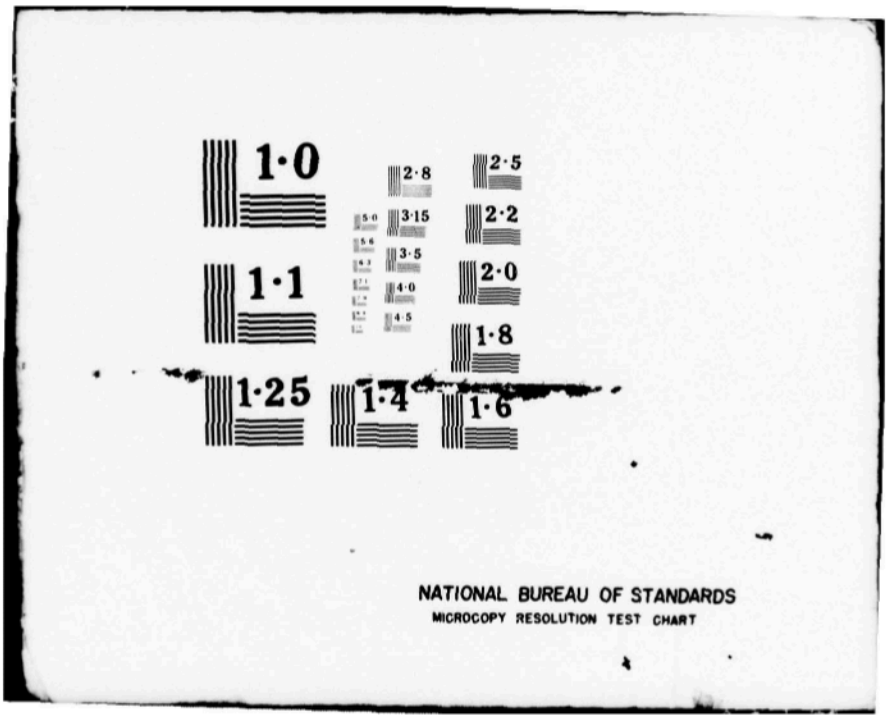
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VOLUME III
NUMBER 3
MARCH, 1979

A DIGEST OF CURRENT LITERATURE

A Quarterly Publication Produced for
National Telecommunications and Information Administration
and United States Navy

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FRANKLIN RESEARCH CENTER
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OF NONIONIZING ELECTROMAGNETIC RADIATION

A Digest of Current Literature

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

Bruce H. Kleinstein, Ph.D., J.D., Project Manager

Gary Freedman, Managing Editor

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BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

March, 1979 Volume III, Number 3

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PREFACE

Biological Effects of Nonionizing Electromagnetic Radiation is a publication researched and prepared by the Franklin Research Center, Science Information Services Organization, under contract with the U.S. Navy and administered by the National Telecommunications and Information Administration.

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 III, 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 Standard
NIH - National Institutes of Health
NSF - National Science Foundation
NIOSH - National Institute for Occupational Safety and Health
NTIA - National Telecommunications and Information Administration
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--

NEWS ITEMS

NONINVASIVE RADIO FREQUENCY PROBE DEVELOPED FOR ACCURATE TISSUE MEASUREMENTS

A researcher at the Georgia Institute of Technology, working under a 2-yr National Cancer Institute (NCI) grant, has developed a noninvasive radio frequency probe that can determine the dielectric properties of cancerous and normal tissues. Development of the probe makes possible for the first time energy absorption measurements in intact, living tumors; standard techniques involve cutting up tissue and putting it in a waveguide. Georgia Tech researcher, Everette C. Burdette explains, "We actually use the probe like a small antenna. We can model the currents along this antenna, and by measuring the change in impedance, we can predict changes in the dielectric properties." Using the probe, Burdette intends to determine the frequencies at which tumors will absorb energy more readily than normal tissues. Because the properties of tumors vary, there is no one particular frequency range that is effective. "Our goal," emphasizes Burdette, "is to find the right frequency range for each type of tumor. We have the analytical and theoretical tools here to predict exactly what the field will look like inside the body." When the measurement stage of the program is completed, Burdette expects to receive a follow-up grant from NCI to design an applicator to treat consenting cancer patients. Once Burdette confirms the frequencies where there is maximum tumor absorption and minimum normal tissue absorption, he will design special applicators for each category of diseased tissue. Based on his research with animals, Burdette feels that this technique presents a great potential for treating cancer patients. It can either be used to supplement other forms of cancer treatment, such as, chemotherapy and ionizing radiation, or eventually be used as a primary treatment.

