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Biological Effects of Nonionizing Electromagnetic Radiation

VOLUME II

NUMBER 1

SEPTEMBER, 1977

A DIGEST OF CURRENT LITERATURE

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A Quarterly Publication
Produced for
Office of Telecommunications Policy
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Volume II, Number 1.

A Digest of Current Literature.

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Literature Selected and Abstracted
by
Biomedical Group, Science Information Services Department

(10) Bruce H. Kleinstein, Ph.D., J.D., Project Manager
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BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

September, 1977 Volume II, Number 1

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PREFACE

Biological Effects of Nonionizing Electromagnetic Radiation is a publication researched and prepared by the Franklin Institute Research Laboratories, Science Information Services Department, under a contract with the U.S. Navy and administered by the Office of Telecommunications Policy.

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 Nonionizing 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 Nonionizing 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 summary abstracts.

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ABBREVIATIONS AND ACRONYMS

A, amp - ampere(s)
Å - angstrom(s)
BRH - Bureau of Radiological Health
C - centigrade
cm - centimeter(s)
cps - cycles per second
dB - decibel(s)
EPA - Environmental Protection Agency
FDA - Food and Drug Administration
g - gram(s)
G - Gauss
GHz - gigahertz
HEW - Health, Education, and Welfare
hr - hour
Hz - hertz
IEEE - Institute of Electronic and Electrical Engineers
IMPI - International Microwave Power Institute
IU - international unit(s)
J - joule(s)
k - kilo--
l - liter(s)
m - meter(s)
m - milli--
M - mega--
mho - unit of measurement of conductivity
min - minute(s)
mo - month(s)
n - nano--
NBS - National Bureau of Standards
NIH - National Institutes of Health
NSF - National Science Foundation
NIOSH - National Institute for Occupational Safety and Health
NTIS - National Technical Information Service
Oe - oersted(s)
OSHA - Occupational Safety and Health Administration
OTP - Office of Telecommunications Policy
PHS - Public Health Service
rad - radiation absorbed dose
R - roentgen(s)
rpm - revolutions per minute
sec - second(s)
USAFSAM - U.S. Air Force School of Aerospace Medicine
USDA - U.S. Department of Agriculture
UV - ultraviolet
V - volt(s)
VA - Veterans Administration
W - watt(s)
Wb - Weber(s)
WHO - World Health Organization
wk - week(s)
wt - weight
yr - year(s)

μ - micro--

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NEWS ITEMS

MICROWAVE BREAST CANCER DETECTION PROGRAM

To help in the all-important early discovery of a disease that has reached epidemic levels in the U.S. (90,000 cases a year), radiologists at Boston's Faulkner Hospital are using microwaves to spot breast cancers. Although microwaves can damage tissue at high energies, Faulkner microwaves are perfectly safe since the radiation is emitted not by the detector, as in conventional mammography, but by the body itself. Because of its rapid growth rate and increased blood supply, a tumor is hotter than normal tissue, and it therefore gives off more radiant energy. The Faulkner breast cancer detection program employs a sensitive antenna that picks up the weak microwave (or heat) emissions from a tumor up to 10 cm below the surface. The antenna is placed against nine different sites on the breast and held at each for about 10 sec. If one spot is significantly hotter than a comparable area on the other breast, the supervising radiologist can make other checks for a tumor, including x-rays. About 70% accurate, the gadget is less precise than mammography (90%). But since there is no radiation risk, the microwave detector could at the very least be used for prescreening--especially those under 35 who are ordinarily not encouraged to have mammograms unless they have a family history of breast cancer or symptoms of the disease.

Time 109(25): 80; 1977.

BRITISH INVESTIGATING MICROWAVES' NON-THERMAL EFFECTS

The British National Radiological Protection Board (NRPB) is investigating the validity of Soviet theories that non-thermal doses of microwaves can cause neurasthenic, cardiovascular, and testicular damage, and endocrine and blood disorders. Details of the project are given in the NRPB's latest report, which outlines results of experiments on mice in addition to research on occupational radiation hazards.

Occupational Health 29(5): 200; 1977.

DIGEST AVAILABLE THROUGH NTIS

Previous issues of this digest can be obtained from the National Technical Information Service (NTIS), Springfield, Virginia 22151, at a nominal cost. The accession numbers for these issues are noted below.

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AD-A034423	AD-A034166
AD-A034893	AD-A034895
AD-A034426	AD-A039956
AD-A034429	AD-A040681

MOSCOW EMBASSY EMPLOYEES SHOW NO ILL-EFFECTS

Although the Russians are still beaming microwave radiation at the U.S. Embassy in Moscow, tests of Americans who used to work there have shown no harmful health effects, according to the State Department. However, Herbert Pollack, a physician and government consultant states that a third of one group of State Department employees showed a slight, apparently harmless, change in their blood composition. In testimony before a Senate Commerce subcommittee, Pollack said "There have been no medical ill effects observed in individuals whose lymphocyte counts have been elevated." He added, "The condition disappears after departure from Moscow." The Russians have been aiming microwave radiation at the embassy since the early 1950's, but in 1975 the signal was intensified, and there were fears that the radiation might reach harmful levels. Although the beaming has declined, the radiation level at the embassy measures above the standard the Russians have set for themselves as being safe.

New York Times June 28, 1977

MICROWAVES HOT ISSUE IN DC

The subject of biologic effects of microwave radiation is becoming an increasingly important issue in the nation's capital this year. Interest is already accelerating in several forums, including the Environmental Protection Agency (EPA). For example, in a recent presentation before the government's Electromagnetic Radiation Management Advisory Council (ERMAC), EPA scientists unveiled preliminary evidence that supposedly "safe" levels of microwave exposure lower body's ability to resist disease and could cause certain types of birth defects. But they claim such levels are found only in occupational settings. Meanwhile, Rep. Henry Waxman has written Federal Communications Commission chairman Richard Wiley demanding something be done about the lack of regulation in the area. "It appears that the responsibility of extensive biological damage from microwave radiation exposure is increasing in some proportion to the proliferation of microwave technology," wrote Waxman. "This raises the most serious questions regarding the health and safety of the American people and the technological basis of the telecommunications industry." Wiley had not responded to the message at presstime, while House Communications Subcommittee Chairman Lionel Van Deerlin favors deferring jurisdiction in the area to the Subcommittee on Health and Environment, chaired by Rep. Paul Rogers. Waxman is a member of both panels. EPA researchers at the Experimental Biology Division of Health Effects Research Lab in Research Triangle Park, NC, claim that equivalent exposures to microwave radiation (at frequencies used by UHF television and microwave ovens) of pregnant mice and rats lowers a body's ability to fight disease. Additionally, such exposures might prompt low inci-

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dence of a birth defect called encephalocele, failure of the brain case to close over the brain. But EPA researcher Dr. Ezra Berman says he's not positive about the birth defect. Researchers have not yet determined a "safe" level for microwave exposure, although the standard of 10 mW/cm^2 has been tagged by the American National Standards Institute. In any case, EPA indicates that the typical city comes nowhere near the level.

Microwaves 16(4): 23; 1977.

