in performance, but the rats returned to the trained level of proficiency after 1 hour.

Microwave radiation was found to affect the behaviour of rats conditioned to respond to multiple schedules of reinforcement (Thomas et al., 1975). Exposure for 30 minutes to 2.86 and 9.6 Ghz pulsed radiation, and to 2.45 Ghz radiation just before experimental sessions at power densities exceeding 5 mW/cm² caused significant alterations in behaviour.

Roberti et al. (1975) did not find any difference in the spontaneous motor activity of rats after exposure for periods totalling 408 hours to 10.7- and 3 Ghz microwaves at power densities ranging from 0.5 to 26 mW/cm². Classical Pavlovian methods were used by Svetlova (1962) and Subbota (1972) to investigate reflex and conditioned reflex actions in microwave irradiated dogs, by determining the time of initiation of saliva secretion following the conditioning stimulus, the latency time, and the number of drops secreted. After lateral exposure to 10 cms microwaves for 2 hours at power densities ranging from 1-5 mW/cm², the intensity of the response increased on the opposite side, and the latency time was shortened. However, following 70 hours of exposure in 35 days (2 hours/day), the conditioned responses became identical to those before irradiation showing that a gradual adaptation of the dogs' responses to successive microwave exposures occurred.

Galloway (1975) investigated the effects of 2.45 Ghz microwave exposure on discrimination and acquisition tasks in trained rhesus monkeys. The heads of the animals were exposed directly with energy deposited at rates ranging from 5 to 25 W (for a 1.2 kg head the resulting average dose rate was between 4 mW/g and 21 mW/g). Before testing, the monkeys were given a dose of 2.5 J/g over 2 minutes. Convulsions occurred in all animals irradiated at 25 W and in some at 15 W, an integral dose approaching 25 J/g (the dose required to produce convulsions (Justesen, 1978)) was given. It is apparent that hot spots were produced in the monkey's brains to induce this effect. Exposure to 10 W for 5 days, for 40 minutes per day did not produce any performance deficit, even in animals suffering from skin burns and severe convulsions caused by exposure to high power radiation.

The performance of a vigilance task was investigated in rhesus monkeys after whole body exposure to 2.45 Ghz far-field radiation. Behaviour was not disrupted provided that increases in colonic temperature did not exceed 1º C. With a 1 hour exposure, the threshold of behavioural disruption was 70 mW/cm² (De Lorge, 1976).

Exposure to continuous wave microwave radiation of 1.2 Ghz at average power densities of 10-20 mW/cm² did not affect skilled motor performance in monkeys even when the animals were positioned for maximum energy deposition in the brains and subjected to three 2 hours periods of exposure (Scholl & Allen, 1979).

A number of studies including some of those already discussed and others for comparison. The results obtained by different investigators vary according to exposure conditions and the end-point investigated. Interpretation of these observations is difficult since many observations are either controversial or contradictory. Data base tend to be better substantiated at power densities above 5-10 mW/cm².

In 1961, Frey reported the sensory effect of "microwave hearing". Man perceives an audible clicking or buzzing sensation on exposure to pulsed radiation at low power densities. He (Frey, 1971) considered that the effect was caused by direct neural stimulation but later studies by Foster & Finch (1974) and Chou et al., (1977) have strongly indicated that an electromechanical interaction occurs due to thermal expansion. The threshold of microwave hearing is approximately 10 mJ/g per pulse and is independent of the pulse width for pulses of less than 30 microseconds (Guy et al., 1975a). Microwave hearing is now thought to be caused by a small but fast rise in temperature which, by thermal expansion, generates a wave of pressure exciting the cochlea.

To summarize, it can be stated that studies on the effects of microwaves/RF radiation on the nervous system indicate that exposure at low-power densities appears to induce detectable changes in some cases (Cleary, 1977). While there seems to be evidence that, at sufficiently high intensities (above 1-5 μW/cm²), non uniform heating of various critical organs takes place in experimental animals, it is not possible at present to exclude other mechanisms. Furthermore, it is difficult to evaluate the significance of microwave-induced behavioural effects because of 'the general lack of quantitative correlations between thermal effects at low power densities and responses at the physiological or psychological levels of analysis (Cleary, 1977).

Studies have been conducted on the effects of microwave radiation on blood and the immunocompetent system, but the results are frequently contradictory and the reasons for the discrepancies are not always easily identified. For example, in 1962, Prausnitz & Susskind irradiated 100 mice with 9.270 Mhz microwaves at 100 mW/cm² for 9.5 minutes daily over a period of 59 weeks and reported an increase in white blood cells accompanied by lymphocytosis. It was reported that leukaemia occurred in 35% of exposed mice, compared with 10% of the controls. However, it appears that no attempt has been made to replicate these studies.