Microwaves 17(9): 11-13; 1978.

MICROWAVE SURVEILLANCE SYSTEMS SET OFF HEALTH DISPUTE

As shoplifting losses continue to increase in shopping centers across the country, growing numbers of retailers have turned for help to surveillance systems that employ low-level microwave radiation. The system involves putting a tag on an article that, if not removed by a sales clerk or cashier, activates an alarm bell or beeper through microwaves emitted by electronic devices positioned on the sides of an entrance. Sensormatics Electronics Corporation of Deerfield, Florida, which has manufactured more than 70% of the microwave electronic-article surveillance systems now in use, has installed more than 9,000 systems in department stores throughout the country. Store owners and manufacturers of the security device insist the low-level microwave systems are safe and point to a Stanford Research Institute study that found that under normal operating conditions the power levels emitted by the devices are up to 10,000 times less than the microwave-exposure guidelines set by the Federal Government. Nevertheless, some clerks and cashiers are asking whether the radiation that is emitted is hazardous to their health and that of the public. In New York State, concern over the possible health hazards associated with the devices has prompted the Suffolk County Legislature to begin a series of hearings on the subject. One Suffolk County legislator, commenting on the shoplifting device, said, "We are not in any way entertaining a ban. But after we gather all the information, we could come to a conclusion that there is a threat and have to act on it."

New York Times December 18, 1978.

BRH RESEARCHER ROBERTS RUGH DIES

Dr. Roberts Rugh, a Bureau of Radiological Health (BRH) researcher in experimental embryology, died November 10 at the age of 75. Dr. Rugh came to the Bureau in 1971 after retiring as professor of radiology at Columbia University's College of Physicians and Surgeons. At the Bureau, Dr. Rugh investigated the effects of microwaves and ultrasound on the embryo and fetus, and he published 17 papers on ionizing radiation, microwaves, and ultrasound. In addition to his work at the BRH, Dr. Rugh authored five standard teaching and reference works on vertebrate development and more than 220 research papers on experimental biology.

BRH Bulletin

RADIO FREQUENCY TUMOR-TREATMENT APPARATUS PATENTED

A radio frequency apparatus that allows treatment of human tumors while inducing hypotension in the patient has been granted a U.S. patent. The apparatus enables the positioning of a patient so that the portion of the body in which the tumor is located can be heated with a radio frequency electromagnetic field for a period of time and intensity to cause necrosis of the tumor, while leaving the adjacent normal tissue unharmed. The apparatus is an improvement over existing radio frequency equipment in that it induces hypotension in the patient while treating the tumor. The apparatus bears U.S. patent number 4,119,102.

Official Gazette of the U.S. Patent and Trademark Office 975(2): 530-531; 1978.

IEEE PLANS SPECIAL ISSUE ON BIOMEDICAL EFFECTS AND APPLICATIONS OF ELECTROMAGNETIC ENERGY

The *Proceedings of the IEEE* will publish a special issue (January 1980) on the "Biological and Ecological Effects and Medical Applications of Electromagnetic Energy." The issue will include articles on electromagnetic fields in the environment, current safety standards, dosimetry, the biologic, behavioral, and ecologic effects of electromagnetic energy, and medical applications, such as, hyperthermia and microwave radiometry.

Bioelectromagnetics Society Newsletter

VISITING PROFESSOR TO RESEARCH ELECTROMAGNETIC FIELD THEORY TECHNIQUES AT THE UNIVERSITY OF UTAH

Dr. Ikuo Tanaka, Associate Professor of Electronics, College of Engineering, Shizuoka University, Japan, will serve for 1 yr as a Visiting Scholar at the Bioengineering Department, University of Utah, to undertake research in the area of electromagnetic field theory techniques for the internal electric fields and power absorption in man and animal models and other related research. He will be working closely with Drs. Om P. Gandhi and Carl H. Durney.

Utah Bioengineering Newsletter 6(1): 7; 1978.

ITEMS FROM THE COMMERCE BUSINESS DAILY

☐ DETERMINATION OF THE FEASIBILITY OF AN EPIDEMIOLOGIC STUDY OF WORKERS TO RADAR.

