AD-A040 681 FRANKLIN INST RESEARCH LABS ROCKVILLE MD SCIENCE INFO--ETC F/G 6/18
BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION. VO--ETC(U)
JUN 77 B H KLEINSTEIN, E P SABOE

UNCLASSIFIED

NL

1 OF 1
AD
A040681



END

DATE
FILMED
7-77

AD A040681

(12)
NW

Biological Effects of Nonionizing Electromagnetic Radiation

DDC
RECEIVED
JUN 16 1977
C

VOLUME 1
NUMBER 4
JUNE, 1977

A DIGEST OF CURRENT LITERATURE

A Quarterly Publication
Produced for
Office of Telecommunications Policy
and
United States Navy

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

"The views and conclusions contained in this documentation are those of the author and should not be interpreted as necessarily representing the officials' policies, either expressed or implied, of the Office of Telecommunications Policy or of the U.S. Navy."

THE FRANKLIN INSTITUTE RESEARCH LABORATORIES
Science Information Services

AD NO.
DDC FILE COPY

(6)

BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

Volume 1. Number 4.

A Digest of Current Literature

(9) Quarterly rept. Apr-Jun 77,

(12) 65p.

(11) Jun 77

A Quarterly Publication
Produced for
Office of Telecommunications Policy
and
United States Navy

DDC
JUN 16 1977
C

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

(10) Bruce H. Kleinstein, Ph.D., J.D., Project Manager
Elena P. Saboe, Production Manager, Editor

NTIS White Section
DDC Buff Section
UNANNOUNCED
JUSTIFICATION Per Form 50.
BY
DISTRIBUTION/AVAILABILITY CODES
Dist. AVAIL. and/or SPECIAL
A

"The views and conclusions contained in this documentation are those of the author and should not be interpreted as necessarily representing the officials' policies, either expressed or implied, of the Office of Telecommunications Policy or of the U.S. Navy."

409 935

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

June, 1977 Volume 1, Number 4

TABLE OF CONTENTS

Preface..... v

Abbreviations and Acronyms..... vii

News Items..... 1

Meetings and Conferences..... 3

Current Research..... 5

Current Literature.....13

Authors of Current Literature Index.....57

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 I, 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.

PRECEDING PAGE BLANK-NOT FILMED

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--

PRECEDING PAGE BLANK-NOT FILMED

NEWS ITEMS

BRH DEVELOPS SAFETY STANDARDS FOR DIATHERMY EQUIPMENT

A study was conducted by the Bureau of Radiological Health's Division of Electronic Products to develop a radiation safety performance standard for microwave diathermy equipment. The study was designed to compare the performance of four commercially available applicators and several direct-contact applicators at 2.45 GHz. The direct-contact units included a square aperture horn, a circular waveguide, a teflon slab-loaded rectangular waveguide, and a circular aperture horn. Laboratory measurements were made on phantoms of simulated human fat and muscle tissue to determine the heating patterns induced by the different applicators. It was shown that direct-contact applicators provided more uniform heating than did spaced applicators. Measurements also were made of the scattered radiation from spaced applicators and the leakage radiation from the direct-contact types. Electric field measurements showed that leakage radiation from the loaded rectangular waveguide was less than 5 mW/cm^2/100 W of forward power, while scattered radiation from a commonly used loaded spaced applicator ranged as high as 30 mW/cm^2/100 W of forward power. Leakage radiation from the circular aperture horn was almost negligible, demonstrating that design techniques for minimizing unwanted radiation from direct-contact applicators are available.

BRH Bull. 11(3): 1977

BUREAU AND MICROWAVE DIATHERMY COMMUNITY AGREE ON DRAFT STANDARD

Attendees at the March 24, 1977, public meeting on the clinical implications of the Bureau of Radiological Health's draft performance standard for microwave diathermy products accepted the present draft, suggesting only one major change that would restate the requirement concerning the heating ability of the applicator. The modification, suggested by Drs. Justus F. Lehmann and Arthur W. Guy of the University of Washington, would change the requirement that diathermy equipment be capable of delivering a net forward power of at least 50 W to an applicator. They recommended that the draft include requirements for specific absorption rate (in units of watts per kilogram) in the simulated muscle tissue of a test phantom. The Bureau concurred, and the Electromagnetics Branch of the Division of Electronic Products presently is studying ways of incorporating such requirements into the draft and integrating them with the specified leakage limits. Once the standard has been redrafted to incorporate the change suggested at the meeting, it will be published in the FEDERAL REGISTER as a proposed rule. The Bureau-convened meeting was attended by representatives of the physical medicine and physical therapy professions, other government agencies interested in physical medicine and rehabilitation, and manufacturers of microwave diathermy equipment. The program included presentations by Bureau staff members and invited speakers on the biologic effects of microwave radiation, the medical uses of microwave diathermy, the performance of present diathermy equipment, prospects for improving that performance, and the requirements of the draft standard. In a presentation on applicator performance, Dr. Gideon Kantor of the Electromagnetics Branch indicated that a new applicator incorporating a flange choke has been developed under contract as part of the Bureau's effort to demonstrate the feasibility of the applicator requirements. The new applicator, he said, could meet the draft requirement of less than 5 mW/cm^2 leakage at 5 cm with a 1-cm air gap between the applicator and the phantom and a net forward power of 100 W. This allayed some prior concern regarding the feasibility of meeting the leakage requirement with an applicator that would be sufficiently simple and light in weight for satisfactory clinical use and that would not depend on physical contact with the patient to limit the leakage. Some clinicians have stated that contact between the applicator and patient may be undesirable because of surface heating problems.

