

BIOELECTROMAGNETICS SOCIETY NEWSLETTER

Number 58
April 1985

SEVENTH ANNUAL MEETING BIOELECTROMAGNETICS SOCIETY SCHEDULE OF EVENTS

SCIENTIFIC SESSIONS

SUNDAY, June 16, 1985

1800-2000 Registration
1800-1930 Welcome Reception
1930-2000 Welcome and Announcements--Plenary Session
2000-2200 Session A Workshop: Microwave Interaction with DNA

MONDAY, June 17, 1985

0830-1600 Registration
* 0800-0900 Tutorial Lecture: Biological Effects and NMR Imaging. T. F. Budinger
0900-1240 Session B. Behavior/Thermoregulation
* 0900-1240 Session C. Effects of Weak Electric and Magnetic Fields
* 0900-1220 Session D. Safety Standards and Dielectric Properties
1400-1740 Session E. Effects of 50/60 Hz Electric and Magnetic Fields
1400-1720 Session F. Cellular and SubCellular Effects

1400-1720 Session G. Instrumentation and Exposure Systems

TUESDAY, June 18, 1985

* 0800-0900 Tutorial Lecture: Basic Concepts in Applying Hyperthermia to Cancer Therapy. W. Dewey
0900-1240 Session H. Medical Applications
0900-1220 Session I. Mechanisms of Interaction.
1400-1730 Session J. Posters

WEDNESDAY, June 19, 1985

0820-1220 Session K. Biological Studies

0820-1220 Session L. Dosimetry

1230-1430 Awards Luncheon

1445-1545 Annual Business Meeting

1545-1715 Informal Discussions

1730-2230 Social Event/Boat Trip

THURSDAY, June 20, 1985

0800-0900 Tutorial Lecture: Diagnostic Capabilities of Microwave Radiometry. K. Carr

0900-1220 Session M. Exposure Assessment

0900-1220 Joint Bioelectrochemical Society/Bioelectromagnetics Society Symposium. Bioelectrochemical Approaches to the Study and Manipulation of Membrane Cell and Phenomenon

