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Biological Effects of Nonionizing Electromagnetic Radiation

VOLUME II

NUMBER 2

DECEMBER, 1977

A DIGEST OF CURRENT LITERATURE

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

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THE FRANKLIN INSTITUTE RESEARCH LABORATORIES
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BIOLOGICAL EFFECTS
OF NONIONIZING ELECTROMAGNETIC RADIATION

A Digest of Current Literature

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

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

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

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BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

December, 1977 Volume II, Number 2

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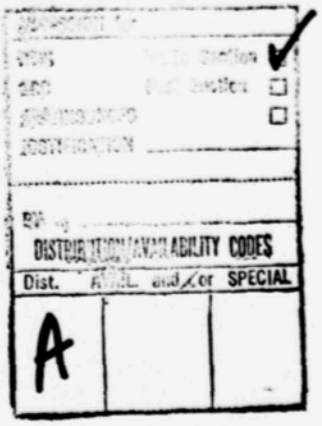
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PREFACE

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--

NEWS ITEMS

TRANSIT SYSTEM GENERATES MAGNETIC FIELDS

Underground trains in San Francisco have been found to generate magnetic fields that are 1,000 times stronger than the natural background and may have long-term effects in people, points out the Stanford University researcher who discovered the phenomenon. Anthony Fraser-Smith of the Stanford Radioscience Laboratory explains that San Francisco's new Bart system, as well as other rapid transit systems, are really a set of varying current loops that can generate a vertical ultra-low-frequency magnetic field at frequencies below 0.3 Hz. Because a train may draw up to 7 mW at 1,000 V direct current, the current can be as large as 7,000 amp, resulting in a huge magnetic field. Fraser-Smith explains that "The human body is an electrically conducting fluid--just a big sack of salty water. A fluctuating magnetic field in a conducting fluid sets up electric currents." Furthermore, cells have their own electric field that would be affected by a varying electromagnetic field. There is a danger, Fraser-Smith argues, that the large electromagnetic signals now being added to our environment may generate currents in the body, which have long-term disruptive effects. "No one monitors our total exposure to electromagnetic fields (of all frequencies) and it is conceivable that the Bart signals, although probably harmless themselves, may increase the possibility of harm from other electromagnetic signals."

New Scientist 75(1064): 358-359; 1977.

MICROWAVES LESS EFFECTIVE THAN CONVENTIONAL HEATING FOR MICROBIOLOGIC DESTRUCTION

Both conventional high- and low-temperature oven cooking were found to be more effective than microwave cooking in the destruction of microorganisms usually present in meat in studies performed at the Department of Animal Science of Ohio State University. Researchers inoculated selected strains of microorganisms into "asceptic" beef muscle tissue and subjected patties of the inoculated and incubated beef to different temperature treatments in a conventional or in a microwave oven. Microwave heating to the same endpoint internal temperature was found to be less effective for microbiologic destruction than conventional heating. The low thermal destruction with microwave heating is explained by the quick rise in temperature in this process, implying that microorganisms are exposed to the lethal temperature for a shorter period of time than in conventional cookery. Also, temperature is more uniformly distributed throughout the food in microwave cooking than in oven cooking so surface temperature does not exceed internal temperature as much as in conventionally cooked food. It is advised that "in order to achieve the same microbiological safety as with traditionally cooked samples, it will be necessary to increase the final internal cooking temperature or maintain the product at the final temperature for a longer period of time in the microwave oven."

Ohio Report on Research and Development pp. 38-41; May/June 1977.

SENATE COMMITTEE INVESTIGATES REPORTED MICROWAVE BURNS

The United States Senate Commerce Committee is investigating burns reportedly sustained by two waitresses while heating food in a microwave oven. The women reported feeling tingling sensations when they took food from the oven and later experienced pain, swelling, and discoloration in the hands. A burn specialist who examined the women said he observed abnormalities in the injuries unlike any other burns, and he assumes the burns were caused by microwave energy. However, a spokesman for the oven manufacturer maintains that the oven is safe and suggests that the women may have burned themselves by touching food that had been heated in the ovens. The manufacturer's claim is supported by the Bureau of Radiological Health, which was unable to find any fault in the oven involved.

New York Times August 9, 1977.

MICROWAVE POWER SYMPOSIUM ANNOUNCED

The International Microwave Power Institute's 13th Annual Microwave Power Symposium will be held at the Chateau Laurier Hotel in Ottawa, Ontario, Canada on June 27-30, 1978. The symposium will include technical sessions as well as a short course on microwave power. Original and review papers related to the biologic effects of microwaves are being solicited. Dr. Stan Stuchly, recently appointed editor of the Journal of Microwave Power, will serve as the 1978 Symposium Chairman.

MEAN 10(3): 14-16; 1977

BRH APPROVES MICROWAVE OVEN CORRECTIVE ACTION PLAN

The Bureau of Radiological Health has approved corrective action plans submitted by Sears, Roebuck and Company for microwave oven, model 564.9927710, manufactured by Sanyo. The ovens were declared in noncompliance when inspection tests revealed that some were leaking microwave radiation in excess of the limit specified by the standard. Of the 7,000 ovens manufactured, 504 were shipped to Sears stores, and it is estimated that no more than 50 units were sold. The correction plan calls for Sears personnel to reinforce the seam of the waveguide and cavity

by mounting screws, nuts, and washers in the existing holes in the magnetron support plate and the seam of the waveguide and cavity, apply a chemical compound on the screws and nuts to secure them permanently, and apply an adhesive aluminum strip over the welds on the seam between the two holes. Following modification, leakage measurements will be made, and each modified oven will be stamped with the letter "0" on the name plate located on the back of the oven.

BRH Bulletin 11(17): 4; 1977

NEW YORK COMMISSION REPORTS BIOEFFECTS OF HIGH-VOLTAGE TRANSMISSION LINES

The New York State Public Service Commisssion (PSC), in the latest stage of a continuing health and safety controversy over upstate power lines, has reported that chronic exposure to 765,000-volt electric-transmission lines "probably would cause biological effects in humans." Citing laboratory tests that showed that electrical fields around ultra-high-voltage lines affect animals, the PSC called for additional research, to be directly controlled by the commission, to "determine whether the proposed transmission lines actually cause specific biological effects under various conditions of exposure that are expected during operation of these lines." The report did not specify the biologic effects. Until the research is completed, the PSC said the public would be adequately protected against undue exposure to electrical and magnetic fields by a protective zone 500-feet wide under the lines.