BRH Bull. 11(7): 1977.

PRIMATE RESTRAINT DEVICE FOR MICROWAVE BIOLOGIC RESEARCH

Researchers at the Naval Aerospace Medical Research Laboratory, Pensacola, Florida, have developed a restraint chair for use with subhuman primates in microwave biologic studies. The Styrofoam chair is essentially non-reflective, causing minimal perturbation of the field incident on the animal. The basic design of the device is simple and adaptable to different experimental configurations.

IEEE Trans. Biomed. Eng. 24(2): 201-203; 1977.

MINIATURE ELECTROMAGNETIC PROBE DEVELOPED FOR BIOEFFECTS RESEARCH

A miniature electromagnetic probe system has been developed by Bureau of Radiological Health engineers to meet the needs of researchers investigating the biologic effects of electronic product emissions in the frequency range of 0.2 to 12 GHz. The probe's accuracy, small size, and fiber optic telemetry system makes it a valuable tool for laboratory measurements. Present probes are not appropriate because of their physical size or hard-wired readout. The system consists of a probe containing an array of three miniature orthogonal dipoles, 2.5 cm long, equipped with individual detector diodes. The probe is 30 cm long and has a cross-section of 3 x 5 mm. The detected voltage output of each dipole/diode is converted to digital form to drive light-emitting diodes whose output is transmitted via a fiber optic cable to a digital receiver. The fiber optically-linked telemetry system provides protection from radiofrequency interference and enhances accuracy by eliminating cable scatter. The Bureau has used the probe to study scattering and field distributions

near Plexiglas animal holders during microwave bioeffects experiments. Field distributions and scatter from animals and their restrainers also have been measured at different frequencies, and near fields with steep spatial gradients—a few centimeters away from microwave diathermy applicators—have been mapped. In many of these applications, the small size and maneuverability of the probe plus its nonmetallic optical data link allowed the use of simple setups and positioners while maintaining good system accuracy. The probe also has been implanted in biologic media to measure electromagnetic field distribution within simulated tissue irradiated with microwaves. Dr. A. Cheung of the University of Maryland assisted the Bureau in the implantation studies. The sensitivity of the present probe is sufficient to measure internal fields in finite biologic specimens irradiated under "nonthermal" plane-wave exposure conditions of a few milliwatts per square centimeter. In recent tests performed under a Bureau grant by the Brain Research Institute of the University of California at Los Angeles, similar probes have been used to measure the internal field strength in the brain of a living cat subjected to a plane-wave exposure of 1 mW/cm^2 at 450 MHz. The probe system was developed by the staff of the Electromagnetics Branch of the Division of Electronic Products with the contract assistance of Collins Commercial Telecommunications Division of Rockwell International, Dallas, Texas. The original fabrication of miniature electric field probes was performed under Bureau contract at the Johns Hopkins University Applied Physics Laboratory. The development effort was partially funded by the U.S. Naval Medical Research and Development Command.

BRH Bull. 11(7): 1977.

MINICOMPUTER SUPPORTS MW RESEARCH

The Bureau of Radiological Health is using minicomputers to expand its research capabilities and to allow more efficient use of time and resources in the administration of its radiation control programs. Each minicomputer is dedicated to a specific application, ranging from the study of radiation phenomena to the editing and formatting of text for publications. One minicomputer, interfaced with experimental equipment, is supporting research on the possible behavioral effects of microwave radiation. In these studies monkeys, which are being irradiated with microwaves, are required to perform repeated tasks and rewarded when they have performed correctly. The system controls the experimental setup and monitors the response of the monkeys.

BRH Bull. 11(2): 1977

TEMPERATURE MEASURING SYSTEM IS DEVELOPED

Ramal, Inc. of Sandy, Utah has developed and manufactured a temperature measuring system for use in microwave research. The LCT-1 Temperature Measuring System utilizes a liquid crystal sensor located at the tip of a fiberoptics bundle to measure temperatures in limited ranges. The probe has no metallic components and is essentially transparent to electromagnetic radiation. The complete system consists of an electronics unit housing a digital read-out and power supplies; an optics module to excite the probe; and the fiberoptic probe with liquid crystal sensor tip. The optics module, which excites the probe, is fabricated from aluminum to shield the unit from microwave radiation.