ELECTRICAL STIMULATION POSES RISKS FOR PATIENTS WITH PACEMAKERS

Electrical stimulation during electromyography and nerve conduction velocity studies should be used with extreme caution in patients with pacemakers according to Food and Drug Administration researcher, James R. Veale. Electrical stimulation for neurological tests is usually below 5-100 mamp when surface electrodes are used. Although the current density in the region of the pacemaker site will most likely be extremely small when the currents are applied to the extremity nerves, the closer the stimulator is to the pacemaker and pacing leads, the greater the chance for inducing a voltage of sufficient amplitude to inhibit the pacer. Veale cautions, "Scrupulous attention should also be paid to the grounding, if the stimulator is ac (alternating current) powered and has a grounded output, especially if monitoring equipment is used or the patient is grounded in some way." Veale concludes that the patient's condition should be carefully monitored throughout the procedure for any indications of pacemaker dysfunction.

JAMA 237(16): 1736, 1977.

INTERNATIONAL GROUP TO STUDY NON-IONIZING RADIATION HAZARDS

The International Radiation Protection Association (IRPA) plans to set up a new international committee for protection against non-ionizing radiation, particularly at microwave frequencies. The decision, taken at IRPA's fourth international congress in Paris in late April, follows recommendations of a working group that pointed out the lack of international agreement on the effects and control of such radiation. The working group was made up of Danish, Polish, French, and American members, including a representative of the National Bureau of Radiological Health. The proposed committee will help find solutions to potential health problems in commercial areas.

Electronics 50(10): 53; 1977.

ITEMS FROM THE COMMERCE BUSINESS DAILY

☐ **RESEARCH PROGRAM DEFINITION FOR THIS STUDY OF BIOLOGICAL AND ECOLOGICAL EFFECTS OF ENERGY TRANSMISSION BY MICROWAVES, EFFECTS OF CHRONIC LOW-LEVEL 2450 MHz ILLUMINATION ON PLANT GROWTH AND DEVELOPMENT.**

The National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California is soliciting proposals for the above study. (April 29, 1977)

☐ **STUDY THE BEHAVIORAL EFFECTS OF ANIMALS EXPOSED TO MICROWAVE RADIATION.**

The Department of Health, Education, and Welfare, Public Health Service, Food and Drug Administration, Rockville, Maryland will negotiate with Randomline, Inc., Huntingdon Valley, Pennsylvania for a continuation of the above study. (April 27, 1977)

☐ **STUDY OF RF PARAMETERS THAT AFFECT THE BRAIN AND BEHAVIOR AT LOW POWER DENSITIES.**

The Department of Health, Education, and Welfare, Food and Drug Administration, Rockville, Maryland, has contracted with Randomline, Inc., Huntingdon Valley, Pennsylvania for the above study. (June 24, 1977)

☐ **R&D STUDY OF 2450 MHz MICROWAVE ABSORPTION IN LARGE AND SMALL ANIMALS AND ITS BIOBEHAVIORAL EFFECTS ON BIRDS AND REPTILES.**

The National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California is soliciting proposals for the above study. (April 29, 1977)

☐ **RESEARCH ON SAFE PROCEDURES FOR ELECTRICAL STIMULATION OF THE NERVOUS SYSTEM.**

The Contracts Management Branch, National Institute of Neurological and Communicative Disorders and Stroke, National Institutes of Health, Bethesda, Maryland is negotiating with EIC Corp. for a continuation of the above study. (June 6, 1977)

☐ **STUDY TO DEFINE MICROWAVE RESEARCH PROGRAM.**

The National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California is negotiating with Techcoor, Palo Alto, California for the above study. (May 6, 1977)

☐ **RESEARCH STUDY TO INVESTIGATE DIRECT SOLAR TO MICROWAVE ENERGY CONVERSION TECHNOLOGY.**

The Procurement Office, National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Alabama will negotiate with Teledyne Brown Engineering, Cummings Research Park, Huntsville, Alabama for the above study. (June 24, 1977)

☐ **EFFECTS OF MICROWAVE IRRADIATION ON EMBRYONIC BRAIN TISSUE.**

The Contracting Branch, Logistics Division, U.S. Army Medical Research and Development Command, Washington, D.C. is negotiating with the Institute for Behavioral Research, Inc., Silver Spring, Maryland for the above study. (May 9, 1977)

MEETINGS AND CONFERENCES

SEVENTH EUROPEAN MICROWAVE CONFERENCE

Date: September 5-8, 1977
Place: Copenhagen, Denmark: Bella Center
Sponsor: Dansk Ingeniorgorening
Requests for Information: Professor Preben Gudmandsen, Conf. Chairman, Electronics Inst., 348 Technical Univ. of Denmark, DK--2800 Lyngby, Denmark

Selected Bibliography of Papers Presented:

BIOLOGICAL EFFECTS BY MICROWAVES. (invited)
A. J. Berteaud

A MICROWAVE RADIOMETRIC METHOD FOR THE STUDY OF THE SEMICONDUCTOR PROPERTIES OF LIVING TISSUE.
J. Rigu-del-Blanco, A. Schneiter, J. C. Beal

[illegible] AND APPLICATION OF SPECIAL MICROWAVE [illegible]FEROMETERS FOR NONINVASIVE STUDIES OF [illegible]CAL EFFECTS.
[illegible]. Griffin

A MODIFIED RADIOMETER FOR TEMPERATURE AND MICROWAVE PROPERTIES MEASUREMENTS OF BIOLOGICAL SUBSTANCES.
A. Mamouni, F. Bliot, Y. Leroy, Y. Moschetto

TERATOGENIC POWER OF SHF FIELDS. FURTHER EXPERIMENTS ON *TENEBRIO MOLITOR COLEOPTERON.*
G. d'Ambrosio, V. La Manna

MILLIMETER WAVE THERMOGRAPH AS SUBCUTANEOUS INDICATOR OF JOINT INDICATOR OF JOINT INFLAMMATION.
J. Edrich, C.J. Smyth

WESTERN ELECTRONIC SHOW & CONFERENCE

Date: September 20-23, 1977
Place: San Francisco, CA
Sponsor: Inst. Electrical Electronics Engineers (Los Angeles & San Francisco Councils); Electronic Reps. Assoc.
Requests for Information: W. C. Weber, Jr., WESCON, 999 N. Sepulveda Blvd., El Segundo, CA 90245

INTERNATIONAL ELECTRICAL AND ELECTRONICS CONFERENCE AND EXHIBIT

Date: September 26-28, 1977
Place: Toronto, Canada: Exposition Place (Auto Bldg.)
Sponsor: Inst. Electrical & Electronics Engineers (Can. Region)
Requests for Information: IEEE, Can. Regional Office, 7061 Yonge St., Thornhill, Ontario, Canada L3T 2A6

AMERICAN ACADEMY OF OCCUPATIONAL MEDICINE 29TH ANNUAL MEETING

Date: October 5-7, 1977
Place: Denver, CO
Sponsor: American Academy of Occupational Medicine
Requests for Information: W. Bentley, AAOM

WESTERN OCCUPATIONAL HEALTH CONFERENCE

Date: October 6-8, 1977
Place: San Francisco, CA: Fairmont
Sponsor: Am. Industrial Hygiene Assoc.; Health Physics Soc. (USA); World Occupational Medical Assoc. (USA); World Assoc. Industrial Nurses (USA); Am. Soc. Safety Engineers
Requests for Information: B. H. Bravinder, WOMA

INTERNATIONAL CONFERENCE ON RADAR (RADAR 77)

