4547 EFFECTS OF THE SURROUNDINGS ON ELECTROMAGNETIC-POWER ABSORPTION IN LAYERED-TISSUE MEDIA. (Eng.) Bernardi, P. (Inst. of Electronics, Univ. Rome, Rome, Italy); Giannini, F.; Sorrentino, R. *IEEE Trans. Microwave Theory Techniques* 24(9): 621-625; 1976.

A model for studying the interaction between electromagnetic (EM) waves and biological tissue is introduced. The influence of the surroundings, the thickness of the irradiated tissue, and of the disuniformity of the incident field was examined by schematizing the environment by a perfectly conducting screen placed beyond the irradiated tissue. The effects of standing waves, which were created in this situation, were determined as a function of the electrical and geometrical parameters of the structure. In particular, the hazard increase due to the presence of the screen combined with a phase disuniformity of the incident field--an elementary schematization of the "near-field"--was pointed out. (13 refs.)

4548 DIFFERENTIAL EFFECTS OF ELECTROMAGNETIC FIELDS IN THE TREATMENT OF NEUROSES AND DEPRESSION. (Eng.) Grunner, O. (Res. Centre Inst. Balncology, Lazne Pesenik, Czechoslovakia). *Act. Nerv. Super.* 17(4): 294; 1975.

The effects of the cerebral application of electronic broad-band noise (EBBN) (1 = 20 mA) to 20 patients with neurotic and depressive disorders were com - pared. Electric skin resistance (ESR) increased after treatment by more than 1/3; whereas, it decreased in patients treated with a "placebo." This indicates a significant inhibitory effect. Some neurotics complained of dizziness and hightened irritability, while others stressed hightened phychic activity during treatment. Patients with depression, treated similarly, indicated no side effects. An EBBN of lower intensity (1-2 mA) or squared pulse-current (0.8-1.2 mA) was suitable for treatment of anxious neurotics. Application of a continuous direct magnetic field (CDMF) for one hour on anxious neurotics with insomnia and hightened irritability exercised a significant inhibitory effect (increase in ESR). Repeated (CDMF) applications, 9 times in 3 weeks, on 12 anxious neurotics with insomnia confirmed this finding. It is suggested that the effectiveness of the treatment depends on the type and intensity of the electric current and magnetic field. (3 refs.)

4549 MICROWAVE-INDUCED HYPERTHERMIA AS AN ADJUVANT TO CANCER THERAPY (SYMPOSIUM SUMMARY). (Eng.) Wallen, C. A. (Dept. Radiation Biology and Biophysics, Univ. Rochester, Sch. Medicine and Dentistry, Rochester, NY 14642); Michaelson, S. M. *J. Microwave Power* 11(2): 175-176; 1976.

A review of the application of microwave-induced hyperthermia as an adjuvant to ionizing radiation and chemotherapy in cancer treatment is presented. The effects of hyperthermia and the temperature levels, which must be maintained, are also discussed. Therapeutically effective hyperthermia must raise the intratumor temperature to approximately 42°C with an operational range in animals and man of 41.5°C to 42°C. Higher temperatures have been found to give more rapid tumor destruction. However, host tolerance considerations, contraindicate the use of temperatures exceeding 42°C, which should be maintained for a sufficient time to inactivate the aerobic and hypoxic tumor cells, while not damaging adjacent normal tissue. It also has been noted that non-uniform heating enhances growth and metastasis of a tumor. Microwave-induced hyperthermia may provide unique possibilities for minimizing the problem of non-uniform heat distribution in the tumor. The thermal effects of high intensity microwave absorption in biological tissue is well established. The allowed frequencies for diathermy are 27.12, 915, and 2450 MHz in the United States and 433 MHz in Europe. In contrast to infrared and surface heating, the relatively long wavelengths of microwave radiation permit the energy to penetrate deeper into biological tissue. Therefore, a more rapid and uniform generation of heat is possible using this modality. Hyperthermia has been shown to interact with radiotherapy and chemotherapy synergistically. This synergistic combination could lead to improved cures since lower levels of both modalities could be used. (10 refs.)

4550 MICROWAVE HEATING OF MALIGNANT MOUSE TUMORS AND TISSUE EQUIVALENT PHANTOM SYSTEMS. (Eng.) Robinson, J. E. (Div. Radiation Therapy, Dept. Radiology, Univ. Maryland, Sch. Medicine, Baltimore, MD 21201); McCulloch, D.; Edelsack, E. A. *J. Microwave Power* 11(2): 87-98; 1976.

