65211); Ellersieck, M. R.; Durham, T. L.; McVickers, W. R.; McWilliams, S. N.; Lasley, J. F. *J Anim Sci* 48(3): 446-452; 1979. (30 refs)

Stress susceptible (SS) and stress resistant (SR) purebred Hampshire swine, weighing approximately 100 kg, were utilized to study the effects of electrical stress on plasma creatine phosphokinase (CPK), blood pH, plasma lactic dehydrogenase (LDH), plasma glucocorticoids, rectal temperature, heart rate, and respiration rate. Blood samples were obtained from jugular cannulas 15 min and 5 min pre-stress, and subsequently at 0, 5, 10, 15, 30, 60, and 120 min post-stress. The electrical stress (.05 A and 30 V) was administered intermittently (2 sec on and 1 sec off) directly on the skin at the point of the poll between the ears and on the medial side of the fore leg above the point of the elbow for a total stress time of 4 min over a 6-min period. Each pig was stressed three times with 3 days rest between stimulations. Post-stress responses ($p<.01$) were obtained over time for all the variables measured except respiration rate. Plasma CPK levels were greater ($p<.01$) for SS pigs at all the pre-stress and post-stress bleeding times. Thus, CPK may have value in differentiating between SS and SR pigs under standardized environmental (stress) conditions. The SS pigs had marked post-stress decrease ($p<.01$) in blood pH compared to SR pigs, although pre-stress blood pH was similar for both groups of pigs. Pre-stress plasma LDH levels were similar for the SS and SR pigs while several post-stress levels were greater for the SS pigs. Plasma glucocorticoid levels were similar for the SS and SR pigs at all the pre- and post-stress bleeding times. The SS pigs had a higher ($p<.05$) overall mean rectal temperature compared to the SR pigs. Both the SS and the SR pigs had elevated post-stress rectal temperatures. The heart rate of the SS pigs was higher at 0 min post-stress compared to the SR pigs while both groups were similar at the other times. Respiration rates were similar for both groups.

6198 RESPONSE OF STRESS-SUSCEPTIBLE AND STRESS-RESISTANT HAMPSHIRE PIGS TO ELECTRICAL STRESS. II. EFFECTS ON BLOOD CELLS AND BLOOD MINERALS. *(Eng.)* Ellersieck, M. R. (Dept. Animal Husbandry, Animal Science Res. Center, Univ. Missouri, Columbia, MO 65211); Veum, T. L.; Durham, T. L.; McVickers, W. R.; McWilliams, S. N.; Lasley, J. F. *J Anim Sci* 48(3): 453-458; 1979. (20 refs)

Stress-susceptible (SS) and stress-resistant (SR) purebred Hampshire pigs were used to study the effects of electrical stress (.05 A and 30 V) on the total number of red blood cells (RBC), white blood cells (WBC), neutrophils (NEU), lymphocytes (LYM), eosinophils (EOS), monocytes (MON), basophils (BAS), hematocrit (HEM), and the serum levels of sodium (Na), potassium (K), and magnesium (Mg). Blood samples were obtained from jugular cannulas 15 min and 5 min pre-stress and 0, 5, 10, 15, 30, 60, and 120 min post-stress from each pig on 3 separate days. The SS pigs had higher ($p<.01$) pre-stress levels of WBC, LYM, and K compared to the SR pigs even though the blood cannulas allowed blood collection with a minimum of stress. The post-stress WBC, NEU, EOS numbers, and K level were similar for the SS and SR pigs until 60 and/or 120 min post-stress when the levels of WBC, NEU, and K values were higher for SS pigs and the EOS number was lower for SS pigs when compared to SR pigs ($p<.05$). The LYM numbers of the SS pigs were consistently lower throughout the post-stress bleedings when compared to the SR pigs. The post-stress LYM numbers of the SS pigs at 15 min and 120 min ($p<.05$) and 60 min ($p<.01$) were lower than those of the SR pigs. The SS and SR pigs had similar MON and BAS numbers at each pre- and post-stress bleeding time comparison. The pre-stress HEM levels were similar for SR and SS pigs, although an immediate post-stress increase ($p<.01$) in HEM levels was obtained for the SS pigs, which remained to the end of the bleedings. Na and Mg levels showed no difference between SS and SR pigs over both pre- and post-stress times of bleeding ($p<.05$). However, at every bleeding time the SS pigs' Na levels were lower and the Mg serum levels were higher when compared to the SR pigs' Na and Mg serum levels.

6199 LOW POWER RADIO-FREQUENCY AND MICROWAVE EFFECTS ON HUMAN ELECTROENCEPHALOGRAM AND BEHAVIOR. *(Eng.)* Bise, W. (Pacific Northwest Center for the Study Non-Ionizing Radiation, Box 22053, Portland, OR 97222). *Physiol Chem Phys* 10(5): 387-398, 1978. (30 refs)

Temporary changes in electroencephalograms (EEG) and behavior were observed in a pilot study involving the exposure of five men and five women (ages, 18-48 yr) to radio frequency (RF) and microwave radiation at levels substantially below typical urban levels. Continuous wave (CW) RF radiation at frequencies ranging from 0.1-960 MHz and at power levels ranging from 10^{-16} to 10^{-13} W/cm^2 was delivered via a 1-m wire rod monopole antenna placed parallel to and 1 m from the upper torso and head. Pulse-modulated (2 μsec on and 6 μsec off) X-band radiation (8.5-9.6 GHz) was delivered at a power level of 10^{-12} W/cm^2 via an open waveguide 1 m from the subject and directed at the sternum. Frequencies that produced an increased amplitude of EEG alpha component, increased slow wave index, and desynchronizations included 200, 350, 360, and 365 MHz CW radiation and 9,100 and 9,150 MHz pulsed radiation. Frequencies that produced decreased amplitude of EEG alpha component, increased slow wave index, and desynchronizations ranged from 130-960 MHz for CW radiation and 9,150 MHz for pulsed radiation. Mental and behavioral changes were also noted and included short term memory impairment followed by concentration inhibition and irritability, apprehension, and mental and physical sluggishness. Brain wave alterations almost immediately reverted to their normal patterns when the generator frequency was changed or turned off. Since the relaxation frequency of protein-bound water is considered to fall between 100 MHz and 1 GHz, absorptions and quantum effects may be the mechanistic basis for the EEG changes

observed in most of the subjects. The EEG changes seen in most of the participants were produced by CW RF radiation between 100 and 960 MHz. Therefore, it is likely that resonance absorptions occurred.

6200 FUNCTIONAL ELECTRICAL STIMULATION: APPLICATIONS IN NEURAL PROSTHESES. *(Eng.)* Hambrecht, F. T.; Reswick, J. B., eds. (New York: Marcel Dekker, Inc.): Volume 3, 561 pp.; 1977. (560 refs)

A book based on selected papers and discussions from a workshop on functional electrical stimulation, held at Kellogg-West Conference Center in Pomona, California, May 17-19, 1976, is presented. The contents are divided into eight general sections covering the following: striated muscle stimulation, micturition reflex simulation, cerebellar stimulation, visual prostheses, auditory prostheses, neurophysiologic considerations, mechanisms of neural damage, and instrumentation and electrodes used for functional electrical stimulation. The book is provided with a subject index.

6201 SELECTIVE ACTION OF DECIMETER WAVES ON CENTRAL BRAIN STRUCTURES. *(Eng.)* Faitel'berg-Blank, V. R. (Dept. Pathological Physiology and Biophysics, Agricultural Inst., Odessa, USSR); Perevalov, G. M. *Neurosci Behav Physiol* 8(2): 172-176; 1977. (28 refs)

The sensitivity of some central brain structures to the action of an electromagnetic field (EMF) of decimeter waves (DW) was studied. Spike activity of 193 neurons in various brain formations (dorsal hippocampus, specific and nonspecific nuclei of the thalamus, hypothalamus, and mesencephalic reticular formation) was investigated in experiments on 29 chinchilla rabbits. The animals were irradiated with a Volna-2 physiotherapy apparatus that generates EMF within the DW range at a frequency of 460 MHz. The action of EMF with an energy flux of 2 or 5 mW/cm^2 was investigated. After irradiation of the animal's head with an intensity of 2 mW/cm^2, an increase in the discharge frequency was observed in 45.6% of the brain neurons tested, and the spike frequency decreased in 39.7% of the brain neurons tested. The activity was unchanged in 14.7% of the neurons tested. Neurons of the hippocampus and hypothalamus with an excitatory type of response had the greatest reactivity to EMF of DW; the percentage of nerve cells with an excitatory type of response to EMF was 64.3% in the dorsal hippocampus and 58.3% in the hypothalamus. The number of neurons with an inhibitory type of response to EMF was greatest in the nuclei of the thalamus and mesencephalic reticular formation. After an exposure of the animal's head to an EMF of 5 mW/cm^2, an increase in discharge frequency was observed in 43.8% of the neurons, a decrease in 41.1% of the neurons, and no response to irradiation in 15.1%. The number of excitatory neurons in the hippocampus fell by 7.2% and in the hypothalamus by 8.3%. Meanwhile an increase in the number of neurons responding by inhibition to the action of an EMF of 5 mW/cm^2 was observed. In the hippocampus the number of neurons with an inhibitory type of response was 35.7% compared with 42.9% in the hypothalamus. The smallest number of neurons not responding to the EMF was observed in these same brain structures. The dynamics of spike activity of the neurons of the dorsal hippocampus was characterized by a shorter period of after-activity than in the case of animals irradiated by an EMF of 2 mW/cm^2. The time taken for spike activity of the hypothalamic neurons to return to its original level, on the other hand, was increased by 1.5 times. These results show that exposure of the rabbit's brain to EMF of DW at different intensities gives rise to opposite changes in the unit activity of central brain structures.

