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The Biological Effects of Electromagnetic Radiation serves as a vehicle through which current documentation of research highlights on the biological effects and health implications of nonionizing electromagnetic radiation (microwave and radio-frequency radiation) are compiled, condensed, and disseminated on a regular basis. BEEMR is intended to be a highly useful current awareness tool for scientists engaged in research or related activities, the great number and diversity of relevant publications make imperative the availability of this service to persons whose work requires that they keep abreast of current developments in the field.

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A Digest of Current Literature and a Forum of Communication

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Literature Selected and Abstracted
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PREFACE

Biological Effects of Electromagnetic Radiation is a publication researched and prepared by the Franklin Institute Research Laboratories, Science Information Services Department, under a grant from the U.S. Army Research Office. The grant is co-sponsored by the Bureau of Radiological Health, Food and Drug Administration; Office of Naval Research; U.S. Navy Bureau of Medicine and Surgery; U.S. Air Force School of Aerospace Medicine; and the Walter Reed Army Institute of Research. The U.S. Environmental Protection Agency is cooperating in this project.

This digest serves as a vehicle through which current documentation of research highlights on the biological effects and health implications of nonionizing electromagnetic radiation (microwave and radiofrequency radiation) are compiled, condensed and disseminated on a regular basis. *Biological Effects of Electromagnetic Radiation* is intended to be a highly useful current awareness tool for scientists engaged in research or related activities. The great number and diversity of relevant publications make imperative the availability of this service to persons whose work requires that they keep abreast of current developments in the field.

Biological Effects of Electromagnetic Radiation is published quarterly. The issues of Volume II, and future volumes, will include materials received during the preceding three months. Each issue will include news items and announcements, a listing of meetings and conferences, abstracts of current literature, and a directory of current research. Materials for which full text is not available will be included as citations. When available, a special report section, technical note, book review, or topical retrospective literature survey will be included.

ABBREVIATIONS AND ACRONYMS

- A -

A, amp - ampere
A - angstrom
AC - alternating current
ACTH - adrenocorticotrophic hormone
AF - Air Force
AMP - adenosine monophosphate
ANSI - American National Standards Institute
ATP - adenosine triphosphate

- B -

BRH - Bureau of Radiological Health

- C -

c - cyclic
C - Centigrade
Ci - Curie
CL - Current Literature
cm - centimeter
CNS - central nervous system
cps - cycles per second
CR - Current Research
CW - continuous wave

- D -

dB - decibel
dc - direct current
DNA - deoxyribonucleic acid
DOD - Department of Defense
DOPA - dihydroxyphenylalanine

- E -

E, $\hat{E}$ - electric field
ECG - electrocardiogram
EEG - electroencephalogram
EHF - extremely high frequency
ELF - extremely low frequency
EM - electromagnetic
EMC - electromagnetic compatibility
EMF - electromagnetic field
EMI - electromagnetic interference
EMP - electromagnetic pulse
EMR - electromagnetic radiation
EPA - Environmental Protection Agency
ES - electrostatic
ELS - electrostatic field

- F -

f - frequency
F - farad
FDA - Food and Drug Administration

- G -

g - gram
G - Gauss
GHz - gigahertz

- H -

H, $\hat{H}$ - magnetic field
HEW, DHEW - Department of Health, Education, and Welfare
HF - high frequency
hr - hour
Hz - hertz

- I -

IEEE - Institute of Electronic and Electrical Engineers
IMPI - International Microwave Power Institute
i.p. - intraperitoneal
IR - infrared
i.v. - intravenous

- J -

J - joule

- K -

kA - kiloampere
kg - kilogram
kHz - kilohertz
km - kilometer
kV - kilovolt
kW - kilowatt

- L -

l - liter
lb - pound
LD_{50} - 50% mortality
LF - low frequency

- M -

m - meter
mA - milliampere
mc - megacycle
mg - milligram
mho - unit of measurement of conductivity
MHz - megahertz
min - minute
ml - milliliter
mm - millimeter
mmho - millimho
mOe - millioersted
mon - month
mW - milliwatt
Mw - megawatt
MW - microwave
mV - millivolt

- N -

NBS - National Bureau of Standards
NIH - National Institutes of Health
NIOSH - National Institute for Occupational Health and Safety
nm - nanometer
NSF - National Science Foundation

- O -

Oe - oersted
ONR - Office of Naval Research
OSHA - Occupational Safety and Health Administration

- P -

PFD - power flux density
PHS - Public Health Service

p.o. - orally
pps - pulses per second
PRF - pulse repetition frequency
PW - pulsed wave

- R -R

R, rad - Roentgen
RF - radiofrequency
RNA - ribonucleic acid

- S -

s.c. - subcutaneous
sec - second
SHF - super high frequency
Sq - solar quiet daily variation
SW - shortwave

- T -

TLV - threshold limit value

- U -

UHF - ultrahigh frequency
US - ultrasound
USDA - U.S. Department of Agriculture
USNC - URSI - International Union of Radio Science - U.S. National Committee
UV - ultraviolet

- V -

V - volt
VA - Veterans Administration
VLF - very low frequency
vol - volume

- W -

W - watt
WBC - white blood cell
WG - waveguide
WHO - World Health Organization
wk - week
wt - weight