This study investigated the use of microwaves to produce stable and reproducible temperatures (44°± 25°) in malignant mammary mouse tumors (1 cm in diameter) and tissue equivalent phantom systems. A 200 watt pulse mode, 2450 MHz diathermy machine was the microwave source. Initial tumor temperatures were well below body temperature, between 28°C and 31°C. Phantom tumors showed a notable increase in heat compared with mouse tumors. Heat variations may have been due to thermoregulation. Temperature profiles were obtained for tumors under four conditions: unheated, microwave heated, air heated, and microwave and air-heated. Similar size tumors were also compared under these conditions. Results indicated that both core temperature and thermal distribution depended appreciably upon ambient temperature. Microwave heating at room temperatures resulted in unacceptably high non-uniform profiles. This technique, which combined microwave and air-heating, decreased thermal nonuniformities, reduced microwave power requirements for elevated temperatures (up to 45°C) in tumor core, and allowed for reproducible tumor temperatures (within ± 1°C). However, this is still considered an excessive deviation. (6 refs.)

4551 USE OF AN INDUSTRIAL PROTOTYPE MACHINE FOR DRYING AND STERILIZING PHARMACEUTICAL AMPOULES BY MICROWAVES AT 2.45 GHz (SYMPOSIUM SUMMARY). (Eng.) Mothiron, J. C. (Etablissement Rene Anrep,

Zone Industrielle du Menneton, 37000 Tours, France); Vialard-Goudou, A.; Maupas, P. *J. Microwave Power* 11(2): 200-201; 1976.

An experimental bacterial contamination of empty pharmaceutical ampoules, by different microbial strains, made it possible to test the sterilizing power obtained with an industrial prototype machine using microwaves at 2.45 GHz. Gram-positive and gram-negative bacteria in vegetative and sporulated forms were used to contaminate the washing water of ampoules treated subsequently with microwaves. With a period of four minutes and a power of 3 kW, drying was complete and sterilization satisfactory. Results indicated that with massive contamination the majority of ampoules were sterilized, although some ampoules still contained a few viable germs. There does not seem to be any significant difference in the sterilization of vegetative forms using microwave and between gram-positive and gram-negative bacteria. The influence of the germ concentration, at a given power, is a non-negligible parameter and leads to variable results depending on the bacterial species and more particularly with sporulated forms. It seems that sterilization is due only to the thermal effect obtained. The results of drying-sterilization with microwaves are favorable and make it possible to envisage industrial applications. (No refs.)

4552 INFLUENCE OF RADIO AND TELEVISION SETS ON IMPLANTED CARDIAC PACEMAKERS. (Ger.) Bisping, H.-J., Irnich, W. (Abteilung Innere Medizin I, Technische Hochschule, 5100 Aachen, Goethestr. 27-29, West Germany). *Dtsch. Med. Wochenschr.* 101(17): 669-672; 1976.

The possible interference by radiation emitted by television and radio sets and their accessories with implanted pacemakers with low threshold was investigated. The leakage fields generated by ultrasonic remote controls for television and radio sets, with a frequency of 30-65 kc/s, had too low an intensity to interfere with pacemaker function. Flexless infrared earphones, with an infrared emitter generating a carrier frequency of 100 kc/s installed in a television or radio set, also represented no danger for pacemaker patients. The interfering frequency emitted by the tuning oscillator of the television set during tuning was in the range of 85-900 Mc/s. Its intensity was too low to cause interference with pacemakers. It was concluded that pacemaker wearers may go near television and radio sets and use remote control accessories without any danger. (6 refs.)

4553 THE CONTINUING MEDICAL SURVEILLANCE OF PERSONNEL EXPOSED TO EXTREMELY LOW FREQUENCY (ELF) ELECTROMAGNETIC FIELDS. (Eng.) Houk, W. M. (Naval Aerospace Medical Res. Lab., Pensacola, FL). *Natl. Medical Res. Lab. Report No. 1225:* 17 pages; March 1976.

The medical surveillance (range 2-5 years) performed on a small group of personnel operating the extremely low frequency (ELF) communications test station in Clam Lake, Wisconsin is reported. In 1971, 24 age-sex pairs of control and exposed personnel entered this study, aimed at investigating the effects of ELF electromagnetic radiation on the health of personnel. In 1973, the seven individuals remaining in the surveillance program underwent physiochemical and psychometric testing. Physicochemical tests included: serum lipid, carbohydrates, blood alcohol, eye, audio, radiography, electroencephalograph (EEG), photic stimulation, glucose tolerance (GTT), electrocardiograph (EKG), triglycerides, and cholesterol. The results indicated little change in health status from 1971 in these seven volunteers. In 1974/75, five of six subjects had elevated GTTs. However, there was no evidence that exposure to the ELF electromagnetic field had any causal relation to this finding. Elevated GTT can be found in connection with lipid abnormalities, obesity, hypertension and heart disease. Except for one individual, all EKGs taken at rest were normal; EEGs, X-rays, and pap smears were all normal. Psychological testing indicated no apparent changes. With the limited number of subjects, it is difficult to determine the possible effects of ELF electromagnetic fields on the health of the general public. (9 refs.)

