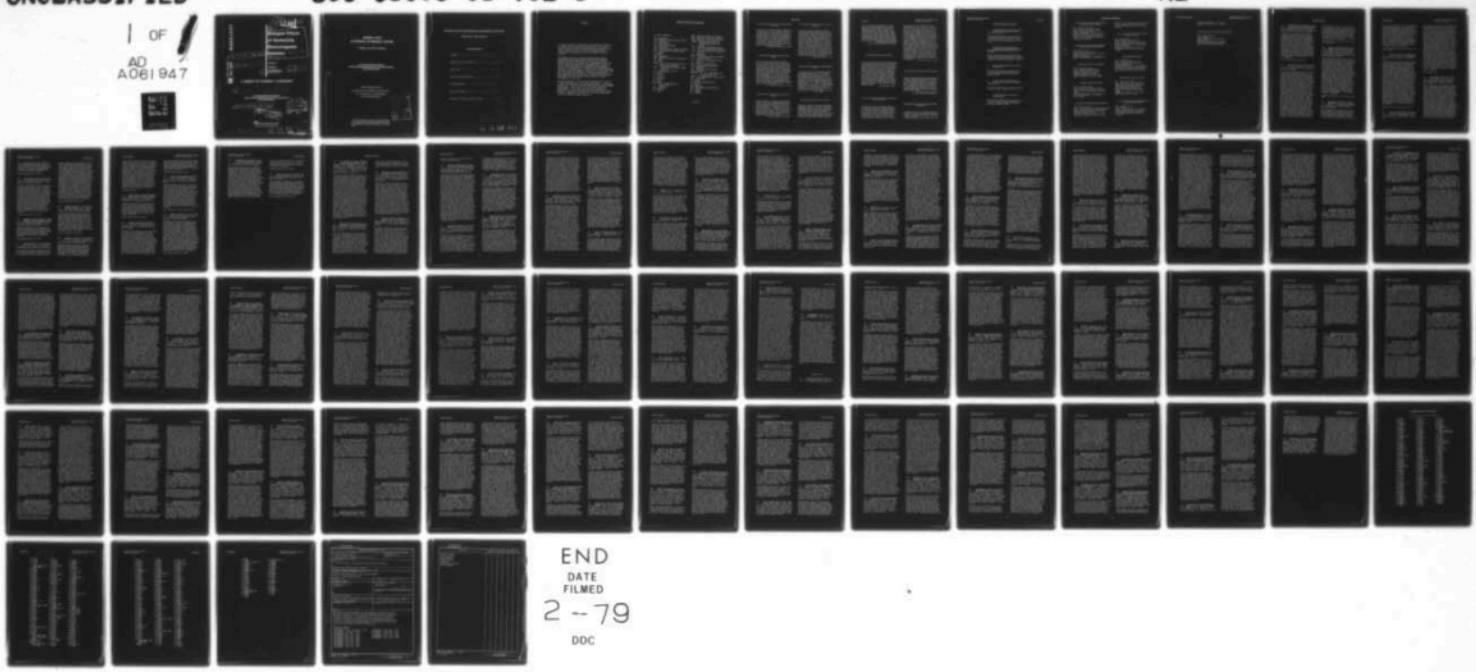
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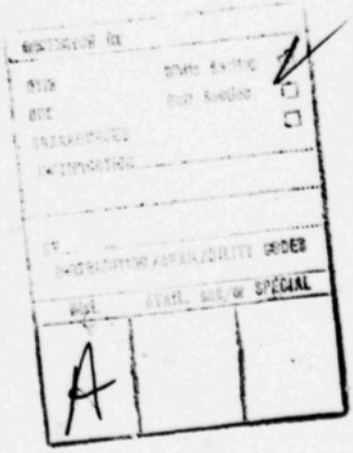
A Digest of Current Literature

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

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

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

Elena P. Saboe, Managing Editor



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

BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

December, 1978 Volume III, Number 2

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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.