6202 EFFECTS OF MODULATED RF ENERGY ON THE EEG OF MAMMALIAN BRAINS: EFFECTS OF ACUTE AND CHRONIC IRRADIATIONS. *(Eng.)* Takashima, S. (Dept. Bioengineering, D2, Univ. Pennsylvania, Philadelphia, PA 19104); Onaral, B.; Schwan, H. P. *Radiat Environ Biophys* 16(1): 15-27; 1979. (30 refs)

The effects of nonthermal levels of modulated radio frequency (RF) fields on electroencephalogram (EEG) power spectra were investigated in male rabbits receiving acute or chronic irradiations. Acute irradiation (2-3 hr) using frequencies of 1-30 MHz at power levels of 0.5-2 kV/m that were amplitude modulated at a frequency of 60 Hz produced no EEG abnormalities as long as intracranial recording electrodes, which generate strong local fields, were not used. Chronic exposure to amplitude modulated (14-16 Hz) RF fields (1-10 MHz) at a field strength of 500 V/m for 6 wk (2 hr/day) resulted in enhanced low frequency components at 4 Hz and reduced high frequency activities. This pattern began to appear after about 2 or 3 wk of exposure. Since most irradiations were performed in the absence of metal electrodes, the abnormal EEG observed was not due to local fields created by internal electrodes. An analysis of EEG power spectra histograms revealed that abnormal EEGs contained two major peaks at 2 and 10 Hz, whereas normal EEGs contained three major peaks at 4.5, 8, and 11.5 Hz. The approximate current density in the rabbit head during chronic experiments (0.082 mA/cm^2) was below that needed to cause noticeable thermal effects, and it is concluded that the mechanism responsible for the EEG abnormalities is nonthermal in nature.

6203 ELECTROCUTANEOUS NERVE STIMULATION--II: STIMULUS WAVEFORM SELECTION. *(Eng.)* Butikofer, R. (Eidgenossische Materialprufungsanstalt, Dubendorf, Switzerland); Lawrence, P. D. *IEEE Trans Biomed Eng* BME-26(2): 69-75; 1979. (28 refs)

The influence of electrocutaneous nerve stimulation parameters on tissue heating and nerve stimulation was theoretically investigated. Rectangular, sym-

metric, positive onset pulses and pulse trains were investigated using computer models for tissue heating and myelinated nerve stimulation. Based on these models the following conclusions were drawn. Minimum heating will be obtained over the full range of pulse width if the pulse separation is equal to 0 (at constant charge). For zero pulse separation the threshold charge required will be minimized at a particular value of pulse width. A unique threshold transmembrane depolarization voltage does not exist for biphasic pulse stimulation. Multiple biphasic pulses (Saunders' "Quantal Stimulation") decrease the threshold charge per pulse and thus act to increase the dynamic range of the stimulator. The methods used in this study can also be applied to other pulse shapes such as asymmetric pulses (e.g., produced by capacitive coupling of a single positive pulse), sine wave like pulses, and pulses starting with the opposite polarity.

6204 COMPARISON OF MICROWAVE IRRADIATION AT 986 VERSUS 2450 MHZ FOR IN VIVO INACTIVATION OF BRAIN ENZYMES IN RATS. *(Eng.)* Meyerhoff, J. L. (Dept. Medical Neuroscience, Div. Neuropsychiatry, Walter Reed Army Inst. Res., Washington, DC 20012); Gandhi, O. P.; Jacobi, J. H.; Lenox, R. H. *IEEE Trans Microwave Theory Tech* MTT-27(3): 267-270; 1979. (16 refs)

The pattern of succinic dehydrogenase (SD) inactivation in the brains of male Walter Reed strain rats sacrificed by exposure to high-intensity microwave irradiation at two different frequencies and four different angles of rotation was studied to demonstrate the effects of angular orientation on the spatial distribution of energy in the rat brain at different frequencies. Four animals were exposed to frequencies of 2,450 MHz or 986 MHz in one of the following four angular positions: 0, 90, 180, or 270 degrees. Unlike the 2,450-MHz applicator in which only the head of the animal was exposed to irradiation, the 986-MHz applicator exposed nearly half of the animal's body. Inactivation of SD enzymatic activity was markedly altered by rotation of the rat when exposed to 2,450 MHz radiation; absorption of energy was much greater at the 0 and 180 degree positions. In contrast, when rats were exposed to 986-MHz radiation, the degree of rotation produced almost no effect on the pattern of enzyme inactivation. These findings suggest that the use of lower frequencies may reduce regional variability of enzyme inactivation and lessen the requirement for immobilization during sacrifice.

6205 FUNCTIONAL STIMULATION OF THE SPINAL CORD IN MULTIPLE SCLEROSIS. *(Eng.)* Cook, A. W. (Dept. Neuroscience, Long Island Coll. Hosp., Brooklyn, NY); Taylor, J. K.; Nidzgorski, F. *J Med Eng Technol* 3(1): 18-23; 1979. (8 refs)

The use of functional electrical stimulation of the spinal cord in patients with multiple sclerosis is described along with some therapeutic results. A pair of electrodes for bipolar stimulation is placed in the epidural space of the spinal canal in the thoracic area through a needle inserted percutaneously. The electrodes, which are stainless steel wires coated with teflon with platinum tips, are left in place for trial stimulation for 3-8 days. If a significant change in motor function occurs, the electrodes are left in place and connected to a passive radio frequency receiver system implanted subcutaneously along the chest wall. Stimulating pulses are provided to the electrodes from the receiver by virtue of inductive coupling through a surface antenna that is connected to the transmitter. The stimulating wave form is a series of unidirectional square wave pulses. The rate and pulse duration are varied from 7-200 pulses/sec and from 50-400 μsec, respectively. Under usual circumstances, a 33-Hz repetition rate and a pulse duration of 200 μsec with graded increments of voltage are employed. The radio frequency carrier of the signals is 2.05 MHz. Recently, the same electrode and transmitting system has been employed in some patients but with the introduction of only a single electrode into the epidural space for cathodal stimulation. The anode is placed in the subcutaneous tissue of the back. This has resulted in greater clinical improvement than that obtained with bipolar stimulation. A review of 166 patients with multiple sclerosis who were treated with functional stimulation of the spinal cord via permanent percutaneous placement of the electrodes revealed that 99 patients showed functional improvement, which was maintained at the end of 1 yr of treatment. The most prominent results were favorable changes in urinary dysfunction, voluntary motor function of limbs, pain, and equilibratory and non-equilibratory coordinant dysfunction.

6206 EFFECT ON DIFFERENT DOSES OF CENTIMETER ELECTROMAGNETIC OSCILLATIONS ON BIOCHEMILUMINESCENCE OF THE CENTRAL NERVOUS SYSTEM AND LIVER TISSUES. *(Ukr.)* Faitel'berg-Blank, V. R. (Odessa Inst. Public Health, Odessa, USSR); Orlova, A. V. *Dopov Akad Nauk Ukr RSR* (11): 1035-1038; 1978. (12 refs)

The effects of whole-body exposure to electromagnetic waves in the centimeter range (intensity 12, 23, and 30.5 mW/cm^2, length of exposure 10 min) on the chemiluminescence, and on the accumulation of lipid peroxide oxidation products in the liver, brain, and spinal cord were studied in 78 male albino rats. The chemiluminescence was studied over a 120-hr period after irradiation. The irradiation caused a significant increase in the maximum chemiluminescence at doses of 12-23 mW/cm^2 in all tissues, but irradiation with 30.5 mW/cm^2 caused only an insignificant increase in the maximum chemiluminescence compared with nonirradiated animals. The lipid peroxide oxidation product levels in the brain and spinal cord were highest after irradiation at 30.5 mW/cm^2, and in the liver after irradiation at 23 mW/cm^2.

6207 THE EFFECTS OF ELECTRICAL POWER TRANSMISSION RIGHTS-OF-WAY ON SMALL MAMMAL DISTRIBUTION, DIVERSITY, AND COMMUNITY STRUCTURE. *(Eng.)* Quarles, H. D. (Ph.D. Dissertation, Univ. Virginia, 1978); 77 pp. [available through Xerox Univ. Microfilms, Ann Arbor, MI 48106, Order No. 7903512]. (60 refs)

The response of small mammal populations to altered habitats formed where powerline rights-of-way penetrate otherwise homogeneous deciduous forests was investigated over a 15-mo period at five study areas containing rights-of-way representative of different widths (30-68 m), line voltages (110 and 500 kV), and stages in the vegetation management sequence. The changing character of the habitat associated with the sequential right-of-way management parall led the natural process of vegetation succession. Each of the most frequently captured species (*Blarina brevicauda, Peromyscus leucopus, Tamias striatus, Microtus pennsylvanicus, Reithrodontomya humulis*, and *Pitymys pinetorum*) responded to the altered habitat in a manner consistent with its ecologic requirements. Electrical field strength and corridor width did not produce apparent effects on the small mammal communities.

6208 SPACE OSTEOPOROSIS: AN ELECTROMAGNETIC HYPOTHESIS. *(Eng.)* Marino, A. A. (Veterans Admin. Medical Center, 800 Irving Ave., Syracuse, NY 13210); Becker, R. O.; Hart, F. X.; Anders, F. *Aviat Space Environ Med* 50(4): 409-410; 1979. (14 refs)

Metabolic studies of astronauts indicate that spaceflight causes a net loss of body calcium, which does not appear to be caused by a deficiency in diet or exercise. During earth-orbital flight, the motion of the spacecraft through the geomagnetic field results in exposure to an extremely low frequency (ELF) magnetic field, and it is hypothesized that the change in the electromagnetic environment of the astronaut has a causative role in space osteoporosis (SO). Calculations of the maximum electric field induced in an astronaut's body during space flight produce a value of 0.4 V/m. In earth-bound experiments this internal electric field has been shown to be produced by ELF magnetic and electric fields of 1 G and 10,000 V/m, respectively. These latter values have been shown to be associated with various biologic effects, including altered behavior and serum triglycerides in humans and altered circadian rhythms and reaction time in humans. While earth-bound experiments support the hypothesis that motion of the periodic type that an astronaut goes through in the geomagnetic field induces internal fields that are biologically active, such experiments do not indicate that SO will occur. Testing the possibility of a link between motion through the geomagnetic field and SO could begin with thorough physiologic monitoring of the effects on earth-bound test animals of an ELF magnetic field, which best simulates the induced electric field caused by spaceflight, especially when the animal is undergoing weightlessness.