1400-1800 Tour: Lawrence Berkeley Laboratory Radiation Facility

COMMITTEE MEETINGS

SUNDAY, June 16, 1985

0900-1800 BEMS Board Meeting

TUESDAY, June 18, 1985

0700-0900 BEMS Editorial Board Breakfast

1830-2230 Dinner Meeting of the IEEE COMAR *

THURSDAY, June 20, 1985

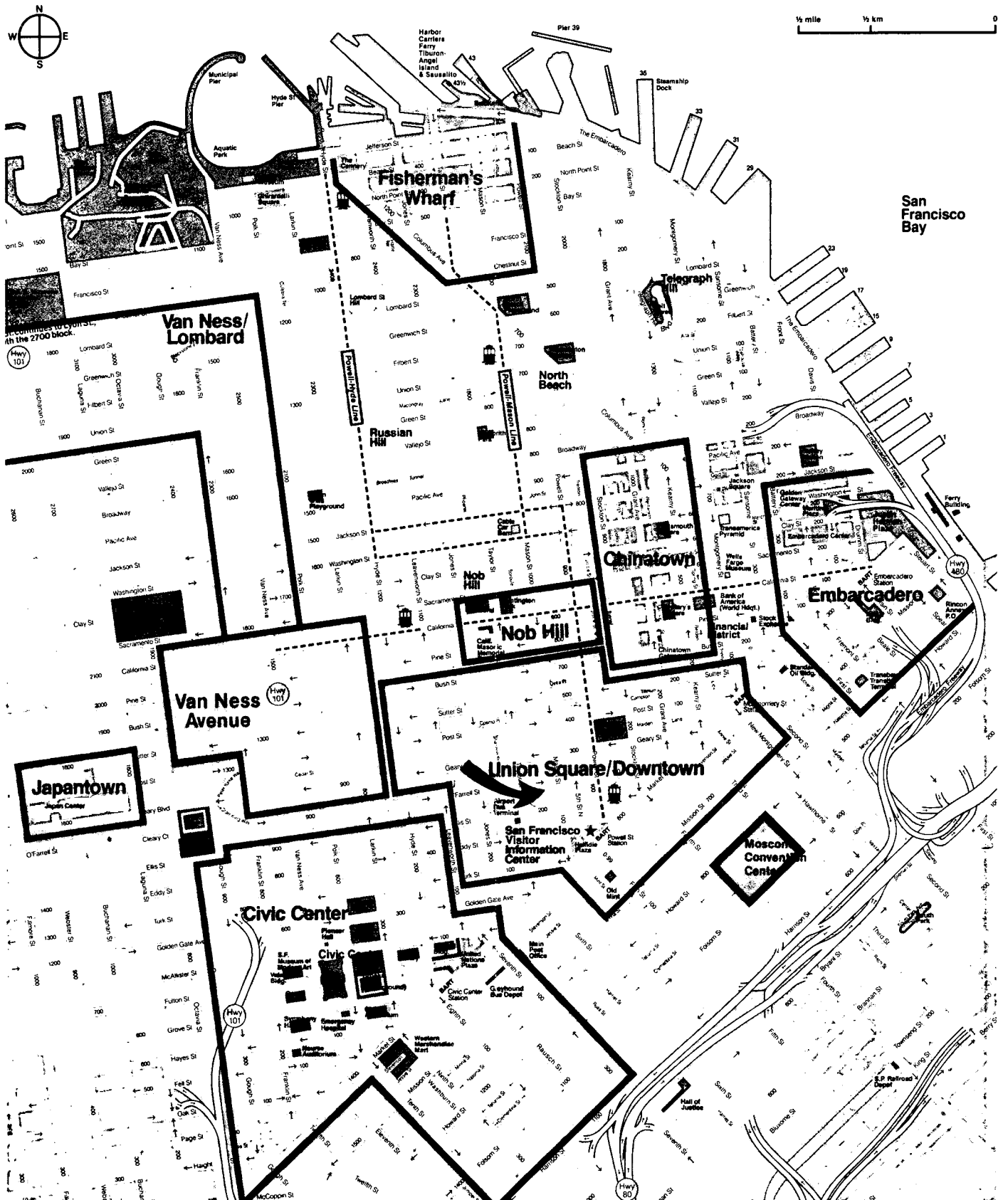
1230-1430 BEMS Board Luncheon Meeting

1430-1630 Meeting of ANSI Subcommittees *

FRIDAY, June 21, 1985

0830-1600 National Council on Radiation Protection and Measurements

BEMS 85: SAN FRANCISCO CITY MAP



CLEARY AND STUCHLY VIE FOR PRESIDENT

The nominating Committee has announced the slate of candidates for Officers and Board Members, and ballots have been mailed to all members eligible to vote. The slate this year is headed by Stephen Cleary and Maria Stuchley who are competing for the office of Vice-President/President-Elect. Cleary is Professor of Biophysics at the Medical College of Virginia in Richmond and Maria Stuchly is with the Radiation Protection Bureau, Health and Welfare, Ottawa, Ontario, Canada.

The entire field of candidates is shown below. All members are urged to cast their ballots early. Space is provided on the ballot for write-in candidates.

SAMPLE BALLOT FOR 1985 BEMS ELECTION

VICE PRESIDENT (PRESIDENT ELECT)

Vote for One

STEPHEN CLEARY
MARIA STUCHLY

SECRETARY/TREASURER

Vote for One

JOHN ALLIS
CHARLES POLK

BOARD (ENGINEERING/PHYSICAL SCIENCES)

Vote for One

STEWART ALLEN
MICHAEL MARRON

BOARD (BIOLOGICAL/MEDICAL)

Vote for Two

PRZEMYSAW CZERSKI
RICHARD LOVELY
CARL SUTTON
SHIRO TAKASHIMA

BOARD (AT LARGE)

Vote for One

JAMES BOND
CAESAR ROMERO-SIERRA

Joseph L. Kirschvink, a geobiologist at the California Institute of Technology in Pasadena, and co-workers correlated a Smithsonian Institution map of 212 beaching events along the eastern United States with a map of the magnetic landscape of that area made by the U.S. Geological Survey. The researchers found that the strandings tended to occur at magnetic lows, or minima - regions where the earth's magnetic field is locally diminished by the opposing field in rocks that solidified when the earth's field reversed direction.

The magnetic lows on the coastline lie at the ends of a number of long, continuous channels of magnetic minima that mark the ocean floor. Kirschvink believes that the whales and dolphins were tracking these magnetic "lowways" when there were stranded. He does not know, however, why the animals approaching the continents "didn't see the stop sign." Ocean currents, temperature and topography are not correlated with beaching sites. And even whales that use sonar have been stranded, although less often.