Date: October 25-28, 1977
Place: London, United Kingdom
Sponsor: Inst. Electrical Engineers (Electronics Div.) (UK); Inst. Electrical & Electronics Engineers (Aerospace Electronics Society; (Int.); Inst. Electronics & Radio Engineers
Requests for Information: Conference Dept., IEE or K. Milne, Plessey Radar, Southleigh Park House, Eastleigh Rd., Havant, Hants P09 2PE, UK

INTERNATIONAL SYMPOSIUM ON BIOLOGICAL EFFECTS OF ELECTROMAGNETIC WAVES

Date: October 30-November 4, 1977
Place: Airlie, Virginia
Sponsor: International Union of Radio Science Commissions A and B
Requests for Information: Professor Saul W. Rosenthal, Chairman, Symposium Steering Committee, Polytechnic Inst. NY, Route 110, Farmingdale, NY 11735

ENGINEERING IN MEDICINE AND BIOLOGY CONFERENCE

Date: November 5-9, 1977
Place: Los Angeles, CA
Sponsor: Alliance for Engineering in Medicine and Biology

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MEETINGS AND CONFERENCES

Requests for Information: Mrs. P. I. Horner, Asst. Dir. & Conf. Coordinator, Alliance for Engineering in Medicine and Biology, Suite 1350, 5454 Wisconsin Ave., Chevy Chase, MD 20015

ELECTROMAGNETIC COMPATIBILITY CONFERENCE

Date: April 4-7, 1978
Place: Guildford, United Kingdom: Univ. Surrey
Sponsor: Inst. Electronic & Radio Engineers (UK); in assoc. with Inst. Electrical Engineers (UK); Inst. Electrical & Electronics Engineers (Int.); Inst. Quality Assurance (UK); Inst. Marine Engineers (UK); Royal Aerntcl. Soc.
Requests for Information: P. M. Elliott, IERE

AMERICAN OCCUPATIONAL HEALTH CONFERENCE

Date: April 9-14, 1978
Place: New Orleans, LA
Sponsor: American Occupational Medical Assoc.; American Assoc. Occupational Health Nurses
Requests for Information: H. N. Schulz, AOMA

FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY: Annual Meeting

Date: April 9-14, 1978
Place: Atlantic City, NJ
Sponsor: FASEB
Requests for Information: Mrs. H. B. Lemp, FASEB

INTERNATIONAL MICROWAVE SYMPOSIUM

Date: May 15-17, 1978
Place: Ottawa, Canada: Univ. Ottawa
Sponsor: Inst. Electrical & Electronics Engineers (Microwave Theory Technique Group)
Requests for Information: A. L. Van Koughnett, Communications Research Center, Box 11490, Station "H", Ottawa, Ottawa, Ontario, Canada

MICROWAVE POWER SYMPOSIUM 1978

Date: May 17-19, 1978
Place: Ottawa, Canada: Univ. Ottawa
Sponsor: International Microwave Power Inst.
Requests for Information: Dr. W. R. Tinga, IMPI

Selected Bibliography of Papers Presented:

ENERGY ABSORPTION OF SIMULATED BODY MATERIAL. Q. Balzano, D. Garay, F. R. Steel

INFLUENCE OF QUALITY ON BIOEFFECTS OF ELECTROMAGNETIC RADIATION. S. K. Ghosh

MEASUREMENTS & INSTRUMENTATION FOR MICROWAVE RADIATION SAFETY. M. A. Stuchly

EMMISSION & EXPOSURE STANDARDS FOR MICROWAVE RADIATION. M. H. Repacholi, M. A. Stuchly

0165 FACTORS AFFECTING THE COLD ACCLIMATION OF CONTAINER-GROWN WOODY ORNAMENTAL PLANTS. Maronek, D. M.; Stoltz, L. P.; Lockard, R. G. (Univ. Kentucky, Agricultural Experiment Station, Limestone & Euclid, Lexington, KY 40506).

The effect of photoperiod and temperature on cold acclimation of plant roots and stems will be studied in addition to the effect of abscisic acid on cold acclimation of plant tops and roots. Investigators will also determine if in vitro culture can be used to evaluate cold hardiness of whole plants, plant parts, or callus tissue. Woody ornamental plants will be grown under controlled photoperiod and temperature regimens to determine how these environmental factors affect the differential rates of cold acclimation and maximum hardiness levels in stems and roots. An attempt will be made to determine the effect of electromagnetic fields on organogenesis of in vitro cultured woody plants. (10/76-9/77)

Supporting Agency:U.S. Dep. Agriculture, Cooperative State Res. Service, Kentucky

0166 RESEARCH AND ENGINEERING STUDIES FOR ELECTROMAGNETIC THAWING OF LARGE ORGANS. Ecker, H. A. (Georgia Inst. Technology, Graduate Sch., 225 North Ave., N.W., Atlanta, GA 30332).

An engineering study of the interaction of electromagnetic energy and biologic tissue will be performed. The research will focus on long-term cryopreservation and short-term preservation by electromagnetic thawing of biologic organs. Several separate but interrelated research tasks comprise the engineering effort. These include determining the electrical properties of canine kidneys, the optimum frequency assignments, the precise temperature and phase state, and the electromagnetic field distributions within the organ. Finally, a methodology will be developed to rapidly and uniformly thaw cryogenically preserved large organs. (8/77-7/78)

Supporting Agency:NSF, Div. Engineering

0167 MICROWAVE EXPOSURE EFFECTS ON BEHAVIORAL ACTIONS OF PHARMACOLOGICAL AGENTS. Thomas, J. R. (U.S. Navy, Behavioral Sciences Dept., Bethesda, MD 20014).

This research will determine if exposure to microwave radiation modifies the effects of pharmacologic compounds on behavior. It is important to determine if microwave radiation interacts with other agents, which may produce potential hazards by changing the efficacy and safety of drugs, medication, and compounds commonly used by military personnel. Initial studies will evaluate how microwave radiation can affect the manner in which organisms react to pharmacologic agents. The research techniques involve the development of complex patterns of behavior in animals. The developed behavioral baselines will be used to assess the effects of both acute and chronic drug regimens under both normal and radiation conditions. Assessment of irradiation effects with low-level microwave energy (near and below 10 mW/cm^2) will be emphasized. Dose-response functions will be determined for a range of radiation intensities for a variety of parameters (frequency, pulse repetition rate, pulse versus continuous wave, acute versus chronic exposure). Using this methodology, modifications in behavior due to interactions between drugs and microwave exposures will be empirically determined. Based on such determinations, re-evaluation of exposure limits for navy personnel and specific recommendations for drug and medication usage in a microwave environment can be made. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Navy

0168 RF EFFECTS OF IMMUNE SYSTEMS. Liburdy, R. P.; Frazer, J. W. (U.S. Air Force, Sch. Aerospace Medicine, Brooks Air Force Base, San Antonio, TX 78235).

The effects of electromagnetic radiation (EMR) stress on immune systems will be investigated. Specifically, the magnitude and direction, causes, and thresholds of EMR-induced changes in immune responsivity will be determined. Nonpunitive thresholds for frequency and power dependency of continuous and pulsed wave EMR stress on immune function will be established. Initially, the effects of EMR stress on the ability of test animals to mount a viable in vivo cell-mediated immune response to antigenic challenge will be quantitated. Subsequently, the effects of EMR stress on specific cell-mediated effector mechanisms operating in delayed hypersensitivity will be delineated through in vitro techniques. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Air Force

0169 MICROWAVE-INDUCED DAMAGE IN THE MAMMALIAN BRAIN. Catravas, G. N. (U.S. Dept. Defense, Armed Forces Radiobiological Research Inst., Bethesda, MD 20014).