- Y -

yr - year

SYMBOLS

ε - dielectric constant
$\hat{\varepsilon}$ - complex permittivity
λ - wavelength
μ - micro
σ - specific conductance
γ - gamma
Ω - ohm

Biological Effects Electromagnetic Radiation II(4), December 1975

NEWS ITEMS

HIGH VOLTAGE POWER LINE CONTROVERSY

There is controversy concerning ultra high voltage power lines as a source of electrical emissions which might be dangerous to humans and animals. The U.S. Environmental Protection Agency's radiation division is investigating the limiting of such lines or imposing special precautions on public exposure. The Soviet Union did find some adverse physiological effects among workers on lines below the ultrahigh voltage level. Exposure limits were set there in 1971 after some workers showed 'instability' of pulse and blood pressure and tremors of arms and legs. Two proposed power lines in northern New York State and another in Michigan are presently under controversy. The ultra powerful lines carry 765,000 V and have noise levels up to 60 dB. The electric field around lines causes shock if a metal surface, such as a vehicle side, is touched. The lines carry alternating current, oscillating at the standard rate of 60 Hz. It is these fluctuations, combined with the strength of the current, that are thought to have harmful physiological effects. Nearly all the ultra high lines in the U.S., in Virginia, West Virginia, Ohio, Kentucky, Indiana, and Michigan, belong to the American Electric Power Co. The lines run from major generating plants to electric companies' distributing centers. There, the current is reduced in steps to the 110 V and 220 V levels. Transmission is progressively less expensive as voltage is stepped up. The power industry claims that by using high voltage lines, the number of lines needed would be fewer. However, the lines run close to where people live and work and under state laws, utility companies generally get right-of-ways by condemnation. There is no federal jurisdiction over power lines.

The News Journal Wilmington, Delaware
November 27, 1975

MICROWAVE COOKING OF LOW GRADE MEAT

The ABR Food Machinery Co., Ltd. and GEC-Elliott Process Automation, Ltd. have developed a process to produce meat and fish products which removes the need for casings, rendering low grade but protein rich meats palatable. The product is free from cooking loss and bacteria. The process uses MWs to cook material which has been extruded from a continuous vacuum processor. The cooked material is then cut or diced. The purpose of the system is to produce meat cubes and similar ingredients for pies, ready meals, and canned products. It can also be used for manufacturing skinless sausages. It is claimed that the product is a solid cube of meat in which tough constituents such as sinew and gristle are made palatable. The end product of the process can withstand freezing, boiling, baking and retorting temperatures without disintegration. Cooking losses are under 5% because the meat cooks almost instantaneously in metal tubes which pass between two microwave guides.

Food Manufacture 50(8):24, 1975

MAGNETIC FIELDS AND HUMANS

Whether humans sense and are affected by magnetic fields is presently being studied at the University of Minnesota. Otto H. Schmitt, chairman of the Bio-Physics Group and professor of electrical engineering, began the two year study after serving on an American Institute of Biological Sciences committee that alerted the U.S. Navy to possible biological dangers from Project Sanguine. In this study, volunteers were placed in a box that screened out all external magnetic fields. Then a magnetic field was generated inside the box, and turned on and off at random. None of the 500 subjects could tell consistently when the low frequency fields used in this study were on.

Popular Science 207(4):22, 1975

OPPOSITION TO PROPOSED DIATHERMY STANDARD

The Technical Electronic Product Radiation Safety Standards Committee of the BRH recently proposed a standard for MW diathermy equipment. At a public meeting held in Rockville, Maryland in September, the IEEE Committee on Man and Radiation's opposing position was presented. COMAR believes that unnecessary restrictions on the use of diathermy equipment by qualified practitioners is undesirable and that it would be better to regulate the qualifications of diathermy operators than to limit the flexibility of the equipment. The question of limits should concern only the power density impinging on portions of the body that are not to be heated and on equipment operators after appropriate screening and shielding. The proposed standard appears to be unnecessary and could seriously hamper the beneficial applications of MW radiation in biology and medicine.

IEEE Spectrum 12(11):20, 1975

MICROWAVE THERMOGRAPHY FOR CANCER AND STROKE DETECTION

Alan H. Barrett and Philip C. Meyers of MIT have developed a technique capable of detecting abnormal temperatures within body tissues as deep as 10 cm. Microwave thermography uses a radiometer sensor attached to the skin to measure heat radiated by internal tissue in the form of microwaves. Abnormal temperatures often signify developing tumors of the breast or reduced blood flow indicative of the onset of a stroke.

Chemical and Engineering News 53(46):31, 1975

NEWS ITEMS

ELECTRIC CURRENT TO HEAL BONES

For more than four years, surgeons at the Hospital of the University of Pennsylvania have been using low voltage electric current to help broken bones heal. They have learned where it is best to place the electrodes and the optimum voltage for various fractures. However, it is not known why it works. Both biochemical and biophysical factors are involved.

The Evening Bulletin November 4, 1975

ITEMS FROM THE COMMERCE BUSINESS DAILY

- RESEARCH ON MICROWAVE RADIATION.

The Office of Naval Research, Arlington, Virginia, has contracted with Battelle Memorial Institute, Richland, Washington, for the above study. (November 4, 1975)

- DEVELOPMENT OF ED MODEL OF AN EM RADIATION SYSTEM.