A decrease in erythrocytes, leukocytes, and haernoglobin in mice was observed by Gorodeckij, ed. (19-64) immediately after exposure to 10 Ghz at 450 mW/cm² for 5 minutes, and 1 and 5 days later, while recovery was evident after 10 days. The influence of microwaves on the response of immunocompetent lymphocytes was investigated in mice by Czerski (1975). The animals were exposed to 2.95 Ghz microwaves at 0.5 ± 0.2 mW/cm² for 2 hours per day, 6 days per week for 6 and 12 weeks. During the 2 hours exposure, the animals were deprived of food and water and were located in separate cages. After exposure, the animals were immunized with antigen and the immune response determined by the number of antibody forming cells in the lymph nodes. Significant differences were found between the control group and the group exposed for 6 weeks, but not the group exposed for 12 weeks. The author attributed this result to adaptation. In non-immunized irradiated mice there was an increased number of lymphoblasts in lymph-node cells, but no differences in the number of plasmocytes.

Blast transformation of human lymphocytes in vitro was observed by Stodolnik-Baranska (1967, 1974) after exposure to 2.950 Mhz microwaves at power densities of 7 and 20 mW/cm². However, Smialowicz (1917) was unable to detect any differences between the blastogenic responses of microwave-exposed (2.450 Mhz, 19 W/kg for 1-4 hours) and control mouse splenic lymphocytes activated with various mitogens in vitro.

The effects on haemopoietic-stem cells in mice of exposure to 2.45 Ghz microwaves at 100 mW/cm² for 5 minutes were investigated by Kotkovsk & Vacek (1975). The response appeared to occur in 2 stages. In the first, the number of leukocytes in the blood increased and both bone marrow and spleen cell numbers decreased for 3-4 days following exposure. In the second stage, the number of nucleated cells in the spleen and the total number of cells in the femur, as detected by incorporation of Fe, increased until the twentieth day after exposure. The incorporation of ^{59}Fe in the spleen decreased to 78% of the control value 24 hours after exposure and increased to 50% after 14 days.

When Lin et al. (1979) studied the effects on mice of single and repeated exposures to 148 Mhz radiation at 1 mW/cm² for 1 hour per day, 5 days per week for ten weeks, they did not find any significant changes in the blood.

In studies on 3 strains of rats, a 7 hours exposure to 24 Ghz microwave radiation at 20 mW/cm² induced significant leukocytosis, lymphocytosis, and neutrophilia with recovery in 1 week after a 10 minutes exposure at 20 mW/cm² or a 3 hours exposure at 10 mW/cm², recovery occurred in 2 days (Deichman et al., 1964). The changes observed were strain-dependent because in 2 strains the number of leukocytes, erythrocytes, and neurophiles increased, while in one strain it decreased.

Decreases in lymphocytes, erythrocytes, and leukocytes, and increases in granulocytes and reticulocytes were observed in rats by Kitsovskaja (1964) after 3 Ghz exposure at 40 mW/cm² (15 minutes per day for 20 days) and 100 mW/cm² (5 min per day, for 6 days). Exposure at 10 mW/cm² (1 hour per day for 216 days) resulted in decreases in total WBC and lymphocytes and an increase in granulocytes with no changes in other blood components. However, in a study on rats exposed to 2.4 Ghz microwaves at 5 mW/cm² (1 hour per day for 90 days), Djordjevic et al. (1977) did not observe any significant differences in the haematocrit, mean cell volume, and haemoglobin between the exposed and control groups during 90 days of exposure and for 30 days afterwards. Furthermore, there were no significant differences in the number of leukocytes, erythrocytes, lymphocytes, and neutrophiles.

Smialowicz et al. (1977) completed a comprehensive study on rats chronically exposed to 425

MHz radiation at 10 mW/cm² (SAR, 3-7 mW/g) and to 2.45 Ghz radiation at 5 mW/cm² (SAR, 1-5 mW/g). The rats were exposed in utero and for the first 40 days of life for 4 hours per day. The only change in the haemopoietic or immunocompetent systems was observed in the response of lymphocytes to mitogen.