According to Kirschvink, who presented the group's findings in San Francisco at the recent meeting of the American Geophysical Union, the difference between the magnetic minima and maxima is at most 4 percent of the background magnetic field strength, and directional variations of the field are too small to be measured with a compass. Therefore, whatever mechanism the whales and dolphins have to detect the magnetic lowways must be extremely sensitive, he says. In both types of animals, as in their insect, bird and fish cousins, a strongly magnetic iron-oxide compound called magnetite has been found. But its distribution within the bodies of whales and dolphins is too widespread for researchers to pinpoint a specific magnetic sensory organ.

Kirschvink has recently obtained a new set of observations of whales and dolphins in the open sea, not just at the coast. Here, too, he says, most species appear to stay away from magnetic highs in favor of lows. One reason for this may be that lows are easier to track over large distances, since they are more continuous and far reaching than high regions, which are often formed by discrete clusters of seamounts. However, when whales are not migrating, Kirschvink suspects - and has found with one species - that they tend to stay around highs as a kind of anchor point.

Since many of the regions that are now highs may have been lows when the earth's magnetic field reversed in the past, Kirschvink hopes to fortify his results by finding corresponding changes in the fossil record of strandings along the coast.

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OF WHALES AND DOLPHINS AND H FIELDS

The beaching of whales and dolphins is a tragic mystery. But records of the strandings are yielding clues about the paths these animals take when they migrate. In particular, the beachings indicate that whales and dolphins, like bacteria, bees, fish and birds ... use the earth's magnetic field to navigate.

DUTCH SURVEY OF RF EQUIPMENT

The Laboratory of Electronic Developments for the Armed Forces in The Netherlands recently conducted a survey of radio-frequency (RF) generating equipment in the country. The survey was commissioned by the Ministry of Health and Environmental Hygiene and included most of the civil RF sources in the frequency band from 0.5 MHz to 18 GHz. In addition to doing an inventory of the range of transmitters, the project had as its objective the development of a computer model that will be capable of predicting the RF environment from a knowledge of certain of the parameters of the transmitter.

In a recent visit to the laboratory, an institute of The Netherlands Organization for Applied Scientific Research (TNO), I learned that this project was carried out by a military institute for a civilian agency because no agency within the civilian part of the government has the expertise needed for such a survey. It was interesting that no consideration was given to military sources of RF energy. There is no legal standard in The Netherlands for human exposure to electromagnetic energy, although the American National Standards Institute standard is highly regarded and generally followed by anyone wishing to use some sort of guideline. The military, however, seems a bit isolated from such considerations, and apparently no guidelines are actually followed by military operators--except for keeping exposures as low as possible. This probably works quite well given the size and complexity of the military force in The Netherlands.

Approach to Study

The project team did not set out to survey every installation that had RF-generating equipment as this would have been impossible in the time allotted. Instead, a representative sampling was made and, using literature sources about industries, the team was able to extrapolate data for the whole of The Netherlands. Several classes of generators were evaluated in the laboratory as well as being measured on location and in actual use. Three types of medical diathermy equipment were studied: shortwave (27.12 MHz), UHF (433.92 MHz), and microwave (2450 MHz). RF heaters and sealers--such as those used for sealing plastic materials, gluing wood, and drying potato chips--were evaluated at in-plant locations.

The computer program developed under the project was designed so that it will roughly predict the RF-environment around different types of emitters using the transmitter parameters. Different approaches are used to calculate the power flux density (PFD), depending on the completeness of the input data. For instance, if the illumination of an aperture antenna is unknown,

the program uses other parameters to estimate the illumination (such as the dimensions of the aperture and the beamwidth). In addition, the program can manipulate data, such as updating the data bank and ranking the transmitters. Finally, it can plot different graphical presentations such as:

- PFD as a function of distance of one transmitter.
- Maximum PFD as a function of frequency of a selected subset of transmitters.
- Geographical view of transmitter locations.
- Some form of statistical information, such as the number of transmitters and the distances at which their PFDs exceed a definite value.

Study Results

A crucial part of the survey was the measurement of actual fields that existed in the environment around several types of equipment. These measurements were done in industries using RF energy for such tasks as sealing plastics, and in medical situations for which diathermy is used. This was the beginning of data collection to verify the computer model. Three different types of sealing machines were measured at two different plants. Field intensities were measured in the vicinity of the operator positioned in the normal operating position.

