

February 15, 1977



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Dr. Zory R. Glaser
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and Health
Priorities and Research Analysis Branch, DCDS
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5600 Fisher's Lane
Rockville, MD 20857

SUBJECT: Low Level Effects Working Group, ANSI C95.4

Dear Zory:

Don McRee has resigned as chairman of the Low Level Effects Working Group of ANSI C95.4 and Bill Guy has asked me to assume the responsibilities as chairman.

Enclosed is the bibliography of experimental and empirical literature provided by Ed Hunt of Working Group 4 on nonionizing EMR bioeffects and related topics for 1964 (59 citations), 1965 (58 citations), 1974 (96 citations) and 1975 (181 citations).

Please review the bibliography and select the papers which you feel are pertinent to the mission of the Group. Use whatever resources that are at your disposal to gain enough information concerning the list of papers and abstracts to make the selection.

Please send me your inputs by May 15, 1977 so I can integrate the results from all members and forward them to Bill Guy prior to the meeting of the Working Group Chairmen scheduled during the 1977 International Symposium on Microwave Theory and Techniques in San Diego, June 21-23, 1977.

I have taken the liberty of sending copies of the enclosed bibliography to all members of the Low Level Effects Working Group rather than routing the packet from member-to-member as suggested by Bill. The time we save should provide ample opportunity for all to review the literature in a leisurely fashion and have the input back to me by May 15.

If you have any questions please call me at (509) 946-2294 or 2297.

Sincerely,

Richard D. Phillips/me

Richard D. Phillips, Ph.D.
Chairman, Low Level Effects
Working Group, ANSI C95.4

Encl.

cc: A. W. Guy

939/
2/22

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0601 NEUROLOGICAL CHANGES IN SUBJECTS EXPOSED
TO HIGH FREQUENCY ELECTROMAGNETIC FIELDS.
(Pol.) Langauer-Lewowicka, H. (Clin. Occup. Dis.,
Inst. Med. Occup. Coal Mine Ind., Sosnowiec, Poland).
Neurol. Neurochir. Pol. 9(2):203-210, 1975.

The effect of prolonged occupational exposure to HF radiation was studied in 33 women, aged 21-53, exposed daily for 1.5-17 yr to a 1-1000 V/m field. Observations were rendered more difficult by the non-specific nature of the symptoms appearing in the affected subjects: headaches, pain in the region of the heart, irritability, insomnia, dizziness, and general weakness. Interruption of occupational duties for a period of 6-12 mon eliminated part of the symptoms (headache and insomnia) in some of the subjects and none in others. EEG recordings of the investigated subjects led authors to the conclusion that high frequency EMR may cause permanent structural damage in the nervous system. (19 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0602

DIELECTRIC MEASUREMENTS FOR HYDRATION OF GLOBULAR PROTEINS. (Ukr.) Kashpur, V. A.

(no affil.). V. Y. Maleev, and T. V. Shchegoleva. *Dopov. Akad. Nauk Ukr. SSR*, Ser. B:150-152, 1975.

The degree of hydration of a group of globular proteins was studied by dielectric measurements, applying 0.76 cm UHF radiation. Proteins examined included: protein of blood serum of bull, egg albumin, chymotrypsinogen, ribonuclease, pepsin, papain, cytochrome c, hemoglobin and myoglobin. When compared with other methods for determining the degree of hydration (calorimetric, sorption and NMR) the dielectric method showed proper correlation with these, as to the relative magnitudes of hydration among individual proteins investigated. With respect to absolute magnitudes of hydration, it showed consistently lower values. On the other hand, hydration values obtained by the dielectric method agreed very well, with a few exceptions, with the values theoretically predicted by models of Bull and Kuntz, emphasizing the importance of the first hydration layer. Only experimental values for cytochrome c and hemoglobin obtained by the dielectric method showed hydration values considerably higher than those predicted by models of Bull and Kuntz. (11 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0604 MEASUREMENT OF PERMITTIVITY OF SOLUTION OF SMALL BIOLOGICAL MOLECULES AT RADIO WAVE AND MICROWAVE FREQUENCIES. (E.) Lawinski, G. P. (Phys. Dep., Queen Elizabeth Col., London, U.K.), J. C. W. Shepherd and R. R. Grant. *J. Microwave Power* 10(2): 147-162, 1975.

A coaxial line cell was designed which extended the lower frequency limit to give accurate values of the complex permittivity ϵ for aqueous solutions in the 50 to 200 MHz range. Measurements of the complex permittivity of 0.25 M triglycine were made at 24 different frequencies between 55 MHz and 4 GHz and 5 temperatures (5, 12.5, 20, 30, and 40 C) using the coaxial line cell. This cell operates on the principle of measuring the waveform in the sample contained in the cell by means of a probe projecting through a sliding inner conductor moving within the sample. The main purpose of the work was to determine the dispersion of the triglycine molecule accurately. A continuous increase in ϵ between 40-800 MHz, followed by a small peak before rising again at frequencies above 2 GHz was seen. This has relevance to the biological effects of MWs and to MW hazards as these rises are paralleled by considerable increases in conductivity and attenuation coefficients, which are parameters directly determining energy absorption from MWs. (28 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0603 LONG-WAVELENGTH ELECTROMAGNETIC POWER ABSORPTION IN PROLATE SPHEROIDAL MODELS OF MAN AND ANIMALS. (E.) Johnson, C. G. (Dep. Bioeng. Univ. Utah, Salt Lake City), C. H. Durney, and H. Massoudi. *IEEE Trans. Microwave Theory Tech.* MT-23(9):739-747, 1975.

The time-averaged volumetric tissue-absorbed power density, defined as the time rate at which energy is absorbed by the tissue, was determined. The low k_a perturbation theory was applied to prolate spheroid models of man and experimental animals to obtain internal EM absorbed power distributions and total absorbed power for different orientations and frequencies. Comparisons were made with experimental measurements. A strong orientation effect, which is a critical factor in determining absorbed power, was found. Theoretical data was obtained for absorbed power distribution and total absorbed power for 3 orthogonal orientations of the prolate spheroid with respect to the plane-wave field vectors. Once biological effects due to tissue-absorbed power density are established, the plots may be used to extrapolate back to find what incident plane wave power density generate the same tissue absorbed density in the man model. This will serve as a guide to establishing radiation safety standards. (18 references)

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AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

N

0608 SEARCH FOR CORRELATION BETWEEN GEOMAGNETIC
DISTURBANCES AND MORTALITY. (E.) Ipa, B.
J. (Inet. Plasma Res., Stanford Univ., Calif.). C. W.
Barnes, P. A. Sturrock, M. Fehleib, and E. Rogot.
SUFR Rep. No. 623, NSF Grant GA-42401 and NASA Grant
NGL 05-020-272, 11p., 1975.

Speculative research on solar terrestrial relations has been concerned with possible associations between solar activity or geomagnetic disturbances and human disorders. Various authors have claimed a real association between these disturbances and myocardial infarction, psychological behavior, CNS activities and various diseases. In this research, statistical analyses were performed on mortality data obtained from the National Center for Health Statistics and geomagnetic data from the World Data Center. Daily deaths due to coronary heart disease and stroke vs magnetic activity, death rate vs magnetic index, mortality rates vs geomagnetic indices in individual cities, and death rate vs the W-index for micropulsations were measured. No statistical evidence for a real correlation was found to exist in any of this work. (9 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0612 A PERSPECTIVE ON ENVIRONMENTAL HEALTH IN
THE USSR. (G.) Glas, R. I. (Dep. Med.,
Mt. Sinai Hosp., New York, N.Y.). Arch. Environ.
Health 30(8):391-395, 1975.

Soviet methods for setting and enforcing environmental standards have been observed. The Soviet government operates as both the prime source of pollution and the sole regulator of pollution levels. The Ministry of Health of the USSR is responsible for planning and promoting research on new pollutants, translating the results into national standards, and ensuring the enforcement of these standards. Environmental standards are based on research in health effects alone, without regard to considerations of available technology, economic feasibility or ability to measure these concentrations in practice. Duplication of scientific effort is not allowed, preventing verification of controversial results. The M^h standard is a thousandfold lower than the American equivalent because it is based on nonthermal effects. As interest in effects of physical factors in the environment has increased in the West, Soviet research serves as a basis for further study. (14 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0614 THE EFFECTS OF ELECTROSLLEEP ON INSOMNIA
REVISITED. (E.) Cartwright, R. D. (Dep.
Psychol., Univ. Ill., Chicago) and M. F. Velas. J.
Nerv. Ment. Dis. 161(2):134-137, 1975.

Ten subjects suffering from objectively and sub-
jectively defined insomnia participated in a double
blind study to determine the effects of electrosleep
on this problem. Half of the group were given 24
treatment sessions, and half received 24 sham treat-
ments. A 2 week no treatment interval followed, and
a 2 year follow-up was done. All sleep symptoms im-
proved for both groups over the time interval involve
however, significant long lasting improvement was only
seen in the actual treatment group. In this group
4 of the 5 subjects were able to fall asleep with
little difficulty and to awake feeling moderately to
very well rested during the 2 yr no-treatment period.
The trend indicates that the sleep habits were im-
proved for most of the real treatment subjects and
suggest that larger, better matched groups should be
run to confirm this. (1 reference)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

70616 DEVELOPMENT OF DOSIMETRY FOR RF AND MICRO-
WAVE RADIATION - I: DOSIMETRIC QUANTITIES
FOR RF AND MICROWAVE ELECTROMAGNETIC FIELDS. (Z.)
Youmans, H. D. (Div. Biol. Eff., BRH, FDA, Rockville,
Md.) and R. S. Ho. *Health Phys.* 29(2):313-316, 1975

The biological effects of radiation result from the interaction of the radiation field and tissues. This interaction cannot be uniquely specified by a single scalar value, power density, as is often done. The strength of the radiation and its interaction with tissues should be quantitatively expressed in a physically unambiguous manner which is causally related to areas of biomedical concern. The essence of dosimetry is found in the transport equations of the mathematical theory of radiation fields. The absorbed dose may be considered as the image of exposure and a transformation which accounts for the absorption, scattering, and geometrical properties of an irradiation condition, such that absorbed energy is the work done on matter by a field of radiation. Equations for energy flux density, absorbed dose rate and total power absorbed are given in terms of E and H , the electric and magnetic field strengths. With nonionizing radiation if a material is located in the near field of a radiation source, some of the absorbed dose will result from the nonradiated reactive components of the E and H inside the medium. The equation may be in a cross field relationship. Also, in media of different permittivity and permeability, wave lengths may be different for the same frequency. Therefore, frequency is a more fundamental characteristic of an E and H and should be used. (6 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0617 DEVELOPMENT OF DOSIMETRY FOR RF AND MICRO-
WAVE RADIATION - II: CALCULATIONS OF
ABSORBED DOSE DISTRIBUTIONS IN TWO SIZES OF MUSCLE-
EQUIVALENT SPHERES (E.) Ho, H. S. (Div. Biol. Eff.,
BRH, FDA, Rockville, Md.) and A. H. Guy. *Health
Phys.* 29(2):317-324, 1975