The USAECOM Procurement Division, Fort Monmouth, New Jersey, has contracted with AEL Service Corporation, Colmar, Pennsylvania, for the above study. (November 5, 1975)

- FURTHER RESEARCH ON DETERMINING THE INFLUENCE OF EMBRYONIC EXPOSURE TO MICROWAVES ON POST-NATAL BEHAVIOR AND GROWTH RATE.

The Office of Naval Research, Arlington, Virginia, proposes to negotiate with the Institute for Behavioral Research, Inc., Silver Spring, Maryland, for the above study. (November 20, 1975)

MEETINGS AND CONFERENCES

**** 1975 ANNUAL MEETING OF THE USNC-URSI

Date: October 20-23, 1975
Place: Boulder, Colorado
Sponsor: URSI, IEEE
Requests for Information: Prof. J. R. Wait, Rm. 242, RBl, CIRES, University of Colorado, Boulder, Colorado 80302

Selected Bibliography of Papers to be Presented:

MICROWAVE HEARING IN MAMMALS AT 3.0 GHz. C. A. Cain (Bioacoust. Res. Lab., Univ. Illinois, Urbana) and W. J. Rissmann.

A THEORETICAL STUDY OF MICROWAVE-GENERATED AUDITORY PHENOMENA IN MAMMALIAN CRANIAL STRUCTURES. J. C. Lin (Dep. Electr. Eng., Wayne State Univ., Detroit, Mich.) and C-K. Lam.

MICROWAVE-INDUCED AUDITORY RESPONSE--COCHLEAR MICROPHONICS. C. K. Chou (Dep. Rehabil. Med., Univ. Washington Sch. Med., Seattle), A. W. Guy, and R. Galambos.

DISCRIMINATIVE CONTROL OF APPETITIVE BEHAVIOR BY PULSED MICROWAVE RADIATION IN RATS. R. B. Johnson (Dep. Rehabil. Psychol., Univ. Washington, Seattle), D. Meyers, A. W. Guy, R. H. Lovely, and R. Galambos.

RF SOUND: POSSIBLE MECHANISMS AS DEFINED BY RECENT RESEARCH. E. S. Eichert (Randomline, Inc., Huntingdon Valley, Pa.) and A. H. Frey.

BIOLOGICAL THERMAL EFFECT OF MICROWAVE RADIATION ON HUMAN EYES. K. A. Al-Badwaihy (Dep. Electr. Eng., Cairo Univ., Egypt) and A-B. Youssef.

EFFECTS OF 35 AND 107 GHz CW MICROWAVES ON THE RABBIT EYE. L. Birenbaum (Polytech. Inst. New York, Brooklyn), I. T. Kaplan, W. Metlay, S. W. Rosenthan, and M. M. Zaret.

MECHANISM OF MICROWAVE CATARACTOGENESIS IN RABBITS. P. Kramar (Dep. Rehabil. Med., Univ. Washington Sch. Med., Seattle), C. Harris, A. W. Guy, and A. Emery.

THE EFFECT OF CATARACTOGENIC DOSES OF MICROWAVE RADIATION ON LENTICULAR TRANSPORT. J. R. Rabinowitz (New York Univ. Med. Cent., Inst. Environ. Med., New York).

A ROSE OF ANOTHER NAME IS A CABBAGE. D. R. Justesen (VA Hosp., Kansas City, Mo.).

STEADY STATE TEMPERATURE PROFILES IN MICROWAVE DIATHERMY. K. A. Al-Badwaihy (Dep. Electr. Eng., Cairo Univ., Egypt) and A-B. A. Youssef.

PHYSIOLOGIC DESIGN CRITERIA FOR THERAPEUTIC APPLICATORS OPERATING AT 915 MHz. J. F. Lehmann (Dep. Rehabil. Med., Univ. Washington, Seattle) A. W. Guy, and J. B. Stonebridge.

MAPPING OF FREE SPACE AND SCATTERED FIELDS IN MICROWAVE DIATHERMY. G. Kantor (Div. Electron. Prod., BRH, FDA, Rockville, Md.), H. Bassen, and M. Swicord.

SHORTWAVE DIATHERMY APPLICATORS. A. W. Guy (Dep. Rehabil. Med., Univ. Washington, Seattle), J. A. McDougall, and M. D. Webb.

MICROWAVE-INDUCED HYPERTHERMIA AND RADIATION SENSITIVITY OF MOUSE INTESTINE. G. A. Gordon (Dep. Radiol., Univ. Utah, Salt Lake City), G. Livingston, and L. A. Dethlefsen.

BIOLOGIC EFFECTS OF PULSED HIGH FREQUENCY ELECTROMAGNETIC RADIATION. B. West (Med. Coll. Virginia, Richmond) and W. Regelson.

MICROWAVE RADIATION AS A DIAGNOSTIC TOOL. P. C. Pedersen (Univ. Utah, Salt Lake City), C. C. Johnson, C. H. Durney, and D. G. Bragg.

REMOTE MEASUREMENT OF RESPIRATION IN INFANT PRIMATES USING AN X-BAND DOPPLER RADAR. F. A. Spelman (Reg. Primate Res. Cent., Univ. Washington, Seattle), C. W. Kindt, D. M. Bowden, G. P. Sackett, J. E. Spillane, and D. A. Blattman.

ANTENNA DESIGN FOR A PASSIVE TEMPERATURE MONITORING AND IDENTIFICATION SYSTEM FOR LIVESTOCK. J. A. Landt (Los Alamos Sci. Lab., N.M.).