Ramal Inc. Announcement

BIOBEHAVIORAL EFFECTS OF MICROWAVES TO BE STUDIED

Drs. Om Gandhi, J. D'Andrea, and Cueller of the University of Utah, Salt Lake City, presented their proposed work on "2450 MHz Microwave Absorption in Large and Small Animals and Its Biobehavioral Effects in Birds and Reptiles" at the conference, *Ecological Impact of Microwaves from Proposed Space Power Satellites.* The conference was held at NASA-Ames Research Center, Moffett Field, California on February 23-25, 1977.

Utah Bioeng. Newsletter 4(4): 1977.

ITEMS FROM THE COMMERCE BUSINESS DAILY

☐ **ADDITIONAL RESEARCH ON THE NEUROPHYSIOLOGICAL AND BIOBEHAVIORAL EFFECTS OF CW AND PULSED MICROWAVES IN RODENTS AND OTHER LABORATORY ANIMALS.**

The Office of Naval Research, Arlinton, Virginia, has contracted with the Board of Regents of the University of Washington, Seattle, for the above study. (April 11, 1977)

☐ **A STUDY OF THE BIOLOGICAL & ECOLOGICAL EFFECTS OF ENERGY TRANSMISSION BY MICROWAVES.**

The National Aeronautics and Space Administration, Ames Research Center, Moffet Field, California, has contracted with Stanford Research Institute, Menlo Park, California, for the above study. (April 13, 1977)

MEETINGS AND CONFERENCES

INTERNATIONAL IEEE/AP SYMPOSIUM 7 USNC/URSI MEETING (RADIO SCIENCE/ANTENNAS AND PROPAGATION)

Date: June 20-24, 1977
Place: Palo Alto, California
Sponsor: Inst. of Electrical & Electronics Engineers (AP, Int.); Int. Union of Radio Science--US National Committee (USNC/URSI
Requests for Information: J. B. Damonte, 1716 Hillman Avenue, Belmont, CA 94002

URSI SYMPOSIUM ON ELECTROMAGNETIC WAVE THEORY

Date: June 20-24, 1977
Place: Palo Alto, CA: Stanford Univ.
Sponsor: URSI (US National Committee)--International Union of Radio Science
Requests for Information: Dr. F. M. Tesche, Science Applications, Inc., Box 277, Berkeley, CA 94701

1977 IEEE MTT INTERNATIONAL MICROWAVE SYMPOSIUM

Date: June 21-23, 1977
Place: San Diego, California
Sponsor: Inst. of Electrical & Electronics Engineers (MTT)
Requests for Information: D. Rubin, Code 2330, NELC, San Diego, CA 92152

Selected Bibliography of Papers Presented:

MICROWAVE THERMOGRAPHY AS A DIAGNOSTIC TOOL FOR THE DETECTION OF CANCER. (invited) A. Barrett, P. Myers

HYPERTHERMIA DOSE DEFINITION. E. R. Atkinson

SELECTIVE HEATING OF CUTANEOUS HUMAN TUMORS AT 27.12 MHz. P. Antich, N. Tokita, J. Kim, E. Hahn

HYPERTHERMIA: HEALING AND HAZARD IN TUMOR BEARING RATS. H. Moroson, S. Stowe, M. Schechter

CHANGES IN TUMOR BLOOD FLOW PRODUCED BY MICROWAVE-INDUCED HYPERTHERMIA. C. Sutton, F. Carroll

INCREASE IN X-RAY SENSITIVITY OF CANCER AFTER EXPOSURE TO 434 MHz ELECTROMAGNETIC RADIATION. J. Holt, P. Keckie, A. Nelson

PRELIMINARY IN-VIVO PROBE MEASUREMENTS OF THE ELECTRICAL PROPERTIES OF TUMORS IN MICE. E. Burdette, J. Seals, J. Toler, F. Gain

NON-PERTURBING MICROPROBES FOR MEASUREMENT IN ELECTROMAGNETIC FIELDS. A. Priou, A. Deficis

NEAR ZONE MICROWAVE EXPOSURE OF A BIOLOGICAL SPHERE. K. Al-Badwaihy, S. Hafiz

EFFECT OF SURFACE COOLING AND BLOOD FLOW ON THE ELECTROMAGNETIC HEATING OF TISSUE. H. Kritikos, K. Foster, H. Schwan

BOLUSING TECHNIQUE FOR BATCH MICROWAVE IRRADIATION OF TUMORS IN THE FAR FIELD. A. Cheung, D. McCulloch, J. Robinson, G. Samaras