New York Times September 18, 1977

STUDY REFUTES ANALGESIC PROPERTIES OF MAGNETS

Despite clinical claims and popular interest, the alleged analgesic properties of magnets have not been rigorously tested. However, researchers at the Department of Psychiatry and Psychology of the University of Manitoba, Canada recently assessed the pain thresholds of people wearing a magnetic bracelet with claimed analgesic properties (Aimante, model CS-5). Pain thresholds were assessed on the back of the hand of 16 healthy volunteers using a radiant-heat apparatus. Each volunteer acted as his or her own control, being tested five time both with and without a bracelet; the hand being tested and the bracelet/no bracelet order of testing were counterbalances. One-half of the volunteers wore an indistinguisable placebo bracelet 5 min before and during bracelet testing, while the remaining volunteers wore the magnetic bracelet for the same duration. Neither volunteer nor observer knew at the time of testing whether the bracelet was magnetic. No significant differences in pain thresholds between the volunteers wearing magnetic and those wearing placebo bracelets were revealed.

The Lancet 2(8027): 47; 1977

UTAH UNIVERSITY INSTALLS MICROWAVE SPECTRAL MEASUREMENT SYSTEM

A solid state computer-controlled system for swept frequency measurements of the absorption spectra of biologic specimens over the frequency band 26.5-90 GHz has been installed at the University of Utah, Salt Lake City. The completely automated system with an on-line x-y plotter has been assembled for use on the National Cancer Institute-sponsored grant, "Effects of millimeter waves on living tissue."

Utah Bioengineering Newsletter 5(5): 1977

MICROWAVE ENZYME INACTIVATOR TO BE DEVELOPED

A pilot study is being initiated at the University of Utah, Salt Lake City, to develop a microwave applicator for uniform inactivation of enzymes in rat brains. The project, headed by Drs. Dickman, Gandhi, and Grosser is funded by the University Research Committee.

Utah Bioengineering Newsletter 5(5): 1977

ITEMS FROM THE COMMERCE BUSINESS DAILY

□ **LOW POWER MICROWAVE EFFECTS RESEARCH.**

The Office of Naval Research, Arlington, Virginia has contracted with the University of Utah, Salt Lake City for the above study. (June 29, 1977)

□ **BIOLOGICAL EFFECTS OF RADIATION.**

The U.S. Energy Research and Development Administration, Argonne, Illinois has contracted with Case Western Reserve University, Cleveland, Ohio for the above muti-discipline approach study. (September 19, 1977)

Biological Effects of Nonionizing Electromagnetic Radiation II(2), December 1977

NON-IONIZING RADIATION: EUROPEAN HIGHLIGHTS

Dr. Paul D. Gillespie, Managing Director
The Franklin Institute, GmbH, Munich, Federal Republic of Germany

In Europe, the research activities surrounding the biological effects of non-ionizing radiation (NIR) are somewhat unsettled. Since national standards do not exist, European-wide exposure limits can not be established. Further, the impetus for establishing such standards has not come from the studies of the Commission of the European Community (CEC, the European Economic Community's research arm) that are presently undergoing review in Luxembourg and whose publication date is uncertain. The individual European Economic Community (EEC) member nations including Belgium, Denmark, Federal Republic of Germany, France, Ireland, Italy, Luxembourg, the Netherlands, and the United Kingdom are taking a wait-and-see attitude to avoid altering national standards to meet eventual European-wide agreements.

According to Dr. F. Kossl, Director of the German Health Ministry's Medical Radiation Technology and Radiation Protection Institute, Germany is reluctant to establish exposure limits and product performance standards that may require re-evaluation in light of EEC guidelines. And, Dr. Hans Eriskat, Director of the CEC Health Protection Directorate's division for EEC standards, studies, and regulations indicates that the picture is not bright for rapidly establishing these guidelines. The problem, explains Dr. Eriskat, is one of coordinating the national requirements and finding a workable middle ground. Since many national agencies have no clear position, Dr. Eriskat finds himself with the difficult task of finding the mid-point for a situation without well-defined boundaries. He hopes, however, that the CEC studies on laser and microwave radiation can be published in late 1977 and that 1978 will find the European community in some agreement.

In spite of these difficulties, research studies in the field have begun to receive increased financial support. Dr. Michael Seuss, Regional Environmental Pollution Control Officer for the World Health Organization's (WHO) office in Copenhagen, which coordinates all WHO activities for NIR problems, reports that an International Radiation Protection Association (IRPA)-WHO meeting for developing a joint program in NIR research support was held in November. Eastern European representatives, including the USSR, also participated in the meeting. In 1978, a small WHO working group of specialists will meet to evaluate the need for health regulations and safety standards for workers in institutions using microwave ovens.

Dr. Seuss emphasizes that the WHO-NIR program depends heavily upon contributions from many national experts, and he encourages unsolicited communications from the medical and scientific community on subjects of common interest. For example, a pressing problem for NIR studies is the necessity of standardizing the nomenclature used to describe effects and organism response as well as terminology, techniques, and criteria used by different countries. WHO is in the process of producing a glossary of terms and is seeking international standardization of terminology and definitions through cooperation with reference centers and/or national organizations.

Certain events, indicates Dr. Seuss, have served to confound international progress in NIR problems. The WHO has concluded studies concerning the suggestion that there was a correlation between the incidence of cardiovascular problems and the exposure to radar radiation in northern Finland (Karelia). It was shown that the incidence of such disorders existed in this region for at least 30 years prior to radiation exposure. Over-reaction to suspected cases of NIR-induced disorders has the effect, Seuss explains, of creating doubt about the real dangers surrounding exposure to NIR.

Along the same lines, Dr. Kossl refers to a study conducted by the University of Ulm, just southeast of Stuttgart, which investigated reports of cardiac pacemaker irregularities in hospital patients near the city of Bremen, Germany. The upper floors of the hospital were exposed to radar from a nearby airport. Exhaustive investigations revealed that no pacemaker irregularity could be traced to radar exposure. In fact, certain hospital practices were considered the more likely causes of the problem.

Regarding WHO NIR priorities, Dr. Seuss concludes that emphasis must be placed upon studies that generate information on NIR biological effect monitoring to form a foundation for coordinating European research.

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MEETINGS AND CONFERENCES

IAEA INTERNATIONAL SYMPOSIUM ON NATIONAL AND INTERNATIONAL STANDARDIZATION OF RADIATION DOSIMETRY

Date: December 5-7, 1977
Place: Atlanta, GA
Sponsor: International Atomic Energy Agency
Requests for Information: John H. Kane, Special Ass't. for Conferences, Office Public Affairs, ERDA, Washington, DC 20545

INTERNATIONAL UNION OF RADIO SCIENCE-U.S. NATIONAL COMMITTEE (URSI-USNC)

Date: January 9-13, 1978
Place: Boulder, CO
Sponsor: URSI-USNC
Requests for Information: S. W. Maley & J. R. Wait, Dept. Electrical Engineering, Univ. Colorado, Boulder, CO 80309

VIII INTERNATIONAL CONFERENCE OF PREVENTIVE AND SOCIAL MEDICINE

Date: March 27-31, 1977
Place: Mexico City, Mexico: National Medical Center
Sponsor: International Federation for Hygiene, Preventive Medicine, & Social Medicine
Requests for Information: Dr. P. R. Lauriola, 11, via Cola de Rienzo, 00192 Rome, Italy