Figure 1 shows the results obtained for all of the sealing machines measured. It is interesting to note that approximately 14 percent of all values are higher than 10 mW/cm², and roughly 56 percent are higher than 1 mW/cm². Some types of machines are worse than others, with the turntable machine giving, for example, 78 percent of the measurements in its vicinity above 1 mW/cm². (All values were corrected for duty cycle, i.e., the sum of the time period when the power is "on" and "off".) When the extreme exposure levels were examined, it was found that this was about the same for all three types of machines (around 30 mW/cm²), but the part of the body exposed at the maximum level was different. In the case of the "sewing" type, the knees received the maximum, while it was the head for the "shuttle tray" machines and the waist for the "turntable" type (Figure 2).

Although the sample size was too small to draw conclusions concerning all types of sealers, the project team did draw some general conclusions:

- The exposure levels are fairly high.
- Peak levels are two to 10 times higher depending on the duty cycle; the maximum peak level found was 300 mW/cm².
- Levels can be reduced by shielding; a shielding effectiveness of more than 20 dB was measured.

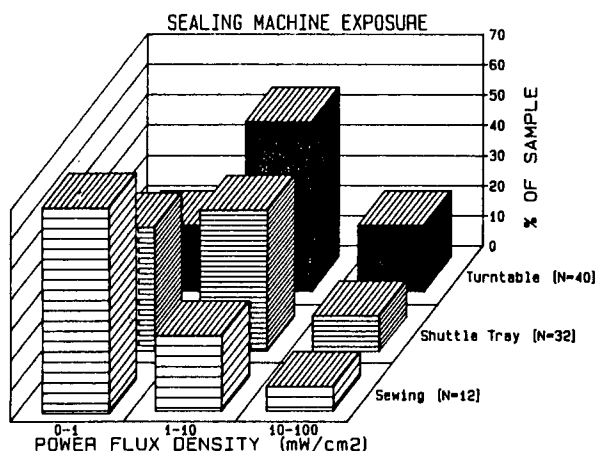


Figure 1. Exposure results for sealing machines.

Measurements of medical diathermy units were carried out in two parts. First, measurements were made of some units in the laboratory using a probe mounted on a mechanical positioner that could be moved in all three directions in front of the diathermy unit. A series of scans was thus made in the X-Z plane at different distances Y from the applicator. From these scans it was possible to get an impression of the spatial distribution of the PFD around the diathermy applicator. This is, of course, without benefit of a patient in place.

To obtain a reasonable picture of the RF levels to which operators of diathermy machines might be exposed, the team went to four different training centers where physiotherapists were trained in the use of the devices. During treatment sessions the team measured the PFD at a number of positions close to the units and close to the patients. Normally, the power setting used was one that produced a slight sensation of heat in the patient.

Although the PFD levels were at the position of the treated body parts, it was found that all values in positions where the operator might be --or at untreated parts of the patient's body-- were generally less than 10 mW/cm².

Concluding Remarks

This type of survey and computer modeling project is unique in that it was carried out by a military laboratory for a civilian agency. It is also the first time, to my knowledge, that an attempt has been made to develop a computer program that can predict PFD around an RF radiator used in industrial and medical environments. Surveys have been made on board ships and around commercial broadcasting antennas by various groups in the US and other countries. An approach like that used by the TNO group might have application to the problem of predicting levels of

Sealer type	No. units	Part of body max exposed	Exposure level (mW/cm ²)	
			min	max
Sewing	3	Knees	<0.2	26.4
Shuttle Tray	5	Head	0.2	30
Turn-table	5	Waist	0.2	29.7

Figure 2. Exposure levels by type of machine

exposure to US Navy personnel on the decks of ships, particularly in the multifrequency environment, where it is often difficult to integrate the PFD due to transmitters operating at several different frequencies.

Thomas C. Rozzell
ONR-London

BEMS 85: SAN FRANCISCO BAY BOAT TRIP

This year's social event provides an interesting approach to enjoying informal discussions with BEMS colleagues! The event is a boat trip in the San Francisco Bay. Bus transportation will leave the hotel at 5:30 p.m., Wednesday, June 19. The cruise will depart from Pier 41 at 6:30 p.m. and return four hours later. The cruise will consist of a buffet, music and a cash bar. Space is limited. Reserve early on your pre-registration form. First come, first served.