The effects on guineapigs and rabbits of prolonged intermittent exposures to 3 Ghz radiation at 3.5 mW/cm² for 3 hours per day over 3 months were investigated by Baranski (1971). Increases in absolute lymphocyte counts in peripheral blood, and abnormalities in nuclear structure and mitosis in erythroblast cells in the bone marrow, and in lymphoid cells in lymph nodes and spleen, were found. Rabbits exposed at 3 mW/cm² (2.950 Mhz continuous and pulsed) for 2 hours per day, for 27 and 79 days showed a decrease in erythropoiesis, as determined by Fe uptake. Pulsed radiation was found to be more effective than continuous radiation at the same power level (Czerski et al., 1974a).

The effects on blood serum in rabbits exposed to 2.45 Ghz continuous and pulsed radiation at 5, 10, and 25 mW/cm² for 2 hours were investigated by Wangemann & Cleary (1976). Changes in the blood chemistry of animals irradiated at the three power densities were found to be consistent with a dose-dependent response to thermal stress. Out of the ten serum components that were analysed, statistically significant increases were observed in serum glucose, blood urea nitrogen, and uric acid. Dose-dependent transient increases returned to normal levels during the week following exposure. No differences in the animal's responses to ew and pulsed radiations (10-microsecond duration, peak power 485 mW/cm² were found at the same average power density.

Dogs were exposed to 1.285 Mhz 2.8 Ghz and 24 Ghz at power densities between 20 and 165 rmW/cm² (Michaelson et al, 1964, 1971). Following exposure to 1.285 Mhz radiation at 100 mW/cm² for 6 hours, a marked increase in leukocytes and neutrophils was found. After 24 hours, the neutrophil count continued to increase but the lymphocyte and eosinophil counts decreased. Neutrophil counts after exposures at 50 and 20 mW/cm² (1.285 Mhz) did not differ significantly from those of control animals. A decrease in lymphocytes was noted after the exposures at 100 mW/cm² and 50 mW/cm², but not after that at 20 mW/cm² (Michaelson et al., 1971). Haernatological examination of the dogs for 12 months after exposure at 20 mW/cm² did not reveal any end points that differed from the control groups.

A number of studies are listed with details of exposure conditions and results of microwave-induced changes in the haernopoietic and immunocompetent cell systems.

This section on the effects of microwaves on the blood forming and immunocompetent cells can be summarized as follows:

(a) Changes in the red and white blood cell counts seem to depend on the dose of microwave energy applied. In most of the studies reporting positive findings, the effects seem to result from thermal stress.

(b) Repeated exposures to 5 mW/cm² or below do not appear to affect the peripheral blood picture. Effects reported from exposures to 15 mW/cm² or more, depending on the biological system exposed, tend to be reversible following termination of exposure.

(c) The response of the haemopoietic system to microwave radiation is significantly different from that to exposure to elevated ambient temperatures, even when both result in the same increase in rectal temperature. This can be attributed to the nonuniform deposition of microwave energy in the body, and the greater depth and rate of heating.

(d) There is evidence that lymphocyte stimulation and effects on response may occur under certain experimental conditions, especially after exposure to pulsed radiation for repeated or prolonged periods at sufficiently high power densities.

Genetic and Other Effects in Cell Systems.

Investigations of biological systems such as cells in culture are conducted to gain an understanding of basic mechanisms of interaction. Although, these systems are less complex and the dosimetry can be better quantitated than in animal studies, the results have to be interpreted carefully in assessing potential health hazards to man.

Microwave exposure has been reported to produce chromosomal aberrations (Janes et al., 1969. Mykolajkzyk, 1970. Yao & Jiles, 1970. Baranski et al., 1971. Yao, 1971. Czerski et al., 1974b) and mitotic alterations (Baranski et al., 1969. Mykolajkzyk, 1970. Baranski et al., 1971. Baranski, 1972. Czerski et al., 1974) in cells.

Yao & Jiles (1970) studied the effects of microwave radiation on cell proliferation and on the induction of chromosomal aberrations in cultured rat kangaroo cells. Cells were exposed to 2.45 GHz radiation in the near field at 1 W/cm² and 5 W/cm² and in the far field at 0.2 W/cm². Exposure to 0.2 W/cm² for 1 minute caused increased cell proliferation, but after 30 minutes, it decreased. Exposure at higher power densities significantly reduced the rate of proliferation. Exposure at 5 W/cm² induced chromosomal aberrations, but it is evident that high temperatures were involved in this result, since the energy absorption rate measured was 15.2 mW/g.