ELECTROMAGNETIC COMPATIBILITY CONFERENCE

Date: April 4-7, 1978
Place: Guildford, UK: Univ. Surrey
Sponsor: Inst. Electronic & Radio Engineers [UK], Inst. Electrical & Electronic Engineers [UK], Inst. Electrical & Electronics Engineers [Int], Inst. Quality Assurance [UK], Inst. Marine Engineers [UK], Royal Aeronautical Society [UK]
Requests for Information: P. M. Elliott, IERE, Conference Services, 345 East 47th St., New York, NY 10017

AMERICAN OCCUPATIONAL HEALTH CONFERENCE

Date: April 9-14, 1978
Place: New Orleans, LA: Fairmont
Sponsor: American Occupational Medical Assoc., American Assoc. Occupational Health Nurses
Requests for Information: H. N. Schulz, AOMA, 150 N. Wacker Drive, Chicago, IL 60606

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, Office Science Meetings, 9650 Rockville Pike, Bethesda, MD 20014

THIRD INTERNATIONAL SYMPOSIUM ON THE NATURAL RADIATION ENVIRONMENT (NRE III)

Date: April 23-28, 1978
Place: Houston, Texas
Sponsor: Univ. Texas & Energy Research and Development Admin.
Requests for Information: Thomas F. Gesell, Univ. Texas Health Science Center at Houston, School of Public Health, PO Box 20186, Houston, TX 77025 or Wayne M. Lowder and James E. McLaughlin, ERDA Health & Safety Lab., 376 Hudson St., New York, NY 10014

INTERNATIONAL MAGNETICS CONFERENCE (INTERMAG)

Date: May 9-12, 1978
Place: Florence, Italy
Sponsor: Inst. Electrical & Electronic Engineers (Mag Gp) [Int] Italian Physics Society, Italian Assoc. Electrical & Electronics Engineers (AEI)
Requests for Information: J. Suozzi, Bell Telephone Lab., Whippany, NJ 07981

INTERNATIONAL MICROWAVE SYMPOSIUM

Date: May 15-17, 1978
Place: Ottawa, Canada
Sponsor: Inst. Electrical & Electronic Engineers (Microwave Theory Technique Group)
Requests for Information: A. L. Van Koughnett Communications Research Center, Box 11490, Station "H", Ottawa, Ontario, Canada K2G 8S2

MICROWAVE POWER SYMPOSIUM

Date: May 17-19, 1978
Place: Ottawa, Canada: Univ. Ottawa
Sponsor: International Microwave Power Inst.

Requests for Information: Dr. W. R. Tinga, IMPI, Edmonton, Canada T5J 2N7

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS: ANNUAL CONVENTION (ELECTRO/78)

Date: May 23-25, 1978
Place: Boston, MA: Sheraton Boston & Hynes Auditorium
Sponsor: Inst. Electrical & Electronic Engineers, Electronic Reps. Assoc.
Requests for Information: W. C. Weber, Jr. C/O IEEE Boston Office, 31 Channing St., Newton, MA 02158

CONFERENCE ON PRECISION ELECTROMAGNETIC MEASUREMENTS

Date: June 26-29, 1978
Place: Ottawa, Canada
Sponsor: Inst. Electrical & Electronic Engineers (IM), National Bureau Standards, International Union Radio Science (US Nat'l Committee)
Requests for Information: A. F. Dunn, National Research Council, Montreal Road, Ottawa, Ontario, Canada

0179 BIOPSYCHOLOGICAL STUDIES OF MICROWAVE IRRADIATION. Justesen, D. R.; Sheridan, C. L.; Levinson, D. M. (U.S. Veterans Admin. Hosp., 4801 Linwood Blvd., Kansas City, MO 64128).

Studies of Pavlovian conditioning of microwave-induced hyperthermia in rats are being performed. Both irradiated rats and controls (unconditioned stimulus [US] equals electrical shock) demonstrated a generalized conditional hyperthermia (colonic temperature approximately 39 C) that was resistant to extinction. The conditioned response was not discriminative to the acoustic conditioned stimulus (CS); a persistent state of hyperarousal occurred after a few pairings of US and CS that was accompanied by a rise of body temperature. Studies of guinea pigs with indwelling electrodes and thermal sensors in the brain have revealed that animals with microwave-induced rises of temperature to 43°C exhibit changes of conduction velocity of primary afferent nerves. Velocity, as indexed by latency-to-peak of the N1 component of the visually-evoked response, first increases and then decreases as a function of increasing temperature. (6/77-5/78)

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

0180 EFFECTS OF CHRONIC EXPOSURE TO MICROWAVE ON SQUIRREL MONKEYS. Kaplan, J. (Stanford Res. Inst., 333 Ravenswood Ave., Menlo Park, CA 94025).

Pregnant squirrel monkeys and their offspring are being exposed to microwave radiation in a cavity-cage module for varying periods of time to determine possible deleterious effects on physiologic and behavioral function. The length of exposure ranges from 5.5 wk in the case of pregnant animals to approximately 16 mo in the case of monkeys exposed both in utero and postpartum. Groups of animals receive either 0.1, 1.0, or 10.0 mW/cm^2 radiation 3 hr/day, 5 days/wk. Physiologic parameters under investigation include cardiac function as determined by electroencephalogram, and stress as reflected by urinary catecholamine output. Behavioral studies include tests of learning ability, activity level, and patterns of reflex development. (1/77-12/77)

Supporting Agency:EPA, Office of Res. & Development

0181 PRE- AND POSTNATAL EFFECTS OF MICROWAVE IRRADIATION. Jensh, R. P.; Weinberg, I.; Brent, R. L.; Vogel, W. H. (Thomas Jefferson Univ., Sch. Medicine, 1025 Walnut St., Philadelphia, PA 19107).

The overall objectives of this project are to determine dosage and monitoring procedures through refinement of techniques and instrumentation of microwave irradiation and by measuring modulated and pulsed transmission of two-frequency (2,450 ± 50 MHz, 915 ± 25 MHz) and two-power ranges. To determine exposure levels that do and do not result in embryopathy, chronic exposure of pregnant rats at low dose levels of microwave irradiation during pregnancy, during the implantation period, during the organogenic period, and during the fetal period will be determined. The specific objectives are to determine: (a) possible increases in rates of embryotoxicity or abnormal offspring and how the threshold dose may vary with different types of microwave exposure and different embryopathies; (b) whether the reproductive performance following in utero or adult exposure is a sensitive measure of microwave exposure; (c) whether the central nervous system will manifest functional or architectural alternations following in utero microwave irradiation; and (d) a comparison between the threshold sensitivity of behavioral changes with observable anatomic or histologic changes in the embryo. (6/77-5/78)

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

0182 MICROWAVE IRRADIATION OF BRAIN THROUGH CRANIOPLASTY. Sutton, C. H. (Univ. Miami, Sch. Medicine, 1400 N.W. 10th Ave., Miami, FL 33124).