A SYSTEM FOR DEVELOPING MICROWAVE INDUCED HYPERTHERMIA IN SMALL ANIMALS. R. Baker, V. Smith, L. Kobe, T. Phillips

THE DESIGN AND PERFORMANCE OF A CIRCULARLY POLARIZED DIRECT CONTACT APPLICATOR FOR MICROWAVE DIATHERMY. G. Kantor, D. Witters, J. Greiser

WORLD ELECTROTECHNICAL CONGRESS

Date: June 21-25, 1977
Place: Moscow, USSR
Sponsor: WELC (Org. Committee; Int)
Requests for Information: WELC: c/o Min for EE Industries, Kalinina prospect, 19, Moscow, G-19, USSR

SECOND ELECTROMAGNETIC COMPATIBILITY SYMPOSIUM AND EXHIBIT

Date: June 28-30, 1977
Place: Montreux, Switzerland
Sponsor: Conv. of Natl. Electrical Engineering Assn. of W. Europe (EUREL); Int. Union of Radio Science (URSI); Inst. of Electrical and Electronics Engineers (EMC Gp) (Int.); Soc. of Auto Engineers (AE-4) (USA); et al.
Requests for Information: T. Dvorak, ETH Zentrum (HF), 8092 Zurich, Switzerland

Selected Bibliography of Papers Presented:

BIOLOGICAL EFFECTS OF HIGH INTENSITY, LOW FREQUENCY ELECTROSTATIC FIELDS. H. B. Graves

SOME SPECIAL APPLICATIONS OF MICROWAVE RADIOMETRY OF BIOLOGICAL SYSTEMS. J. Bigu del Blanco

PERCEPTION OF STATIC FIELDS BY LIVING ORGANISMS AND TERATOGENIC EFFECTS OF MICROWAVES. G. d'Ambrosio, V. La Manna

COMPATIBILITY OF WEAK MAGNETIC ELF FIELDS. H. W. Ludwig

EFFECT OF 60 Hz HIGH INTENSITY ELECTRIC FIELDS ON LIVING PLANTS. G. W. McKee, D. P. Knievel, D. T. Poznaniak, J. W. Bankoske

INFLUENCE ON IMPLANTED CARDIAC PACEMAKERS BY ELECTRONIC SENSOR SWITCHES AND ELECTROSTATIC DISCHARGES. H. J. Bisping, W. Irnich, S. Schroer

AN EMC STANDARD FOR MEDICAL ELECTRONIC DEVICES. R. J. Hoff

INTERNATIONAL SYMPOSIUM ON MICROWAVE DIAGNOSTICS OF SEMICONDUCTORS

Date: July 13-15, 1977
Place: Porvoo, Finland: Haikko Manor
Sponsor: Technical Research Ctr. of Finland--VTT (Semiconductor Lab.); Helsinki Univ. of Technology (Electron. Physics Lab.) Finlan
Requests for Information: R. Paananen, VT

ELECTROMAGNETIC COMPATIBILITY SYMPOSIUM

Date: July 26-28, 1977
Place: Seattle, WA: Washington Plaza
Sponsor: Inst. of Electrical & Electronics Engineers (EMC)
Requests for Information: B. L. Carlson, Jr., Boeing Co., Box 3029, Seattle, WA

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

INTERNATIONAL CONFERENCE ON RADAR (RADAR 77)

Date: October 25-28, 1977
Place: London, United Kingdom
Sponsor: Inst. of Electrical Engineers (Electronics Div.) [UK]; Inst. of Electrical & Electronics Engineers (Aerospace Electronics Society; [Int.]; Inst. of 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. of NY, Route 110, Farmingdale, NY 11735

ENGINEERING IN MEDICINE AND BIOLOGY CONFERENCE

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

0120 MECHANISMS OF MICROWAVE INTERACTION WITH HUMAN AUDITORY SYSTEMS. Lin, J. C.; Yu, F. T. (Wayne State Univ., Graduate Sch., Cass & Antoinette Aves., Detroit, MI 48202).

The mechanism of interaction of pulsed microwaves with living tissues will be investigated theoretically and experimentally. The research will involve analytic studies of the stress and forces induced by the incident microwave energy and optical measurement of vibrations in models of human and animal heads exposed to pulsed microwaves. Theoretic and experimental investigations of the frequency behavior of the induced vibrations will be performed to isolate the precise mechanism involved in the auditory phenomenon. The results will elucidate the quantitative effects of microwave energy on living organisms and provide information needed to determine human tolerance to microwave radiation. (8/76-7/77)

Supporting Agency:NSF, Div. Engineering.

0121 HEART CONDUCTION DEFECTS. Beckett, S. D.; Branch, C. E.; Robertson, B. T.; Sims, M. H. (Auburn Univ., Sch. Veterinary Medicine, Auburn, AL 36830).