E- AND H-FIELD INSTRUMENTATION AND CALIBRATION BELOW 500 MHz. P. S. Ruggera (Div. Electron. Prod., BRH, FDA, Rockville, Md.).

MAGNETIC FIELD STANDARD AT FREQUENCIES ABOVE 30 MHz. H. Trzaska (Tech. Univ. Wroclaw, Poland).

A LOW FREQUENCY H-FIELD RADIATION MONITOR. E. Aslan (Narda Microwave, Plainview, N.Y.).

COMPLETE MEASUREMENT OF HAZARDOUS ELECTROMAGNETIC FIELDS WITH ELECTRO OPTICAL CRYSTALS. H. Bassen (BRH, FDA, PHS, Rockville, Md.) and R. Peterson.

MEASUREMENT OF ELECTRIC AND MAGNETIC FIELD STRENGTHS FROM INDUSTRIAL RADIOFREQUENCY (10-40 MHz) POWER SOURCES. D. L. Conover (NIOSH, DLCD, PAB, Cincinnati, Ohio), W. H. Parr, E. L. Sensintaffar, and W. E. Murray, Jr.

METHODS AND INSTRUMENTATION FOR THE EVALUATION AND CALIBRATION OF MICROWAVE SURVEY INSTRUMENTS. M. L. Swicord (Div. Electron. Prod., BRH, FDA, Rockville, Md.), H. I. Bassen, W. A. Herman, J. E. Duff, and J. R. Bing.

MUTUAL COUPLING BETWEEN LINEAR ANTENNAS. M. L. Swicord (Div. Electron. Prod., BRH, FDA, Rockville, Md.) and A. Y. Cheung.

RESPIRATORY ACTIVITY OF MITOCHONDRIA EXPOSED IN A COAXIAL AIRLINE TO 2000-4000 MHz MICROWAVE RADIATION. J. A. Elder (Exp. Biol. Div., EPA,

Research Triangle Park, N.C.), J. S. Ali, and M. D. Long.

THE EFFECT OF MICROWAVES (2450 MHz) ON LYMPHOCYTE BLAST TRANSFORMATION IN VITRO. R. J. Smialowicz (Exp. Biol. Div., EPA, Research Triangle Park, N. C.).

MICROWAVE PERTURBATION ON CELLULAR ENZYMATIC REACTIONS. S. T. Hsieh (Tulane Univ., New Orleans, La.) and Y. J. Seto.

A SUMMARY OF CELL AND TISSUE LEVEL EVENTS PRODUCED BY RF FIELDS PREDICTED FROM CONSIDERATION OF REGIONAL HYPERTHERMIA. J. W. Frazer (U.S. Air Force Sch. Aerosp. Med., Brooks Air Force Base, Tex.).

EFFECTS OF MICROWAVE RADIATION ON MAMMALIAN CELLS IN VITRO. J. C. Lin (Dep. Electr. Eng., Wayne State Univ., Detroit, Mich.) and K. C. Chen.

EVALUATION OF DOMINANT LETHAL TEST AND DNA STUDIES IN MEASURING MUTAGENICITY CAUSED BY NON-IONIZING RADIATION. M. M. Varma (Dep. Bio-Environ. Eng., Sch. Eng., Howard Univ., Washington, D.C.) and E. A. Trabculay.

MUTAGENICITY INDUCED BY NON-IONIZING RADIATION IN SWISS MALE MICE. M. M. Varma (Bio-Environ. Eng., Sch. Eng., Howard Univ., Washington, D.C.), E. L. Dage, and R. Joshi.

THE EFFECT OF MICROWAVE EXPOSURE ON BACTERIA: MUTATION INDUCTION. C. F. Blackman (Exp. Biol. Div., EPA, Research Triangle Park, N. C.), M. C. Surles, and S. G. Benane.

DEPENDENCE OF TOTAL AND DISTRIBUTED ABSORBED MICROWAVE ENERGY UPON SIZE, SHAPE, AND ORIENTATION OF RAT PHANTOMS IN WAVEGUIDE. A. Leicher-Preka (Inst. Physiol Biochem. Med. Fac., Sarajevo, Yugoslavia) and H. S. Ho.

CONSIDERATIONS OF CHAMBER DESIGN, ENVIRONMENTAL CONTROL, AND MICROWAVE FIELD INTERACTIONS IN SMALL ANIMAL EXPERIMENTATION. W. M. Houk (Naval Aerosp. Med. Res. Lab., Pensacola, Fla.), J. D. Grissett, and A. Longacre, Jr.

CHRONIC EXPOSURE OF A RAT POPULATION BY CIRCULARLY POLARIZED GUIDED WAVES. A. W. Guy (Dep. Rehabil. Med., Univ. Washington Sch. Med., Seattle), C. K. Chou, and R. H. Lovely.

MICROWAVE IRRADIATION APPARATUS DESIGN AND DOSIMETRY. H. S. Ho (BRH, Rockville, Md.), M. R. Foster, and M. L. Swicord.

ADRENOCORTICAL RESPONSE IN RATS EXPOSED TO MICROWAVES. W. G. Lotz (Univ. Rochester, N.Y.) and S. M. Michaelson.

A UNIQUE ELECTROMAGNETIC ENVIRONMENTAL SIMULATOR. E. R. Graf (Electr. Eng. Dep., Auburn Univ., Ala.), D. G. Burks, and F. E. Cole.