This project is part of a broader program that supports the Comprehensive Cancer Center for the State of Florida as a multi-disciplinary cancer center. The center's participants are involved in clinical and basic cancer research, cancer education at all levels, and intensive community outreach programs throughout Florida. Cooperative programs have been established with the state's other universities, the American Cancer Society, and HEW. The overall objectives of this program are the establishment of a core of excellence in cancer research for the State of Florida and the development of interrelationships with other cancer-directed interests in the State (and nation). (6/76-5/77)

Supporting Agency:HEW, PHS, NIH, NCI

0183 NAVY ENVIRONMENT: EFFECTS OF MICROWAVE RADIATION ON CELLS IN TISSUE CULTURE. Chen, K. C.; Taylor, J. D. (Wayne State Univ., Sch. Liberal Arts, 4841 Cass Ave., Detroit, MI 48202).

The complete understanding of the consequence of microwave exposure (as from navy radar) requires an understanding of the interactive mechanisms that occur at the cellular and subcellular level. This research will attempt to elucidate the mechanisms that occur in human (and other) cells in culture following nonthermal microwave irradiation. The biologic activity of microwave-exposed transforming DNA on recipient bacteria will be investigated. The degree of biologic damage attributable to the nonthermal factor will be measured on the basis of the relative frequencies of transformation. The change in the surface structure of cells induced

by microwaves will be examined in terms of their reactions to various concentrations of the carbohydrate-binding protein, concanavalin A. Chinese hamster cells will be used. Cell specific responses to microwave damage will be examined on human and animal cell lines. Cytotoxicity will be measured by evaluating the cloning capability of exposed and unexposed cells. (10/76-9/77)

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

0184 BIOLOGIC RESPONSES TO A CHRONIC MICROWAVE ENVIRONMENT. Lebovitz, R. M.; Seaman, R. L.; Guterman, L. (Univ. Texas Sch. Medicine, 5323 Harry Hines Blvd., Dallas, TX 75230).

As microwave energy becomes increasingly present in our environment, an unmonitored population is placed at risk even though there is an insufficient body of data regarding the biologic effect of such exposure. The basic aim of this project will be to determine the effects of a long-term (4 mo exposure to microwave radiation (MWR) at low incident power densities. The behavioral effects of administratively safe MWR (i.e., less than 10 mW/cm^2 incident power density) will be examined. Data will be obtained from several behavioral variables, and a dose/response curve over the range of 0-20 mW/cm^2 will be defined. The chronic MWR environment will comprise individual radio frequency chambers into which control and experimental animals will be individually introduced for 3-4 hr of whole body MWR exposure/day. Pulse-modulated MWR at 1.3 GHz will be used. In the first part of the study, the effects of 0, 2, 5, 10, and 20 mW/cm^2 MWR on open field behavior and on instrumental behavior for food reward will be determined in rats. Besides the 0 mW/cm^2 group, additional control groups will be exposed to a mild thermal and acoustic stress. In the second part of the study, the changes in instrumental behavior relevant to learning will be determined and extrapolated to humans. Again, dose/response curve will be defined, via radiation at 5, 10, and 20 mW/cm^2 with dual control groups. These studies will provide needed data regarding the origin of chronic low level MWR effects on cognitive behavior and learning. (5/77-4/78)

Supporting Agency:HEW, PHS, FDA

0185 ELECTROMAGNETIC RADIATION INDUCED LENS CHANGES. Bonney, C. H.; Shacklett, D. (U.S. Air Force, Sch. Aerospace Medicine, Brooks Air Force Base, San Antonio, TX 78235).

Cataracts from a variety of causes will be studied and compared with cataracts produced by microwave energy to determine if a microwave cataract develops in a manner clinically distinct from cataracts produced by other causes. Rabbits, dogs, cats, and rhesus monkeys will be irradiated with ionizing radiation, nonionizing radiation, and a nonradiation source. Fifteen animals of each species will be utilized for each etiology. In all treatments the left eye will be exposured, and the right eye will serve as a control. All exposures will be made with the animals anesthetized with sodium pentabarbital. Clinical examination of the anterior segment will be made with a photoslit lamp so that changes may be recorded photographically. Anterior segment angiograms will be made to assess any change in capillary detail or function. Posterior segment examinations will also be conducted with direct and indirect ophthalmoscopes and fundus camera. Photographs of the fundus as well as fluorescein angiograms of the fundus will be made. Histopathologic evaluations will be made when the lens changes have progressed to the stage of obscuring the fundus. At this point, the animals will be sacrificed and ocular tissues will be collected for histologic examination. Glutaraldehyde-formalin mixture will be used for fixation and whole eye sections will be cut and stained utilizing standard light and electron microscopy. (10/76-9/77)

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

0186 ELECTROMAGNETIC BLOOD WARMING. Silva, J. (U.S. Navy, Human Factors Technology Div., San Diego, CA 92152).

The feasibility of using electromagnetic energy to thaw frozen blood products for clinical use in the Navy will be determined. Literature, materials, and products relevant to existing methods for thawing forzen blood products will be reviewed, and the problems associated with these processes identified. An alternative method using electromagnetic heating will be developed over a 3-yr period. The use of energy at different frequencies from approximately 30 MHz to approximately 3,000 MHz will be explored to determine the optimum wavelength for this application. Initial tests will be performed using materials with dielectric properties similar to those of frozen blood. Heat transfer properties and temperature elevation profiles, as a function of frequency and energy level, will be determined. Subsequently, tests using real frozen blood products will be performed. Finally a test protocol for handling electromagnetically thawed blood will be prepared and followed to establish the value of the method of heating as a means of restoring frozen flood to its clinically useful form. (10/76-9/77)

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

0187 DETECTION, SURVIVAL AND CONTROL OF PLANT PATHOGENIC BACTERIA ON SEEDS AND PLANT PROPAGATIVE MATERIAL. Ries, S. M. (Univ. Illinois, Agriculture Experiment Station, Urbana, IL 61801).