The etiology, heritability, diagnosis, and prevention of syncopal attacks and sudden death in a spontaneous animal model are being studied and compared with sudden death in humans. The animal model consists of a line of purebred dogs with a tendency towards syncopal attacks and sudden death. Repeated episodes of atrial asystole have been documented using continuous monotoring of the electrocardiogram. The frequency of atrioventricular heart block was higher for the purebred line than for mixed breed dogs and was associated with autonomic activity. The major objectives of the project are to: (1) document the syncopal attacks using multichannel radiotelemetry to define the etiology of the spontaneous attacks and the susceptibility of individual dogs, (2) compare the baroreflex activity of the purebred line to mixed breed dogs, (3) compare the effects of rapid pacing on overdrive suppression of the purebred line compared to mixed breed dogs, and (4) evaluate the effect of pharmacologic agents on the frequency of attacks. (5/76-10/76)

Supporting Agency:HEW, PHS, NIH, Natl. Heart Lung & Blood Inst.

0122 MINIMALLY-INVASIVE STIMULATION WITH IMPLANTED DIODE. Schuder, J. C.; Stoeckle, H.; Almond, C. H.; Stephenson, H. E. (Univ. Missouri, Sch. Medicine, M228 Medical Sciences, Columbia, MO 65201).

Electrical stimulation of biologic tissue is currently used or under active consideration for use in the treatment of a variety of clinical problems. While the possibility of selective electrical stimulation of a localized region within the body by completely non-invasive means has been postulated theoretically, such stimulation has yet to be demonstrated experimentally. However, the selective stimulation of a localized region within the body can be achieved by implanting a very small diode at the desired site and then applying a pulsed radiofrequency field by means of electrodes or a coil on or near the surface of the body. This project has derived reasonably complete theoretic descriptions of the two systems on the basis of an idealized model in which circular electrodes or the coil are placed on the surface of a semi-infinite homogeneous medium. The direct current component of diode current is related to the power input to the electrode pair or to the coil and to the geometry of the system. The two systems are being evaluated for the cardiac pacing of dogs. The study will be extended to cover other stimulation applications. In addition, input power-diode current relationships for more complex models will be developed. (6/76-5/77)

Supporting Agency:HEW, PHS, NIH, Natl. Heart Lung & Blood Inst.

0123 WESTERN CANCER STUDY GROUP. Block, J. B. (Los Angeles County Harbor General Hosp., 1000 W. Carson St., Torrance CA 90509).

The influence of heat on tumor uptake of anticancer drugs will be investigated. For *in vitro* studies, clinical (surgical) material will be used; for *in vivo* work, microwave heating of transplanted animal tumors will be used. (9/75-7/77)

Supporting Agency:HEW, PHS, NIH, NCI.

0124 REMOTE STIMULATION BY RADIO-FREQUENCY TRANSMISSION. Glenn, W. W.; Holcomb, W. G.; Bouhuys, A.; Gee, J. B.; Cohen, L. S. (Yale Univ., Sch. Medicine, 333 Cedar St., New Haven, CT 06510).

Clinical studies will continue on the selection of patients with chronic ventilatory insufficiency for diaphragm pacing. The evaluation of diaphragm pacing in patients with central alveolar hypoventilation and quadriplegia will be emphasized. A study will be made of the causes of upper airway obstruction in patients selected for diaphragm pacing and a study of the loss of hypoxic drive in patients with ventilatory insufficiency requiring diaphragm pacing will be continued. The influence of diaphragm pacing on pulmonary hypertension during sleep will be studied. A registry of all patients with diaphragm pacemakers will be maintained. Experimental and clinical evaluation of phrenic nerve stimulation on diaphragm function will also be evaluated both experimentally and clinically. Clinical application of a demand-type diaphragm pacemaker will be expanded. In the animal laboratory *in vivo* testing of a hermetically sealed capsule for implant of radiofrequency components will be started. The experimental application of a totally implantable diaphragm pacemaker in the study of several stimulating waveforms will be done. The prototype of a total implantable pace-

maker programmable from the exterior for human application will be constructed. A quantitative study of tissue perfusion by heat loss calorimetry will be expanded. (1/77-12/77)

Supporting Agency:HEW, PHS, NIH, Natl. Heart Lung & Blood Inst.

0125 MOLECULAR MOTION AND ENERGY TRANSPORT IN MOLECULAR AGGREGATES. Prasad, P. N. (State Univ. New York, Graduate Sch., 1300 Elmwood Ave., Buffalo, NY 14222).

The process of energy transport through organic molecular aggregates which proceeds by the molecular motions and electronic excitation in various ordered and disordered crystalline aggregates will be studied. The nature of electron-phonon interaction, and the application of these studies in establishing the detailed nature of the energy transport will be examined. The investigations have both biologic and technologic applications. In a number of photophysical or photochemical processes in biopolymers, the primary step is the transport of the excitation. Additionally, a study of electron-phonon coupling and molecular motional instability is important for the technology of efficient energy transport and superconductors. The research is divided into four categories on the basis of the technique (Raman, electronic, excited state microwave resonance, and thermal modulation). (10/76-9/77)

Supporting Agency:NSF, Div. Materials Res.