4554 POINT ELECTROANESTHESIA: REPORT III: GENERAL ELECTROPHARMACEUTICAL ANESTHESIA. (Eng.) Limoge, A. (Institut de Recherche d'Electroanesthesie, Faculte de Chirurgie-Dentaire, Paris V, 1, rue Maurice-Arnoux, 92120 Montrouge, France); Debras, C.; Louville, Y.; Atinault, A.; Lepresle, E.; Manne, J.; Degos, J. -D.; Boisgontier, M. -T. *U.S. Army Medical Research and Development Command Report* (ADA0 25075): pp. 13-55; February 1976.

This report presents the progress toward total elimination of drugs from anesthesia and the advance of pure electroanesthesia. The report includes a hemodynamic study on animals under electroanesthesia. Eight dogs (15 kg average weight), placed under electroanesthesia, had a stable and deep sleep followed by a rapid awakening. There appeared to be no difference between neuroleptanalgesia and electropharmaceutical anesthesia except for an increase in oxygen consumption during the initial wakening period. Human clinical studies are discussed with applications of electroanesthesia for thoracic, cardiac, and urological surgery. Electroanesthesia was found to be useful in high risk patients on whom it would be difficult to operate under narco-neuroleptanalgesia. Three types of tests were used to compare patients administered classical or electropharmaceutical anesthesia: modifications of neurological exams after anesthesia, quality of awakening following intervention, and the state of memory function. The study of psychological manifestations included testing for modifications of personality and memory. The results of these tests do not provide

a significant difference between classical and electroanesthesia before or after intervention. Further studies will be needed to establish conclusively that electroanalgesia does not cause any deterioration of intellectual functions, and that personality alterations are similar to those resulting from classical anesthesia. (No refs.)

4555 CHROMOSOME STUDIES OF RADAR CENTER STAFF EXPOSED TO ELECTROMAGNETIC RADIATION. (Ita.) Ciaccia, A.; Malacarne, P.; Piffanelli, P.; Della Piccola, A. (Direzione Sanita, 1ª R.A., Milan, Italy). *Minerva Med.* 67(24): 1557-1560; 1976.

Five subjects (ages 32-52) chronically exposed to electromagnetic radiation in radar centers (10, 17, 25 years) were studied for chromosomal alterations. Approximately 450 metaphases were analyzed in short-term cultures of peripheral blood for each subject, including five controls. Hypotonic shock was obtained with sodium citrate in two employees and two controls, and with potassium chloride in the others. Results showed chromatid alteratiosn, two presumed chromosomal alterations in exposed personnel, and five chromosome breaks in controls. There was no statistical difference between the two froups. There was a significant difference between the two hypotonic mediums in the exposed personnel with regard to chromatid and isochromatid alterations (2.05 and 2.17 respectively). (no refs.)

4556 ASSESSMENT OF THE EM FIELD COUPLING OF 915 MHz OVEN LEAKAGE TO HUMAN SUBJECTS BY THERMOGRAPHIC STUDIES ON PHANTOM MODELS (SYMPOSIUM SUMMARY). (Eng.) Webb, M. D. (Bioelectromagnetics Res. Lab., Dept. Rehabilitation Medicine RJ-30, Univ. Washington, Sch. Medicine, Seattle, WA 98195); Guy, A. W.; McDougall, J. A. *J. Microwave Power* 11(2): 162-164; 1976.

Full-sized human female (1.63 m tall; weight, 59 kg) and child (0.94 m tall; weight, 15 kg) phantom models with dielectric properties equivalent to those of muscle were exposed to electromagnetic leakage radiation from a microwave oven. A power amplifier, tuned to 919.5 MHz, was used. The models were exposed in three different positions. The female model was placed 5 cm, 10.1 cm, and 35.5 cm from the power amplifier. The exposure time was 300 sec for each position. The child model was placed at eye level 4.8 cm, 9.9 cm, and 35.3 cm from the power amplifier. The exposure time was 120 sec for all three positions. The regions of maximum specific absorption rates (SAR) were found to be those closest to the power amplifier; moderate levels of SAR were also observed in the neck region of the child. In all other regions of the models, the SAR was too low to be determined. The energy absorption distribution along the normal direction into the female model was similar to that predicted for a plane slab of the same material. The maximum SAR of 136 mW/kg per mW/cm^2 occurred at the surface and decreased exponentially with depth. The energy absorption pattern in the child's head showed the nasal region to have the maximum SAR of 455 mW/kg per mW/cm^2 at the surface. There was also significant absorption in the forehead, nose and mouth. For all of these regions, the maximum SAR occurred at the surface and decayed exponentially with depth. It is concluded that a power density leakage level of 5 mW/cm^2 should be expected to have negligible thermal significance in comparison to the metabolic rate of the human. (No refs.)

4557 STYROFOAM CAGES FOR RATS USED IN MICROWAVE RESEARCH: COATING WITH QUININE. (Eng.) Catravas, G. N. (Armed Forces Radiobiology Res. Inst., Bethesda, MD 20014). *Health Phys.* 31(1): 68-69; 1976.