FIELD MEASUREMENTS FOR A SERIES OF BEHAVIORAL STUDIES. V. R. Reno (Naval Aerosp. Med. Res. Lab., Pensacola, Fla.) and J. O. deLorge.

STUDY OF THE MICROWAVE-INDUCED PERTURBATIONS OF THE BEHAVIOUR BY THE OPEN-FIELD TEST INTO THE WHITE RAT. J. Gillard (Hosp. Instr. Armees Sainte-Anne, 83800 Toulon Naval, France), B. Servantie, G. Bertharion, A. M. Servantie, J. Obrenovitch, and J. C. Perrin.

"AVOIDANCE" BY RATS OF A 2.88 GHz PULSE MICROWAVE FIELD. E. L. Hunt (Walter Reed Army Inst. Res., Washington, D.C.), N. W. King, and R. H. Lovely.

ALTERATIONS IN THE SLEEP PROCESS OF THE RABBIT AS A FUNCTION OF CHRONIC LOW INTENSITY ELECTROMAGNETIC RADIATION EXPOSURE. R. C. Manthei (Biomed. Res. Lab., Naval Surf. Weapons Cent., Dahlgren, Va.) and Z. R. Glaser.

THE EFFECTS OF 1.7 AND 2.45 GHz MICROWAVES ON DRUG-INDUCED SLEEPING TIME IN THE RABBIT. Cleary, S. F. (Dep. Biophys., Virginia Commonw. Univ., Richmond.).

MODIFICATION OF INTERNAL DISCRIMINATIVE STIMULUS CONTROL OF BEHAVIOR BY LOW LEVELS OF PULSED MICROWAVE RADIATION. J. R. Thomas (Naval Med. Res. Inst., Bethesda, Md.), S. S. Yeandle, and L. S. Burch.

BEHAVIORAL EFFECTS OF RESONANT ELECTROMAGNETIC POWER ABSORPTION IN RATS. J. A. D'Andrea (Dep. Electr. Eng. Bioeng., Univ. Utah, Salt Lake City), O. P. Gandhi, and R. P. Kesner.

THE EFFECTS OF MICROWAVE RADIATION ON BEHAVIOR AND TEMPERATURE IN RHESUS MONKEYS. J. O. deLorge (Naval Aerosp. Med. Res. Lab., Pensacola, Fla.).

MICROWAVE AND INFRARED RADIATION EFFECTS ON AN OPERANT RESPONSE IN RHESUS MONKEYS. R. D. McAfee (VA Hosp., New Orleans, La.), S. T. Elder, T. J. Lipscomb, J. G. May, and M. G. Holland.

A TWO IMPEDANCE METHOD FOR WIDE RANGE DIELECTROMETRY. M. Swicord (Div. Electron. Prod., BRH, FDA, Rockville, Md.), J. Saffer, and A. Cheung.

WIDE-BAND CHARACTERIZATION OF DIELECTRIC AND HEAT PROPERTIES OF SIMULATED BIOTISSUES. A. Y. Cheung (Inst. Fluid Dyn. Appl. Math., Univ. Maryland, College Park), D. W. Koopman, and M. L. Swicord.

THE ATTENUATION FUNCTION FOR BIOLOGICAL FLUIDS OF MILLIMETER AND FAR-INFRARED WAVELENGTHS. K. H. Illinger (Dep. Chem., Tufts Univ., Medford, Mass.).

ELECTRIC DIPOLE INTERACTIONS FOR MICROWAVE PULSES AND DAMAGE TO EMBRYOS. S. D. Pyle (Dep. Electr. Eng., Univ. Colorado, Boulder), C. L. Hu, R. Caldwell, and F. S. Barnes.

MICROWAVE-INDUCED AVOIDANCE BEHAVIOR IN THE MOUSE. J. C. Monahan (BRH, Rockville, Md.) and H. S. Ho.

PHYSIOLOGICAL AND BEHAVIORAL EFFECTS OF CHRONIC LOW LEVEL MICROWAVE RADIATION OF RATS. K. E. Moe (Dep. Rehabil. Med., Univ. Washington, Seattle), R. H. Lovely, and A. W. Guy.

THEORETICAL CALCULATIONS OF POWER ABSORBED BY MONKEY AND HUMAN SPHEROIDAL AND ELLIPSOIDAL PHANTOMS IN AN IRRADIATION CHAMBER. H. Massoudi (Univ. Utah, Salt Lake City), C. H. Durney, C. C. Johnson, and S. Allen.

MEASUREMENT OF RADIOFREQUENCY POWER ABSORPTION IN MONKEYS, MONKEY PHANTOMS, AND HUMAN PHANTOMS EXPOSED TO 10-50 MHz FIELDS. S. J. Allen (U.S. Air Force Sch. Aerosp. Med., Radiobiol. Div., Brooks Air Force Base, Tex.), W. D. Hurt, J. H. Krupp, J. A. Ratliff, C. J. Durney, and C. C. Johnson.

POWER DEPOSITION IN A MULTILAYERED SPHERICAL MODEL OF THE HUMAN HEAD. S. M. Neuder (Div. Electron. Prod., BRH, FDA, Rockville, Md.), D. H. Hill, and R. B. Kellogg.