Dosimetry in EM biological effects research has often been quantified in terms of energy flux density (incident power density), and results of animal experimentation have been directly compared to radiation protection guides. The power absorption characteristics of these animals may be drastically different for a given energy flux density than the power absorption of man. Biological effects are more directly related to absorbed dose rate. Theoretical experiments have been obtained for determining the absorbed dose rate distribution in a muscle equivalent sphere uniformly irradiated by a plane wave source. Calculations were made for single layered, muscle equivalent phantom spheres of 3 and 15 cm radii and different source frequencies (40 MHz to 10 GHz). Illustrations of the variation of absorbed dose rate with body size and source frequency. Strong standing wave patterns (hot spots) were found in the smaller sphere for all frequencies less than 5000 MHz. This is due to a focusing effect of the EMF inside a dielectric body when the size of the body is comparable to the wavelength of the radiation inside the body. For the 15 cm sphere standing waves are in evidence at RF ranges. Above 5000 MHz, the absorption in both spheres becomes that of skin depth penetration. The calculations indicate that for a given energy flux density, the absorbed dose rate distribution depends on the size of the body and the source frequency of the plane wave. There is a drastic deviation in behavior from that of ionizing radiation. Specification of energy flux density alone may not be dosimetrically sufficient for relating results of biological effects experiments to radiation protection. Absorbed dose would be more appropriate. Further research is needed for calculations on models more closely resembling human bodies. (6 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0618 DEVELOPMENT OF DOSIMETRY FOR RF AND MICRO-
WAVE RADIATION - III: DOSE RATE DISTRIBUTION IN TISSUE SPHERE DUE TO MEASURED SPECTRA OF ELECTROMAGNETIC PLANE WAVE. (Z.) Ho, H. S. (Dy. Biol. Eff., BRH, FDA, Rockville, Md.) and H. D. Youmans. *Health Phys.* 29(2):325-329, 1975.

The absorption characteristics for biological bodies irradiated simultaneously by RF and MW sources of different frequencies are unknown. Absorbed dose rate distributions have been calculated for two multiple equivalent spheres (6 and 30 cm diameter) exposed to measured EMR spectra. Data from measured spectra in the Washington, D.C. area, representing essentially far-field radiation from radio, TV, and radar transmitters, were used. Absorbed dose rate distribution was shown to depend strongly upon spectral concentration. When a dominant spectral line is present, the absorbed dose rate distribution resembled those caused by a single frequency source. Where no dominant lines exist, the exposure conditions of possible hazardous fields should be characterized in terms of spectral distributions. Further research is needed on man-equivalent models. (3 references)

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AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0619 EXPOSURE OF THE JAPANESE QUAIL EMBRYO TO
2.45 GHZ MICROWAVE RADIATION DURING THE
SECOND DAY OF DEVELOPMENT. (E.) Hamrick, P. E.
(Natl. Inst. Environ. Health Sci., Research Triangle
Park, N. C.) and D. I. McKeen. J. Microwave Power
10(2):211-221, 1975.

Based on previous work which showed effects from exposure at the 48 hr stage of development of the chick embryo, the effects of MW exposure during incubation of *Coturnix coturnix japonica* was investigated. Fertilized Japanese quail eggs (152) were positioned in holders with their long axes vertical and parallel to the E field vector of the MW field. They were exposed to 2.45 GHz CW radiation at a power density of 14 mW/g which could maintain them at 37 C. Exposure lasted for 24 hr on the second day of incubation. During exposure they were not turned. Before and after exposure, the eggs were kept in a commercial incubator with automatic turning and humidity control. The quail were kept for 24-36 hr before weighing, examining for gross deformities, and sacrificing. Blood samples were run for hematocrit, RBC, WBC, hemoglobin and differential white cell percentages. The quail were examined internally and externally for gross deformities and organ weights were determined for the heart, liver, gizzard, adrenals, and pancreas. No significant differences were seen between control and exposed birds although hemoglobin values were slightly lower (3.3%) for exposed quail. No gross abnormalities were seen, and no nonthermal effects were detected. Thus, 2.45 GHz CW microwave radiation at an observed power density of 14 mW/g did not prevent normal development of the quail embryo when exposed on the 2nd day of incubation. (25 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0620 MICROWAVE OVEN LABELING. (E.) Britain, V.
A. (BRI, FDA). FDA Consumer 9(6):16-19.
1975.

The FDA has issued new regulations which are designed to reduce the possibility of injuries by requiring precautionary labels on ovens. These regulations require permanently attached labels on all KM ovens manufactured after October 3, 1975, which state that the oven should not be operated with an object caught in the door, with an improperly closing door, or with a damaged door, hinge, latch, or sealing surface. This decision was designed to make this information readily available to everyone who uses the oven. Precautions are necessary because of uncertainty about possible radiation effects. The original KM standard establishing a maximum limit on radiation leakage has also been recently amended to require that ovens include a system to detect failure of either of the interlocks and automatically render the oven inoperable until it is repaired. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0621 THE EFFECT OF RADAR ON CARDIAC PACEMAKERS.
(E.) Rohl, D. (Dep. Cardiol., Univ. Ulm,
Germany), R. M. Laun, M. E. T. Hauber, M. Stauch,
and H. Voigt. *ISA Trans.* 14(2):115-117, 1975.

Noncompetitive cardiac pacemakers may detect electrical signals from outside the body which can modify their behavior. The interference susceptibility of 16 of these pacemakers to radiation from the most powerful civil radar system in Europe was investigated in the laboratory and 1.2 km from the radar station. The system operates with a RF output power of 5×10^6 W, 1.3 GHz frequency and a duty cycle of 0.002. Tests were performed in the laboratory in air, fat, water, 0.9% NaCl, and after implantation in dogs and humans. The layer of fat or solution was kept constant at 1 cm in front of the pacemaker, and the electrode length was $1/4$ so that it constituted an optimal receiving antenna. By varying pacemaker orientation, electrode length, and electrode position independently, it was shown that the susceptibility of the pacemakers was determined by radiation received through the electrode acting as an antenna in air. Laboratory tests indicated that fat provided the least shielding, similar to that of air. The testing therefore took place in air with an electrode length of 0.25λ and pacemaker and electrode in their most sensitive orientations. Two conclusions were drawn: (1) metal encapsulation of the pulse generator did not provide sufficient shielding because it did not prevent the entry of radiation along the electrode, and none of the pacemakers remained undisturbed at the biological tolerance limit of 10 mW/cm². To protect pacemakers optimally, several units were modified by metal encapsulation of the pulse generator and a low-pass filter at the electrical connections, they were undisturbed at power densities far above 10 W/cm². (5 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

2

Amount of
Exposure

0622 GONADIC FUNCTION IN WORKMEN WITH LONG-TERM EXPOSURE TO MICROWAVES. (E.) Lancranjan, I. (Dep. Occup. Dis., Inst. Hyg. Public Health, Bucharest, Romania), M. Mănescu, E. Răfăle, I. Klepesh, and H. I. Popescu. *Health Phys.* 29(3):381-383, 1975.

Thirty-one technicians (mean age 33 yr) with an average exposure of 8 yr to MWS with frequencies between 10,000 and 3600 MHz were investigated for gonadic function. The complex clinical examination included endocrinologic and endrologic examinations to eliminate those with endocrinologic diseases, venereal diseases, varicocele, hydrocele, testicular trauma, and other causes which could influence spermatogenesis. Spermatic liquid analyses were carried out after at least 3 days of sexual rest. Volume, motility, spermatozoa/ml and percentage of abnormal spermatozoa were measured. The elimination of total neutral 17 ketosteroids and total gonadotropins in 24 hr urine were determined in 19 technicians. Results were compared to controls without occupational exposure to chemical noxae or ionizing radiation. Seventy percent of the technicians showed decreases in libido and disturbances in erection, ejaculation, and/or orgasm. Alterations in spermatogenesis were present in 74% of the technicians. Results of 17 ketosteroids and total gonadotropins were essentially normal, without the possibility that spermatogenesis alterations were secondary to central diencephalopituitary disorder. The alterations seen in technicians exposed for a long term to relatively high intensity MWS were probably due to MWS exposure as two-thirds of the technicians reinvestigated 3 mon after interruption of exposure showed improvement in spermatogenesis. (6 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0623 HEALTH HAZARDS FROM MICROWAVE EXPOSURE.
(E.) Bush, D. (Univ. Radiat. Prot. Off.,
Univ. Birmingham, England). *Health Phys.* 29(3):431,
1975.

It is again noted that there is little research coordination into the basic understanding of the problems presented by HMs, including the nature and scale of biological effects. There is little international cooperation, discussion, and agreement on standards, as exemplified by the 1000-fold difference of maximum permissible exposure levels between the USSR and the USA and UK. The case of long term low level effects vs acute thermal effects should be explored and resolved. (4 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0624

LASER RADIATION AND MICROWAVES: THEIR IMPAIR-
MENT OF THE HUMAN BODY AND THE MEASURES FOR
PROTECTION. (Jap.) Yida, H. (Natl. Inst. Radiol. Sci.,
Jap.). Saf. Dig. (Jap.) 21(4):166-176, 1975.

The impairment of laser and MW radiation on the human body is reviewed. The MW radiation causes both thermal and nonthermal effects, and the latter effect is an obstruction in the nervous system and cell metabolism. The thermal effect depends on the energy absorptivity, specific gravity, and specific heat of the individual tissue or organ, and also depends on how the accumulated heat can be transported to the neighboring tissues or environments. Therefore, the MW radiation causes less obstruction on the human skin than the tissues inside the human body; however, the thermal effect on crystalline lens and testicles is large because of the lack of blood circulation for heat transfer. Cataracts may be caused by a large amount of MW irradiation. The US Air Force employs the value of 0.01 W/cm^2 as the maximum allowed MW energy for eye safety. A 50% increase in the leukocytes is reported in experiments on rats and rabbits as the radiation effect on the erythropoietic organs. There is disagreement about the radiation effect on the CNS between scientists from the USA and USSR. The maximum allowed level for MW radiation safety also differs by countries. (10 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

00626 DISINESTING PROCESS HERTZ ONLY INSECTS.
(Z.) Lowe, J. P. (Eur.: Ed., *Design News*,
06190-Roquebrune-Cap Martin, France). *Des. News*
30(17):62-63, 1975.