The design for a quinine coated styrofoam cage for confinement of rats during exposure to electromagnetic radiation microwaves is discussed. Of all plastic materials used to construct cages for the confinement of rats during exposure to electromagnetic radiation only styrofoam has been found to be transparent to microwaves. Styrofoam sheets 0.5 inches thick were glued together with Elmers casein glue to make a cage of height 6 inches, width 6.5 inches and length 10 inches. Feces and urine were removed from the bottom of the cage by a series of parallel plexiglas tubes 0.375 inches outside diameter, 0.0625 inches wall thickness, and 0.25 inches apart to insure that waste materials would not perturb the electromagnetic field. One end of the tube was embedded in 1 inch thick styrofoam. Good ventillation was achieved by similiarly constructed covers. A 10% solution of quinine in absolute methanol was applied to the inner sides of the cage to determine whether this solution is effective in deterring rats from chewing their way out of the cage. Sprague-Dawley rats, 8-10 weeks old, were placed in coated and uncoated cages. Rats in coated cages remained in the cage for the duration of the experiment (24 hours), while rats in uncoated cages chewed their way out within 1-2 hours. Coated and uncoated cages were identical in terms of microwave transparency. (8 refs.)

4558 EXPERIMENTAL AND CLINICAL ASPECTS OF HYPERTHERMIA APPLIED TO THE TREATMENT OF CANCER WITH SPECIAL REFERENCE TO THE ROLE OF ULTRASONIC AND MICROWAVE HEATING. (Eng.) Har-Kedar, I. (Oncological Dept., Sheba Medical Center, Tel Hashomer, Israel); Bleehen, N. M. *Adv. Radiat. Biol.* 6: 229-266; 1976.

The role of hyperthermia alone, and in combination with radiation and chemotherapy in the treatment of cancer, is discussed, with special attention given to the use of microwaves and ultrasound. The follow-

ing mechanisms for the action of hyperthermia are considered. Tumor masses lack a good blood supply system, and therefore, are more sensitive to heat because heat dispersion is poor. Hyperthermia may act by inhibiting DNA synthesis in tumor cells. Autoradiographic studies indicate that above 39°C there is a drop in DNA synthesis. Large temperature differentials have been achieved by cooling the body to 30-32°C and heating the tumor to 42-43°C. Microwaves and ultrasound beams can be focused at deep seated tumors, and therefore, have potential for widespread clinical use. Further, it is suggested that cancer cells may be more vulnerable than normal cells to certain microwave range frequencies. Cancer cells may contain more bound water than normal cells, and microwave energy absorption has been shown to be greater at certain frequencies for bound water. The use of whole body heating and localized limb perfusion, however, is considered limited, and the theoretical advantages of microwaves over other methods of achieving hyperthermia remain to be demonstrated. (198 refs.)

4559 HEALTH HAZARDS FROM MICROWAVE EXPOSURE (LETTER TO EDITOR). (Eng.) Bush, D. (Univ. Radiation Protection Officer, Univ. Birmingham, Birmingham, B15 2TT, England). *Annu. Rev. Med.* 27: 431; 1976.

It is stressed that the maximum permissible levels of exposure to non-ionizing radiation in the United States may be too high. The maximum permissible level in the U.S.S.R. is 0.01 mW/cm^2, while it is 10 mW/cm^2 in the United States, and the United Kingdom. The U.S.A./U.K. standard is based on aberrations due to thermal effects, while the U.S.S.R. standard considers damage to the nervous system, inhibition of growth, and functional changes. These effects occur at a level well below the present U.S. standard. Due to the large increase in the use of microwave power sources, the author urges the International Radiation Protection Association to seek an international agreement on maximum permissible exposure levels to nonionizing radiation, especially microwaves. (14 refs.)

4560 PASSIVE TELEMETRY FOR IN VIVO MEASUREMENT OF FIELDS IN BIOLOGICAL MATERIALS (SYMPOSIUM SUMMARY). (Eng.) Brodin, M. E. (Northwestern Univ., Evanston, IL 60202). *J. Microwave Power* 11(2): 151-152; 1976.

A passive remote sensing method is described for the measurement of electric fields within biological samples. The intermodulation spectrum reradiated by an implanted diode was used to determine the field. The diode was exposed to dual frequency illumination and, because of inherent nonlinearity, the reradiated field contained intermodulation components. The power distribution among the intermodulation components was uniquely related to the field intensity at the diode, and by measuring the power of the components, the field was determined. The theoretical relation between the incident field and the reradiated intermodulation components was developed and applied to a biological sample. Microwave experiments are described, which verify the theory, and the results of a calculation for the expected observations in a biological sample are presented. Using these results and assuming soft tissue, it was demonstrated that for a material with a loss tangent of 0.5 and the diode implanted 4.0 cm from the surface, 24 dBw would be required for the observation. This corresponds to an input density of 10 mW/cm^2. Similar calculations were performed for 2450 MHz. (No refs.)

