blind study to determine the effects of electrosleep on this problem. Half of the group were given 24 treatment sessions, and half received 24 sham treatments. A 2 week no treatment interval followed, and a 2 year follow-up was done. All sleep symptons improved for both groups over the time interval involved, however significant long lasting improvement was only seen in the actual treatment group. In this group 4 of the 5 subjects were able to fall asleep with little difficulty and to awake feeling moderately to very well rested during the 2 yr no-treatment period. The trend indicates that the sleep habits were improved for most of the real treatment subjects and suggest that larger, better matched groups should be run to confirm this. (1 reference)

0615 THE EFFECT OF EXTREMELY LOW FREQUENCY MAGNETIC FIELDS ON HUMAN PERFORMANCE: A PRELIMINARY STUDY. *(E.)* Gibson, R. S. (Naval Aerosp. Med. Res. Lab., Pensacola, Fla.) and W. F. Moroney. *Tech. Rep.* No. NAMRL-1195, 24p., 1974.

A research program is being conducted to determine whether man can be safely exposed to ELF electric and magnetic fields below 100 Hz. To identify and develop techniques to be used in this project, a set of tests were chosen to determine the following variables: (1) decision making and short-term memory; (2) coordination and dexterity in continuous and discrete modes; (3) long-term memory and concentration. Four standardized tests were chosen: the Response Analysis Tester (RATER) for decision making and short-term memory, the simplified electronic tracking apparatus (SETA) for coordination and dexterity in a continuous mode; Minnesota Rate of Manipulation Test (ROM) for coordination and dexterity in a discrete mode, and the Wilkinson Adding Test for long-term memory and concentration. Eleven male volunteer subjects between 18 and 28 were used, 6 as experimental subjects and 5 as controls. All biological functions were tested and found to be in the normal range for each subject. Tests were made before, during, and after a 24 hr exposure to a low intensity magnetic field at 45 Hz. Neither of the psychomotor tests used (SETA and ROM) yielded any significant results. Both of the cognitive tests yeilded statistically significant results: the number of attempts on the Wilkinson adding test decreased during the second test session and the level 3 delay of the RATER showed a greater than expected increase in performance during the after exposure period. Consequently these 2 tasks should be considered for inclusion in any further studies concerned with the possible effects of ELF fields on human performance. (12 references)

0616 DEVELOPMENT OF DOSIMETRY FOR RF AND MICROWAVE RADIATION - I: DOSIMETRIC QUANTITIES FOR RF AND MICROWAVE ELECTROMAGNETIC FIELDS. *(E.)* Youmans, H. D. (Div. Biol. Eff., BRH, FDA, Rockville, Md.) and H. S. Ho. *Health Phys.* 29(2):313-316, 1975.

The biological effects of radiation result from the interaction of the radiation field and tissues. This interaction cannot be uniquely specified by a single scalar value, power density, as is often done. The strength of the radiation and its interaction with tissues should be quantitatively expressed in a physically unambiguous manner which is causally related to areas of biomedical concern. The essence of dosimetry is found in the transport equations of the mathematical theory of radiation fields. The absorbed dose may be considered as the image of exposure under a transformation which accounts for the absorption, scattering, and geometrical properties of an irradiation condition, such that absorbed energy is the work done on matter by a field of radiation. Equations for energy flux density, absorbed dose rate and total power absorbed are given in terms of E and H, the electric and magnetic field strengths. With nonionizing radiation if a material is located in the near field of a radiation source, some of the absorbed dose will result from the nonradiated reactive components of the EM field and E and H inside the medium may be in a cross field relationship. The equations given allow for these contingencies. Also, in media of different permittivity and permeability, wave lengths may be different for the same frequency. Therefore, frequency is a more fundamental characteristic of an EMF and should be used. (6 references)

0617 DEVELOPMENT OF DOSIMETRY FOR RF AND MICROWAVE RADIATION - II: CALCULATIONS OF ABSORBED DOSE DISTRIBUTIONS IN TWO SIZES OF MUSCLE-EQUIVALENT SPHERES *(E.)* Ho, H. S. (Div. Biol. Eff., BRH, FDA, Rockville, Md.) and A. W. Guy. *Health Phys.* 29(2):317-324, 1975

Dosimetry in EM biological effects research has often been quantified in terms of energy flux density (incident power density), and results of animal experimentation have been directly compared to radiation protection guides. The power absorption characteristics of these animals may be drastically different for a given energy flux density than the power absorption of man. Biological effects are more directly related to absorbed dose rate. Theoretical expressions have been obtained for determining the absorbed dose rate distribution in a muscle equivalent sphere uniformly irradiated by a plane wave source. Calculations were made for single layered, muscle equivalent phantom spheres of 3 and 15 cm radii and different source frequencies (40 MHz to 10 GHz), illustrating the variation of absorbed dose rate with body size and source frequency. Strong standing wave patterns (hot spots) were found in the smaller sphere for all frequencies less than 5000 MHz. This is due to a focusing effect of the EMF inside a dielectric body when the size of the body is comparable to the wavelength of the radiation inside the body. For the 15 cm sphere, standing waves are in evidence at RF ranges. Above 5000 MHz, the absorption in both spheres becomes that of skin depth penetration. The calculations indicate that for a given energy flux density, the absorbed dose rate distribution depends on the size of the body and the source frequency of the plane wave. This is a drastic deviation in behavior from that of ionizing radiation. Specification of energy flux density alone may not be dosimetrically sufficient for relating results of biological effects experiments to radiation

protection. Absorbed dose would be more appropriate. Further research is needed for calculations on models more closely resembling human bodies. (6 references)