A method has been developed to kill 100% of the living insects, grubs, eggs, and larvae in wheat by applying MW energy. The ability of the grain to germinate was unchanged. The process also prevented mold growth. Ionizing, IR, visible, UV and US radiation have all proved unsuccessful and/or uneconomical to use. The MW process involves heating the grain in a HF alternating field between a pair of capacitor plates to 63 C followed by rapid cooling to 45 C. Heating takes place simultaneously at all points within the material and is almost instantaneous. Steps in the process include pre-cleaning and prewarming, MW exposure, cooling, and transfer to storage. Heat extracted during cooling is used for prewarming. This process should be suitable for flour, oats, corn, and packaged products. It is economical and environmentally acceptable as there are no chemical or radioactive residues. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0627 HISTOCHEMICAL AND ULTRASTRUCTURAL ANALYSIS
OF THE EFFECT OF ELECTROMAGNETIC RADIATION
ON RAT LIVER AND BRAIN. (Z.) Robinson, N. (Dep.
Anat., London Hosp. Med. Sch., United Kingdom), J.
G. Nieveel and J. Anderson. *Biochem. Soc. Trans.*
2(6):1359-1360, 1975.

Ultrastructural and histochemical effects of pulsed EMR on rat liver and brain were studied. White female Wistar rats (100 g) were exposed for 10 min to 27 MHz radiation at 300 and 500 pulses/min and to 2.4 and 4% duty cycles of 2.4 and 4%. The animals were sacrificed and liver and brain were rapidly excised. Light and electron microscopic studies were performed and the activities of various enzymes were determined. No significant microscopic changes were observed at either 300 or 500 pulses/min. No enzyme changes were seen in the brain. The activities of alkaline phosphatase, 5'-nucleotidase, isocitrate dehydrogenase, α -glycerophosphate dehydrogenase, lactate dehydrogenase, NADH-diphosphorase, and monoamine oxidase did not change in the liver. However, rats irradiated at 500 pulses/min had decreased glucose-6-phosphate dehydrogenase and succinate dehydrogenase activities around the central veins of the liver; ATPase activity was lower around the bile canaliculi; and acid phosphatase was more diffuse in the cytoplasm of the exposed liver than in control (1 reference)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0629 THE INCREASED EFFECTIVENESS OF CANCER
CHEMOTHERAPEUTIC AGENTS WHEN COMBINED
WITH SIMULTANEOUS MICROWAVE IRRADIATION. (E.)
Brent, R. L. (Jefferson Med. Coll., Philadelphia,
Pa. 19107) and D. Hamf. *Pediatr. Res.* 9(4):386, 1974

A study was made of the ability to alter the effectiveness of drugs present in hyperthermic tissue when exposed to MW radiation. Methotrexate and 5-fluorouracil were administered to pregnant rats at LD/10 to LD/30 doses, and the rats were immediately exposed to MW radiation for 30 min with embryo tissues maintained at 42-43 C. The LD/50 dose of these drugs was significantly lowered in the hyperthermic embryos, indicating that MW radiation may be of use in increasing the effectiveness of the drug in the irradiated tissue. It could be utilized in situations in which a local increase in drug effectiveness may benefit the organism. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0630 COMPUTATION OF THE ELECTROMAGNETIC FIELDS AND INDUCED TEMPERATURES WITHIN A MODEL OF THE MICROWAVE-IRRADIATED HUMAN EYE. (E.) Taffovs, A. (Dep. Electr. Eng., Technol. Inst., Northwestern Univ., Evanston, Ill.) and M. E. Brodwin. *IEEE Trans Microwave Theory Tech.* MTT-23(11):888-896, 1975.

The use of experimental animals to establish a human safety standard for MW radiation implies that the anatomy, physiology and electromagnetic environment of the animal can be related to that of humans. However, the role of tissue structure in determining MW absorption is possibly significant and heating potential contours may develop in different locations and at different magnitudes in man because of dimensional and structural differences in tissue anatomy. The absorbed power distribution pattern within a detailed model of the MW irradiated human eye with its bony orbit has been computed at 750 MHz and 1.5 GHz frequencies of plane wave irradiation, and temperature distribution within the eye has been calculated. The fields are computed using a finite difference, time-domain solution of Maxwell's equations. A numerical solution of the heat conduction equation for the eyeball is also given, using the computed MW heating function as the source function. The heating potential due to irradiation at 750 MHz peaks at the muscle interface at the front of the eye and decreases with depth. At 1.5 GHz irradiation, a pronounced peak is found near the center of the eyeball and the potential also peaks strongly at the muscle interfaces below and in front of the eye. The frequency dependent position of the heating potential peak can be explained on the basis of distinct resonances of the eye scatterer and head as a whole. At lower frequencies the dimensions of the eye orbit are too small to support a wave concentration effect, but at higher frequencies a resonant behavior independent of possible concentration effects of the whole head can be supported. The heat conduction model developed has as its basic assumption that the chief cooling mechanism of the eye is the retinal blood supply localization at the surface of the eyeball. At 750 MHz irradiation, the peak temperature of 40.4 C is located at about the center of the eyeball. The lens temperature is much higher at 1.5 GHz because the surface cooling mechanism is less effective than for the shallow 750 MHz heating pattern. This is a strong indication that tissue thermodynamics must be considered when analyzing MW heating of organs. Comparison of these results with those obtained by Guy et al. for the rabbit eye indicates the possibility of relating MW heating patterns within the respective organs. A more detailed human model and computer runs for higher frequencies are needed. (25 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0656 INDUCTION THERMOCOAGULATION OF THE BRAIN--
QUANTITATION OF ABSORBED POWER. (E.) LIA,
J. C. (Dep. Rehabil. Med., Bioelectromagn. Res. Lab.,
Univ. Washington Sch. Med., Seattle). *IEEE Trans.
Biomed. Eng.* BME-22(6):542-546, 1975.

RF electromagnetic field induction has been suggested as a simple, controllable, and repeatable technique to produce brain lesions. The procedure involves implanting a small metal seed in the brain and then introducing the head into an RF EM induction field. The seed is heated by the external field to produce a cerebral lesion. There is a lack of quantitative information regarding the amount of power absorption by the seed, the degree of tissue temperature elevation, and induction heating of other tissues of the body. A theoretical model was designed to study induction thermocoagulation as related to applied field strength, tissue electrical properties, and tissue geometry. The model is a cylindrical metal implant inside a spherical head containing homogeneous brain tissue throughout the sphere. Without any foreign object, the power deposition inside the sphere is a function of radius squared, increasing quadratically with distance away from the center. When a small cylindrical metal implant is introduced, it may be assumed that the induced current in tissues surrounding the implant is unaltered. Calculations were made for an implant with a 1.0 mm radius and 5.0 mm length. Properties of the implant are that of 430 stainless steel and a 1 MHz operating frequency is chosen. The conductivity of the brain tissue is 0.263 mho/cm. It is found that power deposited in the metal implant is at least 2 orders of magnitude higher than that deposited elsewhere inside a 10 cm radius sphere. It is therefore possible to heat the therapeutic implant selectively. The power absorption throughout the head is highly dependent on location, so it may be possible to orient the head with respect to the applied magnetic field to shield heat sensitive areas. The problem of thermal consequences and tissue degeneration as a result of elevated temperature are not discussed. (12 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0657 NON-THERMAL RADIONAVES AND GENETIC DAMAGE
IN DROSOPHILA MELANOGASTER. (E.) Hittler
S. (Northern Illinois Univ., DeKalb). *Mutat. Res.*
31(5):316, 1975.

Adult *Drosophila* males were exposed to radiowaves produced at frequencies commonly used by amateur radio operators and various stages of spermatogenesis were tested for genetic damage. One group was exposed for 12 hr on the antenna of a 20 W transmitter to 146.34 MHz radiation at 62.5 V/m, and the second group was exposed for 12 hr to 29.00 MHz radiation from a 300 W transmitter. When testing for chromosome loss and non-disjunction, no genetic damage due to radiowave exposure was seen. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0658

A NOTE ON EMP SAFETY HAZARDS. (E.) Guy,

A. W. (Bioelectromagn. Res. Lab., Dep. Rehabil. Med., Univ. Washington Sch. Med., Seattle) IEEE Trans. Biomed. Eng. BME-22(6):464-467, 1975.

EMP is a unique energy source which can produce far greater field strengths in man than can be produced by most sources of EM energy even though the absorbed energy density may be smaller. This is due to the relatively fast rate of change of field of the EMP. In this case, if concern is with limiting maximum field strength induced within the tissues, the time rate change of field is more important than the pulse width. The rise time, t_r , is the most important in terms of magnitude of the induced field, peak absorbed power density, and the energy density deposition. At this time the EMP safety standard can be based on previous experiments with man's exposure to typical radar pulses under the limitation of the ANSI standard (10 mW/cm²) rather than relying on the definition of the upper limit of the electrical field intensity ($E_m = 10^4$ V/m) which has appeared in the Federal Register. (4 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0559 MAGNETOTACTIC BACTERIA. (E.) Blakmore,
R. (Woods Hole Oceanogr. Inst., Mass.).
Science 190(4212):377-379, 1975.

Magnetotaxis, a bacterial response to magnetic field has been found in at least 5 morphologically distinct types of bacteria in the vicinity of Woods Hole, Mass. The cells were characterized by two chains of 5-10 electron-opaque crystallike particles found to be internal cell components. The crystallike particles were often found within intracytoplasmic unit membranes arranged as vesicles about the periphery of the cells. The tendency of these particles to clump when outside the cell is consistent with the possibility that they may be a permanently magnetic substance. Within the particles, iron was the predominantly detectable element. Freely suspended killed cells frequently formed chains of up to 10 cells which acted as a single dipole in response to changes in the position of a nearby permanent magnet. Studies of the behavior of living and dead cells in uniform and nonuniform fields should contribute to an understanding of the magnetotactic mechanism. (5 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0660 PERCUTANEOUS RADIOFREQUENCY DENERVATION OF SPINAL FACETS. (E.) Shealy, C. H. (Pain Rehabil. Cent., S. C., La Crosse, Wisc.). *J. Neurosurg.* 43(4):448-451, 1975.

A technique for RF localization and coagulation of articular nerves supplying the spinal facets, based on Rees' closed surgical procedure, was developed. Following localization of puncture points under fluoroscopy and local anesthesia, No. 12 gauge thin-walled needles were introduced and a thermistor electrode (19 cm x 1.2 mm diameter) was inserted through one of the guide needles. After radiographic position, the RF generator was activated and the lesion temperature was raised over a 1-2 min period to 80 C with maintenance for 150 sec. The procedure was repeated at other involved levels after which the patient returned directly to his room, rested for 2 hr, and was then encouraged to start spinal exercises. Pain relief was usually obvious at completion of the RF lesions. The 207 patients followed for at least 6 mo were divided into 3 groups: (1) 57 who were previously unoperated, (2) 60 who had undergone previous operations without fusion, and (3) 90 patients who had undergone operations with spinal fusion. Patients on follow-up were asked about how much of the time they had pain, severity of pain, inhibition of physical activity, drug usage, and personality effects. No neurological complications were seen in these patients. For those in group 1, 79% achieved relief of pain, 41% in group 2, and 27% in group 3. Most late failures had a return of pain within 1 mo after the procedure. The high failure rate in groups 2 and 3 is related to the extensive scarring, often coupled with arachnoiditis, seen after so much surgery. This procedure is simple and safe and offers relief when there is no comparable alternative therapy. (9 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0662 SOME BIOCHEMICAL AND CYTOLOGICAL OBSERVATIONS ON THE EFFECT OF NONIONIZING (MICROWAVE) RADIATION. (F.J. Delvedt, R. S. (Dep. Doc., Howard Univ., Washington, D.C.), S. Ogunmuyi and W. McCleod. J. Cell Biol. 63(2):90a, 1974.