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

BROADCASTERS INVESTIGATING REPORT OF MICROWAVE RADIATION ILLNESS

The Corporation for Public Broadcasting (CPB), headquartered next to the Soviet Embassy in Washington, is conducting tests to determine whether its employees possibly could be exposed to high doses of microwave radiation. The tests were prompted by a published report indicating that one employee might be suffering from ills caused by such radiation. The report stated that a CPB employee had lost 20% of the hearing in one ear and had periodic "instant sweats." Although the report said the symptoms were those of microwave radiation exposure, a number of radiation experts disagree.

Philadelphia Inquirer August 6, 1978

SALES OF HOUSEHOLD MICROWAVE OVENS SHOW STEADY GROWTH

Sales of microwave ovens exceeded 2.2 million units in 1977, and manufacturers of household microwave ovens foresee promise of sustained growth for several years to come. Although only 5.5% of American households owned microwave ovens in 1976, projections indicate that the level of saturation (percentage of households owning a microwave oven) will reach 22.2% by 1980. However, D. R. McConnell, Senior Vice President, Sales, Major Appliances at Amana Refrigeration, Inc., points out that the "continued development of the market will require that all manufacturers pay close attention to product safety, emission control, and basic quality control." He cautions: "Any manufacturer that cuts corners and creates a highly publicized recall under stringent Federal Safety Regulations can give the entire industry a 'black eye'."

J Microwave Power 13(1): 1-2; 1978

CANADIANS DESIGN UNUSUAL NONREFLECTIVE RADIATION CHAMBER

Canadian researchers, investigating the effects of exposure of low-level microwave radiation on the brain and sexual organs of rabbits, have designed an unusual chamber whose contoured walls are completely nonreflective. Because the walls are entirely nonreflecting, it is possible to deliver a precisely measured dose of radiation from a single source to the test animals. This is particularly important because the project, conducted by the National Research Council of Canada, aims to help establish radiation safety standards.

New Scientist 79(1114): 327; 1978

BRH STUDY SHOWS CATARACTS NOT LINKED TO LOW-LEVEL MICROWAVES

A study by the Bureau of Radiological Health's Division of Biological Effects has shown that repeated exposure to low-level microwave oven radiation (less than 10 mW/cm^2) does not cause cataracts in rabbits. The results confirm earlier observations on rabbits exposed repetitively to 10 mW/cm^2 in an anechoic chamber. Rabbits--whose eyes closely resemble the human eye in size--were placed in front of a microwave oven that was deliberately altered to leak at a rate of 10 to 12 mW/cm^2. (The Federal microwave oven performance standard limits leakage radiation to 1 mW/cm^2 at the time of purchase and to 5 mW/cm^2 over the lifetime of the oven.) After 1 hr of exposure every day for 12 wk, the rabbits' eyes were as clear of cataracts as they were before the experiment began. The lowest exposure level at which cataracts have been observed is 180 mW/cm^2, accumulated at the rate of 1 hr a day for 20 consecutive days.

BRH Bulletin 12(13): 1; 1978

BRITISH CLAIM THEIR MICROWAVE OVEN STANDARD ENSURES SAFETY

In a rebuttal to claims that microwave oven users risk cataract development, the British National Radiological Protection Board has stated that ovens manufactured in compliance with the 1976 British Safety Standard pose no health risk. Cataracts can be produced by exposure of the eye to microwaves at levels of hundreds of mW/cm^2 for more than an hour, but ovens meeting the 1976 British standard will not cause exposure at levels higher than 5 mW/cm^2 at 5 cm distance. "Exposure decreases inversely with the square of the distance from the source and it is therefore highly unlikely that the domestic use of such ovens--given they are in good condition--could injure the eyes."

Lancet 2(8088): 536; 1978

BIOELECTROMAGNETICS SYMPOSIUM--CALL FOR PAPERS

The Bioelectromagnetics Society and the USNC/URSI (Commissions A and B) will cosponsor the Bioelectromagnetics Symposium to be held at the University of Washington, Seattle, Washington on June 18-22, 1979. Authors are invited to submit papers on the following topics: behavioral effects, central nervous system effects, diagnostic applications, dosimetry, extra low frequency effects, exposure systems and instrumentation, acoustic energy ef-

fects, static and modulated magnetic field effects, hyperthermia and therapeutic applications, immunological and hematopoietic effects, macromolecular and cellular effects, mutagenic and developmental effects, sensory effects, thermometry, and static electric field effects. Consideration will be given to papers on other subjects. All summaries and abstracts must be submitted before February 16, 1979 to Professor Akira Ishimaru, 1979 AP-S/National Radio Science Technical Program Chairman, c/o Department of Electrical Engineering, FT-10, University of Washington, Seattle, WA 98195.