Chromosomal aberrations and changes in the duration of particular phases of mitosis (mitotic abnormalities) were reported by Baranski et al. (1969, 1971) in human lymphocyte cultures and cultures of monkey kidney cells following exposures at 3 and 7 mW/cm² to 10 cms pulsed and ew microwaves. Mitotic disorders in the lymphocytes of guineapigs and rabbits were also found following exposure to 3 Ghz at 3.5 mW/cm² for 3 hours per day over 3 months (Baranski, 1972).

Manikowska et al. (1979) studied 16 mice subjected to 9.4 Ghz pulsed (width 0.5 ps, repetition rate 1000 Hz) microwaves at power densities of 0.1, 0.5, 1.0 and 10 mW/cm² for 1 hours/day for 2 consecutive weeks (5 days/week). Disturbances in meiosis were detected at power density levels as low as 0.1 mW/cm². This study needs confirmation since no other studies on effects of microwaves on meiosis could be found.

Exposure of murine splenic lymphocytes in vitro to 2.450 Mhz radiation at 10 mW/cm² (dose rate of 19 mW/g) did not result in any changes in capacity to synthesize DNA (Smialowicz, 1977). This technique used to assess blastic transformations of lymphocytes, was not the same as that used by Baranski (1972), which may explain the discrepancy in results. Elder & Ali (1975) found similarly negative results when they exposed mitochondria of isolated rat liver to 2.45 Ghz radiation at 10 and 50 mW/cm² for 3.5 hours. Furthermore, no effects were found in oxidation of substrate, electron transport, oxidative phosphorylation, or calcium transport.

The effects of 2.450 Mhz microwaves and a 43º C water bath on normal and virus-transformed fibroblasts of mice were compared by Janiak & Szmigielski (1977). Short-term heating by both methods resulted in reversible changes in the active transport of potassium through the cell membrane. Prolonged heating (over 20 minutes at 32º C) caused irreversible damage and the membrane became permeable to large molecules.

In another comparative study, Lin & Cleary (1977) did not find any differences in the release of potassium ions, haernoglobin levels, and the osmotic fragility of the red-cell membrane between samples exposed to microwaves at 2.45, 3.0, and 3.95 GHz and conventionally heated samples.

Chinese hamster ovarian cells exposed to 2.45 Ghz microwaves or treated in a water, bath at the same temperature did not show any differences in response when cell survival and sister chromatid exchanges were the end points (Livingston et al., 1979).

In studies by Blackman et al. (1975), the colony forming ability of Escherichia coli B was not inhibited by exposure to 1.7 Ghz, 2.45 Ghz, 68-74 Ghz, and 136 Ghz at power densities ranging from 0.3 to 20 mW/cm². This was in contrast to an inhibitory effect of microwave radiation at 136 Ghz previously reported (Webb & Dodds, 1968). However, in a more recent study of colony-forming ability and of alterations in the molecular structure of living E. coli B, there were no changes in colony growth, or in molecular structure or conformation after irradiation at frequencies between 2.6 and 4 Ghz with a specific absorption rate of 20 mW/g (Corelli et al., 1977).

Thus, it can be concluded that:

(a) Chromosomal aberrations and mitotic alterations can be produced by microwaves at high power densities where thermal mechanisms play a definite role. However, as there are many conflicting reports, some doubts remain as to whether these effects can occur at lower power densities,

(b) Studies at the cellular and subcellular level are important for understanding basic interaction mechanisms. Chromosomal aberrations and mitotic alterations are potential early indications of biological changes and may reflect a response of specific tissue, but not genetic injury in the organism.

(c) Recent studies on cell proliferation and capacity to synthesize DNA indicate that power densities sufficient to produce thermal damage are necessary for effects to appear. This is shown by experiments comparing the effects of both water baths and microwave exposure. Exposure of animals to resonant frequencies (e.g., 2.450 Mhz for mice), could be expected to induce effects at low power densities because a larger proportion of the incident radiation is absorbed and converted into heat.

****

En lo publicado en esta publicación fechada de hace más de 20 años, ya se tenia una buena idea de lo que eran estas frecuencias, las potencias que utilizaron los diversos investigadores, hoy día se sabe que eran suficientemente altas y peligrosas como para matar a un elefante, todo el mundo pretende hacernos creer hoy día que no existen estudios sobre este tema, la diferencia entre lo expuesto en esta publicación y la data científica de hoy día es que hoy día se sabe de manera más exacta y precisa que intensidades muchísimo más inferiores que las que los diversos investigadores en esta publicación de la **OMS** utilizaron en su época están causando gravísimos problemas de salud, hoy día se sabe que los efectos atérmicos son los que están causando toda una serie de problemas de salud, hasta mismamente causar la muerte, en todos los casos informados nadie podrá afirmar o demostrar científicamente de que fueron efectos térmicos los que han causado toda esa larga lista de patologías cancerigenas y fallecimientos.