0618 DEVELOPMENT OF DOSIMETRY FOR RF AND MICROWAVE RADIATION - III: DOSE RATE DISTRIBUTION IN TISSUE SPHERE DUE TO MEASURED SPECTRA OF ELECTROMAGNETIC PLANE WAVE. *(E.)* Ho, H. S. (Div. Biol. Eff., BRH, FDA, Rockville, Md.) and H. D. Youmans. *Health Phys.* 29(2):325-329, 1975.

The absorption characteristics for biological bodies irradiated simultaneously by RF and MW sources of different frequencies are unknown. Absorbed dose rate distributions have been calculated for two muscle equivalent spheres (6 and 30 cm diameter) exposed to measured EMR spectra. Data from measured spectra in the Washington, D.C. area, representing essentially far-field radiation from radio, TV, and radar transmitters, were used. Absorbed dose rate distribution was shown to depend strongly upon spectral concentration. When a dominant spectral line is present, the absorbed dose rate distribution resembled those caused by a single frequency source. Where no dominant lines exist, the exposure conditions of possible hazardous fields should be characterized in terms of spectral distributions. Further research is needed on man-equivalent models. (3 references)

0619 EXPOSURE OF THE JAPANESE QUAIL EMBRYO TO 2.45 GHz MICROWAVE RADIATION DURING THE SECOND DAY OF DEVELOPMENT. *(E.)* Hamrick, P. E. (Natl. Inst. Environ. Health Sci., Research Triangle Park, N. C.) and D. I. McRee. *J. Microwave Power* 10(2):211-221, 1975.

Based on previous works which showed effects from exposure at the 48 hr stage of development of the chick embryo, the effects of MW exposure during incubation of *Coturnix coturnix japonica* was investigated. Fertilized Japanese quail eggs (152) were positioned in holders with their long axes vertical and parallel to the E field vector of the MW field. They were exposed to 2.45 GHz CW radiation at a power density of 14 mW/g which could maintain them at 37 C. Exposure lasted for 24 hr on the second day of incubation. During exposure they were not turned. Before and after exposure, the eggs were kept in a commercial incubator with automatic turning and humidity control. The quail were kept for 24-36 hr before weighing, examining for gross deformities, and sacrificing. Blood samples were run for hematocrit, RBC, WBC, hemoglobin and differential white cell percentages. The quail were examined internally and externally for gross deformities and organ weights were determined for the heart, liver, gizzard, adrenals, and pancreas. No significant differences were seen between control and exposed birds although hemoglobin values were slightly lower (3.3%) for exposed quail. No gross abnormalities were seen, and no nonthermal effects were detected. Thus, 2.45 GHz CW microwave radiation at an observed power density of 14 mW/g does not prevent normal development of the quail embryo when exposed on the 2nd day of incubation. (25 references)

0620 MICROWAVE OVEN LABELING. *(E.)* Britain, V. A. (BRH, FDA). *FDA Consumer* 9(6):16-19, 1975.

The FDA has issued new regulations which are designed to reduce the possibility of injuries by requiring precautionary labels on ovens. These regulations require permanently attached labels on all MW ovens manufactured after October 3, 1975, which state that the oven should not be operated with an object caught in the door, with an improperly closing door, or with a damaged door, hinge, latch, or sealing surface. This decision was designed to make this information readily available to everyone who uses the oven. Precautions are necessary because of uncertainty about possible radiation effects. The original MW standard establishing a maximum limit on radiation leakage has also been recently amended to require that ovens include a system to detect failure of either of the interlocks and automatically render the oven inoperable until it is repaired. (No references)

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CURRENT RESEARCH

0162 ELECTROMAGNETIC FIELDS GENERATED FROM NEURONAL ACTIVITY. Anninos, P. A. (Sch. Med., Univ. California, Los Angeles).

See CR 0127, Volume II(2), for description of this research. (Renewed 9/74-8/75)

Supporting Agency:HEW, PHS, NIH

0163 NONINVASIVE SENSING OF SUBCUTANEOUS TEMPERATURES USING MICROWAVE THERMOGRAPHY. Barrett, A. H. (Massachusetts Inst. Technol., Cambridge).

This program, designed to evaluate the capability of MW radiometers to sense subcutaneous temperatures for medical diagnostic purposes, has reached the clinical evaluation stage. A radiometer operating at 3.3 GHz has been packaged for hospital use and is now in routine operation at Faulkner Hospital in Boston. The initial clinical application is the detection of sub-surface temperature anomalies associated with tumors of the breast. MW examinations are made in conjunction with the physician's clinical examination, IR thermography, mammography, and a biopsy examination. Conclusions about the usefulness of MW thermography must await the study of many more patients. A radiometer operating at 1.3 GHz is undergoing laboratory development and testing and will be used in the laboratory to check our experimental technique.