DISTRIBUTION OF ELECTROMAGNETIC ENERGY DEPOSITION IN MODELS OF MAN WITH FREQUENCIES NEAR RESONANCE. O. P. Gandhi (Dep. Electr. Eng. Bioeng., Univ. Utah, Salt Lake City), K. Sedigh, G. S. Beck, and E. L. Hunt.

MODELS OF BIOLOGIC INTERACTION WITH ELECTROMAGNETIC FIELDS. J. MacDougal (Dep. Rehabil. Med., Univ. Washington, Seattle), M. Webb, and J. W. Frazer.

MICROWAVE-INDUCED SHIFTS OF GONADOTROPIC ACTIVITY IN ANTERIOR PITUITARY GLAND OF RATS. H. Mikolajczyk (Inst. Occup. Med., 90-950 Lodz, Poland).

THE EFFECT OF 1.6 GHz CW FIELDS ON TRACE METAL CONTENT OF SPECIFIC REGIONS OF RAT BRAIN. F. Chamness (U.S. Air Force Sch. Aerosp. Med., Brooks Air Force Base, Tex.), H. Scholes, S. Sexauer, and J. W. Frazer.

INTERACTION OF MODULATED ELECTROMAGNETIC FIELDS WITH NERVOUS STRUCTURES. C-L. Wu (Dep. Electr. Eng., Wayne State Univ., Detroit, Mich.) and J. C. Lin.

THE EFFECT OF 1.6 GHz RADIATION ON NEUROTRANSMITTERS IN DISCRETE AREAS OF THE RAT BRAIN. J. H. Merritt (Radiobiol. Div., U.S. Air Force Sch. Aerosp. Med., Brooks Air Force Base, Tex.), R. Hartzell, and J. H. Frazer.

NUMERICAL STUDY OF ELECTROMAGNETIC POWER DEPOSITION IN BIOLOGICAL TISSUE BODIES. P. W. Barber (Univ. Utah, Salt Lake City).

FINITE ELEMENT-VARIATIONAL CALCULUS APPROACH TO THE DETERMINATION OF ELECTROMAGNETIC FIELDS IN IRREGULAR GEOMETRY. S. M. Neuder (Div. Electr. Prod., BRH, FDA, Rockville, Md.) and P. H. E. Meijer.

ELECTROMAGNETIC RADIATION EFFECTS ON THE BLOOD-BRAIN BARRIER SYSTEM OF RATS. K. J. Oscar (U.S. Army Mobility Equip. Res. Dev. Cent., Fort Belvoir, Va.) and T. D. Hawkins.

REDUCTION IN SENSITIVITY TO AUDIOGENIC SEIZURE FOLLOWING A SINGLE, 2450 MHz, CW IRRADIATION OF RATS. T. D. Hawkins (Dep. Microwave Res., Walter Reed Army Inst. Res., Washington, D.C.) and E. L. Hunt.

NONTHERMAL EFFECTS OF ELECTROMAGNETIC FIELDS ON THE CENTRAL NERVOUS SYSTEM. H. Kritikos (Dep. Bioeng., Univ. Pennsylvania, Philadelphia) and S. Takashima.

LIGHT AND ELECTRON MICROSCOPIC INVESTIGATION OF BRAINS EXPOSED TO NON-IONIZING RADIATION. E. N. Albert (Dep. Anat., George Washington Univ. Med. Cent., Washington, D.C.).

ELECTROMAGNETIC POWER ABSORPTION IN LOSSY WIRE MODEL OF MAN. K. R. Umashankar (Dep. Electr. Eng., Univ. Mississippi, University) and C. M. Butler.

NUMERICAL SIMULATION OF THE EFFECTS OF NONIONIZING R.F. RADIATION UPON THE HUMAN BODY. A. F. Emery (Dep. Mech. Eng., Univ. Washington, Seattle), A. W. Guy, K. K. Kraning, and R. Short.

COLONIC TEMPERATURE CHANGES DURING MICROWAVE EXPOSURE. S. H. Githens (Dep. Microwave Res., Walter Reed Army Inst. Res., Washington, D.C.), T. D. Hawkins, and J. Schrot.

MICROWAVE FREQUENCY AND E-FIELD ORIENTATION INTERACT WITH ANIMAL SIZE. J. Schrot (Dep. Microwave Res., Walter Reed Army Inst. Res., Washington, D.C.) and T. D. Hawkins.

EFFECTS OF WEAK LOW FREQUENCY ELECTRIC FIELDS ON CALCIUM EFFLUX FROM ISOLATED CHICK AND CAT BRAIN. S. M. Bawin (Dep. Anat. Physiol., Brain Res. Inst., Univ. California, Los Angeles) and W. R. Adey.

LONG-TERM EFFECTS OF WEAK 45-75 Hz ELECTROMAGNETIC FIELDS ON THE SLIME MOLD PHYSARUM POLYCEPHALUM. B. Greenebaum (Div. Sci., Univ. Wisconsin-Parkside, Kenosha), E. M. Goodman, and M. T. Marron.

EFFECTS OF THE FIELD FREE SPACE ON THE CIRCADIAN ACTIVITY RHYTHM OF THE HOUSE SPARROW, PASSER DOMESTICUS, AND OF THE SONG SPARROW, MELOSPIZA MELODIA. V. Bliss (Dep. Zool., Univ. Rhode Island, Kingston) and F. Heppner.