Changes in levels of neurotransmitters and activities of enzymes involved in neurotransmitter metabolism in the central nervous system of microwave-irradiated animals will be determined. Eastern European studies have indicated that microwave irradiation at low, nonthermal levels results in a number of neurologic and behavioral effects in animals and humans. To substantiate Russian data, a systematic study will be conducted to determine if and to what extent neurochemical mechanisms in mammalian brain are affected by exposure to low level microwave radiation. Groups of rats will be exposed to continuous low-level microwave radiation of 2,450 MHZ and approximately 10 mW/cm^2. At various postirradiation time intervals, levels of acetylcholine,

norepinephrine, dopamine, and serotonin will be determined in discrete brain areas of experimental animals and sham-irradiated controls. Radiation-induced changes in activity of brain enzymes, choline acetyltransferase, acetylcholinesterase, tyrosine hydroxylase, cryptophan hydroxylase and monoamine oxidase, which are involved in neutrotransmitter metabolism, will also be determined. In another series of experiments the effect of microwave radiation on adenylcyclase-cyclic adenosine monophosphate and prostaglandin system will be determined. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Defense Nuclear Agency

0170 PROBLEM SOLVING IN RHESUS MONKEYS AS INFLUENCED BY MICROWAVES. Delorge, J. O.; Nelson, T. D. (U.S. Navy, Biomedical Division, Pensacola, FL 32512).

This project will investigate the influence of low-level microwave radiation on learning in primates. Rhesus monkeys will be trained on a task that requires the animal to learn a sequence of stimuli. The correct sequence will be changed daily so that the animal's learning ability can be assessed from session to session. This repeated acquisition will serve as a learning baseline on which the effects of microwaves pulsed at low frequencies and short durations can be evaluated. The average power density of the microwaves will be less than 30 mW/cm^2 at 6 GHZ. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Navy

0171 ASSESSMENT OF PERFORMANCE BASED ON FUNCTIONAL VISION. Devine, J. V. (Univ. Texas, Sch. Liberal Arts, El Paso, TX 79902).

This research will determine changes in functional vision in Air Force crew members exposed to operational and weapons hazards during mission performance. Nonionizing radiation (radio frequency and laser emitters) as well as ionizing hazards (tactical nuclear weapons) will be assessed to develop survivability/vulnerability mathematic models of aircrew performance during specific Air Force missions. Functional vision decrements will be established based on a series of nonhuman primate experiments which employ empirical procedures to determine the minimal amount of energy density able to produce a barely noticeable difference in visual perception as measured by standard psychophysical procedures. This effort involves the determination of pre-exposure visual capability as measured by functionally tracking moving targets, quantification of eye damage, post-exposure visual capability, and follow-up assessment of functional vision. Measures of tracking ability before and after retinal lesion placement will be compared with the known visual acuity loss obtained following similar lesions in the fovea. Stable baseline data will be obtained prior to experimental utilization, and follow-up assessment of functional vision will be performed for a minimum of 10 days. Ophthalmoscopic examinations, fundus photography, angiograms, and appropriate histologic procedures will be performed as part of the follow-up assessment procedure. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Air Force

0172 RADIOFREQUENCY ELECTROMAGNETIC ENVIRONMENT SIMULATION AND MEASUREMENT. Allen, S. J.; Hardy, K. A. (U.S. Air Force, Sch. Aerospace Medicine, Brooks Air Force Base, San Antonio, TX 78235).

The objectives of this project are to develop the equipment and methodology and to perform experiments necessary to define radio frequency (RF) energy transfer to animals and man. The results will enable modification of the personnel exposure criteria for Air Force (AF) RF operations. Instrumentation will be developed to monitor incident fields and absorbed power for biologic systems exposed to RF fields in the range of operational AF systems, namely 10 MHz-10 GHz. Present power absorption techniques are usable from 10-50 MHz. Methodology will be developed to measure power absorptions in the 50 MHz-10 GHz frequency range. Modeling of animals will continue until a suitable model is found able to perform the theoretic analysis necessary to predict power absorption over the stated frequency range. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Air Force

0173 EFFECTS OF MICROWAVE RADIATION ON BEHAVIORAL BASELINES. Thomas, J. R.; Yeandle, S. (U.S. Navy, Behavioral Sciences Dept., Bethesda, MD 20014).

No descriptive information is available. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Navy

0174 NAVY ENVIRONMENT: NEUROPHYSIOLOGICAL AND BEHAVIORAL EFFECTS DUE TO MICROWAVE FIELDS. Lovely, R. H.; Guy, A. W. (Univ. Washington, Sch. Medicine, 500 17th Ave., Seattle, WA 98122).

To provide a better understanding of the hazards associated with microwave fields and establish a scientific basis for safety standards, this study will quantify the biologic effects of continuous wave and pulsed microwaves as well as their frequency and intensity dependence through controlled exposure of test animals. The research involves: (1) theoretic investigation of energy distribution inside animal bodies exposed to microwave fields, (2) experimental study of dosimetry utilizing thermographic determinations of temperature distributions, (3) observation of behavioral change

due to both acute and chronic exposure to microwave fields, (4) monitoring neuroendocrine/metabolic activity during and after chronic microwave exposure, and (5) delineating mechanics of microwave hearing phenomena, its transduction processes as well as an analysis of prior findings relating to behavioral effects of exposure to low-level pulsed microwave fields. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Navy

0175 LASER EYE MEASUREMENT AND EVALUATION SYSTEM. Bruckner, A. P.; Auth, D. C. (Univ. Washington, Sch. Engineering, 206 Guggenheim Hall, Seattle, WA 98105).

This project will develop a system to quantitate eye abnormalities for radio frequency radiation personnel hazard assessment. Specifically, a portable device(s) capable of both holographic recording and short pulse scattering measurements in the eye will be developed. The device is required to quantitate and study radio frequency radiation-induced eye opacities. Previous research resulted in the development of two promising techniques for non-invasive optical evaluation of radio frequency-induced cataracts in the eye in vivo. The first uses short pulse laser rangegating and scattering measurements to determine the thickness of ocular layers. The second records holographically the three-dimensional internal structure of the eye including microcataracts. These techniques will be incorporated into a system that can be used to quantitate eye changes and provide permanent records of such changes. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Air Force

0176 NON-IONIZING RADIATION EFFECTS ON MUSCLE AND NERVE CELLS--SAFETY OF ELECTROMAGNETIC RADIATION GENERATED BY NAVAL OPERATIONS. Portela, A.; Perez, J. C. (Natl. Council of Science & Technology, Junin 956, Buenos Aires, Argentina).

This research will investigate the effects of non-ionizing radiation on cellular and subcellular structures to discriminate between thermal effects and direct field (non-thermal) effects. Studies of effects on nerve and muscle cells will be performed first, with the cells removed (in vitro) and then with the cells intact, exposing whole animals. Dielectric properties of biologic molecules and tissues will be studied as well as the microwave effects on bound water. Additionally, the combined effect of electromagnetic fields and other environmental factors will be studied. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Navy

0177 ELECTROMAGNETIC INSTRUMENTATION TO ACCELERATE BONE HEALING. Bassett, C. A. (Columbia Univ., Sch. Medicine, 630 W. 168th St., New York, NY 10032).