Esta tecnología es mucho más peligrosa de lo que la mayoría del publico se cree **!**, en el caso de los usuarios de los teléfonos móviles, sus problemas vendrán dentro de pocos años, en el caso de las poblaciones expuestas a las emisiones de las múltiples estaciones de base de la telefonía móvil, sus efectos devastadores ya comienzan a resentirse un poco por toda la península, los primeros son los niños por sus bajas edades y tamaños y por estar éstos en fases de desarrollos metabólicos, después son las personas mayores, por tener un sistema inmunológico ya cansado y deficiente y finalmente toda la población confundida, lo que ha sucedido hasta la fecha solo es el comienzo de lo que nadie se ha aun imaginado, yo por suerte o desgracia, todavía no se ha dado respuesta a todas preguntas del punto de vista medical, quedan aún preguntas sin respuestas, creo me he salvado, pero de muy poco **!**, esos comunitarios de la Comunidad donde ago parte en ***Cullera*** que están crónicamente irradiados a **2.2 Voltios/m,** por muy robustos que tengan sus metabolismos, primero o más tarde tragedia les sucederá.

La Nueva España en fecha del **12 de marzo** informa que un **Catedrático en Magnetismo de la Universidad Compútense de Madrid, Sr. Antonio Hernando Grande** ha hallado "***Los teléfonos móviles no nos hacen ningún daño !***", por qué no va a decírselo a la directora de la **OMS** la **Sra. Gro Harlem Brundtland**, por qué no ha respondido positivo ir a vivir a Cullera debajo de las antenas a sólo **2.2 Voltios/m** comparado con la barbaridad que están emitiendo en **Ronda** nada menos que entre: **7.00 Voltios/m** y **9.320 Voltios/m**, si en vez de ir al colegio alumnos y profesores fuesen elefantes y rinocerontes se hubiesen enfermado o muerto igualmente, que salvajada, aun más fuerte que en **Valladolid**, digo lo mismo que dijo mi amiga **Lyn McLaen** de Australia, ***How Horrific***, va de sí que se hubiesen muerto esos dos profesores y la chica de 20 años, si son sin peligro alguno para la salud por qué no va a explicárselo a la chica que padece de un tumor cerebral de 22 años de Cullera, usuaria igualmente de un móvil **?**, decir tonterías hoy día es fácil, tener un dialogo serio a la altura de lo que sus títulos exprimen, esto es otra cosa, verdaderamente hoy día esto es un verdadero circo, que tales absurdidades vengan de parte de un Catedrático español es verdaderamente vergonzoso y lamentable, por otro lado ***Telefónica Móviles*** va a desmontar esa mini **Torre Eiffel** que tienen montada en **Ronda**, la dirección de esta entidad del Sur, han dicho que no quieren que se haga publicidad sobre el tema, esto causaría aun más grande alarma social si la población supiese que están desmontando la antena por razones de salud publica y no por razones técnicas, espero que la lleven por lo menos a la cima de una de esas montañas bien lejos de **Ronda**, el problema solo están desplazándolo de lugar, si alejan las antenas tendrán que emitir potencias bastantes más elevadas que las que emiten en el pueblo, los móviles tendrán que emitir igualmente niveles muchísimos más altos de potencias para alcanzar las antenas, y esta vez serán los usuarios de los móviles quienes se enfermaran por las radiaciones que emiten sus móviles, por lo menos esta vez serán los que los utilizan quienes pagaran las consecuencias del empleo de esos artilugios que poco a poco te harán enfermar, por lo menos esas señoras de la comunidad del lado de esa salvajada de antena, ahora podrán después de un cierto tiempo de recuperación inmunológica tener más familia si lo desean, va de sí que con potencias de entre **7.00 Voltios/m** y **9.320 Voltios/m** hubiesen perdido los fetos, esto es de esperar a tales potencias, una de las señoras de aquí estaba expuesta en su lugar laboral sólo a **0.3 Voltios/m** y solo durante las horas de trabajo, dos veces perdió el feto, y así sucesivamente.................