4561 SEARCH FOR CORRELATION BETWEEN GEOMAGNETIC DISTURBANCES AND MORTALITY. (Eng.) Lipa, B. J. (Inst. Plasma Res., Stanford Univ., Stanford, CA 94305); Sturrock, P. A.; Rogot, E. *Nature* 259: 302-304; 1976.

An attempt was made to correlate the daily number of deaths in the United States due to coronary heart disease and stroke from 1962-66, with different geomagnetic activity. Various Soviet studies have claimed a positive correlation exists between geomagnetic storms and the incidence of some human diseases. In this study, mortality rates were compared with corresponding Ap indices (world indices for geomagnetic activity) using three methods. Mortality data was normalized to remove weekly and seasonal variations and a long term secular trend. No evidence for correlation at the 3σ significance level was found. In an alternate procedure, superposed epoch diagrams were constructed for deaths on days with Ap in selected ranges. No diagram indicated a statistically significant association between daily deaths and magnetic index. The third method of presentation was to plot averaged deaths as a function of magnetic index for $-20 \leq k \leq 20$. These studies did not support the findings of Soviet studies, which claim a positive correlation exists between geomagnetic activity and disease. The Soviet results were either not statistically significant or not due to a causal relationship between geomagnetic disturbances and coronary heart disease and stroke. (10 refs.)

4562 ESTIMATION OF THE OCCURRENCE OF NEUROTIC DISORDERS IN SEA ECONOMY WORKERS EXPOSED TO THE ACTION OF ELECTROMAGNETIC WAVES. (Eng.) Dolmierski, R. (Inst. Maritime and Tropical Medicine, Gdynia, Poland); Nitka, J. *Bull. Inst. Marit. Trop. Med. Gdynia* 27(1): 57-61; 1976.

The incidence of neurosis in 12 persons exposed to electromagnetic waves is investigated. Of the 42, 18 were wireless operators, and 24 were employees of the Maritime Radio Service. Daily exposure had been four hours with length of exposure between 2-24 years. (12.5 average). They were administered the following tests: cuneostatic, orthostatic, Aschner 100, Aschner 150, hyperventilation, and time of maximum apnoea. Clinical examination showed 20 normal, 19 borderline, and 3 neurotic. This group was compared to groups of 40 normal and neurotic sailors. The test group did not differ from controls in orthostatic, hyperventilation, and time of maximum

apnoea tests. However, the cuneostatic tests were similar for wireless operators (-4.5) and neurotic sailors (-4.5). The Aschner 100 and Aschner 150 tests also showed a correlation between neurotic sailors and workers exposed to microwaves. Neurotic symptoms in more than 50% of the test group indicated an increased risk of neurosis for workers exposed to microwaves. These results demonstrate a need for periodic psychoneurologic examinations and exclusion of persons susceptible to neurosis from work with microwaves. (8 refs.)

4563 BIOMEDICAL EFFECTS OF MICROWAVE RADIATION--A REVIEW. (Eng.) Lin, J. C. (Dept. Electrical Engineering, Wayne State Univ., Detroit, MI 48202). *Natl. Electron. Conf. Proc.* 30: 224-232; 1975.

Research conducted in the Soviet Union, Eastern Europe, and the United States on the biologic effects of microwave radiation is reviewed. The clinical, hygienic and experimental studies from the Soviet Union and Eastern Europe indicate changes that occur in the nervous, cardiovascular, digestive, excretory, and hematopoietic systems due to microwave radiation. The main effect, however, is on the nervous and cardiovascular system, while other effects (i.e., lethargy) are secondary manifestations of generalized excitation of the central nervous system. These changes occurred in humans at low level exposures of 10 mW/cm^2 or less and were generally reversible. Recent United States investigations included studies on neural, behavioral, cataractogenic, testicular, and genetic effects. Rabbits exposed to near zone 2450 MHz for a minimum of 150 mW/cm^2 for 100 min developed lens opacity. However, under controlled hypothermia, rabbits similarly exposed did not produce lens opacities. Genetic studies showed only 24% of irradiated pupae of mealworm beetles exposed to 10 GHz continuous wave developed normally. Quail eggs exposed at 2450 MHz with an absorbed energy of 14 mW/gm showed no influence on cellular differentiation. The author stresses a need for studies on long term exposure effects, large scale epidemiologic investigations, and a better understanding of the mode of interaction between microwave radiation and biologic systems. (80 refs.)

4564 INTERACTION OF TWO CROSS-POLARIZED ELECTROMAGNETIC WAVES WITH MAMMALIAN CRANIAL STRUCTURES. (Eng.) Lin, J. C. (Dept. Electrical Engineering, Wayne State Univ., Detroit, MI 48202). *IEEE Trans. Biomed. Eng.* BME-23(5): 371-375; 1976.