The recent demonstration on over 30 human patients that electromagnetic fields can assist in fracture healing will be exploited in a two-phase research program to specify the engineering factors required to design practical equipment for clinical evaluation in orthopedic and dental surgery. The first phase will investigate pulse characteristics designed to stimulate bone repair with intermittent rather than continuous pulsing. These tests will use tissue culture procedures to survey a wide selection of possible pulse characteristics. Pulse regimens likely to yield good results will be tested in two animal models. The second phase will include biologic safety tests to establish that the prospective applications to accelerate simple fracture repair time will not induce side effects. (11/76-4/78)

Supporting Agency:NSF, Div. Adv. Products Research & Technology

0178 NAVY ENVIRONMENT: EXPERIMENTAL DEVELOPMENT OF SIMULATED BIOTISSUES. Cheung, A. (Univ. Maryland, Graduate Sch., College Park, MD 20740).

An attempt will be made to develop a systematic procedure enabling researchers in microwave dosimetry to simulate any biologic tissue electrically at any given temperature. Frequency sweep measurement of dielectric properties of various mixtures of simulated muscle, bone, and fat will be made at several temperatures. Dependence, relative dielectric constant, and conductivity as a function of frequency, temperature and composition will be determined in addition to complex dielectric properties. Compositions and physical properties will be tabulated in handbook form for different temperatures and frequencies, and other physical properties. (10/76-9/77)

Supporting Agency:U.S. Dep. Def., Navy

5028 COLOUR THERMOGRAPHY AND MICROWAVE RADIOMETRY: THEIR APPLICATION TO BIOLOGICAL SYSTEMS UNDER MICROWAVE RADIATION EXPOSURE. *(Eng.)* Bigu del Blanco, J.; Romero-Sierra, C. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at the University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 10-19; 1975. (4 refs)

Experimental results demonstrating the potential applicability of microwave and infrared (IR) radiometry in studies involving microwave exposures (X-band frequencies) of biological specimens are reported. For the IR radiometry (thermography) studies, the application of color thermography was investigated using a color thermovision unit with a sensitivity of 0.1 C at 30 C. The spectral range was 2-5.6 μm. A comparison of black and white and color thermograms of radiation patterns produced in an irradiated microwave-absorbing material by a microwave field of 30 mW/cm^2 revealed that color thermograms show substantially larger amounts of information than black and white thermograms. Color thermograms also show the complexity of the radiation pattern. Time-lapse color thermograms of a microwave-absorbing material, an anesthetized rabbit, and a plant exposed to 30 mW/cm^2 of X-band microwave radiation revealed marked differences in the patterns recorded by the thermograph, emphasizing the dynamics of the interaction and the transient behavior for each of the three cases. If irradiation time is extended, a steady state is reached that is evident from thermography. This steady state differs markedly from the transient behavior, with the latter being vitally important in biological processes. After the microwave disturbance is removed, the thermographic patterns show a return to the initial state. Microwave radiometry experiments involving the measurement of the brightness temperature of an anesthetized rabbit before and after exposure to a 30 mW/cm^2 X-band microwave field for 2.5 min were performed with a Dicke radiometer with a center frequency of 9.2 GHz and a bandwidth of 100 MHz. The brightness temperature differential between the time shortly before the onset of the microwave field and 3 sec after its removal was about 1.8 Kelvin. The results obtained with microwave radiometry are qualitatively consistent with the results obtained using thermography. However, due to the large tissue penetration depth of radiation at microwave frequencies as compared with IR frequencies, microwave radiometry permits measurement of the microwave radiation emitted from structures within the test specimen. IR thermography, on the other hand, posscsses a high spatial resolution and may be used to complement microwave radiometry in studying microwave-exposed specimens.

5029 REACTION OF THE ENDOCRINE SYSTEM TO THE EFFECT OF ELECTROMAGNETIC FIELD OF INDUSTRIAL FREQUENCY (50 Hz). *(Rus.)* Prokhvatilo, E. V. (A. N. Marzeev Kiev Scientific Res. Inst. of General and Communal Hygiene, Kiev, USSR). *Vrach Delo* (11): 135-139; 1976. (12 refs.)

The effect of prolonged exposure to electromagnetic fields generated by high-voltage power transmission lines on the thyroid and adrenal functions was studied in rats. The animals were exposed to fields of 100-5,000 V/m for 3-4 mo. Compared with a control group, reduced iodine uptake in the thyroid, delayed iodine release, and reduced endogenous thyroxine level in the blood were observed. These changes were most pronounced at the end of the experiment, and they completely disappeared in 1-1.5 mo after the experiment. No hypertrophy of the adrenal glands was observed. Eosinopenia observed in animals exposed to 2,000-5,000 Oe fields indicated neuroendocrine reaction and the involvement of the central nervous system, especially of the hypothalamus.

5030 EFFECTS OF DIFFERENT SHF ENERGY LEVELS ON THE FUNCTIONAL STATUS OF THE BODY. *(Rus.)* Shandala, M. G. (A. N. Marzeev Kiev Scientific Res. Inst. of General and Communal Hygiene, Kiev, USSR); Rudnev, M. I.; Nozdrachev, S. I. *Vrach Delo* (12): 113-116; 1976. (3 refs)

The effects of exposure to super high frequency (SHF) energy (50 μW/cm^2 for 7 hr/day for 10 days, or 500 μW/cm^2 for 7 hr) were studied in rats and rabbits. Artificial renal hypertension was produced in some animals, while others were exposed to hypoxia corresponding to altitudes of up to 8 km. Irradiation with the larger dose had a more pronounced effect on hemodynamics, water-salt balance, and bioelectric activity than repeated exposures to 50 μW/cm^2. The increase in the respiratory rate was most pronounced in animals with renal hypertension after exposure to multiple small doses. Altitude hypoxia had a compensatory effect on the irradiation-induced increase in the heart rate. The increase in the heart rate was most pronounced after exposure to a single large dose and in animals with renal hypertension. Irradiation caused an increase in the oxygen tension in the tissues. Irradiation had depressing effect on the excretion of water, salts, and free hydrogen ions by the kidneys. There were no qualitative differences in the effects of irradiation on rats and rabbits.

5031 THE TEMPERATURE-DEPENDENCE OF RESPONSES OF ESOPHAGEAL SMOOTH MUSCLE TO ELECTRICAL FIELD STIMULATION (ABSTRACT). *(Eng.)* Christensen, J. (Univ. Iowa Coll. Medicine, Iowa City, IA 52242); de Carle, D. J.; Szabo, A. C. *Fed Proc* 36(3): 462; 1977. (0 refs)

The temperature-dependence of responses of esophageal smooth muscle to electrical field stimulation was studied using strips of smooth muscle, cut transversely from the opossum esophagus. The strips were superfused with oxygenated Krebs solution at 37 C in a bath that allowed electrical field stimulation of intrinsic nerves and continuous temperature recording. Three-5-sec trains of rectangular pulses (0.5 msec long at 10 Hz) were delivered at 30-sec intervals at supramaximal current strength. In

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strips from the esophageal body, each train resulted in a twitch, the off-response that followed the end of the train with a particular latency. Strips from the esophagogastric junction relaxed during the train. Temperature was then varied above and below 37 C to observe the temperature-dependence of the responses. Latency of the off-response varied exponentially with temperature. Amplitude of the off-response showed a linear decline with changes in temperature, both above and below 35 C, with the zero intercepts being 19.6 C and 42.3 C, respectively. The excitatory response of the strips to exogenous acetylcholine was constant over the range of temperatures tested. Amplitude of relaxation of strips from the junction varied little between 20 C and 37 C but declined sharply beyond those limits, with the zero-intercepts being 14.2 C and 42 C, respectively. The inhibitory response of the junctional strips to isopropylnorepinephrine was unchanged over the range of temperatures tested.