0126 THE EFFECTS OF NON-IONIZING ELECTROMAGNETIC RADIATION ON SUBCELLULAR PREPARATIONS. Straub, K. D. (U.S. Veterans Admin. Hosp., 300 E. Roosevelt Rd., Little Rock, AK 72206).

The effects of low frequency electric fields from 10-20,000 Hz on both the sodium-potassium adenosine triphosphatase (ATPase) from guinea pig brain and mitochondria isolated from rat liver and pig heart were studied. The mitochondria derived from pig heart were subjected to current densities up to the point of marked heating of the solution at 20-2,000 Hz. During this time, calcium uptake was measured and oxidative phosphorylation was monitored; there were no changes in the ability of heart mitochondria to take up calcium, nor were there any decrements in oxidative phosphorylation until heating occurred, which was at current densities well above 1 mA/cm^2. Low frequency magnetic field effects on the active transport of frog skin were examined at 10-2,000 Hz and field strengths up to 100 G peak to peak. The isolated frog skin had a variable but persistent increase in short circuit current and potential immediately after the application of these fields with the maximum effect being observed below 100 Hz. No explanation can be given for the lack of field effects at 7 Hz at 28 kG. Further studies are underway to delineate the magnetic field effect on frog skin and to extend these measurements to sodium potassium ATPase *in vitro*. It can be concluded, however, that low frequency electrical fields from 10-2,000 Hz up to the point of current densities which heat the solution do not affect the sodium potassium ATPase from brain, the function of mitochondria in oxidative phosphorylation, or the calcium uptake from rat liver or from pig heart. (12/75-11/76)

Supporting Agency:U.S. Veterans Admin., Dep. Medicine & Surgery.

0127 ELECTROMAGNETIC RADIATION EFFECTS ON BRAIN TISSUE PERMEABILITY. Oscar, K.; Stokes, N. (U.S. Army, Mobility Equipment & Development Command, Fort Belvoir, VA 22060).

The functional relationship of microwave parameters to changes in the permeability of small inert polar molecules in the blood-brain barrier of rats will be determined. Rats will be exposed to pulsed and continuous wave microwave energy to assess the uptake of nondiffusible neutral polar substances in certain areas of the brain. A quantitative, radioactive isotope method, which uses a highly diffusible substance as an internal standard, will be employed to measure the loss of a labeled test substance to the brain tissue as a function of different microwave exposure parameters. (10/76-9/77)

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

0128 BIOELECTRIC PHENOMENA CONTROLLING BONE GROWTH. Bassett, C. A.; Chokshi, H. R.; Pawluk, R. J. (Columbia Univ., Sch. Medicine, 630 W. 168th St., New York, NY 10032).

Methods and mechanisms will be defined for controlling osteogenesis using inductively-coupled-pulsing electromagnetic fields, established external to the organism. Both *in vivo* studies of fracture healing in a rat femoral osteotomy model and *in vitro* studies of collagen synthesis and ^{45}Ca release by osteogenic cells will be used. Primary emphasis will be on elaborating those pulse characteristics, e.g., shape, width, amplitude and repetition rates, that have biologic significance during bone formation and repair. Attempts will be made to correlate the rate and amount of ^{45}Ca release by prelabeled cells with increases in collagen synthesis by osteogenic cells and with increases in fracture healing, as measured radiographically, histologically, and by mechanical testing. (2/76-1/77)

Supporting Agency:HEW, PHS, NIH, NIAMDD.

0129 NAVY ENVIRONMENT: EFFECT OF RF AND MICROWAVE RADIATION ON NERVOUS SYSTEMS. Takashima, S.; Kritikos, H. N. (Univ. Pennsylvania, Sch. Electrical Engineering, 203 Logan Hall, Philadelphia, PA 19104).

Controversy surrounds the likelihood of significant disturbances to humans resulting from the interaction of low-level electromagnetic (EM) fields with the

nervous system. Although it appears that EM fields do not alter the activity of single axons, it is worthwhile to determine which segment, or process, of the nervous system is susceptible to EM field interactions. The object of this research is to study the activities of relatively simple nervous systems in the presence and absence of EM fields. The first, and most critical, aspect of this work will be the characterization and quantification of the power absorbed by nerve tissue in the exposure chamber. Using the stellate ganglion of the squid, electrical transmission of alternating current and direct current fields across neuromuscular junctions will be studied. The effect of chronic exposure with weak fields on neuromuscular activities will also be studied. A very simple system or response will be studied first followed by more complex systems until the segment of the nervous system that is particularly susceptible to EM fields is found. The synaptic and neuromuscular junctions will be studied primarily. (10/76-9/77)

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

0130 RENAL CRYOPRESERVATION. Lillehei, R. C.; Kubota, S.; Graham, E. F.; Crabo, B. G.; Shatney, C. H. (Univ. Minnesota, Sch. Medicine, 1305 Mayo, Minneapolis, MN 55455).