Supporting Agency:NIH

0164 INTERACTION OF ELECTROMAGNETIC FIELD WITH HUMAN BODY. Chen, K. (Sch. Eng., Michigan State Univ., East Lansing).

This research program will concentrate on the interaction of an EM field with the human body. A theoretical study will be conducted to determine the internal EM field induced inside the body and the external EM wave scattered by the body when it is illuminated by an EM wave. To check the accuracy of the theoretical results, an experimental study will be conducted to measure the electric fields induced inside of simple boxes containing saline solution and inside the phantom model which closely approximates the actual human tissues and torso. The theoretical method involves the numerical solution of a tensor integral equation for the electric field induced inside an irregularly shaped body. Various models of the human torso or other biological systems will be considered. It is anticipated that after the accuracy of the theoretical method is established a user-oriented computer program for the field calculations will be developed. (8/74-7/75)

Supporting Agency:NSF, Div. Eng.

0165 NAVY ENVIRONMENT: INVESTIGATION OF THE BIOLOGICAL EFFECTS OF PULSED ELECTROMAGNETIC FIELDS GENERATED BY NAVAL OPERATIONS. Cleary, S. F. (Sch. Med., Virginia Commonw. Univ., Richmond).

HF, high intensity EMP fields can be produced by certain naval operations. Evidence points toward reversible effects in some biological systems. This research is an attempt to determine if the instantaneous field strengths and pulse characteristics of EMP are capable of producing biological alterations that may ultimately be of interest to man. This will be a study in 2 parts. The first will be a study of the effects of EMP fields on serum proteins, blood chemistry and drug-induced (pentobarbital) sleeping time in the Dutch rabbit. Comparisons will be made to recent findings in these areas due to MWs. The second phase of this work will be a study of EMP fields on an artificial biomembrane of known resistance, membrane potential and dielectric breakdown potential. These membrane properties will then be investigated as a function of the amplitude and pulse repetition rate of an applied EMP field. All exposures will be made using the EMP simulator at the Naval Weapons Laboratory, Dahlgren, Virginia. (7/74-6/75)

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

0166 COMPARISON OF THEORETICAL AND EXPERIMENTAL ABSORPTION OF RADIOFREQUENCY POWER. Durney, C. H.; Johnson, C. C. (Sch. Eng., Univ. Utah, Salt Lake City).

Recent data indicate that the biological hazard of nonionizing EMR is frequency dependent, and body shape, size, and orientation are important variables affecting power deposition and subsequent hazard. The USAF is advocating a frequency related safety standard approach. The objective of this study is to extend theoretical RF power absorption calculations and to perform experimental measurements which are necessary for assessing realistic personnel exposure criteria in the 10 kHz to 100 MHz frequency range. Assessment techniques will account for size and orientation effects in extrapolating from animal to human RF exposure situations. A set of prolate spheroid models will be constructed to represent the rhesus primate and human. Theoretical calculations will be made to determine the amount of power absorbed for exposures between 10 kHz and 100 MHz. Power absorption measurements will be performed from 10-30 MHz and the results compared with theory. Rhesus primates will be exposed in the same geometry as the phantoms to evaluate anisotropic effects. The resulting data will be used to establish appropriate personnel exposure guidelines for a broader frequency range than can be measured with available experimental apparatus. (7/74-6/75)

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

0167 ELECTROMAGNETIC RADIATION STUDY OF TECHNIQUES FOR THAWING FROZEN ORGANS. Ecker, H. A. (Georgia Inst. Technol., Atlanta).

The development of EMR techniques for thawing frozen

organs is a key feature in establishing a procedure for successful transplantations of organs obtained from a frozen organ bank. The success of EMR to thaw frozen organs rapidly and uniformly depends on several parameters: (1) radiation frequency; (2) radiation modulation; (3) applied power level; (4) organ size; (5) dielectric constant of the organ tissue; (6) loss tangent of organ tissue; (7) cryoprotectant drug level in the organ; (8) thermal state of the organ; and (9) doping of the organ with a recoverable material. (3/75-2/76)

Supporting Agency:NSF, Div. Eng.

0168 REMOTE STIMULATION BY RADIOFREQUENCY TRANSMISSION. Glenn, W. W. (Sch. Med., Yale Univ., New Haven, Conn.).

This project is part of a broader program to support the Clinical Research Center at the Yale-New Haven Hospital and Yale University School of Medicine. Clinical investigations are conducted to obtain a better understanding of the mechanisms of disease and therapeutic measures are developed or tested. (10/74-9/75)

Supporting Agency:HEW, PHS, NIH

0169 *MICROWAVE HEATING (HUMAN).* Guy, A. W. (Sch. Med., Univ. Washington, Seattle).

This project is part of a broader program of the Center for Bioengineering which represents a multidisciplinary research effort involving faculty and students from all the departments of engineering engaged in collaborative research with health scientists from many medical and dental disciplines. A comprehensive effort is directed toward transferring the fruits of biomedical engineering research and development to the health care delivery system. (10/74-9/75)

Supporting Agency:HEW, PHS, NIH

0170 DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF MICROWAVES (HUMAN). Guy, A. W. (Sch. Med., Univ. Washington, Seattle).

This project is part of a broader program briefly described in CR 0169, above. (10/74-9/75)

Supporting Agency:HEW, PHS, NIH

0171 NAVY ENVIRONMENT: LIQUID CRYSTAL FIBEROPTIC PROBES FOR MEASURING TEMPERATURE AND MICROWAVE FIELDS IN BIOLOGICAL MATERIALS. Johnson, C. C.; Durney, C. H. (Sch. Eng., Univ. Utah, Salt Lake City).