The effects of 10 mW/cm² 2450 MHz continuous and pulsed radiation on rabbits were studied. Results showed a decrease in levels of lactate dehydrogenase (LDH), glutamic oxalacetic transaminase (GOT), and alkaline phosphatase over a 2 wk period of chronic radiation. Levels of α -1 globulin and α -2 globulin were elevated although total protein, albumin, and β -globulin remained constant. There were striking changes in the LDH isoenzymes of the serum and testes. Severe damage to testicular cells was seen including complete degeneration of tubules and Ley cells. The damaging effects were at least partially reversible if the animals were allowed to recover for several wk. There was little difference in effects due to continuous vs pulsed radiation, indicating that damage was not only thermal. The results suggest that MW radiation is capable of producing serious alterations in the metabolism of various key proteins, especially after prolonged exposure. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0663 RECOMMENDATIONS FOR SPECIFYING EM WAVE
IRRADIATION CONDITIONS IN BIOEFFECTS RE-
SEARCH. (E.) Johnson, C. C. (Dep. Bieng., Univ.
Utah, Salt Lake City). *J. Microwave Power* 10(3):249-
250, 1975.

Bioeffects research data, in terms of irradiation conditions, must be presented in a form suitable for comparison and evaluation. It is recommended that radiation conditions be reported in terms of the average and the localized absorbed W/kg in the sample. With this data it will be possible to extrapolate meaningfully to man for direct use in reassessing safety standards. The specific absorption rate (W/kg in the tissue, PL , is given by $PL = (o/2\rho) E \cdot E^*$ where o is the tissue conductivity at the irradiation frequency, ρ is the tissue density, and E is the electric field strength in the tissue. Conventionally W/kg is measured in tissue by calorimetry, using thermography techniques or making point measurements of temperature rises with nonperturbing temperature probes. If the rise is linear with time, $PL = 4186 \text{ cal/At}$ where C is the tissue specific heat in $\text{cal/g}^\circ\text{C}$, At is the duration of radiation in seconds, and $PL = W/kg$. It is strongly recommended that irradiation conditions be reported in terms of average and local W/kg . This information may be inferred from the following data: (1) specification of the incident wave intensity in mW/cm^2 if the radiation is plane wave with $E/H = 377\Omega$; (2) description of specimen shape, dimensions, electric properties, and orientation with respect to E and H ; and (3) description of specimen irradiation apparatus, specimen placement, presence of reflecting objects, etc. W/kg is the only common ground by which biological effects research can be compared, evaluated and utilized intelligently in the establishment of an irradiation safety standard. (N references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0664 NONINVASIVE MICROWAVE MEASUREMENT OF RESPIRATION. (E.). Lin, J. C. (Dep. Electr. Eng. Wayne State Univ., Detroit, Mich.). Proc. IEEE 63(10):1530, 1975.

A technique using MW radiation to measure respiratory movements of man and animals was developed. Radiation (10 GHz) from an X-band standard gain horn is directed toward the chest of the subject and the reflection is detected and compared to the transmitted wave to give respiratory information. The method is simple, noninvasive, and requires no contact with the subject. Problems such as skin irritation, restriction of breathing, and loose electrode connections are eliminated, and use of radio measurements make oscillator frequency unimportant. (2 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0665 EFFECTS IN RODENTS OF A 1-MONTH EXPOSURE TO MAGNETIC FIELDS (200-1200 GAUSS). (E.)
Nahas, G. G. (Dep. Anesthesiol. Pathol., Coll. Physicians and Surgeons, Columbia Univ., New York, N.Y.), H. Boccia, P. Berter, and B. Wagner. *Aviat. Space, Environ. Med.* 48(9):1161-1163, 1975.

An investigation was performed on the effects of continuous exposure to 200-1200 G magnetic fields. Microscopic observations were made of the capillaries of the mesoappendix of rats exposed to a 500 G field, and a systematic histopathological study was performed of the major organs of rats exposed to magnetic fields of 200-1200 G for one month. Cages containing 3 rats each were placed in a median position between 2 magnets so as to obtain a homogeneous magnetic field around the cages. Three control rats and 3 groups of 3 rats were exposed to 500 G for 6, 12, and 30 days, resp. Following exposure, capillary circulation was observed *in vivo* in the mesoappendix using 160x magnification. These capillaries were normal and showed no intravascular thrombosis regardless of exposure duration. Four groups of rats were exposed for 28-32 days to 0, 200, 400, and 1200 G fields. They were weighed before and after exposure and 24 hr urine specimens were collected following exposure. Twenty-four hr after exposure, blood samples were taken and all animals were sacrificed. Rats exposed to the magnetic field gained significantly more wt than controls. This wt gain was apparently related to field intensity. Final wt of brain, thymus, spleen, kidney, heart, liver, and testes was also significantly higher in exposed rats. Adrenals, ovaries, and lungs had the same final wt in all groups. There was no alteration in the vascular bed, no intravascular thrombosis, and no pathology of the artery walls in any group. Pneumonitis was found in all groups, including controls, and spleen congestion was found in both control and experimental animals: 2/6 controls were congested, 2/4 exposed to 200 G, 2/5 at 400 G, and 5/5 at 1200 G. No alteration in adrenal glands, liver, gonads or CNS tissue was found. There were no significant changes in hematocrit, WBC count, hemoglobin, or coagulation time. Exposure to the highest field used in this study produced no casualty or apparent ill effects. Further studies are needed of the effects of low intensity fields on growth and development. (19 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0666 THERMAL PROFILES OF NATIVE AND MICROWAVE
IRRADIATED DNA. (E.) Varma, M. M. (Bio-
Environ. Eng. Sci., Howard Univ., Washington, D. C.
and E. A. Traboulay, Jr. *Mutat. Res.* 31(5):334, 1974)
Swiss male mice were irradiated for 30 min at 1.7
GHz with a power density of 50 mW/cm² to test for
chemical changes in testicular DNA. A difference
was seen between control and irradiated mice when
measuring hyperchromicity and melting temperatures
of DNA, supporting the possibility that MW irradiation
causes strand separation. Carefully controlled
experiments are needed to determine the degree of
genetic damage. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0671 EFFECT OF PULSED ELECTRICAL DISCHARGES
IN MICROORGANISMS IN WATER. (Rus.)
Pavlovich, S. A. (Kalinin Med. Inst., USSR), G. P.
Belgov, P. P. Tofilo, and M. I. Voronkina. Gig.
Sant. (8):110-111, 1975.

Suspensions of *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus anthracis* in sterile tap water were exposed to high-voltage (50 kV), pulsed (1-2/sec) electrical discharges (capacitance 0.1-0.3 pF). Bacterial suspensions were placed in airtight, stainless steel cylinders with two openings: the operating electrode was immersed in one and the other was covered with a tube for a pipette so that samples could be removed after exposure to 1-120 successive pulsed discharges. These high-voltage, pulsed electrical discharges had an antibacterial effect. When a suspension containing 2 million *E. coli* in 1 ml tap water was exposed to one discharge, 20% of the bacteria were killed; 10 impulses killed 84.6% and 20 impulses killed all of the bacteria. *B. anthracis* was even more sensitive: one pulsed discharge killed 91% of the bacteria and 10 discharges killed all of them. Further experiments demonstrated that bacteria suspended in distilled water were more sensitive to these electrical discharges than those suspended in tap water, while bacteria suspended in saline solution were highly resistant. Exposure of river and tap water to high-voltage pulsed electrical discharges (capacitance 0.1 pF) revealed that tap water was completely sterilized by 20 discharges, but it required 60 discharges to kill 92% of the bacteria in river water. This is attributed to the higher bacterial count in river water and to the high concentration of salts and organic impurities which greatly reduce the antibacterial action of high voltage, pulsed electrical discharges.
(6 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0672 STUDY OF THE BIOLOGICAL EFFECTS OF PROLONGED EXPOSURE OF RATS TO MICROWAVE RADIATION HAVING INTENSITIES OF 5 TO 50 mW/cm². (Ser.) Đorđević, Z. (Inst. Aeronaut. Med., Zemun, Yugoslavia) Vojnosanit. Pregl. 32(1):51-53, 1975.

Experiments were performed on 480 male Wistar rats that were divided into two groups and exposed to: (1) 10 doses of MW radiation (5-50 mW/cm² for 2 hr/day) or (2) a single dose of 5-50 mW/cm² for 2 hr. The frequency of the MWs was 2400 MHz and the wavelength, 12 cm. Body weight and temperature were measured, and differential blood counts and ophthalmological examinations were performed before and after exposure of rats in group 1. These animals were then placed in a chamber under conditions simulating those found at an altitude of 11,000 m above sea level until they died. Rats in group 2 were sacrificed after exposure. Histological examinations were performed on their tissues, and the contents of catecholamines were determined in their brains and hearts. The threshold dose which produced significant changes in the biological parameters measured was 10 mW/cm². Exposure of rats to this dose for 10 days increased rectal and axillary temperatures and produced leukopenia accompanied by relative neutrophilia and lymphopenia. The extent of these changes increased with increasing doses of radiation. No changes occurred in the number of erythrocytes or platelets or in hemoglobin levels in any of the experimental animals. All rats, including those repeatedly exposed to 5 mW/cm² or more of radiation, also had decreased resistance to acute hypoxia. The absolute lethal dose for restrained rats was 30 mW/cm². Animals exposed to this dose developed motor excitation, clonic convulsions, and respiratory collapse and died within 2 hr. Immediately before death the rectal temperature increased to 44 C. Histological examinations performed on rats in group 2 demonstrated that death resulted from the thermal effect of MW radiation which caused thermoregulatory mechanisms to fail. Peripheral blood changes appeared to result from the stressor effect of MW radiation at intensities of 10 mW/cm² or higher. These changes were apparently caused by irritation of the hypothalamus, pituitary, and adrenals. No cataracts or other pathological changes were present in the eyes of any of the experimental animals. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0675 EFFECT OF ATP AND GLUTAMIC ACID ON OXIDATIVE PHOSPHORYLATION AND NITROGEN METABOLISM IN THE BRAIN AND LIVER OF RATS EXPOSED TO A PULSED ELECTROMAGNETIC FIELD. (Ukr.) Hishchenko, L. I. (Kharkov Res. Inst. Ind. Hyg. Occup. Health, USSR) and P. A. Kolodub. *Ukr. Biochim. Zh.* 47(4):528-531, 1975.