5032 PROSPECTS FOR HYPERTHERMIA IN HUMAN CANCER THERAPY. PART I: HYPERTHERMIC EFFECTS IN MAN AND SPONTANEOUS ANIMAL TUMORS. *(Eng.)* Miller, R. C. (Dept. Radiology, Univ. Arizona Medical Sch., 1501 North Campbell Ave., Tucson, AZ 85724); Connor, W. G.; Heusinkveld, R. S.; Boone, M. L. M. *Radiology* 123(2): 489-495; 1977. (39 refs)

A Phase I study involving the use of radio frequency-induced hyperthermia and X irradiation for the treatment of spontaneous animal tumors is described. An RF generator operating at 500 kHz supplied power for localized heating. Needles were implanted in regular geometry encompassing the tumor and were connected proximally with metal braid to act as electrodes. The RF generator, capable of delivering up to 20 W of power, is adequate for small tumor volumes; for larger volumes, an RF amplifier, capable of delivering 200 W of power, can be used. To date, 24 animals with various malignant histologies have been subjected to more than 80 treatments of RF-induced hyperthermia in combination with X irradiation. Of the total number of tumors, 50% have shown marked regression (complete remission in nine cases). Preliminary results indicate that RF currents can be used to produce localized hyperthermia for cancer therapy and that effective thermal doses are probably in the range of 43-45 C for 30 min. Normal tissues within the treatment volumes have tolerated the heat and heat plus radiation doses employed.

5033 SPERMATOZOAN ACTIVITY AND INSEMINATION IN *TENEBRIO MOLITOR* FOLLOWING RADIOFREQUENCY ELECTRICAL TREATMENT (COLEOPTERA: TENEBRIONIDAE). *(Eng.)* Rai, P. S. (Dept. Entomology, Univ. Agric. Sciences, Banglaore 24, India); Ball, H. J.; Nelson, S. O.; Stetson, L. E. *Ann Entomol Soc Am* 70(2): 282-284; 1977. (8 refs)

Spermatozoan activity and insemination in *Tenebrio molitor* insects were examined following exposure to radio frequency (RF) radiation. First, adult females were exposed to a 39 MHz RF field at an electrode voltage of 2.5 kV for 4.0 sec and were paired with untreated males of the same age. Untreated males transferred spermatozoa to about 50% of the RF-treated females in contrast to 100% of control females. Because the treated females rested on their dorsa after RF treatment, making normal copulation difficult, a second experiment was conducted in which egg hatch after RF exposure was evaluated. Males and females were collected soon after eclosion; and after the first cluster of eggs was oviposited, females were exposed to RF fields at 1.5 and 2.5 kV for 4.0 sec. The mean number of eggs laid per female exposed to 39 MHz radiation at 1.5 or 2.5 kV was significantly lower than the mean per untreated female control. The egg hatch percentage for females inseminated before RF treatment and subsequently exposed to RF energy was significantly lower than that for untreated controls. In a third experiment, spermatozoan activity in the spermathecae of females treated with 39 MHz RF energy at 2.5 kV for 4.0 sec decreased directly with time after treatment; whereas, spermatozoan activity 72 hr post-treatment for nontreated females was very high. The activity of spermatozoa in the seminal vesicles of males exposed to 39 MHz fields for 4.0 sec at 1.5 or 2.5 kV 3 days after emergence was also measured, and the mean number of active spermatozoa in the seminal vesicles of RF-treated males was less than 50% of the number observed for untreated males. No morphologic damage to spermatozoa from adults exposed to RF treatment was evident at the treatment levels used.

5034 NORMAL DEVELOPMENT OF THE FRUITFLY *DROSOPHILA* IN VLF MAGNETIC FIELDS. *(Ger.)* Goetz, K. G. (Max-Planck-Institut fuer biologische Kybernetik, Tuebingen, West Germany); Goetz, S. *Z Naturforsch* 32c(1/2): 125-132; 1977. (28 refs)

A strain of wild type males of normal viability and subnormally viable *Attached-X y w* females of *Drosophila melanogaster* were exposed to a steady or rotating homogeneous magnetic field of 9.6 kHz and about 2.5 G for 54 days. The yield and sex ratio of the progeny revealed developmental damage and sex-linked recessive lethal mutations. Compared with subsequent generations of the control group, the subsequent generations in the exposed groups showed no developmental or hereditary load.

5035 MECHANISM OF REACTION OF THE HYPOPHYSEO-ADRENAL SYSTEM ON STRESS ACTION OF THE ALTERNATING MAGNETIC FIELD. *(Rus.)* Udintsev, N. A. (Dept. Biochemistry of Medical Inst., Tomsk, USSR); Moroz, V. V. *...atol Fiziol Ekap Ter* (6): 72-74; 1976. (13 refs)

The effect of permanent or intermittent exposure to alternating magnetic field (200 Oe, 50 Hz) on the function of the hypophyseo-adrenal system (adrenocorticotropic hormone [ACTH] level in the pituitary gland, steroidogenesis, plasma 11-oxycorticosteroid level) was studied in male rats. Continuous exposure for 15 min caused a 94% increase in the plasma

11-oxycorticosteroid level compared with controls. The increase gradually declined from 94% to 50% as the duration of the exposure increased to 24 hr. Intermittent exposure for 6.5 hr daily for 3 days caused a 32% increase, while exposure for 4-7 days caused a decrease compared with the control. Permanent exposure for 24 hr caused a 31% increase in the ACTH level, while intermittent exposure 6.5 hr daily for 4 days caused a 16% decrease. Similar changes were also observed in the activity of steroidogenesis, depending on permanent or intermittent exposure. It was concluded that the effect of magnetic fields was mediated through the hypophyseo-adrenal system and that the intensity of the effect was dependent on the period of the exposure.

5036 EFFECTS OF REPEATED MICROWAVE IRRADIATIONS TO THE ALBINO RABBIT EYE. *(Eng.)* Hirsch, S. E. (Ophthalmic Pathology Div., Armed Forces Inst. Pathology, Washington, DC); Appleton, B.; Fine, B. S.; Brown, P. V. K. *Invest Ophthalmol* 16(4): 315-319; 1977. (4 refs)

Albino rabbits were exposed to repeated 3,000 MHz microwave irradiations at power densities of 50, 100, 200, 300, 400, or 500 mW/cm^2 for 15 min/day over a period of 30 days, and clinical examinations were performed for up to 1 yr to detect microwave effects on the eye. Below power densities of 300 mW/cm^2, no ocular changes were detected. At 300 mW/cm^2 and above, all eyes showed congestion of the limbal vessels, pupillary constriction, and evidence of iritis. Posterior subcapsular iridescence (PSI) developed on the average of 17.5 days after irradiation at the 300 mW/cm^2 level. At 400 mW/cm^2, PSI appeared after an average of 5 days; vacuoles in the posterior cortex of the lens appeared after an average of 8 days, and posterior cortical cataractous changes appeared after an average of 10 days at 400 mW/cm^2 power densities. The lenticular opacities progressed but were limited to the posterior cortex during the following year of observation. It appears that the cataractous changes are dependent on the production of local temperature elevations sufficient to injure the lens' cortical cells which, because of their inability to dissipate heat, undergo first reactive changes (intercellular vacuolation) and subsequently necrotic (cataractous) changes.