Bioelectromagnetics Symposium--
University of Washington--Call for Papers

BRITISH ORGANIZE RADIO FREQUENCY SCHOOL

The British IEE Professional Group S4 (Measurements), in association with the British Calibration service, IERE and UKRI Section of the IEEE, is organizing a fourth vacation school on "R.F. Electrical Measurements," to be held at the University of Lancaster, Lancaster, England in July 1979. The school will provide lectures and demonstrations on the essential theoretic background and an up-to-date exposition of the practical techniques of measurement using modern instruments. Lectures will cover modern practice in radio frequency and microwave measurements and their relation to standard, coaxial line and waveguide techniques for frequencies up to about 40 GHz, and measurements in stripline and on active devices. Further details are available from the Secretary, IEE, Savoy Place, London WC2R OBL, England.

IEE News 32(6):6; 1978

NEWLY DEVELOPED MICROWAVE DIATHERMY APPLICATORS MINIMIZE STRAY RADIATION

The designs for three new microwave diathermy applicators have recently been accepted by the FDA. The applicators, developed by Transco Products, Inc., according to Bureau of Radiological Health specifications, are of the direct contact type and are intended for delivery of therapeutic tissue heating when in very close proximity to the prescribed tissue of the patient. One of the new designs operates at 2,450 MHz and is a circularly polarized horn with a microwave choke around a 15-cm diameter aperture. The other two, which operate at 915 MHz, are designed with four ridges inside a circular waveguide to provide circular polarization. The larger of the 915-MHz applicators has a 25-cm diameter aperture with three concentric annular chokes, while the smaller has a 15-cm diameter aperture with one annular choke. For the 2,450-MHz applicator the net power needed to deliver 235 W/kg in a planar muscle phantom with a 1-cm layer of simulated fat is 19.3 W, and the maximum leakage at this power level is 0.2 mW/cm^2. For the large 915-MHz applicator the corresponding heating and leakage values are 36.4 W and 0.15 mW/cm^2, while for the smaller model they are 33 W and 2.5 mW/cm^2. Results of clinical tests on the leakage suppression characteristics of the 2,450-MHz applicator indicate that for particular treatments, phantoms can be used effectively to predict the leakage levels existing under actual clinical situations. Further information about the availability of drawings for the new designs are available from Dr. Gideon Kantor, Bureau of Radiological Health, 5600 Fishers Lane, Rockville, Maryland 20857.

BRH Bulletin 12(16): 1-2; 1978

SHORT COURSE ON MICROWAVE AND UV RADIATION HAZARDS

The British National Radiological Protection Board (NRPB) has scheduled a one-day course for March 1, 1979 on the hazards associated with the use of various microwave and UV sources. The background leading to the establishment of the accepted protection standards will be discussed in addition to the effects of their application to specific sources. Requests for information may be directed to NRPB Northern Centre, Hospital Lane, Cookridge, Leeds LS16 6RW, England.

British National Radiological
Protection Board Course Announcement

CANADIANS GRANT PATENT FOR MICROWAVE RADIATION PROTECTION DEVICE

The Canadian Patent Office has granted a patent for an "Apparatus for Protection against Microwave Radiation." The patent, granted June 27, 1978, bears the number 1,033,602.

Patent Office Record, Canada 106(26): 26-9; 1978

ITEMS FROM THE COMMERCE BUSINESS DAILY

☐ INVESTIGATIONS INTO THE PERIPHERAL AND CENTRAL RECEPTORS MEDIATING EFFECTS OF MICROWAVE RADIATION ON BRAIN ACTIVITY.

The Procurement Office, National Institute of Environmental Health Sciences, Building 11, Room 1101, P.O. Box 1233, Research Triangle Park, NC is soliciting proposals for the above study. (June 29, 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)

☐ RESEARCH ON MICROWAVE EFFECTS ON THE CENTRAL NERVOUS SYSTEM.