ATP (1 mg/100 g/day) and glutamic acid (5 mg/100 g/day) were injected s.c. into nonirradiated rats and rats which were simultaneously exposed 15 times for 3 hr at each session, to a pulsed EMF (frequency 7 kHz, field intensity 72 kA/m). Controls received 0.2 ml/day of physiological saline. Irradiation of rats significantly decreased the P/O coefficient by reducing the rate at which inorganic phosphate was esterified (by 33% in the brain and by 22% in the liver). Injection of ATP in nonirradiated rats significantly decreased the rate of O₂ uptake (by 13% in the brain and by 9% in the liver) and significantly increased the rate at which inorganic phosphate was esterified in the liver (by 18%). This resulted in a significant increase in the P/O coefficient. However, administration of ATP to irradiated rats had no effect on O₂ uptake and phosphorylation in either the brain or liver. This may be due to changes produced by irradiation in the structure of the mitochondrial membranes. Injection of glutamic acid into irradiated rats increased the rate at which inorganic phosphates were esterified in the brain and liver to values characteristic for controls. No appreciable change occurred in oxidative processes. Irradiation significantly decreased the lactate content of the liver (by 32.2%), possibly by activation of oxidative processes. In irradiated rats given ATP lactate contents were decreased not only in the liver but also in the brain (by 31%). No increase occurred in the creatine phosphate content of the brain in these rats. Irradiation significantly increased the content of ammonia in the brain (by 54%) and glutamine in the liver (by 32%); both of these values normalized after administration of ATP. Glutamic acid normalized the content of these metabolites in the brain and, to a lesser extent, in the liver. It is suggested that complete normalization of nitrogen metabolism in the liver might be prevented by its increased production of urea which has been shown to occur when animals are exposed to pulsed EMFs. (11 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0676 BEES EXPOSED TO HIGH VOLTAGES. (Ger.)
Harnke, U. (Fachber. Biol. Univ. Saarbrücken
Germany) and R. Paul. *Unsch. Wiss. Tech.* 75(13):
415-416, 1975.

Abnormal behavior was induced in bee colonies in Styropore boxes by exposing them to electrical fields produced by high voltage generators at 50 Hz. This behavior could be reproduced under certain (unspecified) meteorological conditions. The bees became very restless when placed in an alternating field at a maximum intensity of 11 kV eff/m . This can be attributed to the change in temperature. The bees also became very aggressive, not only toward outsiders, but even toward other bees in the colony and their own queen. Some of the bees that were attacked were stung to death. At lower field intensities (7 kV eff/m), only some of the brood were fed; the workers no longer stored honey and pollen, and cells which had been filled with honey were emptied. If colonies had been placed in the Styropore box only a few days before they were exposed to the electrical field, bees went out again after a few days. However, if the bees had lived in these boxes for some time before exposure, they cemented up all tears and holes, including the flight hole. Within 5 days, the flight hole was completely closed, acute oxygen deficiency set in, and the entire colony suffocated. The temperature in the hive was so high that the wax melted. (8 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0677 AUTORADIOGRAPHIC ANALYSIS OF PROTEIN SYNTHESIS AND MEASUREMENTS OF NUCLEAR VOLUME IN WISH CELL CULTURES IRRADIATED WITH 3 GHz ELECTROMAGNETIC RADIATION. (E.) Szmigielski, S. (Inst. Ayat. Med., Warsaw, Poland) and M. Luczak. *Phys. Med. Biol.* 20(5):825-833, 1975.

The investigation aimed to evaluate the relationship between the amount of protein synthesis and nuclear volume in cells irradiated with MWs, and to determine the relation between time and inhibition and stimulation under these conditions. WISH cell cultures were irradiated 24 hr after passage with 3 GHz MWs for 30 min at intensities of 5 or 20 mW/cm². After 1, 4, 12 and 24 hr of exposure the cells were incubated with 5 µCi/ml of ³H-glycine and autoradiographs were made using stripping film. The incorporation of the amino acid was measured for four groups, 0-10, 10-20, 20-40, and above 40 grains per cell. Karyometric analysis of irradiated cell cultures was performed 1, 4, 8, 12, 24 and 48 hr after exposure. In cultures irradiated at an intensity of 20 mW/cm², inhibition of protein synthesis with lowering of nuclear volume and enlargement of nucleoli was found one hr after irradiation. This was followed by increase in glycine incorporation 12 and 24 hr after irradiation with enlargement of nuclei. In cultures irradiated at an intensity of 5 mW/cm² stimulation of protein synthesis and enlargement of nuclei were seen 24 hr after irradiation. These results suggest that low intensity MWs stimulate metabolism of cells grown *in vitro*, although at higher intensities the phase of stimulation is preceded by a short period of inhibition in the culture viability. (26 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0678 MICROWAVE EFFECT ON RABBIT SUPERIOR CER-
VICAL GANGLION. (E.) Courtney, K. R.
(Dep. Rehabil. Med., Sch. Med., Univ. Washington,
Seattle), J. C. Lin, A. W. Guy, and C-K. Chou.
IEEE Trans. Microwave Theory Tech. MTT-23(10):809-
813, 1975.

An investigation was made to discover where precisely known doses of MW radiation would be applied to the nervous tissues of higher complexity, i.e., nervous tissue containing synoptic connections. The superior cervical ganglion of the rabbit was selected for excision and exposure to CW 2450 MHz fields within a temperature controlled waveguide environment. Absorbed power densities between 2 and 1000 W/kg failed to influence significantly transmission latencies of responses recorded from postganglionic fibers due to stimulation of either myelinated or unmyelinated fibers in the preganglionic trunk. (12 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0680

SOME AUTONOMIC REACTIONS IN RABBITS EXPOSED
TO A UNIFORM MAGNETIC FIELD. (Rus.)Klimovskaya, L. D. (No affil.) and N. P. Smirnova.
Kosm. Biol. Aviakosmicheskaya Med. 9(3):18-22, 1975

Exposure of rabbits to a uniform magnetic field (450 Oe) for 3 hr significantly reduced the rate of respiration for 3 hr after exposure had ended. Arterial pressure decreased during exposure but normalized within 1 hr after exposure. Although the pulse did not change significantly, significant decreases were observed in some animals during exposure and for short periods thereafter. Before exposure to the magnetic field, injections of epinephrine (4 or 10 $\mu\text{g}/\text{kg}$ i.v.) produced dose-dependent bradycardia and increases in blood pressure, but the effects on respiration varied greatly. Cardiovascular response to 10 $\mu\text{g}/\text{kg}$ epinephrine was reduced when injections were performed 1-3 hr after exposure. Exposure to the magnetic field had no effect on cardiovascular changes produced by acetylcholine (20 $\mu\text{g}/\text{kg}$ i.v.) or by electrical stimulation of the reticular formation in the midbrain (100/sec stimuli from a square wave generator for 30 sec). Exposure of rabbits to the magnetic field before or after they had been subjected to accelerations of 6 or 10 g did not decrease cardiovascular or respiratory compensation in the animals. (6 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0681 HEATING PATTERNS PRODUCED IN HUMANS BY 433.92 MHz ROUND FIELD APPLICATOR AND 915 MHz CONTACT APPLICATOR. (Z.) Lehmann, J. P. (Dep. Rehabil. Med., Univ. Washington Sch. Med., Seattle), B. J. Delateur and J. B. Stonebridge. *Arch. Phys. Med. Rehabil.* 56(10):442-448, 1975.

Theoretically, 433.92 MHz MAs should selectively heat muscle more effectively than 915 MHz MAs, which is a frequency legal for diathermy use in the U.S. To test this, 20-45 yr. old human volunteers were used to determine the temperature distribution produced by a 433.92 MHz round field applicator as compared to a 915 MHz contact applicator. The subjects were divided into 2 groups: those with 5.1 cm fat in the anterior thigh of the right leg and those with 2.2 cm fat. This portion of the thigh was scrubbed and temperature measuring probes were inserted up to a depth of 4-5 cm. All subjects were exposed to 433.92 MHz MAs at a power output of 55 W for 20 min. The difference between incident and reflected power was measured. At the end of 20 min exposure, the combined effect of continued heating with MAs and cooling by increased blood flow allowed the muscle temperatures to rise to therapeutic temperatures ($> 40^{\circ}\text{C}$). Four of the five subjects had their highest recorded temperature in the muscle, while one had the highest temperature at the skin surface or in subcutaneous tissue. The effective depth of heating was on the average 2.4 cm from the interface into the muscle at 433.92 MHz and 2.5 cm at 915 MHz. In subjects with 2.2 cm fat the peak temperatures also occurred in the superficial muscle and were cooled by increased blood flow. After 20 min the highest temperature was found in the subcutaneous fat which is only slightly cooled. When the cooled contact 915 MHz applicator was used, temperatures at the skin surface were much lower, but the highest temperature still occurred in the subcutaneous fat layer. As no significant differences were found in using 433.92 MHz vs 915 MHz radiation, there is no reason to legalize the 433.92 MHz frequency for diathermy use in the U.S. (12 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0682 ADRENOCORTICOTROPIC ACTIVITY OF THE PITUITARY UNDER THE EFFECT OF A UHF FIELD.

(Rus.) Murashov, B. F. (D. I. Ulyanov Med. Inst., Kubyshchev, USSR), P. Z. Krasnobayev, V. L. Goban, A. V. A. Romanushko. *Gig. Tr. Prof. Zabol.* (3):36-38 1975.

The ACTH activity of the blood was determined by Sayer's method in 82 men, aged 19 to 50 yr, who have worked with UHF generators for 6 months to 11 yr. Controls consisted of 23 clinically normal subjects. The ACTH activity was significantly higher in work exposed to UHF radiation (28.5 mg/100 ml) than in controls (value not given), suggesting that the low intensity UHF fields used in industry increase pituitary function. A single exposure of Wistar rats to a UHF field (wave length 12.62 cm, power flux densities of 0.1, 1, or 10 mW/cm²) significantly increased ACTH activities, whereas a single exposure of rats to high intensity (100 mW/cm²) UHF radiation for 30 min had no effect on the ACTH activity of their blood. When rats were exposed to low intensity (1 mW/cm²) UHF radiation for 30 min/day for a relatively short period (10-20 days), the ACTH activity increased, but the increase was not statistically significant. The ACTH activity tended to decrease in rats irradiated under the same conditions for 30 days. Pituitary stimulation occurred in both nonirradiated and irradiated rats (1 mW/cm² for 3 min/day for 30 days) when 0.12 mg/kg of epinephrine was injected i.p. This indicates that exposure to UHF radiation in the range studied does not impair the ability of the pituitary-adrenal system to respond to epinephrine. The reversible functional changes observed in these experiments are probably caused by disorders in processes regulating secretion of ACTH. (10 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0683 _____ EXPERIMENTAL STUDY OF SOME PROBLEMS ABOUT
THE BIOLOGICAL EFFECT OF WATER EXPOSED TO
A UNIFORM MAGNETIC FIELD. (Rus.) Stefanov, B.
(Med. Acad., Varna, Bulgaria) and S. Solakova. *Cig*
Sant. (8):70-72, 1975.