5037 THE EFFECT OF CONSTANT MAGNETIC FIELD ON ECG IN EXPERIMENTAL ANIMALS. *(Eng.)* Gonet, B. (Zaklad Patologii Ogoinej i Doswiadczalnej PAM, 70-111 Szczecin, Powstancow 72, Poland). *Acta Physiol Pol* 26(2): 165-168; 1975. (24 refs)

Rats, mice, and hamsters were exposed to a constant homogenous magnetic field of 7,000 Oe over periods of up to 60 min to investigate electrocardiogram (ECG) changes. The ECG of rats generally did not change during exposure, although in some cases there was a tendency towards increased T-wave amplitude. The magnetic field likewise failed to change the ECG of mice. When hamsters were exposed to the field, significant ECG changes appeared after 30 min of exposure and consisted mainly of increases in the T-wave amplitude which amounted to an average of 22±8% after 30 min and 28±11% after 60 min of exposure. When the magnetic field was switched off, the ECG pattern returned to its initial shape; however, sometimes there was a delay of several min and a decrease in the T-wave amplitude. Since the ECG changes observed during exposure to the magnetic field involved the T-wave, it appears that the magnetic field affects mainly the process of repolarization in the myocardium.

5038 EFFECTS OF MICROWAVE RADIATION ON EGGS, EMBRYOS, AND CHICKENS. *(Eng.)* Davidson, J. A. (SHUR-GAIN Div., Canada Packers Ltd., Box 130, Winnipeg, Manitoba); Kondra, P. A.; Hamid, M. A. K. *Can J Animal Sci* 56(4): 709-713; 1976. (12 refs)

A series of experiments to assess the immediate and long-term effects of single high-wattage doses of microwave energy (produced by a Raytheon Radarange) on 1-day-old Leghorn hybrid chicks were performed. The minimal lethal dose of microwave energy input for the day-old chick was established at approximately 88.6 W/sec over a 9-sec interval or a total of 800 W-sec (J). Sublethal radiation at 596 W-sec (6-sec exposure) caused unconsciousness for up to 5 min and 42% mortality; survivors showed some cutaneous burns associated with reduced early growth. From 3-40 wk of age, there were no effects on growth, mortality, or reproduction. Radiation at 392 W-sec (4-sec exposure) had no immediate or long-term effects on the birds. A safe maximum exposure dose of 1 mW/cm^2 over 9 sec is proposed for 1-day-old chicks.

5039 CONTROL OF NON-IONIZING RADIATION EMITTING DEVICES IN CANADA. *(Eng.)* Repacholi, M. H.; Ghosh, S. K.; Benwell, D. A.; Dutt, G. C. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. pp. 337-340; 1977. (3 refs)

The control of nonionizing radiation (NIR) emitting devices in Canada is discussed. Over 60 NIR devices are being considered for possible regulatory control, and high priorities have been given to the following: ultrasound (diathermy, diagnostic, and industrial cleaning devices); microwaves (diathermy, bloodwarmers, commercial communications devices, and active metal detectors); and ultraviolet (sun lamps, dental polymerizers, mercury lamps, and industrial sterilizers). Draft regulations on the above devices are at various preliminary stages. Final form safety codes, which outline how to use the devices in a safe manner and how to install necessary precautions to ensure that personnel exposures are within acceptable levels, have been completed on open beam microwave devices, closed cavity microwave devices, active metal detectors, and demonstration lasers. A survey in Ottawa area schools indicated that some demonstration lasers are sufficiently powerful to produce eye damage quicker than the "blink" reflex to students who might view

the direct beam. Investigations of the possible effects of ultrasound or microwave radiation on blood enzyme activity have indicated that no effect is detectable when the temperature of the specimen is held constant.

5040 CANCER AND THE LAW OF WORK—A CLASSICAL PHYSICS APPROACH. *(Eng.)* Obermann, W. (New York: Vantage Press): 102 pp.; 1976. (15 refs)

The use of direct current for the treatment of cancer is discussed theoretically in terms of the physical process of forced ion migration. It is contended that cancerous tissue contains a higher than normal negative ion concentration, which leads to changes in cellular biochemistry that in turn produce cancer cell proliferation. The effectiveness of radiation therapy against cancer is analyzed as being the result of forced migration of existing ions, which causes cellular biochemical changes that lead to cancer cessation. It is proposed that such forced migration of existing ions can also be produced by small direct currents with potentials of around 6-9 V (battery power). It is suggested that two 15-min sessions with such direct current on successive days plus a 4-wk wait period should be adequate for producing regression of small tumors on the hand or foot of a human volunteer.

5041 AN EXPERIMENTAL AND THEORETICAL STUDY ON THE INTERACTION OF ELECTROMAGNETIC FIELDS WITH ARBITRARILY SHAPED BIOLOGICAL BODIES. *(Eng.)* Guru, B. S. (Ph.D. dissertation, Michigan State Univ., 1976); 212 pp. [available from Xerox Univ. Microfilms, Ann Arbor, MI 48106, Order No. 77-58101].

An experimental verification of a numeric technique for calculating the electric field induced inside and scattered by biological systems of arbitrary shape and composition when irradiated by electromagnetic waves is presented. The numeric approach involved the use of an integral equation, which was transformed into a set of simultaneous equations for numeric solution. Experiments were conducted on regularly and irregularly shaped biologic models containing saline solutions at frequencies ranging from 1.7-3.0 GHz (with 1 kHz modulation), with the electromagnetic field either at normal or end-on incidence. The effects of increasing the conductivity of a given region were examined, and the induced field and absorbed power density inside adults and children's torsos were quantified. The numeric technique was also used to quantify the above parameters inside cell samples. When human amnion cells were exposed to 2.45 GHz at 20.6 V/m for 60 min or 41.3 V/m for 8 min or longer, chromosomal aberrations were observed. Such aberrations were also observed in human lymphocyte cells exposed to 20.6 V/m for 40 min or 42.84 V/m for 5 min. These chromosomal aberrations were nonthermal in nature, since the temperatures of all cell samples were kept at 37 C or below during the exposures. These exposures were substantially lower than the U.S. safety standard of 194 V/m.