6209 THE MEASUREMENT OF cAMP AND cGMP IN MICROWAVE IRRADIATED CHEST AND HEART MUSCLES. *(Jpn.)* Nagada, J. (Dept. Pharmacology, Sekinishi Medical Univ., Japan); Matsuda, S.; Morita, M. *Folia Pharmacol Jpn* 74(7): 119P-120P; 1978. (0 refs)

The temperature changes and the concentrations of cAMP and cGMP in the chest and heart muscles of microwave-irradiated mice and rats were investigated. The temperature of the chest muscles irradiated with 2-kW microwaves rose to 80-90 C after a 1-1.5 sec exposure for mice and after 2-3 sec exposure for rats. The temperature of heart muscles irradiated with 2-kW microwaves for 1.5-2 sec (mice) and approximately 6 sec (rats) increased to 80 C. The concentrations of cAMP and cGMP in the auricle and ventricle of rats irradiated with 2-kW microwaves for 10 sec were: (cAMP) 72.5 ± 18.8 picomoles/g tissue in auricle and 159 ± 6.7 in ventricle; (cGMP) 15.1 ± 1.3 picomoles/g tissue in auricle and 13.6 ± 1.3 in ventricle. The concentration of cAMP in excised rat papillary muscles electrically stimulated with 2 Hz at 30 C was greater than in muscles irradiated with microwaves. The concentrations of cAMP and cGMP in these tissues when frozen (-80 C) were 5.8 ± 0.6 and 1.4 ± 0.2 picomoles/mg protein, respectively. When irradiated with 2 kW for 2 sec the levels were 4.1 ± 1.3 and 2.1 ± 1.3 picomoles/mg protein, respectively. When homogenized after excision the levels were 2.9 ± 0.2 and 0.8 ± 0.1 picomoles/mg protein, respectively. Rat heart auricles were excised, induced to autokinesis with isoproterenol, and irradiated with 1.5-kW microwaves for 4 sec. The concentrations of cAMP in the sinoatrial nodal structure and the atrium before irradiation were 2.1 and 8.8 picomoles/mg protein, respectively; 10 sec after irradiation the concentrations were 9.2 and 22.3, respectively; 20 sec after irradiation they were 26.3 and 26.6, respectively; and 30 sec after irradiation they were 16.3 and 23.5, respectively. Faster beats and stronger contractions were induced in the autokinetic auricle following irradiation than after isoproterenol administration alone.

6210 EFFECT OF HIGH-POWER DENSITY MICROWAVE IRRADIATION ON THE SOLUBLE PROTEINS OF THE RABBIT LENS. *(Eng.)* Oosta, G. M. (Sidney Farber Cancer Inst., Rm. J409, 35 Binney St., Boston, MA 92115); Mathewson, N. S. *Invest Ophthalmol Visual Sci* 18(4): 391-400; 1979. (25 refs)

Ten New Zealand rabbits were irradiated on the left side of the head with 2.45-GHz microwaves at a power level of 300 mW/cm^2 for 20 min on each of 2 consecutive days to investigate lens changes as observed by biomicroscopy and changes in soluble protein distribution (SPD) as determined by pore-gradient electrophoresis (PGE). Only five of the animals survived the irradiation, and changes ranging from vacuoles along the posterior suture to very small posterior subcapsular opacities were observed in the left lenses only of four of the five survivors. No significant defects were found by biomicroscopy in the lenses of six control ani-

mals or in the right lenses of the exposed animals. A study of the SPD of the lens cortex and nucleus by PGE revealed a marked difference in distribution between the two lens components and a progressive shift in molecular weight from approximately 6 x 10^4 (beta-crystallin) to approximately 8 x 10^5 (alpha-crystallin) in lenses damaged by microwave exposure. It also appeared that the right lenses of irradiated animals had been comprised despite the fact that they remained free of defects visible by biomicroscopy. The results indicate that PGE can be applied to detect lens protein alterations even if changes are in localized regions of the lens. It may be possible with this technique to develop a more detailed understanding of the early stages of protein involvement in opacity formation.

6211 MICROWAVE-INDUCED HAZARDOUS NONLINEAR THERMOELASTIC VIBRATIONS OF THE OCULAR LENS IN THE HUMAN EYE. *(Eng.)* Neelakantaswamy, P. S. (Sch. Applied Sciences, Univ. Science Malaysia, Minden, Penang, Malaysia); Ramakrishnan, K. P. *J Biomech* 12(3): 205-210; 1979. (14 refs)

A theoretic analysis of microwave-induced hazardous nonlinear thermoelastic vibrations of the ocular lens of the human eye is presented. Assuming a dielectric spherical shell model to depict the ocular globes, the temperature distribution within the eye was evaluated when a plane microwave (2,450 MHz, 100 mW/cm^2) irradiated the eye. The temperatures at the posterior and anterior surfaces of the lens were computed to be 40.5 and 38 C, respectively. The rise in temperature at the lens surface was used to calculate the thermal stresses developed in the lens medium. A thermoelastic equation of motion was also formulated to assess the nonlinear transverse vibrations of the lens. For this purpose, the lens suspended anatomically by the zonal ligaments was considered as an isotropic circular plate with variable rigidity clamped along its peripheral boundary. The relevant nonlinear differential equation thus formulated was solved in terms of Jacobian elliptic functions. The hazardous effects due to the thermoelastic stresses, such as the evoked physiochemical processes in the ocular tissues resulting from stress-induced micromassaging, were quantified in terms of damage parameters and a thermal shock resistance coefficient. It is concluded that exposure of the human eye to pulsed microwave environments would correspond to the situation wherein the ocular lens is subjected to cyclic thermal shocks and is therefore vulnerable to fatigue failures in vivo.

6212 MICROWAVE RADIATION-INDUCED CHROMOSOMAL ABERRATIONS IN CORNEAL EPITHELIUM OF CHINESE HAMSTERS. *(Eng.)* Yao, K. T. (Bureau Radiological Health, Food and Drug Admin., Rockville, MD 20857). *J Hered* 69(6): 409-412; 1978. (15 refs)

The production of lens opacities in Chinese hamsters and the concomitant induction of chromosomal aberrations in the corneal epithelium following exposure to microwave radiation are reported. A 2.45-GHz microwave diathermy machine with a modified type-C applicator was used to irradiate the eyes of 5-mo-old female Chinese hamsters. For lens opacity studies, the right eye of each of seven animals was irradiated for 10 min in the immediate vicinity (2 mm) of the aperture at an equivalent power density of 75 mW/cm^2. Three of the animals were irradiated twice, with a 1-wk separation. Slit lamp examination 1 mo after irradiation revealed lens opacities in the exposed eyes of two animals that had been irradiated only once. Lens opacities were not observed in the other animals, including those irradiated twice. No lens opacities were observed in the unexposed eyes of the seven animals. For chromosomal studies, the right eye of each of 32 animals was irradiated in the immediate proximity of the aperture (2 mm) or at 5 cm from the aperture for 5, 10, 20, or 30 min. The equivalent power densities were 100 mW/cm^2 and 25 mW/cm^2, respectively. In the cells from eyes irradiated proximal to the aperture (100 mW/cm^2) for 5, 10, 20, and 30 min, there were 0.0488, 0.0819, 0.0794, and 0.1562 chromosomal breaks per cell, respectively. Tetraploid cells and cells with chromosomal endoreduplications were also observed and constituted 0-4.7% of the cells. The frequencies of abnormal cells among microwave-irradiated cells ranged from 0.8-9.4% of the total number of cells observed. The group of animals with the highest and longest exposure (100 mW/cm^2, 30 min) scored significantly greater than a control group for both percentage of abnormal cells and number of chromosomal breaks per cell.

6213 TESTS OF BIOLOGICAL INTEGRITY IN DOGS EXPOSED TO AN ELECTROMAGNETIC PULSE ENVIRONMENT. *(Eng.)* Baum, S. J. (Experimental Hematology Dept., Armed Forces Radiobiology Res. Inst., Bethesda, MD 20014). *Health Phys* 36(2): 159-165; 1979. (9 refs)

The acute effects of electromagnetic pulse (EMP) exposure on the hematopoietic system and on some aspects of the reproductive system was investigated in healthy, purebred beagle dogs (1-2 yr old). A total of 26 dogs were employed; 9 (4 males, 5 females) were exposed to the simulated EMP environment and 9 (4 males, 5 females) served as sham-irradiated controls. Four pregnant female dogs were exposed to the EMP environment between day 10 and day 55 of gestation to measure possible radiation effects on the fetuses, and 4 nonexposed pregnant female dogs served as controls. The animals were exposed to the EMP environment 8 hr/day for 45 days. At the end of that time they received 5.8 x 10^6 EM pulses at 5 pulses/sec, with a peak electric field intensity of 447 kV/m. Blood samples were obtained 1 wk prior to exposure and thereafter every week during the 45-day exposure period and for 3 wk thereafter. Final blood samples were obtained 1 yr after the last EMP exposure. The concentrations of erythrocytes, leukocytes, neutrophils, lymphocytes, reticulocytes, and platelets were routinely determined in 1 mm^3 of blood. Bone marrow samples were obtained 7 days before and 7 days after the last EMP exposure. A

comparison of concentrations of the circulating erythrocytes and reticulocytes indicated that exposure to EM pulses had no injurious effects. The number of peripheral leukocytes, neutrophils, and lymphocytes of irradiated dogs was similar to that of nonirradiated control animals. No changes were observed in the concentration of platelets. No differences were observed in blood values obtained from the same dogs 1 yr after the last EMP exposure. The percentage of mitotic erythrocytic and myelocytic bone marrow cells in all dogs 7 days prior to irradiation did not differ significantly from that obtained in similar determinations 7 days after the last exposure. At no times during periodic examinations were any damaging effects observed in the exposed animals. The litters of the 4 irradiated pregnant female dogs were similar in size (4-6 pups/litter) to those of the 4 unirradiated controls. All pups were clinically normal. When the 4 EMP-exposed male dogs and their 4 nonexposed controls were mated with normal female beagles, sizes of litters were normal (5-6 pups) in all cases and no differences in mating capabilities between the irradiated and nonirradiated male dogs were observed. Veterinary examinations of the pups disclosed no abnormalities in the newborn dogs sired by previously irradiated male beagles. It is concluded that the absence of any deleterious effects observed in dogs exposed to the EMP environment, which closely simulated human occupational exposure conditions, strongly suggests that humans face no hazards under these conditions.