The Environmental Protection Agency, Contracts Management Division (MD-33), Office of Administration, Research Triangle Park, NC 27711 will negotiate with the National Research Council, Medical Follow-Up Agency, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC for the above study. (July 27, 1978)

☐ BASIC RESEARCH AND DEVELOPMENT WORK IN CONNECTION WITH THE ASSESSMENTS OF THE EFFECTS OF EXPOSURE TO MICROWAVE ENERGY ON HEALTH AND THE ENVIRONMENT.

The Satellite Power System Environmental Assessment Program, Energy and Environmental Systems Division, Argonne National Laboratory, Argonne, IL is soliciting proposals for the above study. (August 9, 1978)

☐ EVALUATION OF THE POTENTIAL NEUROLOGICAL HAZARDS OF MICROWAVE FIELDS.

The Office of Naval Research, Arlington, VA has contracted with the University of Utah, Office of Research Administration, Salt Lake City, UT for the above study. (October 19, 1978)

MEETINGS AND CONFERENCES

AMERICAN THERMOGRAPHIC SOCIETY/CANADIAN THERMOGRAPHIC ASSOCIATION JOINT MEETING

Date: March 31-April 1, 1979
Place: Toronto, Canada: Sheraton Center
Sponsor: American Thermographic Society; Canadian Thermographic Society
Requests for Information: W. B. Hobbins, M.D., 7803 Mineral Point Road, Madison, WI 53717
Content: Clinical research in medical thermography; biological applications; veterinary and industrial applications

BRITISH OCCUPATIONAL HYGIENE SOCIETY ANNUAL CONFERENCE

Date: April 3-6, 1979
Place: London, United Kingdom
Sponsor: British Occupational Hygiene Society
Requests for Information: D. Doran, British Occupational Hygiene Society, British Airways Medical Service, Heathrow Airport, Hounslow, Middlesex TW 6 2JA, United Kingdom
Content: Sessions will include physical, chemical, toxicological, and legislative aspects of occupational hygiene

AMERICAN OCCUPATIONAL HEALTH CONFERENCE

Date: April 29-May 4, 1979
Place: Anaheim, CA: Disneyland Hotel
Sponsor: American Occupational Medical Association (AOMA); American Assoc. of Occupational Health Nurses (AAOHN)
Requests for Information: H. N. Schultz, AOMA, 150 N. Wacker Dr., Chicago, IL 60606

INTERNATIONAL MICROWAVE SYMPOSIUM

Date: April 30-May 2, 1979
Place: Orlando, FL: Sheraton Twin Towers
Sponsor: Institute of Electrical & Electronics Engineers (IEEE), Microwave Theory & Techniques Society
Requests for Information: R. E. Henning, College of Engineering, Univ. South Florida, Tampa, FL 33620

INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY

Date: May 1-3, 1979
Place: Rotterdam, The Netherlands
Sponsor: Netherlands National Electrotechnical Committee of the IEC; Inst. of Technology Zurich
Requests for Information: Dr. T. Dvorak, ETH Zentrum-HF, 8092 Zurich, Switzerland (01) 326 2111, Ext. 2790
Content: Will include sessions on Magnetic Fields, Biological Effects, Spectrum Management, Electromagnetic Fields, Immunity and Susceptibility

SIXTH INTERNATIONAL CONGRESS OF RADIATION RESEARCH

Date: May 13-19, 1979
Place: Tokyo, Japan: Zenkyoren & Nihon Toshi Centers
Sponsor: International Assoc. Radiation Research (IARR); Science Council Japan (JSC); Japanese Association Radiation Research
Requests for Information: Professor S. Okada, Hongo Box 152, Bunkyo-ku, Tokyo 113-91, Japan
Content: Physics, chemistry, biology, and medicine and their interdisciplinary areas of radiation research (including nonionizing radiations) will be covered

MICROWAVE POWER SYMPOSIUM 1979

Date: June 11-15, 1979
Place: Monte Carlo, Monaco
Sponsor: International Microwave Power Institute
Requests for Information: Intn'l Microwave Power Institute, Box 634, SUB 11, Univ. Alberta, Edmonton, Alberta, Canada T6G 2E0
Content: Topics will include fundamental properties, microwave power generation, transmission and rectification, industrial microwave systems, microwave instrumentation and measurement, microwave properties of materials, industrial applications, food industry applications, medical and biological applications, biological effects of microwaves, domestic and catering microwave ovens, microwave field distribution and measurement, energy balance of microwave processes, equipment safety, RF interference and frequency allocations, economics and marketing of microwave ovens