A significant problem in freezing organs is the need for a substitute for cryo-precipitated plasma, which is used pre- and post-freezing. Various colloid solutions will be substituted for the plasma, and weight gain of the kidney compared with that using the plasma. Lactate dehydrogenase (LDH) and glutamic oxaloacetic transaminase (GOT) levels in the venous effluent are already used to assay *in vitro* renal damage following freeze-thawing. A similar study will correlate electrolyte changes as a measure of renal damage. While microwave thawing is the only way to achieve quick thawing, microwaves may intrinsically damage the kidney. Electronmicroscopy will be used to assess such damage at various power outputs and frequencies when kidneys are thawed from 75°C. Observations on using increasing concentrations of cryoprotective agents during freezing and decreasing concentrations during thawing will continue. (1/76-12/76)

Supporting Agency:HEW, PHS, NIH, NIAMDD.

0131 A STUDY OF DENDRITIC SPINE MORPHOLOGY IN RAT BRAIN FOLLOWING CHRONIC EXPOSURE TO LOW INTENSITY MICROWAVE RADIATION. Manthei, R. C.; Glaser, Z. R. (U.S. Navy, Surface Weapons Center, Dahlgren, VA 22448).

Eastern European studies suggest that reversible changes occur in the proliferation and/or the number of synaptic spines associated with the apical dendrites of rat cortical pyramidal cells following chronic electromagnetic radiation (EMR) exposure to between 1 and 10 mW/cm^2 of pulsed and continuous 10 cm waves. As such a phenomenon has broad implication for central nervous system plasticity, the credibility of Soviet data will be tested and a reliable histologic technique developed to complement future neurologic study. Eighty adult male rats (40 experimental, 40 control) will undergo 2-hr daily exposures to 10 cm pulsed microwaves at a power density of 10 mW/cm^2 for a period of 3 mo. Attempts will be made to assess morphologic effects described as having an early onset as well as the progressive, yet reversible effects described by the Soviets. Basalar and apical dendritic processes of pyramidal cells located in discrete areas of sensory-motor cortex will be examined at various depths utilizing accepted rapid Golgi procedures. Quantitative spine counting on 48 (24 experimental, 24 control) animals utilizing light microscopic technique will enable the classification of type of dendritic process and area of tissue involved. Histologic procedure and spine density counting will be performed by the Dept. of Anatomy, U.C.L.A.; Naval Medical Research Institute, Detachment Laboratory (Dahlgren, Va.) will be responsible for research design, irradiation (including field mapping, dosimetry, etc.), tissue preparation for shipment, as well as interpretation, analysis, and reporting of data. (10/76-9/77)

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

0132 NAVY ENVIRONMENT: THE NATURE OF ELECTROMAGNETIC FIELD INTERACTION WITH BIOLOGICAL SYSTEM FUNCTION. Frey, A. H. (Randomline Incorporated, Huntingdon Valley, PA 19006).

The effects of exposure to low power, modulated, and continuous wave microwave energy on nerve cells is being studied utilizing a preparation of the ventral nerve cord of the crayfish. Exposure will be in an anechoic chamber, and the dye chosen will allow for detection of active and passive parameters. Relevant information is expected on critical aspects of electromagnetic energy in inducing neural effects and the thresholds for such direct neural effects. Additionally, holography will be used to determine if the radiofrequency hearing phenomenon is caused by vibration of the skull or other head and ear structures. (10/76-9/77)

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

0133 LABORATORY AND FIELD EVALUATIONS OF HEAT ENERGY TO CONTROL STORED-PRODUCT INSECTS. Kirkpatrick, R. L. (U.S. Dept. Agriculture, Stored Products Insects Res. & Development Lab., 3401 Edwin Ave., Savannah, GA 31405).

The objective of this project is to develop rapid simple and practical techniques in the laboratory and to adapt these methods for field evaluations using temperature, including infrared and microwave radiation, to control stored-product insects infesting grain or other stored commodities. Research data obtained from these laboratory and field tests will be used to develop a practical and inexpensive commercial unit to control stored-product insects.

The laboratory tests will determine the repellancy, attractancy, effect on life history, behavioral responses, and dosage-mortality relationship of stored-product insects exposed to infrared, microwave radiation and other types of heat energy. Thus far, larvae of the pecan weevil, *Curculio caryae* (Horn), have survived temperatures of 5C but could not survive warm air temperatures of 43C for 24 hr. No changes in quality, taste, or lipid content of pecans occurred after treatment or during a 5-mo storage at 2C. Adult mortalities of 99% or more were obtained by treating bulk quantities of wheat with an infrared heater to obtain grain at a temperature of 48C. The immature insects were controlled at this temperature if the wheat retained at least 38C for 24 hr after treatment. (10/76-9/77)

Supporting Agency:U.S. Dep. Agriculture, Agricultural Res. Service, Georgia-South Carolina Area.