The Office of Naval Research, Arlington, VA has contracted with the George Washington University, Rice Hall, Washington, DC for the above study. (August 18, 1978)

☐ LITERATURE SURVEY AND PROBLEM DEFINITION STUDY ON THE BIOLOGICAL EFFECTS OF MILLIMETER WAVES (35-220 GHz).

The Eglin Air Force Base, FL is soliciting proposals for the above study. (August 23, 1978)

☐ ELECTROMAGNETIC AND NUCLEAR RADIATION ENVIRONMENTS STUDY.

The Naval Surface Weapons Center, White Oak, Silver Spring, MD is negotiating with Stanford Research Institute International, Menlo Park, CA for the above study. (October 2, 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

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS SOUTHEAST CONVENTION (SOUTH-EASTCON)

Date: April 1-4, 1979
Place: Roanoke, VA: Hotel Roanoke
Sponsor: Institute of Electrical & Electronics Engineers (IEEE)--Region 3
Requests for Information: K. R. Thompson, Room 244, 1501 Roanoke Blvd., Salem, VA 24153

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

SIXTH INTERNATIONAL CONGRESS OF RADIATION RESEARCH

Date: May 13-19, 1978
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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS CONFERENCE (ELECTRO 79)

Date: May 24-26, 1979
Place: New York, NY: The Coliseum
Sponsor: Institute of Electrical & Electronic Engineers (IEEE), Region One & METSAC sections; Electronic Representatives Assoc., New England and New York chapters
Requests for Information: W. C. Weber, Jr., ELECTRO, 999 N. Sepulveda Blvd., El Segundo, CA 90245

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

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS MIDWEST CONFERENCE (MIDCON '79)

Date: November 6-8, 1979
Place: Chicago, IL
Sponsor: Institute of Electrical & Electronics Engineers (IEEE), Regions 4 & 5, Chicago & Dallas Sections; Electronic Representatives Assoc. (ERA), Mid USA Council, Chicago & SW Chapters

Requests for Information: W. C. Weber, Jr., ECI, 999 N. Sepulveda Blvd., El Segundo, CA 90245

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

0378 ELECTROMAGNETIC RADIATION PRODUCT INVESTIGATION—MICROWAVE DIATHERMY APPLICATORS. Kantor, G. (Electromagnetics Branch, U.S. Dept. Health, Education, and Welfare, Bureau Radiological Health, 5600 Fishers Lane, Rockville, MD 20852).

In support of the proposed microwave diathermy standard, direct contact applicators are being developed that meet the standard's requirements of leakage, radiation safety, and effectiveness in heating simulated muscle tissue. Thermographic heating patterns in phantoms of simulated fat and muscle tissue were investigated to determine the spatial distribution of the energy deposition Associate leakage radiation from the surface of applicators during exposure of planar phantoms was also measured. The emphasis was on diathermy operating at the industrial, scientific, and medical (ISM) frequency of 2,450 MHz. Presently, direct contact applicators operating at the ISM frequency of 915 MHz are being evaluated to demonstrate the feasibility of the standard provisions concerned with leakage radiation and effectiveness in heating. (10/76-9/77)

Supporting Agency:HEW, PHS, FDA, BRH

0379 RADIO FREQUENCY ENERGY FOR INSECT CONTROL. Nelson, S. O.; Stetson, L. E. (Univ. Nebraska, U.S. Dept. Agriculture, Agricultural Res. Div., Lincoln, NB 68503).