The BIOELECTROMAGNETICS Society Newsletter is published approximately ten times per year and distributed to all members of the Society. Information regarding the Society may be obtained by writing the Society Headquarters at 1 Bank Street, Gaithersburg, MD 20878. Institutions and libraries may subscribe to the Newsletter at an annual cost of \$35 (\$45 for overseas subscriptions).

The Newsletter serves the membership and subscribers in part as a forum for the presentation and discussion of ideas and issues related to bioelectromagnetics research. It is intended that ideas and issues will be presented on which a consensus has not been reached. Accordingly, all submissions to the Newsletter are signed and reflect the individual views of the authors and not official points of view of the Society or of the institutions with which the authors are affiliated. The Society solicits contributions to the Newsletter from its members and others in the scientific community. News items as well as short research notes and book reviews are welcome. Submit items for consideration for publication to Michael Marron, Editor BEMS Newsletter, P. O. Box 3651, Arlington, VA 22203.

BOOK REVIEW

THE MICROWAVE DEBATE. Nicholas Steneck, Professor of History, University of Michigan, MIT Press, 1984.

Professor Steneck, a member of the Department of History at the University of Michigan, has an interest in "values in science." In general, the book presents some excellent principles and guidelines for the media to follow when discussing scientific developments for popular consumption. In particular, he has chosen electromagnetic radiation, more specifically the standard setting procedures, as his focus, and has written and lectured on this subject. His thesis is that standard setting (permissible levels of power density of electromagnetic radiation for human exposure) should be turned over to the social scientists, the public, and historians.

In his discussion of Mass Media and the Public, he writes that the press has a responsibility to get the facts straight and provide enough background to allow independent judgment. However, the author fails to follow his own advice. In some instances the Steneck text (1) has factual errors, (2) fails to present equally, divergent points of view, (3) misidentifies people, and (4) contains unsubstantiated anecdotal material. The author's repeated broad condemnation of expert testimony and of scientists as self-seeking and even venal, casts doubt on the validity of his judgment. While there may be isolated instances of venal actions in any walk of life, to generalize and stigmatize the entire scientific community is an overreaction. To support his thesis, Steneck uses examples such as the HBO application for permission to build a satellite up-link in Rockway, NJ, and the Soviet radiation of the US Chancery in Moscow.

The book could have benefited by an explanation of some simple facts about public exposure. Nowhere in the book does one see a differentiation between the various types of exposures, i.e., whole-body vs. partial-body or near field and far field. Bioeffects, for which standards are designed, depend on the type of exposure as well as frequency and power density. While Steneck does mention that EPA measured exposures of up to 100 to 200 microwatts/cm², he does not say that over 90% of the general public receive less than 1 microwatt/cm².

Herbert Pollack, MD, PhD
Washington, DC

CLONES ARE PEOPLE TWO

SPECIAL IEEE ISSUE ON HYPERTHERMIA

The IEEE Transactions on Microwave Theory and Techniques is planning to publish a Special Issue on Phased Arrays for Hyperthermia Treatment of Cancer in May, 1986. Papers are solicited which describe original work concerned with theoretical, experimental and clinical methods and techniques for improved heating of superficial, accessible and deep-seated tumors. Special emphasis will be placed on state-of-the-art phased array systems and on new technology for the next generation systems. Topics of interest include but are not limited to the following areas: noninvasive ultrasound, RF and microwave techniques; interstitial and implanted arrays; antennas in lossy media; array components and elements; optimal architectures and configurations; control strategy and excitation schemes; thermal field mapping; and numerical techniques

Authors are requested to submit four copies of the manuscript by October 1, 1985 to guest editors:

Professor James C. Lin
Department of Bioengineering
University of Illinois at Chicago
Box 4348
Chicago, IL 60680
Phone: (312)-996-2331

IN CASE YOU MISSED IT . . .

****The Body Electric: Electromagnetism and The Foundation of Life,**** by Robert O. Becker and Gary Selden has recently been published by William Morrow and Company, 105 Madison Avenue, New York, NY 10016, 364 pages, \$17.95.

****On September 10, 1984, Dr. J.A. D'Andrea,** assumed the position of Chief, Behavioral Assessment Division, Bioenvironmental Sciences Department, at the Naval Aerospace Medical Research Laboratory in Pensacola, Florida.

****In the January 1985 issue of Esquire,** the magazine's editors present one of the Dubious Achievement Awards for 1984 to Professor Leonard Taylor of the University of Maryland for developing a way of shucking oysters with microwaves.