The interaction of two cross-polarized plane electromagnetic waves with six-layered spherical models of a mammalian head was studied. The numerical results indicated that the absorbed powers induced inside small animal and human heads by incident circularly polarized waves and linearly polarized waves were very similar, except that the absorbed power in the planes transverse to the direction of propagation is uniform for the cross-polarized wave. It was also shown that the average absorbed power depended strongly on the frequency and head size involved. The maximum absorbed powers in a given size spherical head varied only slightly with frequency for the two frequencies studied. However, since a greater amount of the absorbed power occurs in the inner sphere representing the brain of a human head when 918 MHz rather than 2450 MHz is used, the former constitutes a greater health hazard to man at the same incident power. (13 refs.)

4565 STUDY OF THE EFFECTS OF CHRONIC LOW LEVEL MICROWAVE RADIATION ON RABBITS (SYMPOSIUM SUMMARY). (Eng.) Guy, A. W. (Sch. Medicine, Univ. Washington, Seattle, WA); Harris, C.; Kramer, P. O.; Emery, A. F. *J. Microwave Power* 11(2): 134-135; 1976.

A special exposure system was developed and used to chronically irradiate rabbits to a power density level of 10 mW/cm^2 for a period of six months. The system allowed a total of eight rabbits to be studied simultaneously--four receiving continuous 2450 MHz continuous wave microwave radiation and four serving as controls. Lines of constant specific absorption rate (SAR) values were measured and plotted for rabbits exposed in the chamber. The results were obtained by observation of temperature increases in the exposed rabbit carcasses by thermography. The results indicated that a peak SAR of 14 W/kg could be expected in the head of the rabbit when the animal was in the normal resting position in the cage. Four New Zealand albino rabbits weighing approximately 4 kg were exposed each day for 23 hours a day for a period of six months in the system. Periodic examination of the eyes with a biomicroscope and opthalmoscope were made and the following parameters were monitored throughout the exposure period: body weight, urinary output, rectal temperature, hematocrit, hemaglobin, white cell count with differential, platelet count, and basic blood coagulation studies. No significant differences were found between experimental and control animals. (No refs.)

4566 EFFECT OF ELECTROMAGNETIC PULSE ON AVOIDANCE BEHAVIOR AND ELECTROENCEPHALOGRAM OF A RHESUS MONKEY. (Eng.) Mattsson, J. L. (Armed Forces Radiobiology Res. Inst., Bethesda, MD 20014); Oliva, S. A. *Aviat. Space Environ. Med.* 47(6): 644-648; 1976.

A 12-kg male rhesus monkey was exposed to an electromagnetic pulse (EMP) field with pulse characteristics similar to those of industrial systems and at a field intensity and pulse rate much greater than those in typical work areas. The effect of the EMP was determined by electroencephalogram (EEG) and Sidman avoidance behavior. An EMP exposure at 266 kv/m, 5 pulses/sec was begun in the second Sidman session and ended one hour later, midway in the sixth session (18,700 pulses). During Sidman performance sessions, the monkey consistently avoided a 0.2-sec shock, administered with an interval of less than 10 sec. Sessions lasted 10 minutes with

five minute rests. No significant changes in Sidman avoidance behavior or EEG were noted. Almost all EMP energy in this study was in the frequency range below 30 MHz, where wavelengths are long. Model studies predict only minimal energy deposition when wavelengths are long relative to subject size. Also, there was a broad distribution of energy across the lower frequency so that only a small electric field existed at a specific low frequency. Future EMP experiments should consider the wavelength to body size relationship of man in an EMP field. (19 refs.)

4567 MICROWAVE-INDUCED COCHLEAR MICROPHONICS IN CATS (SYMPOSIUM SUMMARY). (Eng.) Chou, C. K. (Bioelectromagnetics Res. Lab., Dept. Rehabilitation Medicine RJ-30, Univ. Washington, Sch. Medicine, Seattle, WA 98195); Guy, A. W.; Galambos, R. *J. Microwave Power* 11(2): 171-173; 1976.

Recordings of Cochlear Microphonics (CM) from cats exposed to pulsed microwave radiation fram an aperture antenna were made. Microwave pulses (10 μsec) of 918 MHz were provided by a square aperture source (13 X 13 cm) located 8 cm away from the occipital pole of the cat and were fed by the AML PH40K microwave pulse generator. A piezoelectric crystal transducer was also attached to the skull of the same cat providing acoustic stimuli by bone conduction. Upon death of the cat, the nerve responses disappeared before the CM. After several minutes, CM also disappeared, but the artifact persisted, indicating the 38 kHz oscillatory signal was a genuine physiological response. A CM produced mechanically by the piezoelectric crystal had the same frequency and duration as that produced by the microwaves. The 38 kHz CM induced by microwaves pulses appeared to be related to the size of the cat skull when compared with the 50 kHz CM of guinea pigs. This frequency is also consistent with the fact that masking noises of 50 Hz to 15 kHz did not effect the threshold of evoked responses in the medial geniculate of cats. (No refs.)