EFFECTS OF 45 Hz ELECTRIC FIELD EXPOSURE ON RATS. N. S. Mathewson (Armed Forces Radiobiol. Res. Inst., Def. Nucl. Agency, Bethesda, Md.), G. M. Oosta, S. A. Oliva, and A. P. Blasco.

EXPOSURE OF DOMESTIC FOWL TO ELF ELECTRIC AND MAGNETIC FIELDS. W. K. Durfee (Dep. Anim. Sci., Univ. Rhode Island, Kingston), P. R. Plante, P. Marton, S. Muthukrishnan, and C. Polk.

HIGH VOLTAGE ELECTRIC FIELD COUPLING TO HUMANS USING MOMENT METHOD TECHNIQUES. R. J. Spiegel (IIT Res. Inst., Washington, D.C.).

THE EFFECTS OF WEAK ELF ELECTRIC FIELDS ON SCHEDULE-CONTROLLED BEHAVIOR OF MONKEYS. R. G. Medici (Brain Res. Inst., Univ. California, Los Angeles).

EFFECT OF AC ELECTRIC FIELD APPLICATION UPON HUMAN VISUAL THRESHOLD. S. Sugiyama (Kwansei Gakuin Univ., Nishinomiya, Hyogo, Japan) and K. Mizuno.

IMPACT OF EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS ON ANIMALS IN NATURE. B. Greenberg (Prof. Biol. Sci., Univ. Illinois Chicago Circle, Chicago).

PHYSIOLOGICAL BASIS OF HUMAN ELECTRIC SHOCK THRESHOLD. W. P. Moran (Dep. Phys., Univ. Tulsa, Oklahoma).

USE OF DIELECTRIC MICROPROBES FOR ELECTROMAGNETIC FIELD MEASUREMENT. A. Deficis (Microwave Dep., O.N.E.R.A.-C.E.R.T., 31055 Toulouse Cedex, France).

PERFORMANCE OF THE LCOF PROBE IN CALORIMETRIC AND TISSUE TEMPERATURE MONITORING APPLICATIONS. G. K. Livingston (Univ. Utah, Salt Lake City), C. C. Johnson, C. H. Durney, and T. C. Rozzell.

A BIREFRINGENT CRYSTAL OPTICAL THERMOMETER FOR MEASUREMENTS OF ELECTROMAGNETICALLY INDUCED HEATING. T. C. Cetas (Div. Electron. Prod., BRH, FDA, Rockville, Md.).

OPTICAL ETALON TEMPERATURE SENSOR FOR MICROWAVE TISSUE HEATING APPLICATIONS. D. A. Christensen (Dep. Electr. Eng. Bioeng., Univ. Utah, Salt Lake City).

A TEMPERATURE PROBE FOR RF HEATED MATERIAL. R. R. Bowman (Natl. Bur. Stand., Boulder, Colo.).

QUANTIFICATION AND MEASUREMENT OF INDUCED FIELDS INSIDE FINITE BIOLOGICAL BODIES. K. M. Chen (Dep. Electr. Eng. Syst. Sci., Michigan State Univ., East Lansing), B. S. Guru, and D. P. Nyquist.

EXPERIMENTAL CALIBRATION OF A MINIATURE ELECTRIC FIELD PROBE WITHIN MUSCULAR TISSUES. A. Y. Cheung (Inst. Fluid Dyn. Appl. Math., Univ. Maryland, College Park), M. L. Swicord, and H. I. Bassen.

THE EFFECTS OF ENVIRONMENTAL TEMPERATURE ON THERMOREGULATORY, SERUM LIPID, CARBOHYDRATE, AND GROWTH HORMONE RESPONSES OF RATS EXPOSED TO MICROWAVE. W. M. Houk (Naval Aerosp. Med. Res. Lab., Pensacola, Fla.), S. M. Michaelson, and D. E. Beischer.

THE EFFECTS OF 19 MEGACYCLE IRRADIATION ON MICE AND RATS. W. B. Stavinoha (Univ. Texas Health Sci. Cent., San Antonio), M. A. Medina, S. T. Weintraub, D. H. Ross, and A. T. Modak.

LONG TERM EXPOSURE STUDIES OF HIGH PEAK POWER (HPP) PULSED ELECTROMAGNETIC RADIATION ON MICE. T. C. O'Grady (Biomed. Res. Lab., Naval Surf. Weapons Cent., Dahlgren, Va.) and Z. R. Glaser.

INVESTIGATION OF ELECTROMAGNETIC EFFECTS OF A 1000-FOOT TV TOWER ON MIGRATORY BIRDS. D. G. Burks (Electr. Eng. Dep., Auburn Univ., Ala.) and E. R. Graf.

SOME DEVELOPMENTAL AND BEHAVIORAL FACTORS OF LOW INTENSITY X-BAND RADIATION. C. W. Kindt (Reg. Primate Cent. Univ. Washington, Seattle), D. M. Bowden, F. A. Spelman, and M. K. Morgan.

THE BIOLOGICAL SIGNIFICANCE OF RADIOFREQUENCY RADIATION EMISSION CHARACTERISTICS ON CARDIAC PACEMAKER PERFORMANCE. J. C. Mitchell (U.S. Air Force Sch. Aerosp. Med., Radiobiol. Div., Brooks Air Force Base, San Antonio, Tex.) and W. D. Hurt.