Information and methods for more efficient control of stored-grain and seed-infesting insects using radio frequency (RF) electric energy will be developed. Additionally, methods will be developed for determining the temperature and frequency dependence of the dielectric properties of insects and grain in the frequency ranges where selective absorption of energy by the insects can be obtained. The dielectric relaxation frequencies for insects and grain as functions of temperature will be determined. After obtaining new measurement data, researchers will assess the improvement in efficiency of stored-grain insect control with RF energy and evaluate the degree of success in controlling chalcid-infesting tree seeds. Earlier studies have shown that all developmental stages of stored-grain insects can be controlled by exposures of a few seconds to RF electric fields of sufficient intensity in the frequency range between 10 and 50 MHz. Measurements of the dielectric properties of insects and grain revealed that, in this frequency range, the insects absorb energy from the electric field much more rapidly than the grain and therefore can be selectively heated and killed by dielectric heating. Since the dielectric properties of insects and grain are temperature as well as frequency dependent, information on the variation of dielectric properties with temperature is important. If the frequency of maximum energy absorption shifts as the temperature of the insects increases, a major improvement in the efficiency of RF treatment for insect control might be achieved by varying the frequency during treatment. A series of dielectric measurements on adult rice weevils and hard red winter wheat using existing measurement equipment (modified to provide temperature control for the samples) showed that the dielectric constant of both insects and wheat increased with temperature in the range from 25 to 60 C. The dielectric loss factor of the insects also increased with temperature at most frequencies in the range (0.5 MHz to 2.4 GHz). (10/76-9/77)

Supporting Agency:U.S. Dept. Agriculture, Agricultural Res. Service

0380 MORTALITY, INDUSTRIAL HYGIENE STUDY OF WORKERS EXPOSED TO MICROWAVE AND RADIO FREQUENCY ENERGY. Egan, E.; Ness, G.; Johnson, P. (Survey Hazard Evaluation Field Study Div., U.S. Dept. Health, Education, and Welfare, Natl. Inst. Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226).

Little research has been conducted in the U.S. to determine the long-term health effects of low-level microwave radiation on humans. The consequence of undervaluing or misjudging the biologic effects of long-term, low-level exposure could become a critical public health problem since virtually every person in the U.S. is exposed to some form of electromagnetic radiation. Recent evidence indicates that the development of certain forms of cancer may be associated with exposure to electromagnetic radiation. At a naval air station at Quonset Point, Rhode Island, three civilian employees among a group of eight technicians who were engaged in the overhaul and repair of Tactical Airborne Navigation Equipment (TACAN workers), which is similar to radar in operation, either have developed or died of cancer since 1970. Two of the men (aged 31 and 35) developed pancreatic cancer, a form of cancer that occurs in only 1% of persons under 40. These two men worked side by side at a test bench at Quonset Naval Air Station for several years. NIOSH plans to conduct a retrospective mortality study to further investigate the health effects resulting from long-term, low-level exposure to electromagnetic radiation. (10/78-9/79)

Supporting Agency:HEW, PHS, Center Disease Control, NIOSH

0381 BIOPSYCHOLOGICAL STUDIES OF MICROWAVE IRRADIATION. Justesen, D. R.; Sheridan, C. L.; Levinson, D. M. (Neuropsychology Res. Lab., U.S. Veterans Admin. Hosp., 4801 Linwood Blvd., Kansas City, MO 64128).

Completed studies in this research project have assessed longevity of tumor-bearing and tumor-free mice, determined optimal microwave doses for experimental treatment of intracranial neoplasms in rats, evaluated avians incubated in an intense microwave field, and analyzed the spatio-temporal fac-

tors that control a microwave-induced, classically conditioned hyperthermia in rats. Ongoing studies of longevity and development of tumor-prone mice, whose dams were subjected to LD_{10} radiation, are entering the second year; few behavioral differences were observed between radiated and control mice. There was no incidence of spontaneous tumors in both groups but close monitoring will continue in the months ahead. Nearing completion is a study in which rats are being observed for evidence of escape learning during trials in an intense 918-MHz field. Although marked behavioral and physiologic signs of overheating have been observed, there has been no evidence of purposive escape. Diffuse whole-body heating--lack of directional cueing--is believed responsible. (6/77-N/A)

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

0382 MICROWAVE RADIATION AND THERMOREGULATION. Adair, E. R. (John B. Pierce Foundation of Connecticut, 290 Congress Ave., New Haven, CT 06519).