The body weight, rectal temperature, and blood were investigated in 3 groups of albino rats fed (1) ordinary drinking water, (2) water exposed to a uniform magnetic field (induction 0.1 tesla), or (3) water exposed to a uniform magnetic field (induction 0.6 tesla). Rats in groups 2 and 3 were given 2.5 ml/d of 'magnetic' water p.o. through a stomach tube for 45 days and received the rest of their water in pet dishes. The most pronounced biological effects were observed in rats in group 2. After 45 days, significant decreases had occurred in the absolute weight gain; total serum protein; Na^+ and K^+ ; and rectal temperature. The number of reticulocytes in the blood increased significantly. There was a tendency for total blood cholesterol concentrations to decrease. None of these changes exceeded normal limits (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0684 DESTRUCTION OF SALMONELLAE ON POULTRY
MEAT WITH LYSOZYME, EDTA, X-RAY, MICROWAVE
AND CHLORINE. (E.) Teotia, J. S. (Dep. Anim. Sci.
Colorado State Univ., Fort Collins) and B. F. Miller.
Poult. Sci. 54(5):1388-1394, 1975.

Experiments were conducted to study the destruction of *S. senftenberg* 775W and *S. typhimurium* on poultry meat with lysozyme, EDTA, x-rays, MWs, and chlorine. A frozen stock culture of the microorganisms was incubated until it reached the stationary growth phase. It was then diluted in 0.1% sterile peptone water to a concentration of 5×10^5 to 8×10^5 viable cells. Small white turkey hen carcasses and medium size ducks were placed in bags and covered with 500 ml aliquots of the contaminating fluid. The bag was shaken for 2 min and the fluid was poured off. The carcass was held in the closed bag at room temperature for 60 min before experimental treatment. Each carcass was aseptically transferred into a glass pan and covered with sterile Saran Wrap. They were irradiated in a MW oven for 1-10 min each, removed from the pan, and examined for any change in physical appearance. The test organism and other bacteria were destroyed in 120 sec on drumsticks and in 600 sec on broiler carcasses with MW irradiation. MW treatment produced partially cooked meat. If this cooking had no effect on shelf life, flavor, and acceptability by customers, it could be the quickest and cheapest means of destroying salmonella on poultry meat. (References)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0685 EXPERIENCE WITH MAGNETOTHERAPY FOR PAINFUL NEUROMAS IN STUMPS OF THE EXTREMITIES. (Rus.) Kucherenko, A. E. (Vinnitsa Med. Inst., USSR) and V. I. Shevchuk. *Vrach. Delo* (7):124-125, 1975.

Magnetotherapy was used to treat 42 World War II veterans, aged 48-75 yr, who had undergone amputations for gunshot wounds and fractures 29-32 yr previously. All of the patients had painful neuroma in the stumps of the extremities and severe phantom pain syndrome. The stump of the upper or lower extremity was placed between the poles of an electromagnet with an alternating magnetic field of 200-400 Oe for 15 min/day over a 20 day period. Pain was alleviated after the first session and edema after 3-4 days. Edema and inflammation disappeared completely after 10-11 days, sleep normalized, and neurotic reactions disappeared. To improve the results of therapy, magnetotherapy was continued even after the pain disappeared. Pain was completely alleviated in 37 patients. In 3 cases, there was no pain at rest, and slight pain was felt only when the neuroma was palpated. Two patients had no pain at rest, but a spastic sensation persisted in the phantom limb. Magnetotherapy proved superior to all of the methods tested so far. These include electro-sleep, ultrasound, diodynamic currents, and electrophoresis combined with analgesics. The results of special tests indicate that magnetotherapy has an inhibitory effect on the CNS, a spasmodic action on peripheral blood vessels, and analgesic and antiedemic actions. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0687 A SUMMARY OF THE ERMAC WORK SESSION ON NERVOUS SYSTEM AND BEHAVIORAL EFFECTS OF NON-IONIZING ELECTROMAGNETIC RADIATIONS. (Z.) Calloway D. (BRN, FDA, PHS, Washington, D.C.), S. M. Bavin, J. Frazer, W. Scavino, A. Guy, R. Lovely, D. Hawk, J. Schrot, J. R. Thomas, D. R. Justesen, E. L. Hunt, A. Frey, R. Seaman, and M. Desantis. J. Microwave Power 10(2):127-140, 1975.

On October 31 and November 1, 1974, an Electromagnetic Radiation Management Advisory Council (ERMAC) work session took place in Washington, D.C., to review research and progress pertaining to possible nervous system and behavioral effects of NIE and to assess the biological effects of these radiations. The participants described their current research efforts, after which a summary and set of recommendations were drawn up. It was noted that a large amount of work is emerging with commonality, especially with regard to biochemical, endocrine, and neuroendocrine effects. There remains a need to build up a greater base of information without precluding new or innovative approaches. Liaison and communication between laboratories and agencies should also be improved. In the neural/behavioral field, indications of nervous system and behavioral effects warrant further investigation, particularly in terms of specific exposure conditions and health conditions. Difficulties in determining doses and distribution of absorbed energy remain and the importance of characterizing power density and absorbed energy in a uniform manner was emphasized. Measurement guidelines should be published. Discrepancies between studies in which performance effects were observed only during irradiation and those in which they were observed following exposure were noted and a hypothesis for a possible mechanism was suggested which could account for this. The difference between pulsed and CW radiation effects should be studied with associated neurochemical and mechanical studies. The use of RF as a tool for understanding brain function was noted. Areas requiring more empirical studies included: chronic exposure; separation of E and H fields; CW vs PW effects; parallel efforts to investigate mechanisms; more work at the biophysical, molecular, and neurochemical levels; and uniformity of measurement to allow extrapolation between animals and man. The levels of funding for this research are inadequate and multi-year funding was particularly stressed. (No references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0689 EXPERIMENTAL MODELS FOR THE EVALUATION OF
MICROWAVE BIOLOGICAL EFFECTS. (Z.) Czeretk,
P. (Dep. Hum. Genet., Natl. Res. Inst. Mother Child,
Warsaw, Poland). Proc. IEEE 63(11):1540-1544, 1975.

Biological organisms are self regulating systems equipped with interdependent homeostatic mechanisms. Absorption of radiant energy creates a disturbance which activates these mechanisms. Biological effects resulting from exposure should be considered as a chain of events initiated by the primary interaction of radiation with living matter and may be classified as early (immediate direct effects, early (immediate) indirect (secondary) effects, or late (delayed) effects. This approach should serve in experimental design and interpretation of results obtained in MW experimentation. The term primary interaction should refer to the mechanisms of radiation energy absorption and direct interference with biophysical, biochemical, and bioelectrical mechanisms or phenomena in the living system. The present knowledge of biophysical aspects of complex living systems is insufficient to predict the whole range of modes of the primary interaction of MWs with such systems. Assessing the biological significance of the phenomena produced is also difficult. Empirical observations should be included in the knowledge forming the basis for further experimental approaches and used for verification of the validity of theoretical predictions. The most investigated primary interaction of MWs with living systems is the transformation of absorbed energy into increased kinetic energy of the absorbing molecules. Its physiological consequences are insufficiently taken into account in experimental design. The internal distribution of fields within the irradiated object is nonuniform and is a function of frequency, exposure conditions, tissue geometry and dielectric properties. An increase in temperature changes metabolic rate and magnitude of blood flow (early direct biologic effects) and these changes influence metabolism and transport of metabolites. These local changes may influence the function of the whole organism (secondary early biological effects). It becomes obvious that research on MW biological effects is a highly interdisciplinary domain which requires a team consisting of a physiologist, cytologist, biochemist, biophysicist, and electronics engineer. In future research, thermal balance characteristics of animals exposed to MWs should be studied; physiological and pharmacological methods should be used to discriminate between early immediate and secondary biological effects; the possibilities for developing biological MW dosimetric indices should be examined; and effects on growth and development should be urgently investigated under carefully controlled conditions. (References)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0690 EVALUATION OF POSSIBLE MICROWAVE-INDUCED LENS CHANGES IN THE UNITED STATES AIR FORCE. (B) Shacklett, D. E. (U.S. Air Force Sch. Aerosp. Med., Brooks Air Force Base, Tex.), T. J. Fredick, and D. L. Epstein. Aviat., Space, Environ. Med. 46(11):1403-1406, 1975.

A Joint Service Ad Hoc Committee on Microwave Ocular Effects was formed to research MW effects in terms of lens changes using an epidemiologic approach. If significant ocular effects occurred from exposure to MWs, a difference between control and study groups could be statistically determined. The presence or absence of effects was recorded qualitatively using the following diagnostic signs: opacities, vacuoles, and posterior subcapsular iridescence. Subjects (477) and age matched controls (340) were examined at 8 different Air Force bases over a 3 yr period. The subjects had known histories of having worked around MW generating equipment. Controls had no known MW exposure. Examination included a detailed work history, past medical history, and family history. The distant visual acuity was measured for each eye individually and pupils were dilated. In a double-blind study the subjects were examined for 3 lenticular criteria and given an external ocular examination and direct ophthalmoscopic fundus examination. The groups were broken into age decades and compared. No significant differences were seen between the 2 groups: 60% of the controls and 56% of the study subjects had lenticular opacities; 41% of each group had vacuoles; and 62% of the controls and 60% of the study subjects had posterior subcapsular iridescence. An expected increased incidence of lens changes with age was seen. This study does not support the contention that MW exposure causes human cataracts at levels permitted by U.S. safety standards. (18 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0691

ELECTROMAGNETIC FIELD EFFECTS IN NERVE TISSUE

(E.) Sandler, S. S. (Northeastern Univ., Boston, Mass.), G. S. Smith, and E. N. Albert. *Aviat. Space, Environ. Med.* 46(11):1414-1417, 1975.

An attempt was made to correlate morphological alterations in nerve tissue from the bullfrog with specific local electric fields in the tissue. A train of high intensity, short duration pulses was used to produce a high electric field intensity with negligible thermal heating. The peak electric field was 1.3×10^5 V/m with a pulse repetition rate of 250 Hz. The nerve tissue of freshly dissected sections of the spinal cord and brainstem of bullfrogs was irradiated and the large motor neurons were used for histological study. The tissue was fixed, cut, and stained with chionin or hematoxylin. No significant histological differences were seen between control and exposed tissue, suggesting that previous findings may have resulted from appreciable amounts of thermal heating. (7 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0692 MICRONAVES CHALLENGE TODAY'S HEAT PROCESSING
(G.) Schiffmann, R. F. (Redroian Assoc.,
Alpine, N.J.). Food Eng. 47 (11):72-76, 1975.