6214 PROGRAMMED SIX-CHANNEL ELECTRICAL STIMULATOR FOR COMPLEX STIMULATION OF LEG MUSCLES DURING WALKING. *(Eng.)* Strojnik, P. (Faculty Electrical Engineering, Univ. Ljubljana, Ljubljana, Yugoslavia); Kralj, A.; Ursic, I. *IEEE Trans Biomed Eng* BME-26(2): 112-116; 1979. (21 refs)

Recent trends in the use of functional electrical stimulation (FES) for the treatment of stroke patients are reviewed along with the development of a six-channel FES unit for complex stimulation of leg muscles during walking. The state of art in the field of FES clearly shows that complex multichannel systems for support and correction of principal gait functions are still at an initial stage. However, it may be expected that present systems for therapeutic and training stimulation will develop in the course of commonly used orthotic devices. A six-channel FES unit is described that uses a shoe-insole heel switch to synchronize stimulation with the gait. To exclude any accidental occurrence of cross stimulation pulses, only one generator with a frequency six times higher than the required stimulation frequency is used. A ring counter distributes the pulses among the channels so that overlapping and cross-talk between the electrodes cannot arise. The stimulation frequency can be set within the range of 20-60 Hz and the pulse width between 0.1 and 1 msec. The six-channel FES unit has been used on 20 patients so far, and most of them have accepted the walking pattern given by the stimulator. After having used the stimulator for 3 wk, several patients were able to walk without a cane. Moreover, the walking pattern remained for a while after stimulation was stopped. This preliminary experience indicates that multichannel FES represents a successful approach to complex correction of the hemiplegic patient's gait.

6215 EFFECTS OF 9.4 GHz MICROWAVE EXPOSURE ON MEIOSIS IN MICE. *(Eng.)* Manikowska, E. (Dept. Genetics, Natl. Res. Inst. Mother and Child, Kasprzaka 17A, 01-211 Warsaw, Poland); Luciani, J. M.; Servantie, B.; Czerski, P.; Obrenovitch, J.; Stahl, A. *Experientia* 35(3): 388-390; 1979. (13 refs)

The effects of microwave exposure on meiosis in mice was investigated. Adult male Balb/c mice were exposed 1 hr/day for 2 consecutive wk (5 days/wk) to 9.4 GHz pulsed microwaves (pulse width 0.5 μsec, repetition rate 1,000 Hz) in far-field conditions in an anechoic chamber at incident mean power densities of 0.1, 0.5, 1.0, and 10.0 mW/cm^2. Four animals were exposed at each power density (16 animals in total), and seven mice served as controls. Following exposure the animals were sacrificed, testicles extracted and examined. The results of qualitative analysis of meiotic metaphase I indicated the presence of aneuploid metaphases. Hypoploid metaphases were seen both in control and experimental animals. However, no significant differences were noted in the frequency. In control animals, the presence of quadrivalents was noted in three metaphases out of 175. In two metaphases besides bivalents, two and four univalents were seen. Following exposure to 0.1, 1.0, and 10.0 mW/cm^2, the incidence of metaphases with quadrivalents (and in some instances of hexavalents) increased significantly. The chromosome associations (translocations) occurred at random and no particular chromosome pairs demonstrated a tendency for translocations. Metaphases with one or more (up to 6) chromosome pairs remaining at metaphase I as univalents were significantly (chi^2 test) more frequent in all groups of exposed animals. The largest proportion of such metaphases was seen following exposure to 0.1 and 10.0 mW/cm^2, 15.2% and 30.4%, respectively. The results indicate that repeated microwave exposure at incident power levels equal to or lower than values accepted as maximum exposure levels may interfere with meiosis. The high incidence of metaphases with the presence of univalents, instead of bivalents, may indicate that microwave exposure interferes with chiasma formation and/or behavior. Possible consequences of the observed phenomena in terms of reduced fertility or hazards to offspring remain to be verified in studies employing a larger number of animals, other mice strains, and other animal species.

6216 STIMULATORY ACTION OF AN ELECTROSTATIC FIELD ON DEVELOPMENT OF A *Candida tropicalis* CULTURE. *(Eng.)* Kradenov, V. P. (No affiliation given). 4 pp.; 1978. [available through National Technical Information Service, Springfield, VA 22161, Document No. HC A03/MF A01]. (7 refs)

The effects of electrostatic fields of varying intensity on the development of 2- to 3-day old *Candida tropicalis* (SK-4) cultures were studied. Yeast suspensions were exposed to 1-7 kV/cm from a direct electrostatic current source for 3, 10, or 1,200 sec. At all field intensities, suspensions treated for 3 sec showed an inhibitory effect on survival. A 10-sec treatment produced a stimulatory effect on survival at all intensities except for 6 kV/cm. The greatest stimulatory action was observed at 3 kV/cm for 1,200 sec producing a 14-fold increase in the number of treated suspensions compared to the untreated controls. Exposure of the yeast suspension to 6 kV/cm for 300 sec induced intensive cell growth during the first 6 hr after treatment; by 8-12 hr, however, there were more cells in the unexposed cultures than in the treated suspensions and by 24 hr, there was a threefold increase in cell numbers in the treated groups. A similar pattern was observed for feed yeast biomass accumulation and at 6 hr, the treated suspensions had developed two times more biomass than the untreated controls. These experiments indicate that electrostatic treatment of yeast suspensions produces either inhibition or stimulation of cell development depending on the duration and intensity of exposure.

6217 EFFECT OF PERMANENT MAGNETIC FIELD ON THE SPERM OF BREEDING BULLS. *(Rus.)* Kovalev, M. G. (Belorussian Scientific Res. Inst. Animal Husbandry, USSR). *Veterinariia* (11): 83-84; 1978. *(0 refs)*

The effect of a permanent magnetic field (parameters not given) on 61 ejaculates of breeding bulls was studied. Some ejaculates were placed into the south pole of the magnetic equilibrator for 5-6 hr immediately after dilution with lactose medium (Group 1), after which the samples were frozen. Other samples (Group 2) were diluted with lactose medium previously exposed to the magnetic field for 6 hr. After thawing, the activity (motility) of the sperm was 5.2 units in Group 1, 4.9 in Group 2, and 3.6 in the untreated controls. The percentages of the samples that had to be rejected after thawing were 10% in Group 1, 12% in Group 2, and 32% in the controls. The survival of the sperm at 38 C after thawing was 9.6 in Group 1, 8.2 in Group 2, and 6.3 in the controls (no unit given). The fertility of cows inseminated with the treated sperm was 16% higher than in the cows inseminated with untreated sperm.

6218 RODENT REPELLERS ATTRACT EPA STRICTURES. *(Eng.)* Smith, R. J. (No affiliation given). *Science* 204(4392): 484-486; 1979. (0 refs)

Tests conducted by the EPA on electromagnetic insect and rodent repellers indicate that the devices do not work. Three of the repellers have been taken off the market by EPA order, and 10 other models may soon follow. Because none of the devices had any effect on insects and rodents, the EPA has concluded that the entire concept of electromagnetic repellency at low levels may safely be dismissed. Although some creatures are sensitive to magnetic fields, tests conducted by the NBS indicate that the repellers generate a field far too weak to have this effect, a field roughly comparable to that generated by a hair dryer, for example. At a distance of 10 feet from the repeller, the field strength is less than that normally present in nature. No measurable electromagnetic field was detected emanating from three of the repellers. One of these three, the Nature Shield, is claimed to operate on a principle called contro-clusive magnetism. This term is defined by the manufacturer as a multiple vortex energy flow resolving in an elastic expansion and capacitance in relation to space and position.