5042 PROGRESS REPORT OF THE IRPA STUDY GROUP ON PROTECTION AGAINST NON IONIZING RADIATION. *(Eng.)* Jammet, H. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. 9 pp.; 1977. (0 refs)

Sources of nonionizing radiation (electromagnetic radiation of photon energy equal to or less than 10 electron V) are surveyed. Hazardous sources of visible light include projector bulbs, spotlights, and floodlights. Occupational health hazards arising from exposure to infrared (IR) and ultraviolet (UV) radiation are associated with metal welding and cutting (UV); the fabrication, control, and use of fluorescent and mercury vapor lamps (UV); UV sterilization; and outdoor activities under the sun. Medical exposure to IR and UV radiation is increasing owing to the expanded use of thermotherapeutic (IR) and phototherapeutic (UV) methods. Lasers also present an optical hazard with occupational exposure representing the chief potential health problem. Sources of microwave and radiofrequency radiation include radars, radiotelecommunication links and repeaters, television, and radio broadcasting stations. Occupational exposure remains the main source of chronic and high level exposure with respect to the following activities: broadcasting, telecommunications, air and shipborne radar navigation, air traffic control, satellite communication, meteorology, metallurgy, food processing, sterilization, scientific research, and medical practice. Major occupational sources of exposure to ultrasound are industrial cleaning, machining, plastics welding, emulsifying, flaw detection, electronic signal processing, sonar detection of submerged objects, and medical uses (which are the most rapidly increasing source of exposure). The need for international agreements on exposure limits and guidelines for equipment performance standards is stressed.

5043 INDUCTION OF LH RELEASE AND OVULATION IN RATS BY RADIOFREQUENCY LESIONS OF THE MEDIAL BASAL TUBER CINEREUM (MEETING ABSTRACT). *(Eng.)* Everett, J. W. (Dept. Anatomy, Duke Univ. Sch. Medicine, Durham, NC); Tyrey, L. *Anat Rec* 187(4): 575; 1977. (0 refs)

The effects of non-specific tuberal lesions made by radiofrequency were examined in 4-day cyclic rats (Charles River CD strain) under pentobarbital during the pro estrus critical period. The active electrode was a 0.13 mm platinum wire encased for stiffening in 0.4 mm Pt tubing and insulated except at the very tip. The indifferent electrode was a brass rod in the rectum and descending colon. Current (2 MHz) was adjusted by trial to make lesions about 0.5 mm diameter when continued for 30 sec. Bilateral basal lesions centered approximately 1.5 mm apart and 2 mm behind the optic chiasma caused full ovulation overnight in five of five rats, while approximately eight controls were anovulatory (including two rats in which the electrodes had merely been inserted and left for 2 min). Unilateral lesions centered 0.9 mm or farther from the midline failed uniformly to produce ovulation in seven rats. When lesions were

centered 0.5 mm or less from the midline (i.e., impinging on the median eminence) six of six rats presented full ovulation next morning. Radioimmunoassay of serum luteinizing hormone (LH) in 0.5 ml blood samples taken by cardiac puncture 60 and 90 min after near-midline lesioning disclosed concentrations of 278 ± 66 and 449 ± 139 ng/ml (N=6 and 5, resp.). The continuing rise of LH long after the brief lesioning procedure implied either (1) continuing release of luteinizing hormone releasing hormone (LHRH) (possibly caused by persistent irritation at the electrode site) or (2) initial dumping of a large amount of LHRH.

5044 NONIONIZING RADIATION EXPOSURE IN URBAN AREAS OF THE UNITED STATES. *(Eng.)* Janes, D. E.; Tell, R. A.; Athey, T. W.; Hankin, N. N. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. pp. 329-332; 1977. (7 refs)

EPA measurements of radio frequency (RF) field strengths made at 72 sites located in Atlanta, Boston, Miami, and Philadelphia are reported for the 54-900 MHz frequency range. Within this range of frequencies, the frequency-modulated band contributed the most to RF exposure. The three television bands contributed about equally, and land mobile bands made an almost negligible contribution to the total power density. The maximum power density at any site summed over all bands was 2.5 $\mu W/cm^2$. Four sites, or about 6%, fell in the range of 1-2.5 $\mu W/cm^2$; therefore, some of the population is potentially exposed to values in excess of 1 $\mu W/cm^2$. An estimation of population exposure based on information on the distribution of RF levels and population distribution indicate that less than 1% of the population is exposed to values greater than 1 $\mu W/cm^2$. This estimate holds only for populations residing in areas where an unobstructed measurement is made 6 m above ground.

5045 CURRENT VIEWS ON MECHANISM OF INTERACTION OF MICROWAVE AND RADIOFREQUENCY RADIATION WITH LIVING SYSTEMS. *(Eng.)* Czerski, P. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. pp. 315-317; 1977. (2 refs)

Possible mechanisms for the interaction of microwave (300 GHz to 300 MHz) and radiofrequency (RF) (300 MHz to 0.1 MHz) radiation with living systems are discussed. The thermal approach is suggested as being insufficient for explaining several empirical observations. For example, it has been demonstrated that different bioeffects are induced in the nervous system and hematopoietic system of animals exposed to 3,000 MHz radiation depending on the mode of generation (pulsed versus continuous) at the same mean energy density. Frequency dependence of effects on mitosis in bacterial and animal cells as well as on colicin synthesis in *Escherichia coli* have been demonstrated in the USSR. Frequency dependence of effects on the nervous system has been demonstrated following exposures to 147 MHz radiation which was amplitude modulated at frequencies between 8 and 20 Hz. An explanation to account for some of these phenomena has been proposed that consists of developing a quantitative electrochemical concept of the greater neuronal membrane comprising the neuronal phospholipid sheet of the cell membrane and the constituents of the intercellular spaces in brain tissue and serving as a physical substrate for electromagnetic field interaction with the nervous system. Quantum mechanical approaches may offer possible explanations for the primary interaction of microwaves and RF radiation with living systems.

5046 RADIATION LEAKAGE CONTROL OF A RADIOFREQUENCY INDUSTRIAL SYSTEM. *(Eng.)* Grandolfo, M.; Ranghiasci, C. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. pp. 325-328; 1977. (6 refs)

Preliminary results on the E-intensity pattern existing in the vicinity of a typical radiofrequency sputtering system, a relatively low power apparatus operating at a frequency of 13.56 MHz, are reported. Leakage intensity measurements were made with a field-strength meter at eye level in zones near the unit where personnel could be exposed in the normal course of their duties. Results obtained along an axis perpendicular to the sputtering apparatus at working power levels of 400 and 600 W indicate that leakage levels of no greater than 20 V/m at a distance of 10 cm from any accessible surface can be achieved with proper maintenance and inspection.

5047 PRACTICAL EXPERIENCE IN THE GDR AT THE MEASUREMENT OF THE ELECTRICAL COMPONENT OF THE ELECTROMAGNETIC FIELD. *(Eng.)* Eggert, S.; Goltz, S.; Kupfer, J. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. 8 pp.; 1977. (0 refs)

A near field strength meter for measuring electromagnetic fields over the frequency range of 60 kHz to 300 MHz (high frequency range) in occupational situations is described. The device includes two dipole probes: one for frequencies between 60 kHZ and 30 MHz and the other for frequencies between 10 MHz and 350 MHz. The measurement ranges for the two probes are 3-2,500 V/m and 1.5-1,250 V/m, respectively. The accuracy of the instrument is ± 20%, and its response time is 1 sec. The device operates off of two 9-V batteries, which power it sufficiently for at least 10 hr. The minimum distance that must be kept between the dipole probes and the conducting parts of the high frequency installation being monitored is 25 cm for the lower frequency range and 10 cm for the higher frequency range. The field strength meter is suited for optimizing screening devices and for checking their screening effects as well as for determining the degree of homogeneity and the size of the electrical field in animal exposure chambers.