The effect of microwave irradiation on pathogen survival in infested seed and propagative plant parts will be investigated. Several phytobacterial diseases overseason in infected plant parts, frequently in seeds. Hot water dips, prolonged storage, or pesticide treatments of infected seeds

have been moderately successful in reducing pathogen numbers in seed sources, but these methods are expensive, time consuming, and involve pesticide usage. The application of microwave heat, a physical treatment, would be extremely quick and very inexpensive. *Pseudomonas glycinea*, infested soybean seed, will be the model for these studies. *P. glycinea* is seed-borne in all soybean cultivars. Although probably present in a hypobiotic state, there may be a moisture differential between the moisture content of the seed and the bacterium. This moisture differential will be exploited by irradiating with microwaves. selective death of the pathogen should occur before seed death, if the pathogen has a higher moisture content than the seed. Infected seed will be adjusted to a selected moisture content, irradiated for varying periods, and assayed for germinability and for *P. glycinea*. Preliminary evidence suggests that soybean seed at 6% moisture can be irradiated for 2 min with a complete destruction of *P. glycinea* and without reducing seed germinability. (10/76-9/77)

Supporting Agency:U.S. Dep. Agriculture

0188 TREATMENT OF ACROMEGALY WITH RADIOFREQUENCY TELETHERMO HYPOPHYSECTOMY (HUMAN). Boden, G. (Temple Univ., Sch. Medicine, 3223 N. Broad St., Philadelphia, PA 19122).

This project is part of a broader program of the General Clinical Research Center at Temple University Hospital to provide a carefully controlled environment for coordinated research of some of the more human common disorders. The Center employs interdepartmental scientists of diverse interests and physicians of various medical disciplines. (12/76-11/77)

Supporting Agency:HEW, PHS, NIH, Res. Resources Div.

0189 FLUID SHEAR OR MAGNETIC ALIGNMENT OF BLOOD COMPONENTS. Gardner, R. A. (Washington Univ., Sch. Engineering & Applied Sciences, 4559 Scott Ave., St. Louis, MO 63130).

The objective of this project is to quantitatively identify field mechanisms of interaction in blood due to either fluid flow (rate-of-shear) or externally applied fields (electric or magnetic). Two effects, which have been recently documented are the delay of in vitro thrombus formation due to either increasing rate-of-shear in the flow or the application of an external magnetic field. The results of this research may validate the hypothesis that the mechanism that results in these effects is the preferential alignment of one or more of the macromolecular participants in the in vitro thrombus-formation process. Fresh whole blood (wb) or platelet-rich-plasma (prp) from fasted normal donors will be used to produce coagula under the controlled in vitro flow conditions of a modified Chandler rotating loop system. The effects to be studied include: (a) the dependence of thrombus-formation time in prp and wb on field strength and rate-of-shear, and (b) the dependence of thrombus structure in wb and prp on field strength and rate-of-shear. The reduced sedimentation of erythrocytes in whole blood or single protein solutions in a transverse field will be examined theoretically and experimentally to identify orientation effects. Solutions of single blood proteins will be examined using the optical techniques of spectrophotometry, spectropolarimetry, and birefringence to quantify their orientation in a transverse magnetic field. (6/77-5/78)

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

0190 CUMULATIVE TERATOGENESIS FROM LOW LEVEL MICROWAVES. Rosenbaum, F. J. (Washington Univ., Sch. Engineering & Applied Sciences, 4559 Scott Ave., St. Louis, MO 63130).

It has recently been shown that prolonged exposure to low-level microwave radiation (0.5 mW for 8 hr at 9 GHz) will induce putatively cumulative teratogenic damage in pupae of the darkling beetle *Tenebrio molitor*. The proposed work will determine (a) whether intermittent exposure to microwave energy during pupation causes damage like that predicted by previous results; (b) the power level for putatively thermally-induced damage and the distribution of types of damage below the thermal level; and, (c) the influence of microwave frequency in the production of teratogenesis and thereby help identify possible mechanisms for the nonthermal effects already observed. (5/77-4/78)

Supporting Agency:HEW, PHS, FDA

0191 MICROWAVE CATARACTOGENESIS. Oosta, G. M.; Mathewson, N. S. (U.S. Dept. Defense, Armed Forces Radiobiological Res. Inst., Bethesda, MD 20014).

This research will determine the effect of microwave radiation on proteins in the rabbit lens and the relationship between expected microwave-induced alterations of lenticular proteins and duration of exposure at constant power density. Test animals will be exposed to subcataractogenic and cataractogenic levels of 2.45 GHz radiation. Possible conversion of soluble lens proteins to an insoluble form during microwave-induced cataractogenesis will be investigated. The quantity of soluble protein will be determined after extraction of all soluble lens proteins in a suitable solvent. Variables in extraction procedure will be studied to determine if soluble protein is converted to insoluble protein by the extraction procedure itself. After suitable extraction of lens proteins, quantity of alpha, beta, and gamma crystallins will be measured to determine possible alterations in protein concentration in rabbit lens as result of irradiation. Each crystallin will be further analyzed to deter-

mine shifts in subunit composition and changes in chemical/physical properties attributable to microwave damage. (10/76-9/77)

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

0192 MICROWAVE DIATHERMY AND RADIOFREQUENCY OF MALIGNANT TUMORS. Miller, L. S.; Raymond, U. (U.S. Veterans Admin. Hosp., 508 Fulton St., Durham, NC 27705).

This study will evaluate the effectiveness of microwave diathermy alone and in combination with ionizing radiation in the management of human cancer. Patients with metastatic malignant disease considered unmanageable by conventional surgery, radiotherapy, or chemotherapy and with measurable lesions in the skin, subcutaneous tissues or other accessible locations and a life expectancy of at least 2 mo will participate. The microwave diathermy to be used in the study poses no significant risks. Risks posed by x-ray and gamma-ray therapy are conventional, and at the doses specified, no added risks are anticipated. There is a small risk of bleeding and/or infection from needle implantation of the temperature-monitoring devices (thermistors). Potential benefits to the patient include reduction in pain, cessation of bleeding, healing of ulceration, and regression of tumor masses. (4/77-3/78)

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

0193 HYPERTHERMIA--A DIFFERENTIAL RADIOSENSITIZER IN VIVO. Gibbs, F. A.; Dethlefsen, L. A.; Johnson, C. C.; Gordon, G. A. (Utah Higher Education System, Sch. Medicine, 1400 E. 2nd St., Salt Lake City, UT 84112).

The potential of hyperthermia as a radiosensitizer will be evaluated for a rapidly proliferating normal murine tissue (duodenal crypt lining epithelium), a slowly-turning-over normal murine tissue (spinal cord), as well as a slow-growing (slow line) and a fast-growing (S102F) C3H mouse mammary tumor. This combination of tissues will allow the assessment of hyperthermic radiosensitization for both the early and late effects on normal tissue and on tumors with widely varying growth kinetics. The hyperthermia will be induced locally via a 915 MHz microwave system and the effects on the tissues will be assayed, respectively, by microcolony crypt survival, hind-leg dysfunction, tumor growth delay and local tumor control (TCD50/120). Several temperatures and heating intervals will be studied as will heating before and after x-irradiation. The therapeutic indices for tumor versus normal tissue will be determined for the various protocols. The long-term goal is to assess the feasibility of introducing hyperthermia as an adjuvant for clinical radiation therapy. (5/77-4/78)

Supporting Agency:HEW, PHS, NIH, NCI

0194 EFFECTS OF MICROWAVE RADIATION ON THE NERVOUS SYSTEM. Gandhi, O. P. (Utah Higher Education System, Sch. Engineering, 1400 E. 2nd St., Salt Lake City, UT 84112).