Industrial MW heating is becoming a more important food processing tool due to economic and/or product quality benefits. Foods are processed faster, cheaper, and with less labor. Increased production, increased yield and reductions in processing time pay for the initial investment. MW tempering of meat shortens tempering time, reduces drip loss, and improves sanitation. The MW doughnut proofer heats dough uniformly to 45.5 C in just 4 min from cutter to fryer. It provides speed, better control of production and product quality. The MW fryer yields a product which never before existed: a coreless doughnut which is larger and less chewy. MW dryer is used to produce uniformly dried pasta at lower capital costs and process times, with lower requirements for space. Internal heating by MWs drives the water to the surface very efficiently to avoid hardening. To thaw fish, new thawing tunnels use refrigerated air (-30 C) in the MW system. The product of kw-hr of MW power is more costly when thawing than when tempering, but not any higher than present methods. Some potential commercial uses of MW include freeze drying and/or vacuum drying. Though still being researched, the process is presently used commercially in Europe to make natural color extracts and to dry tea leaves. MW baking hopes to make use of domestic soft wheat flour as a partial replacement for imported hard wheat. Continued use of MWs in the puffing, drying, and blanching of foods awaits further investigation (No references).

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0693 MEASURE OF ENZYMATIC ACTIVITY COINCIDENT WITH
2450 MHz MICROWAVE EXPOSURE. (G.J. Ward, T.
R. (Exp. Biol. Lab., Natl. Environ. Res. Cent., EPA,
Research Triangle Park, N.C.), J. W. Allis, and J. A.
Elder. J. Microwave Power 10(3):315-320, 1975.

A dual beam Cary 15 spectrophotometer was fitted with a waveguide tuner and applicator so that a sample could be irradiated at 2450 MHz while being spectrophotometrically compared to an unirradiated reference solution. The CW beam was perpendicular to the light path and it radiated the sample through the top of the open cuvette. Enzymatic activities were determined at 25 C. Temperatures in both reference and sample solutions were measured continuously with microthermocouples, as enzymatic activity is temperature sensitive. To maintain 25 C during irradiation the sample was regulated at 19.8 C without radiation. Total irradiation time was about 5 min. Human and Torula yeast glucose 6-phosphate dehydrogenase were assayed for enzymatic activity by following the change in absorbance at 340 nm. Adenylate kinase from rat liver mitochondria and rabbit muscle were determined at 340 nm by the method of Schmitman and Greenawald. NADPH cytochrome c reductase was assayed at 550 nm. No differences were seen in specific activities of unirradiated and MW irradiated preparations ($p < 0.05$). An absorbed dose rate of 42 ± 4 W/kg was calculated from temperature differences before and during irradiation. These results are relevant to the use of a 2450 MHz MW blood warmer to raise the temperature of refrigerated bank blood to body temperature prior to transfusion. The lack of a difference between control and sample NADPH cytochrome c reductase, which is membrane bound to the endoplasmic reticulum, is important in regard to the hypothesis that MW interactions can occur with biological membranes. If membrane interaction does occur, it is not detectable as a change in enzymatic activity. (40 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0694 OXYGEN CONSUMPTION AND RESPIRATORY QUOTIENT
IN FIVE ANIMAL POPULATIONS NATURALLY EX-
POSED TO SANGUINE ELECTROMAGNETIC FIELDS. (E.)
Greenberg, B. (Dep. Biol. Sci., Univ. Illinois,
Chicago Circle). Res. Rep., Contract No. N00039-
73-0030, 16p, 1975.

A study was made to determine if or how ELF EM fields have biological effects. Specimens taken in September from the Sanguine experimental antennae in Wisconsin were tested. At this time mating and reproduction are over and day length is diminished. The animals tested included the wood louse, earthworm, redworm, slug, and redbacked salamander. These animals undergo a seasonal change in metabolic rate related to reproduction and general activity cycles so it was of interest to determine whether the fall populations responded differently to Sanguine EMFs because of their different physiologic states. Exposed and control animals, grouped for uniformity of size, were tested simultaneously. Oxygen consumption was measured in a closed manometric system. The electric and magnetic fields were measured at each collecting site. No significant difference was found in O_2 consumption or respiratory quotient between test and control groups of fall animals. As all the species collected have limited mobility it is reasonable to assume that they are the third or later generation of animals that have been exposed to Sanguine-generated fields for 5 years. After 5 yr of Sanguine operation, metabolic rate, behavior, habitat selection and external features are not altered. (14 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0695 OVICIDAL LEVELS OF 2.45 GHz ELECTROMAGNETIC ENERGY FOR THE SOUTHERN CORN ROOTWORM. (Z.) Fanslow, G. E. (Dep. Electr. Eng., Eng. Res. Inst., Iowa State Univ., Ames), J. J. Tollerts and J. G. Owens. *J. Microwave Power* 10(3):321-325, 1975.

To use EM energy as a nonpolluting means of controlling insects, it is necessary to determine the energy level required to produce a specific effect on a given insect. This study describes the determination of the threshold energy levels required to produce an ovicidal effect on the southern corn rootworm. The eggs of southern corn rootworm were subjected to EM energy at 2.45 GHz in slotted waveguide applicators. The effect of the EM energy was determined by comparing the average number of hatched eggs/treatment with the average number of hatched eggs/control. By comparing treatments with controls, the effect of EM energy can be separated from normal egg mortality. IR measurements of temperature changes were made with a scanning system. The temperature changes found were very large, suggesting that the ovicidal mechanism is thermal. The most effective EM treatment occurs when a high power is applied for a longer time. When a low power is applied for a longer time, the sample has time to cool, and it takes a larger amount of power to produce the ovicidal effect. (2 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0696 A THEORETICAL INVESTIGATION OF MICROWAVE IRRADIATION OF SEEDS IN SOIL. (2.) OIE R. G. (Dep. Electr. Eng., Washington State Univ., Pullman). *J. Microwave Power* 10(3):281-286, 1975.

Seeds in soil are exposed to MW radiation in an attempt to prevent germination. MW energy absorbed by the seed and soil is converted into heat resulting in lethal temperature rises. The larger the temperature rise, the larger the probability of lethal effects is. The seed can be heated to a significantly higher temperature than its soil environment and this can lead to a saving in the energy necessary to produce germination control. The amount of energy absorbed by seeds irradiated from above is not only a function of the dielectric field intensity and the exposure time, but also depends upon the reflection of the radiation from the surface and the geometry of the seed. Maximum power absorption occurs from frequencies in the range of 1 GHz for seeds buried at 2.5 cm. For seeds closer to the surface, higher frequencies will result in greater power absorption. For seeds buried more deeply, a lower frequency is desirable. The temperature rise of the seed is a function of the power dissipated in the seed, the duration of irradiation, and the heat capacity and mass of the seed. The soil type is an important factor in determining the effect of the exposure. For seeds buried in a mineral soil, the required energy density for germination control is in excess of 800 J/cm. The greater the thermal conductivity of the soil, the faster the decay in soil temperature is. (17 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0697 CONDITIONS OF STRONGEST ELECTROMAGNETIC
POWER DEPOSITION IN MAN AND ANIMALS.
(R.) Gadhil, O. P. (Dep. Electr. Eng., Univ. Utah,
Salt Lake City). IEEE Trans. Microwave Theory Tech.
MTT-23(12):1021-1029, 1975.

The strongest whole body absorption for biological bodies was found for EMFs polarized with the electric field along the long dimensions of the bodies. The major length is approximately 0.4 times the wavelength of radiation for bodies in free space. EM power absorption was measured for bodies of fixed size at various frequencies using a parallel-plate waveguide as a transmission medium of plane waves. Bodies scaled down in all dimensions result in peak absorption frequencies scaled up by the same factor and vice versa. Experiments with biological phantoms and figures show a high power deposition in the neck region. Initial experiments with anesthetized and dead rats have shown a higher power deposition in the neck region than in the core of the animals. The frequencies of maximum absorption for adult humans is projected to be on the order of 65-75 MHz for free space conditions and about half as much in the presence of ground effects. (12 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0698 MUTAGENESIS BY RADIOWAVES IN ANTIRRHINUM
MAJUS L. (Z.) Harte, C. (Inst. Dev.
Physiol., Univ. Cologne, West Germany). *Mutat. R*
29(1):71-75, 1975.

The pollen of *Antirrhinum majus* L. Sippe 50 was irradiated ($\lambda = 1.5$ m; field strength = 1.5 V/m) for 4, 12 and 43 3/4 hr to test the mutagenic effect in the progenies. The irradiated pollen was crossed onto styles of emasculated flowers of plants in the greenhouse. The only difference between experimental pollen and the controls was the exposure to radio waves. The frequency of progenies with a high percentage of empty seeds shows a correlation with the duration of the pollen treatment. Abnormalities were only counted as mutations when several seedlings of the same progeny showed the same character. The mutagenic effect was confirmed by the increase in embryonic lethality after selfing the M_1 plants and the increase in relative frequency of segregating progenies with seedling anomalies. (9 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0699

THE DISTRIBUTION OF HEATING POTENTIAL
INSIDE LOSSY SPHERES. (E.) Kritikos,R. N. (Dep. Bioeng., Moore Sch. Electr. Eng.,
Univ. Pennsylvania, Philadelphia) and B. P. Schwa
IEEE Trans. Biomed. Eng. BME-22(6):457-463, 1975.

One mechanism which contributes to the effects of EMs on biological tissues is the process by which the heating potential is distributed inside the test objects. A nonuniform distribution implies the possibility of nonuniform temperature rise or the creation of hot spots. This study was designed to establish the conditions under which the heating potential peaks inside the test object and to determine the exact size and shape of these potential hot spots. Biological tissues are lossy dielectric providing joules heat when subject to EMs. For this study, the dielectric properties of brain tissue in a homogeneous sphere was chosen. In no case was the heating found to be uniformly distributed throughout the sphere. The type of nonuniformity was dependent on the radius of the sphere and frequency of the radiation. Two regions could be distinguished: one where heating takes place primarily at the front surface and a second where maximum heating takes place inside the sphere. The magnitude of the maximum heating potential was substantially different from values calculated by traditional methods, with maximum discrepancy (larger by a factor of 10) taking place in the region where hot spots occur. Hot spots occur only for small spheres and are therefore pertinent to heads of small animals and infants. Only the heating potential was calculated; the resulting temperature rise is reduced by heat diffusion and heat convection due to blood flow. (7 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0702 MICROWAVE DRYING OF MICROORGANISMS: I.
INFLUENCE OF THE MICROWAVE ENERGY AND OF THE
SAMPLE THICKNESS ON THE DRYING OF YEAST. (G.) Gomes,
A. M. P. (Dep. Chem. Eng., Sch. Eng. Mauá, São Paulo,
Brazil), G. F. Leonhardt, N. Tórtola, and W. Borzani.
J. Microwave Power 10(3):265-270, 1975.