BIOELECTROMAGNETICS SYMPOSIUM

Date: June 18-22, 1979
Place: Seattle, WA: Univ. Washington
Sponsor: USNC/URSI (Commissions A and B); Bioelectromagnetics Society
Requests for Information: A. W. Guy, Technical Program Committee Chairman, Bioelectromagnetics

Symposium, c/o Dept. Rehabilitation Medicine, Univ. Washington School of Medicine, Seattle, WA

XII INTERNATIONAL CONFERENCE ON MEDICAL AND BIOLOGICAL ENGINEERING/V INTERNATIONAL CONFERENCE ON MEDICAL PHYSICS

Date: August 19-24, 1979
Place: Jerusalem, Israel
Sponsor: Israel Society for Medical & Biological Engineering (ISMBE); International Federation for Medical & Biological Engineering (IFMBE); International Organization for Medical Physics (IOMP); Israel Society for Medical Physics (ISMP)
Requests for Information: Dr. A. Werner, Chaim Sheba Medical Center, Dept. Oncology, Sackler School of Medicine, Tel-Hashomer, Israel
Content: Tentative topics will include artificial organs, biomaterials, biomechanics, clinical engineering, diagnostic radiology, hazards and safety, health physics, non-ionizing radiation, medical instrumentation, and radiation dosimetry

WESTERN OCCUPATIONAL HEALTH CONFERENCE

Date: October 11-13, 1979
Place: San Francisco, CA: Fairmont Hotel
Sponsor: Western Occupational Medical Assoc. (WOMA); American Industrial Hygiene Assoc. (AIHA); Health Physics Society (HPS); American Society Safety Engineers (ASSE); Western Assoc. Occupational Health Nurses (WAOHN)
Requests for Information: B. H. Bravinder, WOMA, Box 201, Alamo, CA 94507

RADIOLOGICAL SOCIETY OF NORTH AMERICA: ANNUAL MEETING

Date: November 25-30, 1979
Place: Atlanta, GA
Sponsor: Radiological Society of North America (RSNA)
Requests for Information: Ms. A. Swenson, RSNA, Suite 1150, Oak Brook Regency Towers, 1415 W. 22nd St., Oak Brook, IL 60521

FIFTH INTERNATIONAL CONGRESS OF THE INTERNATIONAL RADIATION PROTECTION ASSOCIATION

Date: March 9-14, 1980
Place: Jerusalem, Israel: Jerusalem Convention Center
Sponsor: Israel Health Physics Society; Intern'l Radiation Protection Assoc. (IRPA)
Requests for Information: Israel Health Physics Society, C/O Soreq Nuclear Research Center, Yavne 70600, Israel
Content: Sessions will cover all aspects of protection against ionizing and nonionizing radiation

0396 EFFECTS OF WEAPONS RADIATION ON AIR-CREW TASK PERFORMANCE. Brown, G. C. (U.S. Air Force, Sch. Aerospace Medicine, San Antonio, TX 78235).

The development of mathematic models of crew survivability/vulnerability (S/V) analysis is dependent upon accurate descriptions of performance effectiveness under radiation environmental conditions. Studies of high dose, high dose-rate exposures have largely been completed. Emphasis will be placed on lower dose and dose rates, specific long mission scenarios, and complex interactions of ionizing and nonionizing radiation with task requirements. The objective of this effort is constructed dose-response curves for radiation environments and interactions of interest to SAC. Specifically, the combined effects of multiple radiation pulses, sustained low dose rate exposure, and aircrew task complexity upon system performance effectiveness will be determined. The description of aircrew performance during and following irradiation for S/V model applications (7757-05-23) is the ultimate goal. Selected models of operational task requirements will be utilized. Highly accurate simulations of specific system dynamics will be constructed and analyzed through application of mathematic control theory. Closed loop studies of operator control capabilities in radiation environments will be assessed through the identification, description, construction, and utilization of continuous (tracking) tasks. The problems of motivation, fatigue, work load, and time stress will be investigated to further strengthen S/V model predictions. (funding period n/a)

Supporting Agency:U.S. Dept. Defense: Air Force, Sch. Aerospace Medicine

0397 RFR EFFECTS ON GI TRACT. Erwin, D. N. (U.S. Air Force, Sch. Aerospace Medicine, Brooks Air Force Base, San Antonio, TX 78235).