The effects of long-term, low intensity microwave exposure on the nervous system of rodents, will be investigated. Effects on the physiologic function of the nervous system, particularly the brain, will be measured and correlated with behavioral results. Biochemical analyses of the cholinesterase activity of the blood, the sulfhydryl groups in the blood, and ketosteroid in the urine will be performed and correlated with nervous system and behavioral measurements. (6/77-6/78)

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

0195 SEQUENTIAL CHEMOTHERAPY AND HYPERTHERMIA IN THE TREATMENT OF EXPERIMENTAL GLIOMAS. Sutton, C. H.; Carroll, F. B. (U.S. Veterans Admin. Hosp., 1200 Anastasia Ave., Miami, FL 33134).

Temperature gradients combining local heating of neoplasms with body-core temperature at 37 C or 28 C were investigated to determine their ability to enhance or inhibit the selective accumulation of parenterally administered antineoplastic agents in tumor implants. The Zimmerman murine ependymoblastoma was implanted subcutaneously in both flanks of C57BL/6 mice. In each animal, one flank tumor was heated to 40 C, 41 C, or 45 C with a 2.45 GHz microwave diathermy generator. The contralateral implant and the remainder of the animals were shielded with microwave-absorbing Eccosorb. Tracer doses of either ^{3}H-cytosine arabinoside or ^{3}H-methotrexate were injected either intraperitoneally or intravenously. These were measured in plasma, in heated tumor, in contralateral unheated tumor, and in liver and kidney 15-120 min post-injection. It was found that peak plasma concentrations of both agents were reached after 30 min. The greatest uptake of each agent during a 45-min period after intraperitoneal injection was obtained by heating tumors to 41 C. With both agents, the peak plasma concentrations achieved were two to three times greater in hypothermic than in normothermic mice. Higher concentrations were achieved in heated tumors using cytosine arabinoside than were achieved with methotrexate. Systemic hypothermia at 28 C served to minimize the amounts of antineoplastic agents entering liver and kidney during this 45-min period. These results confirmed that the distribution of antineoplastic agents can be affected by temperature gradients. The results also demonstrated an enhanced accumulation of antimetabolites selectively in microwave-heated tumors in the presence of body-core hypothermia. It is suggested that the microwave heating of tumors to 41°C for periods of 30 to 45 min after the parenteral administration of antineoplastic agents may prove beneficial in the chemotherapy of human neoplasms. (9/76-8/77)

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

0196 BIOELECTRIC STIMULATION OF DOG CORTICAL BONE GRAFTS. Burchardt, H.; Rudner, C. (State Univ. Florida System, Sch. Medicine, 1600 Archer Rd., Gainesville, FL 32610).

Cortical bone grafts are used in repairing congenital defects and in many other applications in orthopedic surgery. However, fatigue fractures of the grafts and/or nonunion of the graft-host junctions occasionally occur. The proposed study is an attempt to find a noninvasive method of enhancing the incorporation and/or repair of cortical bone grafts. It has been demonstrated that electromagnetic stimulation of experimental fractures can increase the speed of callus formation and the strength of healing fractures. This study will determine whether electromagnetic stimulation will enhance the incorporation and/or repair of segmental cortical fibular autografts in dogs. Adult mongrel dogs weighing 20 to 25 kg will be employed. Each dog with bilateral segmental fibular autografts will carry an electromagnetic coil fixed to each hind leg over the grafted segment for 12 wk postgrafting. The coil on one hind leg of each dog will emit an electromagnetic signal, and the other will serve only as a sham coil for control purposes. When the fibular segments are removed at 12 wk they will be tested for torsional strength. The segments will then be analyzed for porosity and cumulative new bone formation using continuous tetracycline labeling with fluorescent photography and microradiography of serial cross-sections of the transplant segments. The data will be compared statistically with established data on homotypic autograft variation to determine whether bioelectric stimulation by means of electromagnetic fields alters the strength or repair process of autogeneous bone grafts. (11/76-10/77)

Supporting Agency:Easter Seal Res. Foundation

0197 BIOLOGICAL TEMPERATURE SENSOR USING OPTICAL ETALONS. Christensen, D. A. (Univ. Utah Sch. Engineering, 1400 E. 2nd St., Salt Lake City, UT 84112).

This project will develop a nonmetallic temperature probe using a small optical etalon as the sensing element. The etalon--an optical flat coated to form a reflecting cavity--will be connected to the light source and detector by a fiberoptic bundle. Biologic applications of such a system include monitoring of microwave biohazards, microwave thawing of frozen organs and blood, and microwave therapy for cancer. Conventional thermistors, thermocouples and their metallic leads cannot be used in all these radiation experiments because they significantly perturb the electromagnetic fields and therefore cause temperature errors. The optical technique will rely upon the change in the wavelength-dependent reflection from the face of the etalon as the temperature varies. Temperature changes will cause thermal expansion or contraction in the etalon material as well as changes in the index of refraction, thus varying the resonant wavelengths. A similar technique, based upon the temperature shifts of the band energy gap in semiconductors, which can be sensed optically by measuring the wavelength of the adsorption edge, will be pursued. Prototype probes are under development. (4/77-3/78)

Supporting Agency:HEW, PHS, NIH, Natl. Inst. General Medical Science.

0198 REMOTE STIMULATION BY RADIOFREQUENCY TRANSMISSION. Glenn, W. W. (Yale Univ., Sch. Medicine, 333 Cedar St., New Haven, CN 06510).

This project is part of a broader program conducted by the Clinical Research Center at the Yale-New Haven Hospital and Yale University School of Medicine. The Center conducts clinical investigation concerning the mechanisms of disease. Therapeutic measures are developed or tested in this Unit. (12/76-11/77)

Supporting Agency:HEW, PHS, NIH, Res. Resources Div.

0199 EFFECTS OF MICROWAVE RADIATION ON THE NERVOUS SYSTEM. Lovely, R. H. (Univ. Washington, Sch. Medicine, 500 17th Ave., Seattle, WA 98122).

The effects of long-term, low intensity microwave exposure on the nervous system, particularly the brain, will be investigated. The effects of microwaves on the brain will be measured and correlated with behavior and biologic functions. (1/77-6/77)

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

0200 MICROWAVE THAWING OF FROZEN TISSUE. Lehr, H. B.; Holst, H. I.; Ketterer, F. (Univ. Pennsylvania, Sch. Medicine, 36th & Hamilton Walk, Philadelphia, PA 19104).