6219 CYTOFLUOROMETRY OF ELECTROMAGNETICALLY CONTROLLED CELL DEDIFFERENTIATION. *(Eng.)* Chiabrera, A. (Electrical Engineering Dept., Univ. Genoa, Viale F. Causa 13, 16145 Genoa, Italy); Hinsenkamp, M.; Pilla, A. A.; Ryaby, J.; Ponta, D.; Belmont, A.; *et al. J Histochem Cytochem* 27(1): 375-381; 1979. (23 refs)

Controlled alterations in the electrochemical environment of the frog nucleated red blood cell in vitro resulted in changes in cellular morphology that appeared to be related to dedifferentiation (despecialization). These changes were achieved by a selective modification of the ionic concentrations of an isotonic amphibian Ringer solution and by the induction of low-frequency pulsating electromagnetic currents having specific waveform parameters. Laser flow microfluorometry showed that the modified Ringer solution was able, per se, to partially trigger the process during the same time interval that certain induced current waveforms significantly affected the number of cells in the dedifferentiated state. For a given waveform, the repetition rate had a significant effect on the rate of cell change. A frequency window of 40-70 Hz was found such that if the fundamental frequency of the signal was external to the window, the dedifferentiation process was inhibited. On the other hand, if the fundamental frequency of the signal was inside the window and close to 55 Hz, the process was enhanced. Laser flow microfluorometric measurements revealed a bimodal distribution in the green fluorescence of red blood cells that depended on the time of exposure and the waveform characteristics of the external signal. The two subpopulations had a different level of dye uptake. Sorting of the two populations showed that the second peak of higher fluorescence intensity corresponded to dedifferentiated cells and that the lower fluorescence intensity corresponded to control differentiated cells. Preliminary results obtained by the automated image analysis of cell smears stained with a Feulgen method suggested that dedifferentiated and normal cells have the same integrated optical density but different nuclear areas, resulting in an increased chromatin dispersion (larger area per unit of deoxyribonucleic acid) for dedifferentiated cells, which corresponds perfectly to the increase in their green fluorescence (increase in chromatin-

deoxyribonucleic acid binding sites). It appears that one of the first stages of the dedifferentiation process is the unfolding of chromatin supercoiling without any deoxyribonucleic acid synthesis.

6220 THE PERCEPTION OF WEAK ELECTRIC A.C. CURRENTS BY THE EUROPEAN EEL, *Anguilla anguilla*. *(Eng.)* Berge, J. A. (Inst. Marine Biology and Limnology, Univ. Oslo, Oslo, Norway). *Comp Biochem Biophys* [A] 64(4): 915-919; 1979. (24 refs)

The perception of weak electric fields of alternating polarity and the regional sensitivities of the European eel, *Anguilla anguilla*, were investigated at different water resistivities (6×10^2 to 3.6×10^4 ohm cm). Nine eels, in cylindrical plastic cages, were placed either parallel or perpendicular to the alternating current. Shocking electrodes were attached to the tail-end of the cage or to the middle of the fish (for regional sensitivity testing). The threshold current was established as that current intensity giving a 50% probability for conditioned brachycardia to occur. Sensitivity to 0.5, 2, 5, and 50 Hz were tested in fresh water (resistivity 3×10^4 ohm cm). Voltage gradient thresholds with the eel parallel to the current direction average 0.97 mV/cm (range, 0.47-1.9 mV/cm) at 0.5 Hz, increasing to 19 mV/cm at 50 Hz. There was a linear relationship between stimulation frequency and thresholds. With the eels perpendicular to the current, the thresholds average 3.6 and 50 mV/cm at 0.5 and 50 Hz, respectively. Current density thresholds decreased with increasing resistivity with the eel oriented parallel to the current, from 0.88 $\mu A/cm^2$ in brackish water (resistivity 6.3×10^2 ohm cm) to 0.031 $\mu A/cm^2$ in fresh water (resistivity 2.9×10^4 ohm cm). The corresponding voltage gradients were approximately 1 mV/cm irrespective of resistivity. When part of the eel's body was shielded from the current, the front half was four to five times more sensitive than the tail half, mean thresholds being 2.0 and 9.0 mV/cm in fresh water at 0.5 Hz. The results demonstrate maximum sensitivity to electric currents in the European eel at low frequencies (0.5 Hz). There was no evidence that the eel was more sensitive to alternating than to direct current and the results do not support the hypothesis that the eel can orient in the Earth's geomagnetic field.

6221 MAGNETITE IN FRESHWATER MAGNETOTACTIC BACTERIA. *(Eng.)* Frankel, R. B. (Francis Bitter Natl. Lab., Massachusetts Inst. Technology, Cambridge, MA 02139); Blakemore, R. P.; Wolfe, R. S. *Science* 203(4387): 1355-1356; 1979. (18 refs)

A fresh-water magnetotactic bacterium spirillum (MS-1), isolated from swamp sediments, was cultured in chemically-defined media and magnetic and nonmagnetic whole cells were analyzed by Mossbauer spectroscopy. The cells analyzed included magnetic cells grown in medium containing bog water, magnetic cells grown in chemically-defined medium containing 3.6 μmolar iron, and nonmagnetic cells grown in chemically-defined medium containing 3.6 μmolar iron. The Mossbauer spectrum of the magnetic cells grown in medium with bog water was identical to that of magnetic cells cultured in the chemically-defined medium. Based on the comparison of the spectra of the iron in magnetite of the magnetic cells and that of stoichiometric magnetite, the iron-containing material can be described as ferrimagnetic Fe_3O_4, with either approximately 4% vacancies in the octahedral sublattice or with a small admixture of a γ-Fe_2O_3 phase. The calculated magnetic moment of each cell is 1.3×10^{-12} electromagnetic unit, sufficient to produce alignment in the geomagnetic field (H=0.5 G) at ambient temperatures. Thus, the magnetite in these cells constitutes a biomagnetic compass and it is speculated that its presence may also be involved in the orientational responses of some eukaryotic organisms to geomagnetism.

6222 MEASUREMENTS OF ELECTROMAGNETIC FIELDS IN THE CLOSE PROXIMITY OF CB ANTENNAS. *(Eng.)* Ruggera, P. S. (Div. Electronic Products, Bureau Radiological Health, Food and Drug Admin., Rockville, MD 20857). *HEW Publication* (FDA) 79-8080: 23 pp.; 1979. (6 refs)

Measurements of near fields generated by citizen band antennas operating at a frequency of 27.12 MHz are reported. Types of antennas for which data are presented with full legal power of 4 W input include 1/4-wavelength whip; base-, middle-, and top-loaded; two sets of twin antennas; and a hand-held walkie talkie. Measured emission levels at 5 cm from all of the antennas tested exceeded either 200 V/m or 0.5 A/m or both at some point along the vertical height of the antenna. These field strengths (equivalent to a far-field power density of 10 mW/cm^2), which were exceeded, are the radiation protection guides for continuous unmodulated field strengths recommended by the American National Standards Institute with respect to personnel exposure of 0.1 hr or more. For some of the antennas, emission levels exceeding these guidelines persisted at a 12-cm separation distance. The health implications of these observations are not clear at this time.

6223 MORE PROTECTION FROM MICROWAVE RADIATION HAZARDS NEEDED. *(Eng.)* Comptroller General of the United States. (General Accounting Office, Washington, DC). *General Accounting Office Publication* HRD-79-7: 84 pp.; 1978. (112 refs)

A General Accounting Office (GAO) report by the Comptroller General of the United States on the need for protection from microwave radiation hazards is presented. Although the FDA has identified two microwave products that need performance standards -microwave ovens and medical diathermy equipment- only a performance standard for microwave ovens has been issued. No standard for medical diathermy machines has been issued to protect the patient, operator, and the public from microwave radiation. The GAO believes such a standard should be estab-

lished because of potentially adverse biologic effects reported in human and animal studies at exposure levels well below those to which machine operators and patients may be exposed. The FDA has also failed to always review manufacturers' reports promptly so that problems could receive early attention. The GAO also recommends that the FDA develop material for training diathermy equipment operators to help minimize patient and operator exposure to unnecessary radiation. Although voluntary guidelines setting 10 mW/cm^2 as a maximum safe level of occupational exposure have been published, no Federal standards exist to protect the general public and workers from potential microwave hazards. A review of 112 reports that were either cited as reference material supporting the FDA's microwave oven emission standard or that were identified by Administration officials as particularly important to the evaluation of the standard's adequacy indicates that over half of these reports state that animals and humans exposed to microwave radiation levels of 10 mW/cm^2 or less experienced biologic effects, some undesirable. Overall it is concluded that the FDA should improve its regulation of microwave radiation-emitting products and that mandatory standards to protect the public and workers from microwave exposure should be established.

6224 A COMPARISON OF MEASUREMENT TECHNIQUES TO DETERMINE ELECTRIC FIELDS AND MAGNETIC FLUX UNDER EHV OVERHEAD POWER TRANSMISSION LINES. *(Eng.)* Lambdin, D. L. (Electromagnetic Radiation Analysis Branch, EPA, P. O. Box 15027, Las Vegas, NV 89114). *EPA Publication* ORP/EAD-78-1: 14 pp; 1978. (3 refs)

The magnetic flux and electric field strength under extra high voltage (510 kV) overhead transmission lines were measured, and comparisons were made between U.S. and Russian techniques. A Polytech Model FBM 100 field meter was used to measure the primary electric field strength and magnetic flux; supplemental measurements were made with a Monroe Electronics Model 238A-1$_1$ field meter. Field strength measurements were made in three geometries with each of the instruments: 1) a U.S. technique--the meter was *held 1 m above ground level and 1 or 2 m from* the observer, with a Monroe or Polytech meter, respectively; 2) a Russian technique--the meter was held 1.8 m above ground as if attached to an 11-inch handle; 3) 1.8 m above ground and 1 or 2 m from the observer; and 4) 1 m above ground with an 11-inch handle. Magnetic flux measurements were made in two geometries: 1) with the sensing coil 1 m above ground level and 2) with the coil 1.8 m above ground. Both meters gave similar results when used with equal-length handles. The major difference in measured values using different geometries occurred at 1.8 m above ground level. Electric field strength was greatest when the observer was closest to the meter. Measurements made at 1 m above ground were not as critically affected by the observer's position with respect to the instrument. The variations in the measured value were minimized when the instrument was held at least 2 m from the observer. Measurements at 1 m and at 1.8 m above the ground were similar if a 2-m handle was used. Magnetic flux measurements were not significantly affected by the observer's position with respect to the sensing coil. The magnetic flux increased by 1.09-fold in the area directly under the three phases of the transmission line when the coil was elevated from 1 m to 1.8 m above ground. Magnetic flux measurements were significantly affected by the angular orientation of the coil and by changes in the current flow through the transmission lines. Further studies are necessary to determine the relation between magnetic flux and current flow.