Research is directed toward the establishment of thresholds for radio frequency radiation effects on each of the following biologic end-points: (a) smooth muscle response to direct electrical stimulation and to acetylcholine chemical stimulation; (b) smooth muscle inhibition (relaxation) and then rebound excitation (contraction) due to massive current stimulation of the gastrointestinal neural plexuses; and (c) neurophysiologic parameters of patterned firing in neurons of Auerbach's plexus. Short segments of cat gut will be exposed to a range of intensities of 2 GHz continuous wave radio frequency radiation. The following three stages of activity correspond to the above objectives. In Stage I, spontaneous and stimulated contractile activity will be monitored with strain-gauge transducers. In Stage II, coaxial electrodes in the lumen of gut segments will be used to pass massive current stimulation into the neural plexuses. Resultant relaxation and rebound contraction will be measured as above and integrated. In Stage III, fine platinum wire electrodes will be used to record ongoing activity in the cat gut. Frequency of neural spike trains, burst pattern, and amplitude will be measured and plotted under computer control. Each of these functions will be statistically analyzed by computer and plotted as functions of intensity, time, and percent of control values. (funding period 1/78-12/78)

Supporting Agency:U.S. Dept. Defense: Air Force, Sch. Aerospace Medicine

0398 RADIOFREQUENCY RADIATION BIOEFFECTS MATH MODELS. Bell, E. L.; Cohoon, D. K. (U.S. Air Force, Sch. Aerospace Medicine, Brooks Air Force Base, San Antonio, TX 78235).

Mathematic/computer research adjunctive to laboratory experimentation will be performed to determine the effects of radio frequency radiation on living tissue. The objectives of this research are: (1) to define how radar energy is distributed in the human body and to calculate resultant temperature rises, (2) to quantify acoustic wave generation by pulsed radar and estimate tissue compression responses, and (3) to develop equations describing radio frequency effects on biochemical events including chemical reactions, metabolite diffusion in tissue, and living cell membrane effects. The results will enable prediction of the effects of radio frequency radar on human beings and will improve the quality of Air Force radio frequency radiation safety standards. The use of mathematic/computer formulations will provide estimates of effects presently unavailable through experimentation or direct measurement, improve utilization of available data, and indicate needed critical laboratory tests. To accomplish objectives 1 and 2, the relevant partial differential equations will be solved for specific model living tissues. (funding period 2/78-6/80)

Supporting Agency:U.S. Dept. Defense: Air Force, Sch. Aerospace Medicine

0399 EFFECTS OF 60 HZ FIELDS ON THE MAMMALIAN CENTRAL NERVOUS SYSTEM. Adey, W. R. (Univ. California, Sch. Medicine, Dept. Anatomy, 405 Hilgard Ave., Los Angeles, CA 90024).

The effects of 60-Hz fields from high voltage transmission lines on the central nervous system of mammals will be investigated. Environmental field conditions similar to those found in the vicinity of high voltage transmission lines will be simulated. These field gradients will range from 1 to 2,000 V/m. The effects of these fields on the biologic rhythms in rats will be evaluated. The effects on the neuroendocrine mechanism in rats will be examined by using 17-hydroxysteroids, calcium, phosphorus, vanillamandelic acid, and other urinary indicators of biorhythmicity. Changes in the neurochemistry of cat brain tissue will be studied including the measurement of both Ca_2 ion amino acid effluxes from the cerebral cortex. Exposure of rats to electric fields of 50 and 500 V/m have been completed. Activity measurements at 50 V/m showed

no differences as compared with controls. At 500 V/m an increase in activity of the exposed over the controls was measured. At both 50 and 500 V/m an increase in urine output was measured with no increase in water intake. At 500 V/m no change in growth rate was observed; however, at 500 V/m a slower weight gain was measured. Thyroid and adrenal tissue were weighed at the end of exposure. Average weights of wet adrenal tissue were higher (56.8 mg) in the 500 V/m series than in the control group (43.1 mg). However, no differences were detected in averaged wet thyroid tissue weights (19.0 versus 18.5 mg). (funding period n/a)

Supporting Agency:EPA, Office of Energy Minerals & Industry

0400 INFRARED ANALYSIS OF DOSE DISTRIBUTION IN ANIMALS AND PHANTOM MODELS EXPOSED TO MICROWAVE RADIATION. Kinn, J. B.; Weil, C. M. (U.S. Environmental Protection Agency, Health Effects Res. Lab., Durham, NC 27711).