Es completamente ilógico que ***Telefónica Móviles*** desmonte esa torre de antenas, las radiaciones son inocuas y están muy por debajo de las normas europeas y españolas en vigor, según nos dicen que son completamente inocuas esas frecuencias para la salud según ciertos, científicos, catedráticos, investigadores, médicos, expertos, ingenieros etc........, lo que hace hoy día el dinero, se cambia de nacionalidad, de religión, de nombre, se compra a los científicos u otros, el caso de la industria farmacéutica, compraron los nombres de los médicos para que sus nombres figurasen en los informes fármacos, o sea los habían corrompido como es de costumbre hoy día, menos mal que alguien de alto rango también resiente los efectos que resiento yo cuando estoy irradiado por alguna estación de base o cuando alguien esta hablando por un móvil cerca de mí, a 100 metros son todavía letales, que será del utilizador, cuando estas efectuando una llamada telefónica en modo habla, emiten a más de **8 Voltios/m**, que será de tu cerebro y el resto del cuerpo a tales potencias **?**, dado él caso que esta señora tiene una alta reputación por su antiguo cargo político y su responsabilidad actual en el seno de la **OMS**, le dan más credibilidad que cuando yo comencé a publicar los acontecimientos, cuando los médicos se quieren deshacerse del tema, achacan que son sensaciones sicosomáticas, creo yo que los 70 casos informados por el momento, (20 fallecimientos) no son cosas sicosomáticas.

Si un teléfono móvil después de una conversación telefónica de 20 minutos, hace incrementar la temperatura en el cerebro **<u>en el lado donde estaba aplazada la antena del móvil</u>** de **1º C**, qué hará al cerebro **!**, se tiene que señalar también que durante estos 20 minutos el corazón esta autorregulando la temperatura del cuerpo, es decir esta circulando la sangre por todo el cuerpo lo que hace que la temperatura no se incremente mayormente por decir, solo con aparatos adecuados de medidas térmicas muy bajas y el Scanner esto se ha podido demostrar, el reciente hallazgo del investigador de Marbella, con sólo dos minutos de conversación telefónica por un móvil, en el cerebro de la niña se observaban alteraciones encefálicas hasta una hora después de la comunicación, esto se he publicado a finales del mes de diciembre en un periódico ingles.

El aconsejar que utilicen el móvil con manos libres es completamente criminal, las estadísticas hablan por ellas mismas, estas distraído de una parte, de otra parte el estudio del **Dr. George Carlo** que efectuó entre **1993-1999** demostró que **2.42%** sobre **100.000** de estos usuarios contraen también tumores cerebrales, ni con manos libres, ni sin manos libres, por donde quiera que mires el tema el problema esta sin resolver, distracción, riesgo mayor de accidente de circulación, telefonear dentro de un automóvil es conducir distraído, conducir con un móvil dentro de un vehículo, es más del **40%** de riesgos de accidente, sin tener en cuenta los riesgos de salud que incurre el utilizador dentro de su vehículo por las radiaciones que rebotan dentro del habitáculo metálico, es completamente vergonzoso que tales absurdidades las diga un **Catedrático en Magnetismo**, no se da cuenta que la gente puede discernir que nos esta descaradamente mintiendo y es un pecado ante el **Creador !**

Por qué no publica estos argumentos a ver lo que la **Comunidad Científica Internacional** dicen sobre este tema, esas tonterías ni el mismo se las cree, tan ingenuo no puede ser **!**