See CR 0088, Volume I(3), for description of this research. (Renewed 7/74-6/75)

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

0172 LABORATORY AND FIELD EVALUATIONS OF HEAT ENERGY TO CONTROL STORED-PRODUCT INSECTS. Kirkpatrick, R. L. (USDA, Stored Prod. Insects Res. Dev. Lab., Savannah, Ga.).

The objective of this study is to develop rapid sample and practical techniques in the laboratory and adapt these methods for field evaluations using heat, including IR and MW radiation, to control stored-product insects infesting grain or other stored commodities. Results of laboratory tests to determine the repellency, attractancy, effect on life history, behavioral responses, and dosage-mortality relationships of stored-product insects when exposed to different types of heat energy including that produced by IR or MW radiation will be evaluated in field tests. Research data obtained from these laboratory and field tests will be used to develop a practical and inexpensive commercial unit to control insects that infest stored commodities. (7/74-6/75)

Supporting Agency:USDA, Agric. Res. Serv.

0173 CONTRACTILE DEACTIVATION BY RAPID TEMPERATURE JUMPS. Lindley, B. D. (Sch. Med., Case Western Reserve Univ., Cleveland, Ohio).

Understanding of the kinetics of the processes controlling free intracellular calcium in intact muscle cells has been hindered by inability to achieve suitably rapid changes in membrane potential or intracellular concentration of chemical agents. Diffusion limitations are important in potassium and caffeine contractures of muscle bundles because of the interstitial space, in single fibers because of equilibration of the transverse tubules, and even in fibers free of sarcolemma because of the unstirred intracellular matrix. A MW temperature-jump system will be developed for the study of rapid-heating relaxation of single frog striated muscle cells. Digital averaging and repetitive pulsing will be used to increase resolution. This technique will be used in studying alterations of the calcium regulatory systems involved in excitation-contraction coupling in denervated muscle. It is also of great potential significance for the study of calcium regulation in heart muscle and secretory cells. (7/74-6/75)

Supporting Agency:Am. Heart Assoc.

0174 CLINICAL ASPECTS OF MICROWAVE EXPOSURE. Michaelson, S. M. (Sch. Med., Univ. Rochester, New York).

Evaluation of alterations in the functional status of the neuroendocrine system after exposure to MWs

and elucidation of threshold levels, cumulative effects, interaction with other stresses and environmental factors is the objective of this study. Mature rats will be exposed to MW irradiation in 3 different regimens: 100 mW/cm^2, 10 mW/cm^2, and 1 mW/cm^2 for 8 wk. Periodically throughout the exposure, body wt and temperature will be taken, and blood drawn. Gross behavioral observations will also be made. Thyroid function will be evaluated using T3 and T4 resin sponge absorption studies. Pituitary function will be determined by a bioassay of TSH. Mature dogs will be exposed to MW irradiation. Evaluation of changes in body wt, temperature, behavior, thyroid and pituitary function will also be carried out as with the rats. In addition, hematology, clinical chemistries, free T4, TSH and growth hormones by radioimmunoassay and serum electrophoresis will be studied. (7/74-6/75)

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

0175 INTRAVITREAL SURGERY TECHNIQUES. Peyman, G. A.; Vlchek, J.; Goldberg, M. F. (Sch. Med., Univ. Illinois, Chicago).

The objectives of this study involve four problems related to intravitreal surgery: (1) establishment of an effective means of prevention and treatment of intraocular infection; (2) establishment of the feasibility of coagulation of intravitreal neovascularization with a RF probe, including a comparison of its efficacy to that of the organ laser currently used in occlusion of intravitreal neovascularization; (3) establishment of the feasibility of vitrectomy with emphasis on the best time to perform such surgery, i.e., the early or late stage of vitreous hemorrhage; (4) establishment of the use of vitrectomy in tractional detachment of the retina. Objectives 1, 2, and 3 have been completed in the past 2 yr and objective 4 remains as a goal for the coming year. (1/75-12/75)

Supporting Agency:HEW, PHS, NIH

0176 AN INVESTIGATION OF THE EFFECT OF MICROWAVES ON ISOLATED NEURONS. Wachtel, H.; Joines, W. (Sch. Arts, Duke Univ., Durham, N. C.).

The objective of this study is to investigate the effect of MW irradiation on the neurons of the marine mollusk *Aplysia*. Special emphasis will be given to the pacemaker cells which exhibit regular firing patterns in the absence of external stimulation. A neuron from the abdominal ganglion of *Aplysia* is pined out in a small chamber which is inserted into a MW stripline. The neuronal activity is monitored with intracellular microelectrodes. Both incident and reflected power are recorded. Theoretical as well as experimental determination of the absorbed power are made. (7/74-6/75)

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

0177 CORRELATION OF ACOUSTIC AND BIOLOGIC PROPERTIES OF TISSUES. Ware, R.; Bhagat, P. K.; Lafferty, J.; Bradley, E. (VA Hosp., Lexington, Ky.).