****James D. Bond and Carol A. Jordan** have received Science Applications International Corporation's (SAIC) 1984 award for the best peer-reviewed publication in the area of Chemical/Biological/Health Sciences. The paper, "Electrostatic Influences on Electromagnetically Induced Calcium Ion Displacement from Cell Surfaces," was published in Bioelectrochemistry and Bioenergetics, 1984. The award was received at a ceremony on January 29, 1985.

****Electricity and Medicine, History of Their Interaction**, by Margaret Rowbottom and Charles Susskind, has been published by the San Francisco Press, Box 6800, San Francisco, CA 94101, (415) 524-1000.

****Omni's** science writer Kathleen McAuliffe has written an article, "The Mind Fields," in the February 1985 issue of *Omni*. McAuliffe describes her visit to Dr. Delgado's lab in Spain, and then touches on the work of various international investigators of electromagnetic fields from a scientific, medical and political point of view.

****Dr. Stuart Lindsay** has been awarded a two-year, \$66,811 contract from the EPA to investigate observed resonances in DNA at 600 MHz. Lindsay is a physicist at Arizona State University at Tempe.

****The FDA** has approved a shock wave device the "lithotripter," for the treatment of kidney stones. The device, which pulverizes the stones so that they can then pass through urine, was developed by Dornier System of West Germany.

****A new quarterly journal, International Journal of Hyperthermia**, will begin publication in 1985. It will cover biological and clinical studies, as well as techniques for delivering heat and measuring temperature. This is the official journal of the North American Hyperthermia Group, the European Cooperative Hyperthermia Society and the Japanese Hyperthermia Society. For subscriptions or sample copies, contact Taylor and Francis, Inc., 242 Cherry St., Philadelphia, PA 19106, (215) 238-0939.

MEETINGS

FIFTH ANNUAL MEETING OF THE BIOELECTRICAL REPAIR AND GROWTH SOCIETY: October 13-17, 1985, Boston, Massachusetts. The Bioelectrical Repair and Growth Society is an international, multidisciplinary research organization including clinicians, biological scientists, physical scientists and engineers interested in the study and application of electric fields and currents in relation to the repair and growth of biological systems. Both natural and externally-applied signals are considered.

Contributions to the fifth annual meeting are welcome from all areas of basic and applied research, engineering development, and clinical application. All oral sessions will be plenary, as one of the Society's goals is to share information among the several disciplines represented. Extensive use will be made of poster sessions. Abstract forms and instructions can be obtained from and should be returned to the address indicated. The deadline for abstracts is May 15, 1985.

The meeting will be organized around major research topics, including but not limited to the following: arthritis, osteoporosis, calcium metabolism, demineralization in space travel, Wolff's law, streaming potentials and currents, soft tissue healing, implantable piezoelectric devices, capacitive coupling, induced currents, thermal effects, regeneration, cell membranes, DNA synthesis, chromosomes, cell-free systems, systemic effects, and advances in clinical procedures in orthopedics.

Send abstracts to: Professor Wendell Williams, Program Chairman, c/o BRAGS, P.O. Box 64, Dresher, PA 19025 U.S.A.

WORKSHOP

INTERNATIONAL MICROWAVE SYMPOSIUM: WORKSHOP ON PHASED ARRAYS FOR HYPERTHERMIA TREATMENT OF CANCER: June 3, 1985, St. Louis, Missouri. Hyperthermia has been shown to be effective in treatment of cancer, especially when combined with chemo- and radiotherapy. Its use in combating deep-seated tumors has been restricted by problems associated with noninvasive heating of deep tumors. Recent calculations and experimental measurements indicate that with proper choice of source and applicator parameters, it is feasible to produce therapeutic heating of tumors of different volumes in a variety of anatomic sites.