6225 MEASUREMENTS OF RADIOFREQUENCY FIELD INTENSITY IN BUILDINGS WITH CLOSE PROXIMITY TO BROADCAST STATIONS. *(Eng.)* Tell, R. A. (Electromagnetic Radiation Analysis Branch, EPA, P. O. Box 15027, Las Vegas, NV 89114); Hankin, N. N. *EPA Publication* ORP/EAD-78-3: 35 pp; 1978. (3 refs)

The radio frequency (RF) field intensity was measured in eight tall buildings located in five cities (New York, Chicago, Miami, Houston, and San Diego) that were situated in close proximity to frequency modulation (FM) radio and/or television transmitting antennas. All of the buildings had the upper parts of their structure illuminated by the main beam of radiation from the transmitting antenna. The RF intensities were measured to facilitate the development of an analytical technique for the estimation of field intensities and to determine the exposure level for persons living and working in sites similarly exposed to RF. RF measurements were made in conjunction with a ground level survey of the given metropolitan area by a tuned half-wave dipole receiving antenna connected through coaxial attenuators to a scanning spectrum analyzer. Measurements of polarization components in two orthogonal planes demonstrated electric field intensities as high as 19 V/m in one high-rise building about one block from an FM transmitter and about 10 V/m in a building several blocks away from a television transmitting antenna. Higher levels were observed at unobstructed locations on the roofs of some buildings. The maximum exposure did not exceed 100 $\mu W/cm^2$ in any of the buildings. Field intensities at distances very close to an FM antenna array were significantly lower, as much as 14 dB less at a distance of 26 m for a 12-bay FM antenna, than that predicted by using the far-field effective radiated power of array, demonstrating a near-field gain compression effect. Analysis of near-field gain characteristics of the array were in agreement with this measurement. This observation is significant for estimating close-in fields from extended arrays with a large number of elements. The possible effect of the alteration of antenna calibrations of the half-wave may have affected the field intensity. In particular, use of a half-wave dipole in the near-field of RF transmitting antennas should be examined for spatial resolution of the incident field. It is possible that certain "hot spots" may not be accurately identified and measured by using tuned dipoles, at least at 100 MHz, since at this frequency, the wavelength is 3 M. Another factor found to affect the field was the location

of metallic objects within the field. Such conducting structures (e.g., the metallic leg of an office desk) were observed to create intensified local fields, sometimes as much as 10 times that of the local ambient value. Further investigations of these effects and other phenomena that influence the RF field intensity nearby tall buildings situated near radio and television transmitting antennas are indicated.

6226 NEAR-FIELD RADIATION PROPERTIES OF SIMPLE LINEAR ANTENNAS WITH APPLICATIONS TO RADIO-FREQUENCY HAZARDS AND BROADCASTING. *(Eng.)* Tell, R. A. (Electromagnetic Radiation Analysis Branch, Office Radiation Programs, EPA, P.O. Box 15027, Las Vegas, NV 89114). *EPA Report* ORP/EAD 78-4: 49 pp.; 1978. (41 refs)

Electric and magnetic field strengths in the near-vicinity of dipole and monopole linear transmitting antennas were computed, and the results were analyzed to evaluate potential radio frequency hazards that may exist very near dipole-like broadcast antennas. Calculations for a half-wave dipole indicated that, for distances less than 1.5 m from the antenna, areas radiating 1 kW at 100 MHz will exist in which the American National Standards Institute safety standard for indefinitely long exposure is exceeded. Thus, extreme caution should be exercised by personnel performing tower work in close proximity to very-high frequency broadcast antennas using dipole or dipole-like radiating structures. The phenomenon of gain compression within the near field of an antenna array was also examined by modeling a frequency-modulated (FM) antenna as a series of horizontally polarized dipoles with uniform power division and equal phasing. Significant reductions in field strength near the array were expected and were observed via actual field measurements. The reductions in near field gain were due to the vector summing of fields from the array as opposed to the inherent near field properties of the basic dipole radiator itself. The presence of grating lobes in some FM broadcast antennas suggests that the fields near the base of the FM antenna towers can be relatively intense, particularly for antennas mounted close to the ground or on roof tops.

6227 POPULATION EXPOSURE TO VHF AND UHF BROADCAST RADIATION IN THE UNITED STATES. *(Eng.)* Tell, R. A. (Electromagnetic Radiation Analysis Branch, Office Radiation Programs, EPA, P.O. Box 15027, Las Vegas, NV 89114); Mantiply, E. D. *EPA Report* ORP/EAD 78-5: 39 pp.; 1978. (12 refs)

EPA data on broadcast signal field intensities obtained at 373 locations distributed throughout 12 large cites in the United States and collectively representing about 11,000 measurements of very-high and ultra-high frequency signal field intensities are reported. A computer algorithm was developed that uses these measurements to estimate the broadcast exposure at 39,000 census enumeration districts within these 12 cities. The results indicate that the median exposure level for the population of these cities, which represents 18% of the total United States population, is 0.005 $\mu W/cm^2$ (time averaged power density). The data also suggest that about 1% of the population studied, or about 380,000 persons, are potentially exposed to levels greater than 1 $\mu W/cm^2$, the suggested safety guide in the USSR.

6228 MICROWAVE BIOPHYSICS. *(Eng.)* Lin, J. C. *In: Microwave Bioeffects and Radiation Safety: Transactions of the International Microwave Power Inst.* International Microwave Power Inst. (Edmonton, Alberta, Canada): Vol. 8: 15-54; 1978. (76 refs)

Biophysical aspects of microwave interaction with living systems are discussed. The propagation and absorption of microwaves in biologic materials are governed by dielectric constant, conductivity, and geometric composition. Theoretical studies and experiments on planar and curved tissue models show that microwaves with frequencies between 400 and 1,000 MHz can penetrate more deeply into tissues and that the peak specific absorption rate (SAR) may be five times greater than the average in spheres simulating human and animal brains. Absorption maxima or hot spots are seen in both spherical and prolate spheroidal models of biologic structures. The average SAR for humans is projected to be highest at 70 MHz, while that for rats occurs at 700 MHz. Because the average SAR for humans and for rats at a given frequency may differ by as much as 25 times, body size and operating frequency must be accounted for in relating animal results to humans. Other than the thermal mechanism and the microthermal interaction characterized by thermoelastic expansion of brain tissue in the auditory effect, the mechanisms underlying most observed effects remain speculative.

6229 MICROWAVE AND RADIOFREQUENCY PROTECTION STANDARDS. *(Eng.)* Stuchly, M. A.; Repacholi, M. H. *In: Microwave Bioeffects and Radiation Safety: Transactions of the International Microwave Power Inst.* International Microwave Power Inst. (Edmonton, Alberta, Canada): Vol. 8: 95-101; 1978. (16 refs)

Microwave and radio frequency (RF) protection standards in various countries are reviewed. All Western standards appear to base their recommendations on the thermal effects produced by exposure to RF and microwaves. However, the recognition that focal heating (hot spots), resonance absorption, and adverse environments can produce thermal damage in biologic materials in a field of 10 mW/cm^2 at certain frequencies and exposure conditions has resulted in the proposal of a Canadian Government standard and a revision of the United States exposure standard. Several unexplained inconsistencies in certain Russian standards are apparent. The USSR occupational standard specifies 5 V/m as the maximum permissible electric field intensity for frequencies between 50 and 300 MHz (equivalent power density is 6.7 $\mu W/cm^2$); however, at frequencies above 300 MHz, 10 $\mu W/$

cm^2 is permitted. In the 30-50 MHz frequency range, the electric field intensity of 10 V/m is permitted. The magnetic field intensity giving the same power density is 0.027 A/m, but a magnetic field intensity of 10 times greater is permitted (0.3 A/m). It is also unclear from the standard if the limits for rotating antennas correspond to the values measured with the antennas stationary as is required in the standard's section on measurements. Also confusing are requirements pertinent to stationary and rotating antennas in the Polish standard.

6230 CONTROL OF MICROWAVE EXPOSURE IN CANADA. *(Eng.)* Repacholi, M. H. *In: Microwave Bioeffects and Radiation Safety: Transactions of the International Microwave Power Inst.* International Microwave Power Inst. (Edmonton, Alberta, Canada): Vol. 8: 102-112; 1978. (6 refs)

Activities of the Canadian Radiation Protection Bureau concerning regulations produced on devices emitting microwave (MW) and radio frequency (RF) radiation are reviewed. Regulatory action has been completed or is at the proposal stage for MW ovens, MW diathermy devices, and MW blood warmers. Regulations also exist for industrial activities using radiation emitting devices. An advanced draft of a safety code on MW and RF devices has been developed that also specifies the acceptable maximum exposure limits for both the general public and for occupationally exposed persons. For general public exposure in the frequency range of 0.01-300 GHz, the maximum level is 1 mW/cm^2 over a 24-hr period. For occupational exposures in the 0.01-1 GHz range, maximum exposure levels of 60 V/m, 0.16 A/m, and 1 mW/cm^2 are permitted over an 8-hr period; for this same frequency range, maximum levels of 1-25 mW/cm^2 are permitted for durations in minutes equaling 60/power density (P). For occupational exposures in the 1-300 GHz frequency range, the maximum exposure level is 5 mW/cm^2 over an 8-hr period, 1-10 mW/cm^2 for durations in minutes equaling 300/P, and 10-25 mW/cm^2 for durations equaling 60/P. A criteria document for MW and RF radiation has just been completed by the Radiation Protection Bureau in two parts. Part I has been published and includes details on the characteristics of MW and RF radiations, sources of these radiations that could present potential health hazards, measurement techniques, and interaction mechanisms. Part II is in the final draft stage and includes an extensive review of the bioeffects literature and presents recommendations on protection standards.