The distribution of absorbed energy in a complex biologic system (sectioned animals) and in equivalent phantoms exposed to microwave radiation will be determined using infrared thermography. An infrared thermographic scanner has been purchased and a minicomputer/software system is being designed to collect scans. The basic picture processing software package is operational, and additional software has been designed and written. Preparation of the samples has been completed and data are being collected and analyzed for selected animals. (funding period 7/75-9/81)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0401 NEUROCHEMICAL ANALYSES ON BRAINS OF ANIMALS EXPOSED TO LOW LEVEL EMR. Bursian, S. J. (EPA, Health Effects Res. Lab., Durham, NC 27711).

The effects of low level electromagnetic radiation (EMR) on catecholaminergic and cholinergic components in various brain regions of the rat will be determined. Acetylcholinesterase activities will be determined to assess the effects of low level EMR on cholinergic components, and tyrosine hydroxylase activities will be determined to assess possible catecholaminergic alterations. Two final reports will be prepared: one dealing with the effects of 100 MHz on rat brain neurochemistry and the other dealing with the effects of 915 MHz on rat brain neurochemistry. Tyrosine hydroxylase and acetylcholinesterase activities are being measured in seven brain regions from rats exposed to 100 MHz. The results have not yet undergone statistical analysis. (funding period 3/78-9/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0402 RELATIVE EFFECTIVENESS OF PULSED VERSUS CW EXPOSURE TO EMR ON IMMUNE SYSTEM. Smialowicz, R. J. (EPA, Health Effects Res. Lab., Durham, NC 27711).

The relative effectiveness of pulsed versus continuous wave exposure to electromagnetic radiation on the immune system of mice will be investigated. Antibody response to antigen and response to lymphocytes in vitro to mitogen stimulation will be determined in mice exposed at 425 MHz in the pulsed or continuous wave mode at several power densities for 1 hr on each of 5 consecutive days. The response to antigenic challenge with sheep erythrocytes in exposed mice will be assessed by the direct-plaque-forming cell assay. Circulating antibody titers will be determined and mitogen-stimulated response of lymphocytes will be assessed. Exposure of mice has just been initiated. (funding period 6/78-6/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0403 TDR MEASUREMENT OF DIELECTRIC PARAMETERS OF BIOLOGICAL MATERIALS. Kinn, J. B. (U.S. Environmental Protection Agency, Health Effects Res. Lab., Durham, NC 27711).

The broadband dielectric behavior of biologic materials including tissue and micro-organisms and the frequency dependence of the complex permittivity will be examined to identify the portion most influenced by energy in the radio frequency and microwave region. Time domain reflectrometry (TDR) will be employed to study dielectric behavior. The incident and reflected pulse transmitted to the sample in a coaxial waveguide will be recorded using a minicomputer. The data will then be processed using a Fast Fourier Transform in a large computer yielding complex permittivity as a function of frequency. A hardware/software system has been designed for the CAI minicomputer. The software has been defined and is presently being written. (funding period 7/75-9/79)

Supporting Agency:EPA, Office of Res. & Development, Health Effects Res. Lab.

0404 BODY-DEFENSE-SPECIFIC ABSORPTION FREQUENCIES OF NONIONIZING RADIATION IN BIOLOGICAL SYSTEMS. Allis, J. W.; Weil, C. M.; Blackman, C. F.; Elder, J. A. (U.S. Environmental Protection Agency, Experimental Biology Div., Developmental Biology Branch, Durham, NC 27111).

The interaction of nonionizing radiation with biologic systems will be investigated to identify frequency ranges that preferentially interact with isolated molecular, subcellular, and cellular components and tissues. The interaction will be observed through changes in absorption dielectric constant or insertion/reflection loss as a function of radiation frequency. A microwave spectrometer will be constructed to determine interaction fre-

quencies in the microwave region. The results will define frequencies of interaction with biologic systems and will be used in the design of bioeffects studies using those systems. Two instrumental designs have been found not workable. A third, under study, has given preliminary evidence of reproducing literature data for one molecular system in solution. Refinement of the instrumentation and further experiments are in progress. (funding period 7/75-9/81)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0405 EFFECTS OF NONIONIZING RADIATION ON THE IMMUNE DEFENSE SYSTEM. Huang, A. T. (Duke Univ., Sch. Medicine, Box 3711, Durham, NC 27706).