The emphasis of this proposal is on determination of US acoustic properties of a representative group of tissues and measurement of acoustic differences correlating with different pathophysiologic conditions of tissue. To date, a study of the feasibility of a catheter tip imaging system suggests that US scanning offers more promise than IR or visible EM scanning, although continuous absorption/transmission measurements on dog blood throughout the entire IR spectrum out to 1 mm did show at least two regions of relative transparency. Future plans include completion of a laboratory measurement system, acquisition of acoustic and pathophysiologic data, compilation, analysis, and correlation of data; and application of basic information to practical medical instrumentation problems. (7/74-6/75)

Supporting Agency:VA

0178 RAPID MICROWAVE AND DIATHERMY THAWING OF FROZEN ORGAN GRAFTS MAINTAINED FOR TREATMENT OF BATTLE CASUALTIES. Denysyk, B.; Finch, E. (U.S. Navy Med. Res. Inst., Bethesda, Md.).

No descriptive information is available. (7/74-6/75)

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

0179 GENETIC AND CELLULAR EFFECT OF MICROWAVE RADIATION. Dutta, S. K.; Chakravorty, A.; Blackman, C.; Brusick, D. (Sch. Lib. Arts, Howard Univ., Washington, D.C.).

The proposed research is directed at using a fast and highly sensitive battery of genetic tests and simple tests on cell morphological changes in order to evaluate the effects of low intensity MW radiation critically. Since the non-thermal (less than 1 mW/cm^2) effects of MWs are difficult to distinguish from the thermal effects in large whole animal systems, their distinctions will be studied at the genetic level using systems well characterized for their thermal responses. Genetic alterations, such as gene-conversion, mutation and chromosomal deletion will be studied using repair-deficient his- mutants of *Salmonella typhimurium;* D-4 strain of *Saccharomyces cerevisiae;* ad 3A and ad 3B two-component heterokaryons; and excision repair-deficient mutants of *Neurospora crassa.* Gross morphological changes in development, using the filamentous fungus *N. crassa,* will be used to investigate chronic and delayed effects of CW and PW microwaves existing in our environment. Work will then be extended to study the alteration, if any, of repair processes by MW radiation using human fibroblast cultures. (7/74-6/75)

Supporting Agency:EPA, Off. Res. Dev.

0180 BIOLOGICAL EFFECTS OF AF RF TRANSMITTER FIELDS. Frazer, J. W.; Merritt, J. H. (U.S. Air Force Sch. Aerosp. Med., Brooks Air Force Base, San Antonio, Tex.).

Firm foundations for EM safety standards for DOD personnel and the general population affected by DOD radiators depend on: (1) precise knowledge of the magnitude of the RF insult; (2) the relationship between insults and responses of experimental animals to those of man, (3) the bases on which the insult, in this case internal distribution of EM fields, act; and (4) the magnitude of insult levels no longer producing a measurable response. The objective of this effort is to investigate the biological consequences of AF aircrew exposures to unique RF radiation environments and to extrapolate the empirical findings to adjust personnel exposure criteria. Responses of experimental animals to field modulations said to be at frequencies of brain theta rhythm have been reported. The present hypotheses of high field Kerr effects and low field thermal distribution as major factors in inducing responses to EMR fields are at variance with assumed processes producing such effects. Field modulation effects, including pulsed fields, on a variety of CNS ionic and chemical distributions will be examined. Lymphocyte responses will be studied as a function of field amplitude in intact animals while culture responses are examined. (7/74-6/75)

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

0181 COMPARISON OF RF FIELD DELIVERY TECHNIQUES AND MEASURABLE RESULTS IN CELL CULTURE AND WHOLE ANIMALS. Guy, A. W. (Sch. Med., Univ. Washington, Seattle).

High level national concern over adequacy of existing RF safety standards has highlighted the need to be able to define experimental exposure fields accurately, to insure intercomparability of power deposition and mechanism of injury studies, and to validate theoretical predictions with measured distributions in experimental animals. This effort will investigate ground plane and position effects on power absorption in several man models at the University of Washington and at USAFSAM/RA. This project is designed to intercompare field measurement techniques used at the University of Washington and those used at USAFSAM, together with comparison of theoretical and measured distributions in experimental animals exposed in both facilities. An exposure system will be designed and constructed for cell or tissue cultures when fields within the culture can be exactly specified, and the utility of the culture system will be demonstrated by exposing freshly isolated *prima te* lymphocytes with and without stimulating antigens. The University of Washington personnel are to bring thermographic equipment and field measurement devices to USAFSAM to compare their measurements with those at USAFSAM. Killed animal models and physical models are to be examined after exposure to a variety of frequencies at USAFSAM and the University of Washington including the HF band coax, near field synthesizer and the University of Washington resonant cavity, as well as provisional examination of the fields generated by the multiple frequency exposure apparatus at SAM. An exposure cell is to be constructed from readily available materials and its utility demonstrated by the exposure of freshly isolated lymphocytes to fields calculated for an equivalent field in man models exposed to a variety of field geometries. (7/74-6/75)

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

0182 ADVANCED BIOINSTRUMENTATION. Klein, H. P. (NASA, Moffett Field, Calif.).

The objective of this project is development of bioinstrumentation techniques to enable the measurement of biological, physiological and psychological responses of man and/or selected animal species to actual or simulated space flight conditions. Non-invasive, non-destructive testing procedures will be utilized for obtaining data wherever possible and feasible. Approaches will be directed towards development of instrumentation associated with measurement of central and peripheral cardiovascular function, bone mineral content, deep body physiological and physical functions, new and unique biochemical measurement techniques and methods of sample preservation. Among those developed will be techniques utilizing US and MW tranducers as means for obtaining information from the body surface. (7/74-6/75)

Supporting Agency:NASA

0183 EFFECT OF MICROWAVE RADIATION ON AUDITORY SYSTEM. Konishi, T.; McRee, D. I., Hamrick, P. E.; Cook, R. O.; Yankwich, A. (Natl. Inst. Environ. Health Sci., Durham, N. C.).