Discussants at the workshop will include: Gilbert H. Nussbaum, Washington University, St. Louis, "An Overview of Tumor Heating in Clinical Applications of Hyperthermia;" Michael D. Sapochnik, University of Utah, "Clinical Results of Regional Hyperthermia with an Annular Phased Array;" Paul F. Turner, BSD Medical Corporation, Salt Lake City, "Annular Phased Arrays, Principles and Techniques;" E. Gross, P. Stauffer and T. Cetas, University of Arizona, "Phased Array Microwave Heating at 915 MHz;" Yoshio Nikawa and Shingaka Mori, Keio University, Japan, "Deep and Localized Heating Techniques for Hyperthermia by EM Field Converging Applicators;" Frederic R. Morganthaler and Carey M. Rappaport, Massachusetts Institute of Technology, "EM-Induced Hyperthermia with Controllable Leaky Wave Arrays;" W. Gee, S.W. Lee, R.L. Magin, and E.C. Burdette, Lockheed Missiles and Space Company, Sunnyvale, "Focusing Phased Arrays for Microwave-Induced Hyperthermia Applicator;" L.A. Frizzell, P.J. Beukeser, K.B. Ocheltree, and C.A. Cain, University of Illinois, Urbana, "Ultrasonic Phased Array Applicator for Hyperthermia;" and Everette C. Burdette, URI THERM-X, Inc. Champaign, IL, "Interactive and Adaptive Phased Array Microwave and Ultrasound Hyperthermia System."

See **Calendar** for workshop point of contact.

CALENDAR

May 15-18: First Annual Meeting of the Electromagnetic Energy Policy Alliance, Inter-Continental Hotel, San Diego, CA. Contact: Richard Ekfelt, EEPa, 1800 M St., NW, Washington, DC 20036, (202) 452-1070.

June 3-7: International Microwave Symposium, St. Louis, Missouri. Sponsored by the Microwave Theory and Techniques Society of the IEEE. Contact: James C. Lin, University of Illinois at Chicago, Box 4348, Chicago, IL 60680, (312) 996-2331.

June 16-20: Seventh Annual Bioelectromagnetics Society Meeting, San Francisco Hilton Hotel, San Francisco, CA. Contact: BEMS Headquarters, Suite 307, Gaithersburg, MD 20878, (301) 948-5530.

June 17-21: 1985 North American Radio Science Meeting and International IEEE/AP-S Symposium, University of British Columbia, Vancouver, B.C., Canada. Contact: K. Charbonneau, Conference Services, National Research Council, Montreal Rd., M-58, Ottawa, Ontario, Canada K1A 0R6, or Coordinator: Dr. E. V. Jull, Dept. of Electrical Engineering, University of British Columbia, Vancouver, B.C. V6T 1W5 (604) 228-3282.

June 24-29: Eighth International Symposium on Bioelectrochemistry and Bioenergetics, Bologna, Italy. Contact: C. Bonfiglioli, c/o Institute of Botany, Via Irnerio 42, 40126 Bologna, Italy, Tel. 051-234376.

August 11-16: XIV International Conference on Medical and Biological Engineering/VII International Conference on Medical Physics, Espoo (Helsinki) Finland. Preconference Teaching Course on Bioelectric and Biomagnetic Phenomena; Conference theme planned on Biomagnetism. Contact: XIV ICMBE/VII ICMF, Secretariat, P.O. Box 105, 00251 Helsinki, Finland.

August 26-30: International Conference on Magnetism 1985, San Francisco, CA. Contact: Diane Suiters, Suite 300, 655 15th St., NW, Washington, DC 20005.

September 9-12: 15th European Microwave Conference, Palais des Congres, Paris, France. In cooperation with SEE, EUREL, IMPI, IEEE and URSI. It is planned to have a biological applications workshop on Sept. 13. Contact: Prof. M.Y. Bernard, 15th European Microwave Conference, c/o GIEL, 11 Rue Hamelin, F-75783 Paris, Cedex 16, France.

September 27-30: Engineering in Medicine and Biology—Frontiers of Engineering and Computing in Health Care, Chicago. Sponsored by IEEE. Technical program inquiries should be directed to: Prof. James C. Lin, Chairman, Dept. of Bioengineering, Univ. of Illinois, Chicago, IL 60680, (312) 996-2335.

October 13-17: Fifth Annual Meeting of the Bioelectrical Repair and Growth Society (BRAGS), Boston, MA. Abstract deadline, May 15. Contact: Prof. W. Williams, Program Chairman, c/o BRAGS, P.O. Box 64, Dresher, PA 19025.

December 4-5: International Conference on Electric and Magnetic Fields in Medicine and Biology, London, England. Contact: Secretariat, Conference Services, The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, UK, Tel. 01-240-1871, Ext. 222.

December 9-13: The Tenth International Conference on Infrared and Millimeter Waves, Americana Dutch Resort Hotel, Lake Buena Vista, FL 32830. Contact: Kenneth Button, MIT, Box 72, MIT Branch, Cambridge, MA 02139-0901.

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