The microwave thawing process in frozen organic materials will be investigated. Since 1968 this laboratory has investigated the effects of microwave radiation on rat skin, canine kidneys, and gelatin molds. Radiation tolerance levels of cold cryoprotectant (DMSO) perfused canine kidneys have been established. Methods of thawing a frozen, cryoprotectant-perfused canine kidney have been evaluated by reimplanting the kidney in a dog's neck. To date, no kidney, after being frozen to a minimum of -40 C and stabilized at that temperature, has retained sufficient function to sustain a dog's life although survival of the kidney components as glomeruli and tubules has been obtained. Renal pelvis, ureter, and blood vessels survive consistently. Specifically, this investigation will measure the electrical properties of tissue in the frozen state. Improved qualitative models of microwave heating of kidneys by analysis and computer simulation will be developed and evaluated. A uniform thawing schedule employing more than one microwave

frequency will be developed for artificial organic gel kidneys that are similar in electrical and thermal properties to canine kidneys. Finally, these techniques will be applied to live mammal using rat skin and canine kidneys. (4/77-3/78)

Supporting Agency:HEW, PHS, NIH, NIAMDD.

0201 EFFECTS OF LOW INTENSITY MICROWAVE RADIATION ON MAMMALIAN SERUM PROTEINS. Cleary, S. F.; Berry, E. R. (Virginia Commonwealth Univ., Sch. Medicine, 1200 E. Broad St., Richmond, VA 23298).

Cis and *trans* isomers of beta mercaptoethylamine and gamma mercaptoprophylamine will be synthesized to determine their radioprotective properties. This research is relevant to maintaining military forces in the field during nuclear warfare, and it is in direct support of the Priority I Department of the Army Approved Qualitative Material Development Objective for Prophylaxis and Therapy to Offset Effects of Ionizing Radiation (CDOG 1212b[21]) dated 27 June 1968. (10/76-9/77)

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

0202 NAVY ENVIRONMENT - EFFECT OF MICROWAVE IRRADIATION (AS FROM RADAR) ON EMBRYONIC BRAIN TISSUE. Rioch, D. (Inst. for Behavioral Res., 2429 Linden Ln., Silver Spring, MD 20910).

This research will determine to what extent microwaves, such as are derived from Navy radars, alter the behavior and growth rate of rats that are exposed in utero. The experiments will be divided into three groups: Group I experiments involve exposure during the 6th to 9th and 12th to 16th days of gestation to determine post-natal changes in behavior and growth rate. Group II experiments will involve exposures at different times of the diurnal cycle to determine rhythmic influences. Finally, the relationship between intensity and duration of the exposure when total absorbed energy is constant will be explored. (10/76-9/77)

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

0203 BIOLOGICAL AND ECOLOGICAL IMPACT OF ENERGY TRANSMISSION BY MICROWAVE BEAM (JOINT ERDA/NASA PROGRAM). Sharp, J. C. (U.S. Natl. Aerospace & Space Admin., Ames Res. Center, Moffett Field, CA 94035).

The National Aeronautics and Space Administration (NASA) is currently assessing the feasibility of a Space Power Satellite to generate electrical power in space and transmit it to earth by microwave beam. The environmental impact from the transmission, received over many square miles continuously for 30 yr, appears to be far less than that from many other proposed solutions to the energy crisis, but many aspects have not been researched or tested. The biologic and ecologic consequences on all forms of fauna and flora to be illuminated need to be well defined. In addition, the potential hazard to operational personnel from acute exposure and low-dose chronic exposure must be evaluated to establish areas of restricted use around the receiving area. An initial short-term funded effort (definition phase) will be implemented to develop a 3-yr research program to define major effects and anticipated problems; suggested approaches will be researched in subsequent years. The initial 5-mo study plan will be reviewed, and the accepted plan pursued for an intensive 3-yr research program (Phase A). Results of that research will be assembled in a form suitable for use in decisions by NASA to extend commitments to the Space Power Satellite Concept and to conduct additional biologic and ecologic studies on mechanisms and interactions (Phase B). A further extension of this effort (Phase C) will develop operational procedures and site selections and prepare environmental impact documentation. (10/76-9/77)

Supporting Agency:HEW, PHS, NIH, NIAMDD.

0204 STUDY OF BIOLOGICAL AND ECOLOGICAL EFFECTS OF ENERGY TRANSMISSION BY MICROWAVES ON INSECT BEHAVIOR. Gary, N. E. (Univ. California, Sch. Agricultural and Environmental Science, Davies, CA 95616).

No descriptive information is available. (3/77-9/77)

Supporting Agency:NASA, Organization & Management Office, Univ. Affairs Office

0205 STUDY OF BIOLOGICAL AND ECOLOGICAL EFFECTS OF ENERGY TRANSMISSION BY MICROWAVES. Guy, A. W. (Univ. Washington, Sch. Medicine, 500 17th Ave., Seattle, WA 98122).

No descriptive information is available. (3/77-9/77)

Supporting Agency:NASA, Organization & Management Office, Univ. Affairs Office

0206 ELECTRIC FIELD AND ELECTROMAGNETIC SENSOR CAPABILITIES OF MARINE ORGANISMS. Kalmijn, A. J.; Sheltema, R. (Woods Hole Oceanographic Inst., Main St., Woods Hole, MA 02543).

An analysis of how marine organisms perceive, orient, and react to weak electric and electromagnetic fields in the ocean environment is important for naval operations involving deployment of galvanic hardware systems and for the protection of naval swimmer/diver personnel. Such an analysis would explain shark attack on both personnel and hardware and also the orientation of marine bacteria, which may be initial components in marine corrosion biochemistry

systems. The neural mechanisms and associated behavioral responses in marine organisms to natural electric and electromagnetic fields will be investigated. The principal areas of concern are the biologic relevance of an electric sense, the biophysics of electroreceptor systems, and the central processing of electrical information at lower brain levels. (10-76-9/77)

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

0207 MICROWAVE METHODS OF LUNG WATER MEASUREMENT. Durney, C. H.; Bragg, D. G.; Johnson, C. C.; Morris, A. H. (Univ. Utah, Sch. Engineering, 1400 E. 2nd St., Salt Lake City, UT 84112).

The objective of this research is to measure total lung fluid content by calculating the reflection of microwave energy applied to the thorax or the transmission of microwaves through the thorax. A pulmonary edema animal model will be developed, and microwave measurements will be made on lung phantoms with known water content and on dogs with artificially induced and measured pulmonary edema. Calculations based on a planar layered model will be used to account for differences in the size and shape of the thorax. The results will show whether microwave methods are feasible for monitoring changes in lung water or for measuring absolute levels of lung water. (12/76-11/77)

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

0208 GENETIC AND DEVELOPMENTAL EFFECTS OF MICROWAVE IRRADIATION OF MICE. Czerski, P. (Natl. Res. Inst. Mother and Child, 17 Kasprzaka, Warsaw, Poland).