Según informan ahora el **Dr. Alejandro Úbeda** anda promocionando que se implanten las antenas de los operadores de la telefonía móvil por las azoteas, ahora se ha vuelto representante comercial para la industria, por qué no pide a uno de esos operadores que tanto defiende que le pongan una antena que este emitiendo a lo mismo que esa **Torre de Ronda** esta emitiendo a **9.320 Voltios/m** a ver si lo que dice es verdad, según dice, son inocuas y sacaría unos ***Euros*** de más al año por el implantamiento de las antenas, más la publicidad que haría a los operadores, una cosa si le aseguro, no va a tener problemas de dinero futuros, eso si que se lo garantizo con certitud, él y su familia, problemas de dinero no van a tener, porque se morirán todos en muy poco tiempo a tales salvajadas de potencias, decir que **100 metros** son distancias de seguridad, esto esta demostrado epidemiológicamente que es incierto, el plano de la embajada de los EE.UU de Moscú da como distancias **263,5 metros** y a potencias aun más bajas que las en registradas en Valladolid, en el caso de Moscú **5.520 Voltios/m**, y a más de **263,5 metros** ya se ha constato esto epidemiológicamente que el estar irradiados sólo durante las horas de apertura de la embajada de 14 fallecimientos, (*entre 1953-1976*) 11 fueron de cáncer, no nos harán creer que todas esas 20 personas que ya fallecieron en España fueron por qué sufrieron aumentos de temperatura corporal, creo que el caso de **Valladolid 43 metros** mismamente con sus **5.600 Voltios/m** no podrán estos eventuales científicos demostrar que esos colegiales padecieron de algún incremento de la temperatura corporal, por tanto los hechos están ahí, ellos hablan por ellos mismos, 17 patologías cancerosas en la zona, por tantas vueltas que demos al tema, estas frecuencias interaccionan con los biorritmos celulares del cuerpo humano, todo el mundo esta al corriente hoy día, lo que precede son pasajes de la publicación **WHO** de **1981**, o sea que hace más de 20 años que esta organización lo sabia y están perfectamente al corriente de los riesgos que la populación mundial esta incurriendo, en un reciente articulo publicado iban mencionados los sitios de venta de esta publicación en la península, que tendrá tan comprometedor la publicación **WHO** de **1981** sobre los campos **EMNI** que el mismo **Dr. Michael Repacholi** ni si quiera responde a los Faxes enviados **!**

La próxima reunión de la **Unión Europea** en **Sevilla** van a tratar del tema de las comunicaciones europeas futuras, persiguen que quieren implantar el sistema **WRAP** y el **UMTS**, aparentemente por todos los países de la Unión Europea se estén manifestándose caso tras caso del hecho de haber sido irradiados por estas frecuencias y dan poca importancia al tema **!**, en el caso que nos concierna, ya vamos con 70 casos (20 fallecimientos) más lo que se manifestaran aun !

Si quieren vehicular al mismo tiempo que el sonido la imagen, necesitan más potencias, (*esto es de conocimiento general hoy día en España, si las señales de los diversos repetidores de televisión implantados un poco por toda España no reciben suficientemente señales, la imagen es mediocre o borrosa, por tanto el sonido llega todavía*), la misma formula se aplica a las comunicaciones inalámbricas en telefonía móvil, aun más peligrosas si al mismo tiempo tienen que vehicular también la imagen y en frecuencias pulsadas, o sea del punto de vista tecnológico necesitan más potencias más estaciones de enlace, más polución electromagnética, más problemas de salud, más casos de cáncer se manifestaran y más fallecimientos sucederán, no hay compromiso alguno con esta tecnología, la solución al día de mañana en materia de comunicaciones entre seres es la fibra óptica, rapidísima, sin ningún efecto sobre la salud u otro, sin que nada la perturbe, la tecnología esta presente, cada día se diseñan sistemas de comunicación mas y más perforantes en este dominio, si **Belgacom**, esta enterrando por todo Bruselas tubos vacíos por todas las calles más importantes de la capital, sus buenas razones tendrán, si las comunicaciones hertzianas fuesen la solución del día de mañana, es ilógico que estén levantando calla tras calle para meter tubos de plástico de **6 Ø**, saben muy bien que las comunicaciones hertzianas no son la solución de comunicaciones del día de mañana, ejemplos creo que no faltan, miren lo que sucedió en **Valladolid, Ronda, Torrevieja, Córdoba, Elche, Patraix, Sabadell, Figueres** y los casos que se manifestaran aun **!**

Por otro lado sé esta poniendo en plaza un proyecto para efectuar mediadas por toda la península, es un presupuesto enorme del punto de vista financiarío, efectuar mediciones a las cuales ya se conoce la respuesta de ante mano es completamente absurdo y derrochar recursos económicos del pueblo español, no encontraran ninguna estación de base que emita por encima de lo que esta en vigor, no hay ni una sola estación de base que emita a más de **41.183 Voltios/m** en la frecuencia de **900 Mhz** y **58.249 Voltios/m** en la frecuencia de **1.8 GHz**, la respuesta será que están todas por debajo de la norma actuales en plaza y según las recomendaciones de la Unión Europea, esta entidad ya se sabe que en el pasado todos confundidos en bloque fueron obligados a dimitir en bloque por corrupción de funcionarios, es una verdadera vergüenza a nuestra era que estos dirigentes europeas se les cojan con las manos en el cajón **!**