In recent years, the U.S. research effort in dealing with the biologic effects of nonionizing radiation has increasingly been directed toward the effects produced by low levels of irradiation. These levels have been characterized as having no obvious thermal biologic consequences. This research emphasis has been generated partly by the discrepancy between permitted exposure levels in this country and the Soviet Union and partly by reports from several eastern European countries regarding central nervous system (CNS) malfunctions resulting from prolonged low-level microwave irradiation. If such CNS malfunction could be rigorously demonstrated at any level (from cellular organization to complex behavioral patterns), definitive grounds for reconsideration of the U.S. maximum permissible exposure levels would be provided. The primary goal of this project is to learn whether low levels of microwave radiation can influence or interfere with normal responses, both physiologic and behavioral, that regulate body temperature. The ultimate goal is to evaluate the impact of such disturbances on the human thermoregulatory system with reference to current maximum permissible exposure standards. The research proposed will expose restrained squirrel monkeys to specific durations and intensities of microwave irradiation during ongoing behavioral thermoregulation and during measurement of autonomic responses of heat production and heat loss at a variety of discrete ambient temperatures. (9/77-11/78)

Supporting Agency:U.S. Dept. Defense, Air Force

0383 VALUE ISSUES IN RESEARCH ON THE BIOLOGIC EFFECTS OF MICROWAVE RADIATION--A CASE STUDY. Steneck, N. H. (Dept. History, Univ. Michigan, Sch. Liberal Arts, Ann Arbor, MI 48104).

This project will explore the value presuppositions that operated within the scientific community and society-at-large to determine priorities for research on the biologic effects of microwave radiation between 1945, when microwave technologies became available for non-military purposes, through 1965 when the widespread deployment of microwave devices made it imperative to have scientific data on which to base adequate safety standards. These standards depend critically upon the specific biologic effects of microwave radiation. Until the early 1960's it was assumed that only thermal effects were significant. As a result, inadequate research on the nonthermal biologic effects of microwave radiation was pursued, despite the fact that such research was being pursued for shorter wavelength electromagnetic radiations. This project will try to determine why neither the scientific communicy nor social pressures stimulated research in this area of potential importance to public health. The results will be analyzed as a case study in changing perspectives about ethical standards and social expectations of science. The staff, which consists of a physicist, a physiologist, an historian of science, and a philosopher, will study the scientific and technical literature on microwave radiation research and development and will interview persons involved in those fields to develop a detailed historic and normative case study. The project will result in a book suitable for use in college courses on science, technology and values, and will be accessible to the general public. (6/78-7/80)

Supporting Agency:NSF

0384 HYPERTHERMIA AND RADIATION--X RAYS VS FAST NEUTRONS. Nagle, W. A.; Moss, A. J.; Baker, M. L.; Prior, R. M.; Straub, K. D. (Dept. Radiology Univ. Arkansas, Sch. Medicine, 4301 W. Markham St., Little Rock, AR 72201).

Recent results suggest that hyperthermia combined with X or gamma radiation may simulate the effects of high linear energy transfer (LET) radiation, since radiation sensitivity of hypoxic cells is increased. If this observation is confirmed and can be exploited clinically, radiotherapy can be improved greatly. Patients may derive the expected benefits of high LET radiotherapy without the expense of constructing and maintaining sources of high LET particles. To be clinically useful, heat must be delivered to some depth in tissue, while at the same time, the skin is not heated significantly. This is necessary to maintain a therapeutic margin between the tumor and the incidentally irradiated normal tissues. Two modalities now available for heating deeply-seated lesions are ultrasound and microwaves. An in-depth study of the interaction of agents that cause heating (thermal heat, ultrasound, and microwaves) and ionizing radiations of both low (250 kVp X-rays) and high (fast neutrons) LET will be performed. Cultured cells of three different mammalian lines will be used, and cell populations will be synchronized where appropriate. The experiments

will be performed under conditions of hypoxia as well as normal oxygenation. Both cellular proliferity integrity) and molecular (production and repair of DNA single strand breaks) effects will be measured. The results will help to establish a biologic base from which rational clinical trials can be formulated. (7/77-6/79)

Supporting Agency:HEW, PHS, NIH, NCI.

0385 RADIATION AND HYPERTHERMIC CANCER THERAPY. Robinson, J. E.; Scott, R. (Dept. Radiology Univ. Maryland, Sch. Medicine, 1420 N. Charles St., Baltimore, MD 21201).