6231 QUANTIFYING HAZARDOUS MICROWAVE FIELDS. *(Eng.)* Bowman, R. R. *In: Microwave Bioeffects and Radiation Safety: Transactions of the International Microwave Power Inst.* International Microwave Power Inst. (Edmonton, Alberta, Canada): Vol. 8: 113-128; 1978. (15 refs)

Considerations involved in quantifying hazardous microwave electromagnetic (EM) fields are reviewed. Topics discussed include: complexities of EM fields involving polarization, multipath interference, reactive near-field components, interactions between the source and nearby objects, and complicated modulation of the field; field strength and intensity parameters for EM fields; and instruments for measuring complicated fields. An EM survey device using three orthogonal dipoles is described in detail.

6232 RADIO WAVES AND MICROWAVES - BASIC DEFINITIONS AND CONCEPTS. *(Eng.)* Stuchly, M. A. *In: Microwave Bioeffects and Radiation Safety: Transactions of the International Microwave Power Inst.* International Microwave Power Inst. (Edmonton, Alberta, Canada): Vol. 8: 1-14; 1978. (3 refs)

Basic definitions and concepts dealing with radio waves and microwaves are presented. Definitions and descriptions are given for electromagnetic waves, waves in free space, polarization, reflection and transmission, transmission lines, radiation and antennas, electrical characteristics of materials (complex permittivity and complex permeability), wave modulation, and quantum energy. The activation energies of various molecular interactions and corresponding frequencies and quantum energies associated with various radiations are given in tabular form.

6233 BIOLOGIC AND PATHOPHYSIOLOGIC EFFECTS OF EXPOSURE TO MICROWAVES. *(Eng.)* Michaelson, S. M. *In: Microwave Bioeffects and Radiation Safety: Transactions of the International Microwave Power Inst.* International Microwave Power Inst. (Edmonton, Alberta, Canada): Vol. 8: 55-94; 1978. (209 refs)

Physiologic and pathologic effects of microwave exposure are reviewed. These effects are discussed in relation to cellular and genetic events, growth and development, the reproductive organs, neuroendocrine responses, the nervous system, the cardiovascular system, hematopoiesis, immune responses, auditory responses, cataract development, and cardiac pacemaker interference. For frequencies between 200 and 24,500 MHz, exposure to a power density of 100 mW/cm^2 for several minutes or hours can result in pathophysiologic manifestations of a thermal nature in laboratory animals. Such effects may or may not be characterized by a measurable temperature rise, which is a function of the thermal regulatory processes and active adaptation of the animal. At lower power densities, evidence of pathologic changes or physiologic alteration is nonexistent or equivocal. Several studies support nonthermal interactions between tissues and electric and magnetic fields, however.

6234 MICROWAVE THERMOGRAPHY: APPLICATION TO THE DETECTION OF BREAST CANCER. *(Eng.)* Barrett, A. H.; Myers, P. C.; Sadowsky, N. L. *In: Prevention and Detection of Cancer. Part II. Detection. Volume 1. High Risk Markers - Detection*

Methods and Management. Nieburgs, H. E., ed. (New York: Marcel Dekker, Inc.): 375-385; 1978. (6 refs)

The use of microwave thermography for the detection of breast cancer is discussed along with some preliminary results. The microwave radiometer used operates at a frequency of 3.3 GHz (free-space wavelength 9.1 cm). The antenna is a straight section of rectangular waveguide with aperture dimensions of 1.0 by 2.3 cm and is filled with a low-loss solid having a dielectric constant of 11. During data taking, the antenna aperture is placed flush against the skin to eliminate reflective loss at the tissue-air interface and to permit minimum spatial resolution for the given antenna size. The microwave thermography examination lasts about 20 min. Over 600 patients have been examined by xeromammography, infrared thermography, and microwave thermography at the Faulkner Hospital in Boston. A microwave detection criterion based on measured right-left temperature asymmetry gave true positive and true negative rates greater than 70%, which compares favorably with mammography and infrared thermography.

6235 RESULTS OF THE EPA ENVIRONMENTAL RADIO-FREQUENCY RADIATION MEASUREMENTS PROGRAM. *(Eng.)* Galpin, F. L. (Environmental Protection Agency, Washington, DC); Athey, T. W.; Hankin, N. N.; Janes, D. E. *In: 8th Annual Natl. Conference on Radiation Control*. HEW Publication (FDA) 78-8054: pp. 317-324; 1978. (9 refs)

The EPA environmental radio frequency radiation measurements program is described along with some of its results. The objectives of the program are to describe urban area environmental radiation levels as completely as possible with emphasis on areas containing the majority of the population and on locations near the highest power transmitters and to determine exposure levels that may result in relatively high level exposure (compared to median exposure levels) to few persons because of the unique locations of the transmitters. In the first, eastern phase of the program (September 1975 to October 1976) seven cities were selected for environmental radiation level measurements; these were Boston, Atlanta, Miami, Philadelphia, New York, Chicago, and Washington, DC. Based on data from the first four cities surveyed, the frequency modulated (FM) radio band appeared to contribute the most to environmental exposure between frequencies of 50 and 900 MHz, followed by the very high frequency (VHF) television bands. Land mobile frequency bands made an almost negligible contribution to the total power density, and other frequency bands made even smaller contributions. Only about 6% of the sites had power densities that exceeded 1 $\mu W/cm^2$. The median exposure level for the populations of these four cities was about 0.02 $\mu W/cm^2$, and only 1-2% of the population were exposed to levels above 1 $\mu W/cm^2$. Preliminary results from three more cities suggested that the median population exposures for all seven eastern cities will be about 0.01-0.02 $\mu W/cm^2$. In summary, it appears that the nonionizing radiation exposures of about 98% of the population can be adequately characterized and that the levels for this group could meet any exposure standard in the world. In some locations, such as tall buildings near broadcast transmitters, the levels may be hundreds of times higher than at ground level but still probably always below the OSHA/ANSI occupational standard. Further studies are necessary to adequately describe the above-ground exposures to broadcast radiation in urban areas or in the near vicinity of other specialized sources.

6236 BEHAVIORAL, ETHOLOGICAL, AND TERATOLOGICAL EFFECTS OF ELECTROMAGNETIC RADIATION ON AN AVIAN SPECIES. *(Eng.)* Clarke, R. L. (Ph.D. Dissertation, Univ. Kansas, 1978); 175 pp. [available through Xerox Univ. Microfilms, Ann Arbor, MI 48106, Order No. 7904212]. (109 refs)

The behavioral, ethologic, and teratologic effects of electromagnetic radiation on the domestic chicken (*Gallus gallus*) were examined in a series of experiments. In one experiment, eggs were irradiated with 2,450-MHz microwave radiation at a period during the incubation cycle when the neural structures associated with agonistic behaviors and aggression are known to proliferate. Forced draft cooling in a multi-modal cavity produced more even temperature distribution and higher rates of energy absorption over longer periods (100 mW/g average power for 24 hr) than had been achieved in previous studies. No gross abnormalities were found in eggs irradiated in this manner. Microwave irradiation had little effect on the number of eggs hatched, but it did appear to increase the number of hatchlings that survived to 9 wk. Also, embryonic irradiation with 2,450-MHz microwaves during hr 36-60 of incubation was correlated with being low on the pecking order. In a second experiment, the effect of a low frequency 60-Hz magnetic field on locomotor activity was investigated. However, initial results were inconsistent, and the experiment was abandoned. In a third experiment, it was demonstrated that chickens are apparently able to detect the presence of a direct current (4.01 mtesla) and a 60-Hz alternating current (1.70 mtesla) magnetic field. Unlike other avians, the chicken appears to be able to demonstrate the ability to detect magnetic fields under laboratory conditions that involve classical and instrumental conditioning.

6237 ELECTRICAL AND BIOLOGICAL EFFECTS OF TRANSMISSION LINES: A REVIEW. *(Eng.)* Lee, J. M.; Bracken, T. D.; Capon, A. S.; Sarkinen, S. H.; Ihle, G. M.; Perry, D. E.; Eyler, T. R. (U.S. Dept. Energy, Bonneville Power Admin., Portland, OR). 64 pp.; 1977. [available through National Technical Information Service, Springfield, VA 22161, Document No. HC A04/MF A01]. (117 refs)

Studies on the electrical and biologic effects of high-voltage transmission lines are reviewed. In the small volume of air surrounding a conductor where corona is present, chemical reactions take place including the production of ozone and nitrous oxides. Experience and studies to date indicate

that the amounts of oxidants produced by transmission lines have no adverse effects on humans, animals, or plants. With regard to electric field effects of transmission lines, the EPA issued a request for data with which to determine if there is a need to provide guidance for radiation standards for transmission lines above 700 kV. A preliminary analysis of the data by the EPA did not identify any acute detrimental health or environmental effects. The experience of the electric utilities indicates that long-term exposure to electric fields at the levels that exist near transmission lines in the United States poses no hazard. Soviet studies on extra-high voltage substation workers exposed to 50-Hz fields with intensities ranging from 2-26 kV/m reported such effects as greater variability of pulse and arterial blood pressure, reduced sexual potency, and a number of other changes. Other than reports involving some substations in Spain, the complaints by Soviet workers have not been reported for substation workers in other countries. No harmful biologic effects are expected from exposure to magnetic fields under transmission lines because the magnetic field levels at which effects occur are generally much higher than levels under powerlines. Current information on cardiac pacemakers indicates that with possible rare exceptions high-voltage lines will not interfere with the performance of pacemakers for heart patients. Very little research has been specifically conducted to determine if organisms are affected by the electric fields and ion currents of a direct current (DC) transmission line. Preliminary findings from a study conducted along the Oregon portion of the Celilo-Sylmar DC power line involving natural vegetation, crops, wildlife, and domestic animals do not indicate that there are any significant adverse biologic effects attributable to electrical properties of the DC line.