A lifetime study of progeny of microwave-irradiated mice is proposed. The study will utilize a single exposure rate and a multiple low-level exposure to microwave radiation of two groups of animals. Progeny of one group will be examined for gross structural and induced chromosomal congenital anomalies. Irradiated parents and subsequent progeny of the second group will be observed to determine lifetime morbidity and mortality. (10/77-9/78)

Supporting Agency:HEW, PHS, FDA, Bureau Radiological Health

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5106 RISKS AND DAMAGES RESULTING FROM OCCUPATIONAL EXPOSURE TO HIGH FREQUENCY ELECTROMAGNETIC FIELDS. *(Ita.)* Alberti, S. (No affiliation given). *Securitas* 61(1-2): 27-35; 1976. (30 refs)

The effects from exposure to electromagnetic radiation were investigated in two groups of workers involved in the operation of high frequency (5-50 MHz) heating machines used in wood glueing. The clinical investigations were prompted by subjective symptoms developed by the workers. In a group of five workers (25-40 yr old) with total employment duration (TED) of 1.5-10 yr and similar rhythm of exposure (RE), the spermiogram (Page-Houlding index) showed values of 44, 23, 19, 3 and 0, respectively, versus normal values of 50-80. These indices indicated sterility in 2/5 and decreased fertility in 3/5, while 4/5 subjects showed a marked decrease of testicular pain sensitivity. A group of 26 workers (22 men and 6 women, 16-62 yr old) had a TED of 4-12 mo (12/26), 1-3 yr (10/26), and 3-6 yr (4/26). The RE was continuous (the whole shift in every working day) in 14/26, half shift in 1/26, and intermittent (a few hr/wk for a few days/mo) in 11/26. Recurrent subjective symptoms were found in 22/26: insomnia (9/22), asthenia (6/22), decrease of libido (4/22), and incessant headache (3/22). The spermiogram, performed in only 12 subjects, showed an index of >50 in 8/12, 5-50 in 3/12, and <5 in 1/12. Among the 8 with normal index, 5/8 had intermittent and 3/8 had continuous RE. Among the 4 with decreased index, 2/4 (index 4 and 8) had continuous RE of 6 and 8 mo., respectively; 2/4 (index 9 and 40) had a TED of 4 and 3 yr and continuous, followed by intermittent, RE. Results of other clinical examinations were not be correlated with the effects of nonionizing radiation. A review of the literature preceeds the presentation of the clinical results.

5107 EFFECT OF UHF ELECTRICAL FIELD ON THE BLOOD CLOTTING SYSTEM IN ANIMALS. *(Rus.)* Rusiaev, V. F. (Dept. Physics, Chita Medical Inst., Chita, USSR); Mulyndina, G. I. *Vopr Kurortol Fizioter Lech Fiz Kult* (4): 76-79; 1976. (8 refs)

The effect of exposure to ultra high frequency (UHF) electrical field (80 V/m, 5 min per day for 10 days) on various parameters of blood coagulation was studied in rats. The hemoglobin level decreased from 12.9 ± 0.5% in the control to 11.4 ± 0.3% ($P<0.05$); the erythrocyte sedimentation reaction increased to 7.6 ± 1.8 Hg mm from 2.6 ± 0.2 Hg mm ($P<0.02$); the viscosity of the blood decreased to 3.6 ± 0.1 cP from 4.2 ± 0.3 cP ($P<0.1$); the erythrocyte count dropped to 5.4 ± 0.4 x $10^6/mm^3$ from 6.4 ± 0.7 x $10^6/mm^3$ ($P<0.02$); and the leukocyte count increased from 3,900 ± 460 mm^3 to 4,800 ± 510/mm^3 ($P<0.2$). The recalcification time was 14 sec in the 1:30 dilution of aortic extract vs 13 sec in the control ($P<0.3$); the prothrombin consumption was 818 sec vs 1,200 sec in the control ($P<0.01$); the thrombin time was 21 sec in the control ($P<0.05$); and the fibrinolytic activity was 188 min vs 158 min in the control ($P<0.05$). The findings indicate that UHF electrical field causes hypercoagulability and suppresses the thromboplastic and fibrinolytic activity of the tissue extracts.

5108 EFFECT OF ELECTROSTATIC FIELD ON ANTIBODY SYNTHESIS. *(Rus.)* Tovmasian, V. S. (Central Scientific Res. Lab., Erevan Medical Inst., Erevan, USSR); Gevorkian, M. I.; Artsruni, G. G. *Zh Eksp Klin Med* 16(5): 42-44; 1976. (9 refs)

The effect of exposure to electrostatic field (potential 2,500 V/cm, 24 hr) on antibody synthesis was studied in strainless male mice 4 and 7 days after immunization with sheep erythrocytes (1 ml, 2% suspension, ip). The number of the antibody-forming splenocytes was determined by hemolysis testing. Group I was immunized immediately after exposure; Group II was exposed to the electrostatic field immediately after immunization, while Group III was exposed immediately after immunization, and three days later. The number of the antibody-forming spleen cells was significantly reduced compared with the control (125.6 ± 28.8 x 10^6) on the 4th day (44.1 ± 14.8 x 10^6 in Group I; 4.05 ± 2.83 x 10^6 in Group II, and 5.29 ± 46 x 10^6 in Group III). On the 7th day, the reduction was significant in Group III only (12.06 ± 2.63 x 10^6 vs 53.9 ± 12 x 10^6 in the control). The findings indicate that electrostatic fields cause a considerable immunosuppressive effect, especially when immunization precedes exposure.

5109 ON THE MAGNETIC FIELD DEPENDENCE OF THE YIELD OF THE TRIPLET STATE IN REACTION CENTERS OF PHOTOSYNTHETIC BACTERIA. *(Eng.)* Hoff, A. J. (Biophysical Lab., State Univ. Leiden, Wassenaarseweg 78, Leiden, The Netherlands); Rademaker, H.; Van Grondelle, R.; Duysens, L. N. M. *Biochim Biophys Acta* 460(3): 547-554; 1977. (22 refs)

The effect of an applied magnetic field on the yield of the triplet state in reaction centers of the photosynthetic bacterium *Rhodopseudomonas sphaeroides* was investigated. In chromatophores, the triplet yield in a high magnetic field was 15% lower than that in a zero-field, and the magnetic field at which half the effect was observed ($B_{1/2}$) was about 500 G. In reaction centers with an intact iron-ubiquinone complex, the triplet yield was 25% lower in a magnetic field, and the total extent of the effect was obtained in fields as low as 100 G. In reaction centers in which only ubiquinone acts as the primary acceptor, the triplet yield was 35% lower, with the effect fully developed at about 50 G. The iron in the iron-ubiquinone complex of the R-26 mutant form of *Rhodopseudomonas sphaeroides* is not essential for the magnetic field effect, since the wild type of the bacterium, which lacks a functional iron complexed to ubiquinone, also showed an effect on triplet state yield. Chromatophores of the wild type of *Rhodopseudomonas sphaeroides* that were