BROADCAST RADIATION: A SECOND LOOK. R. A. Tell (EPA, Washington, D.C.) and D. E. Jones.

HEALTH HAZARDS IN MICROWAVE FIELDS. K. D. Woolas (MOD, United Kingdom).

CRITICAL ASPECTS OF HUMAN VERSUS TERRESTRIAL ELECTROMAGNETIC SYMBIOSIS. E. S. Maxey (Res. Div., Miami Heart Inst., Fla.).

THE INFLUENCE OF MICROWAVE EXPOSURE ON NEUROENDOCRINE FUNCTION IN THE RAT AND DOG. S. M. Michaelson (Univ. Rochester, N.Y.).

PSEUDOSUBSTRATE BINDING TO RIBONUCLEASE DURING EXPOSURE TO MICROWAVE RADIATION AT 1.70 AND 2.45 GHz. J. W. Allis (Exp. Biol. Div., EPA, Research Triangle Park, N.C.) and M. L. Fromme.

CHRONIC LOW-LEVEL EXPOSURE OF RABBITS TO MICROWAVES. E. S. Ferri (Div. Biol. Eff., BRH, FDA, HEW, Winchester, Mass.) and G. J. Hagan.

MICROWAVE FREQUENCY AS A FACTOR IN THE INDUCTION OF LENS OPACITIES IN THE RABBIT EYE. G. J. Hagan (Div. Biol. Eff., BRH, FDA, HEW, Winchester, Mass.) and R. L. Carpenter.

A STUDY OF THE EFFECTS OF MICROWAVE IRRADIATION OF THE RAT TESTES. G. J. Muraca, Jr. (Div. Biol. Eff., BRH, FDA, HEW, Winchester, Mass.) and E. S. Ferri.

COMPARISON OF THERMAL EFFECTS IN THE RABBIT EYE FROM MICROWAVE RADIATION AND FROM EXTERNAL HEATING. R. L. Carpenter (Div. Biol. Eff., BRH, FDA, HEW, Winchester, Mass.) and G. J. Hagan.

THE USE OF STRIPLINE TO STUDY MICROWAVE BIOLOGICAL EFFECTS. R. L. Seaman (Dep. Biomed. Eng., Duke Univ., Durham, N.C.), H. Wachtel, and W. T. Joines.

BIOMEDICAL ASPECTS OF RADIOFREQUENCY AND MICROWAVE RADIATION: A REVIEW OF SELECTED SOVIET, EAST EUROPEAN, AND WESTERN REFERENCES. Z. R. Glaser (Biomed. Res. Detachment, Naval Surf. Weapons Cent., Dahlgren, Va.) and C. H. Dodge.

THEORETICAL CALCULATIONS OF POWER ABSORBED BY AN ELLIPSOIDAL MODEL OF MAN AND ANIMALS IN AN ELECTROMAGNETIC PLANE WAVE. H. Massoudi (Univ. Utah, Salt Lake City), C. H. Durney, C. C. Johnson, and S. Allen.

TIME-COURSE OF ADRENAL RESPONSE IN MICROWAVE-EXPOSED RATS. R. Guillet (Univ. Rochester, N.Y.), W. G. Lotz, and S. M. Michaelson.

THYROID RESPONSE TO LOCALIZED MICROWAVE EXPOSURE. R. L. Magin (Univ. Rochester, N.Y.), S-T. Lu, and S. M. Michaelson.

ELECTROMAGNETIC FIELD EFFECTS ON ISOLATED NERVE TISSUE. S. S. Sandler (Bioelectromagn. Lab., Dep. Electr. Eng. Northeastern Univ., Boston, Mass.).

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Selected Bibliography of Papers to be Presented:

DIAGNOSTIC APPLICATION OF MICROWAVE RADIATION. P. C. Pedersen (Univ. Utah, Salt Lake City), C. C. Johnson, D. H. Durney, and D. G. Bragg.

CURRENT LITERATURE

0621 THE EFFECT OF RADAR ON CARDIAC PACEMAKERS. *(E.)* Rohl, D. (Dep. Cardiol., Univ. Ulm, Germany), H. 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 $\lambda/4$ 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/cm^2. To protect pacemakers optimally, several units were modified by metal encapsulation of the pulse generator and a low-pass filter at the electrode. With these alterations, they were undisturbed at pulse power densities far above 10 W/cm^2. (5 references)

0622 GONADIC FUNCTION IN WORKMEN WITH LONG-TERM EXPOSURE TO MICROWAVES. *(E.)* Lancranjan, I. (Dep. Occup. Dis., Inst. Hyg. Public Health, Bucharest, Romania), M. Maicanescu, E. Rafaila, I. Klepsch, 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 andrologic examinations to eliminate those with endocrinologic diseases, veneral diseases, varicocel, hydrocel, testical 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, ruling out 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 MW exposure as two-thirds of the technicians reinvestigated 3 mon after interruption of exposure showed improvement in spermatogenesis. (6 references)

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 MWs, 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)

0624 LASER RADIATION AND MICROWAVES; THEIR IMPAIRMENT OF THE HUMAN BODY AND THE MEASURES FOR PROTECTION. *(Jap.)* Iida, 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)

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. Mamiya, H. Tamiya, K. Sasaki, and S. Yoshida. *Proc., 86th Annu. Meet. Jap. Densorological Soc.*, p. 317-318, Aug. 1975.

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