This research will determine whether microwave radiation injures the immune defense system in laboratory animals, and it will define the minimum exposure that causes detectable effects. Groups of mice (4/group) will be exposed to 2,450 MHz continuous wave radiation for 30 min/day for 2, 5, 7, 9, or 10 days at power densities of 5, 15, or 30 mW/cm^2. The assay for immune response will comprise the in vitro stimulation of lymphocytes with T-cell mitogens (phytohemagglutinin and concanavalin A) and a B-cell mitogen (LPS) as measured by ^3H-thymidine uptake. Preliminary data on the effect of microwaves on lymphocyte mitogen response, killer lymphocytes, and bone marrow colony-forming units have been recorded but not statistically analyzed. Investigation of the effect of microwaves on the morphology and chromosomes of lymphocytes has been completed. (funding period 4/75-10/78)

Supporting Agency:EPA, Office of Res. & Development, Health Effects Res. Lab.

0406 EFFECTS OF AMPLITUDE MODULATED NONIONIZING RADIATION ON MEMBRANES AND BIOPOLYMERS USING SPECTROPHOTOMETRIC AND FLUOROMETRIC MEASUREMENTS. Allis, J. W. (U.S. Environmental Protection Agency, Experimental Biology Div., Durham, NC 27111).

Amplitude-modulated or pulsed nonionizing electromagnetic radiation has been shown to affect animal behavior and the chemistry and physiology of certain isolated organ systems. These effects have been attributed to interaction between the radiation and cellular membranes, but have not been experimentally verified. This work will utilize membranes and membrane-bound enzyme systems during irradiation by amplitude-modulated radiation to determine if such effects can be inferred from changes in fluorescence or enzyme activity. Fluorometric or spectrophotometric measurements will be conducted during exposure to nonionizing radiation using equipment developed specifically for this purpose. Mode of interaction will be investigated if changes are found. A dose series for the erythrocyte membrane bound enzyme adenosine triphosphatase has been completed at several amplitude modulation frequencies between 16 and 150 Hz. Similar measurements have been completed at one exposure level for the mitochondrial membrane bound enzyme cytochrome oxidase. Enzyme activity was measured spectrophotometrically during irradiation, and no changes were found as compared with controls. (funding period 2/76-9/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0407 APPLICATION OF FLUORESCENCE TO DETERMINE THE EFFECTS OF NONIONIZING RADIATION ON MEMBRANES AND BIOPOLYMERS. Allis, J. W. (U.S. Environmental Protection Agency, Experimental Biology Div., Developmental Biology Branch, Durham, NC 27111).

Changes in properties of biologic membranes, membrane model systems, and/or biopolymers as measured by fluorescence techniques will be defined. A fluorometer will be modified to accept a microwave exposure system so that measurements may be made during exposure of the sample. If changes in properties are found, the mode of interaction of radiation with the biologic system will be investigated. To date, the microwave exposure facility has been successfully mated to the fluorometer; exposure system parameters have been characterized showing a useful range of 500-1,700 MHz; and data have been obtained for unirradiated erythrocyte membranes using a membrane lipid probe. (funding period 7/75-9/80)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0408 MICROWAVE DOSIMETRY IN BIOLOGICAL SYSTEMS. Weil, C. M. (U.S. Environmental Protection Agency, Health Effects Res. Lab., Durham, NC 27711).

Temperature data obtained with an infrared thermographic camera will be verified during and following microwave irradiation of phantoms using implantable temperature probes that do not perturb the microwave field. A report will be prepared detailing the results of the measurements and providing quality control validation of the thermographic camera measurements. Progress on this task is pending the completion of a data processing software package that will plot iso-temperature contours from the thermographic pictures. (funding period 10/76-12/78)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0409 DESIGN, CONSTRUCTION AND MODIFICATION OF MICROWAVE EXPOSURE SYSTEMS FOR BIOLOGICAL EXPERIMENTATION. Weil, C. M. (U.S. Environmental Protection Agency, Health Effects Res. Lab., Durham, NC 27711).