See CR 0078, Volume I(3), for description of this research. (Renewed 7/74-6/75)

Supporting Agency:HEW, PHS, NIH

0184 VARIABLE FREQUENCY MICROWAVE EXPOSURE SYSTEM. McRee, D. I. (Natl. Inst. Environ. Health Sci., Durham, N. C.).

See CR 0076, Volume I(3), for description of this research. (Renewed 7/74-6/75)

Supporting Agency:HEW, PHS, NIH

0185 MICROWAVE EXPOSURE SYSTEM AND MICROWAVE DOSIMETRY. McRee, D. I.; Walsh, P. J. (Natl. Inst. Environ. Health Sci., Durham, N. C.).

See CR 0077, Volume I(3), for description of this

research. (Renewed 7/74-6/75)

Supporting Agency:HEW, PHS, NIH

0186 MECHANISMS OF NEUROENDOCRINE RESPONSE TO ELECTROMAGNETIC RADIANT ENERGY. Michaelson, S. M. (Sch. Med., Univ. Rochester, N. Y.).

Investigations are related to elucidating the mechanisms of HHT response to ionizing and nonionizing EMR. Studies are performed in the rat and dog to relate sequential changes in thyroid and pituitary function to thyroid hyperplasia, hypoplasia, and carcinogenesis seen after x-irradiation or functional changes reported during MW exposure. This involves partial as well as whole body irradiation, consideration of species differences in the neuroendocrine system, and proper scaling of animal results to man. Radioimmunoassays of specific hormones are applied to the study of homeostasis, impairment of physiologic capacity, and structural and functional integrity of the neuroendocrine system to assess the body's adaptive capabilities and pathophysiologic sequelae in general as a consequence of exposure to EMR. Detailed sequential analysis of thyroid and pituitary function in the development of thyroid and pituitary neoplasms is performed. Evidence is sought to ascertain axial (HHT) imbalance which could be a reflection of the coincident finding of pituitary adenomas and goiter in rats irradiated in the head and neck (1300 R, 250 kVp x-rays). TRH is used to determine whether thyroid dysfunction is due to injury to the thyroid gland per se (primary) or is related to hypothalamic-hypophysical injury in localized head or thyroid x-irradiated dogs. The relationship between nonionizing EM heating of neuroendocrine components and resulting homeostatic shifts is also investigated. (7/74-6/75)

Supporting Agency:U.S. Energy Res. Dev. Adm.

0187 VENTILATION/BLOOD FLOW FUNCTION BY ELECTRO-IMPEDANCE. Nyboer, J.; Sedensky, J. A.; Thoms, N. (Sch. Med., Wayne State Univ., Detroit, Mich.).

The vascular and respiratory functions of the right and left lungs will be detected regionally by modulations of a transversely imposed RF field to the chest of normal and abnormal human subjects. It is proposed to classify the percentile disability of each lung or zone particularly in pre- and post-surgical conditions. An attempt will be made to arrive at ventilation-bloodflow indices and quotient for each lung. The impedance method of partitioning lung function is more practical and non-traumatic in comparison with obsolete bronchospirometry methods. Previous studies have found it comparable to dynamic Roentgen fluorodensitometric study of the lung. Our non-invasive electrical impedance research will define the functional effect of pneumothorax, infectious or traumatic pleuritis, pleural pericentesis, lobectomy, intrapulmonary or bronchial tumor, and other chest problems. The principal investigative tool is Z, R, X detection by an advanced electrical impedance plethysmograph. (7/74-6/75)

Supporting Agency:Am. Heart Assoc.

0188 EFFECTS OF AIR FORCE TRANSMITTER RADIATION FIELDS ON BRAIN FUNCTION. Polis, B. D. (U.S. Navy Air Dev. Cent., Warminster, Pa.).

This research is designed to determine effects of RF radiation from Air Force EM transmitters on mammalian brain functions. Data will be used to establish human exposure criteria, safety standards (AFM 161-7) and hazardous exclusion areas. It directly supports safety criteria for 4141 OTH radar. High turnover systems most likely to be affected will be studied. Companion efforts in-house and at the Southwest Texas Medical School are investigating other neurotransmitters and brain energy metabolism. The phosphatides of blood have been uniquely defined as stress indicators. A carotid/sagital sinus a/v difference has been shown and this difference is related to emotional states. Dogs are to be sacrificed with Nembutal anesthesia (30 mg/kg). Their brains will be removed and separated into mid-brain and anterior portions of cerebellum and medulla. Part of the tissues are utilized in-house to determine prostaglandin contents in another effort. Other parts are used for phosphatides studies. (7/74-6/75)

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

0189 EFFECTS OF MICROWAVE RADIATION AS FROM NAVY RADAR ON EMBRYONIC BRAIN TISSUE. Rioch, D. (Inst. Behav. Res., Silver Spring, Md.).