The study was made to ascertain whether MW heating could be used to dry yeast cells. A Microvac-2000, 2450 MHz MW oven, with an input power varying from 1.2 to 4.2 kW, was used in the experiments. Commercial pressed yeast in 500 g tablets was used in the drying tests. The moisture content of the pressed yeast was determined by drying 1.5 g of the sample in a conventional oven at 100-105 C for 5 hr. Drying time needed to achieve a final moisture content of 0.05 g of water of dry yeast and drying rate during constant rate period were provided. There was a good linear correlation between the power input and the drying rate calculated during the constant rate period. Sample thickness on the drying rate indicated that for a sample larger than 2.0 cm there is no significant variation of the constant drying rate. The results indicate a real possibility using MW energy for drying single cell protein. (3 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0703 EVIDENCE FOR COOPERATIVE MECHANISMS IN THE SUSCEPTIBILITY OF CEREBRAL TISSUE TO ENVIRONMENTAL AND INTRINSIC ELECTRIC FIELDS. C. J. Adey, W. R. (No affil.). *Functional Linkage in Biomechanical Systems*, ed. T. O. Schmidt, D. M. Schneider, and D. M. Crothers (New York: Raven Press, 1975), pp. 325-342.

Information processing in brain tissue no longer is considered to involve only the nerve cells. There are strong physiological interactions between nervous and surrounding neuroglial cells. Surface regions may have other quite special functions in the detection and transduction of weak chemical and electrical events at the membrane surface. The characteristic phenomenon of overlapping dendritic fields in the palisades of cells that characterize all vertebrate cerebral ganglia may be associated with the concurrent development of a rhythmic electric wave process. This dendritic organization appears to constitute a specific arrangement in cerebral tissue. The possibility that brain tissue may be sensitive to field potentials in the environment of the neuron, including the intrinsic fields of the EEG, is discussed. Experiments involving monkeys are described which involve the effects of low level, low frequency electric fields on EEG and behavior. There was a decided trend to shorter interresponse times in the presence of the fields. To add to the evidence that membrane surface might transduce weak extracellular fields as a step in the excitation process, the effects of VHF electromagnetic fields, amplitude modulated at EEG frequencies, was studied. Unequivocal interactions have been demonstrated between the brain tissue of mammals and birds and a variety of electric and EM fields. Behavioral effects from these studies occur with very low tissue electric gradients. Calcium appears to have an essential role in these interactions, and evidence points to a functional role for intrinsic electric gradients. (65 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0704 NONIONIZING RADIATION. (C.) Silney, D. H. (Oo affil.) and D. L. Conover. *Industrial Hygiene and Health: The Worker and the Community*, ed. L. V. Cralley and P. R. Atkins (New York: Academic Press, 1975), pp. 157-177.

A review of the standards concerning physiologic effects of NIR, with an emphasis on new exposure criteria, is given. Mention is made of national consensus standards and federal rules which are near publication for several types of NIR, including lasers and MW exposure. The ANSI C95.1 standard was modified to include the specification of the TVE in the equivalent free space electric field strength (200 V/m) and the magnetic field strength (0.5 A/m) for CW fields and in electric field strength squared (40,000 V²/m²) for modulated fields. This revision was primarily the result of a growing realization that separate electric and magnetic field strength measurements were mandatory for meaningful and accurate characterization of RF fields below approximately 300 MHz. (63 references)

BIOLOGICAL EFFECTS OF EM RADIATION

ANSI # 75-279

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0705 FREQUENCY AND ORIENTATION EFFECTS ON WHOLE ANIMAL ABSORPTION OF ELECTROMAGNETIC WAVES. (R.) Gandhi, O. P. (Dep. Electr. Eng., Univ. Utah, Salt Lake City). *IEEE Trans. Biomed. Eng.* BME-22(6): 536-542, 1975.

Studies were carried out to determine whether the total power absorbed in a whole animal body varies with frequency, what the frequency regions of most absorption for various polarizations are, what percentage of incident power is absorbed at such frequencies, and whether extrapolations to humans are possible. Using a parallel plate waveguide with a 6.35×15.9 cm² cross section, absorption of 96, 158, 261, and 390 g anesthetized Wistar rats was measured. The animals were placed on a styrofoam sheet to separate them from the waveguide plates as observed characteristics were independent of placement as long as the bodies were 2-3 mm from the plates. It was found that there is a definite frequency of peak absorption and the frequency for maximum absorption reduces as $M^{-1/3}$ with weight M of the animal. For frequencies below resonance, the power absorbed varies as $f^{4/3}$. At the absorption peak, the power absorbed varies as $M^{2/3}$, which is essentially an absorption cross section proportional to the shadow cross section of the animal. Above resonance, absorption reduces monotonically with increasing frequency. The effect of the tail on whole body absorption was minimal. The RF power deposition varied significantly with orientation and frequency, with the strongest absorption for waves polarized along the long dimension of the body at frequencies such that the major length is approximately $\lambda/4$ wavelength of radiation in the presence of ground caused images. The highest whole body absorption for humans is predicted to be 40-50 mW by extrapolation. (6 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0706 INDUSTRIAL AND SCIENTIFIC APPLICATIONS OF
DOPPLER RADAR. (B. J. Whitton, C. P. Orr.
Inst Board, London, England). *Microscopic J.* 18(11):
19-42, 1975.

The principal advantages of Doppler radar over other methods of speed measurement are the lack of any need of physical contact with the system and the ability of the radar to be directed into areas which are normally inaccessible. The RF hardware is usually very simple, ranging from single cavity devices to arrangements in which the oscillator power is transferred to the mixer by a coupler and a circulator is used to allow single antenna working. A physiological application of Doppler radar is its use to monitor the respiration rate of humans and animals. The radar is directed at the subject's chest and respiration rate is inferred from the periodic changes in Doppler shift frequency which occurs as the chest wall moves. It is a great advantage that the radar needs no contact with the patient. The device causes no discomfort and, at 2.5 mW, presents no biological hazard. The same principle is used to form a respiration monitor in a polygraph system. (21 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0708 ECOLOGICAL INFLUENCE OF ELECTRIC FIELDS.
(E.) Bankoske, J. V. Westinghouse Electr.
Corp., East Pittsburgh, Pa.) and G. McKee. Res. Rep.
No. EPRI 129, 20p, 1975.

This project was initiated to study effects of electric fields on plants, animals, and soils in the vicinity of high voltage transmission lines. It was necessary to determine the nature of electric fields in the vicinity of actual transmission lines, including the calculation of the magnitude of fields at ground level, several meters above ground, and the lateral profile of the gradients in a direction perpendicular to transmission lines. The maximum gradients that were calculated were used to set reasonable limits on the fields. The electric field intensity can be minimized by using a triangular configuration for line voltage. The number, size, and spacing of the phase sub-conductors have a minor effect on the gradient, with the gradient increasing as the apparent size of the phase conductor is increased. The steps taken to reduce corona and RIV tend to increase the voltage gradients at ground level. The maximum electric field intensity increases as plant height increases beneath a prototype 1100 KV transmission line. This increase is caused by raising the effective ground plane for the transmission line. The project will involve tests made on the germination rate of seeds and morphological changes at the cellular level. Plants will be grown through several life cycles under different electrical fields to assess effects on pollen tube growth, pollen viability, meiosis, and mitosis.
(20 references)

DC

AUTHOR:

TITLE:

PUBLICATION:

DATE:

TYPE AND CLASS OF STUDY:

WAVE AND/OR FREQUENCY:

0625 THE EFFECTS OF MICROWAVE IRRADIATION ON INSECTS, NEMATODES, FUNGI, AND BACTERIA IN WITHERED PINE TREES. (Jap.) Yamane, A. (Natl. For. Exp. Stn., Minist. Agric. For., Tokyo, Japan). T. Kobayashi, O. Hamaya, H. Tanaka, K. Sasaki, and S. Yoshida. *Proc., 86th Annu. Meet. Jap. Dendrological Soc.*, p. 317-318, Aug. 1975.

The lethal effects of MW irradiation on insects, nematodes, fungi, and bacteria in withered pine trees were studied using 2450 MHz MWs with output powers at 0.6 and 5.9 kW. When the speckled-longicorns larvae, prepupa, and pupa were placed in a plastic capsule and irradiated with 0.6 kW MWs, 25% of the larvae longicorns died after 30 sec irradiation, and 90% of the larvae longicorns died after 60 sec irradiation. The larvae longicorns were more sensitive to the microwave lethal effect than the pupa longicorns. The temperatures attained at the core and under-bark of pine trees after the microwave irradiation were different, and the core temperature was higher than the under-bark temperature. This reflected the observed lethal effect, and longer irradiation time was required for killing the insects, nematodes, fungi, and bacteria which lived in the under-bark than in the core of the pine trees. The effective irradiation time was 45 sec for larvae insects, 2 min for nematodes, and more than 5 min for fungi and bacteria. (1 reference)



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March 3, 1977

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SUBJECT: Low Level Effects Working Group ANSI C95.4 Committee

Dear Zory:

In the last mailing you should have received the bibliography for FY 1974. Enclosed are the bibliographies for 1964 and 1965. The package for 1975 will be sent to you within the next two weeks.

To clarify previous instructions, our job is to review the bibliographies and select the papers which we feel are pertinent to and of sufficient quality to be included for assessing low level effects. After you complete the review, send me a list of your selections. I will compile the lists from our working group and forward them to Bill Guy. The target date Bill has set is May 15, 1977.

Best regards,

Richard D. Phillips, Ph.D.
BIOLOGY DEPARTMENT

RDP/me

Enclosures

cc: A. W. Guy

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SEATTLE, WASHINGTON 98195

School of Medicine
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8 February 1977

TO: Members of Working Group on Low Level Effects
FROM: Arthur W. Guy, Chairman C 95.4

Don McRee has resigned as chairman of the working group and Dick Phillips has agreed to assume the responsibility. In order to get the group started in its work, I am sending you the attached bibliography of experimental and empirical literature on nonionizing EMR bio-effects and related topics. Included are packets of literature for 1964, 1965, 1974 and 1975 provided by Ed Hunt, Chairman of the Surveillance and Reliability Assessment of Literature Working Group WG-4. Ed has also provided the attached explanation of the function of his group in developing the bibliography and his group's relation with other Working Groups in order to aid them in the tedious review of the literature. At this time, you should review the enclosed bibliography and select out the papers which you feel are pertinent to the tasks facing the Low Level Working Group. Since all the members of the group must review this literature, I would suggest that you make a copy of the originals to keep for yourself and then send the packets on to the next member on the distribution list. If you cannot do this, could you then review the bibliography over the next several weeks, make your selections, and send the compilations to the next person on the list.

When you are through with the compilations, please send them on to the next person on the list along with the cover letter and distribution list. I will need your inputs by May 15, 1977, so that I can integrate the results from all the members prior to the meeting of the Working Group Chairmen scheduled during the 1977 International Symposium on Microwave Theory and Techniques in San Diego June 21 - 23, 1977.

Sincerely yours,

Arthur W. Guy (C-95.4)

Arthur W. Guy, Ph.D.
Chairman, ANSI C 95
Subcommittee IV

AWG:vsb

enclosure

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