The action of hyperthermia alone and in combination with ionizing radiation will be investigated to answer current questions on the use of this combined modality in cancer therapy. Laboratory data show that radiation sensitivity is markedly enhanced at elevated temperatures. The objectives of research, which are aimed at clinical applicability, are: (1) to develop and evaluate a technique of microwave heating of animals and animal tumor systems that are clinically relevant; (2) to assess the relative thermal sensitivities and radiosensitivities of normal and malignant tissues under microwave-induced hyperthermic conditions and (3) to compare results with existing experimental data in which elevated temperatures were obtained by tumor immersion in water baths. Localized and generalized hyperthermia, as an adjunct to radiotherapy, offers the potential of further increasing rates of local tumor control. (7/77-6/79)

Supporting Agency:HEW, PHS, NIH, NCI

0386 DEVELOPMENT OF SPECIFICATIONS FOR COMPUTER PROGRAMS TO OBTAIN ELECTROMAGNETIC FIELDS IN DIELECTRIC MEDIA OF GENERAL GEOMETRY. Kellogg, R. B. (Univ. Maryland, Inst. Physical Science & Technology, College Park, MD 20742).

Existing computer programs will be converted and adapted to the computation of induced electromagnetic fields in media of arbitrary geometry exposed to microwave and radio frequency radiation. Programs are nearing completion for 3-dimensional, arbitrary geometry and dosimetric calculations. (9/77-9/78)

Supporting Agency:HEW, PHS, FDA, BRH

0387 BIOLOGIC RESPONSES TO A CHRONIC MICROWAVE ENVIRONMENT. Lebovitz, R. M.; Seaman, R. L.; Guterman, L. (Univ. Texas, Sch. Biomedical Sciences, 5323 Harry Hines Blvd., Dallas, TX 75235).

As microwave energy becomes increasingly present in the 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. (5/77-4/79)

Supporting Agency:HEW, PHS, FDA, BRH

0388 CHROMOSOMAL EFFECTS OF 2.45 GHZ MICROWAVE NON-THERMO EXPOSURE. Yao, K.; Seeke, F.; Fuchs, T. (U.S. Dept. HEW, BRH, Genetic Studies Section, 5600 Fishers Lane, Rockville, MD 20852).

The effects of non-thermal microwave exposure on the chromosomes of cultured cells will be investigated. A specially designed microwave exposure chamber that disperses heat quickly into a temperature-controlled waterbath will be used. Cells will be irradiated at G2 and M stages, since cells at these two stages are more sensitive to irradiation than at other stages. Temperature of the waterbath will be 25 C, 37 C, and 42 C. In earlier studies, cells were exposed at S and G1 stages. Results showed that only the cells exposed at 42 C had a moderately significant increase in chromosome aberration frequency. (11/77-10/78)

Supporting Agency:HEW, PHS, FDA, BRH

0389 ASSESSMENT OF RADIATION LEVELS AND HAZARDS. Sinclair, W. K.; Ney, W. R.; Maletskos, C. J. (Natl. Council on Radiation Protection, 7910 Woodmont Ave., Suite 1016, Bethesda, MD).

The National Council on Radiation Protection and Measurements (NCRP) seeks to collect, analyze, develop, and disseminate information and recommendations on radiation protection and measurements and to foster cooperation among organizations concerned with radiation protection and measurements. This project is concerned with: (1) quantities, units, measurement techniques,

biologic effects and exposure criteria for radio frequency electromagnetic radiation; (2) radiation hazards resulting from the release of radionuclides into the environment (with particular attention directed to examination of the problems associated with the release of ^{129}I; (3) bioassay for the assessment of control of intake of radionuclides; and (4) radon sources and dosimetry. Initial work on NCRP studies is carried out by scientific committees that draft preliminary recommendations. This involves a detailed examination of existing pertinent information, identification of areas in which information is meager or unavailable, and an assessment of the scientific thinking on the relevant problem. The final result of the scientific committee's work is usually a draft of a proposed NCRP report which is submitted to the members of the council for review, modified on the basis of council members' comments, and after membership approval, published. (7/77-7/80)

Supporting Agency:EPA

0390 COMPUTER STUDIES OF DOSE DISTRIBUTION IN BIOLOGICAL MODELS EXPOSED TO ELECTROMAGNETIC RADIATION. Meijer, P. H. (Dept. Physics, Catholic Univ. America, Sch. Arts & Sciences, 620 Michigan Ave. N.E., Washington, DC 20017).