The general objective of this research is to determine whether there is a critical period (or periods) in the circadian rhythm of the rat fetus during which MW fields are effective in increasing the fetal growth, particularly the growth of the cerebral hemispheres. Holtzman (albino) rats which are pregnant will be exposed to 1700 MHz, 10 mW/cm^2 MWs from 1700-1800 hr on the 6th to 9th and 12th to 16th days of gestation. Additional rats will be similarly exposed overnight for 12-14 hr at 5 mW/cm^2. On the 20th day of gestation the rats will be sacrificed, fetuses weighed and brains removed and fixed in Bouin's solution. The gross form of the brains and their sizes will be studied under a dissection microscope. The brains will then be dehydrated and imbedded in paraffin for histological evaluations. (7/74-6/75)

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

0190 ULTRASOUND CINE ANGIOCARDIOGRAPHY. Waag, R. C.; Gramiak, R. (Sch. Eng., Univ. Rochester, N. Y.).

A program will be initiated whose ultimate goal is the production of ultrasonic cross-sectional images of the solid structures of the heart and the intracardiac blood flow patterns in a motion picture format. Existing ultrasonic equipment, a sophisticated computer-controlled data acquisition system, computing facilities and a novel coded pulse ultrasonic rheometer will be used. The preliminary steps to be initiated in this research are the development of gray scale imaging of cardiac and intracardiac echoes by point imaging in a matrix to provide maximal signal intensity at any given point. Also, a program will be generated, probably through the medium of special moving target indicator methods for the differential display of solid structures as well as the moving blood. The 3rd portion involves the application of concepts which appear useful for imaging intracardiac blood flow data. These will include computerized Fourier analysis of RF signals detected by a conventional pulse echo ultrasonoscope and the adaptation of a prototype coded pulse ultrasonic rheometer. The latter research will stress the development of a single transducer operating mode to replace the two transducer method now in operation. (7/74-6/75)

Supporting Agency:Am. Heart Assoc.

0191 ANGIOGRAPHIC DIAGNOSIS AND CONTROL OF GI BLEEDING. Baum, S.; Athanasoulis, C.; Waltman, A.; Malt, R.; Fischer, J.; Coggins, C.; Galdabini, J. (Massachusetts Gen. Hosp., Boston).

This project is designed to attempt to improve radiographic and catheterization techniques of the GI examination by the use of magnification angiography. In addition, nonthrombogenic catheter materials will be evaluated and methods of superselective catheterization will be attempted, and a simple radiographic method of assessing blood flow in the mesenteric circulation will be evaluated. Another specific aim during the next grant period will be to try to answer the question of how long infusions are necessary to satisfactorily control arterial and venous bleeding. We will also attempt to determine the effect on the liver of hepatic arterial infusion of vasopressin. Various mechanical means of controlling gastro-intestinal hemorrhage will also be evaluated, which will include intraarterial RF coagulation, balloon catheters and injectable silastic catheters. Attempts will also be made to determine whether the superior mesenteric artery infusion with vasopressin results in a redistribution of total blood flow so as to increase renal perfusion of patients with Type II hepatorenal syndrome. (5/75-4/76)

Supporting Agency:HEW, PHS, NIH

0192 NAVY ENVIRONMENT: EFFECTS OF MICROWAVES ON MATURATION IN THE RAT. Michaelson, S. (Sch. Med., Univ. Rochester, N. Y.).

Other research has shown that MWs effect the growth and development of the rat fetus when the exposure is properly placed during the gestational period. Brain growth appears to be most affected. This research will attempt to study how subsequent neonatal development and maturation of temperature regulation, which involves neural, hormonal and mutational facets, are modified by the in utero exposures. The development of the brain and ontogeny of temperature will be studied by exposing individual ratlets, previously exposed in utero, of specific ages to a mild cold stress (25-30 C) and measuring metabolism (O_2 consumption) and peripheral venous vasoconstriction. If a deficit appears, substrate, hormonal, or neural factors that may be responsible will be examined. Some animals will be decapitated for gross and microscopic examination of the brain. During the 2nd year, power density/time relationships will be developed on the basis of body surface. (7/74-6/75)

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

0193 MATERIALS SUPPORT TECHNOLOGY: MICROSTRUCTURE-DEPENDENT MECHANICAL PROPERTIES OF VIABLE CORTICAL BONE. Black, J. (Sch. Med., Univ. Pennsylvania, Philadelphia).

The static and dynamic properties of individual and groups of osteons excised from characterized cortical bone, including elastic moduli, fatigue behavior, and strength, are to be measured by a MW method under true physiological conditions. Stress-strain curves (tensile or compressive) will be determined for driving force frequencies between 0.01 and 100 Hz. Mineralization, collagen orientation, and bone character will be correlated with behavior of individual osteons. An extensive analysis will be made of literature reports of dynamic micromechanical properties of bone under various conditions: Deviations in behavior as a result of frequency, structural features, and viability will be emphasized. Analytical calculations of osteons as 2 phase bodies under constant strain in the load axis will be made to determine their contribution to the micromechanical behavior of cortical bone. (7/73-6/74)

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

0194 BEHAVIORAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION ON STORED-PRODUCT INSECTS. Bruce, W. A. (U. S. Dep. Agric., Savannah, Ga.).