0134 TO DESIGN AND STUDY THE EFFECTS OF BIOMEDICAL SYSTEMS ON ANIMALS. Dracy, A. E.; Sander, D. E.; Bush, L. F. (South Dakota State Univ., Agricultural Experiment Station, Brookings, SD 57006).

The threefold objectives of this study are: (1) to design and test the validity of a volume conduction system for measuring body temperature continuously, (2) to study the effects of microwaves for partial and complete sterilization of farm animals, and (3) to design and test a unit that will have an exciting effect on rats and mice. The latter will also be used for rodent control. The stated approach is to use the circuitry built during the school year and improve on the water stability problems as they affect the operation of the circuit, to implant and monitor temperatures of the internal organs of the animal, to build a microwave cavity and obtain equipment to irradiate safely the testicles of a sheep, and to irradiate the subjects and test the amount of sterility as a function of radiation power and time of exposure. In addition, investigators will design and build a power supply from existing sources and test the effectiveness of the sound source on the eradication of rats and mice. In January of 1975, the Federal Communications Commission (FCC) designated the research telemetry bands to be 40.66-40.70 MHz and 216-220 MHz. In anticipation of this change and in order to upgrade the existing implantable electrocardiogram (ECG) telemetry systems previously developed at South Dakota State University, a new telemetry system was designed. This system utilizes an amplitude modulated carrier at 40.67 MHz. The carrier is pulse frequency modulated by a pulse generator whose frequency is dependent on the magnitude of a voltage impressed upon its input. This voltage is, at the present time, an amplified ECG voltage, which is picked up by Ag-AgCl electrodes. However, voltages proportional to pressure, temperature, or other physiologic variables can be used if desired. The system utilizes amplitude modulation with a pulse frequency modulated subcarrier and is reliable because: (1) the radiofrequency carrier is crystal controlled to reduce drift due to metal proximity effects; (2) a magnetically operated switch is used to turn the unit on only when data are to be collected; and (3) the unit is encapsulated in a silicone resin for mechanical strength. (10/76-9/77)

Supporting Agency:South Dakota State Government

0135 ABSORPTION OF RADIO FREQUENCY POWER BY BIOLOGICAL PHANTOMS. Lagrone, A. H.; Hurt, W. D. (Univ. Texas, Sch. Engineering, 200 W. 21st St., Austin, TX 78712).

Analytic solutions for power absorbed by spheroidal and ellipsoidal models of man and animals in the frequency range where the wavelength is long compared to the length of the phantom (up to approximately 30 MHz for man-sized models) were determined using perturbation techniques. The extended boundary condition method is a numeric technique that extends these calculations of absorbed power up to approximately 80 MHz for man-sized spheroidal models in the E-orientation and beyond for other orientations. Comparisons of calculated values of power absorbed by saline-filled spheroidal phantoms at frequencies from 10 to 50 MHz were made with measured values. (7/75-6/76)

Supporting Agency:Univ. Texas.

0136 ELECTROMAGNETIC RADIATION AND BIOLOGICAL SYSTEMS. Bawin, S. M.; Adey, W. R.; Medici, R. G.; Sagan, P. M.; Sheppard, A. (Univ. California, Sch. Medicine, 405 Hilgard Ave., Los Angeles, CA 90024).

The study of interaction between weak electric fields (extremely low frequency and radiofrequency) and calcium ion binding in the central nervous system will be continued and will serve as reference (frequency and amplitude thresholds, size and direction of field effect) for experiments involving amino acids and putative neurotransmitters. Chick and cat isolated cerebral tissues will be compared in their response to field stimulation. *In vivo* experiments on cat cortex will attempt to determine if live tissue responds to a field stimulus that affects isolated samples. Tissue dosimetry studies will be done in collaboration with the BRH. Preliminary measurements of field intensity in cat cortex, made with a miniature E field probe, will be repeated. An attempt to correlate tissue gradient and neurochemical response will be made. Detailed field mapping awaits development of an implantable probe. Recent developments in theoretic physics will be applied in modeling nonlinear responses of the central nervous system to weak perturbations of the extracellular environment. Schedule-controlled behavior in monkeys will be tested during exposure to 450 MHz fields. Performance of neonate chicks and ducklings exposed to the same field conditions will be compared in a series of behavioral measurements ranging from free behavior to sophisticated behavioral tasks, including variation of an interresponse time schedule. (12/76-11/77)

Supporting Agency:HEW, PHS, FDA, BRH