4568 MICROWAVES ACTION IN PROCARYOTIC AND EUCARYOTIC CELLS AND A POSSIBLE INTERACTION WITH X-RAYS (SYMPOSIUM SUMMARY). (Eng.) Averbeck, D. (Fondation Curie, Institut du Radium, Section de Biologie, 26, rue d'Ulm, 75005 Paris, France); Dardalhon, M.; Berteaud, A-J. *J. Microwave Power* 11(2): 143-144; 1976.

Microwaves at frequencies between 70 and 75 GHz and at a power density 5 to 100 mW/cm^2, were used to determine effects on bacterial growth and lethal and mutagenic effects in bacteria and yeast cells. A growing culture of *Escherichia coli* K 12 wildtype was exposed to microwaves No global thermal effects were observed in the power range used. In a second approach the effects of microwaves were studied at a power density of up to 100 mW/cm^2 on the survival and induction of nuclear mutations in *E. coli*. The results show that microwave irradiation for 30 minutes at frequencies between 70 and 75 HGz and at the power density of up to 60 mW/cm^2 did not induce any killing in mutant and wildtype strains. Effects of microwaves on the induction of nuclear reversions in *E. coli* and in *Saccharomyces cerevisiae* were investigated. In yeast the induction of cytoplasmire mutations were studied. The results clearly demonstrate that microwave irradiation produced no mutagenic effects. Reversion rates observed after microwave treatment were always the same as the spontaneous mutation rates. X-rays were shown to affect various targets in the cell. The sensitivity of *E. coli* cells against X-irradiation became variable when cells were treated with microwaves before or after exposure to X-rays. (No refs.)

4569 USE OF THERMOGRAPHY FOR QUANTITATION OF ENERGY ABSORPTION IN ANIMALS IRRADIATED WITH MICROWAVES (SYMPOSIUM SUMMARY). (Eng.) Bielec, M. (Centre for Radiobiology and Radioprotection, Warsaw, Poland); Szmigielski, S. *J. Microwave Power* 11(2): 152-153; 1976.

Color thermovision (AGA-680) with temperature resolution of 0.5°C was used for quantitative analysis of the amount and distribution of energy absorbed in dead and live rats irradiated with 3 GHz microwaves. Dead rats were frozen, covered with a thin layer of metacrylate, and cut alongside the longitudinal axis of the body. Both parts of the body were put together and irradiated at 3 GHz (60 mW/cm^2) under far field conditions. Thermographic analysis of the internal surface (section) was performed every 3 minutes after irradiation. Living animals (rats and rabbits) were irradiated at identical conditions, and the thermographic analysis was performed from the body surface. Both dead and living animals were irradiated in frontal (head-tail) or long-side position to the microwave antenna. The results obtained showed dependence of energy absorption and distribution depending on position of the irradiated body in the microwave field. In rats irradiated at a frontal position, the highest temperatures were found at the brain base and base of the tail, while in those irradiated the highest temperatures were found at the long-side position in chest and pelvis. "Hot" points were found both in dead and living animals and were localized in the head and chest.

4570 A COMPARATIVE PERFORMANCE STUDY OF SPACED APPLICATORS IN MICROWAVE DIATHERMY (SYMPOSIUM SUMMARY). (Eng.) Kantor, G. (Division of Electronic Products, Bureau of Radiological Health, FDA, 12721 Twinbrook Parkway, Rockville, MD 20852); Witters, D. M., Jr. *J. Microwave Power* 11(2): 164-165; 1976.

Spaced applicators in clinical use and appropriate for microwave diathermy were evaluated by comparing near field measurements of external fields in free space and in the presence of phantoms, together with resulting heating patterns. Spatial variations of the field components were mapped in the vicinity of the applicators with a miniature isotropic probe. Digital minicomputer techniques were used to map

free space and scattered fields. The results indicated that for a microwave diathermy setting of 100 W, the total free field was typically 500 mW/cm^2 (equivalent plane wave power density). It also was shown that measured scattered fields around spaced applicators loaded with phantoms of simulated fat-muscle tissue strongly depended on the relative size of applicators and phantoms and exceeded 10 mW/cm^2 (equivalent plane wave power density) for typical treatment conditions. Heating patterns of spaced applicators irradiating planar, arm, and thigh phantoms were obtained by exposing the midplane of each phantom to an infrared thermographic camera. Temperature profiles in the region of maximum intensity were obtained. For planar phantoms, the transverse fields and temperature profiles had similar shapes. Thus, for normal incidence, the longitudinal component does not significantly contribute to the heating pattern.