Esto es una diversión como la diversión del **Ayuntamiento de León**, han pedido efectuar mediciones por un montante de: **€ 36.061** cuando un medidor homologado con certificado de precisión por laboratorio les sale por: **€ 3.495** y es de propiedad permanente del Ayuntamiento, alguien en esta maniobra se ha aprovechado bien de los recursos del Ayuntamiento, los hechos no justifican las actuaciones, sobre todo cuando se trata de recursos contributivos del ciudadano, si las matemáticas no mienten es una diferencia nada menos que de: **€ 32.566** a cargo de las arcas del Ayuntamiento de León **!**

Creo que el ingeniero o técnico del ayuntamiento de León seria suficientemente creíble si el mismo elaborase un informe de medidas constatadas y hubiese ahorrado a los contribuyentes de León la suma de: **€ 32.566** que hubiesen podido emplearlas a fines más adecuados a beneficio de la sociedad.

Lo máximo que he encontrado en España como emisiones que provengan de antenas emisoras de micro-ondas fue en **Llanes** (Asturias) **+8 Voltios/m**, las otras mediciones más altas fueron en **San Vicente de la Barquera** (Santander) a 10 metros en frente en la parada de taxis se midieron **6.63 Voltios/m**, en la plaza donde los niños y residentes van a pasar el rato **!**, las terceras mediciones más altas que se han podido medir fueron en Cullera a la puerta del almacén de naranjas **SELFA** **4.5 Voltios/m**, la cuarta medición más alta que se ha podido medir es igualmente en un apartamento de Cullera **3.0 Voltios/m** y todas están muy por debajo de las normas actuales españolas y de la Unión Europea en vigor, por tanto ya van con 70 casos informados de canceres u otras patologías cancerigenas (20 fallecimientos) más los que se manifiestan aun más **!**, demos las vueltas que demos al tema, ninguna estación emite a **41.183 Voltios/m** en la frecuencia de **900 Mhz** y **58.249 Voltios/m** por la frecuencia de **1.8 Ghz**, o sea es inútil de efectuar mediciones y gastar medios financiaríos de las arcas del Estado, por qué ninguna emite a tales salvajadas de potencias, o sea todas estarán dentro de los limites permitidos por la Unión Europea y en vigor en España, del otro lado los hechos hablan una vez más por si mismos, si son inocuas como explicamos los **70 casos (***20 fallecimientos***)** hasta el presente !

Durante las vacaciones he medido igualmente las emisiones que emite una torre, algo como esa de **Ronda**, que esta dos kilómetros de **Posada de Llanas** (*Asturias*) a unos 300 metros, pero a nivel de suelo de más de ***100 metros*** más bajo que las antenas, lo máximo que he medido fueron **0.3 Voltios/m**, a ***800 metros*** se median **0.6 Voltios/m** en la gasolinera de la pista que va hacia **Oviedo** !

Otro caso muy curioso de la presión que ejerce hoy día este lobby y que esta ejerciendo actualmente, fue el caso que sucedió recientemente en el país vasco, una cadena de televisan local de la comunidad vasca había acordado un presupuesto de un montante de **€ 60.101** para efectuar una emisión sobre este tema, después de haber consumido la dicha suma, después de haber terminado el informe ha sido censurado el reportaje **!**, en teoría debía de haber salido difundido ya a medidos del mes de enero, si los medio de información que en teoría están ahí para darnos a conocer noticias que especialmente concierna toda la sociedad y se retractan de emitir dicho programa, es verdaderamente vergonzoso de parte de estos profesionales, el **Art. 10 de la Declaración Europea de Derechos del Hombre y**

Libertades Fundamentales del **4 de noviembre de 1950** les da el pleno derecho de difundir tales informaciones, es una vergüenza que los dirigentes de dicha cadena cedan al chantaje o presiones y no difundan la verdad que el ciudadano tiene el derecho a conocer **!**

Los operadores de aquí, han adoptado una nueva estrategia de camuflaje de las antenas de los **GSM**, ya había hablado que las había ya encontrado disfrazada dentro en un detector de humo, he baldo de los diversos modelos que camuflan por las fachadas de las casas, ahora están por lo menos aquí en Bélgica, aplazando antenas **GSM** en la fachadas de las casas dentro de cajas de alarma, o sea, están pudiendo cajas que eternamente tienen el mismo aspecto de una caja de alarma con su luz amarilla y todo como si se tratase de una alarma domestica, de comercio, industria etc...., en realidad es una antena **GSM**, por qué tanto camuflaje si sus radiaciones son inocuas para la salud **?**

Brussels (Belgium) ***Francisco Gabiola Guerra***

e-mail: cardasian7@yahoo.fr