A simple and economic exposure system will be developed for chronic, low level exposure of squirrel monkeys to 450 MHz ultra-high-frequency radiation that will directly measure absorbed dose in each animal. The system resembles an existing one designed for exposing rodents at 915 MHz and will employ 16-inch diameter cylindrical waveguides containing a circularly polarized wave. The final output will be an exposure system consisting of approximately four in-house fabricated waveguides, each housing a single animal, plus similar enclosures for housing of sham-irradiated (control) animals. (funding period 10/76-9/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0410 BIOLOGICAL EFFECTS OF 60 HERTZ ELECTRIC FIELDS. Marino, A. A. (State Univ. New York, Sch. Medicine, Surgery, 766 Irving Ave., Syracuse, NY 13210).

The biologic effects of 60-Hz electric fields will be studied to assess the risk of exposure to such fields in the environment. Determinations will include: (a) the effect on mice of chronic exposure to 3.5 kV/m for three generations, (b) the effect on various physiologic parameters of rats of 1-30 days exposure to 3.5 kV/m, and (c) the effect of 0.5-10.0 kV/m for 1-5 days on gross motor activity of mice. Other related studies will also be performed. (funding period n/a)

Supporting Agency:HEW, PHS, NIH, Natl. Inst. Environmental Health Sciences

0411 MAGNETIC FIELDS/BIOMEDICAL EFFECTS. Tenforde, T. S. (Univ. California, Lawrence Berkeley Lab., Berkeley, CA 94720).

A systematic investigation is being carried out to determine the effects of stationary and alternating magnetic fields on living organisms and man. The major goal is to assess the biologic effects of exposure to magnetic fields such as those associated with controlled thermonuclear reactors (CTR) and magnetohydrodynamic systems (MHD), and to acquire quantitative data to establish exposure guidelines for CTR and MHD workers and the populace-at-large. Physiologic parameters will be measured in experimental animals exposed to magnetic fields including food intake, urine and fecal discharge, body weight and temperature, respiration, climbing activity, blood and urine composition, plasma growth hormone and corticosterone, visual function, and cellular mitotic activity. Using a variety of cell culture lines, magnetic field effects on cell growth rate, differentiation, cytokinesis, retinal photoreceptor electrophysiology, neural regeneration, and the electron transport system will be investigated. Magnetic effects on plant cells will be examined by measuring the growth and geotropic response of *Phycomyces*, and by measuring the protoplasmic streaming and membrane excitability in *Nitella*. The influence of magnetic fields on human subjects will be investigated, including effects on the visual system, psychomotor activities, hematopoietic, endocrine, and nervous systems. A facility that will house two large electromagnets and contain an experimental staging area is under construction. Exposure chambers and electronic devices for magnetic field studies on experimental animals and cultured cells are being constructed. Studies involving whole-animal physiology, plant growth properties and protoplasmic streaming, and neural electrophysiology have been initiated using low field strength electromagnets and permanent magnets. (funding period n/a)

Supporting Agency:Dept. Energy, Div. Biomedical & Environmental Res.

0412 MINIATURE OMNI-DIRECTIONAL RF MONITOR PROBE. Ireland, W. C. (Westinghouse Electric Corp., P.O. Box 746, Baltimore, MD 21203).

A miniature broadband electric field probe will be developed for implantation into biologic targets. Electric fields induced by incident microwave energy may then be directly measured in target organs of living animals. The design, technology, and fabrication processing necessary to construct such a probe already exist. Research will entail selection of feasible materials to be incorporated into a suitable design. Key properties of the instrument will be omnidirectionality, minimization of auxiliary equipment, suitably small physical dimensions, appropriate electrical sensitivity, freedom from interaction due to impedance of animal tissue, and low cost. (funding period 4/77-3/78)

Supporting Agency:U.S. Dept. Defense: Army, Medical Res. & Development Command

0413 TWIN-WELL CALORIMETRY SUPPORT OF IN VIVO ANIMAL STUDIES FOR WHOLE BODY EMR ABSORPTION. Kinn, J. B. (U.S. Environmental Protection Agency, Health Effects Res. Lab., Durham, NC 27711).

The total energy absorbed in a complex biologic system exposed to electromagnetic fields will be determined experimentally. Twin-well calorimeters will be employed using in vivo animal studies for total body electromagnetic radiation absorption. Eight calorimeters have been constructed and used in studies involving rats, hamsters, and mice. (funding period 7/75-9/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0414 THERMOGRAPHY-ENHANCED BY MICROWAVE AND ACOUSTIC ENERGY. Thompson, J. E.; Simpson, T. L.; Huhns, M. N.; Caulfield, J. B. (Univ. South Carolina, Sch. Engineering, Administration Building, Room 115, Columbia, SC 29208).