Theoretic dose distribution calculations for man exposed to nonionizing electromagnetic radiation will be performed utilizing newly-developed computer programs. Theory and programs have been perfected using finite element numeric approximation techniques for the calculation of induced fields and power deposition in biologic tissue of two-dimensional geometry and irregular cross sections. (9/77-8/78)

Supporting Agency:HEW, PHS, FDA, BRH

0391 MAPPING OF FREE SPACE ELECTRIC FIELDS ASSOCIATED WITH MICROWAVE DIATHERMY APPLICATORS. Witters, D. M. (U.S. Dept. HEW, BRH, Electronic Products Div., 5600 Fishers Lane, Rockville, MD 20852).

The objective of this project is to map the electric field distribution of electromagnetic radiation in the vicinity of various prototype and clinical microwave diathermy applicators. Also, relative effectiveness in terms of field uniformity and polarization in the therapeutic beam is being determined, and the hazards due to radiation leakage outside the therapeutic beam (applicator side lobes) are being assessed. A miniature (3 mm) dipole/diode isotropic probe and optically-linked telemetry system was used to map the fields in the immediate vicinity (2-5 cm) of the aperture. The data were analyzed using a digital minicomputer, and transverse versus radial electric field components were correlated with thermographic camera heating patterns in planar muscle-equivalent phantoms. The data are being used in a paper entitled "Free Space Electric Field Mapping of Spaced Microwave Diathermy Applicators" by D. Witters and G. Kantor. Further mapping of leakage around applicators during exposure of various anatomic phantoms is planned. A computer-controlled scanning system located in an anechoic chamber is under development to facilitate this concept. (10/76-9/77)

Supporting Agency:HEW, PHS, FDA, BRH

0392 PRIMATE TRACKING PERFORMANCE DURING MODULATED 1.2 GHz EXPOSURES. Scholl, D. M.; Allen, S. J. (U.S. Air Force, Sch. Aerospace Medicine, Brooks Air Force Base, San Antonio, TX 78235).

The possible biobehavioral effects of radio frequency (RF) exposures that meet or exceed current safety criteria will be investigated, and reports in the literature concerning low power level RF effects will be evaluated. Nonhuman primates will perform a 2-hr RF compensatory visual tracking task, a condition considered to be "worst case." The task requires considerable attention/vigilance and is believed to affect the emotional state. Selection of RF parameters will be based upon known energy deposition and wave penetration factors and upon reports of emotional, behavioral, and neurophysiologic effects to low power level RF exposures at specific frequencies and modulations. Tracking performance under RF will be contrasted with stable pre- and post-exposure data. (10/76-N/A)

Supporting Agency:U.S. Dept. Defense, Air Force

0393 BROADBAND MEASUREMENTS OF DIELECTRIC PROPERTIES. Swicord, M.; Athey, T. W. (U.S. Dept. HEW, BRH, Electronic Products Div., 5600 Fishers Lane, Rockville, MD 20852).

Measurement of the dielectric properties of biologic materials is required to synthesize and fabricate simulated biotissue for the modelling of man or animals in support of the dosimetry associated with biologic effects and electromagnetic radiation therapy projects performed at the Bureau of Radiologic Health (BRH). Also, these measurements are being developed to allow BRH investigators to predict or explain the possible existence of frequency-selective biologic effects from electromagnetic radiation. A method was developed for making routine, broadband (0.5-18 GHz), dielectric measurements that is particularly suited for use with automated systems but can also be used with slotted lines. A modified two-impedance method was used that gives results that are approximately independent of the sample size. X-band waveguide sample holders have been constructed and measurements have been published on several materials. Coaxial sample holders for broadband measurements are being tested. A semi-automated network analyzer system has been developed and is being tested. (10/76-9/77)

Supporting Agency:HEW, PHS, FDA, BRH