The objectives of this project are to determine the EM frequencies to control and/or alter insect behavior and to provide working models, based on insect physiology, morphology and behavior, by which economical, nonchemical control might be accomplished. Insects will be exposed to various frequencies and intensities to determine response, thresholds, and probable locations of sensory receptors. Precise receptor location will be accomplished electrophysiologically. Because of the increased power and wavelength penetrability of laser-produced IR radiation, IR spectrum studies will be run. These will utilize

frequencies produced by gas lasers to determine feasibility of using laser technology and techniques for behavioral work involving insect detection of and attraction/repulsion to these frequencies. The principle of differential absorption of laser-produced frequencies between commodity and insect will be utilized for possible detection and control of the infestation within the commodity. (7/74-6/75)

Supporting Agency:USDA

0195 QUANTITATIVE EFFECTS OF EM ENERGY ON HUMAN TISSUES. Guy, A. W.; Lovely, R. H.; Lehmann, J. F.; Galambos, R. (Sch. Med., Univ. Washington, Seattle).

See CR 0008 and CR 0036, Volume I(1) and CR 0068, Volume I(2), for previous descriptions of this research. Work will be continued on the improvement of dosimetric and exposure techniques in the 100 MHz-10 GHz frequency range, including small animal, *in vitro*, partial human body and whole human body exposures. In addition, work on the circular waveguide that uses circular polarized TE11 mode for chronic exposure of small animals and illumination of *in vitro* cell culture preparations will be completed. The high power exposure system will also be completed and calibrated for exposing both full scale and phantom models of animals and scaled models of man, in order to quantify MW coupling characteristics to various subjects over a wide frequency band. Once absorption characteristics are determined for the models, birds will be irradiated as described in the overall proposal, in order to show the relationship effects as a function of body size and frequency. Research on the evaluation of various diathermy applicators, with the aim of providing more efficient coupling between a given laboratory generator and a region of the biological system where deposited energy is desired, will be continued. In this regard, applicators will be developed for improving energy transfer to the CNS or the head of an animal so that studies relating pulsed MW fields and auditory hearing phenomenon may be conducted at the neurophysiological level of analysis. Specifically, the frequency range at which pulsed MWs are heard and the nature or mechanics of the transducer for the hearing of pulsed MWs will be investigated. Finally, a major effort will be made in the coming year to evaluate power absorption patterns in human tissues exposed to current diathermy apparatus, and to relate these findings to current safety standards for human exposure. (Renewed 6/75-5/76)

Supporting Agency:HEW, PHS, FDA

0196 EFFECTS OF 2450 MHz MICROWAVE RADIATION ON BIOLOGICAL MATERIAL AT CELLULAR LEVEL. Hamrick, P. E.; Zinkl, J. (HEW, PHS, NIH, Durham, N. C.).

See CR 0074, Volume I(3), for description of this research. (Renewed 7/74-6/75)

Supporting Agency:HEW, PHS, NIH

0197 EFFECTS OF 2450 MHz CW MICROWAVE RADIATION ON THE EMBRYONIC DEVELOPMENT OF JAPANESE QUAIL. Hamrick, P. E.; McRee, D. I.; Zinkl, J.; Thaxton, P.; Parkhurst, C. (HEW, PHS, NIH, Durham, N. C.).

See CR 0075, Volume I(3), for description of this research. (Renewed 7/74-6/75)

Supporting Agency:HEW, PHS, NIH

0198 BIOPSYCHOLOGICAL STUDIES OF MICROWAVE IRRADIATION. Justesen, D. R. (Sch. Med., Univ. Kansas, Kansas City).

See CR 0001, Volume I(1) and CR 0065, Volume I(2) for previous descriptions of this research. Microbial organisms, mice, rats, guinea pigs, and rabbits have been exposed to intense fields of 2450 MHz MW energy in the multi-mode cavity in studies of ultrastructural, teratological, thermal, behavioral, and growth responses to radiation. At rates of dosing exceeding 40 mW/g and durations of radiation of many hours, there are reliable differences in parameters of growth and in ultrastructure of microbial (bacterial and fungal) organisms as compared to conventionally thermalized controls. At rates of dosing below 40 mW/g and durations less than 25 min, radiated mammals seldom differed reliably from nonradiated controls except for the observation that fetal radiation improved survival of mice treated in utero with a teratogenic agent. (Renewed 6/75-5/76)

Supporting Agency:HEW, PHS, FDA

0199 NAVY ENVIRONMENT - BIOMEDICAL EFFECTS OF RADIOFREQUENCY RADIATION. Lin, J. C.; Kraus, G. E. (Sch. Eng., Wayne State Univ., Detroit, Mich.).

The Navy is attempting to establish a sound basis for exposure standards. This research will be a part of the effort to determine the potential for hazard in the 50-300 MHz frequency range. This study will investigate the effect of RF radiation on the growth, reproduction and pathology of mice. The mice will be exposed, both acutely and chronically, in a parallel strip transmission chamber where plane wave fields with variable E/H ratios can be produced. Temperature distribution and patterns will be established. Phantom models of both mice and man will be used to establish correlations. (7/74-6/75)

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

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