6238 RESEARCH PLAN FOR STUDY OF BIOLOGICAL AND ECOLOGICAL EFFECTS OF THE SOLAR POWER SATELLITE TRANSMISSION SYSTEM. *(Eng.)* Newsom, B. D. (Bernard D. Newsom and Associates, Los Altos Hills, CA). 360 pp.; 1978. [available through National Technical Information Service, Springfield, VA 22161, Document No. N78-32316/9GA]. (74 refs)

A research plan for the study of biologic and ecologic effects of the solar power satellite transmission system is presented. The satellite power concept proposes that solar panel arrays with lifetimes of 30 yr be placed in geosynchronous orbit to collect solar power for subsequent relay to ground collecting stations by continuous wave 2.45-GHz microwaves. The research plan involves studying information on the following categories: absorption of microwave energy in man and animals, chronic low level effects of microwaves, biobehavioral effects of microwave illumination on birds, the effect of microwave illumination on heterotherms, the effects of microwaves on insects and other terrestrial invertebrates, the effects of microwaves on fungi, the effects of chronic low-level microwave illumination on plant growth and development, and dosimetry and facility requirements. An abbreviated version of the plan at an annual funding level of $700,000 for a 3-yr period is presented in an appendix.

6239 FOREIGN SERVICE STATUS STUDY: EVALUATION OF HEALTH STATUS OF FOREIGN SERVICE AND OTHER EMPLOYEES FROM SELECTED EASTERN EUROPEAN POSTS. *(Eng.)* Lilienfeld, A. M.; Tonascia, J.; Tonascia, S.; Libauer, C. H.; Cauthen, G. M.; Markowitz, J. A.; Weida, S. (Dept. Epidemiology, Sch. Hygiene and Public Health, Johns Hopkins Univ., 615 N. Wolfe St., Baltimore, MD 21205). 436 pp.; 1978. [available through National Technical Information Service, Springfield, VA 22161, Document No. PB-288 163/9GA]. (0 refs)

A biostatistical study of 1,827 Department of State employees and their dependents at the Moscow Embassy and 2,561 employees and their dependents from other Eastern European embassies who served between 1953 and 1976 was conducted to determine the possible effects on mortality and morbidity due to exposure to microwaves among employees at the American Embassy in Moscow. The basic information sources included health records, health questionnaires, and death certificates. The maximum exposure levels at the Moscow Embassy over this period of time were 5 $\mu W/cm^2$ for 9 hr/day between 1953 and May 1975, 15 $\mu W/cm^2$ for 18 hr/day between June 1975 and February 7, 1976, and fractions of a $\mu W/cm^2$ for 18 hr/day since February 7, 1976. Sources of radiation beams at the Moscow Embassy were identified using directional antennas and conventional receivers and power meters at various locations within the Embassy. It was concluded that personnel working at the American Embassy in Moscow from 1953 to 1976 suffered no ill effects from the microwaves beamed at the chancery.

6240 EFFECT OF MICROWAVES IN THE THERMAL INTENSITY RANGE ON MICE: BODY WEIGHT, RECTAL TEMPERATURE, RESPIRATION, ACTIVITY IN RUNNING WHEEL, PERCEPTION REACTIONS, AND TRAINING. *(Swe.)* Criborn, C. O. (Forsvarets Forskningsanstalt, Huvudavdelning 5, 104 50 Stockholm 80, Sweden). 47 pp.; 1977. [available through National Technical Information Service, Springfield, VA 22161, Document No. N78-29730/6GA]. (24 refs)

The effect of exposure to microwaves of the thermal intensity range (2,450 MHz, 100 mW/cm^2, length of exposure 3 or 6 min) on various physiologic parameters of 70-day-old male CBA mice was studied. All mice exposed for 6 min died, but those exposed for 3 min survived over 6 mo. The rectal temperature was 39.7-43.1 C 1 min after the 6-min exposure, versus 37.6 C in the controls, but it decreased to 34.5 C 20 min after the exposure. The rectal temperature was 39 C 1 min, and 36.8 C 20 min after the 3-min exposure. The respiratory minute volume was 6.8-11.6 (unit not specified) 1 min after the 6-min irradiation, versus 9.7 in the controls. In the group irradiated for 3 min, the respiratory minute volume was 13.4 during the exposure, and 8.2 20 min later. During the first 3 days after the 3-min exposure, there was no change

in the activity of the animals in the running wheel, or in their ability to learn to change direction after the wheel was braked down in one direction. Later, there was a stress symptom, manifested in impaired ability to learn. The changes in the activity in the running wheel appeared after about 1 wk; they were probably due to damage of the hematopoietic organs. The Hb level was 14.3 g/100 ml 9 days after the 3-min irradiation versus 15.2 g/100 ml in the controls.

6241 BIOMEDICAL EFFECTS OF MILLIMETER RADIO WAVES. *(Eng.)* Cherkasov, I. S.; Nedzvetskiy, V. A.; Gilenko, A. V. (Dept. Eye Diseases, Odessa Medical Inst., Odessa, USSR). 7 pp.; 1978. [available through National Technical Information Service, Springfield, VA 22161, Document No. HC A03/MF A01]. *(27 refs)*

The effect of millimeter radio waves (MMW) on both normal and injured corneas and on corneal healing was studied in adult rabbits. The animals received MMW either to the right eye for 10-100 min; to the right eye with the rest of the body shielded from irradiation; to the occipital region after a 5-mm cut was made in the cornea of both eyes; and to both eyes with the intensity and exposure time increased by four and three times, respectively, daily for 10 days. For all experiments, the condition of the eye before and after injury and immediately after MMW exposure was monitored with a fluorescence test, ophthalmoscopy, and biomicroscopy. No abnormal deviations in the corneal morphology were detected in controls, MMW-exposed, or in treated rabbits observed for 1 yr. However, statistical analysis demonstrated an increase in the mitotic index (MI) of the irradiated cornea after 1 10-min exposure (16 ± 1) compared to the nonirradiated cornea of the same animal (11 ± 1), which increased with 30-min (25 ± 2 and 15 ± 1, respectively) and 60-min (53 ± 3 and 25 ± 2, respectively) of exposure and was most pronounced after 100-min of MMW (107 ± 7 versus 40 ± 3). In all cases, the mitotic activity was greatest 1 hr after exposure and the MI declined to its initial level 24 hr after MMW. Significant acceleration of wound healing was demonstrated following irradiation of the damaged cornea; highly stable healing occurred in 3 ± 0.5 hr in exposed animals and in 8 ± 0.5 hr in controls. When the rabbits were shielded, MMW-induced elimination of the defect was accelerated, but at a slower rate (5 ± 0.5 hr) than those receiving MMW without shielding. When one eye received MMW, healing of the nonirradiated eye was also accelerated, but was 1 hr slower than in the injured eye subject to MMW. Injuries to both eyes healed simultaneously following MMW to the occipital region, reducing defect elimination time to 1 ± 0.5 hr (from 8 ± 0.5 hr). These results indicate that MMW interacts with the body to produce a pronounced therapeutic effect; in particular, reparative regeneration becomes significantly more stable and accelerated. The effects of MMW on healing depend on the wavelength, irradiation time, the body systems that are irradiated, and the irradiation conditions.

6242 HEALTH AND SAFETY OF HIGH VOLTAGE TRANSMISSION LINES. *(Eng.)* Michaelson, S. M. (Univ. Rochester Sch. Medicine and Dentistry, Rochester, NY 14642). 33 pp.; 1977. [available through National Technical Information Service, Springfield, VA 22161, Document No. UR-3490-1255]. (32 refs)

A review of data on the biologic effects of high voltage transmission lines indicates that there is no demonstrable effect produced by such electric and magnetic fields that may be hazardous to human health and safety or to the general biologic environment. Experiments that have reported possible genetic effects have been poorly designed and have not yielded the same results on repetition. Reported effects of electromagnetic fields on litter size in mice and on the growth of rats and chicks are comparable in magnitude with natural biologic variabilities, related temporal factors, or normal biorhythms that are not otherwise accounted for. Studies of triglyceride increases associated with low frequency fields had serious control deficiencies, and well controlled studies have not shown any such association. Experiments in which very slight changes in circadian rhythms were found in human subjects shielded from natural background fields are not considered applicable to the possible effects of high voltage transmission lines. Also, experiments performed with silk tree leaflets, fluor beetles, and mice have not shown alterations in circadian rhythms under conditions considered applicable. It is not possible to define a cause-effect relationship from Soviet studies describing symptoms of listlessness, excitability, headache, drowsiness, and fatigue in persons occupationally exposed to high electric fields because these symptoms are also caused by many other occupational factors.

6243 CONDITIONED TASTE AVERSION IN RATS EXPOSED TO 2450 MHz CW MICROWAVES. *(Eng.)* Williams, W.; Michaelson, S. M. (Dept. Radiation Biology and Biophysics, Univ. Rochester, Rochester, NY 14627). 6 pp; 1978. [available through National Technical Information Service, Springfield, VA 22161, Document No. UR-3490-1331]. (6 refs)

The ability of 2,450 MHz continuous wave microwaves to induce a behavioral aversion to saccharin was investigated in rats. Female rats adapted to a restricted water regimen (4 rats/group) were presented with a 0.01% saccharin solution and either sham-irradiated or exposed for 10 min to microwaves at incident power densities of 10, 20, 25, 35, 50, or 55 mW/cm^2. Some groups were re-exposed several weeks later to either 20 mW/cm^2 for 2 hr or 65 mW/cm^2 for 1 hr. A water-saccharin preference test was given to each group 24 hr later. Core body temperatures were measured with a rectal probe before and after microwave exposure. Only those rats irradiated with 65 mW/cm^2 for 1 hr demonstrated significantly reduced saccharin consumption. The aversion correlated with a rise of core body temperature to >39.8 C. Rats retested for saccharin aversion following an intraperitoneal injection of apomorphine-hydrochloride showed a significant reduction in saccharin intake, lowered core body temperature,