4571 BIOCHEMICAL CHANGES IN THE BRAIN OF RATS EXPOSED TO MICROWAVES OF LOW POWER DENSITY (SYMPOSIUM SUMMARY). (Eng.) Catravas, G. N. (Armed Forces Radiobiology Res. Inst., Defense Nuclear Agency, Bethesda, MD 20014); Katz, J. B.; Takenaga, J.; Abbott, J. R. *J. Microwave Power* 11(2) 147-148; 1976.

The effects of microwaves on macromolecular constituents of the brain of Sprague-Dawley rats were investigated. Groups of rats, weighing 200-220 g, were exposed to continuous wave microwave radiation of 2450 MHz frequency and 10 mW/cm^2 power density (8 hours/day for 8 days) in an anechoic chamber. Control rats were effectively protected from the microwave beam. The microwave-induced changes in the PGE_1-stimulated brain adenyl cyclase and serotoninergic systems were determined. Preliminary results indicated an increased sensitivity of brain adenyl cyclase to PGE_1, with a shift of the dose/response curve to the left. This shift was more pronounced in irradiated animals euthanatized 8 hours post-exposure than those euthanatized immediately after exposure. However, the maximal adenyl cyclase activity did not appear to be affected. Marginal changes (increase) in the activity of tryptophan hydroxylase and levels of serotonin in the hypothalamic-thalamic region were also observed. No changes in monoamine oxidase activity were seen. (No refs.)

4572 MICROWAVE HEATING OF THE UTERINE WALL DURING PARTURITION (SYMPOSIUM SUMMARY). (Eng.) Daels, J. (Kliniek Maria Middelares, Gent, Belgium). *J. Microwave Power* 11(2):166-168; 1976.

Microwave heating of the uterine wall during parturition was carried out in a selected group of 2000 patients. The apparatus used was the Radarmed 12 S 230 with the curved Grossfeldstrahler widefield radiation electrode. Treatment was applied intermittently only during the uterine contractions. The dose administered varied between 80 and 100 mA. The results were compared with a control-group of 2000 patients whose pregnancies and deliveries were similar. Of the 2000 patients treated, 1936 described the analgesic effect as good, the remaining 64 experienced only moderate attenuation. The "transcalancy-group" required significantly less sedation than the control group. Comparison of the average duration of the dilation stage revealed a significant shortening of the average duration of the dilation period in those receiving microwave transcalency: 108 minutes for primiparae and 43 minutes for multiparae. This acceleration was localized mainly in the latent phase. No side-effects of microwave heating of the tissues were observed. After intermittent microwave transcalency, temperature of the amniotic fluid never exceeded 36.5°C. The temperature of the newborn was slightly increased but never exceeded 37.8°C. (No refs.)

4573 PACEMAKER INTERFERENCE: A LOW RISK. (Eng.) Anonymous. *Med. World News* 17(17): 40; 1976.

It has been publicized that electromagnetic radiation (i.e., from microwave ovens) may interfere with the operation of cardiac pacemakers. Experts, however, feel that the chances of such an occurrence are rare and would seldom be fatal. The R-wave-inhibited demand pacemaker, used in about 90% of recent implants, operates by stimulating the heart if an R-wave is not detected. This device is susceptible to electromagnetic interference (EMI), which may cause the heart to skip a beat, temporarily "control" the heart, or stop it. Moving away from the EMI source remedies the situation. Recently, manufacturers have designed better shielding and filtering circuits to minimize the risk. FDA, Biomedical Engineer, J. R. Veale, feels the risk of EMI of pacemakers is low, except in some work areas where 15-20% of pacemaker wearers under age 60 come into contact with high powered electrical equipment. Automobile mechanics may have their pacemakers stop within a foot of a well-tuned operating Volkswagen engine. It is suggested by Veale, that employers warn pacemaker wearers of the potential EMI of pacemakers and be aware of the electromagnetic radiation levels of their equipment. Dr. Doris Escher, a cardiologist at the Albert Einstein College of Medicine does not feel the risk of EMI is great, but suggests caution to pacemaker wearers when using electrical equipment. (No refs.)

4574 AN INVESTIGATION OF THE USE OF MICROWAVE RADIATION FOR PULMONARY DIAGNOSTICS. (Eng.) Pedersen, P. C. (Dept. Bioengineering, Univ. Utah, Salt Lake City, UT 84112); Johnson, C. C.; Durney, C. H.; Braggs, D. G. *IEEE Trans. Biomed. Eng.* 23(5): 410-412; 1976.

A new technique is described in which penetrating microwave radiation was used for the diagnosis and monitoring of pathologic cardiopulmonary conditions,

such as, pulmonary edema. Edema was shown to cause changes in the electromagnetic characteristics of the lung tissue, which in turn produced a change in the reflected and transmitted microwave radiation. Both the amplitude and phase changes of the microwave signals were measured and correlated with lung volume. (5 refs.)

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